Santa Barbara Metropolitan Transit District

Response to RFP for
AVL & ITS Management Systems (AIM)

December 4, 2013

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1 Cover Letter

December 4, 2013

Mr. Bradley P. Davis
Assistant Controller
Santa Barbara Metropolitan Transit District
550 Olive Street
Santa Barbara, CA 93101

RE: Request for Proposals for AVL & ITS Management Systems (AIM)

Dear Mr. Davis:

Clever Devices is pleased to present our best-value, state-of-the-art solution for the Santa Barbara Metropolitan Transit District (MTD) AVL & ITS Management Systems (AIM). With our robust integration capabilities and world-class intelligent transportation solutions, Clever Devices is uniquely qualified to help you achieve and exceed your goals in this solicitation. As detailed in our response, our proven integration and deployment methods will ensure that this implementation is completed successfully and efficiently. Further, we will be at your side every step of the way, laying the foundation for MTD to reap the benefits of this project for years to come.

We are confident that by choosing Clever Devices you will minimize your inherent project risk, not only because we have world-class products that are proven throughout North America in transit agencies similar in size and scope to MTD, but because we have a strong and ever-growing presence in the state of California. Clever Devices' current clients in California include Sacramento (SacRT), Contra Costa County (CCCTA), the City of Torrance, and San Diego MTS. Furthermore, Clever Devices has recently been selected to provide a full ITS system for Riverside Transit Agency's 181-vehicle fleet.

Clever Devices has a proven track record of forming partnerships with our clients to achieve their desired outcomes and to improve the customer experience. We appreciate that during project implementation, your operational staff working on the project still have transit operations to manage, and it is imperative that you continue making daily service without revenues being compromised. With this in mind, our approach is to leverage our internal resources to make the entire process as easy as possible for you.

Our proposed solution and products are designed to ensure project success for the long term and provide a significant return on MTD's investment. Having the broadest, deepest collection of transit technology solutions of any firm, Clever Devices is committed to continued investment in additional functionality that will continue to create options for our clients beyond our present offerings. Each generation of our technology is designed to be "future proof," meaning that it is backward and forward compatible, as well as modular. As such, each new innovation will be available to you without the need to upgrade your base system as your technology needs grow.

Clever Devices

In compliance with the RFP, we have provided a comprehensive response to your specifications. Clever Devices is able and willing to obtain insurance meeting the requirements indicated in the MTD Master Agreement. Clever Devices accepts the terms and conditions included in the Master Agreement and AIM Specifications excluding the modifications and clarifications listed on the following page.

If you have any further questions or need additional clarification, Dan Trujillo – Strategic Account Manager – is your point of contact. Dan lives in Santa Clarita, only a short drive to the MTD offices, which would allow him to meet with MTD personnel and assigned Clever Devices employees working on the AIM project at a moment's notice. Dan is a southern California native and understands the complexity that local transit faces. Dan can be reached by phone at 661-644-8929 or by email at dtrujillo@cleverdevices.com.

Thank you again for allowing us to participate in the AIM RFP. As the Senior Officer of the firm, I am authorized to make a binding commitment with regard to the information contained in this document. Our proposal is valid for 90 days from the date of submittal. We look forward to supporting MTD in your endeavor to revolutionize your ITS technology to support your ridership and community.

Sincerely,

Francis J. Ingrassia
President
Clever Devices Ltd.

Modification to the *MTD Master Agreement*:

The following is Clever Devices' modification to the *MTD Master Agreement* provided in the RFP.

Item	Section	Short Description
1	Item 24. Indemnification	Clever Devices, if selected, respectfully requests the opportunity to discuss limiting indemnification to the value of the contract, reflecting industry experience and common practice.

Modifications and Clarifications to the *AIM Specifications*:

Clever Devices has proposed proven, innovative products that have been deployed at hundreds of transit agencies across North America. As such, there are a few clarifications of the technical requirements from the RFP for MTD to review. For most items listed below, the clarification is simply to verify our interpretation of the requirement or that Clever Devices' solution complies with the intent of the requirement. Each item has an explanation for the clarification based on our experience deploying similar if not identical systems.

In the event that MTD desires the originally specified requirement, Clever Devices can provide this feature as specified with additional effort. This additional effort is not included with our proposal.

There are only thirteen items which Clever Devices is providing clarification, and the first item is relative to using the MotoTRBO as a data radio vs. cellular technology for real time data communications.

Item	Section	Short Description
1	2.2.4 3.2.1.2 3.3.3 4.10.1.1 5.3.2.4 7.2.3	Clever Devices' proposal includes cellular for real-time data communications and use of the existing MotoTRBO voice radio system for voice calls. The sections listed have references to the use of MotoTRBO as a "data radio" for real time data communications. The references within these sections do not apply. 2.2.4 Reference to use of MotoTRBO for data radio 3.2.1.2 Reference to documenting protocol for data radio 3.3.3 Entire section 4.10.1.1 Reference to EIA 204 and 374, as these only apply to land mobile radios 5.3.2.4 Reference to EIA 316-B, this this only applies to land mobile radios 7.2.3 Entire section

2	4.1.4	Clever Devices' GPS receiver meets the requirements as specified. For clarification of interpretation the standard GPS receiver specification is 5m CEP (50% probability) in clear unobstructed skies, as interpreted from the RFP. Clever Devices' proposed navigation system includes a GPS receiver with equivalent specification, gyro, odometer, kalman filtering and expert algorithms such as self-calibrating odometer and map matching. Clever Devices' navigation system meets 10m with 99% probability providing a more accurate and reliable navigation system than that of a COTS GPS receiver as specified.
3	4.2.1.1	Clever Devices' solution meets this requirement with the following subtle clarifications: All web applications that display bus location are updated upon receipt of the bus location. Predictions are calculated upon location update from the bus and displayed to the public via all web tools every 30 seconds. Clever Devices' solution automatically displays departure time at the first stop and arrival time for all other stops. Clever Devices' solution includes a prediction measurement tool which will demonstrate the following average predicted accuracy: 0-5 min < 75s error 6-10 min < 120s error 11-20 min < 180s error 21-30 min < 240s error
4	4.2.2	Clever Devices' solution fully meets the intent of this requirement. The only difference is in how Clever Devices' solution indicates scheduled vs. predicted information. For real-time arrival predictions, Clever Devices' TOA system displays the bus ID directly adjacent to the estimated time of arrival (e.g. 3 min). When no prediction is available, schedule data is displayed and no bus ID is displayed. This solution is simple and user friendly and the displaying of the bus number reinforces to riders the trustworthiness of the real-time system.
5	4.2.3	Clever Devices solution meets this requirement with the following minor clarification: While Clever Devices' TOA system does support sending service bulletins to social media applications, it does not (by design) send arrival predictions because of the volume and frequency of data. Also, SMS only supports one language. All other media support two languages.

6	4.4.1.1	Clever Devices' solution includes tagging and automatically clears the tagging events after the configured duration of the event (up to 15 minutes). All tagged video events include recordings for a configured time before the event and after the event. This solution ensures that tagged video covers the event. The automatic tagging minimizes operational activity for safety situations and ensures no video is lost. The automatic clearing of the tag event has been implemented based on experience at other transit agencies to eliminate the need to put additional responsibilities on transit personnel. The DVR captures video all the time, which also affords MTD access to the recorded video for up to two weeks, based on recording settings, to retrieve any additional video around the tagged event.
7	4.4.2.1 4.4.3	Clever Devices' proposed solution does not include 720p. The proposed solution includes configuration of the settings from 352x240 to 704x480. These resolutions ensure MTD with the ability to ensure video coverage on-board the bus is excellent while containing storage requirements.
8	4.6.1.1	Clever Devices' off the shelf solution is configurable to display the operator ID on the interior LED sign but not the operator name. Clever Devices' experience is that operators and operator unions do not approve of operator names being publically displayed as they feel it can result in unsafe situations for the operator.
9	4.6.1.1	Over the past 25 years, Clever Devices' experience at hundreds of transit agencies is that, given the opportunity, bus operators will disable the bus stop announcement (BSA) system during normal operation. Clever Devices' off the shelf system is purposefully designed to not permit operators to disable the system for this reason.
10	4.6.1.1	Clever Devices is the founder of BSA technology in North America. Our solution is state-of-the-art and has many configurable features to accommodate MTD's solution. Our experience with outside announcements is that the audio must be triggered within 500 msec of a door opening event or the public will view it as being late and misleading. The lack of doors (and thus door controls) on the 20 shuttle buses would therefore impede the delivery of timely and ADA-compliant exterior announcements. Clever Devices has therefore not included this feature in our proposal for the 20 shuttle buses, but will be committed to working with MTD to design an optimal solution.

11	4.9.1.2	Clever Devices' experience is that changing thresholds based on lines, vehicles, and time is unmanageable and can lead to untraceable and undesirable behavior. Clever Devices' manages all thresholds as global settings to improve ease of use and system administration and to ensure consistent results. CleverCAD® allows the dispatcher to create waivers, which prevents the display of events associated with excessive thresholds to minimize nuisance events. **The following is proposed alternative language that Clever Devices' complies with:** Operations status entries shall be generated automatically by AIM when an out-of-tolerance condition is detected. AIM shall generate notifications for a number of bus conditions that shall include at a minimum: off route, schedule adherence variance, out late, missed relief, voice or data communications failure, and vehicle movements without a valid logon. Tolerances for determining abnormal conditions and the recipient and type of the resulting notifications shall be settable by the system administrator. Enabling or disabling, ~~or changing the threshold~~ events for **displaying** of each condition shall be settable by the Dispatch Supervisor based on lines, vehicles, and times. Other requirements, capabilities, or features related to notifications shall include:
12	4.10.1.1	Clever Devices' research indicates that there are no airbag compliant mounting devices available. Clever Devices will do vehicle type engineering, work with MTD to select a location to prevent any adverse effects on airbag operation or any passenger, and obtain MTD approval. Clever Devices has extensive experience with the installation of equipment in service, supervisor, and maintenance vehicles. We always find a suitable solution that ensures the safety of the vehicle driver and passenger.
13	5.3.2.4	For environmental testing, Clever Devices uses SAE J1455 standard. SAE J1455 is the Recommended Environmental Practices for Electronic Equipment Design in Heavy Duty Vehicle Applications and is based on the processes and procedures identified by the Mil-Std 810G, which is the latest version. SAE J1455 is the environmental standard used in the bus industry today and encompasses all of the environmental standards required by MTD and more. Clever Devices' environmental standards for on-board equipment are listed in section 7.4.4.1.

2 Executive Summary

Clever Devices welcomes the opportunity to partner with MTD to deliver the state-of-the-art Intelligent Transportation System (ITS) you require. We have structured our offering to meet each of your requirements while ensuring that all of the products and software that we implement for the AVL & ITS Management Systems (AIM) will be compatible with your existing systems and future initiatives.

In addressing your requirements, Clever Devices has reviewed in detail the RFP for the AIM project and has considered all of your stated technical and operational requirements in developing our proposed solution. Our solution incorporates proven, time-tested technologies that currently provide similar functionality in nearly 200 cities throughout North America. As a result, we are confident that it will enable MTD to become a leader in transit services that are safe, efficient, reliable, and focused on customer needs.

Our richly diverse client base is comprised of transit agencies of all sizes – those smaller than MTD, those that are the same approximate size, and those that are far larger. In all cases, every client of Clever Devices, regardless of property size and level of pre-existing technology, receives the full measure of our capabilities, know-how, and support to ensure successful project implementation and on-going sustainment. We will be at your side every step of the way. It is for this reason that Clever Devices enjoys a project completion and success rate of 100% that spans over 25 years.

A significant advantage to MTD is that Clever Devices' solution provides the lowest cost of investment over the life of the product. You are in the process of purchasing a system that will be utilized by MTD for at least the next decade. Clever Devices' on-board system and fixed end applications are mature and yet continue to functionally grow to meet today's and tomorrow's demands. Clever Devices' on-board IVN® system is fourth generation and, being deployed with the base system, has all the power and capacity to meet the MTD's on-board requirements for the base and all optional systems.

Another advantage to MTD is that Clever Devices' systems are backward compatible. This means that over the years there will be additional generations of on-board platforms. With Clever Devices, MTD will never have to do a fleet replacement of the IVN® platform with the release of a new generation, as the new generations will seamless work in conjunction with that deployed for AIM. This level of commitment by Clever Devices provides forward-thinking organizations like MTD the opportunity to incrementally grow the on-board and fixed end system without replacement or adding redundant systems. This results in significant savings in dollars, in manpower, and in maintenance.

For MTD, Clever Devices is providing our commercially off the shelf (COTS) products and system solution to meet all of the requirements of the RFP in accordance with the modifications and clarifications stated on page 7. The systems we propose to implement are proven, reliable and easily maintained by MTD personnel and includes in the base system:

- IVN® and our color MDT are rugged, reliable, and provide the foundation of all ITS functionality on-board the vehicle – Once installed, new features are easily added without on-board system replacement or adding expensive new hardware platforms

- All real-time data services for fleet to fixed end communications via Verizon cellular services
- BusTime® real-time bus arrival passenger information system for automatic vehicle location (AVL) and time of arrival (TOA) information
    - Includes a royalty free license of BusTime®'s developer API for use and access to bus arrival information to MTD and any MTD authorized third party developer
    - This free API has been used to interface with 511 systems and is readily available to MTD to interface with your future 511 system
    - SMS messaging has proven to be a highly effective way for MTD to communicate TOA information to the riding public and pricing is included
    - Clever Devices has include the cost and installation of metal signs to display QR codes and instructions at each bus stop
    - Supports two languages
- One LCD sign for inside the transfer center, which provides an intuitive view of all routes servicing the transit center
- Two double sided LED signs that provides easy accessibility to TOA information outside the transit center
- CleverReports™ web based business intelligence reporting solution to provide route and schedule adherence reporting with additional reports as the system grows
- Video surveillance system (VSS)
    - All the tagging capability specified and the automatic transfer of tagged video to the fixed end
- Yard wireless system (YWS) that provides 100% coverage at Olive terminal and Clever Devices' BusLink® WLAN communications system for the automatic transfer of performance data from the vehicle and software and data updates to the vehicle
- The AVL database delivered as Clever Devices' BusTools® data management tool, which includes the system initialization and validation of existing route and stop data and provides an intuitive and easy way for MTD to maintain the system
- A transit database solution that ensures MTD access to all historical, real-time information, schedule, route and stop, and interfaces with Trapeze data
- On-board equipment for tracking two supervisor vehicles
- Test bench with cart for maintenance and for training
- Ruggedized laptop for test, maintenance and field work
- All the servers SAN, IT equipment, to support the base and optional components and monitor all systems

Clever Devices has also included the following optional systems, as specified by MTD:

- Bus stop announcements in two languages
- Vehicle health monitoring with our AVM® vehicle health monitoring

- Automatic passenger counters (APC) & reporting with two alternatives: One is fully complaint, while the other is mostly compliant and results in approximately $90,000 in savings
- YWS expansion to include additional WLAN access points to support full video coverage and the additional storage for the video
- YWS that includes Clever Devices' SmartYard™ location and status with the most accurate vehicle tracking inside a depot
- YWS that includes the addition of the SmartYard™ bus assignment module
- CleverCAD® computer-aided dispatch (CAD) with state of the art and full featured mature fleet management
- CleverCAD® is easily accessible for workstations and remotely for road supervisor vehicles
- Two road supervisor laptops for remote access to CleverCAD® CAD system
- Call routing system (CRS), which includes on-board integration to the MotoTRBO radio and fixed end equipment to support the routing functionality including a console, instant recall recorder and all equipment to use the system
- Silent alarm system (SAS) which includes the on-board switch and fixed end functionality
- On-board equipment for tracking sixteen service vehicles
- Remote bus stop sign hardware
- Integrated voice response (IVR) system in two languages

About Clever Devices and Our Continuous Record of Success

Clever Devices, a privately-owned firm incorporated in 1988, is exclusively focused on ITS solutions research, development, and system implementations. Clever Devices currently employs over 330 ITS professionals with extensive industry experience with transit agencies of all sizes, including agencies of similar scope and size to MTD.

Clever Devices' corporate headquarters is located in Woodbury, New York and we continue to grow rapidly because our products work and are in high demand by transit authorities. We provide cutting-edge solutions that both facilitate mass transit operations and enhance rider experience. We strive to produce reliable value-added products that have low life-cycle costs and high return-on-investments, resulting in rapid payback periods for our clients. We are also committed to "green" engineering, and environmental sustainability plays a vital role in our current and future products, the methods we use to manufacturer our solutions, and the reduced impact that our operations and solutions have on the environment.

Clever Devices has a proven track record of 100% success and has implemented our turnkey solutions at eight of the fifteen largest bus fleets in North America, including the largest real-time AVL and web-based customer service tracker solution installed in the nation at the Chicago Transit Authority (CTA). In total, Clever Devices' products automate transit operations for over 200 transit authorities. Our vast experience across large, medium, and small agencies enables Clever Devices to address the specific needs and operations of each of our customers to ensure successful deployments, and our project with MTD will enjoy similar results. Moreover, Clever Devices has a strong presence in the state of California, including Sacramento (SacRT), Contra Costa County (CCCTA), the City of Torrance, and San Diego MTD. Most recently, Clever Devices has been selected through competitive bid to deploy a full ITS system for Riverside Transit Agency's 181-vehicle fleet.

A Long Equipment Lifecycle and Research & Development – Looking Ahead

Clever Devices' products and software solutions enjoy an operational longevity that is well known in the industry. Designed from the beginning to be both forward and backward compatible, our on-board equipment has doubled the typical industry standard (from six to twelve years, or even longer). Clever Devices has several clients operating three generations of our equipment seamlessly, the oldest of which has been operational for over 14 years now, and is expected to operate for many more years. Clever Devices' equipment continues to provide a significant return-on-investment for our current clients and will provide the same benefits to MTD for the long-term.

Clever Devices continues to work closely with new and existing clients to develop thoughtful and innovative solutions across the spectrum of transit operations that best meet the specific needs of our clients. For example, we recently worked collaboratively with New Jersey Transit to develop a critical safety solution that alerts operators to check for pedestrians before making left or right turns. We developed a VoIP solution for CNYRTA-CENTRO in Syracuse, NY that enables them to use a public cellular data network for voice communications. Moreover, Clever Devices is working with the Chicago Transit Agency to use state-of-the-art technology to lockout vehicle ignitions to prevent unauthorized individuals from operating CTA vehicles. These are just three examples of how our client-centric focus results in a unique understanding of our clients' challenges. The technology and products that result are then made available to all of Clever Devices' clients, so choosing Clever Devices' technology is a true future investment.

Clever Devices' Best Value Proposal

Clever Devices offers a full and robust suite of ITS solutions that meet or exceed in all respects the requirements specified by your RFP. We are confident that our response provides MTD with a best value, high quality, and fully integrated solution that will significantly reduce risks and the overall time to achieve deployment and success.

Clever Devices' long-standing goal is to be the leading provider of cutting-edge transportation technology. By partnering with MTD, as we do with all of our customers, we will work together in full collaboration to assist you in your efforts to improve transit safety and reliability, enhance the rider experience, and provide operational efficiencies and environmental benefits.

In executing the resulting contract, Clever Devices will supply all hardware, software, spare parts, and services necessary to accomplish the installation and testing of our proposed system. Because each generation of our technology is designed to be "future proof," it is backward and forward compatible as well as modular, meaning that each new innovation will be available to you without the need to upgrade your base system as your technology needs grow. This ensures project success for the long term and will provide a significant return on investment to MTD.

In Closing

Clever Devices will commit our attention and all of the resources necessary to ensure a successful project. Our singular commitment and focus to mass transit technology is unparalleled and reflected in every one of the solutions we provide. As a leader in intelligent transportation technology systems, we offer a low-risk program backed with the experience of multiple large and mid-sized deployments. The technical investment with Clever Devices will support your immediate and future growth visions and will deliver a sound return on investment. As with our other clients, a partnership with Clever Devices will support MTD for decades.

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3 Description of the Firm

Clever Devices was incorporated in 1988, and since that time has been an industry leader in providing ITS solutions across North America. Our mission at Clever Devices is to provide innovative, state-of-the-art technology-based solutions to public transportation which improve the rider experience, increase safety and security, augment operational efficiencies, and support socially and environmentally responsible provision of mass transportation.

For over 25 years, Clever Devices has built an unparalleled record of achievement in design and delivery of intelligent transportation systems and CAD/AVL infrastructure. Clever Devices dedicates 100% of its resources to providing advanced technology to the mass transit industry, setting us apart from most intelligent transportation system providers. With a staff of over 330 members, we strive to serve the ever-changing needs of mass transit by developing and implementing the most innovative and sustainable transit systems available. Our corporate headquarters is located in Woodbury, New York, and we have regional offices in Richmond, Chicago, Vancouver (WA), Durham (NC), and Mississauga (Ontario).

Clever Devices' entry into the transit market started with the delivery of ADA-compliant voice announcement systems. We developed the SmartBus™ concept, perfecting on-board transit fleet automation technology and setting the market standards for such features as CAD/AVL, bus stop announcements (BSA), automatic passenger counters (APC), real-time passenger information (RTPI) systems, and automatic vehicle health monitoring. Today, we continue to drive the market with solutions focused on sustainable transit operations that increase accessibility and security while reducing operating and maintenance costs. Transit has always been our sole focus, ever since our first installation at Long Island Bus (now called NICE). Clever Devices' commitment to innovation has resulted in a number of significant achievements, awards and industry firsts, including:

Clever Devices' Awards & Distinctions	
2013	Ranked as one of the 500 fastest growing technology companies in North America on Deloitte's 2013 Technology Fast 500™ Ranked as one of
2013	LISTnet winner for CleverCAD®
2012	Living Labs Global Award for Modern Urban Transport Information
2012	LISTnet winner for Automatic Vehicle Monitoring (AVM®)
2011	First VoIP-based voice communications deployed at a US transit system
2010	Chicago Innovation Award for BusTime® real-time passenger information system
2007	Deployed largest passenger information system in North America
2002	First Automatic Passenger Counting (APC) system certified for NTD Reporting
1999	First automatic vehicle health monitoring system installed on a US public transit
1998	Helen Keller Award of Appreciation for commitment to the Americans for Disabilities Act
1998	New York City Transit,- Innovative Technology Supplier of the Year
1997	First automatic voice announcement system installed on a US public transit vehicle
1995	First GPS-based bus stop announcements (BSA) system installed on a US transit vehicle

Clever Devices has a long history of providing cutting-edge ITS solutions to a broad spectrum of customers and is able to deploy solutions across any size fleet. A small sampling of our richly diverse customer base, including recently and successfully deployed similar projects, is shown below.

Clever Devices has provided solutions for all of the agencies shown on the map below, and internationally, including Canada and South America.

Figure 1: Installed Systems and Client Base

With over 200 clients of all sizes, Clever Devices' deployments include eight of the top fifteen largest transit agencies in North America. These systems include the same relevant technology that is required for the AIM project. Clever Devices was awarded two large-scale CAD/AVL projects at NJ Transit (2,200 buses) and Washington Metropolitan Area Transit Authority (1,500 buses) through competitive best value procurements, both of which include private radio integration. We have also implemented the first successful CAD/AVL projects using VoIP for Worcester Regional Area Transit Authority and Pinellas Suncoast Transit Authority. We have a history and reputation for delivering innovative solutions and a fierce determination to get the job done right. This was clearly evidenced in Chicago when we were selected to install the largest AVL deployment at that time in the United States. Clever Devices delivered what would turn out to be an award winning predictive arrival solution for the Chicago Transit Authority.

4 Prior Experience with Similar Projects

Clever Devices has unparalleled experience deploying public transit projects across North America. Five reference projects for Clever Devices are described in the subsections below. These references are also listed on the required *Credit & Work References* form provided in section 12 on page 299.

Clever Devices' proposed subcontractors/suppliers are described in section 5.11 on page 38, including company descriptions and experience with similar projects.

4.1 Pinellas Suncoast Transit Authority (PSTA)

Pinellas Suncoast Transit Authority (PSTA)	
Contact Information	[redacted]
Time Period of the Project	September 2010 – December 2012
Fleet Size	187 buses, 8 community buses/cutaways, 10 supervisor

Pinellas Suncoast Transit Authority (PSTA) represents a recently deployed system with similar functionality and comparable size to MTD. PSTA utilizes the CleverCAD® CAD/AVL system extensively, having 40 workstations and 60 users with access to the CleverCAD® CAD/AVL system for monitoring and managing their operations.

Clever Devices provided onboard equipment such as IVN® units with cellular modems for data communications, along with a full-featured BSA system. The PSTA project required communications infrastructure such as the Data Communications Controller (DCC) for real-time transmission and Wi-Fi access points in bus depots for bulk data transmission. The BusTime® system was deployed to provide PSTA's passengers with real-time estimated arrival information.

Additional functionality delivered to PSTA included: integration with Motorola radio system for voice control and communications; interactive voice response with text to speech; extensive reporting with AVM® and CleverReports™; operator behavior reporting with Incident Analytics; single point logon and integration with GFI farebox, destination signs, and PA system; transfer connection protection; and Wi-Fi infrastructure and bulk data communications.

As the prime contractor, Clever Devices partnered with PSTA and directly provided project management, requirements management and traceability, configuration management of individual products and the system, product enhancements, system design and integration, system implementation and test plan encompassing FAT and mini-fleet and system acceptance testing, training (operator, dispatcher, maintenance, IT, administration, management), vendor management, release process utilizing a virtual test environment, and production deployment on the fleet, depot, and central systems. Clever Devices utilizes a project management plan and system implementation plan to ensure a quality system solution that results in timely deployment and meeting or exceeding customer expectations.

4.2 Worcester Regional Transit Authority (WRTA)

Worcester Regional Transit Authority (WRTA)	
Contact Information	[redacted]
Time Period of the Project	December 2010 – January 2013
Fleet Size	46 fixed-route vehicles, 41 paratransit vehicles, 5 supervisory/support vehicles.

The WRTA deployment involved a fleet size of 46 fixed-route vehicles, 41 para-transit vehicles, and five supervisory/support vehicles. This was a CAD/AVL solution that incorporated the IVN® on-board platform, CleverCAD® CAD/AVL, BSA, BusTime® RTPIS, LED and LCD RTPIS signs, AVM® vehicle health monitoring, APC, CleverReports™, TSP, BusLink® bulk data transfer, Handy Line IVR, BusTools® data management, pre-post trip inspection, and Clever Devices' VoIP solution is state-of-the-art and embedded within the IVN® system.

As the prime contractor, Clever Devices directly provided project management, requirements management and traceability, configuration management of individual products and the system, product enhancements, system design, system implementation and test plan encompassing FAT and mini-fleet and system acceptance testing, training (operator, dispatcher, maintenance, IT, administration, management), vendor management, release process utilizing a virtual test environment, and production deployment on the fleet, depot, and central systems. Clever Devices utilizes a project management plan and system implementation plan to ensure a quality system solution that results in timely deployment, and meeting or exceeding customer expectations.

Beyond the scope of the project, Clever Devices created a more robust VoIP system to mimic the legacy voice radio functionality. This included full voice control and the ability for management and supervisors to monitor conversations between the dispatcher and the drivers. Also, all audio was recorded for management to review any calls made between their employees.

4.3 Roaring Fork Transportation Authority (RFTA)

Roaring Fork Transportation Authority (RFTA)	
Contact Information	[redacted]
Time Period of the Project	November 2011 – November 2013
Fleet Size	109 fixed-route buses

RFTA's implementation began in November 2011, and Clever Devices set out to deliver a CAD/AVL and passenger information system solution with a focus on minimizing the impact the deployment would have on daily operations. Our solution included CleverCAD® CAD/AVL, BSA, AVM®, APC, BusTime®, and CleverReports™ comprehensive business intelligence reporting solution. Additionally, passengers are granted access to the internet via Wi-Fi onboard the 18 BRT vehicles.

As the prime contractor, Clever Devices directly provided project management, requirements management and traceability, configuration management of individual products and the system, product enhancements, system design, system implementation and test plan encompassing FAT and mini-fleet and system acceptance testing, training (operator, dispatcher, maintenance, IT, administration, management), vendor management, release process utilizing a virtual test environment, and production deployment on the fleet, depot, and central systems. Clever Devices utilizes a project management plan and system implementation plan to ensure a quality system solution that results in timely deployment, and meeting or exceeding customer expectations. This deployment demonstrates Clever Devices' ability to successfully manage and implement a complex CAD/AVL deployment while minimizing impact to the agency's ongoing operations.

Clever Devices provided RFTA with onboard equipment which included IVN®, cellular modems for data communications, and full-featured BSA and APC systems. RFTA's system required communications infrastructure such as the DCC and Wi-Fi access points in bus depots for real-time and bulk data, respectively. The BusTime® system was deployed to provide RFTA's passengers with real-time estimated arrival information. Clever Devices also integrated to the existing Trapeze scheduling system.

A new feature implemented for RFTA included Speed Breach, which signals the driver when they are exceeding the posted speed limit. At the same time, dispatch is notified of the speed breach. Historically, the user can run reports detailing Speed Breach events.

4.4 Central Contra Costa Transit Authority (CCCTA)

Central Contra Costa Transit Authority (CCCTA)	
Contact Information	[redacted]
Time Period of the Project	September 2011 – December 2012
Fleet Size	121 fixed-route buses

For our first project with the CCCTA, Clever Devices deployed an BSA solution and APC with APC reporting software to enhance the 121 vehicle fleet, while also interfacing to the existing bilateral data communications, destination signs, and Trapeze scheduling suite.

As a result of the success of this deployment, CCCTA contracted Clever Devices in the next phase of this project to install both our CleverCAD® CAD/AVL and our BusTime® real-time passenger information systems for the 121-vehicle fleet.

Clever Devices provided system design, schematics, project management, installation, integration to existing systems, testing, training, and onsite maintenance.

4.5 Chicago Transit Authority (CTA)

Chicago Transit Authority (CTA)	
Contact Information	[redacted]
Time Period of the Project	Multiple projects since 2003
Fleet Size:	2,000 Buses

In 2001, the CTA settled a lawsuit which found them to be noncompliant with many ADA regulations. As part of satisfying the settlement, the CTA agreed to make a series of upgrades to increase the accessibility of their transit system. One such upgrade was the implementation of a fully automatic stop announcement system by December of 2003. In August 2002, the CTA issued an RFP for an ITS solution which included BSA, APC, schedule integration, and reporting on their fleet. Clever Devices deployed the IVN® system with BSA, APC, and a comprehensive suite of APC, schedule adherence and route adherence reports within 15 months, ahead of schedule and on budget. The deployed system satisfied the legal complaint and the ADA community. CTA has expanded the on-board IVN® to include the award winning AVM® vehicle health monitoring system fleet-wide, followed by the RTN project in 2007, which provided real-time passenger information via Clever Devices' BusTime® product, then TSP integration, and finally as a subcontractor to Cubic integration with the new open fare payment system.

Of special note are Clever Devices' AVM® certification process and the public acceptance of the CTA Bus Tracker system, powered by BusTime®. In coordination with New Flyer Industries, Clever Devices provided the most comprehensive integration of on-board systems and was responsible to certify each on-board piece of equipment for J1939 compliance. This integration included upwards of twenty unique electronic devices on-board the vehicle. This has resulted in significant financial savings and improved maintenance processes at CTA. Secondly, the deployment of BusTime® to power the CTA website (ctabustracker.com) has been so widely accepted that in 2010 Google rated this website as the second most hit website in the city of Chicago. Because the system is so user friendly with state-of-the-art media, the SMS text messaging averages over 2,700,000 messages per month. Both are indicators of a quality passenger information system.

Clever Devices was the prime contractor for all projects listed and supports all new bus procurements. Clever Devices maintains a full working partnership with CTA and has dedicated staff on-site under a service agreement to maintain the fixed end system and the on-board system for the entire fleet. The deployment of the projects listed included providing project management, requirements management with traceability, configuration management of individual products and the system, product enhancements, system design and integration, system implementation and test plan encompassing FAT and mini-fleet and system acceptance testing, training (operator, dispatcher, maintenance, IT, administration, management), vendor management, release process utilizing a virtual test environment, and production deployment on the fleet, depot, and central systems. Clever Devices utilizes a project management plan and system implementation plan to ensure a quality system solution that results in timely deployment and meeting or exceeding customer expectations.

5 Key Project Personnel Resumes

Clever Devices' project team participants have been carefully selected for MTD's AIM project. The team includes personnel seasoned in the transit industry with the capacity and experience to perform quality work and deliver a state-of-the-art, user-friendly solution with minimal disruption of ongoing daily operations. Our methodology includes an experienced project manager to handle daily operations who will have the oversight of a vastly seasoned program manager at every step of the process. Our expert systems engineer and project engineer will likewise ensure that the proposed solution results in a successful and compliant deployment. Clever Devices' experienced project team is optimally suited for MTD's project and will deliver the proposed solution on schedule and within budget.

Program Manager

The program manager will provide oversight to both the project manager and project engineer and will be responsible for ensuring that all aspects of the project are successfully completed. The proposed program manager is Mr. Jon Nilsen, whose leadership skills will be well utilized for MTD. Mr. Nilsen's resume is provided in section 5.1 on page 28.

Project Manager

With the oversight of the program manager, the project manager is responsible for ensuring that the project team completes the project. The project manager develops the project plan with the team and manages the team's performance of project tasks. It is also the responsibility of the project manager to secure acceptance and approval of deliverables from the project sponsor and stakeholders. The project manager is responsible for communication, including status reporting, risk management, escalation of issues that cannot be resolved in the team, and, in general, making sure the project is delivered in budget, on schedule, and within scope. The proposed project manager for MTD is Mr. Ross Sinclair. Mr. Sinclair's resume is provided in section 5.2 on page 29.

Systems Engineer

The systems engineer is responsible for the technical aspects of the project. It is the responsibility of the systems engineer to develop the system architecture and overall design. The systems engineer will provide support during the proposal stage as well as manage vendor interactions for the project. The systems engineer is responsible for defining the subsystem level requirements, detailed design requirements, and the interface control requirements. Working with the deployment engineer, the systems engineer will create the test plans for the Factory Acceptance Test (FAT) and the field system acceptance test. The proposed systems engineer is Mr. Thomas Radenhausen. Mr. Radenhausen's resume is provided in section 5.3 page 30.

Project Engineer

The project engineer works with the systems engineer on the overall design for the project as well as with engineering and production on the deployment tasks for the project. The project engineer is responsible for the requirements matrix, requirements tractability and verification, risk management, design reviews, acceptance tests, and the successful deployment of the project. The proposed project engineer is Mr. Bradley Taylor. Mr. Taylor's resume is provided in section 5.4 on page 31. Together, the systems engineer and the project engineer make up the systems engineering team. They are supported by matrix resources that are provided according to the project needs and schedule. The project team is structured using an IPT model which includes the subcontractors being managed as an integral element of the team rather than through a separate contracting department.

In addition to the direct staff, various subject matter experts provide services to the project. These subject matters experts like Lou Peragine, John Locascio, Darryl Curtis, Phil Bockrath, Jonathan Arena, and James Kunkel will dedicate their time on the project during design and various stages of testing. Their resumes can also be found below, beginning on page 32.

The organizational chart on the following page also provides a breakdown of the professionals involved with these types of projects.

5.1 Program Manager – [redacted]

Program Manager – [redacted]
[redacted]

5.2 Project Manager – [redacted]

Project Manager – [redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	
[redacted]	[redacted]

5.3 Systems Engineer – [redacted]

Systems Engineer – [redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	
[redacted]	[redacted]
[redacted]	[redacted]

5.4 Project Engineer – [redacted]

Systems Engineer – [redacted]
[redacted]

5.5 Applications Engineering Manager – [redacted]

Applications Engineering Manager – [redacted]	
Professional Profile	
[redacted]	
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

5.6 IT Deployment Manager – [redacted]

IT Deployment Manager – [redacted]	
[redacted]	
[redacted]	
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[redacted]	[redacted]
[redacted]	
[redacted]	
[redacted]	

5.7 Vice President of Technology Deployment – [redacted]

Vice President of Technology Deployment – [redacted]
[redacted]

5.8 Senior Communications Engineer – [redacted]

Senior Communications Engineer – [redacted]	
[redacted]	
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[redacted]	
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[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	
[redacted]	[redacted]
[redacted]	
[redacted]	

5.9 Data Systems Manager – [redacted]

Data Systems Manager – [redacted]
[redacted]

5.10 Training Manager – [redacted]

Training Manager – [redacted]	
[redacted]	
[redacted]	
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[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	
[redacted]	[redacted]

5.11 On-Site Installation Lead – [redacted]

On-Site Installation Lead – [redacted]
[redacted]

6 Description of Key Partners, Subcontractors, & Suppliers

Clever Devices has combined our resources with subcontractors who have proven credentials and that are optimally suited for this project. Clever Devices' proposed subcontractors are identified in the following list, and are further described in subsections below.

- **Transit Solutions Services (TSS) –** On-board installation of ITS equipment
- **Apollo Video Technology** – Video surveillance system (VSS) technology supplier
- **Genfare** – Farebox upgrade and installation
- **Enghouse Transportation** – Optional interactive voice response (IVR) system provider
- **Hella –** Optional APC hardware supplier
- **Urban Transport Associates (UTA)** – Optional APC reporting software provider

Clever Devices has provided the required Partner, Joint Venture, and Subcontractor Listing form in section 13 on page 305.

Clever Devices has provided our project organizational chart on the following page, showing the roles and responsibilities of our major project team members.

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6.1 Transit Solutions Services (TSS) – On-Board Installations

Transit Solutions Services (TSS) in included in our proposal to provide on-board installation of ITS equipment.

TSS is a DBE company of 13 people based in Ocala, Florida with an office in New Jersey. TSS was founded in August 2013, built on 10 years of installation experience. Between the management team and installation technicians, TSS has provided installation services for many major ITS companies and transit agencies. Clever Devices has had great success working with TSS on previous and current projects, including bus installations at Fort Collins, Pittsburg, New Jersey Transit, CENTRO, and WMATA. TSS always has performed successfully and in accordance with Clever Devices' required installation schedules for each project.

6.1.1 TSS' Experience with Similar Projects

TSS has provided on-board installation of ITS equipment for the following transit agencies:

- NYC Transit System (MTA)
- Westchester County Transit System
- Memphis (MATA) Transit System
- Nashville (RIPTA), Transit System
- Vancouver Canada Transit System
- Tampa Bay (HART) Florida Transit
- Kansas City (KCATA) Transit System
- Maryland Transit System (ride On)
- Golden Gate Transit, CA
- BARTA (Readington PA)
- New Jersey Transit (NJT)
- Pittsburg Transit System (PAAC)
- Washington D.C. Metro (WMATA)
- Syracuse NY (CENTRO)
- Fort Collins Colorado (Transfort)
- Grey Hound Canada
- Academy Bus company

6.2 Apollo Video Technology – Video Surveillance System (VSS) Supplier

Apollo Video Technology is included in our proposal as the Video Surveillance System (VSS) supplier.

Apollo Video Technology is a leading manufacturer of video surveillance and fleet management solutions for public transit, rail, school transportation, law enforcement, military, commercial transportation, and EMS applications. With public and private-sector installations throughout North America and worldwide, the RoadRunner™ mobile video and audio recording system provides exceptional video quality with management software optimized for wireless downloading and live video streaming.

Renowned for reliability, durability, and ease of use, Apollo Video's solutions improve accessibility of data and deliver streamlined, fleet-wide management of video surveillance and on-board equipment to reduce liability, mitigate risk, improve efficiency, and reduce maintenance and operating costs. Apollo Video is unique in the industry with software interoperability and compatibility across multiple generations of hardware.

In 2013, Apollo Video was named the No. 1 supplier of transit bus mobile video surveillance equipment in the World and continues to be the No. 1 supplier in the Americas, since 2010 - an achievement that further supports the company's commitment to offer its customers superior, compatible solutions throughout the lifetime of their fleet.

Apollo has approximately 50 employees and is headquartered in Bothell, Washington. Apollo has been in business since 2004, and has supplied the RoadRunner system to over 340 agencies worldwide, representing over 18,000 total implementations.

6.2.1 Apollo Video Technology's Experience with Similar Projects

Reference projects for Apollo Video Technology are listed below:

1. **AC (Alameda Contra-Costa) Transit Dist**.
   Oakland, California
   Initial Implementation: August 2010

2. **Antelope Valley Transit Authority**
   Lancaster, California
   Initial Implementation: October 2008

3. **City of Clovis**
   Clovis, California
   Initial Implementation: January 2009

4. **LA Metro**
   Los Angeles, California
   Initial Implementation: August 2006

5. **San Diego Metropolitan Transit System**
   San Diego, California
   Initial Implementation: August 2010

6.3 Genfare – Farebox Upgrade and Installation

Genfare, a division of SPX Corporation, is included in our proposal for the farebox upgrade and installation.

Genfare is a leader in providing customized fare solutions to transit agencies of all sizes throughout North America. As a leader in fare collection systems for more than three decades, Genfare focuses on delivering solutions that are secure, reliable and highly flexible. Genfare currently has 143 employees and is headquartered in Elk Grove Village, Illinois.

Genfare is working to bring the latest innovations in fare control and management to you and your transit customers. Genfare integrated systems encompass the latest in electronic validating fareboxes, smart card and mobile payment options, ticket vending and point of sale card distribution systems, all managed by sophisticated local and web based data processing systems.

6.3.1 Genfare's Experience with Similar Projects

Similar projects carried out by Genfare (which all featured the J1708 interface) are listed below:

1. **Bay Area Transportation Authority**
   Traverse City, MI

2. **City of Colorado Springs/Mountain Metropolitan Transit**
   Colorado Springs, CO

3. **City of Santa Rosa**
   Santa Rosa, CA

6.4 Enghouse Transportation – Optional Interactive Voice Response (IVR) System Provider

Enghouse Transportation is included in our proposal as the provider of the optional Interactive Voice Response (IVR) system.

Enghouse Transportation is a division of Enghouse Systems Limited, a publicly traded Canadian based software and services company founded in 1984 and headquartered in Markham, Ontario. Enghouse Systems as a whole has over 600 employees, while Enghouse Transportation has approximately 85. Enghouse develops and delivers solutions for public and private transportation industries through innovative computerized applications and consulting support.

Enghouse's overall strategy is to create a larger and more diverse enterprise software company through strategic acquisitions and managed growth. The company is led by a seasoned team of proven executives who have years of experience building and running successful software companies.

Only Enghouse is qualified and authorized to install the Enghouse products. As such, with all of if its clients, Enghouse is involved in all aspects of the project implementation, from solution design to testing and support. Enghouse is also occasionally involved in the installation of the hardware.

6.4.1 Enghouse's Experience with Similar Projects

Similar projects carried out by Enghouse involving the BusLine IVR system are listed below:

1. **The City of Calgary**
   Calgary, Alberta

2. **Pinellas Suncoast Transit Authority**
   St. Petersburg, FL

3. **Long Beach Transit**
   Long Beach, CA

6.5 Hella – Optional Automatic Passenger Counter (APC) Hardware Supplier

Hella is included in our proposal as the on-board technology supplier of the optional (APC) hardware.

Hella is a world-wide company with over 25,000 staff members, including three business units in the USA employing almost 1,000. Hella is a globally positioned, independent, family-owned company with a history spanning more than 100 years. Hella develops and manufactures a wide range of high quality automotive, public transit and industrial products. Hella supports its products through a network of company-owned, world-wide deployed business units located throughout Europe, the Americas, and Asia.

Hella's mobile passenger counter for mobile applications is extensively fielded on all types of transit systems, including rail, bus, people movers, and marine vehicles. Hella's APC product is developed, sold, and supported by the Berlin based Hella Subsidiary - Hella Aglaia Mobile Vision GmbH, an experienced and successful function developer for intelligent visual sensor and driver assistance systems. While the Hella Brand is in existence for over 100 years, Hella Aglaia was founded in 1998. This wholly owned subsidiary is part of Hella KGaA Hueck & Co with headquarters in Lippstadt, Germany.

Given the tremendous success Hella achieved over the course of the past seven years in the European public transit market, specifically the APC market, Hella is now on course to build and extend that same success in North American markets. With the recent deployment of units in US projects, Hella is positioned to achieve an equally strong growth in the mobile APC market. This is because of Hella's modern and highly accurate People Counter product, the versatility and added functionality it offers to integrators and end-users, and Hella's ability to price the product extremely competitively.

6.5.1 Hella's Experience with Similar Projects

Similar projects carried out by Hella are listed below:

Integrator	End-user / Project	Counters
OEM – USA	Miami Trolley Fleet	40
Bombardier	BR430, Dosto2010, Deutsche Bahn (D)	>3000
OEM	RTM Marseille, RATP Paris, Bordeaux, Lyon (F), Movia (DK)	1300
OEM / Siemens	Oslobahnen (N)	600
OEM / Systems	Wiener Linien, Vienna, (AT)	700
OEM	Mönchengladbach (D), Canberra (AUS)	1300
OEM	Postbus (AT), Malmö (S)	300
OEM	Eberswalde, Erfurt (D), Stadler SBB (CH), Istanbul (TR)	900
OEM	Shangij Airport (Singapore)	500
OEM	Flensburg, Köln (D)	350
OEM	Augsburg, Aachen Regensburg, Verkehrsverbund Berlin Brandenburg (VBB)	450
OEM	Kiew (Ukraine)	120
OEM	Livorno, Florenz (I)	300
OEM	Hannover, Rostock (D)	400
Skoda	Miscolc (H)	700

6.6 Urban Transportation Associates (UTA) – Optional APC Reporting Software Provider

Urban Transportation Associates (UTA), headquartered in Cincinnati, Ohio, was founded in 1981 by two individuals (including current President/CEO T.W. Kowalski) who had formerly served as research engineers with General Motors Transportation System Division. During their tenure with GM TSD from 1976 - 1981, an operational Automatic Vehicle Location (AVL) system was developed that included an Automatic Passenger Counting (APC) sub system. GM-TSD discontinued the AVL/APC product in 1981. The newly formed UTA purchased product rights from GM-TSD and created a business in applying APC technology within the transit industry. With UTA's experience of more than three decades in the ITS marketplace, UTA is most unlike the current set of firms populating the transit ITS marketplace. Firms with an abundance of technological resources but with little transit knowledge/experience are migrating into the transit marketplace from other sectors of the economy.

UTA is unique in that UTA in an employee-owned firm. With 15 employees, 100% of UTA stock is owned by active UTA employees. This ownership model allows UTA the freedom to place APC quality and user satisfaction above short-term revenue generation. The ITS market is highly volatile with firms changing ownership on a frequent basis, often to the detriment of transit users. UTA has the freedom to apply high levels of energy to meeting transit agency's analytic needs without being encumbered by the demands of distant corporate management and stock holders. UTA's business model applied to the public transit marketplace has allowed UTA to operate on a consistently profitable basis for the past twenty (20) years.

UTA's sole business is providing automated data collection and analysis tools to transit planning and scheduling departments. UTA has developed handheld data collection systems, Automatic Passenger Counting (APC), and Bus Signal Prioritization (BSP) systems that have been implemented in North American transit agencies since 1981. Another unique characteristic of UTA is that UTA often executes APC Lease projects where transit agencies lease the APC system and support. In these APC lease projects, UTA not only implements the APC system but also operates the APC system. UTA staff performs the APC maintenance and APC report generation in exactly the same manner as transit users. The UTA engineers that have developed the APC hardware and software have the opportunity to operate the APC system in a manner that provides extraordinary insight into the day-to-day issues that the APC system must confront and overcome.

UTA is dedicated to the transit marketplace. It is this presence in the transit marketplace that provides assurance that an APC system provided by UTA will operate successfully and meet transit agency's analytic needs for at least the next ten years. Many transit agencies have been utilizing UTA's APC system for 15-20 years.

6.6.1 UTA's Experience with Similar Projects

Similar projects carried out by UTA are described below:

1. **San Francisco Municipal Railway (MUNI)**
   In August 2006, UTA was awarded a sole-source contract to provide 110 stand-alone APC systems to MUNI. This award came after MUNI had evaluated other (Dilax, IRMA/IRIS) APC systems in comparison with a two (2) bus, no-cost, UTA APC demonstration project executed in early-2006.

UTA's APC system was initially directed at a comprehensive data collection and analysis project (TEP) at MUNI in fall 2006. Based on the performance of UTA's APC system, MUNI expanded its fleet equipped with UTA APC systems beginning with nine (9) articulated buses in 2007 and an additional one hundred 125 buses later in 2008. In June 2011, MUNI increased their total number of buses equipped with UTA APC units to over 250 after UTA installed five (5) new units on MUNI buses. UTA also provides MUNI with maintenance and support services for all the hardware and software components of the UTA APC systems. UTA also provides MUNI with maintenance and support services for all the hardware and software components of the UTA APC systems. In 2013, MUNI is purchasing an additional 62 UTA APC-equipped buses from New Flyer.

2. **Massachusetts Bay Transportation Authority (MBTA)**
   In mid-2007, after reviewing the APC marketplace, MBTA specified UTA APC systems on twenty-one (21) New Flyer buses being built for MBTA. In September 2007, the UTA APC equipped buses were placed in revenue service operating out of the Charlestown Division. After extensive MBTA staff evaluation of UTA APC accuracy, reliability, economic feasibility, and analytic reporting capability, MBTA specified UTA APC systems on an additional 20 New Flyer buses produced in mid-2008.

   The initial UTA APC systems installed at MBTA were UTA's StandAlone APC configuration. MBTA staff needed large amounts of ridership detail while MBTA's TransitMaster APC system was being implemented. In 2009, after MBTA's acceptance of the TransitMaster AVL system, UTA 'traded' 75 'Integrated' APC hardware sets for the 'StandAlone' APC CPU's. This transition resulted in approximately 125 buses with UTA's APC system successfully integrated with MBTA's newly implemented TransitMaster AVL system.

   Based on the confidence MBTA developed in the UTA APC system performance, MBTA has continued to purchase APCs for their buses. In 2010, 25 New Flyer new articulated buses were delivered to MBTA equipped with UTA APC systems. Later the same year, UTA installed an additional 40 units on existing MBTA buses. All UTA APC systems at MBTA are integrated with the TransitMaster AVL system.

   Analytically, UTA technical staff has made a number of major adaptations to UTA's standard APC Reporting Software to replicate traditional MBTA analyses - Load Profile and CTPS Trip Summary.

   For the past six (6) years, UTA and MBTA staff has diligently executed a weekly conference call during which any APC-related issues are addressed.

3. **Miami-Dade Transit (MDT)**
In early-2009, as an integrated element of the fare collection system, UTA's APC system was installed on 850 MDT buses. In late-2009, MDT Planning and Scheduling staff utilized APC-generated data to make significant service changes in response to county budget reductions. In 2010, an additional twenty (20) UTA APC systems were installed on articulated buses at MDT. Later in 2010 another five (5) Gillig buses were purchased by MDT equipped with UTA APC systems.

4. **Baltimore-Maryland Transit Authority (MTA)**
In 2003-2004, Baltimore MTA purchased a Voice Annunciator system from Clever Devices that included APC's installed on approximately 500 MTA buses. In early 2008, after years of attempting to obtain analytic reports from the APC system, MTA awarded a contract to UTA for the provision of APC Software adapted to process/report APC data generated from the Clever Devices on-board APC equipment. MTA planners and schedulers are utilizing reports/analyses generated from UTA's APC Software package.

5. **Los Angeles County Metro Transportation Authority (LACMTA)**
In late 2001, UTA was selected over two (2) other bidders (OSC, Siemens) to provide all engineering, equipment, installation and support for a Bus Signal Prioritization (BSP) project on Line 210/310 Crenshaw Blvd Corridor. This project includes an initial set of ten (10) buses equipped with UTA's BSP configuration followed by an additional 94 BSP-equipped buses. UTA's standard APC CPU has the capability of adding BSP capability with minor modifications. Since 2003, UTA's BSP configuration has been selected as the standard for future LACMTA Rapid Bus Corridors. In 2006, BSP has been expanded to three (3) additional LACMTA Rapid Bus corridors. In 2007 and 2008, UTA BSP systems will be added to LACMTA buses serving at least three (3) new Rapid Bus Corridors.

7 Technical Proposal

RFP Specific Detail Request	Where Located In Proposal
Description of systems and features that are not part of the offeror, partner, subcontractor, or supplier standard offerings and would need to be developed to meet the AIM Specifications (e.g., functions, hardware, software applications, databases, interfaces, reports)	Clever Devices' solution includes standard off the shelf products with modifications and clarifications listed immediately after the cover letter.
Listing, data sheets, and pictures for all significant equipment included in the proposal.	Section 7.3 starting on page 74 and section 7.4 starting on page 219
Description of onboard equipment interface types and standards to be used. If open standards are not used, provide the rationale for the use of proprietary decision.	Section 7.2.2.7.2 on page 72
If proposing a data radio system, a calculation showing the expected and worst case percent utilization for the data channel to be used for the data radio system including a narrative explaining the calculation and assumptions made.	Clever Devices is proposing the use of cellular. Cellular bandwidth can be found in section 7.2.3 on page 72
If proposing a cellular data service, the proposed wireless data service and a coverage map.	Section 7.2.3 on page 72
Description of any proposed encryption for the data radio or cellular data service, including type of encryption used, key size and if the encryption is always active.	Section 7.2.3.1 on page 74
Description of the algorithm for time of arrival predictions and report of the accuracy of the time of arrival predictions for previously implemented systems	Section 7.3.2.2 on page 80
Information on Time of Arrival webpage including whether separately hosted or part of MTD website.	• Map view in section 7.3.2.3 on page 82 • Prediction view in section 7.3.2.4 on page 86 • Mobile App view in section 7.3.2.5 on page 93 • Web via Text only in section 7.3.2.6 on page 93 • SMS in section 7.3.2.7 on page 94 and 7.3.2.8 on page 97
Description of power and communications link with remote bus stop electronic display signs	Section 7.4.5.8 on page 263
Analysis and calculation of the APC system accuracy from APC verification tests.	Section 7.3.9.1.3 on page 173
Listing of onboard equipment to be monitored by Vehicle Health Monitoring system and specific information being monitored.	Section 7.4.4.3.13 on page 247

RFP Specific Detail Request	Where Located In Proposal
Samples of offeror's standard reports for all relevant AIM systems. Listing of reports that must be custom developed.	CleverReports™ - Section 7.3.4.8 on page 113 AVM® - 7.3.8 on page 166 APC - 7.3.9.5 on page 180
List of recommended spares and test equipment. This list shall include the equipment specified in Chapter 7 of the AIM Specifications.	Section 7.7 on page 273

7.1 AIM System Solution Overview

This section provides an overview of the entire system architecture for Clever Devices' proposed AIM system. To achieve this we provide the system architecture overview as shown in Figure 1. This is followed by a very brief description of each of the products and system components. We then provide a set of data flow diagrams to categorize the system and products for more detailed understanding of the system. There are four categories of data flow:

Build Time	Illustrates how static data (schedules, routes, stops, audio, etc.) is managed and flows through the system
Real Time	Illustrates how data flows in real-time (Passenger information, CAD/AVL, Trapeze OPS, etc.)
Historical Reporting	Illustrates the source of all data and how it flows through the system for the purpose of historical reporting
TDB	Although the TDB is reflected as a component in all other data flows, this provides a complete view of the entire TDB and how data flows in and out and its accessibility to MTD personnel

Clever Devices' system solution and proposed architecture addresses all the requirements within the RFP. The system is color coded: green is provided by Clever Devices, blue represents optional or future and tan components are provided by MTD. This is shown on the next page followed by a description of each of the components of the system.

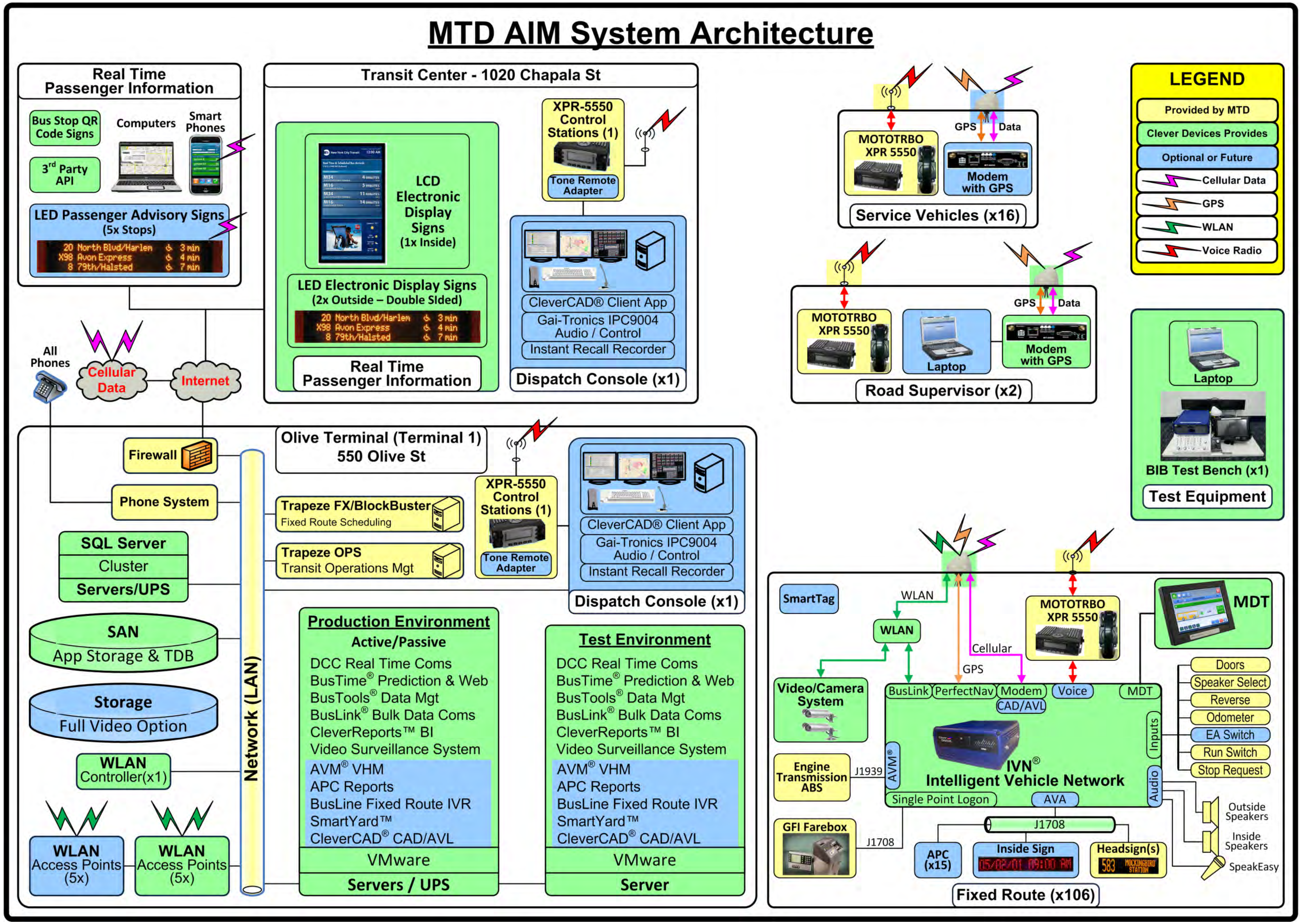

Figure 2: MTD AIM System Architecture

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The base system includes all components shown in the green boxes in the system architecture on Figure 2 on page 53. The hardware quantities shown in the architecture represent installation and do not include spares:

Fixed End Applications (Includes server and user access)	
Time of Arrival	BusTime® provides trustworthy and accurate real-time passenger information to the public via the web, mobile phones, passenger information displays (PIDs), email, integration to IVR systems and future SMS text messaging and **free** BusTime® developer API.
DCC	The Data Communications Controller is the real-time communications gateway to manage data communications between the fixed route fleet and all fixed end systems including BusTime® and CleverCAD®.
AVL Database	BusTools® is the AVL database. BusTools® is the data management tool used as the single data management solution for all the proposed system components, provides a route and stop inventory management solution, and affords MTD personnel to be "in complete control" of their system. BusTools® seamlessly automates the use of schedule data from Trapeze FX and ensures that any changes (schedule, route, stop, passenger information, and configuration) are exercised once and easily distributed to all system components.
TDB	The Transit Database solution is for sharing schedule, route and stop, and assignment information (optional) between the proposed AIM system, Trapeze, and other MTD or MTD authorized third party systems.
Trapeze FX Interface	MTD is to provide the Trapeze FX scheduling data license, setup and configuration. Clever Devices will import the Trapeze data into BusTools®. From BusTools®, the schedule data is correlated to the routes and stops (AVL database) and made accessible from the TDB.
BusLink®	BusLink® is the bulk data distribution management tool. BusLink® provides automatic distribution of all updates and data to all system components and the automatic retrieval from the fleet of all performance and detailed log data.
Route and Schedule Adherence	CleverReports™ is a web-based business intelligence reporting solution that compiles information from all system components into a transit database, analyzes the data, and provides meaningful reports. CleverReports™ comes with many built in reports and allows our clients to build custom reports using any data contained within the CleverReports™ database.
Video Surveillance Application	Apollo ViM software is the core of the video surveillance software with the ability to download, review, customize, view status of DVRs and archive evidence-grade video clips. Clever Devices has also included ViM AutoClip which supports the automatic transmission of tagged recordings to the fixed end via WLAN.

All Clever Devices' **client applications are royalty free** and can be installed or accessed on any workstations at MTD.

	Fixed End Hardware (x106)
Production Servers	Dedicated high available and redundant server to support the base system and all optional systems ** Possible cost reduction with finalized selection of optional systems
Test Servers	Dedicated server to test new releases of based and optional system software without impacting operation ** Possible cost reduction with finalized selection of optional systems
SQL Servers	Dedicated high available and redundant server to support the base and optional system ** Possible cost reduction with finalized selection of optional systems
SAN Storage	High performance state of the art storage system to support base system and capable of expansion to support all options – Full video will be handled by a separate storage system to save cost ** Possible cost reduction with finalized selection of optional systems
WLAN Controller	Cisco WLAN controller to support and manage all WLAN access points
WLAN Access Points (x5)	Cisco 802.11n WLAN access points provide complete yard coverage as specified in Addendum 2
Test Laptop	Ruggedized laptop for field diagnostics and updates
BIB Test Bench	Clever Devices' Bus in a Box (BIB) provides a platform for training and test of the on-board system – This will be equipped with all Clever Devices' provided equipment and any MTD equipment such as radio, GFI farebox, etc.
	Time of Arrival Signs
LCD Sign	One 42" LCD display in rugged enclosure with thermal control and fitted with Clever Devices' talking sign controller for integration to BusTime® and audio – This sign will be mounted inside the transit center
LED Signs	Two LED double sided displays with 16 x 144 pixels, up to 4 lines of 24 characters, Ruggedized NEMA 4x enclosure and fitted with Clever Devices' talking sign controller for integration to BusTime® and audio - These will be mounted outside the transit center
Bus Stop Codes	750 metal signs for installation
	Fixed Route Fleet Hardware (x106)
IVN® On-board Computer System	Integrated, proven and rugged platform (hardware and software) that provides all the ITS functionality required by MTD and integrates and controls the TCH (Clever Devices MDT), all bus systems IO, GFI farebox, as well as interfaces to the following optional components: EA switch, interior sign, APC, headsigns, any component that supports the standard J1708 or J1939 for vehicle health monitor. IVN® includes embedded GPS and cellular modem and will be configured
MDT	Proven and rugged operator interface that provides a color, daylight readable full nine inch display

VSS - Video Surveillance System	Apollo RoadRunner digital video recorder (DVR) with five cameras on short buses and 8 cameras on longer buses are rugged and proven and provide a cost effective security solution
WLAN	A WLAN device that supports both the IVN® and the Apollo VSS systems access to WLAN
Antenna	Quad band antenna that supports MIMO for 802.11n, GPS, and cellular data communications

Road Supervisor Hardware (x2)	
Modem & GPS	2x modems with GPS installed on the supervisor vehicles to track vehicle location and for the optional ruggedized laptop access to cellular services
Antenna	Dual band antenna that supports GPS and cellular data communications

The following **optional** features and their associated hardware and software components are shown in blue boxes of the system architecture drawing in Figure 2 on page 53 and are described below. The hardware quantities shown in the architecture represent installation and do not include spares:

Bus Stop Announcements (BSA)	
Inside Sign	On-board 20 character LED sign to display passenger information to riders, which can be configured for next stop, transfer, time and more
IVN® Upgrade and Harness	On-Board IVN® upgrade is required to support the audio functionality and additional harness
Services	Includes the additional effort to manage, configure, FAT test, fleet install, mini fleet test, system acceptance test, and train for the BSA functionality on-board the vehicle and on the fixed end

Nova Head Sign	
Head Sign Upgrade And Harness	Hardware and software to support J1708 interface for integration to IVN®
Installation	Includes the additional installation effort to install the associated harness and equipment
Services	Includes the additional effort to manage, configure, FAT test, fleet install, mini fleet test, system acceptance test, and train for the head sign functionality on-board the vehicle

Vehicle Health Monitoring	
AVM®	Fixed-end AVM® solution that provides the most sophisticated solution for monitoring and maintain the fleet analyzing and processing the data and presenting the information in a useful and intuitive web interface
IVN® Upgrade and Harness	On-board IVN® upgrade to support state of the art collection, storage, transfer of AVM® fault and performance data to the fixed end and additional harness

Harness	On-board harness to support interfacing with J1708 and J1939 devices on the fixed route fleet
Services	Includes the additional effort to manage, configure, FAT test, mini fleet test, fleet and fixed end system install, system acceptance test and train for the AVM® functionality on-board the vehicle and on the fixed end
	Automatic Passenger Counting
APC Reporting	Fixed end APC reporting solution from UTA that includes data filtering/cleansing, statistical processing, tabular reports, graphical reports and NTD reporting
APC Alternative 1	On-board APC counters from Hella that support state of the art overhead vision technology for the most accurate counting available on the entire fixed route fleet
APC Alternative 2	On-board combination of APC counters from Hella state of the art overhead vision technology for wide door buses and Clever Devices economical and accurate dual beam technology on buses with narrow doors
IVN® Upgrade and Harness	On-board IVN® upgrade to support APC data collection, storage, transfer of APC performance data to the fixed end and additional harness
Services	Includes the additional effort to manage, configure, FAT test, fleet and fixed end system install, mini fleet test, system acceptance test and train for the APC functionality on-board the vehicle and on the fixed end
	Interactive Voice Response
IVR	Fixed end Enghouse's Busline fixed route IVR system integrates with the scheduling data from Trapeze FX and Clever Devices' BusTime® to provide bus arrival information over the phone system
Services	Includes the additional effort to manage, configure, FAT test, fixed end install, mini fleet test, system acceptance test and train for the APC functionality on-board the vehicle and on the fixed end
	Yard Location
SmartYard™	Fixed end yard location system to provide accurate and reliable reporting of the bus in the yard and depot with an intuitive web user interface for viewing bus location
SmartTag	On-board SmartYard™ tag mounted on each vehicle of the fixed route fleet for accurate and reliable location tracking
Harness	On-board harness to provide power to the SmartTag
Services	Includes the additional effort to manage, configure, FAT test, fleet and fixed end system install, mini fleet test, system acceptance test and train for the SmartYard™ location functionality on-board the vehicle and on the fixed end
	Bus Assignment Option
SmartYard™ Upgrade	Fixed end SmartYard™ application upgrade to support operator to bus assignments through an intuitive web based user interface
Services	Includes the additional effort to manage, configure, FAT test, fleet and on-board and fixed end system install, mini fleet test, system acceptance test and train for the SmartYard™ bus assignment functionality on the fixed end

CAD/AVL	
CleverCAD®	Fixed end solution that provide a reliable, mature and feature rich fleet management CAD/AVL system utilizing state of the art technology
Workstations	Fixed end workstations with dual monitors for CAD/AVL dispatchers
IVN® Upgrade and Harness	On-board IVN® upgrade is required to support the CAD functionality for CAD functionality, voice control and additional harness
Services	Includes the additional effort to manage, configure, FAT test, fleet and fixed end install, mini fleet test, system acceptance test, and train for the CAD functionality on-board the vehicle and on the fixed end

Call Routing Service	
Console Equipment	Clever Devices has included the Gai-Tronics IPC9004 Navigator communications console for each of the two dispatcher workstation positions. Navigator is a feature rich and integral part of the dispatcher work stations to provide the required voice radio control management and integration to the existing XPR-5550 control stations
Tone Remote Adapter	Provides the integration of the Gai-Tronics IPC9004 Navigator to the XPR-5550 control station to the dispatcher workstation positions
Instant Recall Recorder	An additional component to the dispatcher workstation positions to provide one-touch replay of the last 20 seconds of receive and transmit audio and ability to search the past 80 minutes of transmit and receive audio for review
Headset	A Plantronics headset is provide for each of the two dispatcher workstation positions
Microphone	A noise cancelling gooseneck microphone for each of the two dispatcher workstation positions
Services	Includes the additional effort to manage, configure, FAT test, fleet and fixed end system install, mini fleet test, system acceptance test and train for the call routing functionality on the fixed end

Silent Alarm System/Emergency Alarm	
EA Switch	Emergency/covert alarm switch that will be used to replace the existing switch and support both the radio and the IVN® system
Services	Includes the additional effort to manage, configure, FAT test, fleet and fixed end system install, mini fleet test, system acceptance test and train for the silent alarm functionality on-board the fleet and fixed end

Full Video Transfer	
Storage	150 TBytes of standalone non-raid storage system dedicated to support storing all video retrieved from the fleet
WLAN Access Points	Five additional WLAN access points to support the option to transfer all on-board video
Services	Includes the additional effort to manage, configure, FAT test, fleet and fixed end system install, mini fleet test, system acceptance test and train for the SmartYard™ bus assignment functionality on the fixed end

Remote Bus Stop Signs	
Passenger Information Displays	Five single sided four line LED signs with ruggedized enclosures dual language and audio are useable in high sunlight areas and integrate to BusTime® for display of passenger information
Road Supervisor System	
Ruggedized Laptop	MTD personnel can utilize the ruggedized laptop in supervisor vehicles or anywhere to access CleverCAD® for fleet monitoring, dispatch, and fleet management. The ruggedized laptop provides a user friendly solution for remote fleet monitoring, dispatch and fleet management. This option includes mounting brackets for installation and integration to the modem for cellular access
Services	Includes the additional effort to manage, configure, FAT test, fleet and fixed end system install, mini fleet test, system acceptance test and train for the road supervisor system
Service Vehicle Hardware	
Modem & GPS	Modems with GPS installed on the supervisor vehicles to track vehicle location and for the optional ruggedized laptop access to cellular services
Antenna	Dual band antenna that supports GPS and cellular data communications
Services	Includes the additional effort to manage, configure, FAT test, fleet and fixed end system install, mini fleet test, system acceptance test and train for the service vehicles

7.1.1 Build Time Data Flow

Figure 3 is the build time data flow and represents how static (non-real-time) data flows to the system components. The scheduling system on top provides the schedule data to the entire system through a single interface, BusTools®. The green boxes represent the products Clever Devices will provide with our proposed solution, and the blue boxes represent optional systems. The red arrowed lines represent how data flows form the scheduling system throughout the system. The blue arrowed lines represent data sources that are managed by BusTools® to support the solution. BusTools®, as the single point of interface to the AIM system for all static data, reduces overall maintenance, and provides structure and organization.

BusLink® is fully automated for the distribution of build time data to the system. The user only has to identify the released data from BusTools®, assign an activation date and time, select a group or all buses to receive the distribution and press "go." The distribution process is easy, intuitive, and reliable, which allows MTD to focus on operating their business.

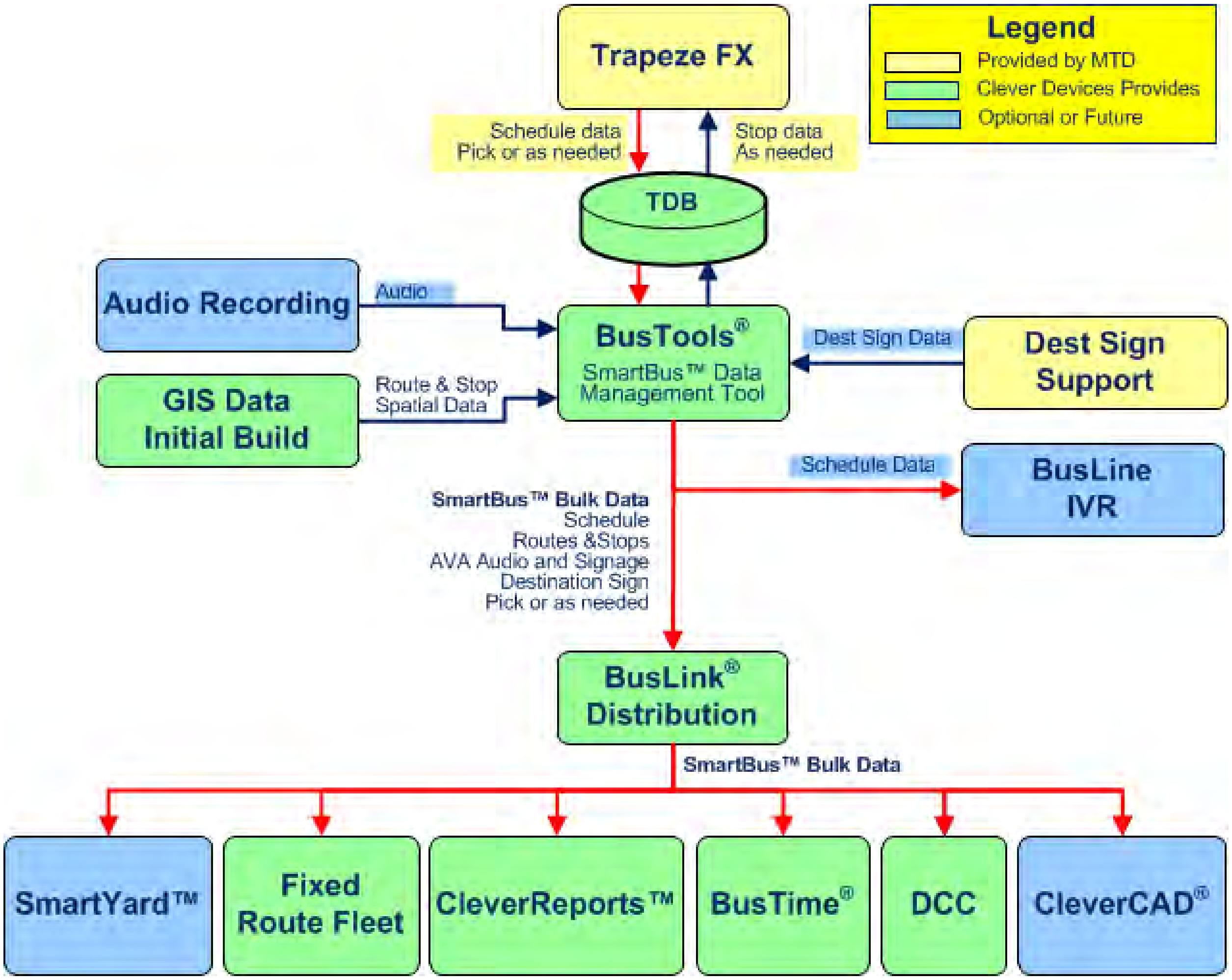


Figure 3: Build Time Data Flow

7.1.2 Real Time Data Flow

The real-time fixed route data flow in Figure 4 provides an overall view of how data and voice flows during daily operations. The tan boxes represent MTD's existing or to be provided systems, equipment, or radio system components. The blue boxes represent optional items and the green boxes represent deliverables by Clever Devices.

The blue lines reflect the real-time data communications of the system. IVN® communicates data through the cellular network to the DCC, which is the communication gateway between CleverCAD® and the fleet. CleverCAD® provides the fleet management interface to the dispatcher personnel through the dispatch workstations and to the supervisors through the ruggedized laptops. Trapeze OPS provides all the work assignments to CleverCAD® for validation of operator logon and to SmartYard™. SmartYard™ provides accurate vehicle location inside the depot and bus assignment functionality.

The green lines reflect the data flow for dissemination of information to the public through the BusTime® time of arrival system. BusTime® feeds all devices and systems that require access to real-time traveler information. The optional IVR provides the riding public voice access to real-time information.

The red lines represent voice communications. IVN® controls operator access to the MotoTRBO voice radio system. All call routing service is provided by Gai-Tronics console and immediate access to previous calls through the instant recall recorder.

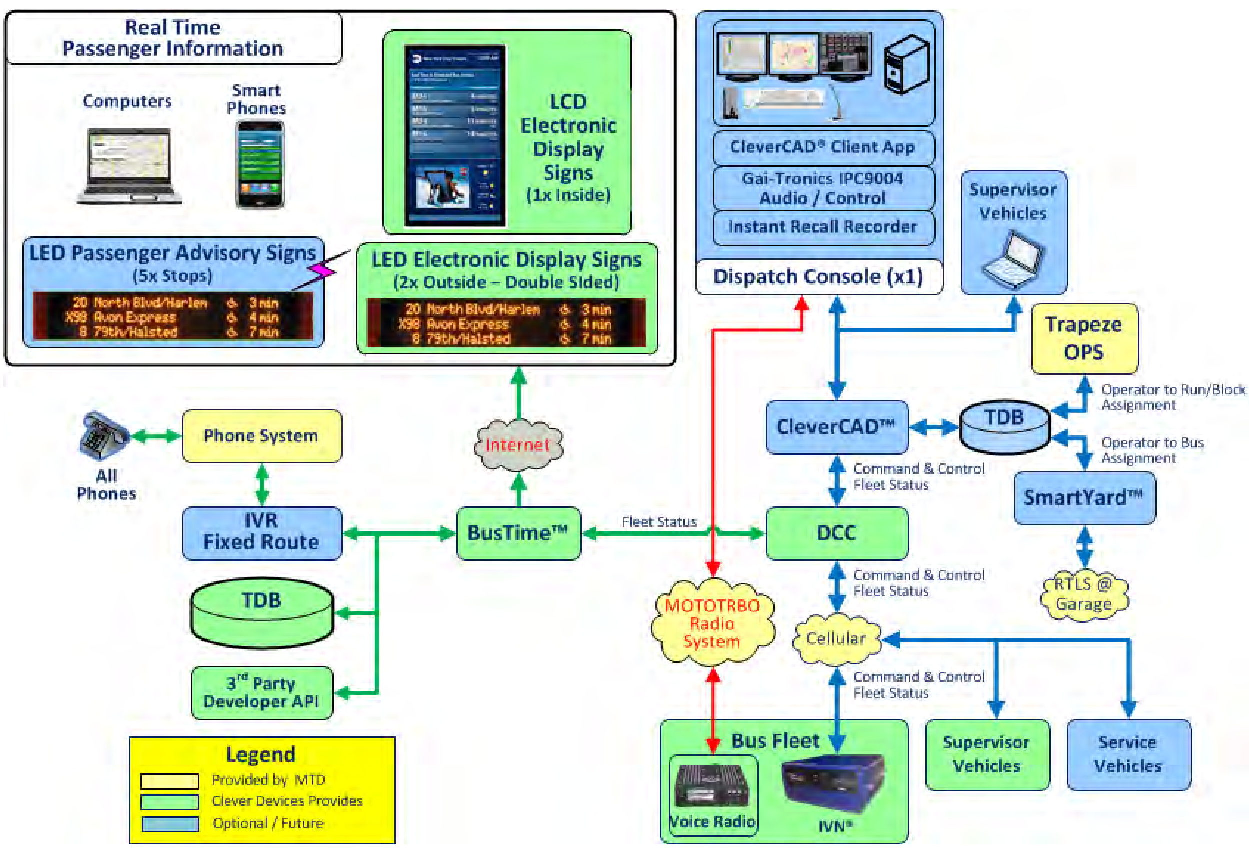


Figure 4: Real Time Data Flow

7.1.3 Historical Reporting Data Flow

The historical reporting data flow in Figure 5 demonstrates how performance data flows, and how it is processed and reported. IVN® and CleverCAD® collect performance data during normal operations and periodically transfer it to the historical database. IVN®'s performance data flows from the bottom up. Daily, IVN® transfers all performance data to the BusLink® server which automatically ingests into the CleverReports™ and optional AVM® data warehouses. CleverCAD® historical data is available to CleverReports™ for reporting purposes. CleverReports™ and AVM® are state-of-the-art web reporting tools and provide MTD with the ability to customize reports as necessary. Each has a data warehouse designed by Clever Devices specifically for transit. As such, MTD can easily create reports with these intuitive and user friendly tools.

An optional APC reporting solution is included. The APC reporting solution has been deployed at many transit authorities and meets all the requirements of the RFP including NTD reporting.

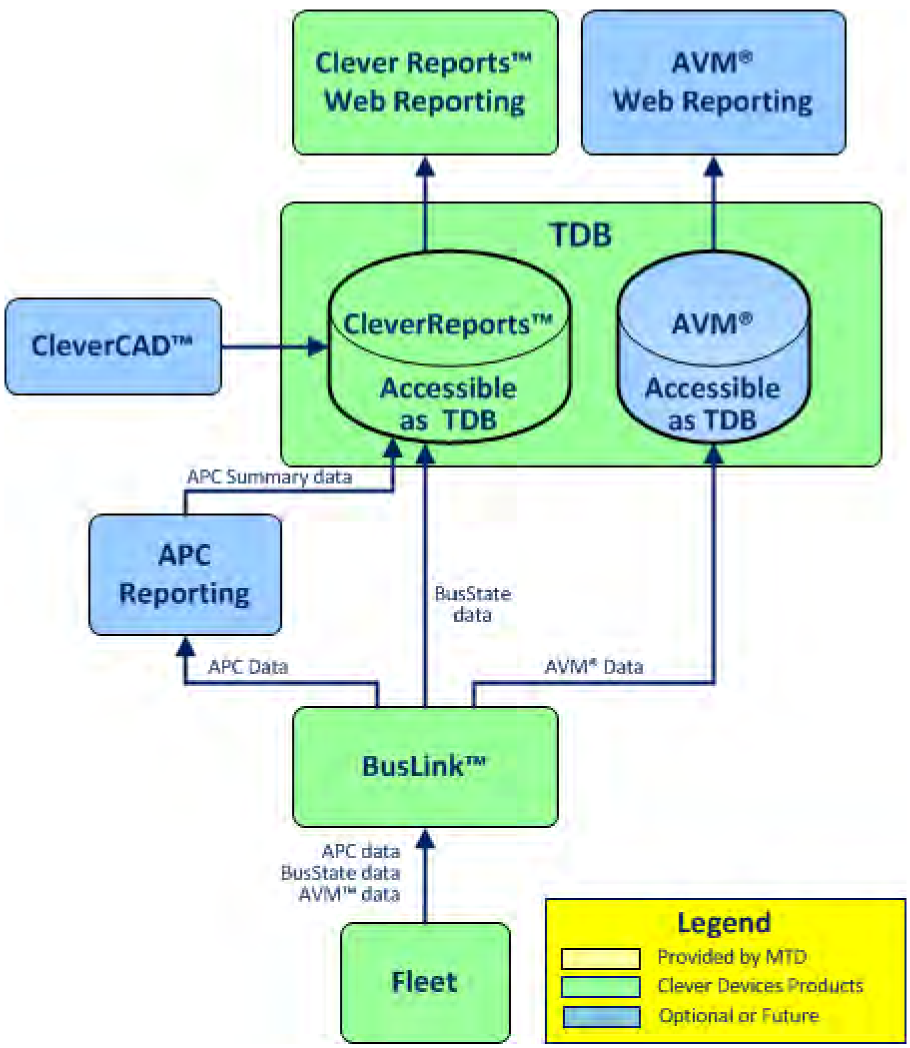


Figure 5: Historical Reporting Data Flow

7.1.4 TDB Data Flow

The data flow for the transit database (TDB) gives a holistic view of all activity of data into, out of, and through the transit database. Clever Devices' philosophy is "All data is owned by MTD". Therefore we give royalty free access to data in our system.

The transit database is primarily used as a central repository for the following three features:

Interface:	Interface and user access between AIM and Trapeze FX and the AVL database is through CleverReports™ and is represented by the blue lines
Real Time Data:	Interface and user access between AIM and Trapeze OPS is represented by the red lines
Historical Data:	Access to historical data by MTD systems is provided by CleverReports™ and AVM® (optional)

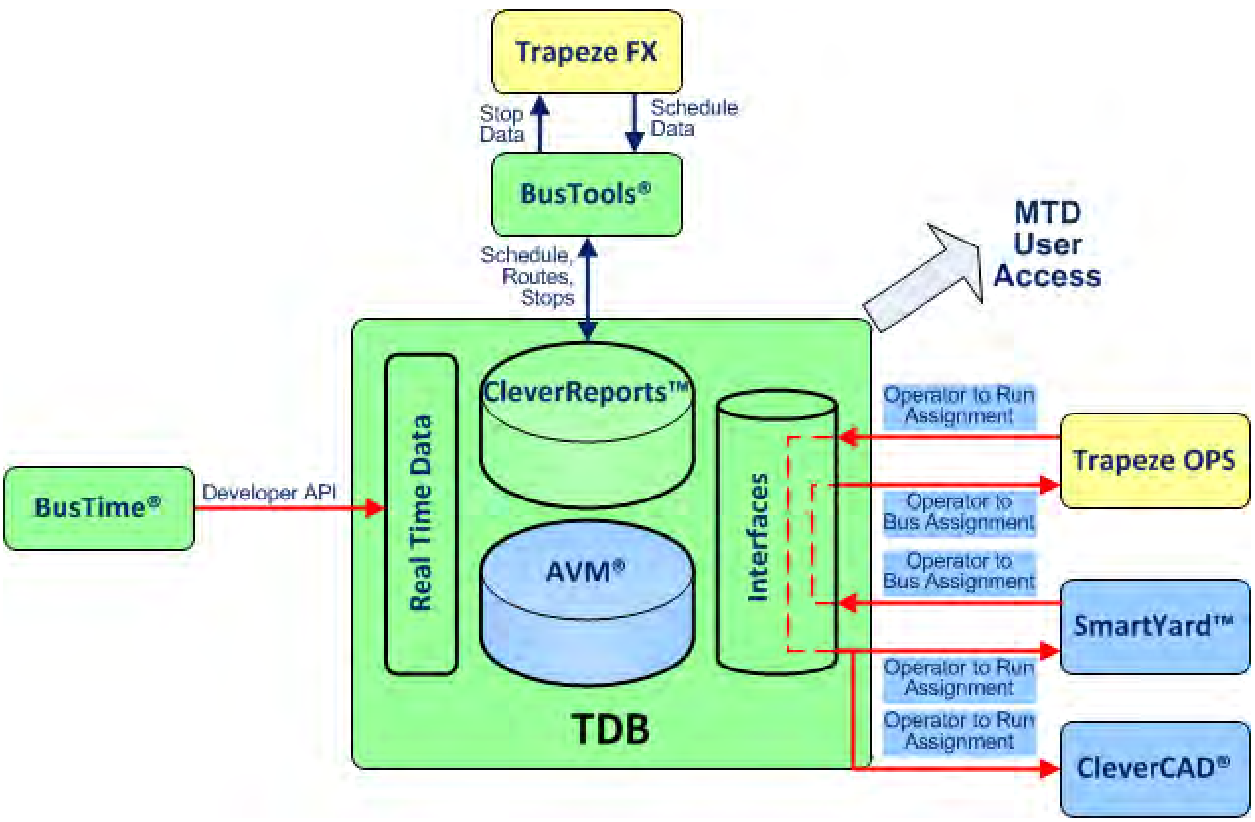


Figure 6: Transit Database Data Flow

7.1.4.1 Schedule Integration to Trapeze and TDB

Clever Devices' proposed solution utilizes BusTools® as the interface between Trapeze FX and the TDB. BusTools® provides the means to manage the routes and stops, as described in section 7.3.1.1 titled "AVL Database – BusTools®" on page 74. The schedule is exported from Trapeze and imported into BusTools®. BusTools® correlates the schedule data to the route and stop data and manages the version and release of information to the AIM system. Of course the schedule data version is maintained and available. Once the correlated route, stop and schedule and are validated by BusTools®, it is exported for used by the AIM system and input into the TDB.

Per addendum 1 and 3, MTD is responsible for procuring from Trapeze the licenses, configuration and setup of the Trapeze FX interface.

7.1.4.2 YWS – SmartYard™ Integration to TDB (Option)

Clever Devices' proposed solution capitalizes on the TDB to interface the SmartYard™ YWS system with Trapeze OPS. Trapeze OPS provides the assignment of operator to run. This data is input into the TDB periodically. SmartYard™ retrieves, from the TDB, this data periodically and utilizes it for display and to aid in the assignment of operators to buses. The MTD personnel that assign operators to buses will use SmartYard™ to do the assignment of operators to buses. All assignments are then posted back into the TDB for retrieval by Trapeze OPS.

CleverCAD® will retrieve the operator to run assignments through the same interface as required by SmartYard™. CleverCAD® uses this data for logon validation.

An advantage to MTD is that Clever Devices side of this interface and the TDB are fully operational at another transit agency. Trapeze is currently in process of updating their Trapeze OPS interface to support importing the operator to bus assignments back into Trapezes OPS.

7.1.4.3 Access to Real Time Fleet Infromation and TOA via TDB

BusTime® comes with a free Developer API. The BusTime® Developer API allows the user to request and retrieve data directly from BusTime® in real-time. Registered third-party developers can make an HTTP request for data and receive an XML response from the BusTime® web server.

Data available through the API includes:

- Vehicle ID
- Current vehicle location (latitude, longitude, heading)
- Timestamp
- Route status
- Destination
- Route data (route lists, geo-positional route definitions, stop lists, etc.)
- Prediction data
- Service bulletins

The API is fully backward compatible allowing time for developers to upgrade their applications to make use of new API features.

In order to use the API, you must sign in to your BusTime® account and request an API key. Only one key will be available per account. Once the request has been approved, an email will be sent to the user with the API key.

Once you receive the key, the user will be able to make calls to the API by providing the key as part of every request for data.
By default, the Developer API will place a limit of 10,000 requests on an API key. If MTD believes that it will require more than 10,000 daily requests, MTD must request that the cap on MTD's key be raised to handle the additional traffic.

7.1.4.4 *Data Integrity*

A significant advantage to MTD is the data integrity enforced by BusTools®. A primary objective of BusTools® is data integrity. BusTools® goes above and beyond data validation and provides 63 data integrity checks. BusTools® also is used to visually plot, validate, and simulate all route variants, Timepoints, and bus stops prior to and after deploying to the fleet.

BusTools® not only identifies the specific problems but provides reference material as to the source of the anomaly and recommends solutions to resolve the anomaly. BusTools® categorizes the warnings as "Error" or "Warning" and provides the user with a summary of all errors. Simply double clicking on any of the identified errors takes you to the error log screen that identifies each specific error and provides sufficient data for the user to resolve the problem. The figure below demonstrates the power of BusTools® to take a complicated issue, categorize it, organize it, and provide a summary to track all issues. With BusTools® data is cleansed prior to deployment on the fleet. This way MTD will have confidence in the system by having confidence in the data.

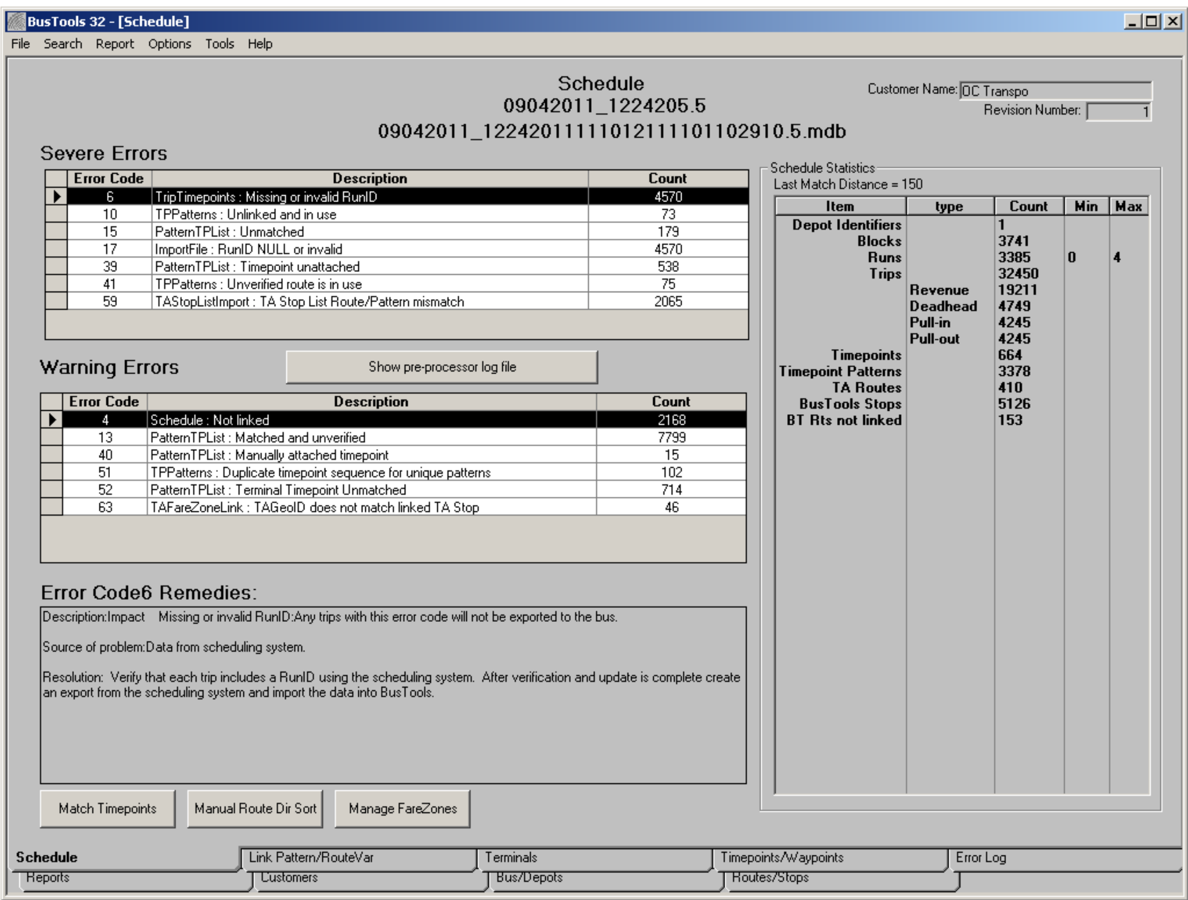
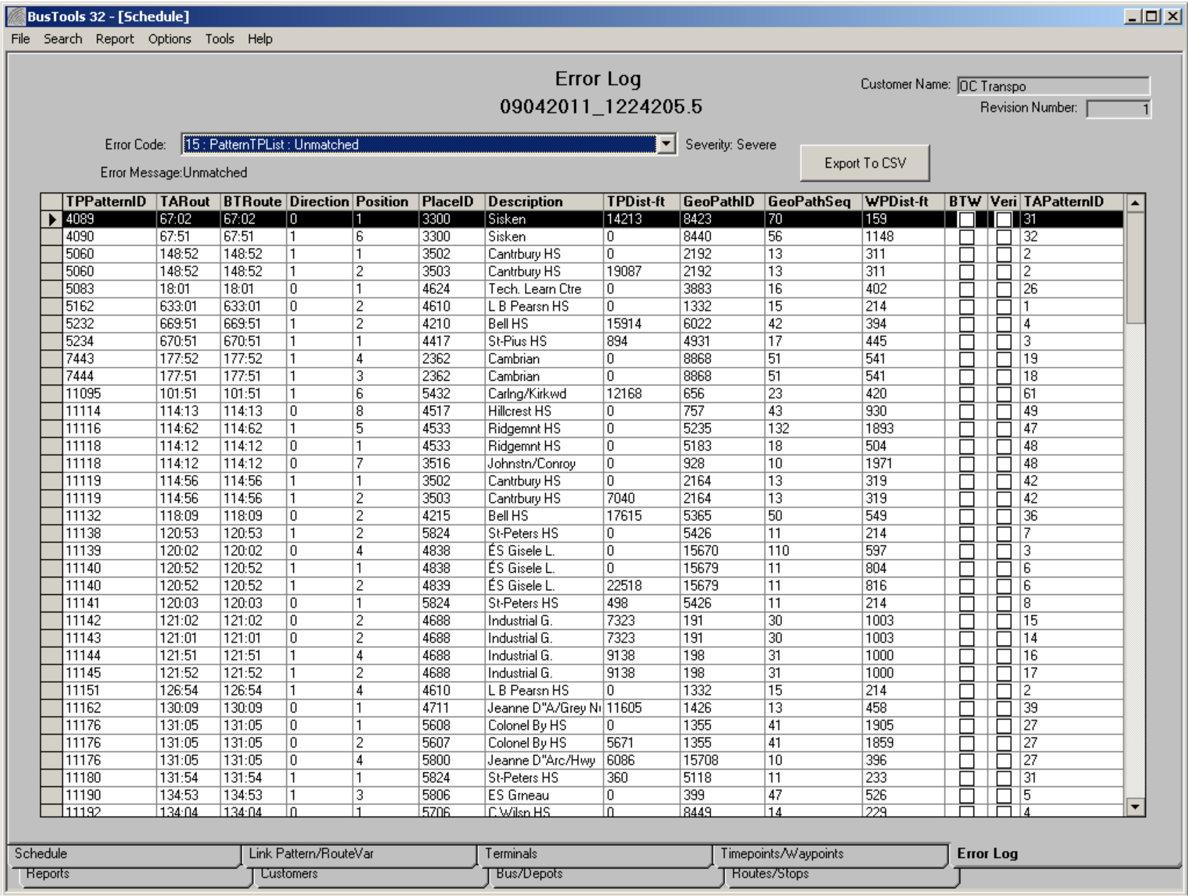


Figure 7: BusTools® Data Integrity

The user can simply double click on any error or warning and the Error Log tab is displayed. The error log tab provides details of each specific anomaly and displays appropriate data to help resolve the issue. The figure below provides a screen shot of the error log and the wealth of data available to help resolve the issue.



TPPatternID	TARout	BTRoute	Direction	Position	PlaceID	Description	TPDist-ft	GeoPathID	GeoPathSeq	WPDist-ft	BTW	Veri	TAPatternID
4089	67:02	67:02	0	1	3300	Sisken	14213	8423	70	159			31
4090	67:51	67:51	1	6	3300	Sisken	0	8440	56	1148			32
5060	148:52	148:52	1	1	3502	Cantrbury HS	0	2192	13	311			2
5060	148:52	148:52	1	2	3503	Cantrbury HS	19087	2192	13	311			2
5083	18:01	18:01	0	1	4624	Tech. Learn Ctre	0	3883	16	402			26
5162	633:01	633:01	0	2	4610	L B Pearsn HS	0	1332	15	214			1
5232	669:51	669:51	1	2	4210	Bell HS	15914	6022	42	394			4
5234	670:51	670:51	1	1	4417	St-Pius HS	894	4931	17	445			3
7443	177:52	177:52	1	4	2362	Cambrian	0	8868	51	541			19
7444	177:51	177:51	1	3	2362	Cambrian	0	8868	51	541			18
11095	101:51	101:51	1	6	5432	Carlng/Kirkwd	12168	656	23	420			61
11114	114:13	114:13	0	8	4517	Hillcrest HS	0	757	43	930			49
11116	114:62	114:62	1	5	4533	Ridgemnt HS	0	5235	132	1893			47
11118	114:12	114:12	0	1	4533	Ridgemnt HS	0	5183	18	504			48
11118	114:12	114:12	0	7	3516	Johnstn/Conroy	0	928	10	1971			48
11119	114:56	114:56	1	1	3502	Cantrbury HS	0	2164	13	319			42
11119	114:56	114:56	1	2	3503	Cantrbury HS	7040	2164	13	319			42
11132	118:09	118:09	0	2	4215	Bell HS	17615	5365	50	549			36
11138	120:53	120:53	1	2	5824	St-Peters HS	0	5426	11	214			7
11139	120:02	120:02	0	4	4838	ÉS Gisele L.	0	15670	110	597			3
11140	120:52	120:52	1	1	4838	ÉS Gisele L.	0	15679	11	804			6
11140	120:52	120:52	1	2	4839	ÉS Gisele L.	22518	15679	11	816			6
11141	120:03	120:03	0	1	5824	St-Peters HS	498	5426	11	214			8
11142	121:02	121:02	0	2	4688	Industrial G.	7323	191	30	1003			15
11143	121:01	121:01	0	2	4688	Industrial G.	7323	191	30	1003			14
11144	121:51	121:51	1	4	4688	Industrial G.	9138	198	31	1000			16
11145	121:52	121:52	1	2	4688	Industrial G.	9138	198	31	1000			17
11151	126:54	126:54	1	4	4610	L B Pearsn HS	0	1332	15	214			2
11162	130:09	130:09	0	1	4711	Jeanne D"A/Grey N	11605	1426	13	458			39
11176	131:05	131:05	0	1	5608	Colonel By HS	0	1355	41	1905			27
11176	131:05	131:05	0	2	5607	Colonel By HS	5671	1355	41	1859			27
11176	131:05	131:05	0	4	5800	Jeanne D"Arc/Hwy	6086	15708	10	396			27
11180	131:54	131:54	1	1	5824	St-Peters HS	360	5118	11	233			31
11190	134:53	134:53	1	3	5806	ES Grneau	0	399	47	526			5
11192	134:04	134:04	0	1	5706	C Wilsn HS	0	8449	14	229			4

Figure 8: BusTools® Error Log Details

The table below provides a detailed list of the 63 unique data integrity checks. This list has been instrumental in cleaning data from schedule systems and to validate data prior to deployment on the fleet.

Table 1: BusTools® Data Integrity Check List

Schedule System Data Integrity Checks		
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	

Clever Devices utilizes the standard scheduling system export to keep your BSA systems contemporary with your service. Once the schedule data is authorized for use, the schedule user simply exports the current schedules using the standard export. The schedule data is then imported directly into BusTools®. Once imported, the schedule data is automatically linked to pre-existing data (i.e., stop name, text, audio, etc.) in BusTools®. Any changes in data are identified for the user to resolve. Typical pick data from the scheduling system is ready to go within one day of export from Schedule. The process is simple, reliable, and results in quality data you can trust.

The figure below demonstrates the import flow allowing MTD to wirelessly upload and utilize schedule data, time point location data and destination sign data. In this diagram BusTools® enforces data integrity and data correlation automatically.

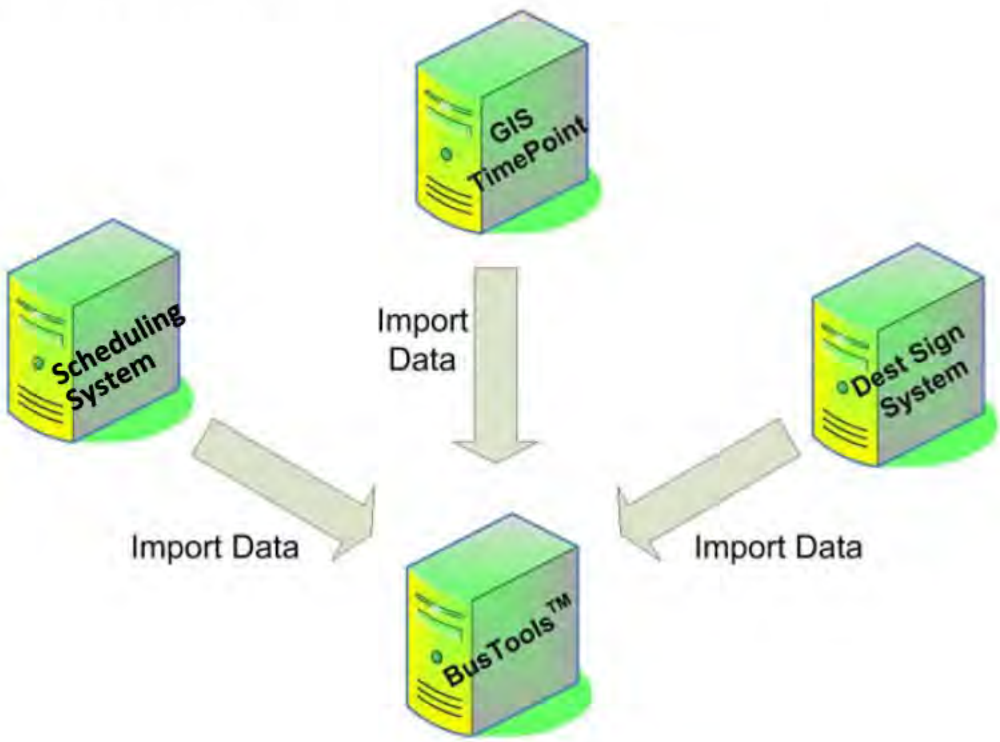


Figure 9: BusTools® Data Import Management

Within BusTools® the following process is enforced:

- Access data from external products
- Data relationships established
- Data relationships enforced via software and data
- Over 63 software and data rules
- Data relationship anomalies tracked and reported
- Anomaly resolution is described
- Traceability of data anomaly to bad source data

With BusTools®, the import data has built-in integrity to ensure only valid data gets to the fleet. Once data relationships are identified, they are maintained. This makes it easy to manage the complex schedule import data process. Without this capability the user of the system would be inundated with the menial and time consuming task of manually finding and resolving data anomalies.

Distribution of BusTools® data to the fleet, and operational performance data from the fleet for further analysis and utilization, is critical to the overall success of the BSA system. BusLink® is the system that facilitates the wireless LAN bulk data transfer to and from the fleet.

Clever Devices system solution supports multiple data sets of schedule and announcement data. The schedule export includes all schedules assigned to the export. These can include weekly, holidays, specials, and more. The single export includes all data for this schedule version. BusTools® imports this data as a complete and single version of schedule data.

For the fleet the new schedule version takes effect on the activation date and time as defined by MTD when creating the distribution with BusLink®. The fleet automatically downloads the data, validates it, and then waits for the very first boot after the activation date and time to apply the update. This process ensures that every bus currently running service at the activation time completes it with the previous schedule (as it should), and any bus that powers up after the activation date and time, utilizes the updated schedule.

The process is reliable, is proven, and eliminates the need to manually update the fleet or process multiple sets of data on the vehicle. After all, the vehicle can only be running one schedule at a time.

7.2 AIM Design & Communications

7.2.1 Capacities and Expandability

The proposed server hardware is sufficient to support the base system and all optional systems. The advantage to MTD is that the optional systems will only require server software licenses.

All the products included with this proposal are designed and proven at much larger transit agencies. The advantage to MTD is that the products are off-the-shelf and proven.

Clever Devices' proposed solution uses cellular for all real time data communications. The advantage to MTD is that fleet expansion will not limit periodic reporting of data communications.

7.2.2 Open System Architecture

Clever Devices uses standard off the shelf sever hardware, operating systems, virtual machine software, and database technologies for our products. Clever Devices' uses multiple facilities for the manufacture of all hardware products. Clever Devices' software products are developed in accordance with Microsoft standards. Clever Devices utilizes standards for all on-board interfaces.

7.2.2.1 Software

Clever Devices is a Microsoft shop and capitalizes on Microsoft technology and standards to ensure products are state of the art, current and maintainable. Clever Devices makes every effort to keep our products current with the latest MS SQL Server database technology and MS operating systems. All application software is written in high level languages such as C++, Java, and in a MS .Net environment.

Clever Devices has included a fixed end test server environment to support the installation and test of software updates and upgrades without impacting MTD normal operations. All new software is installed on this test server and tested for ease of installation, proper configuration and reliability. Once all testing is complete it is migrated to the production server environment.

7.2.2.2 Data Protocols

Clever Devices uses SAE J1939 and J1708 and Ethernet for all on-board communications. Clever Devices capitalizes on 802.11 a/b/g/n technology for WLAN communications. Clever Devices will utilize TCIP with equipment and or systems that support it.

For real time data communications over the cellular network, Clever Devices will provide MTD with information on the standards used such as UDP. However, the detailed communications protocol is proprietary to Clever Devices.

7.2.2.3 Databases

Clever Devices uses MS SQL database technology for nearly all products. These utilize relational databases and for historical reporting start schema database designs. All are ODBC compliant with multiple user access.

7.2.2.4 National ITS Architecture

Clever Devices' system architecture is based on the National ITS architecture developed by APTA. Clever Devices uses standards for communications and data interfaces where available. Clever Devices philosophy is that all data is owned by MTD. The advantage to MTD is royalty free access to data. As an example, Clever Devices' BusTime® Developer API is an XML based interface that allows MTD authorized third party developers free access to all predictions. In Chicago there are multiple third party developers using this interface to provide real time of arrival information to the riding public through we and mobile applications.

7.2.2.5 Reliability and Maintainability

Clever Devices has proposed a state-of-the-art server environment with redundant servers. The solution is described in detail in section 7.4.2 titled "Servers" on page 219. The on-board systems are proven in similar environments and configurations.

An advantage to MTD is that Clever Devices' on-board systems is sufficiently high that the quantity of spares can easily be reduced to 5% and have no effect on maintainability or availability.

The voice radio system will remain as is. Clever Devices will integrate on-board the vehicle for the sole purpose of providing a closed mic voice system. The user of cellular for real time data communications provides MTD with a more reliable overall system solution, as there are two communication technologies. Thus if one fails the other is still available.

Clever Devices has included PA Monitor to monitor all fixed end equipment and applications. To monitor on-board systems, the AVM® option is required.

All console equipment shall be replaceable without affecting other consoles or workstation positions.

7.2.2.6 Response Times

Clever Devices server and storage solution has sufficient capacity to support a pleasurable user experience in reference to usability and response times.

7.2.2.7 AIM Interfaces

Clever Devices solution addresses the interface requirements outlined in the RFP.

7.2.2.7.1 TDB

Clever Devices has included a transit database for the use of interfacing and MTD access to data from the AIM system. The TDB is described in detail in section 7.1.4 on page 64.

7.2.2.7.2 Vehicle Equipment

Clever Devices' IVN® system provides all the interfaces for the base system, as well as, the optional systems. Clever Devices' solution includes the integration to on-board systems that currently have an existing interface that meets existing standards. Clever Devices' has included the cost to upgrade the GFI fare system to support J1708.

7.2.2.8 Utilities and Third Party Services

Clever Devices has included the costs for all cellular data services and SMS text messaging. Clever Devices will utilize existing MTD internet service provider for data into and out the fixed end. MTD is responsible for providing electrical power to all workstations, servers and storage. MTD is responsible for all networking between MTD facilities where workstations, servers and storage will be installed.

7.2.2.9 Log-in Device

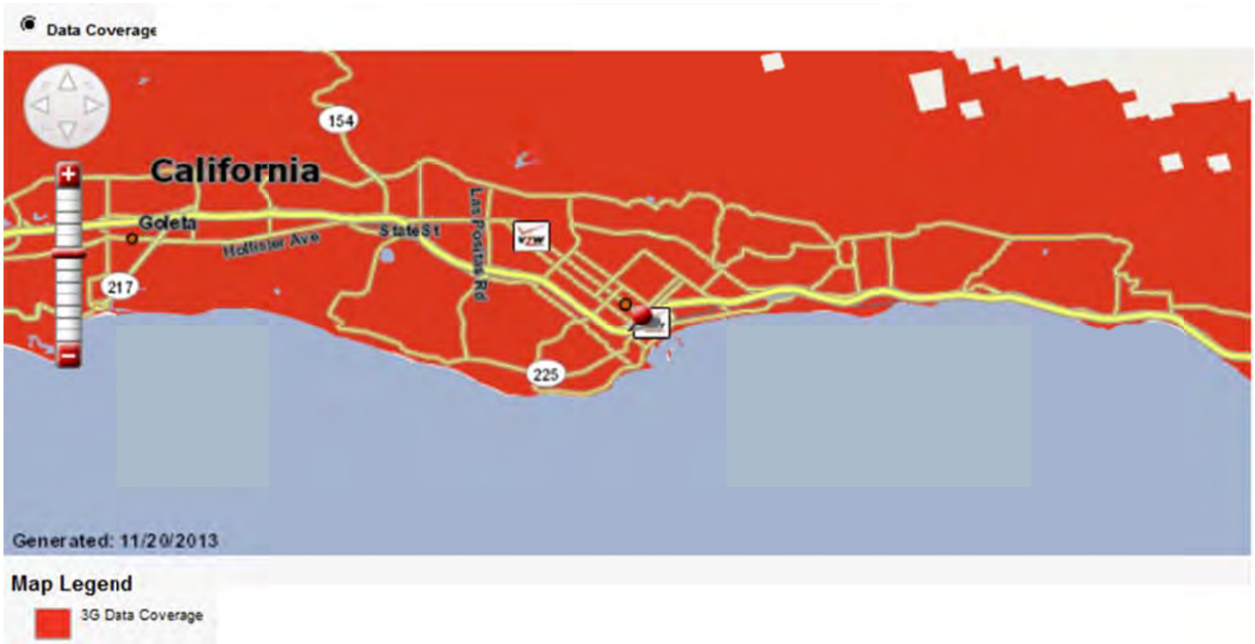
Clever Devices has included our MDT as part of the base system to support logon. Although not technically required, as the logon could be accomplished through the GFI farebox, the MDT is required to meet the functionality of the BSA system. Since the BSA system is the highest priority device and the budget is sufficient to accommodate this, we have included the MDT with the base system.

Clever Devices has deployed many on-board systems in similar and more complicated configurations. In nearly all cases, we have integrated with GFI to share information and provide a single point logon for all devices. Clever Devices' proposed single point logon is off-the-shelf and operational at multiple agencies.

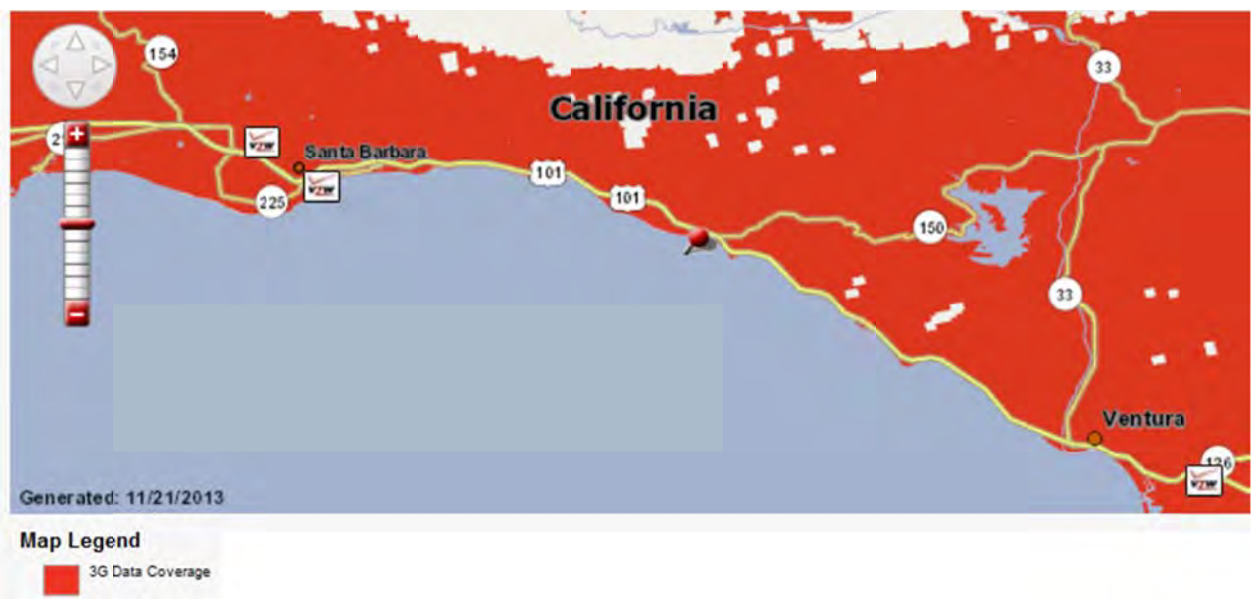
7.2.3 Vehicle Data Communications

Clever Devices has evaluated the existing MotoTRBO radio system deployed at Santa Barbara. The single RF channel that is currently used by MTD for primary communications is insufficient to support both voice and data. To utilize a data radio solution using the MotoTRBO radio system would require a redesign of MTD's central radio system and the addition of a minimum of one RF channel at each of the three coverage areas (Gibralter, Santa Ynez, and Oxnard). Clever Devices has therefore selected cellular as for real time data communications to minimize the effort, time and cost associated with a MotoTRBO radio system upgrade.

Clever Devices' solution can support any cellular service provider. For MTD Clever Devices' has proposed Verizon as the cellular data service provider for all real time data communications. Verizon coverage in Santa Barbara area is outstanding and indicates complete coverage as shown below.



The following picture illustrates that the Verizon coverage between Santa Barbara and Ventura is also excellent and will support real time data communications for the Ventura Route optionally required to support by the AIM system.



Clever Devices' proposed solution includes the following:

- Cellular data for real time data communications
- 802.11n for WLAN data communications at the depot
- Existing MotoTURBO for all voice communications

Real-time data communications is 30 seconds and is configurable upon request from MTD. The bandwidth cost included in the proposal is based on the 30 second update. The bandwidth associated with a 30 second location update is expected to be less than 20 MB/month/bus.

When the operator presses the silent alarm switch (EA Switch), the system automatically updates the vehicle location reporting rate to an MTD specified rate. This is typically 15 seconds.

The on-board system, as shown in the system architecture, includes all the equipment to support the WLAN, cellular and GPS communications including modems, antenna, wiring and installation.

7.2.3.1 Encryption

Cellular Real-Time Data:

Clever Devices has deployed the proposed system at many transit agencies throughout North America with and without secure connections over cellular service. Most deployments do not use or require secure real time data connections for cellular service, because the on-board system is an embedded closed system, and the data path into the fixed end is for internet service. For deployments that require encryption or other security features, Clever Devices includes additional services provided by the cellular carrier. These have not been requested by MTD and therefore have not been included. If desired by MTD, these can be included at an additional cost.

802.11n WLAN at the Depot:

Clever Devices proposed solution includes the security features as specified in the RFP. Clever Devices will work with MTD staff to understand your security guidelines and configure the WLAN accordingly.

7.3 AIM Systems

7.3.1 AVL

7.3.1.1 AVL Database – BusTools®

Clever Devices' proposed solution includes BusTools®, which provides an intuitive and easy way to manage the route and stop GIS spatial data. BusTools® will utilize the export from Trapeze to initialize its route and stop data. Any GIS data not available from Trapeze will be collected and maintained by BusTools®. BusTools® will utilize a MTD bus stop ID for unique stops. Clever Devices will validate all route and stop GIS data by driving the routes. BusTools® will export any stop data for import back into Trapeze. BusTools® GIS stop management includes extensive data integrity rules, makes management of route and stop GIS data easy.

To achieve a fully operational and functional ITS system, a comprehensive data management system is required. As we all know, the system is only as good as the data it uses. However, Clever Devices' BusTools® takes data management to the next level. BusTools® is easy to use, is reliable, and most importantly has built-in data integrity to prevent bad data from getting in the system. MTD personnel will utilize BusTools® to maintain all data required by the on-board system. BusTools® seamlessly interfaces to MTD's scheduling system. With every schedule change (pick) the schedule data is imported into BusTools® where integrity checks validate all schedule data for completeness, accuracy, and missing data. The import is simple, automated, provides error reports, identifies sources of errors, and recommends solutions on how to resolve errors.

Clever Devices will initialize the BSA system with all BusTools® data including schedule, configuration, routes, stops, and passenger information as part of the system deployment and approved by MTD.

The advantage to MTD is BusTools® requires only one non-technical person to manage all data for the BSA system.

Clever Devices' BusTools® is a database management application that has 3 major functions:

- Supports and utilizes route, stop, and all BSA data
- Interface and utilizes schedule system data
- Vehicle configuration control
- Generate all data for the on-board BSA system

The primary objective of BusTools® is to seamlessly merge the new on-vehicle data requirements into MTD operating environment. To achieve this, BusTools® is used to define what the bus is supposed to do. Secondly, it provides a route and bus stop inventory management system with data mapping which meets the stringent requirements for reliable and accurate on-vehicle navigation. Thirdly, it guarantees data integrity so that what you see and hear in BusTools® is the same as what you see and hear on the bus.

BusTools® is used for the preparation of all data on the IVN® which includes:

- Equipment Configuration
- Route and Bus Stop Inventory
    - Trigger locations
- Schedule Data
- Passenger Information System
    - Interior and Exterior Announcements
    - Interior Sign text
    - Exterior Destination Sign codes and text

7.3.1.1.1 Reports

BusTools® data management tool provides extensive reports for data management, analysis, and information. These include ASCII, CSV, XLS, and all are printable directly from BusTools®. A subset of the available reports is listed here:

Type	Report Name
Informational	Route List Bus List Single Route List Assigned Dest Codes Next Stop List (Info ID) Farezone List WorkID Summary Passing Times
Spatial Analysis	Data Collection Tool Request Duplicate Stop List

	Spatial Data Exception List GeoID Pairs List GeoPath Analysis Routes with no Dest Code Distance Discrepancy Schedule Route not in Export Routes not Linked
Audio Work	Studio Work Request Audio Phrase List
Configuration	Parameters
Transfer Tickets	Transfer Tickets Transfer Duration Transfer Ticket Security Codes
Schedule Data	There are over 63 unique reports related to schedule anomalies. These are described in Table 1 on page 68

7.3.1.1.2 GIS Geocoding

BusTools® comes with an integrated solution to manage the collection of route and stop information while driving the routes. This will be used to validate the existing data from the Trapeze system. Clever Devices has also included with our proposal a map based editing for route and stop GIS data. This will allow MTD to maintain the route and stop data without going into the field.

7.3.1.2 On-Board Navigation

Clever Devices' proposed solution includes an embedded GPS receiver with gyro, odometer, kalman filtering and map matching to ensure the bus reports its location accurately and with high reliability. Clever Devices calls our navigation system PerfectNav™. PerfectNav™ is described in section 7.4.4.3.18 on page 252 for complete details.

7.3.2 Time of Arrival – BusTime®

Clever Devices offers our industry-leading BusTime® real-time passenger information (RTPI) system as a high-value, low cost solution that is highly reliable and is the best in class integrated Customer Information System. Clever Devices has extensive experience deploying customer information systems, having implemented the largest customer information system in the United States at the Chicago Transit Authority (2,200 buses, 160 routes, and over 12,000 bus stops), as well as at small transit authorities and mid-sized transit authorities similar to MTD.

Clever Devices' BusTime® is the central system component for RTPI for public consumption. BusTime® is a RTPI system designed to provide estimated arrival and departure information, schedule, and map-based automatic vehicle location (AVL) information for equipped fleets through a variety of media: signs, wireless devices such as smart phones and personal digital assistants, and the internet. The system is user friendly, automated, and once implemented requires no operational support on the part of MTD.

The following is a list of the major features included within BusTime®:

- Unrestricted royalty free access, through an API (Application programming Interface), to fleet data for third party application development
- Public accessible WEB AVL map display of routes, stops, vehicles while providing predicted arrival/departure information

- Public accessible WEB tabular display of routes, stops, vehicles while providing predicted arrival/departure information
- Public accessible iPhone and Android mobile application that provides quick and easy access to:
  - o Google Trip planner
  - o Transit agency website for fare, safety rules and transit help
  - o Transit agency website for access to rider alerts
  - o Determine current location based on phone's GPS receiver, plot on Google Maps, and display nearest stop/stations with a pin and display lines/routes as a popup when you touch the stop/station pin and access bus arrival/departure information as provided by BusTime®
- BusTime®'s existing alert management interface that allows anyone to register, change, and manage alerts
- The ability to search for an address or point of interest and display stops/stations and routes/lines near the found item
- Public accessible smart phone SMS interface
- Optional public accessible IVR (Interactive Voice Response) solution for all touch tone phones
- Public viewable LCD displays at transit agency defined locations for the dissemination of predicted arrival/departure information, time, alerts, MTD Icon/graphic, service bulletins, and multi-media (video)
- LED and LCD sign management and configuration control
- BusTime® has an enhanced Supervisor view available to MTD which provides additional information for use by customer service organizations and road supervisors

BusTime® makes transit more accessible by means of communication to the riding public. This ultimately results in increased ridership, more efficient service, and improved customer satisfaction. With BusTime®, MTD will enhance transportation services for its riders with reliable and trustworthy predictions of when the bus will arrive and where the bus is. This information is disseminated to the riding public via web, smartphones, SMS for text capable cell phones, wayside LED and LCD DMS signs, and Interactive Voice Response (IVR). MTD administrators or customer information service representatives will be able to post service bulletins (critical and important announcements or alerts) that affect a stop, route, entire service area, or a general service area to the riders through all display devices and electronic endpoints listed above and as shown below.

A significant advantage to MTD is that BusTime® is deployed with an automated accuracy monitor tool that tracks prediction accuracy system-wide, identifying any problematic routes and/or stops.

Another advantage to MTD is Clever Devices' philosophy on data: "It is your data". Clever Devices' BusTime® is developed with open architecture and provides an unlimited access and royalty free API interface to MTD and third party developers for the creation of new and future applications. The data available through this API are guaranteed to be the most recent arrival predictions to ensure that information displayed to the end user is up-to-date.

BusTime® also comes with a supervisor view that provides MTD authorized personnel access to additional information such as: operator logon credentials, quantity of buses on the route, service status, and operator ID.

BusTime® is a mature passenger information solution designed to simplify the daily commute for public transport users. Unlike traditional bus schedules, BusTime® lets riders see and track the actual status of any bus at any specific route, so people know when their ride is really coming. Instead of waiting at the bus stop, BusTime® helps users to spend their time the way they want to - running another errand, finishing up another project, or simply waiting inside.

Increased use of public transit directly impacts our environment and society. The use of BusTime® improves the safety, reliability, and security of the transit service by reaching riders anywhere, anytime with valuable transit service information. The results are:

Improved Acceptance of Transit as Mode of Choice:
Improved rider information enables transportation choice decisions, increases rider acceptance, and use of Public Transit. Increased ridership decreases congestions, dependency on oil, and improves air quality.

Increased Community Safety and Security:
BusTime® reaches riders anywhere, anytime with critical emergency information enhancing Transit's role in supporting emergency response.

7.3.2.1 Features and Benefits Overview

BusTime® provides several important features and benefits to MTD's administrators and ridership alike. The main features and benefits of BusTime® are shown in the following tables:

BusTime® Streamlines Customer Service…	
Features	**Benefits**
ADMINISTRATION: Setup and configuration	The BusTime® Administration console is an application that serves as the graphical user interface for nearly all configuration, monitoring, and maintenance duties to be performed by the BusTime® Administrator/dispatcher. This provides MTD with peace of mind that the system is running properly.
ACCURACY: An accuracy monitor displaying real-time accuracy of BusTime® predictions	BusTime® calculates accuracy (in seconds) at whole minute intervals from a stop. The accuracy monitor reports BusTime®'s average accuracy results for a given route over a selectable time period. This accuracy monitor allows personnel to ensure that the BusTime® system is running properly and delivering the most accurate predictions possible for customers.

BusTime® Improves Ridership Experience…	
Features	**Benefits**
WEBSITE: Easy to use and widely accessible	The bus service, stops, arrival predictions, routes, maps and Service Bulletins are all accessible on-line and are available in real-time to the riding public.
MAPS: **Display** the location of buses on the route	BusTime®'s Map engine capitalizes on Google maps to illustrate the real-time bus locations with quick and easy access to predicted arrival times of all vehicles on a given route. A stop location of interest is marked as a green star for quick reference on the BusTime® website screen. All buses servicing the selected route are shown progressing on that route.
Service Bulletins: Quick and easy notification to the	Affords MTD the ability to notify the public of any service disruptions, emergency alerts and any other public service messages. Service bulletins can be associated to Stops, Routes, and the entire transit authority.
ALARMS: The capability to set alarms for arriving buses	Setting an arrival alarm for a particular stop is easy. Users can just click on the roadway below their stop of interest. An alarm bell icon appears on the roadway to mark the set alarm. When a vehicle reaches that location, a pop-up alert is issued to inform the user. This makes BusTime® convenient and easy to use.

BusTime® Improves Ridership Experience…	
Features	**Benefits**
ALERTS: Information via Email	With a valid email address, users can sign up for an online BusTime® account for access to any service alerts and/or bus arrival notifications which may be relative to their desired route of travel, including the real-time status information of the last bus of the day, if desired.
SUBSCRIPTIONS: Information via SMS text messaging	In addition to email, users will be able to specify a mobile telephone number for receipt of information alerts through SMS text messaging. This is known as one-way text messaging as it does not require users to issue a text message from their mobile phone to receive a BusTime® informational alert.

7.3.2.2 Prediction Algorithm

BusTime® requires key inputs to create arrival predictions for buses and display buses on the map. These inputs include vehicle location data, fleet schedule, and route maps. The design and use of common language makes BusTime® understandable even for those that read or speak English as a second language.

The foundation of any real time passenger information system is accurate data. BusTime®'s patented prediction algorithms use the route/schedule database, real-time AVL data, and historical performance data to generate accurate predictions. BusTime® validates the AVL report for the corresponding vehicle and matches it to the vehicle's schedule. Upon receiving a vehicle's most current AVL report, BusTime® uses the schedule data and the historical data to execute its prediction algorithm which generates an arrival time for every scheduled stop in the next 30 (configurable) minutes.

BusTime®'s display components use route definition data to populate graphic user interface (GUI) controls (e.g. stop names, stop order, etc.). BusTime®'s display components also use schedule data to display arrival information when AVL information is not available to generate predictions. The prediction process is fully automated as described below:

Step 1: Initialize the System with Static Data

BusTime® requires all spatial data (routes, variations, stops) and temporal data (schedule, timepoints, patterns, block, run, trips, and time) for the entire transit authority. This data is loaded into BusTime® through BusLink®, which keeps the entire system synchronized. This data is updated with each pick – three or four times a year – and sometimes more frequently as required by MTD.

Step 2: Collect Information in Real Time

In order to make a prediction, it is required to know what route the vehicle is on and where the vehicle is currently located. BusTime® requires periodic location data from the vehicle, the block associated with the logon, an indication of logon and logoff, and if available, an indication that the bus is running normal scheduled service or unscheduled service. BusTime® uses this information to determine the route and trip the vehicle is on, its location, and direction of travel.

Step 3: Access to Historical Information

The environment that buses contend with on a daily basis can affect predictions significantly. BusTime® collects and stores historical information about daily performance related to schedule anomalies. This data is used by BusTime® to improve prediction accuracy.

Step 4: Process Information in Real Time

With every received location update, BusTime® performs calculations to generate a "prediction" for that vehicle's arrival at each stop within the next 30 minutes (configurable). These predictions can span to the next schedule route. This prediction is based on the vehicle's current position and BusTime®'s patented algorithms. BusTime® uses geospatial information (route paths, stop locations, etc.), schedule information from the transit authority's schedule system, historical schedule adherence/running times (collected and maintained by BusTime®), and real-time GPS data from the vehicles as inputs into its prediction algorithm. Based on the location of the vehicle and current time, BusTime® determines how a vehicle is tracking to its schedule. BusTime® also uses historical performance data based on a weighted average algorithm for the running times between stops (weighted average by hour of the day, route, and direction). This puts more weight on the most recent running times. BusTime® generates bus arrival predictions for all stops to be serviced in the next 30 minutes. Predictions are updated every time a vehicle transmits a GPS location to BusTime®. Predictions are stored in memory until they are to be displayed on BusTime®'s various display components (web, signs, SMS, mobile device, etc.). Predictions are fully accessible to MTD and authorized third party vendors through the BusTime® Developer API.

Step 5: Distribute Information in Real Time

Each prediction that BusTime® generates is indexed by vehicle, route, and stop in real-time. This information is then displayed on the BusTime® website in response to a rider's query, sent to a rider's mobile phone / personal digital assistant based on user settings, sent to LED and LCD signs, sent as a response to an SMS request, and available to IVR systems upon request.

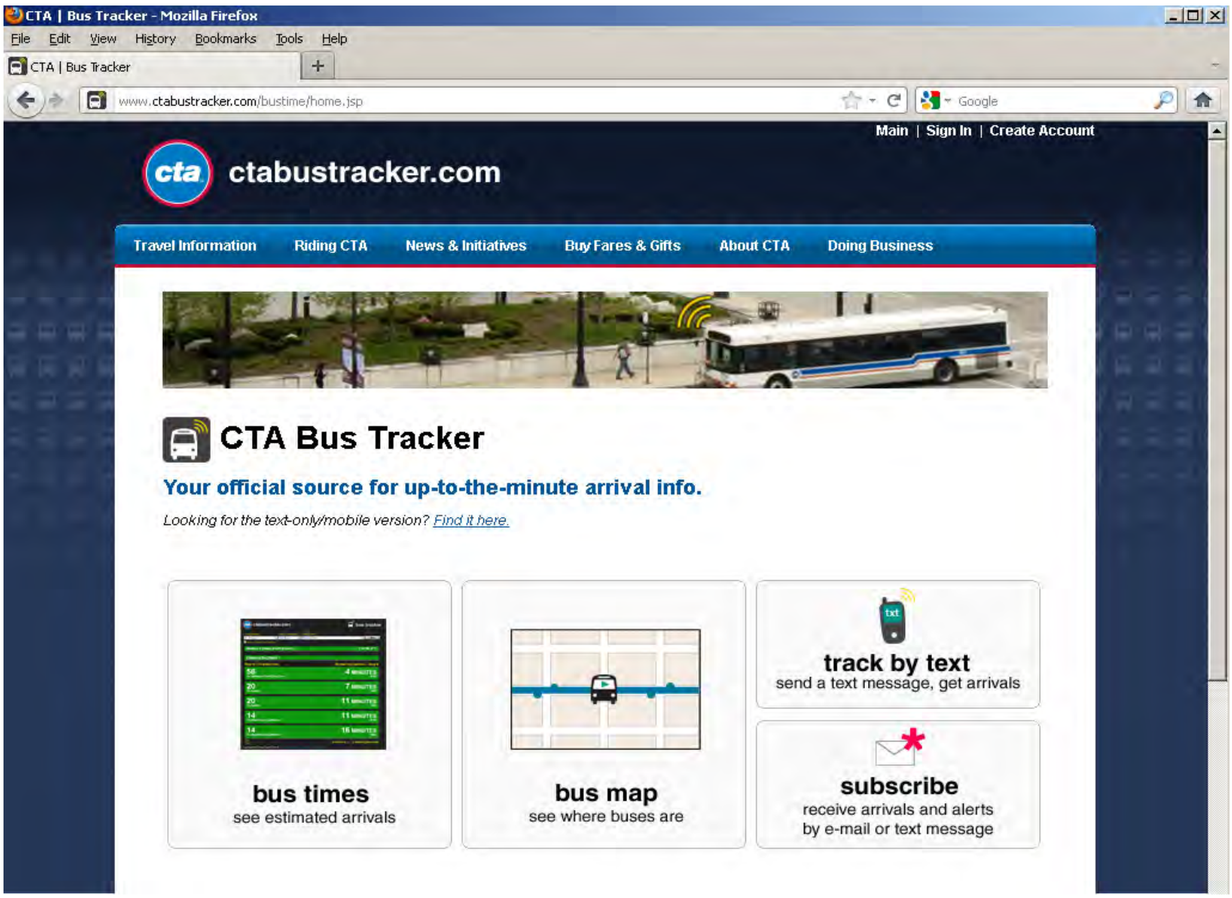
In addition to providing predictions, BusTime® allows an authorized user to construct, review, and distribute service bulletins through all of the same interfaces listed above. Service bulletins are text messages that can represent public service messages, service bulletins relative to a stop, route, or the entire transit authority, or system alerts. All service bulletins can be previewed before they are transmitted.

BusTime® has an HTTP and SMPP interface for transmitting SMS-style text messages to an SMS Service Provider. The service provider will then be responsible for delivering the SMS text messages through various mobile carriers. The transit authority is responsible to establish a plan with an SMS service provider that offers an HTTP or SMPP interface.

For users that have cell phones that support text only (non-smart phones), and for users that prefer text access only, BusTime® provides two options: one-way text messaging and two-way text messaging.

7.3.2.3 WEB Access via Prediction View

BusTime® provides several browser-based views of bus service, routes, stops, arrival predictions, maps, and service bulletins. BusTime® Web components are accessed using a Web browser and an Internet connection. BusTime® can be deployed in entirety at MTD facilities or can be hosted. As part of the standard deployment, Clever Devices will develop the MTD BusTime® website or seamlessly integrate BusTime® into MTD's existing website. The final solution will appear as if it was developed specifically for MTD. The figure below demonstrates the integration of a typical customer website.



BusTime® predicts the time at which a bus will arrive at each stop. The Prediction View shows the predicted arrival times of buses at a selected stop. The predicted arrival time updates as new information is received. The Prediction View is accessed from BusTime®'s main page or from mobile devices.

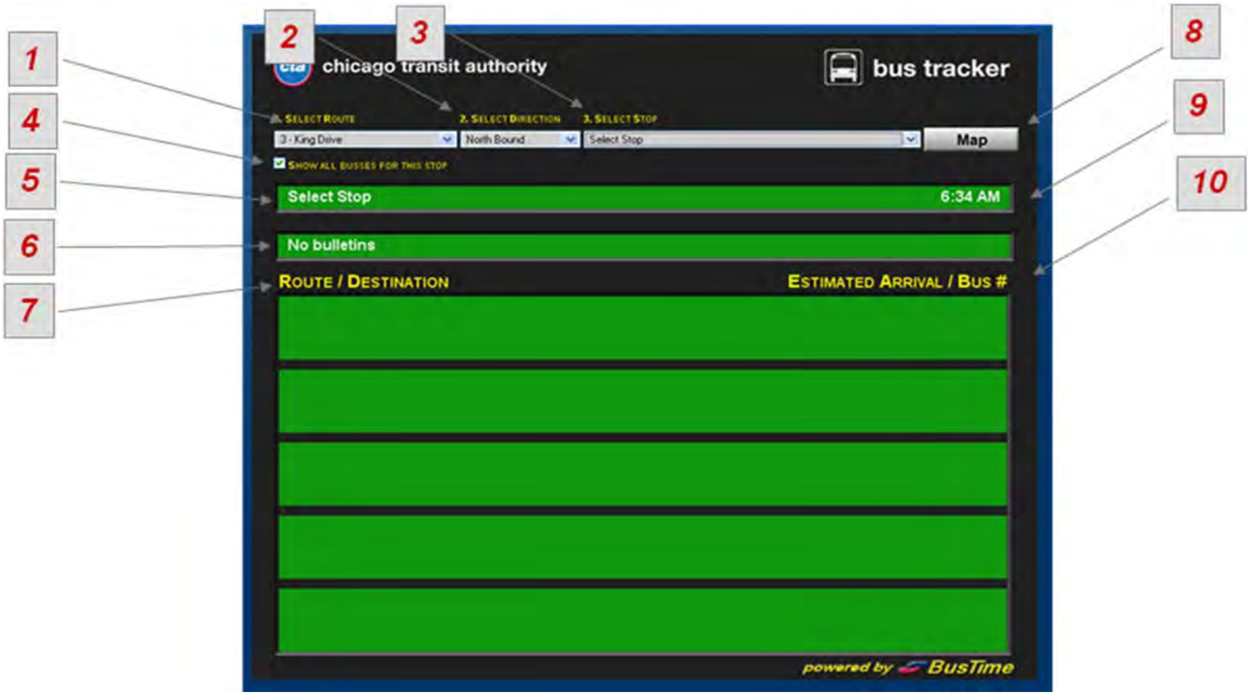


Figure 10: BusTime® Website Prediction view

1. **Route Menu**: Drop-down menu that displays all available routes from which to choose.
2. **Direction Menu**: Drop-down menu that displays the route direction for the route selected in Step 1.
3. **Stop Menu**: Drop-down menu that displays the stop for the route and direction selected in Steps 1 and 2.
4. **Show all buses**: Check this option to see all buses passing this stop, even those on routes other than the one you selected. This allows you to see arrival times of buses on interlining routes passing through this stop, to help make a connection.
5. **Bus stop**: Drop-down menu to select the desired stop to display arrival times.
6. **Service Bulletins:** Displays transit information such as service advisories, service changes, AMBER alerts, Public Service Announcement, etc.
7. **Route and Destination**: Title heading for predictions. Each prediction will display the Route and Destination below this title.
8. **Map Button**: Navigates you away from the prediction view to a map. Your bus stop selection is carried forward.
9. **Time and Temperature:** Displays the current time and temperature.
10. **Predicted Time to Arrival and Bus ID:** Title heading for predictions. Each prediction will display the predicted time of arrival and the BusID below this title.

The Map View and the Prediction View pages set cookies to remember the last stop information entered. If the browser is closed and opened again, the last stop information is preserved and immediately displayed. This helps commuter and other riders that frequently utilize specific stops

In the example below, the rider is at the eastbound Belmont and Clark stop of the #77 route for the Chicago Transit Authority. At this time, all buses are going to the Nature Museum terminal, though some patterns of this route end at a different location. BusTime® allows users to choose the bus that best meets their needs.

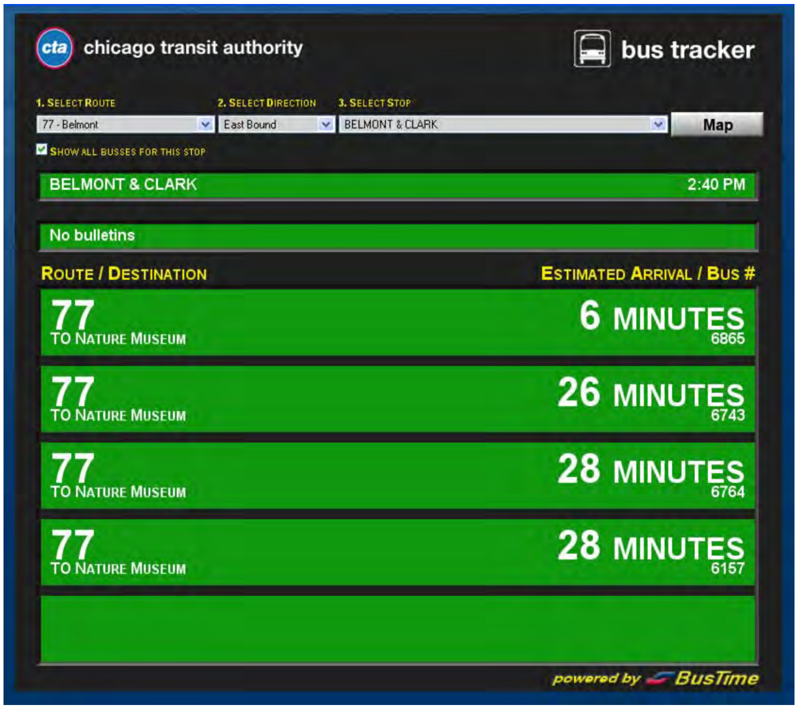


Figure 11: BusTime® Website Prediction View Example

In the Figure above, BusTime® is configured to predict the arrival time of all buses within the next 30 minutes. The screen automatically updates when new predictions are created.

The user can select the route, direction, and stop from pull-down menus at the top of the prediction view. Arrival information is immediately shown for buses arriving at that stop within a configurable amount of time determined by the BusTime® administrator / dispatcher using the console and features described above.

The bus route, direction of travel (e.g., North, South, East, West), and stop are selected from choices present in the pull-down menus. The menus are filtered to only show the appropriate information, based upon the previous menu selections.

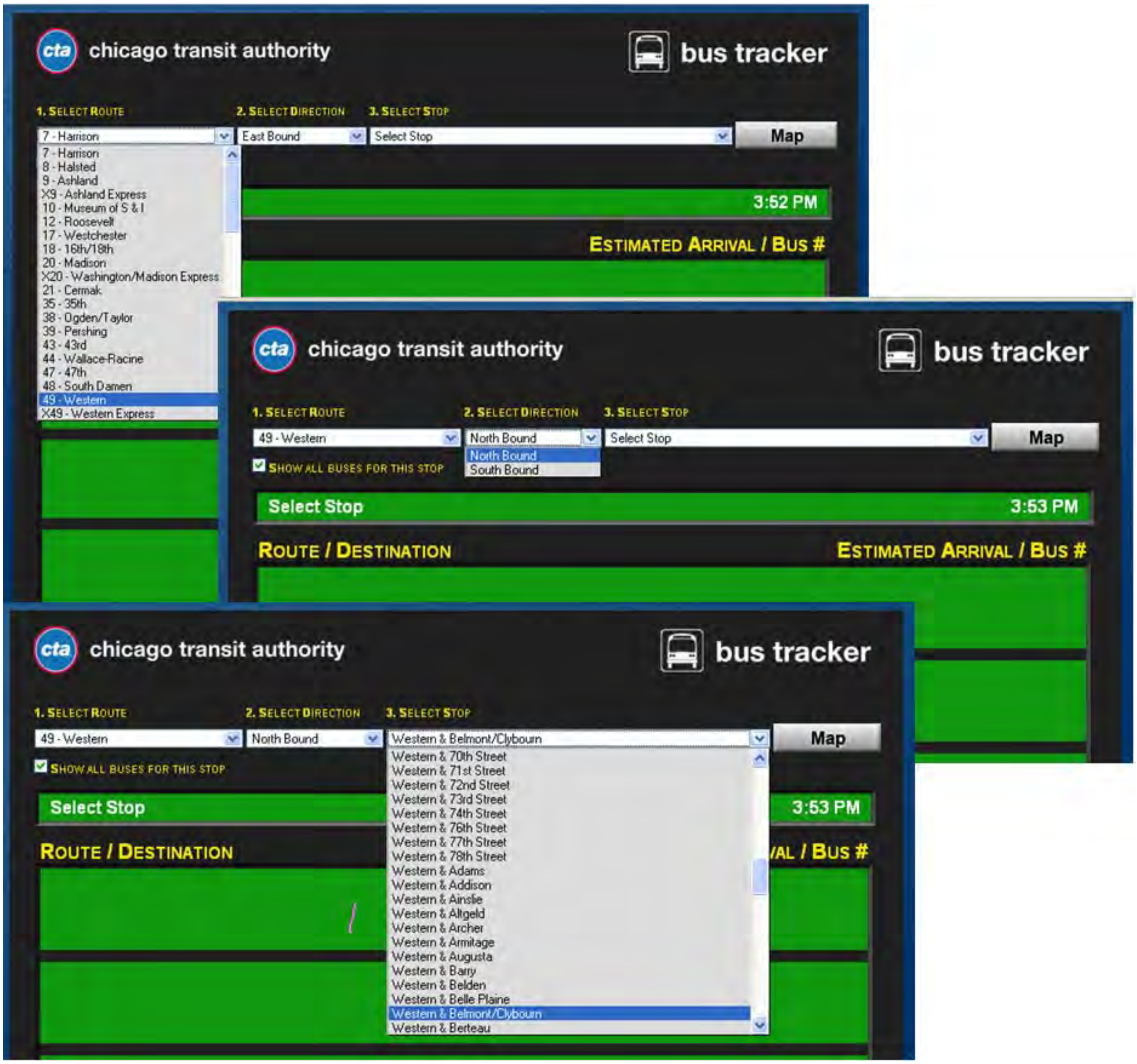


Figure 12: BusTime® Route and Stop Selection

The user can display all routes for a given stop as shown in Figure 13 below. This allows the user flexibility in selecting the appropriate bus and to check to see if they can make their transfer to another route.

Figure 13: BusTime® Show All Routes

7.3.2.4 WEB Access via MAP

BusTime® utilizes Google's map for the public facing passenger information as well as the internal Supervisor management map views. BusTime®'s Map view shows the real-time locations of all vehicles of the associated routes the user selected to display, the route path, the stops along the route, service bulletins, the selected bus stop as a green star in the center of the map, and the predictions of all buses headed to the selected stop.

Only buses servicing the selected route or routes are displayed. While the interface is automatically sized to fit the screen, users can zoom in or out on the map and pan to see other areas of the selected route. Clicking on the star icon centered between the panning arrows re-centers the map on the selected stop.

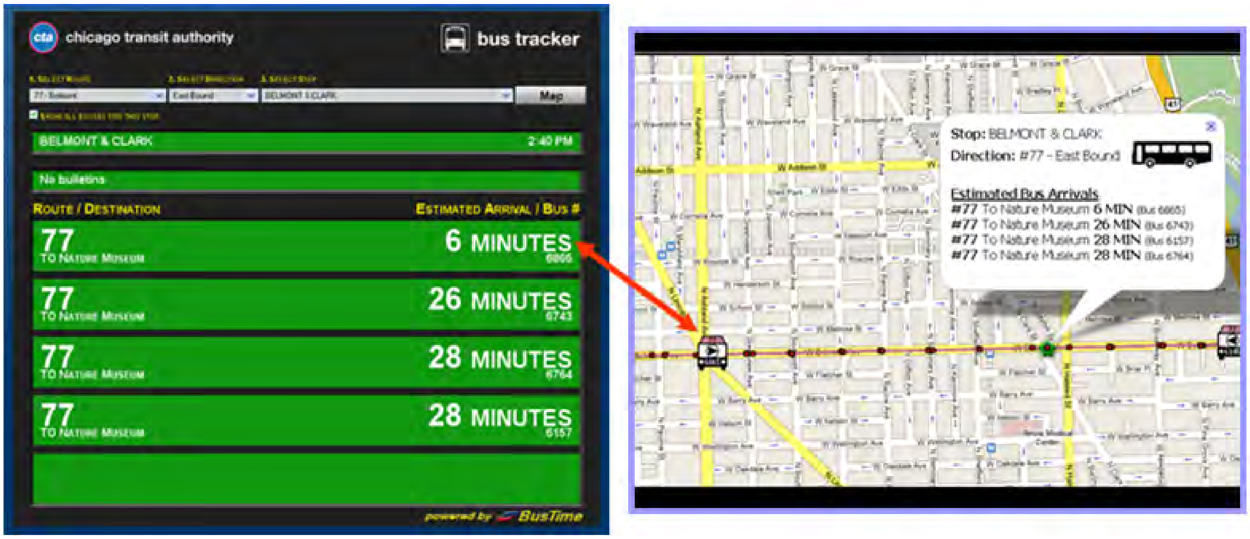


Figure 14: BusTime® Prediction Queue Correlated to Map View

Figure 7 above details the correlation between the BusTime® prediction queue and the BusTime® Map view as follows:

(LEFT)	Prediction Queue for the #77 Eastbound bus, Belmont & Clark Stop
(RIGHT)	Corresponding map view showing a bus (6685) 6 minutes away from the Belmont & Clark stop
(RIGHT)	Green star represents the selected location; Belmont & Clark
(RIGHT)	The bubble displays the predictions and BusIDs of the next eastbound buses arriving at the Belmont & Clark stop

The Map view has unique views at different zoom levels. This improves the usability of the system. When zoomed out beyond a certain threshold (Figure 15), only direction of travel and color are visible on the bus icon. The route and stops are always visible on the map. Clicking on the bus icon provides details such as the BusID, Route and direction, as well as arrival time of stops within proximity of the vehicles current position.

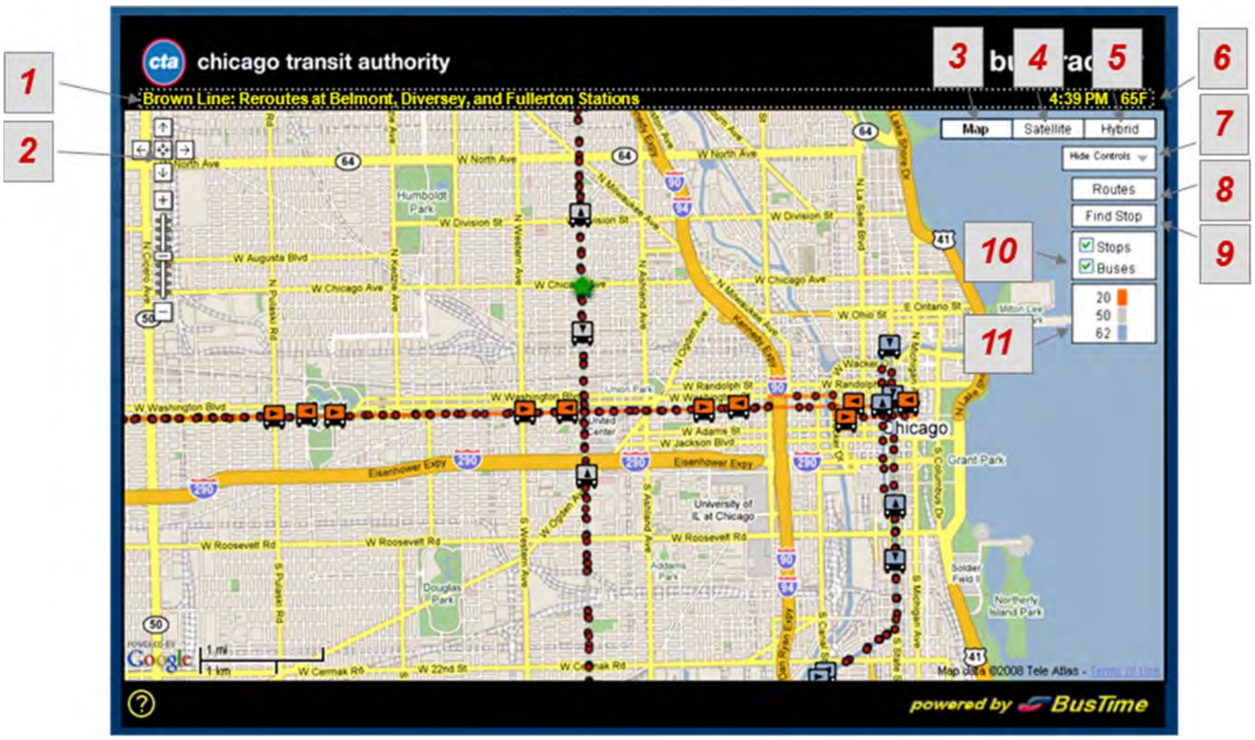


Figure 15: BusTime® Map Zoomed Out View

1. **Marquis Area**: Displays custom messages such as, public service messages, advisories, AMBER alerts, Emergency Broadcast Messages, transit service changes/updates.
2. **Map Control**: Pan, Zoom, and re-center
3. **Map View:** Display streets as a standard map view.
4. **Satellite View**: Aerial photograph view
5. **Hybrid View**: Combination of "Map" and "Satellite" views
6. **Time and Temperature:**
7. **Show/Hide Controls:** Quick way to remove the controls for Routes, Find Stop, Stops and Buses, and Route Legend.
8. **Routes**: Click to get a list of routes and choose which are and are not visible on the map
9. **Find Stop**: Click to select a specific bus stop
10. **Stops and Buses**: Check or uncheck the boxes to display/hide bus routes and stops
11. **Route Legend:** Indicates the routes shown on the map and their corresponding color

When zoomed in, more details are available. As shown in Figure 9 below, the route, corresponding route color, direction, and BusID are shown on the bus Icon. The Map layers are also enhanced to show street direction and the stops are enhanced with the Google icon. These reflect Google data and are not generated from BusTime® directly.

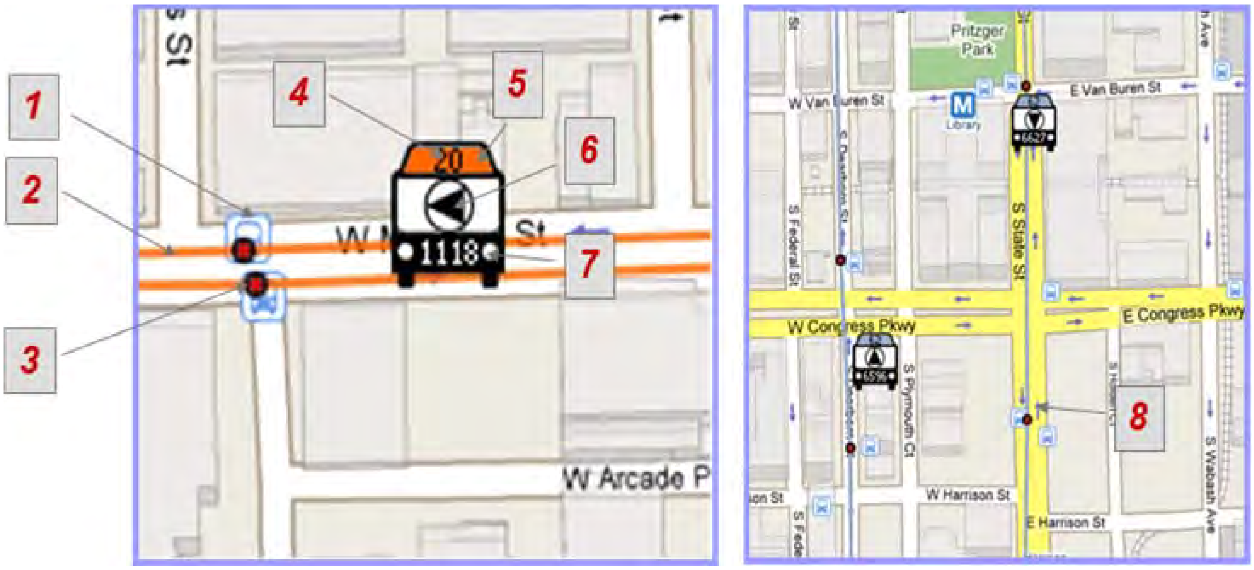


Figure 16: BusTime® Map Zoomed In View

1. Google placed bus stop. These are bus stops embedded in the Google map and are not from our actual route/stop (BusTools®) data. These stop locations are not up to date and are sometimes incorrect. Our bus stop locations are continually updated and are the most accurate.
2. #20 Madison Route (highlighted orange)
3. Clever Devices bus stop from BusTools® data
4. Route number of bus
5. Color corresponding with the route the bus is operating
6. Direction bus is traveling (westbound)
7. ID number of bus
8. Direction of street

When a bus stop is selected on the AVL map view, BusTime® will center your stop location on the map, display a popup with arrival times for the next 3 or 4 buses approaching that stop, and represent the selected stop with a green star as shown in Figure 17 below:

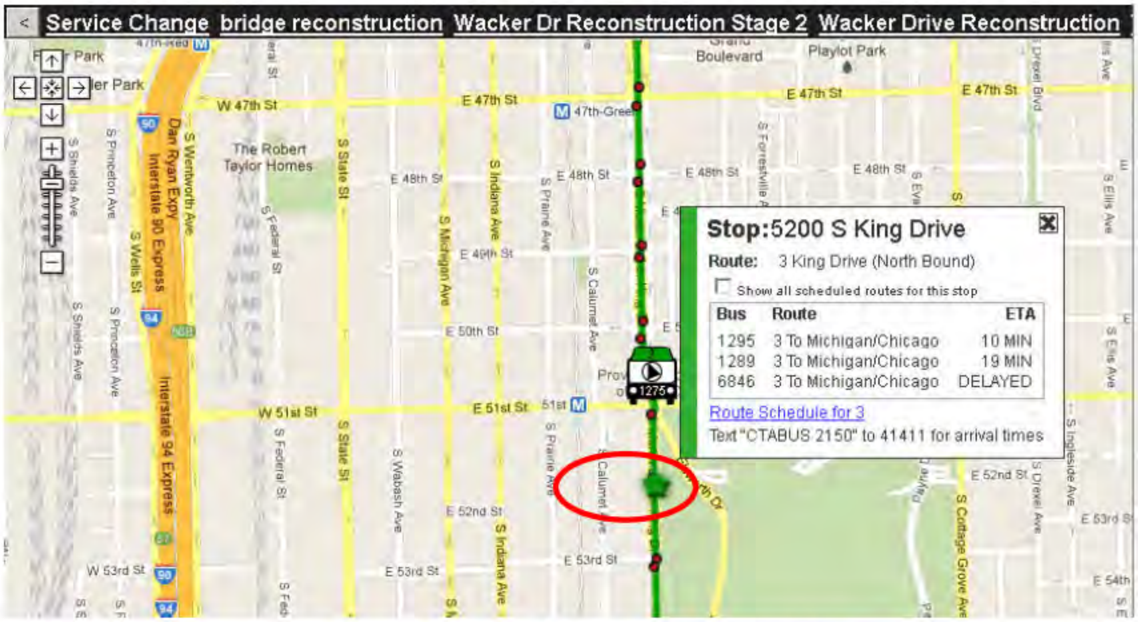


Figure 17: BusTime® Map View of Selected Stop

Likewise the user can place the mouse over a stop and a pop-up with the current stop and arrival time predictions for the next 3 or 4 stops will be displayed as shown in Figure 18 below:

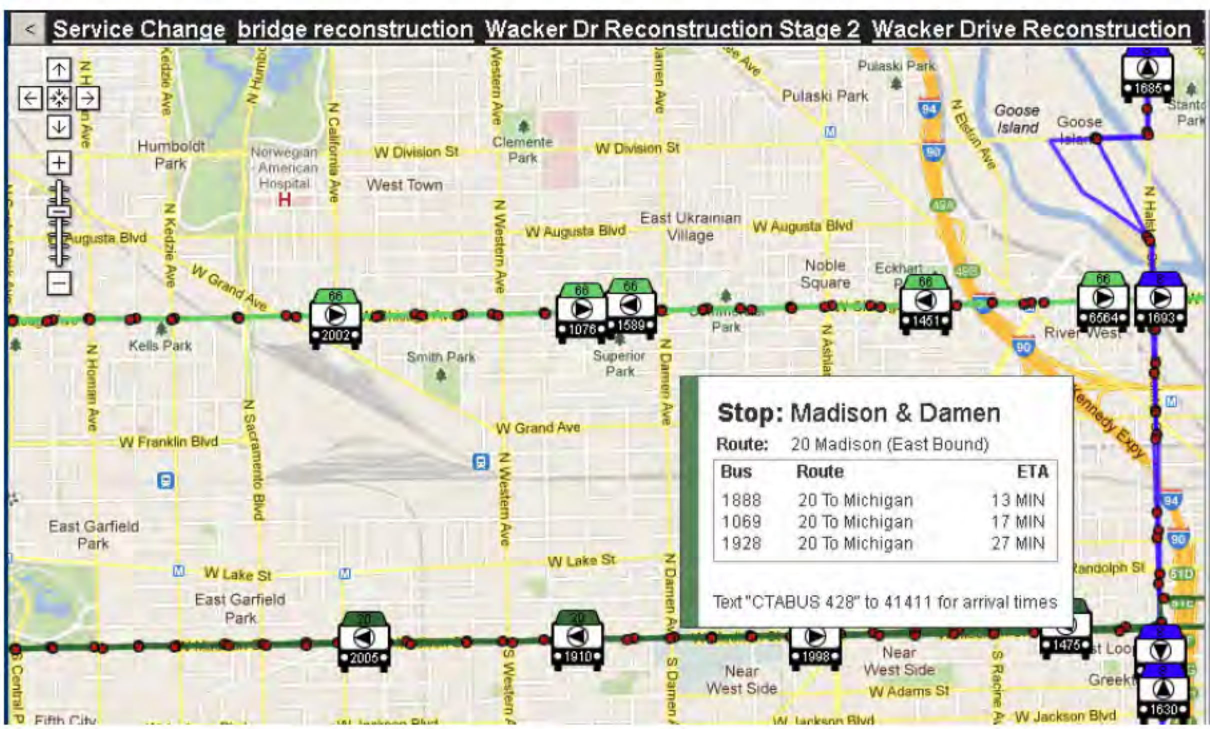


Figure 18: BusTime® Map View with Mouse Fly-over a Stop

The user can also left click on a bus to access the Route Progress and Route Schedule. Access to these two features is shown in Figure 19 below. When "Route Schedule" is selected a hyperlink to the transit agency's schedule (pdf view) will immediately display.

Figure 19: BusTime® Left-Click on Bus for Details and "Route Progress" View

When "Route Progress" is selected, all buses in one direction of travel along the selected route are illustrated as in Figure 20 below.

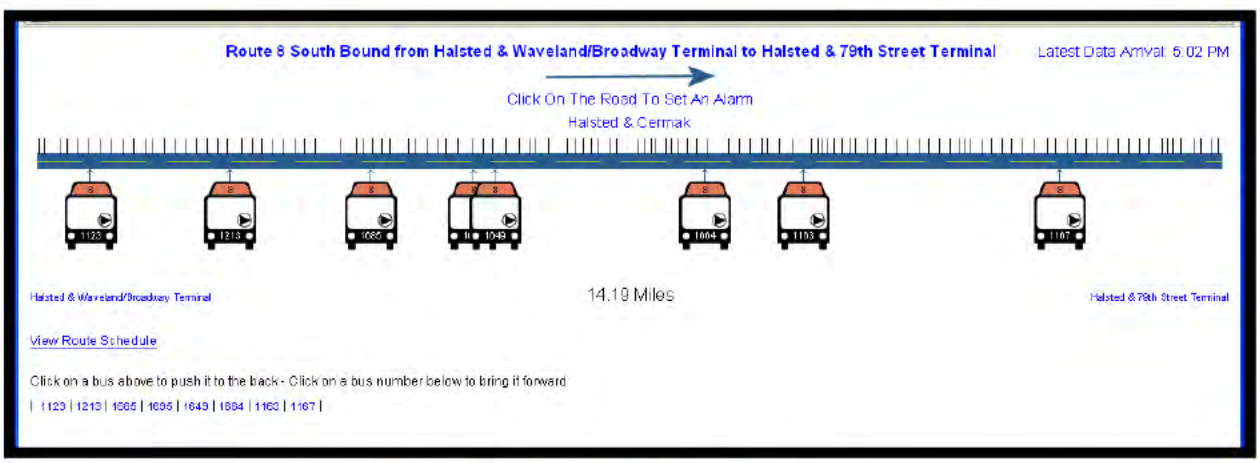


Figure 20: BusTime® Real-Time Route Progress

The direction displayed in the route progress view will be the same as the direction of travel of the bus in the map view. The stops are displayed as vertical lines. Moving the mouse cursor over a stop will display the stop's name.

The first stop is always located on the left side of the map. Users can set an alarm to alert them that their desired bus is nearing their stop. This is done by a simple mouse click on the road below the desired stop. An "alarm clock" icon appears on the roadway at that point as shown in Figure 21.

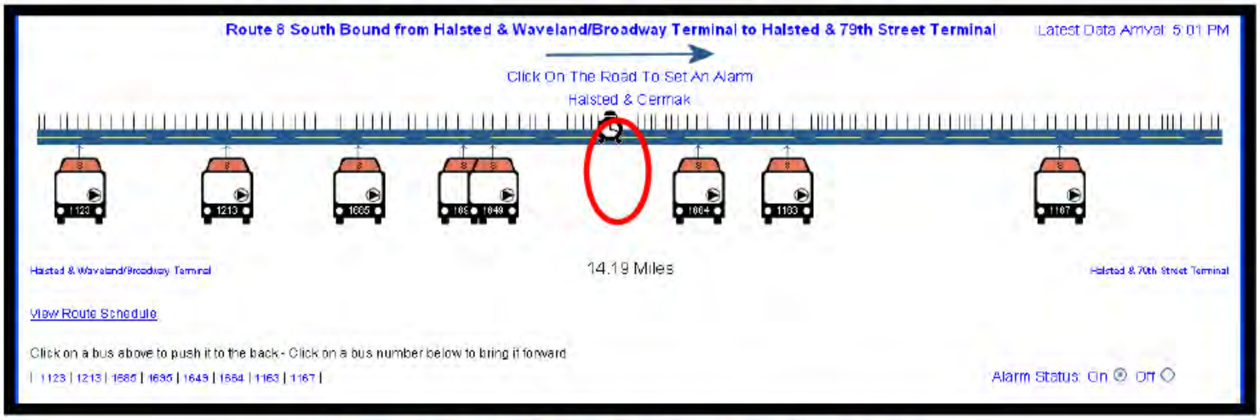


Figure 21: BusTime® Route Progress View with Alarm Set

When a vehicle reaches the alert location, a pop-up alert informs the user that their bus is within range and they can now comfortably make their way to the stop as shown in Figure 22.

Figure 22: BusTime® Notification of Arriving Bus

7.3.2.5 WEB Access via smartphone & PDA

Clever Devices' BusTime® system solution is fully compatible with smartphones. All the features available on a standard computer are available on smartphones and PDA's.

Figure 23: BusTime® Supports Smart Phones

7.3.2.6 WEB Access via Text only

Clever Devices' BusTime® system features a text version of the website compatible with screen readers used by the blind and visually impaired. An example is shown in Figure 24.

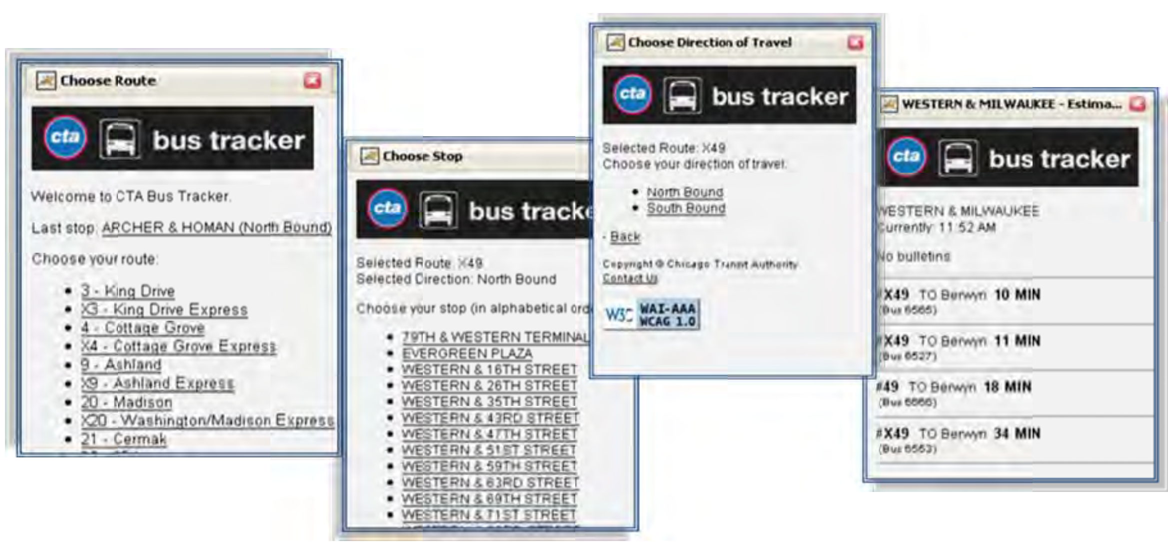


Figure 24: BusTime® Text Only Website

Findings –

1. The Primary CTA Bus Tracker Website now passes all of the automatic checkpoints of priority 1 review and as such, complies with conformance level A of the current W3C Web Content Accessibility Guidelines.

2. The Text based pages were also evaluated using Bobby 5.3™. These pages passed all of the automatic checkpoints of Priority 1, 2 and 3 and therefore comply with Confomance Level "Triple-A" of the current W3C Web Content Accessibility Guidelines.

Based upon this comprehensive review, it is our opinion that the CTA Bus Tracker Website meets the current requirements for ADA accessibility as well as the W3C guidelines. The design of this web site will allow people who are blind or have low vision to gain meaningful access to the ctabustracker.com website's dynamic content using a range of screen reading software and equipment.[A]

Figure 25: BusTime® W3C Accessibility Verification

7.3.2.7 Text Access via SMS One Way Email or Text Message Alerts

In one way text messaging, the user creates a BusTime® account via the website and subscribes to service bulletins and bus arrival predictions at specific routes and stops. Figure 26 provides a view of the account creation screen.

Figure 26: BusTime® Alert Account Creation

After an account is configured, the "My Alerts" page is displayed. On this page you can select the routes and stops for specific times and days that you wish to be alerted, configure the Alert Type as text or email, and subscribe to the different types of service bulletins. This is shown in Figure 27.

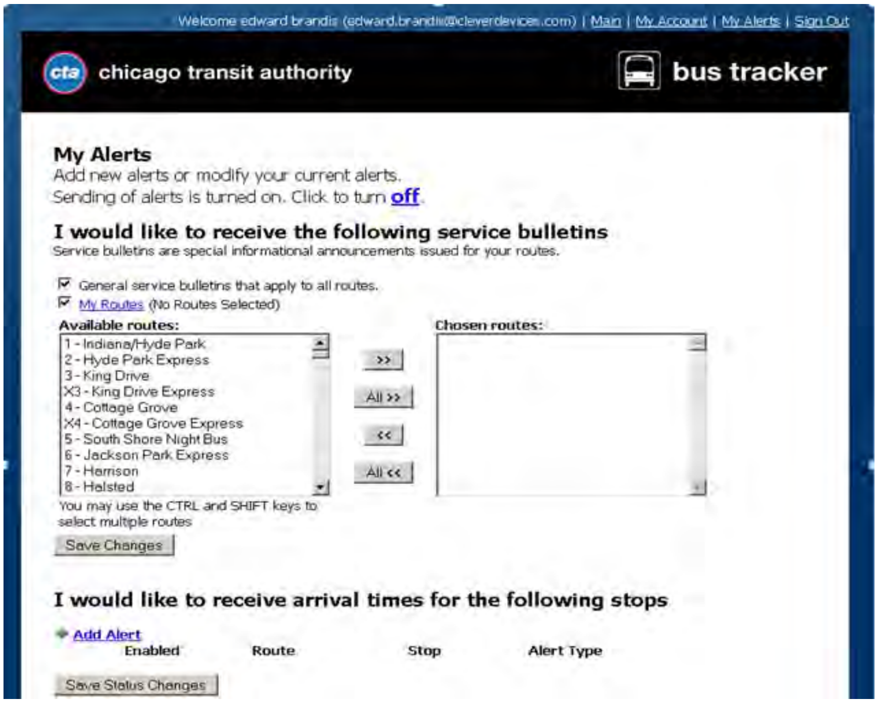


Figure 27: BusTime® My Alerts Setup Screen

When the Alert is saved, the following is displayed. This screen displays a list of all alerts and allows for easy enable/disable of the Alert, subscribe/unsubscribe to service bulletins, edit or delete the Alert, and save any changes. This is shown in Figure 28:

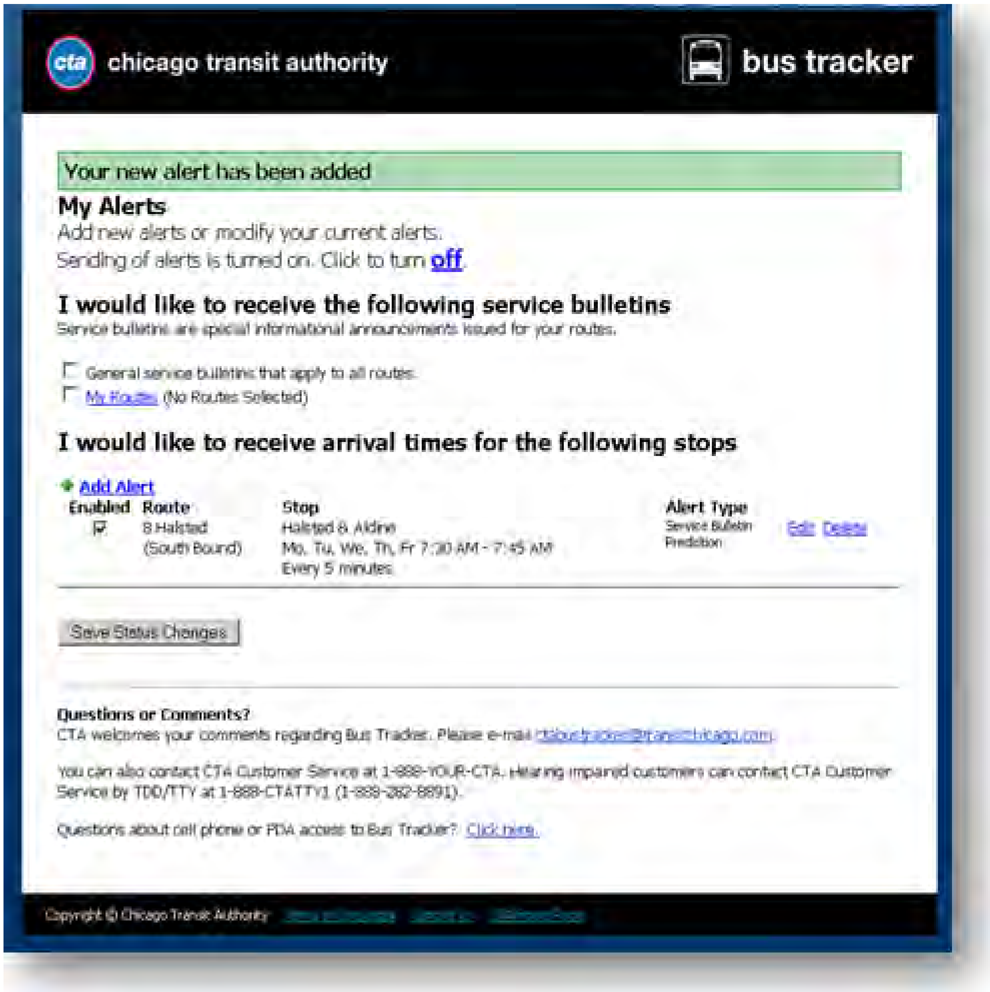


Figure 28: BusTime® My Alerts Summary

When the bus approaches the stop defined in My Alerts, an email is or a text message is sent to you as configured in My Alerts. An example of an email Alert is shown in Figure 29.

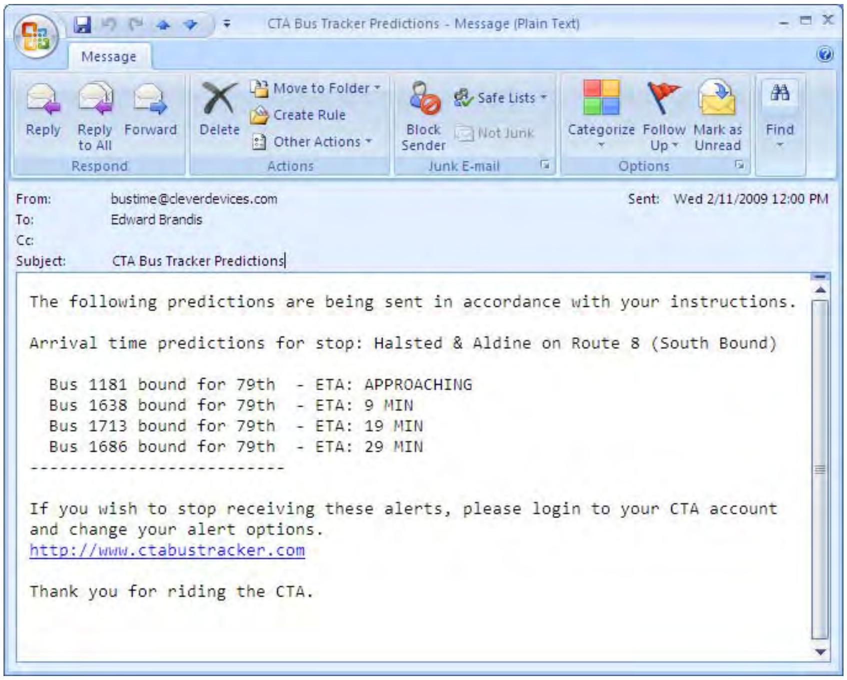


Figure 29: BusTime® Email Alert

7.3.2.8 Text Access via SMS Two Way Text Messaging

Two way SMS text messaging requires the rider to issue a request for information on a particular stop through an SMS text message sent from his/her phone. This typically is done by texting BusTime® with a unique alphanumeric Stop identifier managed by the transit authority. When received, BusTime® will retrieve arrival predictions and service bulletins for the requested stop and return the information as an SMS text message to the rider's phone.

7.3.2.9 Bus Stop Codes

Clever Devices has included the installation of a metal sign that will contain a QR code with instructions. A metal sign will be installed at each bus stop. Clever Devices will work with MTD on the sign design colors and specific information to be put on the sign.

7.3.2.10 Electronic Display Sign Functionality

Clever Devices offers bus stop and shelter signs in a variety of options that can be customized to the transit authority's needs. Some of the customizable options are the number of rows of text, LED or LCD, interior or exterior, wired power vs. solar power, Ethernet, and/or wireless, heated, and a variety of mounting options.

Clever Devices' BusTime® system can support any sign that has an existing published sign protocol. BusTime® will display sign information relevant to the routes/buses that are serviced by the bus stop/bay where it is installed. The signs will display the ETA for at least one bus for each route serviced by the bus stop/bay. If the arrival time for a following bus is within 15 minutes of its leader on a route, then the information for the following bus will also be displayed. BusTime® will present the following information for each bus:

- Current time (if configured by the Console user)
- Route
- Destination
- Estimated Time of Arrival (ETA)
- Service bulletins on a separate row

In addition, Clever Devices can configure the sign to alternate ETA information and service bulletins at specified intervals as well as choose the amount of time for which each message is displayed.

Electronic display sign hardware and installation, including the optional remote bus stop displays, are described in section 7.4.5 starting on page 259.

7.3.3 IVR - BusLine

With BusLine, callers are able to request schedule information at any time-point along a route. When stop level information is available, the IVR can provide schedule lookup and next bus times by stop number. If automated speech recognition option, callers can also say their stop or landmark name if known. Automated speech recognition can be added as an additional option to the platform.

The following outlines the IVR features and information available from Sched21.

- Next bus arrival times by stop number – real-time with fallback to scheduled times.
- Optional filtering results by route for stops with more than three routes passing by
- Route / stop / direction specific incident bulletins that can be targeted during certain times of the day, or for a set period of time.
- Global floodgate messaging allowing customers to be immediately notified of any urgent announcements before hearing the main menu of options
- Future times – Ability to look up scheduled times for a stop in the future by selecting day and time.
- Trip origin/destination - plays back the trip origin and destination location name and bus arrival/departure times.

The IVR will be hosted on a VXML platform that includes a high performance VoiceXML Interpreter, compatible both with VoiceXML 1.0 and 2.0 recommendations; its high efficiency and reliability has been reached leveraging on the experience gained in large scale deployed systems serving hundreds of thousands of calls per day. The platform can be combined with the paratransit inbound and outbound IVR systems to provide more efficient sharing of phone lines across the 3 applications.

The VXML platform comes standard with Text-to-Speech in English. Additional languages can be purchased for additional multilingual support. The platform supports Automated Speech Recognition with additional 3rd party licensing.

Being aware of the impact of management tools on the global quality of the service, the platform offers graphical and easy to use interfaces and provides features to monitor and administer the platform and to collect information useful for service tuning, such as information about visited pages and the dialog tree.

Enghouse uses SpeechBlock technology to allow changes to wording of both static and dynamic variable data such as arrival times and headway signs to allow maximum flexibility when localizing the application to MTD's requirements.

If a client is requesting next-bus-times, Enghouse will check the actual real-time next busses arriving, noting how they deviate from the actual schedule. Any route or stop specific announcements will also be played for applicable stops and routes.
Enghouse's fixed route IVR system is fully compatible with the following scheduling software:

- Giro HASTUS
- Trapeze FX
- Enghouse Sched21
- Schedule Masters

7.3.4 Route and Schedule Adherence Analysis – CleverReports™

The following is standard documentation, which may include features and functions not required by MTD. These afford MTD the opportunity to understand the full capability of the on-board system. Clever Devices' proposal includes the costs of only those features and functions specified in the RFP.

The reporting paradigm has changed. Reports are no longer just stagnant pieces of data printed on paper. Reports have to turn data into information which helps users make operational and business decisions. Reports have to be interactive and fluid, allowing users to look at information on the fly from a variety of perspectives. CleverReports™ is a web-based application reporting tool with unlimited and unrestricted user access through today's most popular browsers (Internet Explorer, Chrome, Firefox, and Safari).

CleverReports™ is a business intelligence solution that addresses current and future reporting requirements. It generates reports such as paddle reports, relief reports, schedule reports, as well as a number of service performance reports. Users are empowered with the ability to filter the information in a single report or an entire dashboard based on what is needed at the moment.

The benefits to the users of CleverReports™ are listed in the table below:

Table 2: CleverReports™ Benefits to User

SmartBus™ Solution User	Key Functionality
Operator	Empirical data will exonerate operators that operate within tolerances and safely
Controller	Real-time views will clearly illustrate performance against key performance indicators Exception based reporting will highlight areas that need immediate attention
Manager	Accurate, timely, and complete performance data will provide the decision support for service level adjustments, schedule improvements, roster and fleet level changes Reports will clearly identify areas of performance improvement Manages can identify operators that require retraining to bring their performance in line with corporate safety and quality standards
Customer	The application of this information by XYZ will result in more accurate schedules and increased service reliability

Reports and supporting data can be printed or exported to many applications including PDF, Microsoft Word, and Microsoft Excel. Reports may also be sent manually or automatically to individuals or groups via built in email functionality.

CleverReports™ also includes a user customizable ad-hoc report generating capability. This affords MTD the ability to create reports and view data your way.

Table 3: CleverReports™ Key Features

Feature	Description
Browser Based Reports and Dashboards	No local software to install. Uses popular browsers such as Internet Explorer, Chrome, Firefox, and Safari
Open Star Schema Data Warehouse	Open and non-proprietary database can ingest data from various sources and openly share data. Optimized for ease-of-use and query/report response time.
Ad-Hoc Reporting	Users can easily create, save, share, and export their own data without database training. Users browse and drill-down to desired views and customize data through menus and drop-downs. Users can save custom reports and use them again in the future.
Real-time and Historical Reports	All SmartBus™ data is in one place. SmartBus™ data stored by IVN® over the course of the day is downloaded and ingested periodically. Data from real-time system such as CleverCAD® and BusTime® is immediately available for applications, reports, dashboards, and more.

Uses Data from Multiple Sources and Formats	Import data from external systems to enhance reporting and create a more complete picture of performance, areas of improvement, and ROI
Graphical with Key Performance Indicators	Graphical presentation of data highlights the exceptions or pertinent information. At a glance, users see the result they are looking for without combing through rows and columns of text, as with tabular reports.
Organized Access to Reports	Reports can be organized by user access, department, garage, period, product
Share Reports in Popular Formats	Users can share create reports and share data via email, text, MS Word, MS Excel, and Acrobat PDF
Easy Report Filtering	Users can easily customize reports and views using filters and menus

Clever Devices proposes CleverReports™ as our comprehensive business intelligence and operational analytics reporting tool. Business Intelligence dashboards and reports that result from centralized data lead to greater operational efficiencies and reductions in costs. CleverReports™ offers web based dashboards, reports, and data warehousing in one easy to use, yet powerful application.

Since CleverReports™ is a web based application, any user in the organization with a web browser can be granted access. Major browsers such as Internet Explorer, Firefox, Chrome, and Safari are supported. In addition, mobile devices with browsers built-in can access CleverReports™, and an iPad application can also be provided.

In CleverReports, and all other Clever Devices applications, the data is open and it belongs to you. Store it locally or have it hosted and use the data as needed to run transit operations.

The following table represents a growing subset of reports available in CleverReports™:
Over 100 standard reports are included in CleverReports. These reports have been combined and summarized for ease of use in the system. Reports are organized by subject matter and are numbered for easy reference. In addition, search capability is included, so the user may find a report based on all or part of a report name.

Table 4: Standard Reports List & Descriptions

[redacted]

Report Name	Description
[redacted]	[redacted]

Report Name	Description

Report Name	Description
[redacted]	

Table 5: APC Reports (APC Option)

[redacted]

7.3.5 On Board Video Surveillance – Apollo

The Apollo Video Technology RoadRunner™ is being submitted as the on-board bus video surveillance system. The RoadRunner™ is a powerful, reliable, and functional video recording system is available in several compatible formats for recording up to sixteen (8) cameras, designed to provide full video surveillance for all types of transit and rail vehicles.

RoadRunner Mobile Digital Video Recorder (DVR)

The RoadRunner™ DVR is Mil-Spec and SAE rated for proven durability against shock and vibration commonly found in harsh mobile environments. The RoadRunner™ system includes a wide variety of accessories designed to provide comprehensive vehicle information, easy video search methods, and fleet-wide management tools.

- Available in compatible and interchangeable formats that support simultaneous recording of up to sixteen (16), twelve (12), eight (8) or four (4) cameras – the RoadRunner™ DVR provides full video surveillance coverage for all vehicle types
- Supports simultaneous recording of independent audio channels synchronized to user-selectable cameras
- Mil-Spec and SAE rated for vibration and shock tolerance, the DVR is ruggedized, constructed of steel, and secured with a lockable removable hard disk drive to prevent unauthorized access
- Password protection with adjustable access-rights for up to 64 groups and 256 users ensures security for agencies of all sizes
- Delivers high-quality, high resolution video providing easy identification
- Recording each camera at up to 30 images per second, the RoadRunner™ DVR features a system-wide recording rate of up to 480 images per second
- State-of-the-art H.264 compression delivers optimal network performance for remote viewing and live video streaming
- Retention requirements for video evidence are easily fulfilled with months of on-board recording. Hard drives are field upgradable, "swappable" for use in any same model DVR. 2.0TB of storage is provided
- Configure video quality, resolution, and recording speeds individually for each camera to ensure the highest quality video is being recorded for the cameras most important to your agency
- Optional built-in heater ensures recording in temperatures as low as -20°F

Sample Recording Duration Chart:

The RoadRunner system provides months of on-board recording with swappable hard drives up to 2.0TB. Below are estimated recording durations for SMART configuration at various resolution settings and recording rates…

Hard Disk Drive Size:	30 ips:	60 ips:	120 ips:	240 ips:	480 ips:
2.0TB HDD	6,020 hours	3,010 hours	1,504 hours	752 hours	376 hours

*NOTE: Calculations based on CIF resolution (352x240) setting. To calculate recording durations at 2CIF (704x240) resolution, divide the total number of hours by 2. To calculate recording durations at 4CIF (704x480) resolution, divide the total number of hours by 4. **MRH4** DVRs feature a maximum recording rate of 120ips at CIF; 120ips at 2CIF and 60 ips at 4 CIF; **MRH8** DVRs feature a maximum recording rate of 240ips at CIF; 120ips at 2CIF and 60ips at 4CIF;*

- Integrated driver event switch features a system “heartbeat” style health indicator, providing the driver with visual confirmation that the system is operating properly and allows the driver to initiate event recording status. Event recording is adjustable and can include up to 30 minutes prior to, and 15 minutes after an event
- Live monitoring and management with a keyboard, mouse and monitor
- Live monitoring with a laptop connected directly to the unit
- Optional UPS/battery source in the event power is disconnected
- Delayed turn off up to 24 hours in one minute increments
- Bus operator interface of an LED to identify whether the RoadRunner™ system is functioning or experiencing a failure
- Full built in diagnostic software and remote access to diagnostics through the ViM DVR Health module

RoadRunner™ is a mobile color DVR designed for mass transit use and operates using 9 to 30 volts DC, which makes it compatible with the typical 12 VDC and 24 VDC power systems found in buses. The DVR provides viewing and recording capabilities for 4, 8 or 16 cameras or other video sources. It provides exceptional picture quality in both live and playback modes, and offers the following features:

- Vibration isolation mounting bracket
- Removable hard disk drive
- Lock & key power switch
- Programmable system shutdown or start after ignition switch is turned off
- Compatible with color (NTSC or PAL) and B&W (CCIR and EIA-170) video sources
- Auto detection for NTSC and PAL
- H.264 codec
- Compact size
- Multiple search engines (date/time, calendar, event)
- Continuous recording in disk overwrite mode
- 2 USB 2.0 ports for data extractions and software upgrade
- Continues recording while transmitting to remote site and during playback
- User-friendly graphical user interface (GUI) menu system
- Multiple recording modes (time-lapse, pre-event, event and panic)
- 2-Channel audio recording and 1-channel audio playback
- Text input for ATM, POS
- Alarm connections include: input, output and reset input
- Live or recorded video access via Ethernet
- Time synchronization using industry standard protocol
- Self-diagnostics with automatic notification including hard disk drive self-monitoring, analysis, and reporting technology (S.M.A.R.T.) protocol

The following are the specification for the on-board RoadRunner™ video recording system.

VIDEO	
[redacted]	[redacted]
INPUTS/OUTPUTS	
[redacted]	[redacted]
STORAGE	
[redacted]	[redacted]
GENERAL	
[redacted]	[redacted]

ENVIRONMENTAL	
[redacted]	[redacted]

The RoadRunner™ for the fixed route fleet integrates with IVN® for GPS information. The RoadRunner™ for the fixed route fleet integrates with IVN® for all acceleration events. The events created by IVN® in support of hard brake, hard turn, and hard vertical acceleration will be used to trigger video recordings. The RoadRunner™ will utilize the same WLAN device as IVN®

7.3.5.1 Cameras

Apollo Video provides a complete line of cameras designed specifically for optimal viewing angles and image quality in transit applications. All cameras are designed for transit applications.

- High resolution (540 to 560 TV lines of resolution) provides the highest quality and most detailed recordings
- Automatic IR illumination delivers exceptional quality in low light conditions to 0 lux (complete darkness)
- Cameras feature either vari-focal lenses or optional fixed lenses for wide-angle to narrow viewing angles optimal for all on-board installation locations
- All exterior cameras meet IP67 or IP66 standards for dust and moisture resistance and have proven durability and tolerance in mobile exterior mounting locations; optional heaters ensure operation in extreme temperatures
- Built-in microphones provide superior audio recording
- Exterior cameras feature durable metal housings providing vandal protection and resistance to impacts
- Low-profile and compact housing provide maximum flexibility for mounting in compact interior locations and protection against impacts when mounted on exterior surfaces
- Wide dynamic range cameras feature technology that provides better response to bright lights and varying light conditions common in mobile applications –prevents images from being "washed out" when bright lights are present

- Cameras featuring back-light compensation technology provide better views of surrounding objects when bright spots are present - useful for blocking out headlights from passing vehicles or lighted road signs

Clever Devices has proposed the following cameras on each of 86 buses that are longer than 25 feet. Clever Devices will work with MTD to review the cameras and their mounting locations, and get approval from MTD prior to installation.

1x RR-C2 36	Color, audio recording, 3.6mm lens, vandal resistant cover
3x RR-CTM	Color, vandal resistant exterior, high resolution, miniature tapered dome for exterior
4x RR-CIR2	Color, audio recording, IR illumination, day/night for interior

Clever Devices has proposed the following cameras on each of the 20 buses that are shorter than 25feet. Clever Devices will work with MTD to review the cameras and their mounting locations, and get approval from MTD prior to installation.

1x RR-C2 36	Color, audio recording, 3.6mm lens, vandal resistant cover
2x RR-CTM	Color, vandal resistant exterior, high resolution, miniature tapered dome for exterior
2x RR-CIR2	Color, audio recording, IR illumination, day/night for interior

The following figure provides an overview of the different cameras available.

MODEL NO.	RR-CSRIR	RR-CTM	RR-CTMIRA	RR-CTIR	RR-CT540	RR-CIR2	RR-C2
Audio Recording			✓	Optional		✓	✓
Low-Light	✓		✓	✓		✓	
Vandal-Resistant	✓	✓	✓	✓	✓		
Interior/Exterior Use	✓	✓	✓	✓	✓		
High Resolution	✓	✓	✓	✓	✓	✓	✓
Wide Dynamic Range		✓	✓	✓	✓	✓	✓
Varifocal Lens					✓		
Resolution, TV Lines:	560	600	600	600	600	600	600
CCD:	Sony 1/3" Super HAD	1/3" Sharp CCD NVP2040 DSP	1/3" Sharp CCD NVP2040 DSP	1/3" Sharp CCD NVP2040 DSP	1/3" Sharp CCD NVP2040 DSP	1/3" Sharp CCD NVP2040 DSP	1/3" Sharp CCD NVP2040 DSP
S/N Ratio:	>50dB	>50dB	>50dB	>50dB	>50dB	>50dB	>50dB
Min. Illumination (Color):	0.3 Lux	0.8 Lux	0.1 Lux	0.1 Lux	0.8 Lux	0.1 Lux	0.8 Lux
Min. Illumination (B/W):	0.002 Lux	0.002 Lux	0 Lux	0 Lux	0.002 Lux	0 Lux	0.01 Lux
Dimension, mm(WxHxD):	80x80x98	68x49x90	68x49x90	94x70x130	103x92x61	80x39x50	80x39x50
Outdoor Rating:	IP67	IP66	IP66	IP66	IP66	-	-
Lens:	2.5, 3, 3.6 or 6.0mm	2.9mm	2.5 or 3.6mm	2.5 or 3.6mm	4-9 mm Varifocal	2.5, 3.6, 6 or 8mm	2.5, 3.6 6 or 8mm
Additional Features:	"Smart" IR	-	"Smart" IR Adjustable Audio	"Smart" IR, Adjustable Audio	-	-	-
Options:	Curved Surface Mount: RR-CMCS	Orientation Options: Ceiling: RR-CTM-C Side: RR-CTM-S	Orientation Options: Ceiling: RR-CTMIRA-C Side: RR-CTMIRA-S	With Audio: RR-CTIRA	Curbside: RR-CT-CS-540 Streetside: RR-CT-SS-540	See reverse / page 2	See reverse / page 2

Figure 32: Available Cameras

7.3.5.2 VSS Viewing Application - RASplus

RASplus program is an integrated software program that controls system management, video monitoring, searching, recording, and image playback of multiple remote sites. RASplus offers the following features:

- Checks and reports status of remote DVRs
- Notification of events detected at remote sites
- Remote monitoring of live camera images
- Panic recording of monitored images
- Time-lapse and event search of recorded images
- Remote software upgrades and system programming
- View system and event log information of remote DVRs
- Remote monitoring of multiple remote sites using maps
- Connect up to 64 remote sites (up to 16 remote sites for remote search) at a time

7.3.5.2.1 System Requirements

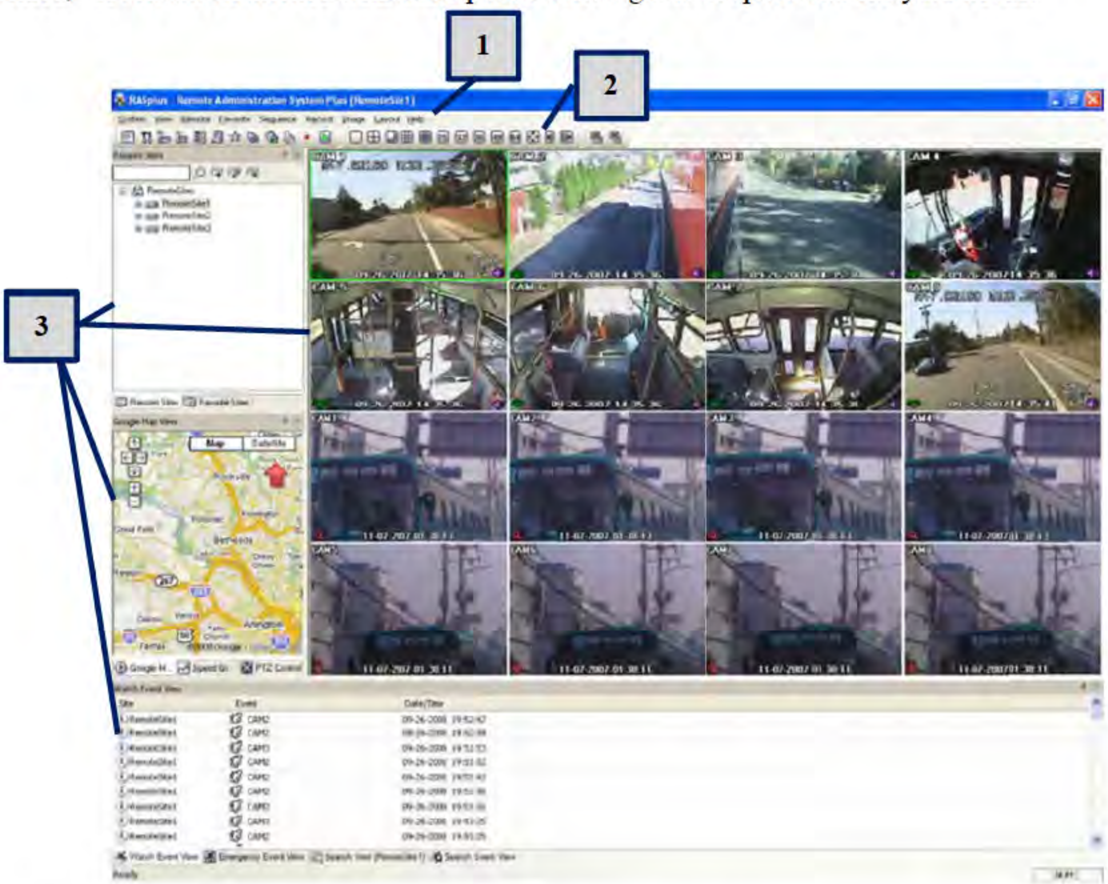
RASplus can be installed on any workstation computer or laptop with the minimum configuration shown here:

- Operating System: Microsoft® Windows® XP x86 (32 Bit) (Service Pack 3), Microsoft® Windows® Vista x86 (32 Bit) (Service Pack 1) or Microsoft® Windows® 7 x64 (64 Bit)
- CPU: Intel Pentium IV (Celeron) 2.4GHz or faster
- RAM: 512MB or higher
- VGA: AGP, Video RAM 8MB or higher (1024x768, 24bpp or higher)

The application is free, easily installed, and intuitive to use. Complete training is provided with users manuals.

7.3.5.2.2 Overview

RASplus has many powerful tools that can be used to streamline your work. Most of the tools are located on 12 docking panels that can be placed on the screen where they are most convenient. You can keep your screen free of clutter by displaying only the panels you use most frequently. Panels can be hidden, resized, moved and combined with other panels creating a workspace that fits your needs.



The RASplus program consists of the screen, 12 docking panels, menu and toolbar. These are described in the following sections.

7.3.5.2.2.1 RASplus Panels

The screen displays images from selected cameras in the live monitoring or playback modes. RASplus provides various multi-screen layouts: single-screen, quad, 1+7, 3x3, 4x4, 5x5, 1+32, 6x6, 7x7, 8x8, and full-screen.

Panels can be resized, moved, and combined with other panels creating a workspace that fits your needs.

The layout possibilities are virtually unlimited. With a little experimentation you will be able to lay out the screen so that it best meets your workflow.

Remote Sites Panel: RASplus allows access to remote systems and sites to review video, system logs, or event logs while connected. You can also connect to the remote site using the VNC function if configured in the remote DVR.

Favorite Sites Panel: The Favorite Sites panel displays the list of favorite sites registered during RASplus system setup. Selecting your favorite site from the list and then dragging and dropping it in the desired position on the screen connects all remote sites registered in the Favorite site automatically.

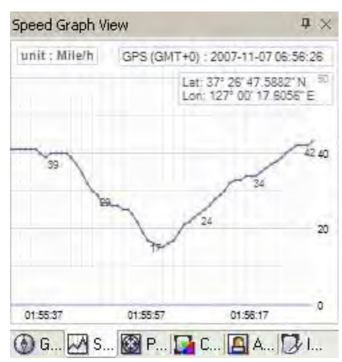
Map Panel: The Map panel allows efficient monitoring of the remote sites by displaying a map of the selectable site. Click the right mouse button on the map panel to select the map image file (.rmp) you want to monitor from the list.

The selected map image displays in the Map panel and the sites registered on the map image file will be connected. When the selected map is linked with sub-maps, clicking the linked image moves to the sub-map.

The Map panel pops up another screen when alarm-in, motion or video loss events are detected or when you click the device icon according to the Map Editor settings.

Clicking the right mouse button on the Map panel causes a text menu screen to display. Selecting Watch Event View from the menu displays the event information of the connected remote sites. Selecting Close disconnects the current connection on the Map panel.

Google Map Panel: The Google Map View panel displays the location and direction of vehicle of the images you are monitoring or playing back if they have the GPS information. The Map view and Satellite view from Google Map will be provided.



Speed Graph View Panel: The Speed Graph View panel displays the vehicle speed of the images you are monitoring or playing back if they have the GPS information. Clicking the right mouse button on the Speed Graph View panel allows you to set up the graph type and unit, GPS information display, and high quality display.

PTZ, Color and Alarm Out Control Panels: Three panels allow Pan Tilt Zoom (PTZ) control, color control, and alarm out control while live monitoring a remote site with cameras that support PTZ.

Image Processing Panel: Allows enhancing played back images.

Watch Event View Panel: Displays events detected at individual remote sites while RASplus is in the live monitoring mode. The description of event icons is as follows:

Alarm-In On	Alarm-In Off	Motion Detection
Object Detection	Video Loss	Video Blind
Text-In	Alarm-In Bad	Recorder Bad
Disk S.M.A.R.T.	Disk Bad	Disk Full
Disk Almost Full	Disk Config Change	Disk Temperature
Panic Recording On	Panic Recording Off	Fan Error On
Fan Error Off	System Boot Up	System Alive
System Restart	System Shut Down	Video Analytics Detection
Audio Detection		

Emergency Event View Panel: The Emergency Event View panel displays a list of events (preset for notification at the remote site) that were called from individual remote sites (LAN connection only). Selecting an event from the list and then dragging and dropping it in the desired position on the Watch or Search screen connects to the remote site, and a checkmark is placed in the box at the left. Selecting an event or site from the list and then clicking the right mouse button causes a tooltip to appear, which contains the emergency event instruction from the remote site. The Emergency Event View function is available only for the remote sites that were set to notify the RASplus system when configuring each event setup.

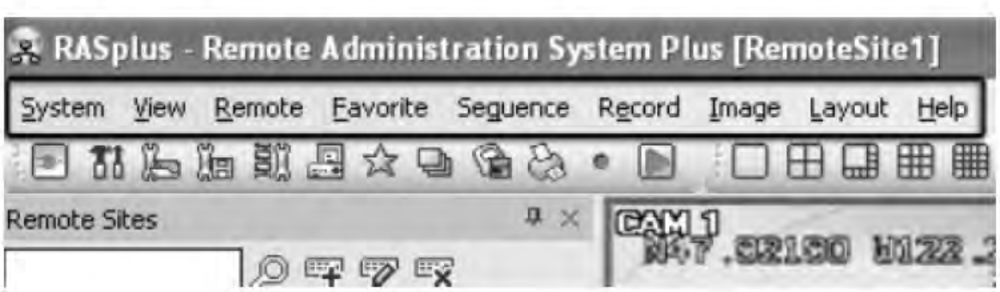
Report View Panel: The Report View panel displays the system status information of remote sites. RASplus checks the remote site and reports system status. Report Setup must be configured during RASplus system setup for this feature to function.

Search View Panel: The Search View panel allows time-lapse or event searching of recoded data on the remote DVR. The Search Event View panel displays alarm-in events searched while playing back images in the RASplus search mode.

Status View Panel: RASplus provides a status display, remote setup, system log, and event log view of the connected remote site in real-time. To display a status of the remote site, select a camera or a site from the Remote Site list and drag it to the Status View panel. You can also select Connect Status from the popup menu displayed by clicking the right mouse button after selecting the site from the Remote Site list.

7.3.5.2.2.2 RASplus Menu Items

RASplus has a full featured menu as shown here. A description of each menu item follows:



System	Provides configuration and standard file menu items including: • Configuration of the on-board DVR system, for events, network, security, status reporting period, remote access, normal and panic recording, remote desktop, and events • Configuration of RASplus for usability including, live monitoring and search default screen configurations, drawing mode setup, remote sites, drawing mode, date and time format, screen display functionality, emergency event, and language • Remote site/DVR configuration including login credentials, remote desktop, and emergency event instructions • Favorite sites/DVR configuration • Sequence site configuration to group and access multiple sites/DVRs and automatically sequence through each site/DVR • Load a setup file that is preconfigured • Save a setup file for use by other systems • Batch setup to distribute configurations or upgrades to multiple remote sites/DVRs • View logs to display the type of log and the number of log entries of RASplus. Selecting a log type from the list displays all entries of the selected log type, and you can search for the desired log by setting up a search filter
View	Allows the user to enable/disable the display of toolbars and multiple panels
Remote	Provides quick access to the following: • Change the setup of a remote DVR • Search and display the system or event log of a remote DVR with ability to print, save, and move
Favorite	Allows the user to save the current screen layout directly to the favorite site
Sequence	Allows the user to enable/disable auto sequencing
Record	Allows the user to enable/disable panic recording while connected to the remote site/DVR
Image	Allows the user to save or print the current image
Layout	Allows the user to configure the RASplus screen layout including cameras and video size

7.3.5.2.2.3 RASplus Toolbar

The toolbar allows convenient and immediate access to desired functionality through panels and menus as described in sections 7.3.5.2.2.1 and 7.3.5.2.2.2 above.

7.3.5.2.3 Using RASplus

The features described in the following sections are available in RASplus:

7.3.5.2.3.1 Live Monitoring

RASplus provides remote monitoring functions for viewing video images in real time from either a single site or multiple sites. In addition, when events are detected at a remote site while in the live monitoring mode, RASplus displays the event information on the Watch Event View panel. In order to perform live monitoring, the display option must be set to Watch Screen or Watch and Search Screen during system setup.

Screen Layout and Frame Layout: RASplus provides multiple screen layout options. The formats available are single-screen, quad, 1+7, 3x3, 4x4, 5x5, 1+32, 6x6, 7x7, 8x8, and full-screen.

Audio Communication: RASplus supports audio communication between the RASplus system and the remote site/DVR equipped with audio.

Color Control: Adjusts the brightness, contrast, saturation, and hue of live video for each camera by clicking the target icons on the Color Control panel. Only the users authorized for color control can adjust the image at RASplus.

PTZ Control: Select a PTZ camera at the remote site, and control pan, tilt, and zoom. Only the users authorized for PTZ control can control PTZ at RASplus.

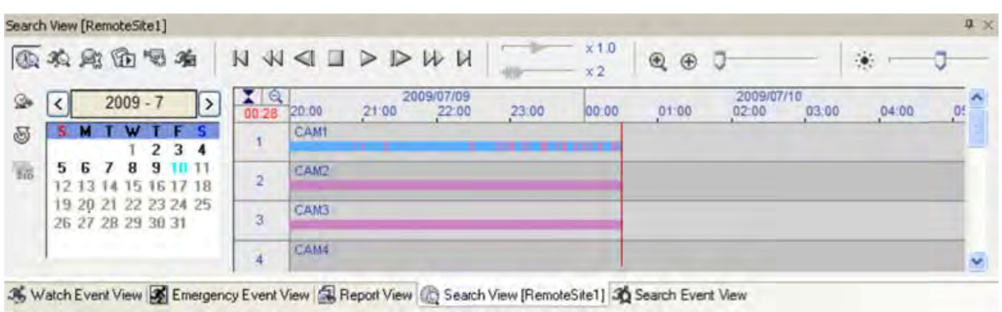
Alarm Out Control: Control alarm out devices on the remote DVRs by clicking the ON or OFF buttons. Only the users authorized for alarm out control can control an alarm out at RASplus.

7.3.5.2.3.2 Playback and Search

RASplus allows you to play back and search recorded images on remote DVRs. It also provides additional functions including zoom, various image enhancements, image saving, and image printing. To use remote playback and search functions, the display option must be set to of Search Screen or Watch and Search Screen during system setup.

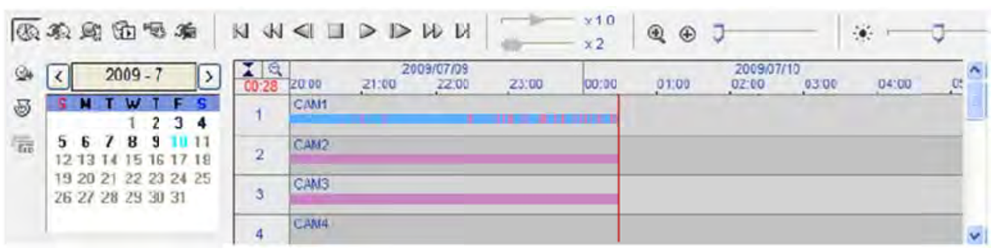
It is possible to display cameras in both the Watch Screen mode (live view) and Search Screen mode at the same time. For example, you can connect to a remote DVR site with nine cameras. Drag and drop the site into the first frame on the viewing screen and select Watch Screen. Live video will display in the first nine frames on the screen. Then, drag and drop the site into the tenth frame on the viewing screen and select Search Screen. You will be able to view any video recorded on the remote DVR in frames 10 through 18.

Search View Panel: The Search View panel consists of playback and search controls, time-lapse search table, and event search table. You can control the playback speed of images that are currently being played back by using the control slider. You can control the fast forward or fast backward playback speed of images by using the control slider.



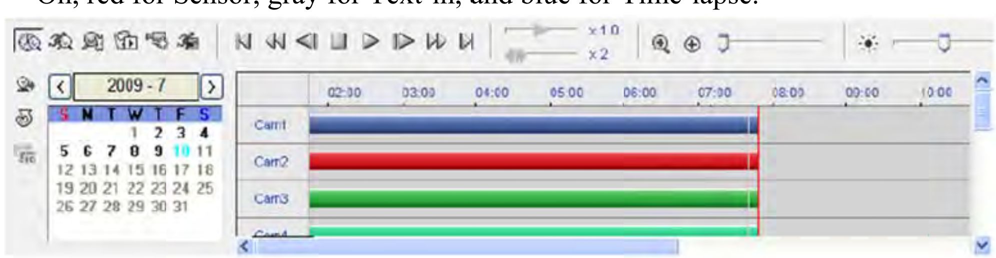
Time Lapse Search: The time-lapse search mode searches for recorded data by time and then plays back images found within the time parameters.

The recorded data of all camera channels are displayed by time in one-hour segments and a yellow-highlighted segment indicates the selected time that will be played back. Select a specific hour by clicking the mouse on the desired hour segment, and video images will be played back starting with the first image captured within the one-hour segment. If the remote DVR's time and date have been reset to a time that is earlier than some recorded video, it is possible for the DVR to have more than one video segment in the same time range. Click the (Segment) button and select the video segment you want to search. The active segment will be highlighted with pink, and the inactive segment will be highlighted with gray on the timetable.

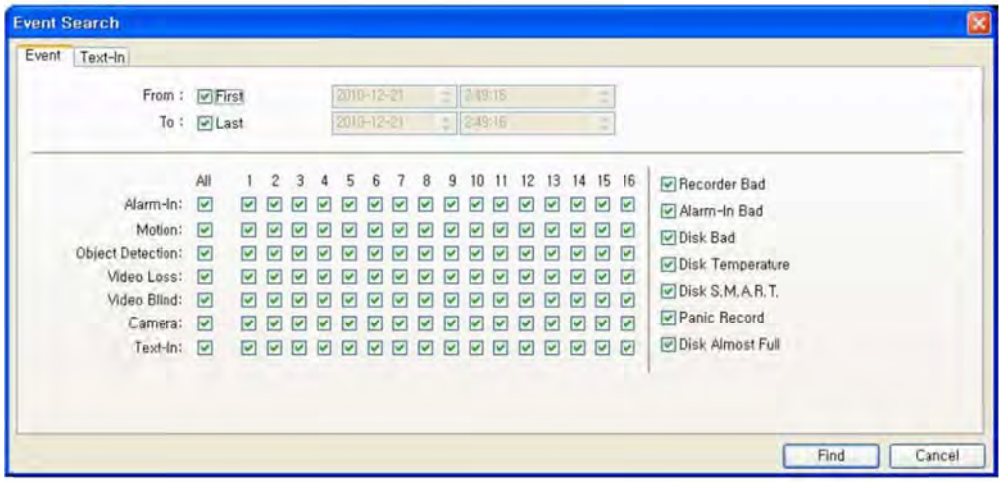


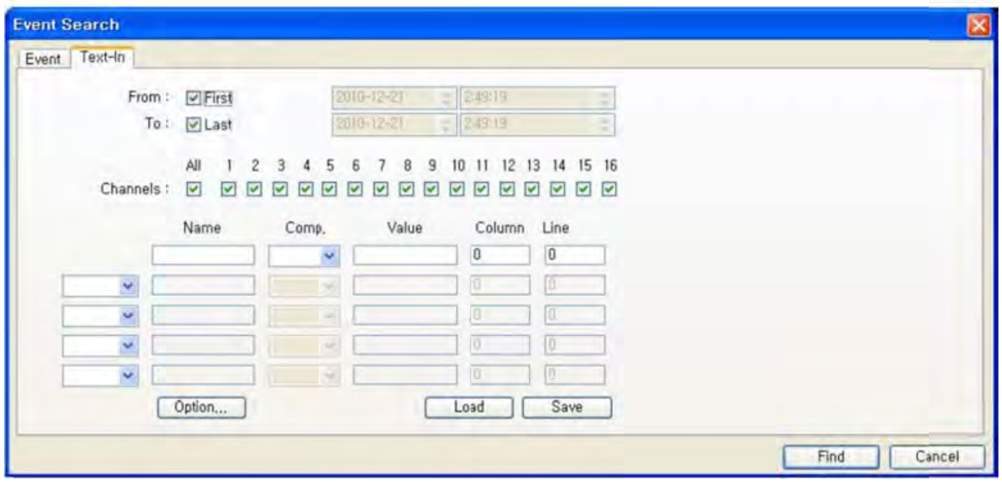
The recorded data of each camera channel are displayed by time in one-minute segments and a red vertical line indicates the selected time that will be played back. The color of the bar indicates different types of recording: yellow for Pre-event, purple for Event, red for Panic, and blue for Time-lapse. If the DVR has more than one video segment in the same time range, each segment will be separated by a yellow vertical line.

When searching video recorded on a PC-based DVR, the recorded data of each camera channel are displayed by time in one-minute segments. The color of the bar indicates different types of recording: yellow for Pre-event, cyan for Motion Detection, lime for Object Detection, purple for Video Loss, brown for Video On, red for Sensor, gray for Text-in, and blue for Time-lapse.



Event Search: The event search mode searches for event log entries using specific conditions and plays back the images associated with those event entries.





Set up the search criteria for the event search in the Event Search dialog box, and click the Find button. The results will be displayed in the event list. A total of 100 results can be displayed at a time. Click the (Query Next) button to display the next results. If you select an event in the list, the recorded data associated with that event will be displayed on the screen. The images may be played back using the playback buttons.

When searching video recorded on a PC-based DVR, you can adjust the event dwell time from 1 second to 10 minutes. If you adjust the event dwell time, RASplus will display the images of first queried event and ignore remaining events occurring during the preset period.

Searching Data Source: The user can search recorded data on primary storage installed in the remote DVR or archived data on backup storage installed in the remote DVR or search recorded or archived data on storage used for another DVR then installed in the selected remote DVR.

Screen Layout and Frame Layout: RASplus provides multiple screen layout for playback. The available formats are single-screen, quad, 1+7, 3x3, 4x4, 5x5, 1+32, 6x6, 7x7, 8x8, and full-screen.

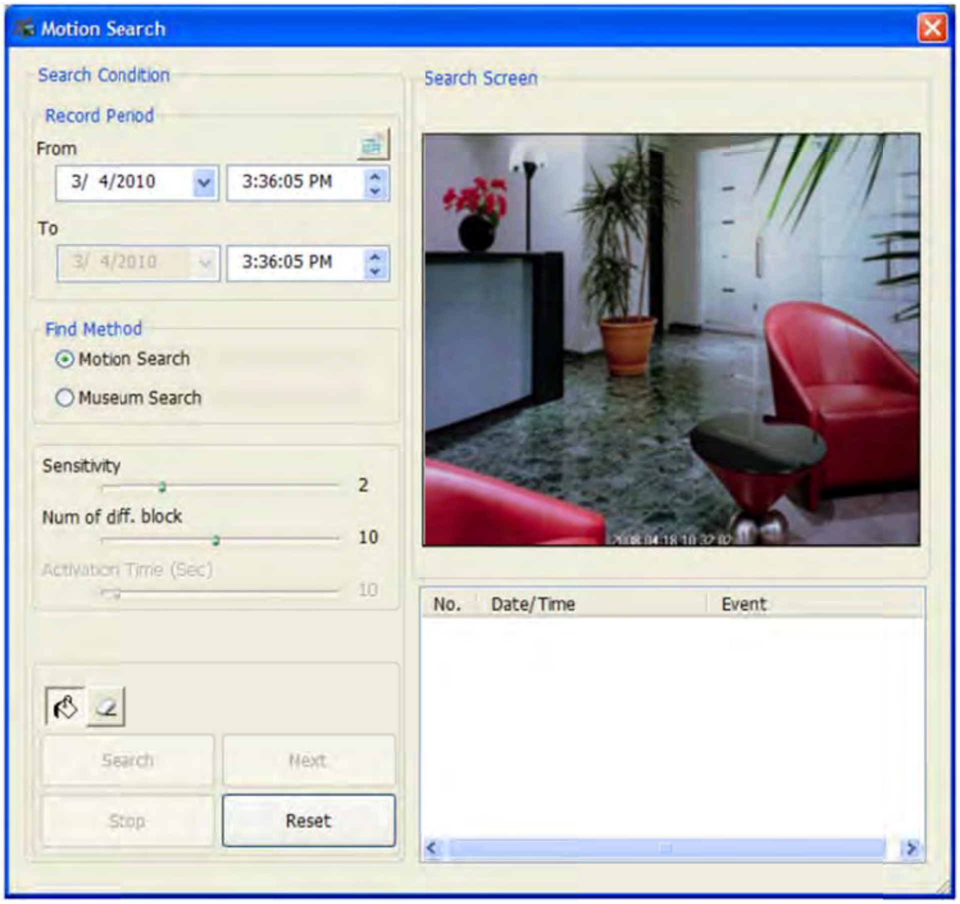
Image Processing: The Image Processing panel allows enhancing played back images using processing controls such as:

- Blur the image
- Sharpen the image
- Equalizes the image
- Reduce the alias effect that occurs when using the zoom function
- Reload the original image

Playing Recorded Audio: RASplus can play audio when it is in the single-screen layout while playing back recorded video that has recorded audio. Audio playback can be On or Off by selecting Enable Audio from the menu displayed by clicking the right mouse button on the screen.

Save: You can save any video clip of recorded data as an executable file or an AVI (Audio Video Interleaved) file format.

Motion Search: The Search View panel supports a search for motion in the recorded images on remote DVRs while in the single-screen mode. The following are available to the user:



Record Period sets up the record period of images to search.

Motion Search finds images with changes in the Detection Area between two consecutive images (for example, when there was movement).

Museum Search finds images with changes which last for the Activation Time in the Detection Area when compared to the image displayed currently on the Search Screen (for example, when an object disappears).

The **Sensitivity** sets the change detection. The higher the number, the more sensitive it is.

The **Num of diff block** sets the minimum number of blocks that must be activated to be considered as a change (Motion Search only).

The **Diff. % to ref. image sets** the minimum proportion (%) of blocks that must be activated to be considered as a change (Museum Search only).

The **Activation Time** sets the duration that the change must last to be considered as a change (Museum Search only). If a change is detected but does not last as long as the Activation Time, the change is not considered as a change.

Detection Area Select/Clear sets the detection area on the Search Screen by selecting or clearing blocks.

Search/Stop starts or stops searching. The last recorded image is displayed on the Search Screen.

Next continues searching after 100 results are found.

Reset: Resets the search condition.

7.3.5.2.3.3 Additional Functions

The following additional features are available:

Save the image and associated image information

Print the image and associated image information

Screen Menu supports the following:

- **Change Camera Title:** Changes the camera name displayed on the screen. Leaving the Camera Title blank causes the camera name set up on the remote site to display. Changing the camera title does not affect the camera name set up on the remote site.
- **Enable Audio:** Enables audio communication with the remote site on the Watch screen (Two-way audio equipped remote sites only). Plays audio while playing back recorded video that has recorded audio on the Search screen.
- **Aspect Ratio:** Changes the image aspect ratio displayed on each camera screen.
- **Fit to Screen:** Displays images by fitting them to the screen size.
- **Original Ratio:** Displays images by fitting them within the screen size while maintaining their original ratio. Half Size (x0.5) to Quadruple Size (x4): Select the desired image size. Options are enabled when the selected camera screen can display images in that size.
- **Draw Motion Block:** Displays the area that detects motions with red blocks on the screen. (Network Video Transmitter connection only)
- **Trim The Black (noise) Edges:** Trims the black line (noise) displayed at the edge of the image (Network Video Transmitter and some models of Network Camera connection only).
- **MultiStream:** Allows you to choose the desired stream if the remote DVR is in the multistream mode for live monitoring.
- Set Record Camera: Sets the selected camera channel to be recorded during panic recording.
- **Deinterlacing:** Enhances image display quality of interlaced video on the screen by eliminating horizontal scan lines or noise in areas with motion.
- **Anti-Aliasing Screen:** Enhances image display quality for all cameras on the screen by eliminating stair-stepping (aliasing) effects in the enlarged image.
- **Disconnect Camera:** Disconnects a camera on the screen.

7.3.5.2.3.4 Panic Recording

Up to 16 channels can be recorded at a time with Panic recording, and you can select which cameras are to be recorded during the system setup.

Clicking the button on the toolbar starts panic recording of cameras currently displayed on the Watch screen. Clicking the button again stops panic recording. Up to 16 channels can be recorded at a time, and you can select which cameras are to be recorded during the system setup. Clicking the button on the toolbar initiates the Record Player program and plays video saved in the recording folder designated during the System setup. The Record Player GUI and its controls are almost identical to the Clip Player.

If you want to play back video saved in another recording folder, run the Record Player program first. Move to the Start menu in Windows. Then, select RecordPlayer from the RASplus options and select the recoding folder path you want.

Recorded video can be saved as a bitmap or as an executable file using the save function of the Record Player.

7.3.5.2.3.5 Status View

RASplus provides a status display, remote setup, system log, and event log view of the connected remote site in real-time. To display a status of the remote site, select a camera or a site from the Remote Site list and drag it to the Status View panel. You can also select Connect Status from the popup menu displayed by clicking the right mouse button after selecting the site from the Remote Site list. The available function buttons are:

Disconnect: Disconnects the current connection on the Status View panel.

Remote Setup: Allows changing the setup of the remote DVR connected to the Status View panel.

Remote System Log: Displays the system log information of the remote DVR connected to the Status View panel.

Remote Event Log: Displays the event log information of the remote DVR connected to the Status panel.

Remote Panic Control: Controls the panic recording of the remote DVR connected to the Status View panel. The button indicates that the remote DVR is not in the panic recording mode and you can start panic recording by clicking the button. The (Off) button indicates that the remote DVR is in the panic recording mode and you can stop panic recording by clicking the button.

7.3.5.2.3.6 Status Display Window

The Status Display window displays the event, alarm out, system check and recording status information of the remote system connected to the Status View panel in real-time.

Event:	Displays event (Motion Detection, Alarm In, Object Detection, Video Blind, Audio Detection)
Alarm Out:	Displays status of the alarm-out signals
System Check:	Displays the function status of the camera, alarm, and recording
Record From/To:	Displays the record period
Status:	Displays the recording, playback, archiving, clip-copy status
Version:	Displays the system version information

7.3.5.3 ViM Fleet-Wide Management Software

Vehicle Information Management (ViM) is a modular software platform designed to improve accessibility of data to agency employees. ViM provides streamlined, fleet-wide management of video surveillance and on-board equipment to reduce liability, mitigate risk, improve efficiency, and reduce maintenance and operating costs.

The ViM Server and client software uses authentication security practices to keep video clips and information safe from potential attacks through its web interface. The database and video files are stored in a central storage location defined by the server administrator. These files are not hidden or encrypted in any way. It is the responsibility of the network administrator to protect access to these files to prevent unauthorized tampering or deletion of critical ViM Server files.

ViM Base is the core of the software with the ability to download and review user-selected video clips from DVRs. ViM is licensed on a per-server and per-vehicle basis with the exception of ViM Base. Each module requires one (1) software license for each server on which it is installed and one (1) additional license for each vehicle / site. ViM Base requires only a server-license, and can be used with an unlimited number of vehicles / sites.

The ViM server resolves a unique challenge in mobile video recording. DVRs are powered on and off with the operation of the vehicles and are often out of network range. This complicates the ability to retrieve video when needed as the vehicle may be powered off or out of range at critical times. The ViM Server monitors the connection status of each DVR and downloads important information when a DVR is on and in network range. Using ViM Base, an operator can request a video clip and have that clip retrieved the next time the vehicle establishes a network connection. The ViM Server application manages all DVRs, stores all video and data files, and serves as a web interface for Client users.

The ViM Client application provides full access and capabilities to the ViM Server for all levels of users. A subset of the ViM Client capabilities is also available using ViM web interface with a supported browser.

The ViM Base software is provided with the proposed solution and includes the following functionality:

- Download video clips on-demand
- Customize event video clips
- View status reports
- Archive evidence-grade video clips

- **AutoClip Module:** Featuring status reports, event logs, on-demand video clip retrieval and automated download of event video clips, the AutoClip module provides simple fleet-wide video management ideal for monitoring fleets of RoadRunner™ DVRs. AutoClip does not require the user to request data to be uploaded. It is configurable to automatically transmit event data. The ViM Server automatically downloads important portions of video requiring immediate review or availability, as configured by MTD, and saves video clips in Apollo Video's proprietary evidence-grade format. These Clip-Copy video clips feature watermarking and encryption to ensure that video is authentic and has not been subject to tampering. Provided in an executable format, the file includes an embedded player, so there is no software required for viewing. Clip-Copy video clips also feature optional password protection to prevent unauthorized viewing access.
    - Automated video management for small and large bus fleets.
    - Providing customized temporary and long-term storage options, ViM easily fulfills agency retention requirements and ensures desired video is available upon request.
    - Using ViM Software, each DVR/bus is set up as a unique site with independent configuration options for event and pre-event download options. The software displays information about the site including setup parameters and the time and date the DVR was last connected to the network.
    - Maintain a detailed "clip log" that provides the operator an easy method for locating and reviewing video and the ability to disposition a clip for removal or long term storage.
    - Request a video clip anytime – the Get-A-Clip utility will download the video clip automatically the next time the vehicle connects.

7.3.6 Yard Wireless System

7.3.6.1 WLAN Infrastructure

A wireless LAN system will be installed at the MTD depot to distribute updates to the fleet and to collect performance data from the fleet. Clever Devices estimates five (5) access points will be required based on the requested coverage areas provided by MTD. Clever Devices also estimates that MTD will need to install an additional five (5) access points if uploading all video from the buses is required. However, a site survey will be required to confirm the areas of coverage necessary to support the solution as well as proper access point placement. The following parameters are taken into consideration when performing a site survey.

Data Rate & Roaming	The wireless LAN coverage should be capable of staying within an 18 to 54Mb/s zone. The system would be designed for seamless roaming in the areas defined for coverage.

Application Types	The BusLink® program furnished by Clever Devices will track and receive data from buses within the Bus Garages. While daily data transfers should only be around 4mb daily, database distributions to the bus can be as large as 60mb.
User Density	User density should typically not exceed 30-35 network devices per access point, where possible (preferably 20-25 clients per AP).
Access Point Location	The critical factor in the implementation of any wireless network is the location of the Access Points. A site survey is recommended prior to installing a wireless system. Antennas should be mounted below any obstruction in the ceiling. The preferred height for antennas is 16'-18' when possible but should never be mounted lower than 11'.
Access Point Channels	A preliminary site survey should be performed prior to wireless installation to determine outside sources of interference from 802.11 networks as well as proprietary protocol devices on the 5GHz band. Access Point channel selection should be assigned to avoid these devices.

Clever Devices has included the Cisco Aironet 1600 series access points for MTD's WLAN. The Aironet 1600 series includes 802.11n-based 3x3 multiple-input multiple-output (MIMO) technology with two spatial streams, making it ideal for small and medium-sized enterprises. The Aironet 1600 Series also provides at least six times the throughput of existing 802.11a/g networks. With an entry-level path to 802.11n migration, the Aironet 1600 Series can add capacity to the network for future growth for expanding applications and bandwidth.

To simplify the deployment of the wireless network, Clever Devices has included a Cisco 2504 Wireless Controller that can manage up to 50 access points. This controller delivers centralized security policies, wireless intrusion prevention system (wIPS) capabilities, award-winning RF management, and quality of service (QoS) for voice and video. Delivering 802.11n performance and scalability, the Cisco 2500 Series provides low total cost of ownership and flexibility to scale as network requirements grow.

7.3.6.2 Bulk Data Transfers – BusLink®

Clever Devices' BusLink® is a comprehensive and easy to use tool to transfer all bulk data between IVN® and the BusLink® server via WLAN. All bulk data transfers are fully automated and require no operator interaction. When the bus comes in range of the BusLink® server, all on-board performance data is automatically transferred to the BusLink® server, and all updates are distributed to the bus. BusLink® is secure, reliable, easy to use, and trustworthy. No data is lost and it has a guaranteed delivery. All data is transferred by achieving only 15 minutes of connectivity per day.

- Automated download and distribution of software and data updates to the fleet, and all fixed end system components
  - User settable distribution date and time
  - User settable affectivity date and time
  - User selectable distribution to: vehicle, groups of vehicle, fleet type, all
- Automated upload and retrieval of vehicle performance data to the BusLink® server
- Guaranteed transfer of all files from the vehicle
- Aborted data transfers are automatically resumed from point of disconnect
- Compression is provided by well-known ZIP tools
- 2 second in-range detection, 15 second out-of-range detection

- Connectivity management of thousands of vehicles concurrently
- Provides a user interface for viewing real-time connectivity and bandwidth utilization
- Reports based upon wireless activity including bandwidth, time within wireless range, and last upload
- Database to support tracking software and data versions by vehicle, and application
- TCP/IP protocol (media-independent, wireless compatible, error correcting protocol)
- FTP protocol
- Priority management by file

7.3.6.2.1 Authentication and Security

BusLink® controls, manages, and distributes updates to the fleet, CleverCAD®, CleverReports™ and all components of the system. It is a database application which runs on a standard PC configured with Microsoft Windows operating system. It provides user authentication as well as automated upload and retrieval of vehicle data and manages connectivity and data transfer between the vehicle and the BusLink® server.

BusLink® supports the automated authentication of buses to the BusLink® server ensuring that only those bus systems authorized to communicate to the BusLink® server can do so. It provides an application level of security above the standard WPA2 built-in WLAN security mechanisms. It tracks connectivity of each vehicle, details on what was transferred between the vehicle and the Server, and provides a complete reporting mechanism.

When a vehicle comes in range of the wireless LAN, it receives an encrypted message from the BusLink® server. The SmartBus™ system decrypts this message using an algorithmic key and responds back with a newly encrypted message that is received by the wayside BusLink® server. Once authenticated, another security layer is executed that consists of the Windows username and password required to access the local FTP server on the BusLink® server. This is encrypted and sent back to the vehicle, permitting transfer of data through the wireless LAN. This process is executed each time a vehicle moves into WLAN range and is accomplished in a few seconds. Once authenticated, the vehicle can transfer files to the BusLink® server and retrieve updates.

BusLink® reports on the latest files that each vehicle transferred.

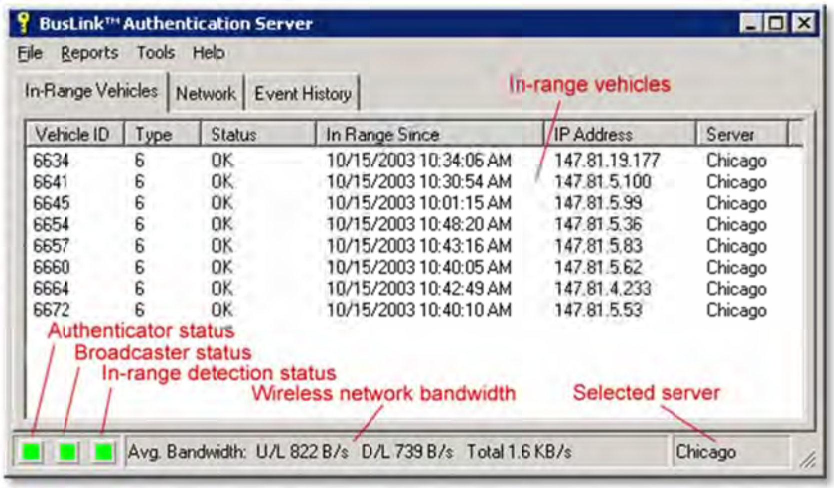


Figure 33: BusLink® Connection Status

The illustration below is a typical report from BusLink® and provides the data bandwidth consumed on a daily basis.

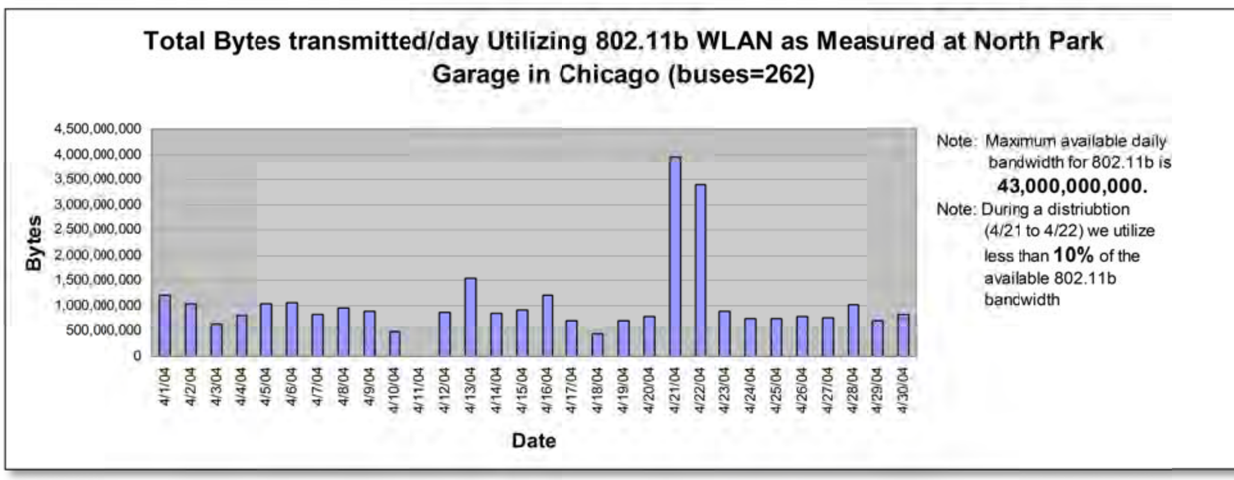


Figure 34: Bandwidth Report

All performance and log data uploaded from the fleet is recorded in BusLink® and is viewable by BCT.

7.3.6.2.2 Data and Software update Distribution

BusLink® is the single point of distribution and ensures data synchronization across all products within the system, tracks the update with time and status, and reports on any update anomalies. The following figure demonstrates the data distribution process to the fleet and all system components.

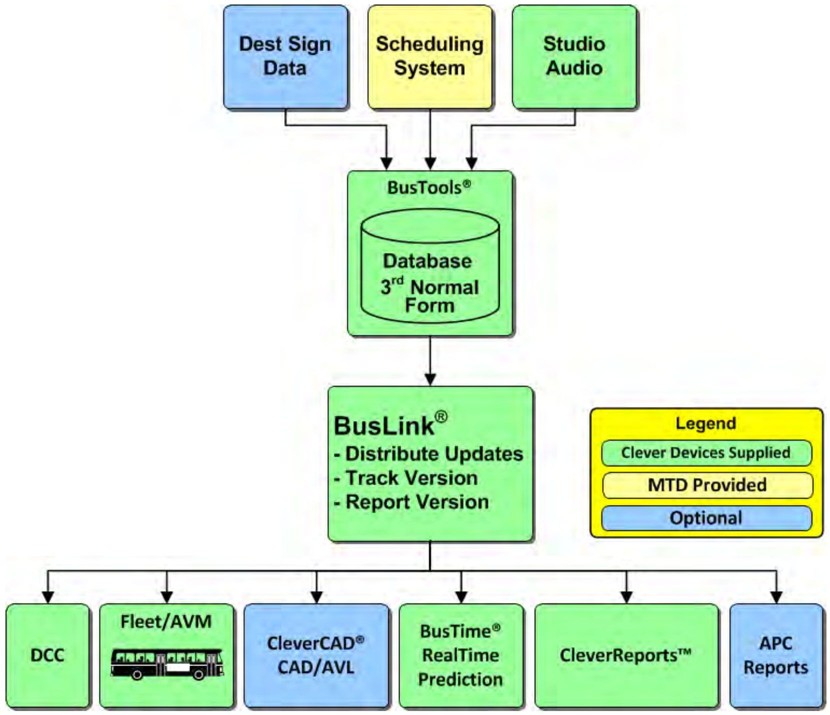


Figure 35: Data Supply via BusLink®

BusLink® is more than just a data distribution mechanism to the system. It ensures data synchronization across all products within the system, tracks the update with time and status, and reports on any update anomalies. The distribution process does all the work while the user simply imports the data, assigns it to be distributed to all system components, sets an activation date and time, and presses "Go."

All fixed end applications monitor for updates. When an update is found, it retrieves the update and prepares to make it active at the time specified by the user. When the activation time arrives, the update is made active. Since not all vehicles will be updated the exact same instant, the fixed end applications (CleverCAD®, DCC, and BusTime®) accommodate both the previous and new updates to ensure seamless operation.

When a vehicle comes in WLAN range of a BusLink® server, it automatically checks for software and updates. Any updates found will be downloaded to the vehicle and status reported. After the activation date and time passes, the vehicle will automatically apply the update. BusLink® tracks version information for data and software on each vehicle.

BusLink® provides a means to review all the files assigned to an update for distribution to the fleet and the ITS applications.

BusLink® is a fully automated process. However, as with all Clever Devices' products, manual override is always available. The user can always provide updates by manually using a USB memory device to transfer updates to IVN®. When completed, the bus will report its new version to BusLink® and CleverCAD®.

7.3.6.3 Full Video Transfer (Option)

Clever Devices has included an additional five (5) WLAN access points and 150 TBytes of storage to support full video transfer. To maintain costs, the additional storage is not redundant.

7.3.6.4 Yard Location & Status SmartYard™ (Option)

SmartYard™ is a depot management system that provides real-time tracking of vehicles anywhere in the depot and includes business applications to support the depot staff in managing the maintenance or service status of the vehicles. To provide yard location and status, the following SmartYard™ modules are required:

Real-Time Location System:	Real-time tracking of vehicles anywhere in the depot
Yard Mapping Module:	Display of vehicle locations in the depot with cross-reference to key vehicle characteristics and status

SmartYard™ is web based and is viewable in any workstation, notebook, or other mobile devices that use versions of Internet Explorer, Safari, Chrome and Firefox that support HTML5. Any workstation can access information from SmartYard.

SmartYard™ is designed to deliver information to any user with an Internet connection.

SmartYard™ is deployed with a standard number of user roles and privileges. The system administrator can easily add new roles and permissions to different service functions.

SmartYard™ monitors for events that can trigger real-time alerts to one or more users. The system administrator can select the users who should receive the alerts. Alerts are delivered by email or SMS (not included). Some examples of available real-time alerts:

- Warning for a block with a pending late pull-out
- Alert that a bus arrived at location xxx in the depot
- Alert that the status of a scheduled bus was just changed to unavailable.

The real-time location system (RTLS) component of SmartYard™, tracks the location of vehicles in the specified coverage area in and around the depot including anywhere the vehicle can travel, outdoors or indoors, in formal parking areas, temporary locations and unauthorized areas are tracked.

The RTLS consist of three major parts, a location server, a network of anchors and gateways, and SmartTags installed on each vehicle.

7.3.6.4.2 From Depot Map to Depot Dashboard

The depot map with vehicle locations makes a good platform for a depot dashboard. SmartYard™ takes many information already available in a transit agency's ITS infrastructure to create a depot dashboard. The optional data and the visual enhancement to the depot map is summarized in the table below. As a dashboard, these parameters are only displayed. The display is updated in real time.

Table 6: SmartYard™ Data Sources

Typical ITS Source	Optional Data	Visualization Impact	
		Icon	Tooltip
MMIS (not included)	Vehicle configuration & components	Vehicle icon representing length	Tooltip display of vehicle details
	Work Orders	Vehicle icon with work order symbol	Tooltip display of work order summary
AVM® (option)	Vehicle health status	Vehicle icon showing green/yellow/red health	Diagnostic events

Availability	Holds & Trippers	Vehicle icon status for holds & trippers	Tripper limits by time required at depot, mileage limits, or operating hours limit
Scheduling	Blocks	Vehicle icon status indicating block assigned	Block vehicle type restriction
	Runs		Route description
	Operators	Vehicle icon indicating operator assigned	Operator details

As seen in the table above, there are many data elements that are optional to the function of SmartYard™. These data elements are not universally used by all transit agencies. Each transit authority will work with their deployment team to determine which data elements will be used for their system. Data elements are often not available for the following reasons:

- The ITS source is not used at the transit agency
- The ITS source does not provide the information in a form that is available for integration
- The data is not included to reduce the integration cost of deployment
- The data is not used because the information is not needed for the work flow at the transit agency

7.3.6.4.3 Dashboard Example: AVM® (not included)

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted] [redacted]

[redacted] [redacted]

7.3.6.5 Bus Assignments – SmartYard™ (Option)

The SmartYard™ Pull-Out Management module provides the bus assignment function required by MTD. The Pull-Out Management module provides functions to assist in improving pullouts for on-time service delivery and reducing service interruptions from road calls.

The data required for the operation of pull-out management are shown in the table below.

Table 7: SmartYard™ Bus Assignment Data Requirements

Data	Requirement	Typical Source	Usage
Schedule Blocks	Mandatory	Scheduling	Service required from the depot
Operator Assignments	Optional		Warnings if a bus cannot pullout due to missing operator assignment
Vehicle Inventory	Mandatory	MMIS	Vehicles available at the depot or vehicles that are scheduled to be at the depot but currently in service
Vehicle Type	Optional		Matching vehicle requirements or restrictions of a block
Vehicle Health Status	Optional	AVM	Matching operating limitations to blocks to minimize road calls
Holds & Trippers	Optional	-none-	Set by mechanics for buses that are not available for service or for limited service; matches work orders that are planned for the day
Holds & Trippers	Optional	-none-	Set by mechanics for buses that are not available for service or for limited service; matches work orders that are planned for the day

Schedule Blocks: The scheduled blocks represent the bus work needed to be assigned at the depot. The number of blocks can be dynamically changed as the service dispatchers respond to changing conditions, which results in adding or deleting buses. Changes in service needs are reflected in real-time changes to the blocks.

A road call for a bus in service will result in the need for a replacement vehicle. This will be represented by a real-time change in a block when it is split with the second (later) part of a split representing the work to be performed by the replacement vehicle.

Operator Assignments (Optional): If the operator assignments are available to SmartYard™, then this status is displayed. The Pull-Out Management module can provide warnings on pending scheduled pullouts that are missing operator assignments. Last minute changes in operator availability (e.g. substitutions or late call in for sickness) could result in a missing operator assignment.

Vehicle Inventory: The number of buses typically available to the depot is represented by the vehicle inventory. SmartYard™ tracks their fundamental status as "in depot" or "in service" when the vehicle is late returning to the depot.

Vehicle Type (Optional): Some scheduled blocks have specific equipment requirements. Details on the vehicle type enables SmartYard™ to make more accurate matches of block requirements and vehicles. Some examples of requirements on a block are:

- Vehicle length, from turning restrictions of some intersections
- Vehicle height, from restrictions of underpasses
- Seating capacity
- Engine or fuel type, from zoning or neighborhood restrictions

Vehicle Health Status (Optional):	Vehicles with critical faults are not considered available for assignments to scheduled blocks. This consideration can be overridden by staff authorized to make the decision.
Holds & Trippers (Optional)	The maintenance supervisor selects vehicles for work by the maintenance team. These vehicles are assigned various holds and tripper status. SmartYard™ replicates this system support the maintenance work flow. Authorized personnel can make the decision to risk a road call and dispatch one of these vehicles.

7.3.6.5.1 Vehicle Assignments

SmartYard™ supports three modes of assigning buses to service blocks.

Automated mode:	SmartYard™ automatically makes the best match between available vehicles and the required schedule blocks.
Semi-automated mode:	SmartYard™ proposes the best match between available vehicles and the required scheduled blocks but a vehicle dispatcher is required to confirm the assignments
Manual mode:	SmartYard™ presents the options for matching vehicles to scheduled blocks and a vehicle dispatcher selects buses to assign to each scheduled block.

7.3.6.5.2 Vehicle Availability

SmartYard™ considers all the information available to compute vehicle availability. For each scheduled block, vehicles are grouped into the following classes:

- Recommended and available
- Alternative recommendation and available (for use when there are insufficient recommended vehicles)
- Not in depot at time of pull-out
- Critical faults, do not dispatch
- Other

SmartYard™ maintains vehicle availability in real-time. Any change in a vehicle status is reflected in the availability computation. Completed maintenance task can immediately return a vehicle to service. Late returns due to inclement weather or traffic delays will result in assignment changes.

7.3.6.5.3 Improving On-Time Pullouts

SmartYard™ ranks vehicle availability according to their physical locations or parking configuration in the depot. Vehicles that can pull-out without shifting other vehicles are more available than vehicles that are blocked in.

SmartYard™ computes assignments of vehicles to schedule blocks to minimize the labor required to prepare vehicles for pullout.

7.3.6.5.4 Reducing Road Calls

The priority is always assigning vehicles to enable on-time pullout of each service block. The vehicle dispatcher always makes vehicle assignments to enable each service block to leave the depot on-time. Especially under the time pressure of the peak pullout times, vehicle assignments do not always fully consider the maintenance status of vehicles as they are assigned. This contributes to the tension between the performance metrics of maximizing on-time pullout of blocks and minimizing road calls.

Road calls are both an inconvenience to the passengers and an expense to be avoided. No one likes to see a tow truck hauling a vehicle back to the depot.

SmartYard™ will consider all the maintenance issues in making vehicle assignments. Shifting vehicle assignments from the vehicle dispatcher to SmartYard™ removes the time pressures of peak pullout times and eliminates the assignment errors from making assignments with changing vehicle availability due to traffic, weather, maintenance schedules or the latest trouble reports from operators.

7.3.6.5.5 Pull-out Display

A display of the scheduled blocks in pull-out order can be used as a real-time dashboard of pullouts from the depot. The vehicle dispatcher or operations supervisor can easily see the pull-out status of each scheduled block as it becomes due. Any missing vehicle or operator assignments are easily seen. Blocks with potential late pullouts are highlighted and real-time alerts can be sent to one or more staff members that may not be dedicated to monitor the pullout status.

7.3.6.5.6 Standard Reports

The standard reports for the Pull-out Planning module are:

Service Availability Report:	List of all vehicles and their maintenance status for readiness to deliver service, for the selected date.
Assignment Report:	List of all vehicles sorted by either vehicle or service block numbers, for a selected date.

7.3.7 Bus Stop Announcements (BSA) – Option

The bus stop announcements (BSA) feature provided by IVN® provides automatic audio announcements as in compliance with the Americans with Disabilities Act (ADA). This function is derived by the association between the requirements for announcements and the database residing on IVN® that allows BSA to be made. The exported image from BusTools® contains all the data to identify when and where to trigger announcements and what to announce. IVN® accesses the audio data, decompresses it, and sends it to the audio hardware sub-system. Here it is converted from its digital format to analog signals, amplified, directed to the appropriate speaker group, and ultimately played for your riders. IVN® monitors the ambient noise of the vehicle and raises and lowers the volume so that it is comfortably audible over the existing noise. The announcement volume is automatically compensated within a pre-defined acceptable range. All announcements and messages will be made.

IVN® includes the provision of audible and visual annunciation of every stop, route, and route variation in the MTD fixed route system. IVN® supports multiple languages if required.

IVN® monitors the progress of the bus on the route, and if off-route, next stop announcements are disabled. All other functions will remain operational. IVN® will automatically detect when the vehicle has resumed the programmed route and will automatically resume making the automated announcements.

7.3.7.1 Stop Announcement Database

Clever Devices' solution includes BusTools® data management for all functionality associated with the on-board ITS system.

BusTools® manages all data required on the bus for BSA. As such, it exports the data into a compressed data structure. The BusTools® database with all audio, configuration, text, routes, stops, and schedule data will be approximately 350 Mbytes of data. The exported image compresses down to approximately 50 MBytes for distribution to the fleet. The image is a high performance data structure.

BusTools®' data integrity is implemented to minimize if not eliminate data redundancy. Clever Devices' data philosophy is to maintain atomic data and reference it everywhere it is required. This eliminates data duplication and assures that a single data changes is applied across all references.

The exported dataset contains all the information required for BSA and all future ITS applications.

- Next stop audio and sign text are easily managed with the BusTools® data management. The next stop data has audio text and sign text with sort, filter, and is easily managed through the GUI interface. The user can define prefixes, and two languages are fully supported. Special characters are supported and the inside sign text is displayed as it would be viewed on the bus.
- Route and destination audio and text are easily managed with the BusTools® data management. The route and destination data has audio text and sign text with sort, filter, and is easily managed through the GUI interface. The user can define prefixes, and two languages are fully supported. The user can assign a destination code to each route for automated control of the destination sign, if desired in the future.
- Transfers are created with the BusTools® data management tool. The Transfer has audio text and sign text and can be configured to display based on different service types. Special characters are also supported. The user can define prefixes, and two languages are fully supported. BusTools® also manages transfer printer ticket definitions if required.

  After the transfer is created, it can be assigned to a stop in a route. This reduces the amount of data and data management required by MTD users in managing this data.
- BusTools® data management product allows complete configuration control of public service messages as shown in the figure below:

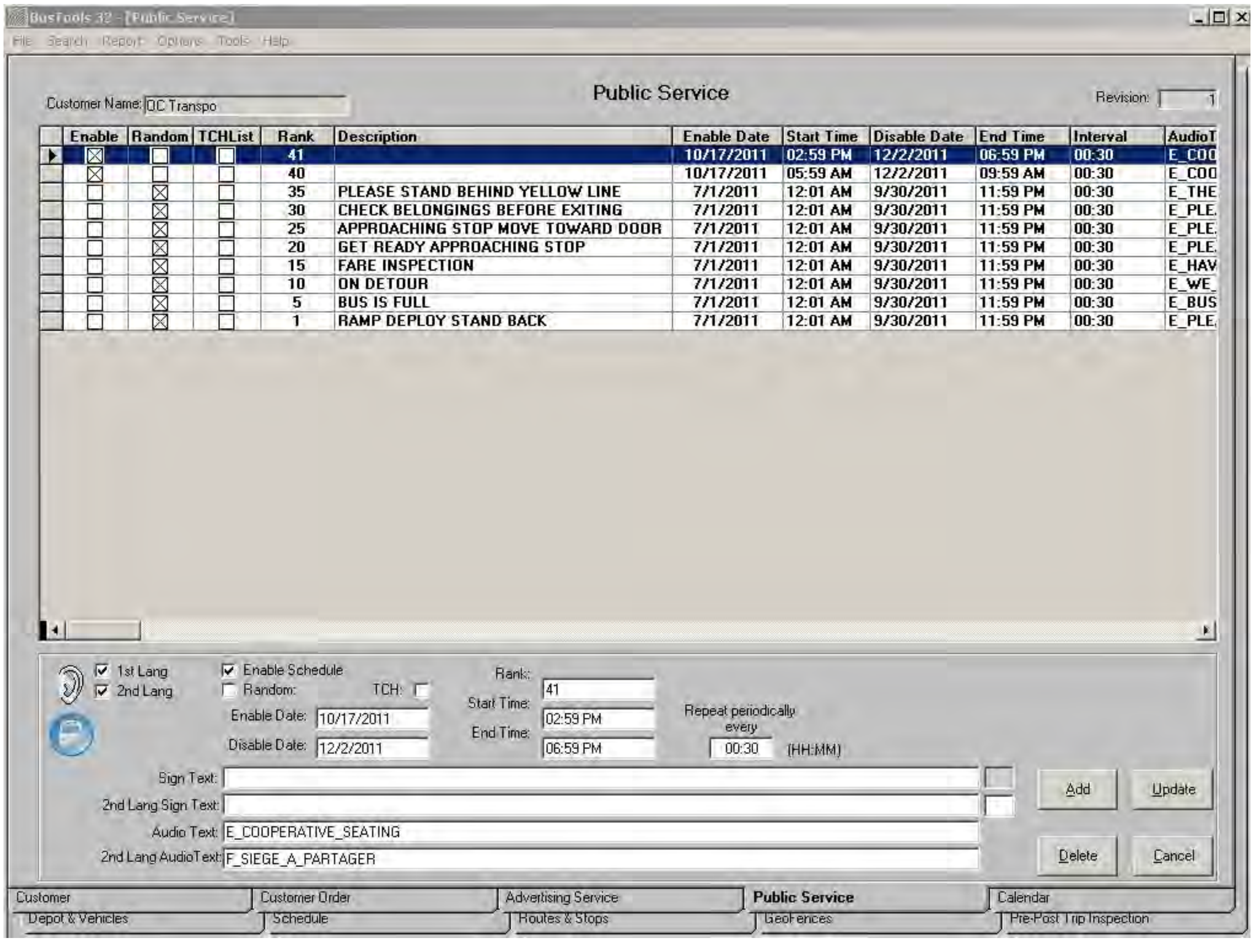


Figure 40: BusTools® Public Service Management

- BusTools® supports natural human voice recordings and Text To Speech (TTS) audio. Both are fully supported and imported into BusTools® for distribution to the fleet. When using natural human voice recordings, BusTools® compresses the audio data by a factor of 16 to minimize audio file size while maintaining a high audio quality for playback. MTD has the option to select which technology you desire. This has no impact on our proposed solution.
- Clever Devices' proposed solution supports two languages. Each language has separate configuration control, can be enabled/disabled individually, and is managed as completely separate data. This makes data management easy. It also improves data integrity and allows Clever Devices' technology to minimize data size by using individual words and phrases in multiple messages.

7.3.7.2 Audible Announcements

Interior Next Stop

The interior "next stop" announcement is configurable via BusTools®, the bus stop data management system, to operate in either "departing audio" or "approaching audio" mode. In departing audio operation, the "next stop" announcements are made as the bus departs the present stop en route to the next stop. In approaching audio operation, the "next stop" announcements are made as the bus approaches the next stop. The distance that the announcement is made from the approaching bus stop is configurable. While viewing the operator screen, a visual notification of an announcement playing is given by the animation of lines moving out from a speaker as highlighted with the red ellipse. Touching this bar at any time will replay the interior announcement.

Figure 41: Next Stop Announcements

Interior Transfer

IVN® announces information regarding transfers to be made at the next stop announcements. The trigger of a transfer announcement takes into account when the connecting route is scheduled and will not play transfer announcements when the connecting route is not scheduled. Transfers have a global prefix that can be enabled on a stop by stop basis.

Interior Stop Requested

IVN® announces that a stop has been requested when a passenger activates the "stop requested" signal on the bus.

Interior Public Service

Public service announcements are automatically triggered based on a configurable random algorithm, periodically or manually by the operator. All the public service announcements for the entire service area are stored and available on-board IVN®. Each public service announcement can be configured for a specific start and end date and time.

Maintenance Action Necessary

IVN® can be configured to trigger announcements based on digital inputs from external equipment. This has been used in other transit agencies to remind maintenance personnel that the current bus has a pending fault.

Exterior Route & Destination

IVN® plays route and destination announcements when the front and/or rear door of the bus is opened. This is configurable to play when the door opens or when the door opens at a stop.

Repeat Next Stop

The operator has access to repeat the next stop audio via the MDT.

Repeat Route & Destination

The operator has access to repeat the exterior route and destination audio via the MDT. The operator also has access to disable the exterior audio if desired.

Automatic Volume Control

IVN® provides independent monitoring of the ambient levels of the interior and exterior of the bus to automatically adjust the audio levels of the automated announcements.

Commuter Time	The system has two independently configurable periods of time called "commuter times" to attenuate the interior and exterior audio. Automatic Volume Control (AVC) calculates the amplifier level to playback and then attenuates the audio playback level by the configured amount.
Prefixes	Prefixes are global audible tones or announcements that are played before each specific type of announcement. Clever Devices supports prefixes for stop, route, destination, and transfer. Prefixes can be enabled and disabled at the stop level.
Audio Priority	IVN® controls the priority of announcements over the speakers based on configurable settings. This feature controls which of the two announcements, (live operator announcement or the automatic announcement) gets priority to play over the bus speakers.
Multi-Lingual	IVN® fully supports multiple languages for all automated announcements.
Volume Adjustment	The operator has the ability to adjust a majority of the components within the bus. Audio levels and adjustment options can be viewed by navigating to by touching the "audio adjustment" button displayed in the toolbar while viewing the PSA list.

Figure 42: Volume Adjustment

1	Driver speaker volume control
2	Voice handset volume control
3	Interior PA volume control
4	Exterior PA volume control
5	MDT volume control

7.3.7.3 Automatic Visual Display – ADA Compliant

IVN® controls and displays text messages to the interior LED sign through the standard SAE J1708 interface. The message will not scroll off the sign. When a single message is being displayed on the screen, the message is constantly displayed. When more than one text message is required to be displayed, IVN® cycles through the visual messages, displaying one at a time and alternating between the messages. IVN® includes the automated delivery of next stop, transfer, stop requested and date and time.

Interior Stop	IVN® displays the descriptions of the next stops consistent with the audio announcement. The next stop text is displayed just prior to the audio announcement.
Interior Transfer	IVN® displays the preprogrammed transfer information for the associated bus stops synchronized with the "next stop" audio and visual display.
Interior Stop Requested	IVN® displays the text "stop requested", when a passenger activates the "stop requested" signal on the bus.
Interior Date And Time	IVN® displays the current date and time on the interior LED sign upon start-up and will remain displayed while the system is on. IVN® alternates this information with the required ADA information as required.
Multi-Lingual	IVN® fully supports multiple languages for the LED sign.

The intended sign is similar to that illustrated below.

Figure 43: LED Interior Sign

7.3.7.4 HeadSign Control

BSA provides automatic control of the headsign. This is described in detail in section 7.4.4.3.4.3 on page 236.

7.3.8 Vehicle Health Monitoring – Automatic Vehicle Health Monitoring (AVM®) – Option

Clever Devices' AVM® is a comprehensive web-based vehicle component monitoring solution providing business intelligence reporting. Its capabilities are well beyond any other vehicle monitoring product available in the market today. Our AVM® system provides detailed maintenance and vehicle health information that allows maintenance staff to respond efficiently to issues before they turn into road-calls and service interruptions. This entirely new approach to vehicle maintenance is yielding powerful results, including reduced maintenance costs, decreased vehicle downtime (increased MDBF), extended vehicle life, and dramatically improved service to passengers. AVM® also significantly reduces the amount of time spent troubleshooting and diagnosing defects.

A bus contains separate systems from a variety of manufacturers. Prior to the introduction of AVM® there was no single diagnostic tool that could centralize maintenance of all component systems. With AVM® there are much better outcomes, since AVM® identifies issues before they become costly problems. In one simple example, by detecting a sudden decrease in pressure in a high pressure hose, AVM® alerted mechanics that there was a leak that, if left undetected, would have caused a $1,000 compressor to fail rather than what actually occurred – the simple identification and replacement of a $6 hose.

The AVM® system collects and reports on fault and operational performance data through available J1708, J1939, and pre-existing multiplex gateway connected devices of on-board systems such as:

- Engine
- Anti-lock Brake
- Tire Pressure Monitoring
- Supplemental Heater
- Camera
- Oil and Hydraulic Pressures
- Wheelchair Ramp Deploy
- Door Position
- Transmission
- Brake Wear/Condition Monitoring
- Battery Equalizer
- Heating/Ventilation/Air Conditioning
- Event Data Recorders
- Hard Breaking Events
- Bus Kneel Activation
- Multiplex Systems

AVM® continuously monitors and reports on vehicle condition and operation readiness for every vehicle in the fleet, seeking out hundreds of potential fault conditions that could lead to costly service interruptions. Problem vehicles are instantly and easily identifiable by maintenance personnel using AVM®'s color-coded status icons, and detailed views of information are easily modified to shift from single-vehicle analysis to fleet-wide condition reports. No additional staffing is required to operate this system once installed. It is used by existing maintenance departments to support work planning and can be interfaced to other maintenance work management systems.

AVM® is the realization of years of partnership with our customers to bring the best ideas and practices into one system. AVM® leverages state of the art data structure and storage utilizing MS SQL Server 2008 x64 Enterprise and Server 2008 operating environment. AVM® is a web delivered application requiring no client side installed software and can be delivered to users either over the internet or intranet. Best of all, AVM® centralizes all data into one database structured into a data warehouse. This design brings all the information together in one place while maintaining enough detail to run reports by garage, bus type, bus manufacturer, individual fault, individual bus, or over the entire AVM® monitored fleet. AVM® further leverages this new architecture by providing a truly agile, easy to use ad-hoc report generator for custom report creation by authorized personnel. AVM® not only answers today's business questions, but empowers MTD's staff to answer new challenges in the future. Please see Figure 44 below:

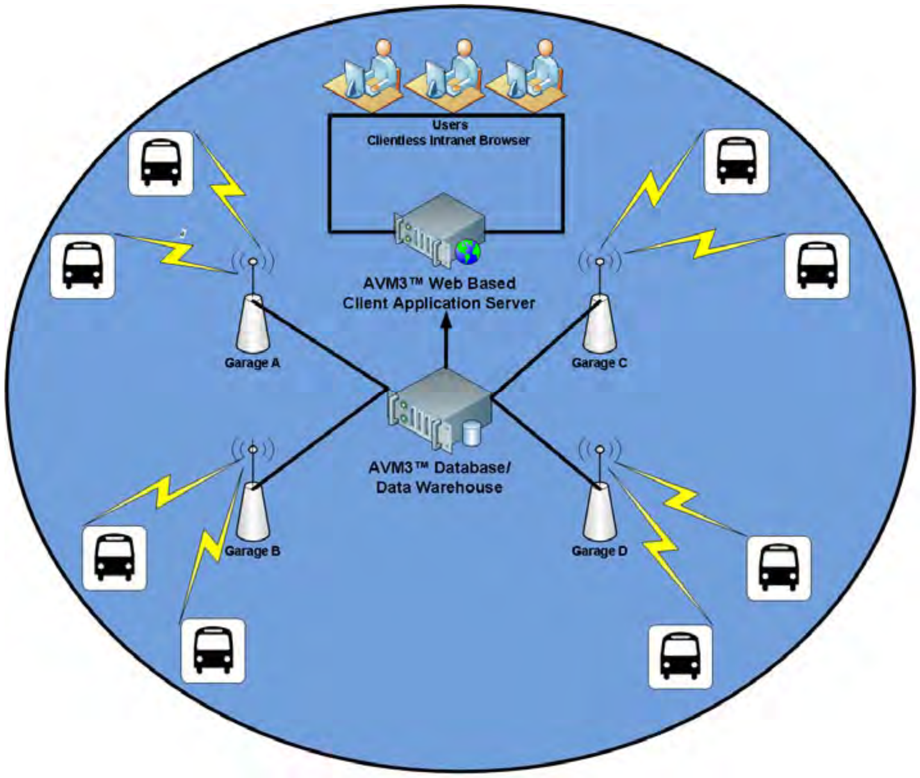


Figure 44: AVM® High Level Architecture

AVM® is a web-based application that can be accessed from Internet Explorer, Google Chrome, Mozilla, and Safari that provides users ultimate flexibility and gives system administrators painless client deployment/support. AVM® features a wide range of standard dashboards and reports and allows users authorized by the system administrator to generate custom dashboards and reports. AVM® also allows the export of data in .CSV, .XLS, .RTF, .DOC, and .PDF formats for use by MTD or other third party users such as the maintenance system.

AVM® provides the means to configure which specific faults and performance data are to be collected and their severity level (warning, fault, etc.) by vehicle type. MTD can also choose which faults are reported in real time and which are addressed when the vehicle returns to the garage through bulk data transfer. When there is a change to the configuration of the data to collect (fault, performance data, algorithm, etc.), the entire configuration file is automatically distributed to the fleet through Clever Devices' BusLink®. When the bus reaches the activation date and time of the distribution as set by MTD Transit personnel, it applies the updated configuration.

A significant advantage provided by AVM® is the flexibility of its algorithms. The customizable algorithms are available to MTD to define faults from the gathered performance data. Clever Devices has over 30 generic and custom algorithms specifically designed for transit applications. A few examples are:

- Definition of which faults should be sent in real-time
- Count brake applications to determine wear on brakes and warranty
- Detect overheat conditions before the engine actually overheats
- Require a minimum quantity of a specific fault type before notification
- Diesel Particulate filter control
- Delta change
- Count within duration (period of time)
- Active for minimum duration (period of time)
- Frequency of occurrence

7.3.8.1 Standard Reports and Dashboards

AVM® comes standard with over 60 standard reports and 14 dashboards screens. Standard reports provide detailed reporting and analysis of all faults, performance, and alphanumeric (SoftwareID, Firmware, Version) points. Standard reports and dashboards employ a variety of filters including:

- Date
- Garage
- Component
- Fault Description/Exceptions
- Bus
- Bus Type
- Manufacturer and Model
- Flash Code

The following is a list of standard dashboards available in AVM®:

- Fault Explorer
- Transmission
- MAX/AVG/MIN Performance
- Fleet
- Mechanic Current Month
- Engine
- ABS & Brake
- Trend Analysis (Performance Points)
- Garage
- Foreman Current Month

Please see the below list of standard reports available in AVM®:

Fault Reports	Performance Reports	Administrative Reports
Fault Priority	Alphanumeric	File Ingestion Summary
Fault Summary	Accumulating Performance Point Summary	File Ingestion Detail
Fault Detail	Accumulating Performance Point Detail	ETL (Extraction Transformation Load) Failure
Fault Trends Bus Type	MAX/AVG/MIN Performance Point Summary	Configuration File Ingestion Failure
Fault Component Percentage	Performance Point Detail	And many more…
Fault Trends Date	Performance Threshold	
Fault Trends Garage	Performance Measure	
Fleet Defect	And many more…	
Bus Type Fault Percentage		
Fault Priority		
And many more…		

Because of the extent of the reports available we have not included them with the proposal. Sample reports are available upon request.

7.3.8.2 Report Generation

AVM® provides state of the art dashboards and centrally administered reporting. To minimize administrative responsibilities and to provide the maximum value to the maintenance team, AVM® provides an easy to use ad-hoc report generation which allows MTD to create any report on demand. In addition, AVM® supports a copy function that makes a copy of any standard report and turns it into a custom report fully editable by agency staff. All ad-hoc reports use pre-defined data marts with all data relationships defined ensuring accurate and correct information for users every time they create a new report, no matter how many users are retrieving data.

7.3.8.3 Report Automation and Distribution

AVM® features a fully functional report automation and distribution engine. The automation engine provides traditional scheduling for report generation as well as logical conditions to only send reports when important events occur. This design philosophy prevents the users from being overwhelmed by email reports. AVM® also supports group and email distribution lists for created reports and includes an address book.

7.3.9 Automatic Passenger Counter (APC) – Option

Clever Devices has provided two alternatives for APC counting technology on-board the vehicle. Alternative #1, which is in the base, includes the use of the Hella overhead APC sensors on the entire fleet to meet both APC accuracy requirements.

Alternative #2 includes the use of Clever Devices' dual beam break technology on buses with narrow doors and Hella on buses with wide doors to provide a more cost effective solution. Alternative #2 is deployed in many transit agencies with NTD certification, meets the first APC accuracy requirement but falls a little short of the second APC accuracy requirement from the RFP and shown below. Both alternatives will meet NTD certification for the generation of passenger miles and ridership. Alternative #2 can save MTD approximately $90,000 while achieving similar results.

The APC accuracy requirements from the RFP are:

1) Provide accurate passenger accumulated count data that shall be within 5% accuracy for each 1,000 consecutive boardings and each 1,000 consecutive alightings.
2) Provide accurate stop-by-stop count data that shall be fully accurate for 85% of all door cycles; within one passenger for 90% of all door cycles; and within two passengers for 97% of all door cycles. This shall include stops for which there was no observed boarding or alighting activity.

Both proposed APC alternatives by Clever Devices includes the on-board APC counters, APC reporting, data correlation of APC counts to operational data, and NTD reporting. The following sections describe these.

7.3.9.1 Hella APC Counters (Alternative #1)

The following is standard documentation, which may include features and functions not required by MTD. These afford MTD the opportunity to understand the full capability of the on-board system. Clever Devices' proposal includes the costs of only those features and functions specified in the RFP.

The design, reliability and quality of Hella APC counters are based on our unique image processing and 3D camera technology. It uses 3D sensing or stereo-image capture, accomplished with two VGA cameras installed overhead. This solution eliminates a range of limitations that apply to conventional technologies including IR based counters.

Figure 45: Hella APC Counter

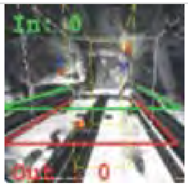
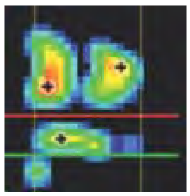
The Hella APC counter offers a web browser interface for setup and test. It also minimizes the required number of hardware components and offers a web browser interface for setup and test.

- Main system controller
- Digital output
- Power and protection
- APC counter
- Multiple interface options
- Video streaming utility
- (dependent on IT solution)
- Digital input
- Commercial connectors/cables

The resulting key advantages are:

- Ability to deal with complex motion patterns, thus maximizing counting accuracy
- Only one counter per door required
- No periodic maintenance

Stereo-Image capture	Two high-definition video cameras observe the monitoring area or Area of Interest **(AOI).**
3D-Image generation within AOI 	Innovative Image-processing methods calculate a 3D position for every pixel (visual object) within the field of view. The AOI, while set smaller than the field of view covers the entire door entry area and covers a smaller are outside the vehicle (once door is open) and a set are in the vehicle's interior. Passengers are tracked while inside this AOI. Real-time comparison with 3D baseline. Stereoscopic representation of the observed environment, objects and identified passengers.
Stereo-Image matching	Objects with a third dimension are recognized and tracked. Continuous tracking of multiple people within AOI.
Tracking of 3D-structures	Highly granular object data is collected and assessed: Object List (Current) • Object ID • Entry Position (in AOI) • Dwell time (within AOI) • Motion vector

 	• Object height (current) Object List (Historical) • Object ID • Entry Position (in AOI) • Total Dwell time (within AOI) • Average object height • Exit position (from AOI) Counts are registered when the user defined counting line is crossed AND the passenger exits from the AOI.
APC bi-directional count data delivery 	Confirmation of entry and exits from AOI ➔ boarding and alighting counts. Ability to: • Capture and zero balance reversal movements • Identify non-moving objects • Identify and report/action on objects in defined area within AOI (Clear Zone Monitoring)
Video streaming (dependent on IT solution)	Ability to stream video to external device: • Real-time video observation of entire door area • Backend counting accuracy validation through overlay viewing recorded video with inserted numeric counts
Digital Input / Output	Handling of a wide range of logic conclusions and control of external devices by use of one each DI/DO ports.

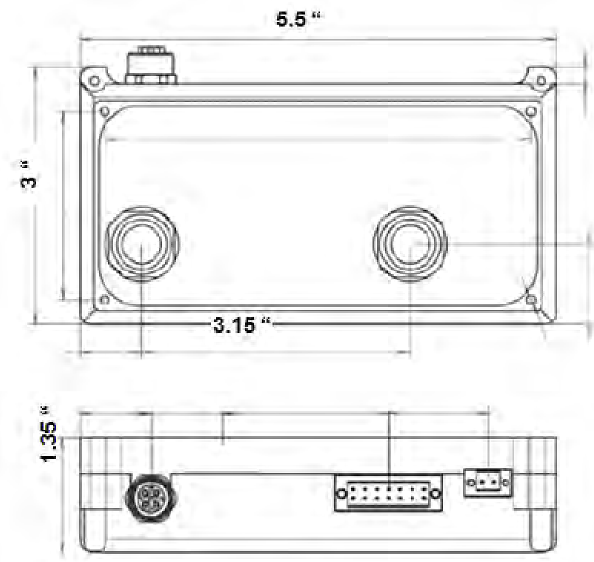
7.3.9.1.1 Typical Two Door Bus Configuration

The following depicts a basic system layout in a two door bus.

Figure 46: Hella Bus Install Overview

7.3.9.1.2 Key Features and Functions:

- Typical accuracy proven to exceed 98% counting accuracy (RAW data delivered by the counter)
- Single unit solution, compact design
- Interface: TCP/IP, J1708, RS485
- One device per door – for openings up to 63 inches wide
- Open source connectors and cables
- Management of complex motion pattern
- Ensues no double/multiple counts on immediate reversal of entries or exists by driver or passengers)
  - Walk-in and reversal
  - Walk-out and reversal
- Clear Zone Management
  - Detection of objects in definable are – e.g. to prohibit door close when passengers are in door area
- Capture surface load and time within detection area (e.g. near driver)
- Remote operation, upgrade and configuration over Ethernet (TCP/IP)
- Video streaming (based on IT solution)
- Remote comparative analysis by use of captured video that is combined with numeric counts
- Self-test capability



7.3.9.1.3 Accuracy

Accuracy Statement: Under the conditions typically found in Public Transit Systems, operated in urban areas, the Hella people counter product typically meets and exceeds the common market requirement of 95% (1) counting accuracy by a substantial margin of up to and exceeding 3%.

The stated accuracy level has been verified through internal testing and confirmed by Hella clients that conducted independent accuracy test/verification programs such as the ones illustrated below.

ACCURACY VERIFICATION

Location :
Bus Identity Windhoe

City of Windhoek

WEEKDAY & DATE	MORNING RUN CAMERA COUNT	ACTUAL COUNT	COUNT ERROR	AM ACCURACY	AFTERNOON RUN CAMERA COUNT	ACTUAL COUNT	COUNT ERROR	PM ACCURACY	CAMERA TOTAL	ACTUAL TOTAL	TOTAL ERROR	TOTAL ACCURACY
Fri 1 Jun 12	66	65	1	98.5%	15	16	-1	93.8%	81	81	0	100%
Sat 2 Jun 12	-	-	-	-	-	-	-	-	-	-	-	-
Sun 3 Jun 12	-	-	-	-	-	-	-	-	-	-	-	-
Mon 4 Jun 12	84	85	-1	98.8%	-	-	-	-	84	85	-1	98.8%
Tue 5 Jun 12	78	76	2	97.4%	76	76	0	100%	154	152	2	98.7%
Wed 6 Jun 12	86	88	-2	97.7%	0	0	0	100%	86	88	-2	97.7%
Thu 7 Jun 12	51	53	-2	96.2%	x	x	x	x	51	53	-2	96.2%
	365	367	2	99.5%	91	92	-1	98.9%	456	459	-3	99.3%

NOTES

1. The " - " comment denotes the bus was not in operation / service and therefore there are no passenger counts in the database.
2. The " x " comment denotes the bus was in operation / service but there is currently a lag in the data replication.
2. The " v " comment denotes the validation of the actual count is still in progress.

Figure 47: Independent accuracy Test Result Windhoe – Bus

Customer confirmed counting results Lint 4Train ARRIVA
based video data gathered at 4 doors

			Tür 1	Tür 2	Tür 3	Tür 4	Gesamt
Stations/Stops	Num Of		786	613	567	404	2370
Stations/Stops	With Errors		110	78	75	45	308
Stations/Stops	Correct		676	535	492	359	2062
Sum	Auto	In	1472	1179	952	716	4319
Sum	Auto	Out	1394	1202	999	695	4290
Sum	Auto		2866	2381	1951	1411	8609
Sum	Manual	In	1487	1178	937	724	4326
Sum	Manual	Out	1376	1204	983	703	4266
Sum	Manual		2863	2382	1920	1427	8592
Error	Signed	In	-15	1	15	-8	-7
Error	Signed	Out	18	-2	16	-8	24
Error	Signed		3	-1	31	-16	17
Accuracy		In	98,99	99,92	98,40	98,90	99,84
Accuracy		Out	98,69	99,83	98,37	98,86	99,44
Accuracy			**98,85**	**99,87**	**98,39**	**98,88**	**99,64**
			Normal mode	With additive LED light	Normal mode	Normal mode	

Figure 48: Independent accuracy Test Result ARRIVA – Rail

The following image depicts the result of a comprehensive analysis, designed to determine the ability of the counter to generate “stop accurate” count results.

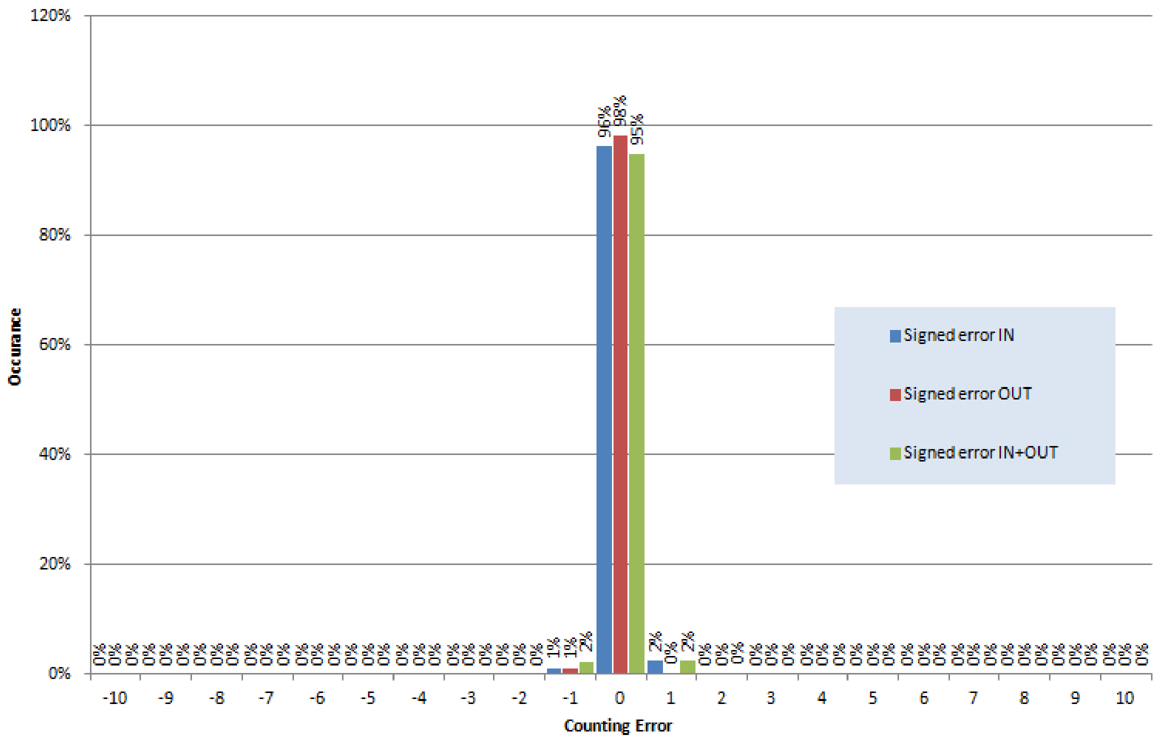


Figure 49: Performance - Stop granular counting accuracy

The results demonstrate the excellent performance of the Hella Stereo Camera counter.
Our solution achieves exceptional accurate results at the stop-level thereby confirming its small random error. With the exception of a couple %, stop results were accurate.

The sample also demonstrates the counter’s small or almost inexistent systematic error as results are centered to mid-point or 0 counting error mark.

NOTE: A small random error is critical when returned data is aggregated through a post processing process used for data management and reporting.

Example: Passenger miles are aggregated values, calculated by multiplying trip segment distance with the total number of APC reported passengers onboard at the start of the next trip segment. Evidently, the aggregated totals depend directly on the counter’s ability to provide accurate stop-level counts.
While systematic errors can conceivably be corrected, systematic errors cannot!

7.3.9.2 Clever Devices APC Counters (Alternative 2)

Alternative two includes the use of Clever Devices’ dual beam break APC technology on buses with door widths less than 40” and Hella on buses with door widths greater than 40”. Clever Devices’ APC technology is described here.

Clever Devices' Automatic Passenger Counter (APC) system provides accurate passenger counting utilizing dual infrared beams implemented on each side of the vehicle door. This system gathers comprehensive data to the data warehouse for utilization. Passenger counts are also communicated to the CleverCAD® dispatcher system providing real-time insight to vehicle loading at any given point in time. The figure below shows Clever Devices' lateral dual beam doorway APC sensors.

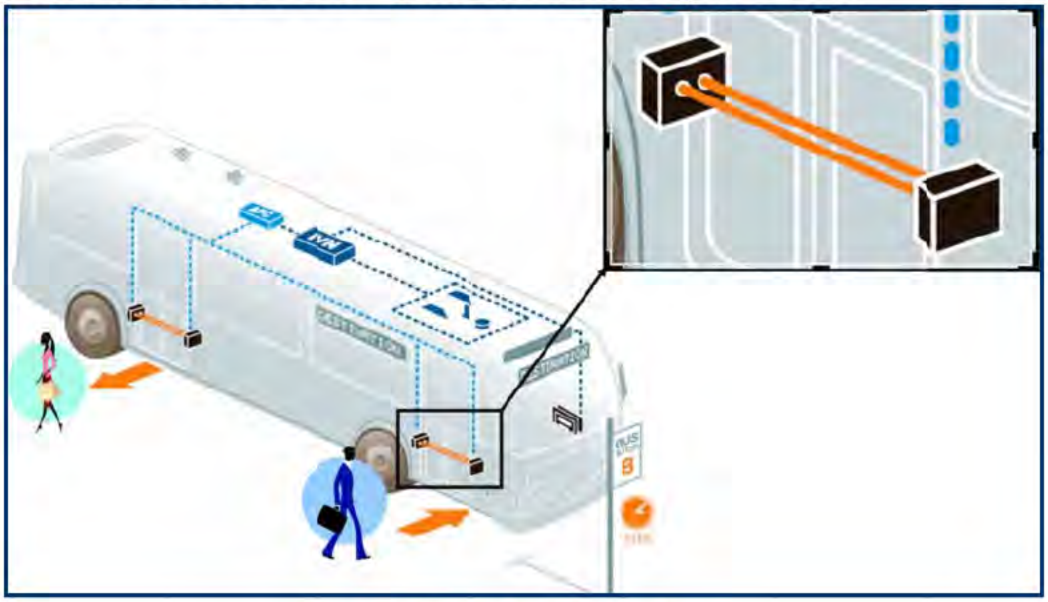


Figure 50: APC On-board System Overview

Clever Devices' APC system includes a two unit design; the APC Controller and the APC receiver/transmitter sensors. The system can support up to three doorways without an additional controller. The APC system is designed in such a way that each item of equipment is an individual unit. The sensor units include self-diagnostics to support ease with installation and maintenance.

The sensors use active infrared technology to project two parallel beams of infrared energy from a transmitter module to a receiver module. They receive/transmitter pair locations ensure that boarding or alighting passengers break the beams as they enter or exit the vehicle. The sequence in which the beams are broken allows the controller to determine the direction of movement. Passenger counts are processed based on the counting algorithm selected (a total of eight different algorithms are available), door status, vehicle in motion status, as well as several other internal parameters. The statistical accuracy attained for Clever Devices' APC system is 95% for boarding and 90% for alighting. The APC controller is capable of communicating count and diagnostic data via the SAE J1708 Standard.

Clever Devices' APC system also has the ability to filter out events such as passengers that do not pass completely through sensors. This situation is typical when passengers are waiting to pay the fare and may be moving forward or backward in front of the APC sensors. The count will only be considered valid if the sequence of beam breaks is proper for the direction of travel. For a boarding passenger, the sequence is as follows: only beam "B" broken, beams "A" and "B" broken, only beam "A" broken, no beams broken. For alighting passengers, the sequence is reversed. Count events that meet this criteria as well as the minimum count threshold are considered a "raw" count. What happens from this point forward is subject to several factors: count algorithm selected, door state, and vehicle-in-motion status.

7.3.9.2.1 APC Doorway Sensor

The APC sensor is designed to meet the same environmental characteristics of SAE J1455 as the APC controller.

The APC doorway sensors use infrared beam technology to count boardings and alightings. It is housed in a rugged enclosure that is designed to be splash resistant when properly installed (using the supplied gasket). Scratch-resistant lenses protect the actual transmitting devices.

The unit must be mounted toward the back of the door with the lenses facing the front of the vehicle. An arrow is visible on the bottom surface of the transmitter to indicate the direction of travel. The cable may be routed through the slot on the bottom flange of the unit, or through a hole in the surface it is mounted to. Figure 51: APC Transmitter Module illustrates the transmitter sensor.

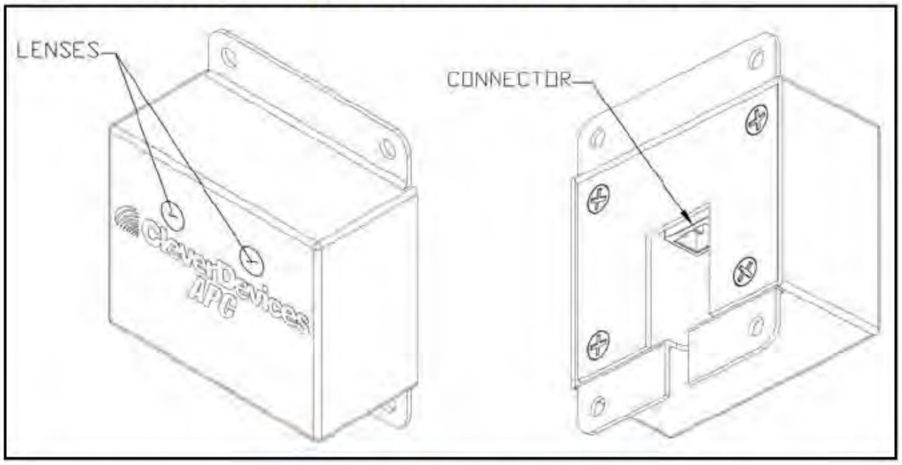


Figure 51: APC Transmitter Module

The receiver module, shown in Figure 52: APC Receiver Module, receives the infrared beams and relays the information back to the controller. Its construction is similar to the transmitter. It is mounted toward the front of the door with the lenses facing the back of the vehicle. The receiver and transmitter lenses must be on axis with each other.

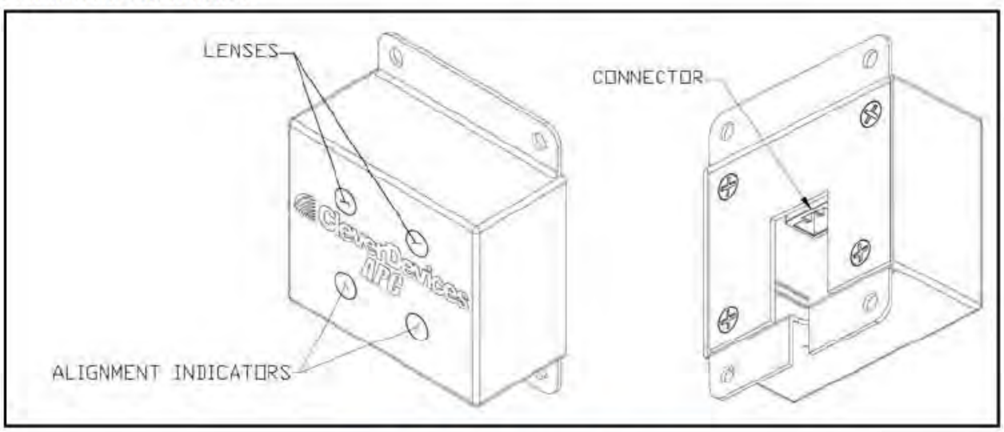


Figure 52: APC Receiver Module

The alignment indicators are provided as a means to facilitate aligning the modules. They glow red when the infrared beam is detected. However, final validation of the installation must be performed using the built-in diagnostics.

7.3.9.2.2 APC Controller

The APC system controller handles all of the processing required to count passengers and process J1708 communications. It directly controls beam period and processes the associated received beam states. The status of the beams, as well as other parameters such as door states, vehicle-in-motion, and the selected count algorithm all play a part in the controller's determination of valid or invalid counts. The controller can accommodate up to three receiver/transmitter pairs.

The APC system is designed to meet the SAE J1455 standards for temperature, vibration, and shock. This includes operational temperatures between -40°C to 66°C (-40°F to 150.8°F) as per SAE J1455. In addition to being designed to the SAE J1455 standards for vibration and shock, the APC controller has functioned properly with severe mechanical vibrations and operational shock in the field. Through the utilization of the APC system in varying climates, such as Florida and Illinois, the APC controller has proven resistant to extreme variations in humidity.

Short circuit, transient and electrostatic discharge protection is incorporated into Clever Devices' APC equipment design. In residential and industrial areas, the APC has proven resistant to power transients and radio frequency interferences. In the APC controller, electrostatic discharge (ESD) is controlled by grounding the system.

Using Microsoft HyperTerminal or Clever Devices' APC Controller Diagnostic Utility software, the APC controller can be locally programmed and maintained on-site using a laptop computer. The APC controller supports RS-232, RS482, and J1708 communication ports. The APC controller requires limited maintenance, thus programming is completed prior to installation.

The APC controller is designed to minimize size and bulk (6.625in x 3.500in x 1.24in); therefore, allowing the controller to not obstruct existing or future equipment installations. Different connectors, pin-outs, and labels for harnesses are used to prevent un-intentional miss-wiring during APC controller and sensor installation or maintenance.

Every APC controller and sensor is assigned a unique serial number with barcodes that can be electronically scanned. The APC controller incorporates a 36 Volt, 5000 watt transorb to prevent over-voltage and reverse polarity from occurring. Figure 53: APC Controller illustrates several of the unit's features.

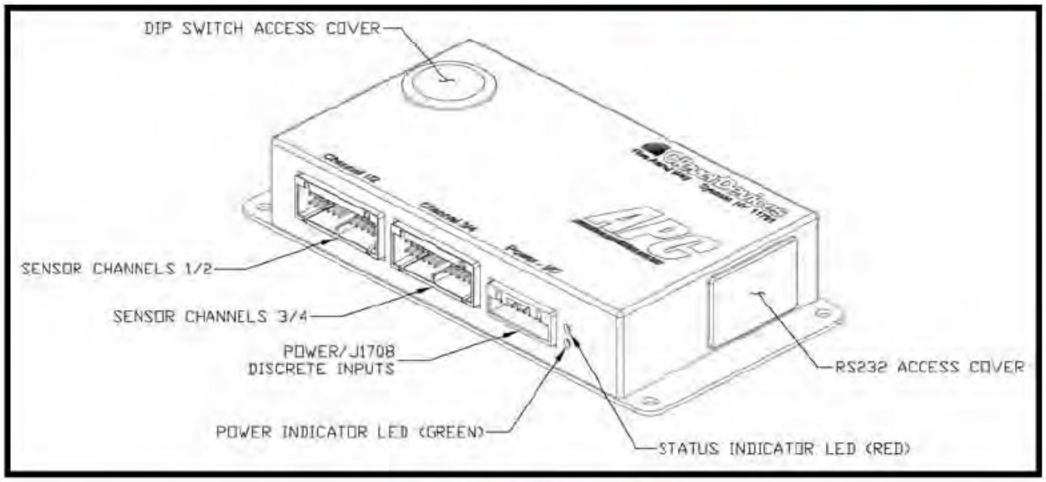


Figure 53: APC Controller

The APC controller is housed in a rugged aluminum enclosure and the printed circuit board is conformal coated to protect against the harsh transit environment. Connections to the vehicle are made through three heavy-duty automotive grade connectors. There is no internal cabling; all components are board-mounted.

The top of the controller has an access cover for an 8-position DIP-switch. The DIP-switch is used to select the communications mode (RS232, RS485, J1708/1587) and count algorithm, enable the alignment LED's, and enable firmware reprogramming.

Two indicator LED's are visible on the front panel of the controller. The bottom (green) indicator is a power indicator. It is illuminated whenever power is applied to the controller. The top (red) indicator is a system status indicator. Under normal conditions, the status indicator will flash at a rate of approximately once every two seconds. If a fault is detected by the controller, the status indictor will flash quickly, approximately twice per second. The most common fault is either a sensor module has not been detected, or an incorrect algorithm has been selected.

7.3.9.2.3 APC Controller Operational Features

The APC controller is interfaced with the IVN® to ensure accurate passenger counts from the use of a wheelchair lift. The APC controller continues to count the passengers entering and exiting the door well as the wheelchair lift is being used, while the IVN® counts the operational cycles of the wheelchair lift to eliminate counting error that may occur in the system. A time-stamped data record is developed each time either vehicle door is opened that records the number of passengers entering and alighting from the bus. To correctly process boarding passengers while the door closes, a ten second safety gap is initiated in the APC software to provide an opportunity for passengers to pass the APC receiver and transmitter who may have been standing in the door well. The APC receiver and transmitter are mounted so that alighting passengers are correctly processed for the proper stop.

The APC controller can be connected through an RS232 or J1708 port to a laptop computer. Using Clever Devices' APC Diagnostic Test Utility or Microsoft HyperTerminal, stored data records can be accessed from the laptop. Alternatively, APC data is automatically uploaded to the IVN® to provide a centralized data location for the user. APC data is not erased or overwritten on the APC controller until the IVN® has received the information. The APC controller responds to the receipt of the data and this response can be viewed by the operator on the transit control head.

7.3.9.3 Installation

The MTD selected APC alternatives will be installed on MTD's vehicles. All cabling will be designed to MTD's requirements. The APC sensors will be exposed; however, cabling is armor-shielded to discourage vandalism. Clever Devices proposes to review the specific recommendation for the APC installation with MTD based on our fleet survey and preliminary and final designs.

Both APC alternatives include self-calibration diagnostics that are used during installation and maintenance.

7.3.9.4 Integration

Both APC alternatives integrate with the IVN® VLU using a J1708 or similar network interface.

7.3.9.5 UTA APC Reporting

Clever Devices' proposal includes UTA's APC reporting solution. Coupled with Clever Devices' APC system architecture and IVN® correlation of all performance data on-board the vehicle, MTD is afforded the best of breed APC system and reporting solution. The IVN® data correlation improves APC accuracy and reduces post-processing data requirements. IVN® ensures that the APC counts are correlated to route, stop, date, time, GPS location, block, run, trip, operator, bus, and more.

7.3.9.5.1 Diagnostics Software

From the unedited and unmatched raw APC data file, a series of diagnostic routines review the data for logical consistency and APC hardware subsystem performance. A series of diagnostic reports and historical performance files are created which identifies any APC maintenance requirements.

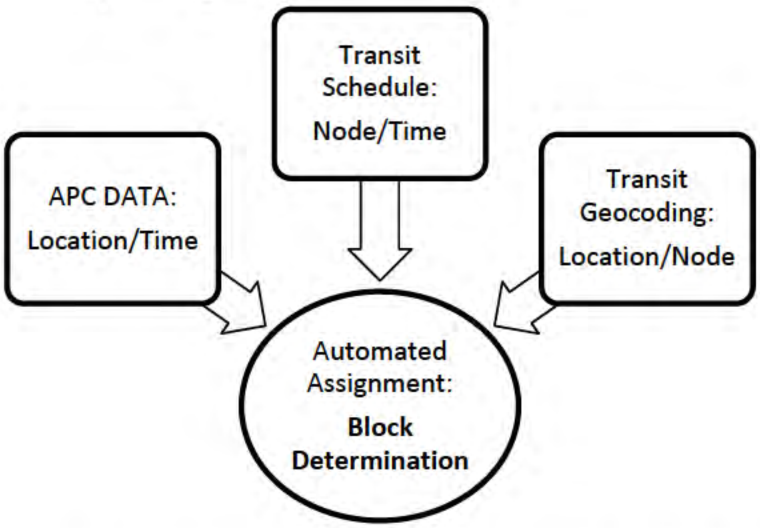
The APC diagnostic software consists of a number of modules that will be linked together to operate automatically after the data has been downloaded from the APC system. The APC diagnostic software will review the data that has been transferred and will produce the desired diagnostic information in the specified medium (screen, hard copy, data file) that will await the review of MTD APC staff. This task will be performed automatically overnight. The three (3) output reports are as follows:

- **Daily Total Listing** reviews overall APC performance for all APC equipped buses at a particular garage. The software aggregates the APC data into daily totals of all APC observed variables. Algorithms check the daily totals to determine if they fall within acceptable tolerances. Conditions, which can be identified, include: passengers count accuracy, GPS performance, odometer performance, wheelchair operation, correct date, APC serial number, and the reliability of the APC unit.
- **APC Anomaly Report** reviews each APC data record and applies a number of tests for logical consistency. If the data fails the test, a record is made of the condition and is summarized in an Anomaly Report for each APC equipped bus. The frequency of APC inconsistencies serves as a reliable indicator of APC equipment performance. If necessary, the option exists for the user to obtain the specific dates and times when anomalies are identified.
- **APC Exception Report** (APC_Maintenance_List.CSV) provides a summary APC equipment status review of all APC equipped buses. The APC Diagnostic software aggregates the APC data into

weekly totals of all APC observed variables. Algorithms check the weekly totals to determine if they fall within acceptable tolerances. Conditions, which can be identified, include: passengers count accuracy, GPS performance, wheelchair operation, bicycle rack operation, correct date, APC data transfer, and APC unit reliability.

7.3.9.5.2 Automated Assignment Algorithm

UTA has developed a sophisticated yet simple algorithm that reviews the raw APC data against the geo-coded time points and the master schedule and determines the block operated by APC equipped bus on a given date. APC data has location and time information; schedule data has node and time; transit geocoding has node and location. UTA's automated assignment algorithm uses a fuzzy logic to find an optimal block for a vehicle assignment. The logic compares a virtual geo-spatial line over time from the APC data with a virtual geo-spatial line from the schedules and geocoding, to provide a best vehicle assignment match. See conceptual diagram below:



The automated assignment algorithm has been in use for the last fifteen (15) years and is successfully being utilized in approximately ninety (90) UTA APC projects.

7.3.9.5.3 UTA APC File Creation Software

Once the assignments have been determined, the file creation step will begin. File Creation generates the meaningful data that serves as input to the report generation step. UTA's file creation APC software module consists of a number of executable programs that apply a variety of algorithms to the raw APC data and aggregates the raw APC data to various levels of spatial and temporal resolution. This module incorporates APC reference files (master schedule and bus stop geo-coding) with the raw APC data in order to provide critical variables (route, trip, variant, bus stop, and schedule time) to the aggregated APC data record that can then be utilized in analytic and administrative control report generation.

Transit Variables	Spatial Resolution	Temporal Resolution
On \off	Bus stop	Event
Front\rear door cycles	Zone	15 minute
Time\date	Time point segment	30 minute
Odometer	Trip	Trip
Latitude,\longitude	Leg	Hourly

Vehicle ID	Direction	Time period
Route\block	Routes	Weekday
Wheelchair – out\in	Corridor	Saturday
Bicycle rack – out\in	Political jurisdiction	Sunday
Passenger miles	System-wide	Quarterly
Scheduled run time	Other	Annually
Trip length-distance		Other
Trip length-time		
Passenger hours		
Distance-cumulative		
Time-cumulative		
Passenger load		
Passengers per mile		
Passengers per hour		
Number Of stops		
Overcrowding time		
Load factor		
Velocity		
Avg\max\min load		
Schedule deviation		
Dwell times		

7.3.9.5.4 Filter/Edit Software

In the practical day-to-day operation of a transit system, deviations from normal operating procedures sometimes occur. Given a degree of transit operational anomalies and APC system anomalies, the Filter/Edit subsystem serves a critical role by filtering out and/or editing anomalous data. The algorithms present in this subsystem are a result of years of reviewing APC data and determining the optimal set of criteria for maximizing the rejection of anomalous data. Two (2) examples of such algorithms are described below.

UTA Trip Balancing Algorithm:

- UTA APC trip balancing algorithm identifies any discrepancy in the total boarding and alighting and balances the trip total by applying the missing boarding/alighting to appropriate stop.

UTA End of Line Load Adjustment Algorithm

- To prevent APC hardware counting errors to propagate from trip to trip, UTA's APC load adjust algorithm identifies illogical passenger load at the end of the line location and adjust the load to zero. This logic helps provide appropriate passenger loads and passenger miles for NTD reporting and other analytical needs.

7.3.9.5.5 APC Reports

UTA's APC software creates a unique database(s) from which flexible report generators can be easily adapted to create unique formats and summary statistics. APC File Creation software produces the various APC aggregated data files such as: bus stop, segment, trip, time period, schedule adherence and block totals for APC reporting. These files are automatically added to previously produced files of the same type for the current scheduling period to generate APC reports/analysis.

UTA APC Standard Analytical Reports:

- Ridecheck report
- Bus stop: Load plot by stop by trip
- Segment report: Running time
- Route ridership: Route level daily ridership/trip length
- Trip report: Ridership/max load plot
- Actual vs. scheduled running time plots
- Schedule adherence: Time period summary
- Bus stop: Individual stop observations
- Segment report: Individual segment observations
- Segment report: Max load
- Trip report: Individual observations
- Trip report: Route demand by direction plot
- Route ridership: System ridership/trip length
- Schedule adherence: Time point summary
- Bus stop: Daily ridership summary by unique stop number
- Segment report: Ridership
- Segment report: Velocity
- Trip report: Summary
- Trip report: Route demand plot
- Schedule adherence: Individual observations
- Schedule adherence: Totals by day of week

UTA APC Productivity Reports:

- Deadhead running time: Individual observations
- Deadhead running time: Summary by origin-destination
- NTD reports/substantiation: Route summaries
- NTD reports/substantiation: Trip summary
- NTD reports/substantiation: Selection of random trip samples
- NTD reports/substantiation: individual trip observations
- Schedule adherence consistency
  - Exception report – consistent times/locations
  - Exception report – inconsistent times/locations
- 15 min peak/30 min off-peak summaries
  - Stop ridership ranking report
- Trip productivity analysis
  - Exception report – low productivity trips
- Exception report – overcrowded trips
  - Garage schedule adherence
- Stop productivity ranking report
- Block productivity report
- Ridership, passengers/mile, passengers/hour, passenger miles
- Census tract/ TAZ productivity reports
- EOL dwell time report
  - Scheduled vs. actual summary
  - Scheduled vs. actual individual observations
- Daily totals report
- Daily totals hourly summaries
- Multi markup (signup) productivity analysis by time period
- Multi markup (signup) productivity analysis by route
- Wheelchair lift usage report (if available and specified)
  - Frequency plot by hour
  - Paired origin-destination observation
  - Frequency plot by route
- Route productivity ranking
  - Ridership, passengers/mile, passengers/hour, passenger miles
- Headway determination report
- Headway maintenance report
- Municipal service utilization report
  - System summary – miles, hours, ridership
  - Route summary – miles, hours, ridership

UTA APC Administrative Control Reports:

- APC sampling status: Trip sampled per route summary table
- APC sampling status: Un-sampled blocks report
- APC sampling status: Hourly sampled/scheduled plot
- APC deployment plan: Daily blocks per division per bus type
- Reference file comparison: Trips/stops/time-points by route-dir-pattern.
- Next day impact analysis
- Trip start of line/end of line matching: Summary table by route
- Trip start of line/end of line matching: Individual observations

- APC diagnostics: Daily totals – last seven days
- APC diagnostics: Anomaly report
- APC diagnostics: exception reporting
- Bus stop geo-coding accuracy/comprehensiveness
  - Summary exception report by non-compliant bus stop
- Individual observations
- Trip start of line/end of line matching: First and last trip analysis
- Time point segment contiguity
- Schedule adherence complaint validation
- APC system performance/trend (data yield analysis)
- Reference file comparison: Trips/stops/time-points by schedule-route-dir-pattern.

It is our APC software philosophy to create a unique database(s) from which flexible report generators can be easily adapted to create unique formats and summary statistics for the various APC users. IBM SPSS software allows this GUI to query various database formats, from ASCII text to SQL databases. All reports can be generated against imported data from the fleet, manually collected, or other sources as long as it is in a standard CSV or Excel format. Some of the sample reports are listed below:

7.3.9.5.6 Sample Reports

This section contains a small sample of the many reports available from UTA. Additional report samples are available upon request.

ROUTE	SAMPLE RIDERS	SAMPLE PASSENGER MILES	SAMPLE TRIP LENGTH	TRIPS SMPLD	TRIPS OPRTD	EXPNSN FACTOR	EXPND RIDERS	EXPND PSNGR MILES
Rt 1 - Philadelphia Pike	2420	8900	3.68	82	115	1.4024	3394	12481
Rt 2 - Concord Pike	1408	6237	4.43	41	42	1.0244	1443	6389
Rt 3 - 26th St/Lea Blvd	775	1177	1.52	44	52	1.1818	916	1391
Rt 4 - West 4th St/Lancaster Ave	1532	2273	1.48	67	105	1.5672	2401	3562
Rt 5 - Maryland Ave	1191	5752	4.83	38	92	2.4211	2884	13926
Rt 6 - Kirkwood Hwy	2873	14831	5.16	79	96	1.2152	3491	18022
Rt 7 - DuPont St Clayton St Riverfront	146	288	1.97	18	18	1.0000	146	288
Rt 8 - 8th St 9th St	837	863	1.03	64	64	1.0000	837	863
Rt 9 - Boxwood Rd Broom St - Vandever Ave	658	1679	2.55	26	50	1.9231	1265	3228
Rt 10 - Delaware Ave Kennet Pike	368	785	2.13	34	56	1.6471	606	1292
Rt 11 - Washington St	945	1649	1.74	60	73	1.2167	1150	2007
Rt 12 - Baynard Blvd	948	1316	1.39	64	79	1.2344	1171	1625
Rt 15 - New Castle Ave	677	3896	5.75	23	66	2.8696	1944	11180
Rt 16 - Newark Express	151	1865	12.37	9	13	1.4444	218	2694
Rt 17 - Dunleith/Holloway Terrace - Health and Social Services Campus	494	2032	4.12	34	48	1.4118	697	2869
Rt 19 - Pike Creek Valley	512	2948	5.76	28	34	1.2143	622	3579
Rt 20 - Lancaster Pike	245	1330	5.42	17	28	1.6471	404	2190
Rt 21 - Foulk Road	504	2022	4.01	32	38	1.1875	599	2402

Figure 54: Route Ridership Report

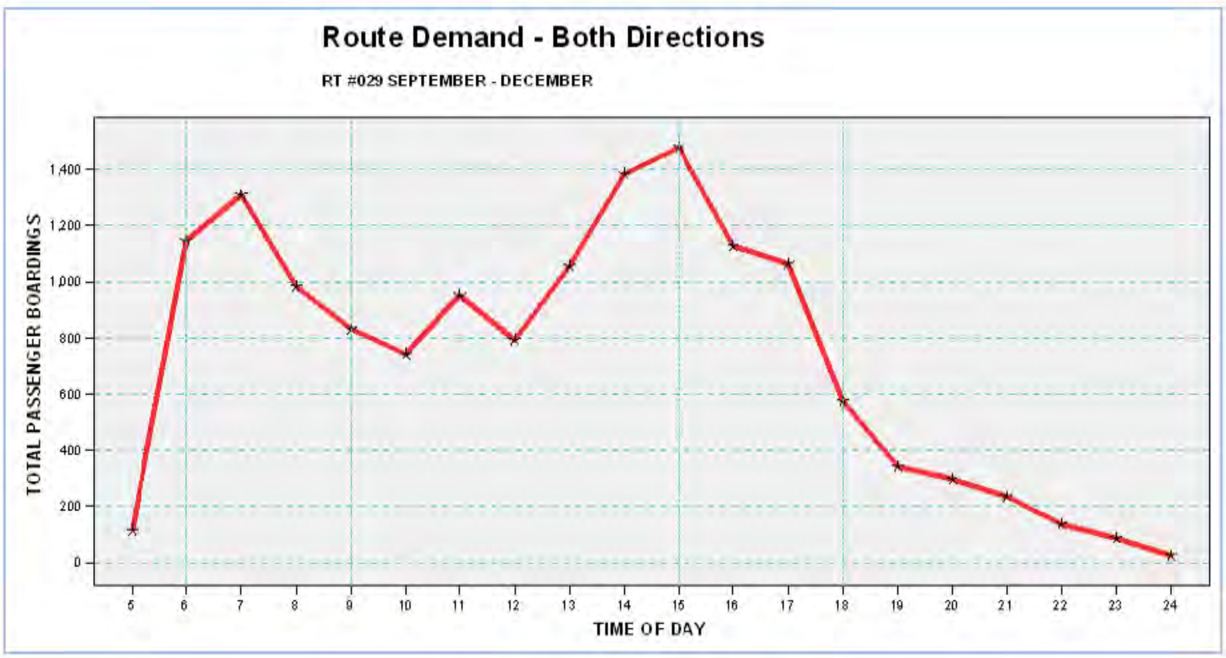


Figure 55: Route Demand Plot

ON-TIME= Between -1.0 Min Early and 5.5 Min Late

		STATUS							
		EARLY		ON TIME		LATE		Total	
ROUTE		Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
ROUTE	Rt 1 - Philadelphia Pike	352	12.6%	1452	51.9%	995	35.5%	2799	100.0%
	Rt 2 - Concord Pike	365	19.6%	1184	63.7%	310	16.7%	1859	100.0%
	Rt 3 - 26th St/Lea Blvd	623	10						100.0%
	Rt 4 - West 4th St/Lancaster Ave	340	17						100.0%
	Rt 5 - Maryland Ave	242	16						100.0%
	Rt 6 - Kirkwood Hwy	596	20						100.0%
	Rt 7 - DuPont St Clayton St Riverfront	41	4						100.0%
	Rt 8 - 8th St 9th St	118	8						100.0%
	Rt 9 - Boxwood Rd Broom St - Vandever Ave	45	11						100.0%
	Rt 10 - Delaware Ave Kennet Pike	219	21						100.0%

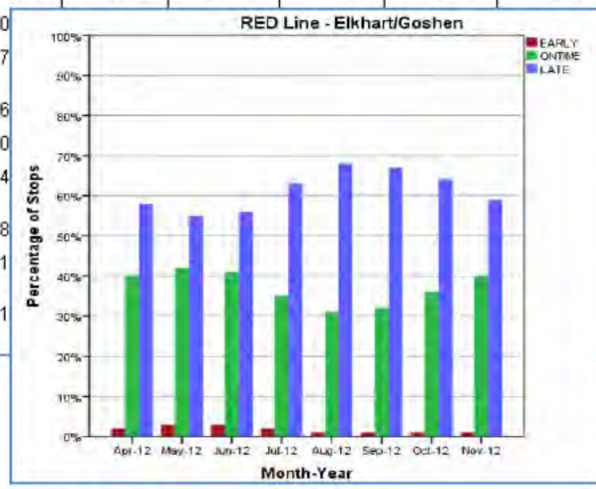


Figure 56: Schedule Adherence Reports

SEGMENT RIDERSHIP SUMMARY REPORT
RT #045 DIRECTION 1
Weekday - Inbound

		0102:LYONG NWH-UNINSTEI		0203:UNINST EI-UNINV.N.		0304:UNINV. N.-UNINCOLM		0405:UNINC OLM-STOKSUTT		0506:STOKS UTT-.4STMRKT		0607:.4STMR KT-TOWN.4ST		TOTAL	
		ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF
TRIP NO.	05:38	1	0	4	1	7	1	5	6	1	5	2	9	21	21
	05:55	4	0	3	2	7	2	21	6	2	18	7	16	44	44
	06:03	1	0	4	0	5	1	4	4	1	5	2	8	16	17
	06:12	3	0	6	0	7	3	21	5	2	22	12	19	51	50
	06:22	2	0	6	0	5	1	22	5	3	20	15	26	53	53
	06:31	3	0	10	2	9	3	30	6	3	20	12	31	68	62
	06:40	1	0	5	0	7	1	12	4	2	15	5	11	31	31
	06:48	2	0	4	1	6	2	19	5	1	19	4	10	37	37
	06:57	5	0	6	1	8	4	21	8	1	23	9	14	50	50
	07:06	3	0	8	1	7	2	13	8	3	15	7	15	41	41
	07:14	4	0	8	1	13	2	24	11	3	23	11	26	62	62

Figure 57: Segment Summary Report

7.3.9.5.7 NTD Reporting and Certification

For more than two (2) decades, UTA APC users have been meeting NTD (previously Section 15) reporting requirements using UTA APC data. Critical to UTA's NTD reporting are the highly developed APC Administrative Control software modules that assure high quality APC data being available for NTD reporting. UTA's APC diagnostics, data quality codes, filter/edit algorithms, sampling status, deployment plans, reference file quality control are but a few of UTA APC administrative control elements that result in high quality APC data for both NTD and non-NTD reporting. As a result of successful application of APC technology to NTD reporting, FTA is in the process of modifying guidelines relative to the use of APC technology for NTD reporting. The random selection of trips/blocks will not be necessary given comprehensive sampling of all service each scheduling period. The annual verification of APC accuracy may be waived given the presence of a reliable APC data quality control system. By monitoring passenger trip length (PTL) on a continual basis and demonstrating consistent PTL values, FTA has been, and is currently, approving UTA APC users to utilize the full annual set of APC data for NTD reporting.

Critical to successful NTD reporting is the calculation of passenger miles. UTA's APC software automatically calculates passenger miles for each bus stop by multiplying the Passenger Load by the inter-stop distance. With highly refined EOL load balancing algorithms assuring an accurate passenger load at each bus stop and algorithms that convert lat/long change into inter-stop distance, UTA'S APC Passenger Mile variable is highly accurate and auditable down to the bus stop level. Along with an accurate UTA APC Ridership variable, the Passenger Trip Length (PTL) is a standard output of UTA's Route Ridership report.

UTA has been supporting, including local audits, the application of UTA's APC System at dozens of transit agencies for many years. Typically, NTD reporting is a routine by-product of UTA's APC reporting package that is easily prepared by local transit staff.

Over the past three (3) years, UTA and FTA NTD staff meets regularly to discuss the application of UTA's APC system to NTD reporting. FTA staff noticed the large number of UTA APC users that were successfully generating NTD reports in contrast to the number of transit agencies utilizing non-UTA APC systems. This recognition started a dialogue that focuses on making NTD reporting less burdensome on the transit agencies and more coordinated with other analytic needs of the transit agency.

For example, most UTA APC users deploy the APC-equipped buses in such a manner that a comprehensive and statistically confident sampling of all revenue service takes place each schedule period. The NTD procedure of randomly selecting trips to be sampled becomes unnecessary with a well-controlled deployment of APC-equipped buses. With FTA's recognition of a well-controlled APC system (as presented in an application to FTA to utilize APC data for NTD reporting), FTA is agreeable to including 100% of all APC data into an annual NTD report.

The process for MTD to achieve NTD certification includes the following:

1) UTA to provide a document with the following:
    a. Sampling plan to support FTA guidelines for NTD reporting
    b. Benchmarking plan, which is the basic APC acceptance testing that compares APC counts with manual counts
    c. Maintenance/calibration plan for post NTD certification
2) MTD to continue existing process for NTD submission for 1 year
    a. MTD to provide UTA manual counts
3) UTA to compare manual counts to APC counts and generate a comparison
    a. The results of this, based on the proposed APC counters and experience with UTA, is expected to be positive

   b. UTA software routinely produces both the unlinked passenger trips (UPT) and passenger miles traveled (PMT) reports
4) UTA to prepare document for NTD certification that includes:
   a. The sampling plan
   b. The benchmarking plan
   c. The maintenance plan
   d. The comparison and analysis
      i. APC accuracy which includes the consistency of counts over fleet and chronological period
      ii. Sample size (fleet equipped with APC) and confidence limits of the APC data set
      iii. APC generated passenger miles traveled algorithms
      iv. APC data quality control process which describes how APC system diagnostics are performed, reported and maintained
      v. APC reference file quality control process, which includes the use of schedule, route and stop data, administrative controls, monitoring of PTL and software auditing capability of ridership, PMT, PTL
   e. Any adjustment factors
5) UTA to get statistician to certify the document
6) UTA to submit document to MTD
7) MTD to review and submit to FTA
   a. FTA will review the letter and typically approve in short order
8) A yearly maintenance plan by MTD is unnecessary, since the UTA APC diagnostics allow MTD personnel to monitor the system periodically

7.3.9.5.8 UTA APC Application to FTA Title VI Reporting Requirements

In October 2012, FTA issued revised requirements and guidelines (Circular FTA C 4702.1B) for Title VI reporting for public transit agencies. A number of required Title VI analytic reports can be generated from UTA's APC system. In chapter IV of Circular FTA C 4702.1B, specific required reports are referenced:

Reports	UTA APC System Capability
Local service standards compliance	Yes
Vehicle load for each mode	Yes
Vehicle headway for each mode	yes
On-time performance for each mode	Yes
Service availability for each mode	Yes W/GIS
Distribution of transit amenities for each mode	No
Vehicle assignment for each mode	Yes

In early-2013, similar to the regular meetings between UTA and FTA NTD staff, UTA and FTA's Title VI staff to review the capability of UTA's APC system in reducing the reporting burden on transit agencies while still providing the information required by FTA. UTA and FTA have agreed to identify possible Title VI/APC reporting demonstration sites where new APC analytics can be developed for Title VI.

Title VI reporting requirements focus on the census tract and census tract block level of spatial detail. Local GIS capabilities export the specific census tract for each unique bus stop number. From local metropolitan planning organizations (MPO), demographic information can be obtained for each Census tract. With this GIS and MPO information, APC-generated analyses can be easily produced that meet Title VI reporting requirements.

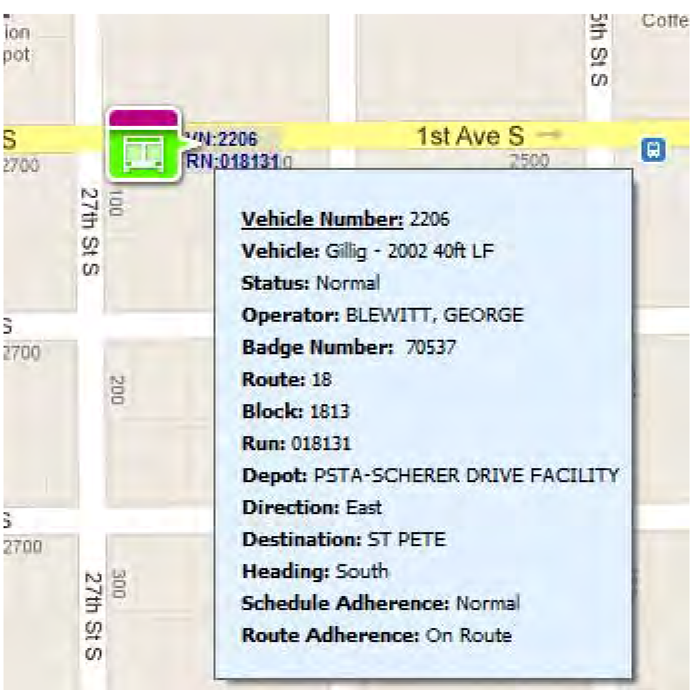
MTD will be able to apply UTA APC-generated data and UTA APC software to meeting many, if not all, of the recently revised Title VI reporting requirements.

7.3.9.5.9 APC Exports to GIS Applications

A common application of UTA's APC system is to export processed APC data into a format that can be easily imported into GIS applications. UTA's APC software routinely exports APC data into the appropriate formats for local GIS applications. Typically, in public transit agencies, ESRI ArcView GIS systems are present and UTA's APC software exports APC data in.csv format that can be executed by ArcView. UTA also exports APC data in a .KML format for representation in Google Earth applications. A GIS export module within UTA's APC software package creates a .csv file for each bus data-day that can easily be imported into standard GIS products. UTA's APC GIS export capability is contained in the APC software.

7.3.10 Computer Aided Dispatch – CleverCAD® – Option

CleverCAD® is a state-of-the-art CAD/AVL solution designed for transit agencies that require a comprehensive transit service management solution for transit operation via central control center and/or remotely via field/street supervisors. CleverCAD® is the central system designed specifically to interface with Clever Devices' on-board IVN® system for complete CAD/AVL functionality.



CleverCAD® is "the eyes and ears on the street" with command and control to prevent and react to normal operational activity. It is designed to streamline day-to-day operations so MTD can accomplish much more with existing resources. The deployment of CleverCAD® will result in improved transit service, improved customer information, and reduced costs to MTD.

CleverCAD® is built on modern technology with a multi-tier architecture, strategic integration of WEB based technologies, and an intuitive Google map engine. The "information on demand" design enhances dispatcher performance, provides efficient presentation of crucial transit service (fleet and operational) information, delivers reports via web-based technologies, and is designed for rapid implementation. The information-driven user interface is easy to learn and navigate, provides the information necessary to reduce voice calls, and enhances fleet visibility and transit service management.

CleverCAD®'s primary objectives are:

- Improve communications between the fleet, dispatchers and field/street supervisors
- Organize fleet and operational data into information
- Provide easy access to this information
- Utilize an intuitive user interface
- Customize to MTD's business processes
- Record all data and communications for reporting, tracking and documentation of issues and how they are handled.

CleverCAD® affords MTD the opportunity to make an additional and significant leap forward in transit service management. It monitors the transit service (fleet and operational behavior) and generates significantly more information than currently available. With CleverCAD® the entire fleet can be monitored and managed from MTD's control center. The deployment of CleverCAD®, sufficient training, and Clever Devices hands-on support will ensure success and a more efficient transit service operation. Clever Devices will be on-site during and after the deployment to monitor the system, help with operational behavior, and work with MTD to tune the business processes.

7.3.10.1 CleverCAD® Major Features

CleverCAD® is a state-of-the-art component of Clever Devices' ITS system solution. Table 8 provides a summary of its major features and capabilities.

Table 8: Summary of CleverCAD® Features

CleverCAD® Major Features	
Dispatcher Logon Authentication	• Active directory authentication • Built-in CleverCAD® authentication • Administratively configurable feature by feature user access
Map Window and AVL	• Centralized quick and intuitive access to information via menus and ribbons • Quick access toolbar • Ribbon menu • Ribbon toolbar • Status toolbar • Vehicle monitoring and location tracking features • Synchronized to grids and other views • Standard map control such as pan, zoom, and select area • Reverse geo-coding for easy to interpret locations • Map, satellite and street views
Dispatcher Work Assignment	• Grouping of work by route, garages, vehicles, runs, blocks, vehicle type or Incident type to specific dispatch workstations • Creation of custom dispatcher groups

	• Separate visual designation between assigned and unassigned vehicles and events
Operator Logon and Validation	• Operator enters operator ID and Work ID • GFI integration • Eliminate duplicate logons • Manual logon backup is always available
Run Work Management	• Simple view of all active and not active scheduled work Monitor and manage pullout and pull-in • Support for daily changes • Assignment of work to dispatcher
Headway Management	• Monitor all buses on a route for spacing • Easy bus bunching detection
Route and Schedule Adherence	• Monitor and event creation for route adherence • Monitor and event creation for schedule adherence
Event Management	• Custom event prioritization and grouping • Duplicate event detection • Multiple event stacking • Event types and subtypes
Incident Management	• Automated or manual incident creation • 16 pre-built incident types with the ability to create custom types • Auto-populated system data to decrease the average dispatcher response time
Text Messaging	• Canned (pre-defined) text messages • Ad-hoc (free-form) text messages • Multiple & easy vehicle selection techniques
Voice Call Control	• Reliable • Quick & easy access to voice calls and public announcements • Multiple and easy vehicle selection techniques
Vehicle Details Window	• Quick access to all the details of a specific vehicle • Current status of the vehicle with exhaustive details
Transfer Connection Protection	• Provides the rider with transfer connection information • Supported by the
Playback	• Review past events by viewing historical dispatcher and bus activity and status • View playback of a single vehicle or the whole fleet of vehicles
Dispatcher to Dispatcher Communications	• Text messaging similar to vehicle text messaging • Chat room

7.3.10.2 Dispatcher Logon Authentication

CleverCAD® can be configured to authenticate dispatcher logon through active directory or internally based on MTD's IT requirements. All users will logon with their assigned username and password assigned in active directory or CleverCAD® based on the configuration.

When CleverCAD® is deployed a workstation is configured by the MTD administrator as primary or non-primary. The only difference is that work (routes) for all non-primary workstations are controlled by the system as configured by the MTD administrator and primary workstations allows the dispatcher to select their work by garage or route. The Workstation Status in in the upper right hand corner of the Home determines the distinction or map ribbons. If the workstation status can be changed, then the dispatcher is logged onto a primary workstation.

All dispatcher activity is tracked by the logged in username. Any authorized user can logon to any workstation that has CleverCAD® installed and all of their associated configurations and permissions travel with them.

7.3.10.3 Map Window & AVL

CleverCAD® is design for ease of use and ease of access to information. When CleverCAD® starts the map window is displayed as shown in Figure 58. The map window provides centralized access to all CleverCAD® features. This is accomplished through the use of ribbons similar to many Microsoft applications to provide an intuitive user experience. Each ribbon contains a menu bar and a toolbar at the top of the window. The menu bar provides access to features through drill down menus, and the toolbar provides immediate access to the most commonly used features through icons. The map window has five main areas of interest:

Quick Access Toolbar:	Items 1, 2, 3, and 4 in Figure 58 provide immediate access to critical features, grids, command prompt, and windows functions.
Ribbon Menu:	Item 6 in Figure 58 provides quick access to a group of features specific to the menu item selected.
Ribbon Toolbar:	Item 7 in Figure 58 identifies each toolbar as an icon for quick access to specific features associated with the menu item selected.
Map window:	Map, Vehicle tracking, routes, zoom, pan, etc.
Status Bar:	Item 16 in in Figure 58 provides status information and feedback to the logged in user.

Figure 58: Map Window

1)	General	Part of the quick access toolbar for immediate access to: Voice call window Open a new incident report Revert to the previous view
2)	Command Line Prompt	Part of the quick access toolbar for typing command shortcuts as listed here: **ADMIN** Open CADMinistrator™ **EV** Open the event grid **Exit** Exit CleverCAD® **FS** Show the AVL map in full screen **INSET** Show/hide the map inset (12) **IR** Open the incident reports grid **L vvvv** Locate the vehicle identified by vvvv **MC** Show the GPS coordinates in the status bar **MSG** Open CleverCAD® mail **P vvvv** Poll the vehicle identified by vvvv **RPTG** Open the CADVisor™ reporting application **SI** Search incidents in CADVisor™ **Status** Open the status grid **T vvvv** Track the vehicle identified by vvvv
3)	Grid Status:	Part of the quick access toolbar for immediate access to the five primary CleverCAD® grids and summary statistics for each: **Status grid** Total quantity of vehicles being monitored **Events grid** Total quantity of open events **Run work grid** Total quantity of scheduled run IDs **Incident reports** Total quantity of open incident reports **Transfer protection** Total quantity of pending TCP requests
4)	Exit and Relocate	Part of the quick access toolbar. The red icon will exit CleverCAD®. The Arrow will move the quick access toolbar below the map ribbon toolbars.
5)	Workstation Status	Dispatcher selects one of the following commands to notify CleverCAD® of his/her status so that CleverCAD® will move work to another dispatcher. End of Shift — Issues a CleverCAD® logoff Lunch — Temporarily reassigns work to other workstations. Work assignment will resume when dispatcher returns and logs back on. Meeting — Temporarily reassigns work to other workstations. Work assignment will resume when dispatcher returns and logs back on. Break — Temporarily reassigns work to other workstations. Work assignment will resume when dispatcher returns and logs back on. Transfer Work — Reassigned work assignment to the next dispatcher logging onto that workstation.
6)	Ribbon Menu Bar	Provides access to specific toolbars grouped to the selected menu item. When selected the associated toolbars are displayed for that menu item. This combination is intuitive and provides quick and easy access to all menu and data management functions.
7)	Ribbon Toolbars	This area provides all the toolbars for the selected menu item. Each toolbar provides access to a unique CleverCAD® feature.
8)	Pan	Standard map movement control.

9) Zoom — Standard zoom in and zoom out control.

10) Vehicle Icon — Icon of the vehicle. The icon is configurable for each vehicle type and includes standard bus; flex route bus, articulated bus, paratransit, and supervisor. Icon color is configurable to current status. The color of the top line of the icon correlates to the route color. Status information is fully configurable and can represent any one or combination of the following:

BK	Block number	**RT**	Route
BN	Badge number/operator ID	**VN**	Vehicle number
HD	Heading	**VS**	Vehicle status
RN	Run number	**VT**	Vehicle type
RA	Route adherence (on route or off route)		
SA	Schedule adherence (early, normal, or late)		

11) Route — The colored line on the map represents the route currently operated by the bus.

12) Bus Stop — The round dots on the route represent stops. If you place the mouse over the dot (hover), the stop text and routes this stop services are displayed.

13) Street/ Hybrid view — With Google Maps, CleverCAD® provides access to the street only view and the hybrid view which is street with aerial view street overlay.

14) Legend: — Legend for vehicle icon.

15) Map Inset — A Transit-wide view of the map that shows the location of the area displayed in the main AVL map window.

16) Status Bar — Provides access to current status. This includes:

Left section:	LEDs are used for communication status between CleverCAD® and radio system
Middle section:	Action response messages
Right section:	GPS Lat/Long
Far Right section:	System Time

CleverCAD® provides a map based view of the transit service area with information that is intuitive, customizable, and very easy to understand. CleverCAD® capitalizes on Google Maps and supports both street and satellite views. Routes are color-coded, the vehicles are color coded, and the amount of information displayed is based on the zoom level while, all information is quickly available by simply placing (hover) the mouse on the object.

Example vehicle icon types available in CleverCAD® are shown below. The color on the top of the icon matches the route color. In the examples below the associated route is colored blue.

Fixed Flex Articulated Para-transit Maintenance Police Supervisor

CleverCAD® is fully configurable to MTD's preferences. The vehicle icon default color configuration is shown below.

AVM **Crowded** **Emergency** **Normal** **Off Route** **Out of Service** **Powered Off** **Early** **Late**

Subset of map detail views:

CleverCAD® provides the dispatcher with much more information than can be seen on the street. The AVL map window has many features. A subset of these features is listed here:

- Enable/disable route display (color coded)
- Vehicle icon color based on current state
- Ghost view for vehicles assigned to different dispatcher
- Select vehicles by click, or by area
- Distance tool
- Google traffic layer overlay
- Zoom & pan
- Last view
- Map bookmarks
- User defined configuration/filters of what information to display with a vehicle
- Find a vehicle based on user defined criteria
- Find closest supervisor to a vehicle
- Track a vehicle
- Inset of current map screen in transit service area
- Enable/disable map legend
- Enable/disable coordinates (lat/long)
- Right click on vehicle for command menu
    - Text message
    - Locate closest supervisor
    - Remove vehicle
    - Manage vehicles
    - Create fallback group
    - Quick call
    - Track vehicle
    - Logoff vehicle
    - Search incidents
    - Add to fallback group
    - Vehicle details
    - Poll vehicle
    - Logon vehicle
    - Create incident report
    - Help

The advantage to MTD is the availability of more information relative to the operator and bus on the AVL map screen with quick and easy access to communicate with the vehicle & operator. All this accessible and organized information affords MTD dispatchers the ability to prevent and react to anomalies quickly. CleverCAD® provides tools to manage MTD's transit service more efficiently which result in improved transit service, improved customer information, and reduced costs.

7.3.10.4 Dispatcher Work Assignment

MTD's business rules may require that certain dispatchers do certain work. CleverCAD® allows the MTD administrator to define dispatcher work groups, save them, and assign them to specific users. Dispatchers can logon to any workstation and their work assignment will follow them.

The assignment of work to each dispatcher work group can be any one or combination of the following: route, garage, block, run, vehicle/s, and fleet type. MTD may change these assignments as their business rules change.

CleverCAD's work assignment visually differentiates the "my work" from "other" dispatchers work. This allows each dispatcher to see their primary work and also allows them to assist with "other" dispatcher work, if necessary. Therefore all dispatchers see all fleet information, primarily acting on their own but allowing them to assist other dispatchers. In the case of AVL, vehicles are displayed with partial transparency (ghosted). Figure 59 demonstrates this visualization.

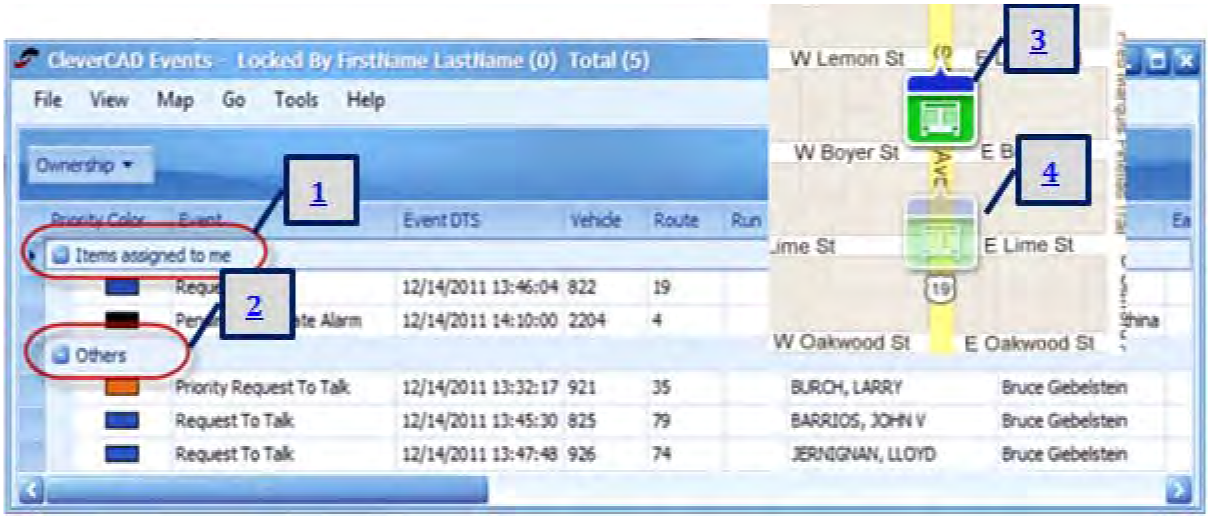
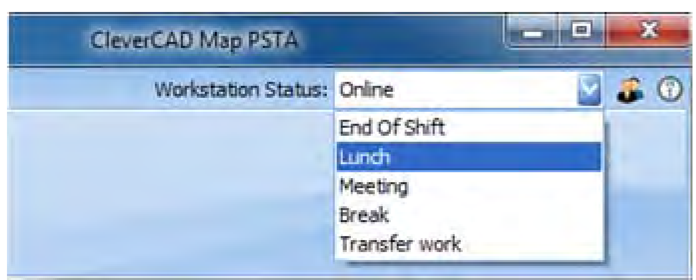


Figure 59: Visualization of Assigned and Unassigned Work

1) Assigned work in the events grid
2) Unassigned work in the events grid
3) Assigned vehicle in AVL
4) Unassigned vehicle (ghosted) in AVL

Additional dispatcher work assignment features:

- At any time, the dispatcher can disable the ghosted vehicles by toggling the “Hide/Show Other Vehicles” button.
- The MTD administrator can configure workstations as “primary” workstations. Users on these workstations can then choose which garages or routes they are assigned after logon.
- When it is time to take a break or leave for lunch, a user can simply change the status of their workstation, using the ‘workstation status’ drop down selection box. CleverCAD® will evenly reassign work to the remaining logged on dispatchers to ensure the assigned work is attended too. The AVL map on this logged off workstation and all information grids will be hidden from view for protection from an unauthorized user.



- In situations where only a single dispatcher is logged on, all work is defaulted to the system-wide work assignment, which ensures all vehicles, events, and incidents are properly monitored. When additional dispatchers logon, the current user’s workstation will automatically transfer work from the system-wide work assignment back to the user configured assignments.
- When the last dispatcher attempts to logoff, CleverCAD® prompts for a supervisor password. This safety feature ensures a dispatcher monitors all work.

The advantages to MTD are:

1) MTD can manage work in a manner that is best for MTD. As MTD becomes more familiar and experienced with CleverCAD®, the partitioning of work can change as configured by the MTD administrator.
2) Although work is partitioned, all dispatchers can still see all information without a cluttered screen or overflow of information.
3) CleverCAD® guarantees that all work is assigned to a dispatcher.

The dispatcher work assignment feature will improve dispatcher efficiency, which will allow the same dispatcher to do more.

7.3.10.5 Operator Logon and Validation

Note: CleverCAD® manages all vehicles installed with an IVN® and monitors all other vehicles configured appropriately.

A primary function of CleverCAD® is to ensure that the correct operator is driving the correct vehicle and logged on with the correct credentials. Each transit authority has different processes and different data management capabilities to achieve different levels of logon automation. With Clever Devices, you can choose which level of logon automation best suits your organization. To accommodate this, Clever Devices system solution provides three administratively controlled levels of logon functionality these are:

1) Fully automated logon	Operator only needs to power on the bus or optional Ack
2) Operator ID logon	Operator must ender operator ID only
3) Operator ID and work ID logon	Operator must enter operator ID and work ID

Additional features of CleverCAD® logon

- In the event communications are lost between IVN® and CleverCAD®, the operator can logon using manual mode and begin work. When communications are re-established, IVN® will send the logon credentials are sent to CleverCAD® for validation.
- If the vehicle loses power and causes the on-board IVN® to reset, IVN® will automatically initialize on system restart by sending the logon credentials to CleverCAD® for validation. The restart must be within a configurable amount of time after the unsolicited power down.
- The dispatcher can issue a remote logon with operator ID and work ID to a vehicle. This is sometimes necessary in the situation where an operator either forgot to logon or accidently pressed logoff without noticing. The dispatcher first selects a vehicle and is brought to the remote logon dialog to choose the appropriate operator ID and work ID. Once completed, the information is sent to the vehicle and normal logon authentication takes place. The operator interface on-board the vehicle appears as if the operator issued the logon.
- If CleverCAD® is integrated with the scheduling system for real time work assignments, the work is automatically associated with the operator ID, work ID, or Vehicle ID. In this scenario the dispatcher only needs to assigns the operator to the vehicle.
- The dispatcher can access the remote logon and remote logoff features from the run work grid or the vehicle status grid an example is shown in Figure 60.

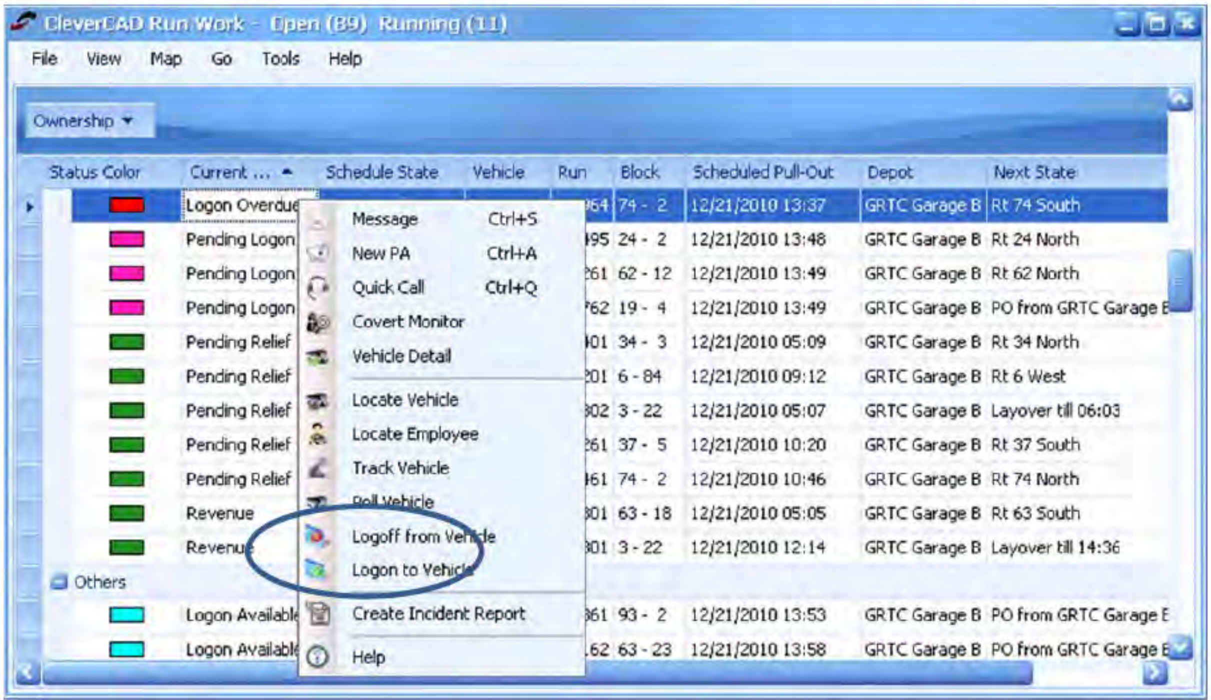


Figure 60: Run Work Grid

- The dispatcher can issue a remote logoff to vehicles for situations where the driver used the wrong logon credentials, logged on with the incorrect work assignment, or inadvertently departed the vehicle without logging off. Upon selection of the remote vehicle logoff tool, the dispatcher is presented with a list of all the currently logged on vehicles to select the appropriate vehicle to logoff.
- If a vehicle reaches the last timepoint of its assigned block and after a configurable time period, CleverCAD® automatically logs off the work.
- If a vehicle is off route at the time it is scheduled to reach the last timepoint, CleverCAD® automatically logs off the work.
- If a vehicle is in a depot and initiates a shutdown, CleverCAD® automatically logs off the work.
- The dispatcher can issue a remote logoff to the vehicle from the AVL map or any of the information grids with a simple right click on the associated vehicle icon or ID. The dispatcher is then alerted via a confirmation dialog.

The advantages to MTD are:

1) MTD can select the desired logon validation technique that is most appropriate to your business process.
2) Logon validation is built-in, reliable, and allows MTD easily finding and resolving anomalies.
3) Remote logon and logoff is easy and accessible.

In this scenario the operator enters their operator ID via the MDT and then their work ID. Once entered, IVN® validates the work ID exists in the current schedule and starts the work. When validation is complete, the farebox and any optionally integrated systems will be initialized. IVN® provides full automation for the remainder of the day. This means that the farebox will be automatically initialized at the start of each trip and all optionally integrated systems will be initialized based on the configuration of the system to MTD business rules. The optional systems include BSA, AVM® and the head/destination sign.

If the CAD option is selected, IVN® will retry forever to send a logon request which includes the operator ID and work ID to CleverCAD®. Once received, CleverCAD® validates the logon based on the interface to Trapeze OPS and compares to the current fleet status to ensure no duplicate work is being conducted. Once validated, CleverCAD® will acknowledge to the bus that logon is good. In the event of an anomaly, the dispatcher can always override the system.

7.3.10.6 Run Work Management

The first step in managing transit service is to know when logon anomalies happen as quickly as possible. CleverCAD® provides a run work grid that is populated with the status of all of the work scheduled for the current time period. This is typically by the schedule run ID. This grid has status indicators that indicate when a piece of work is not logged into, revenue or non-revenue service, early, late, overdue, etc. This grid also displays, but is not limited to the state of the work (revenue, relief, logon…), vehicle, driver, schedule adherence, and route adherence. The run work grid is automatically updated in real time as the work status is refreshed and received by the system. The dispatcher can sort on any column and quickly get access to the information that is most important.

Status Color	Current State	Vehicle	Driver	Run	Block
	Pending Relief	514	THOMPSON, TERENCE	7341	73 - 4
	Pending Relief Late	215	SMITH, MICHAEL	341	3 - 23
	Pending Relief Early	115	Proshina, Alla	441	4 - 32
	Revenue	103	MORRIS JR, ALFRED	3742	37 - 1
	Pending Relief	117	LOUCA, Steve	1042	10 - 2
	Revenue	102	GREENE, FLOYD D.	6242	62 - 12
	Revenue	116	Garcia, Mario	1041	10 - 4
	Revenue	204	Flaherty, Kevin	3242	32 - 10
	Revenue Late	203	DOUGLAS, DEBORAH	3241	32 - 11
	Revenue Early	202	CHURCHWELL, HAR...	3441	34 - 5
	Logon Overdue			2403	24 - 1

Figure 61: Run Work Grid

The current state field is designed to notify the dispatcher prior to a problem. For instance, if the work starts at 1:00 p.m. and the operator has not logged in by 12:50 p.m. the work state will change to yellow and go to pending logon.

Additionally, CleverCAD® imports your schedule information to provide schedule block and run reports at the touch of a button through our schedule display.

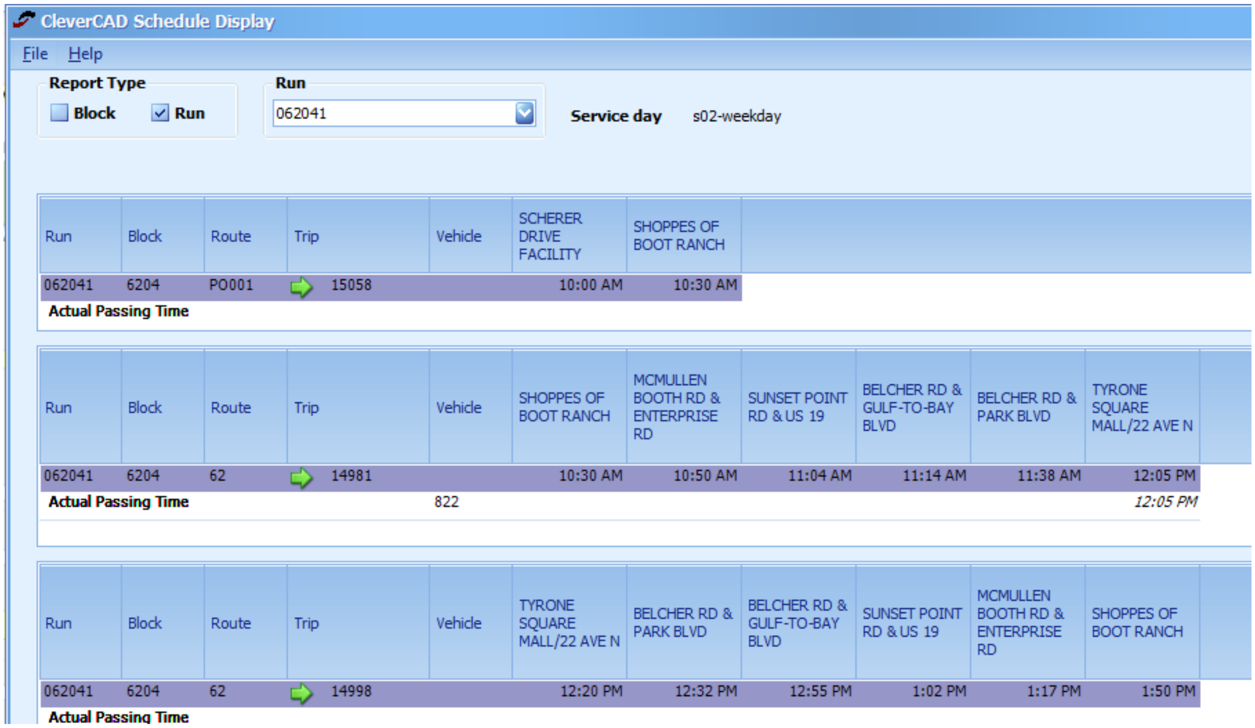


Figure 62: CleverCAD® Schedule Display

The advantages to MTD are:

1) MTD will immediately know what scheduled work is not running
2) Informs MTD dispatchers of the overall state of current transit service which results in quick recovery of any missing or invalid service
3) The dispatcher will know any and all anomalies associated with missing work, pending work/logon, invalid work, or work in a bad state (late, early, etc.)
4) The dispatcher can prevent work related issues or react to anomalies quickly
5) Fingertip access to all information required to resolve work related anomalies

7.3.10.7 Headway Management

In order to assist MTD with the management of their daily transit service, CleverCAD® provides dispatchers both a tabular and graphical headway display. This feature allows MTD to manage a specific route by headway instead of schedule adherence which can be beneficial for heavily traversed routes. The headway management view is based on a ladder style and is shown below:

The graphical headway display depicted in Figure 63 displays the selected inbound and outbound routes with their associated timepoints at their corresponding distances along the route. The vehicles are plotted along the route at their actual position respective to the overall length of the route. The vehicle's scheduled location is plotted as a leading or trailing arrow depending on the vehicle's schedule deviation (early or late). Vehicles that are adversely affecting the route's headway are depicted in either red (early) or yellow (late). If the operator has not logged on, the vehicle is shown as a "ghost" to inform the dispatcher a vehicle is missing. The vehicle's scheduled ETA and run number are also displayed adjacent to the vehicle ID. Finally, on the each side of the graphical headway display are both layover and pull-in/out tables. Each layover table is populated with vehicles waiting to begin the next trip, either outbound or inbound. The pullout table is populated with vehicles for the selected route that are due to pullout, the run ID, and the pullout time. Likewise, the pull-in table is populated with all of the vehicles that are pulling in to the garage from the selected route.

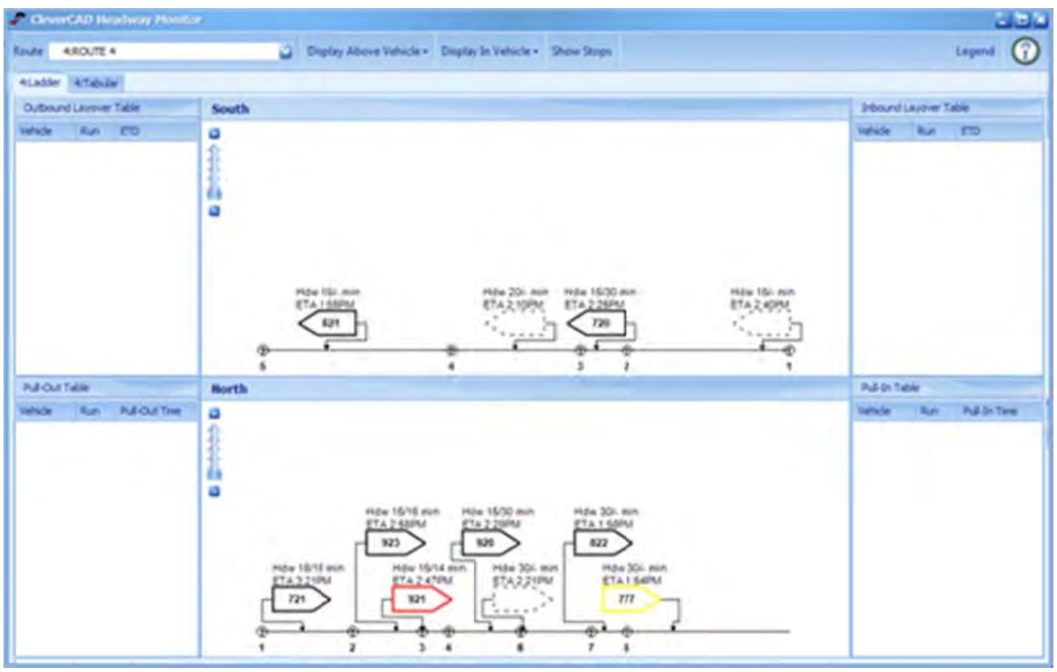


Figure 63: Headway Monitor Display

The tabular headway display is a different way to view headway. As illustrated in Figure 64, the tabular display provides a view of the route for both directions and lists each of the scheduled vehicles assigned to that specific route. Dispatchers will view headway along the route between differing timepoints via this representation. Vehicles that are adversely affecting the route's headway are depicted in either red (early) or yellow (late). The vehicle icon itself visually represents the actual position of the vehicle. The scheduled position is either shown as a red bar (early) or blue bar (late). If the vehicle is on time, the icon depicts both schedule and actual location. As is with the graphical headway display, a ghost vehicle is utilized to symbolize a schedule vehicle that has not logged on.

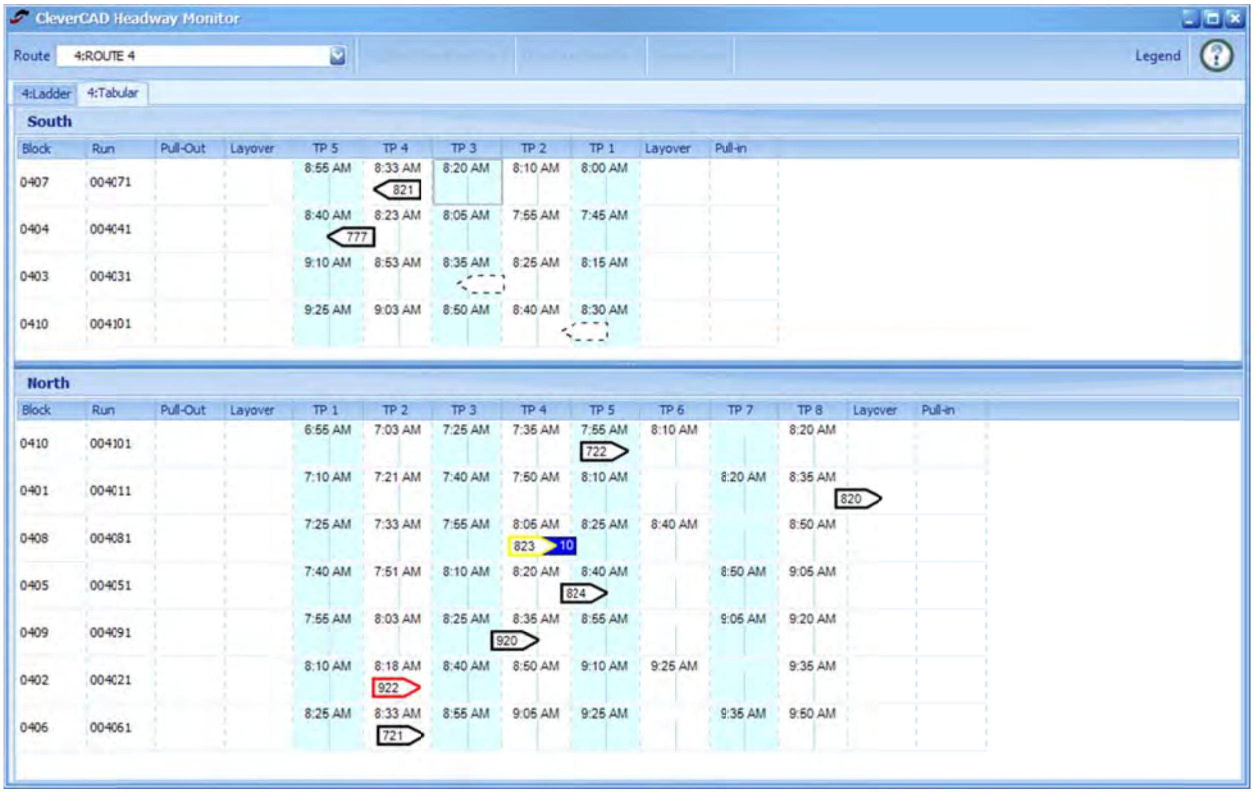


Figure 64: Headway Tabular View

The advantage to MTD is that highly traveled routes are more easily managed through a headway display versus a schedule adherence display. With CleverCAD®'s headway management the dispatcher can maintain and control reliable service for the selected route.

7.3.10.8 Route and Schedule Adherence Management

CleverCAD® affords MTD the ability to manage and monitor the fleet's route and schedule adherence. This information is available in the AVL map, the status grid, the run work grid, and the event grid. The dispatcher can define custom views for just this information and has the ability to define which grids this information can be shown. With CleverCAD®, dispatchers can easily find buses that are off route and/or off schedule and resolve any issues quickly.

The advantage is MTD dispatchers will immediately know which buses are off route or off schedule and by how much. CleverCAD® allows the dispatchers to focus on buses with problems which results in improved transit service and customer information.

7.3.10.9 Event Management

Events are exception based notifications that require the attention of the dispatcher. They are generated automatically by the vehicle's on-board computer, manually by the operator, or by CleverCAD®. CleverCAD® provides a comprehensive view and management of all transit service wide events. An important feature of the event grid is the ability to organize, prioritize, sort, and filter events based on MTD and dispatcher specific desires for quick and easy access. Events can be configured as follows:

- Enable/disable event type
- Prioritize events for the agency
- Set audible alarms per event type
- Automatically create incidents
- Assign to specific grid
- Assigned to user by work assignment

The dispatcher can customize the event grid to their liking. This includes the order of columns, the default sort order, and event grouping. For instance events assigned to other dispatchers are shown below the current dispatcher's assigned events.

The event grid tracks several different types of events, some of which are listed here:

AVM	Avm alert
BusCrowded	Bus crowded
BusFull	Bus full
BusToolsVersion	Incorrect Bustools® database version on vehicle
DoorOpenMovement	Moving with door open
EAStatus	Emergency alarm
IllegalVehicleMovement	Left depot area without valid sign on
InvalidLogonAttempt	Invalid logon attempt
MailEvent	Handle a mail message as an event
Miscellaneous	Miscellaneous
OpenRun	Open run alarm
OutofRange	Vehicle out of range
PendingReliefLate	Pending relief late alarm
PremTransferDeparture	Premature transfer vehicle departure
PRTT	Priority request to talk
RouteAdherence	Route adherence violation
RTT	Request to talk
ScheduleAdherenceAhead	Vehicle early
ScheduleAdherenceBehind	Vehicle late
UnknownVehicle	Unknown vehicle
VehicleComm	Vehicle communication problem
WheelchairFull	Wheelchair full

Additional event management features:

- CleverCAD® tags the event or incident owned by the dispatcher that first takes action on it. Each dispatcher has the ability to see the ownership of each event/incident in the "locked by" column of the event and incidents grid. Unhandled events will appear bol . in the events grid until a dispatcher tak:s action on it.

- ach event ca ı be configured by the MTD administrator to be dis ›layed or not.
- .t the dispatc ıer's discretion, events can be documented through incidents. Dispatchers can quickly and e sily create incidents. CleverCAD® will automatically associate all current operating data to that in :ident.
- 'he dispatche : has complete control to group, sort, and filter data on the events grid.

7.3.10.9.' Emergency Alarm (Covert Alarm)

One of the major reas ›ns for CAD/AVL system is to increase the safety a ıd security of transit. MTD must hav: situational ıwareness of critical incidents to maint ıin a safe en ironment for your ridership. For the ıost critical situations, CleverCAD® offers the dispatcher several levels of situational awareness for incidents generate l by the operator pressing the on-board emergency alarm switch. The instant an operator presses the c ›vert alarm, the following happens:

- 'leverCAD® is notified in the events grid (highest priority)
- Polling is incr:ased
- . private trac :ing window is opened to show the vehicle's exact location
- .n audible al rm is generated to ensure the dispatcher is notified ›f the urgent situation
- 'he vehicle icon changes color to red and includes the emergency status decoration attached to t ıe vehicle ic n regardless to the vehicle's previous state.
- .n incident form, if configured by MTD, is automati :ally generat:d

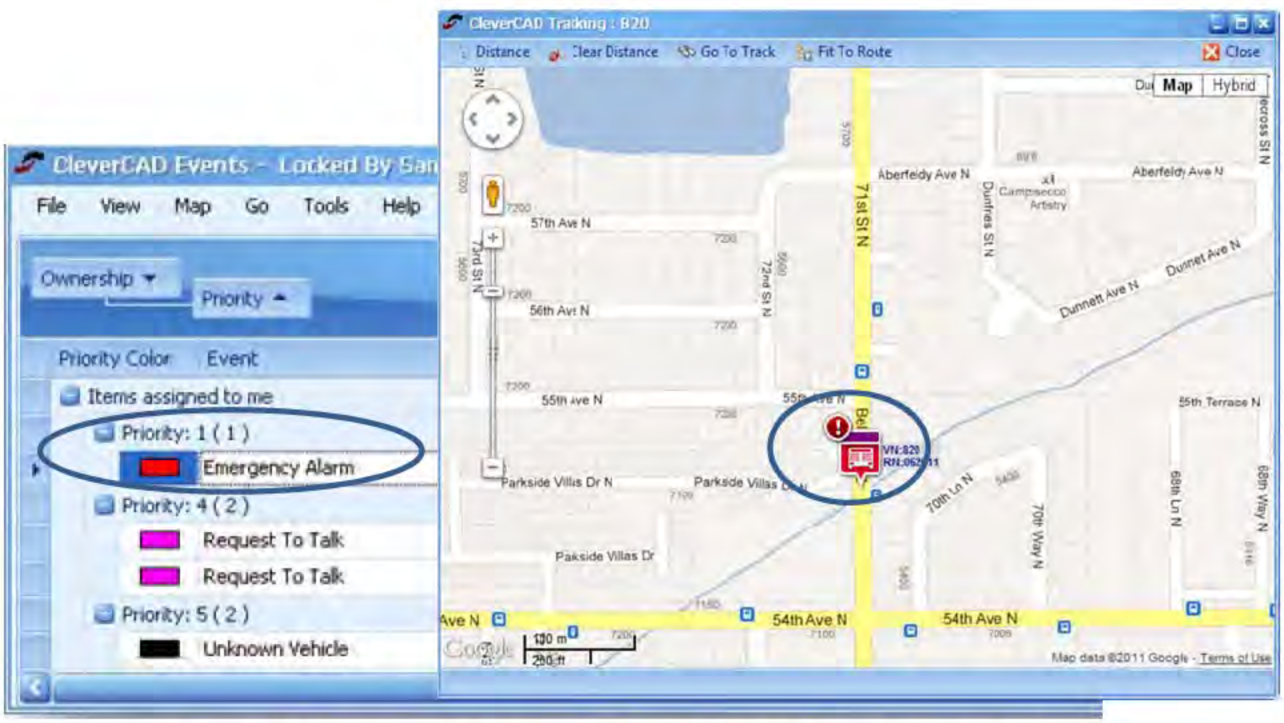


Figure 65: EA Events as highest priority in Events Grid and Private Tracking Window

The disp ıtcher can en ıble the covert microphone on the bus ›nly when th : vehicle has an active emergency alarm event.

Once the covert call option is selected, the user is prompted with the covert call setup dialog box so to choose call duration and channel/talk group as seen below.

Figure 66: Covert Call Setup Dialog

After the user has selected preferred options in the covert call setup, the covert call status window as seen in Figure 67 keeps the dispatcher informed of the call status.

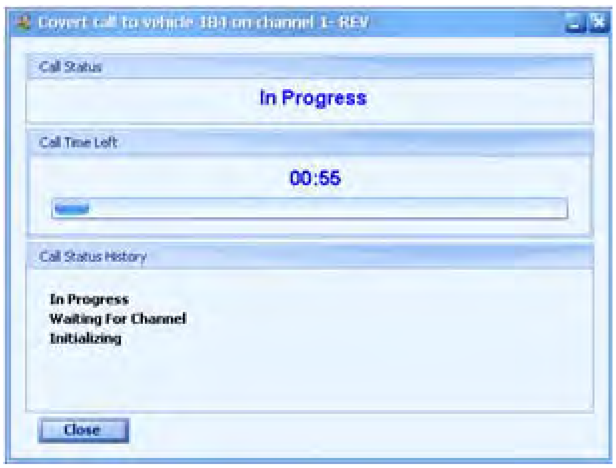


Figure 67: Covert Call Status Window

While a vehicle is in an emergency state, all voice calls and text messages are disabled to that vehicle.

The dispatcher always does the cancelation of an EA event. However, the [TA] administrator can configure whether or not the operator can send an RTT or PRTT as an "all clear" request to cancel the EA event. If the "all clear" is enabled and the dispatcher attempts to cancel the emergency condition before receiving the "all clear", the dispatcher will be prompted by a confirmation message as shown in Figure 68. This is done to ensure the emergency alarm is not accidently canceled.

Figure 68: EA Cancelation Confirmation

While handling the emergency alarm, the operator on-board the vehicle is notified with subtle indications of the current EA status via the date and time separators. When the EA switch is pressed, the colon in the time changes to a period and notifies the operator that CleverCAD® has received the emergency condition. Finally when the dispatcher initiates the covert call to the vehicle in the emergency state, the slashes in the date display change to dashes and informs the operator that the situation is being actively monitored. These subtle indications inform the operator of the status of the emergency alarm while preventing notification to riders and on-board offenders.

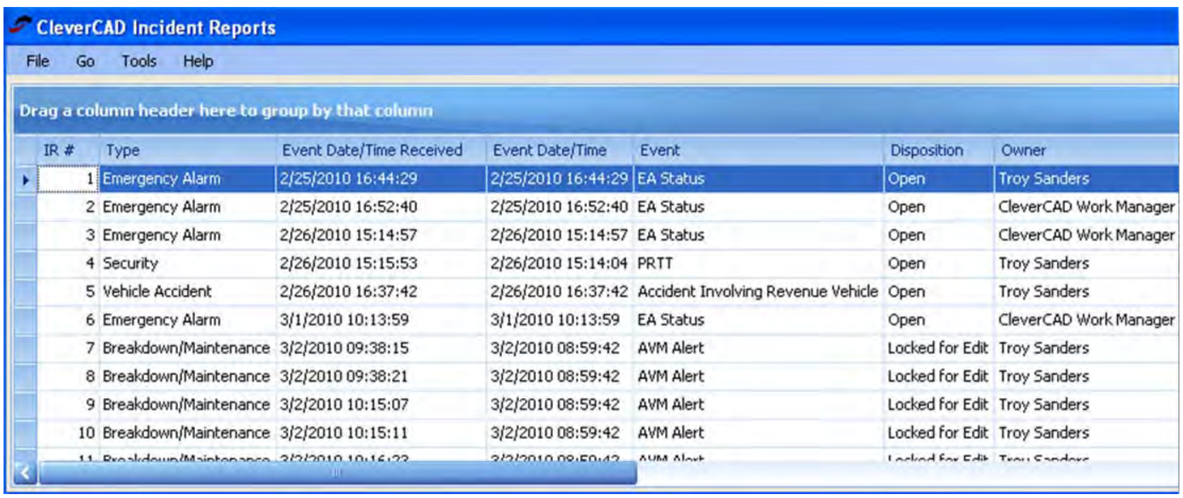
The advantages to MTD are:

1) Event management provides a controlled means to communications. Text messages can be sent without consuming voice bandwidth. The vehicle operator can also request voice communications allowing the dispatcher to establish a voice call in a timely and MTD managed level of priority.
2) Event management allows MTD to configure events so that dispatchers can focus on those that are more important for an efficient resolution. The higher the priority requires the quickest response.
3) Comprehensive Emergency Alarm management to ensure a safe and secure transit environment.
4) Event management allows the MTD to easily and quickly manage and resolve vehicle events in a controlled manner.

7.3.10.10 Incident Management

Incidents are used as a means to identify, track, and manage a specific transit service event, collect data from the time of the event until the incident is closed, and generate historical reports. Incidents are typically used as a means to manage, communicate, and record notes and details about events, service interruptions, and employee incidents. This provides MTD with the ability to create, manage, and track an incident from its source through its resolution. Incident reports are stored in Clever Device's web based incident management program CADVisor.

When an incident is created, all available data in the system is automatically populated in the incident report. The incident report also provides ad-hoc data and text fields so the dispatcher can add or modify information. Each incident is tracked and displayed in the incident report grid, as shown in Figure 69 below, with detailed information regarding the event, time, event type, event subtype, and status of the incident. This grid is used by dispatchers to track and manage incidents.



IR #	Type	Event Date/Time Received	Event Date/Time	Event	Disposition	Owner
1	Emergency Alarm	2/25/2010 16:44:29	2/25/2010 16:44:29	EA Status	Open	Troy Sanders
2	Emergency Alarm	2/25/2010 16:52:40	2/25/2010 16:52:40	EA Status	Open	CleverCAD Work Manager
3	Emergency Alarm	2/26/2010 15:14:57	2/26/2010 15:14:57	EA Status	Open	CleverCAD Work Manager
4	Security	2/26/2010 15:15:53	2/26/2010 15:14:04	PRTT	Open	Troy Sanders
5	Vehicle Accident	2/26/2010 16:37:42	2/26/2010 16:37:42	Accident Involving Revenue Vehicle	Open	Troy Sanders
6	Emergency Alarm	3/1/2010 10:13:59	3/1/2010 10:13:59	EA Status	Open	CleverCAD Work Manager
7	Breakdown/Maintenance	3/2/2010 09:38:15	3/2/2010 08:59:42	AVM Alert	Locked for Edit	Troy Sanders
8	Breakdown/Maintenance	3/2/2010 09:38:21	3/2/2010 08:59:42	AVM Alert	Locked for Edit	Troy Sanders
9	Breakdown/Maintenance	3/2/2010 10:15:07	3/2/2010 08:59:42	AVM Alert	Locked for Edit	Troy Sanders
10	Breakdown/Maintenance	3/2/2010 10:15:11	3/2/2010 08:59:42	AVM Alert	Locked for Edit	Troy Sanders

Figure 69: Incidents Grid

MTD business rules and processes will require a unique set of incidents. CleverCAD® addresses this by allowing the MTD administrator to define the incident types and sub-types. This grouping method allows MTD customizing the organization of Incidents for easy access. There is no limit to the quantity of incident types and sub-types. Below is a list of common incident types used by other transit authorities. Remember these are examples and can be defined by MTD as desired.

Accident	Accident involving revenue vehicle
AVM®	AVM over the air alarm
Bunching	Bus bunching
Big gaps	Time between buses is more than double scheduled interval
Bus crowded	Bus is approaching maximum capacity
Bus full	Bus is at maximum capacity
BusTools® version	Incorrect BusTools® database version on vehicle
Covert alarm	Emergency covert alarm button has been depressed on the vehicle
Door open movement	Moving with door open
Driver maintenance alert	Maintenance event message selected by driver

Early pull in	Vehicle pull-in early
EA status	Emergency alarm
Fleet coms	Fleet communications problem
Fleet coms resolved	Fleet communications problem has been resolved
GPS fail	GPS device has failed on the vehicle
Illegal vehicle movement	Left depot area without valid sign-on
Late pullout	Vehicle pulled out late
Mail event	Text message received from vehicle
No AVL message	AVL message not received from a registered vehicle
Open block	Scheduled block does not have a vehicle logged on
Open run	Scheduled run does not have a vehicle logged on
Passenger incident	Incident involving passenger
PRTT	Priority request to talk
Route adherence	Route adherence violation (off-route)
RTT	Request to talk
Schedule adherence ahead	Vehicle is running early
Schedule adherence behind	Vehicle is running late
Unknown vehicle	A vehicle not defined in the system has registered with the DCC.
Vehicle Ack not received	Vehicle has not acknowledged a message within a specified time period
Vehicle coms	Vehicle communication problem
Vehicle incident	Incident involving revenue vehicle
Vehicle turnback	The vehicle has made an illegal turn back

At a minimum, the incident grid provides the type of event or incident, the operator involved, the vehicle involved, route ID, run ID, block ID, and the status of the event or incident. The grid also identifies which dispatcher has ownership of the event or incident.

The advantage to MTD is that CleverCAD® has significantly more incident types and configurability than the current MTD incident system. CleverCAD® automatically populates much of the data for the incident and allows the dispatcher and other authorized users to monitor, modify, manage, and close incidents in a MTD controlled manner.

7.3.10.11 Text Messaging

Text messaging, an alternative to voice communications, is a quick and cost effective manner to communicate with operators to resolve transit service anomalies. Many transit authorities have limited voice channels available, which limits its use. Text messaging is much like email and allows the dispatcher or operator to send messages and to view incoming messages. The CleverCAD® interface to send a message is shown below:

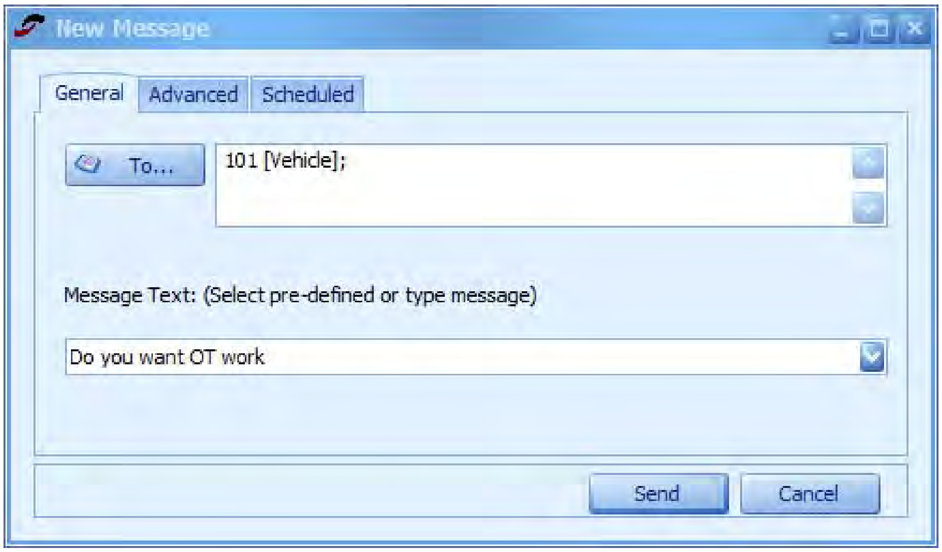


Figure 70: New Message Dialog

The dispatcher may send pre-defined (canned) text messages or ad-hoc (free form) text messages to a vehicle or any set of vehicles through a myriad of selection techniques listed here:

- Vehicle
- Group
- Block
- Garage
- All vehicles
- Operator
- Run
- Route
- Geographical area (rubber band on the map)

Text messages to the fleet can be sent to general, detour, or Informational inboxes. This is used to make it easy for vehicle operators to find and manage text messages on-board the vehicle.

CleverCAD® text messaging feature also supports:

Store and Forward: Allows the dispatcher to schedule a text message for delivery at a given time in the future, a specific time period, or when the operator logs on to a specific route, run, or block during a specific time period. A common use of this feature is to ensure that all operators on a specific route receive applicable detour instructions.

Response Required: Allows the dispatcher to request a response from the operator. There are multiple responses the dispatcher can select from: yes/no, yes and time /no, or yes and number/no.

Spell Check: Spell check is available.

The vehicle operator can also send text messages to other CleverCAD® users. These are viewed in a mail client and have all the features and functions such as create a new text message, reply to driver requests, and confirm who has responded to a group message.

The advantage to MTD is a highly effective, reliable, and timely means of communications to and from the fleet. This will reduce voice communications dependency and will allow the dispatcher to handle multiple issues quickly. Text messaging will improve the dispatcher's ability to resolve problems quickly and will result in improved transit service.

7.3.10.12 Voice Call Control

Any CAD/AVL system must come with a reliable, responsive, and comprehensive voice call management solution. CleverCAD® provides complete voice control communications to the fleet for private or public radio solutions. IVN® provides the interface to CleverCAD® and the on-board voice control. The dispatcher can establish a voice call to a bus or group of buses at any time. However, the operator cannot just pick up the handset and talk. The operator must send an RTT or PRTT request to get the attention of the dispatcher through the event grid. When the dispatcher processes this event he/she then makes the voice call to the vehicle.

CleverCAD® supports two types of voice calls: one-way and two-way. A one-way voice call is typically a public service announcement or an informational announcement to the operators, and can be made to a single bus or group of buses. A two-way voice call is generally between a dispatcher and a single vehicle. The audio for both can be routed to the driver speaker, interior speaker, exterior speaker, or handset. By default one-way voice calls are routed to the driver speaker. If at any time the operator picks up the handset, the audio is automatically routed to the handset and the driver speaker is muted. Both one-way and two-way calls can be made to a single vehicle, a group of vehicles, or all vehicles. Because voice calls are a critical feature there are many ways for the dispatcher to access this feature. A few are listed here:

- Right click on the vehicle in the map view
- Quick call from the event grid
- Voice call from the event grid
- Voice call setup from tool ribbon
- Vehicle detail information box

Quick call method uses the default talk groups, destination, and call duration to quickly make a call to a vehicle associated with an event, incident, or work piece. Calls initiated from a vehicle Icon on the map, as shown in Figure 71 from the vehicle detail information box and other grid locations.

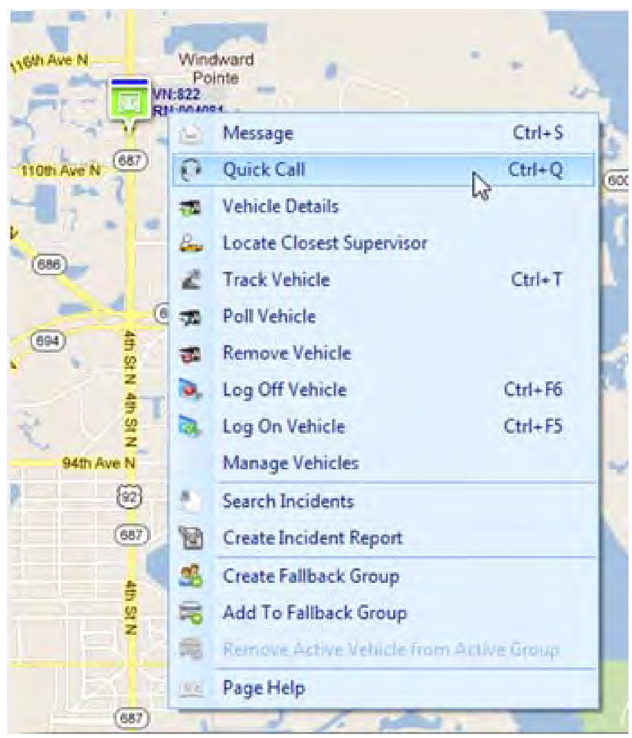


Figure 71: Quick Call from AVL Map

The other methods access the voice call setup dialog as shown below. This allows the dispatcher to select multiple vehicles by different criteria such as vehicle, garage, user ID, etc… as well as the destination (operator speaker, handset, inside/outside speakers), and the call duration.

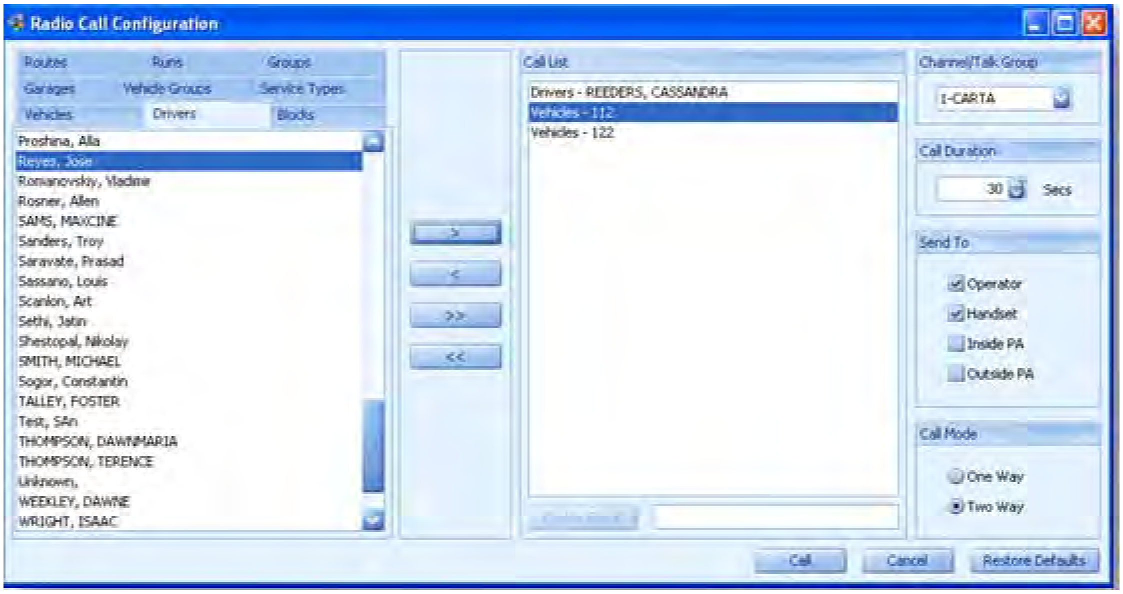


Figure 72: Voice Call Setup

Once the dispatcher initiates a voice call, the call status dialog is displayed while waiting for the fixed end radio system to provide a channel.

Once the desired channel is cleared for use, and a validated connection is established with the bus being called, the controller is advised the call is in progress" and shown the time remaining for the connection. The operator on the bus is also presented with the time remaining for the connection. This allows for the efficient use the available voice communications spectrum by preventing voice channel "camping".

The controller can terminate a voice call at any time, or by the operator by hanging up the handset, or it automatically ends upon the expiration of the call timer. The call status box will indicate when the call has been completed.

In the scenario where a dispatcher calls a group of vehicles, CleverCAD® displays the statistics of the voice call as indicated by quantities of vehicle for each status type as shown below. If necessary, the dispatcher can chose the call missed vehicles option to initiate a second call which will only include vehicle that either could not be reached or did not respond.

As mentioned earlier, the dispatcher can create custom call Lists (groups) within the main radio call configuration display. Once the call list is created the dispatcher can select it to establish a voice call. The dispatcher can create a call list with any one or more of the following items:

- Vehicle
- Operator
- Run
- Depot/Garage
- Vehicle Group
- Block
- Service Type
- Routes

The advantage to MTD is that voice control is reliable, trustworthy, and timely. From the time the dispatcher makes a call till the operator is notified is measured in a few seconds.

7.3.10.12.1 Call Routing System Console Equipment

To support the voice call functionality defined in the RFP, Clever Devices has proposed supplying Gai-Tronics IPC9004 Communications consoles as an integral part of the dispatcher work stations for the CAD option. The IPC9004 Navigator Series Console is a stand-alone radio communications console that provides the required radio transmit and receive audio management as well as integration to the existing XPR-5550 control stations via provided Tone Remote adapters. The Gai-Tronics IPC9004 Communications console works in concert with the CleverCAD® client to allow for radio transmit and receive capability once calls are established via the CAD client. In the event that the CAD system is set to the "fallback" mode (open Mic operation), the Gai-Tronics console will continue to provide the dispatcher with radio dispatch capability. All pushbutton and indicator functionality is located on an interactive computer display supporting touch-screen or mouse operation. The ICP9004 NAVIGATOR is feature rich and provides the dispatcher with complete system control. The dispatcher can choose single or multiple channels (if available) to transmit and receive audio. The audio is routed to volume controlled select and unselect speakers (left and right PC speakers). Instant Recall Record is included to provide one-touch replay of the last 20 seconds of receive and transmit audio as well as the capability to search the past 80 minutes of transmit and receive audio for review. A noise cancelling gooseneck microphone and Plantronics headset is provided for dispatcher interface.

7.3.10.13 Vehicle Details Window

The Vehicle Details window as shown in Figure 73 provides all available information about the selected vehicle and its current status. The window is comprised of two major areas: the top and bottom. The top area provides immediate access to details of the vehicle and current operating status. The bottom area provides access to additional information as determined by the selected tab. These are the vehicle information, route information, emergency alarm history, AVM exceptions, and the arrival times for the next five stops for the selected vehicle.

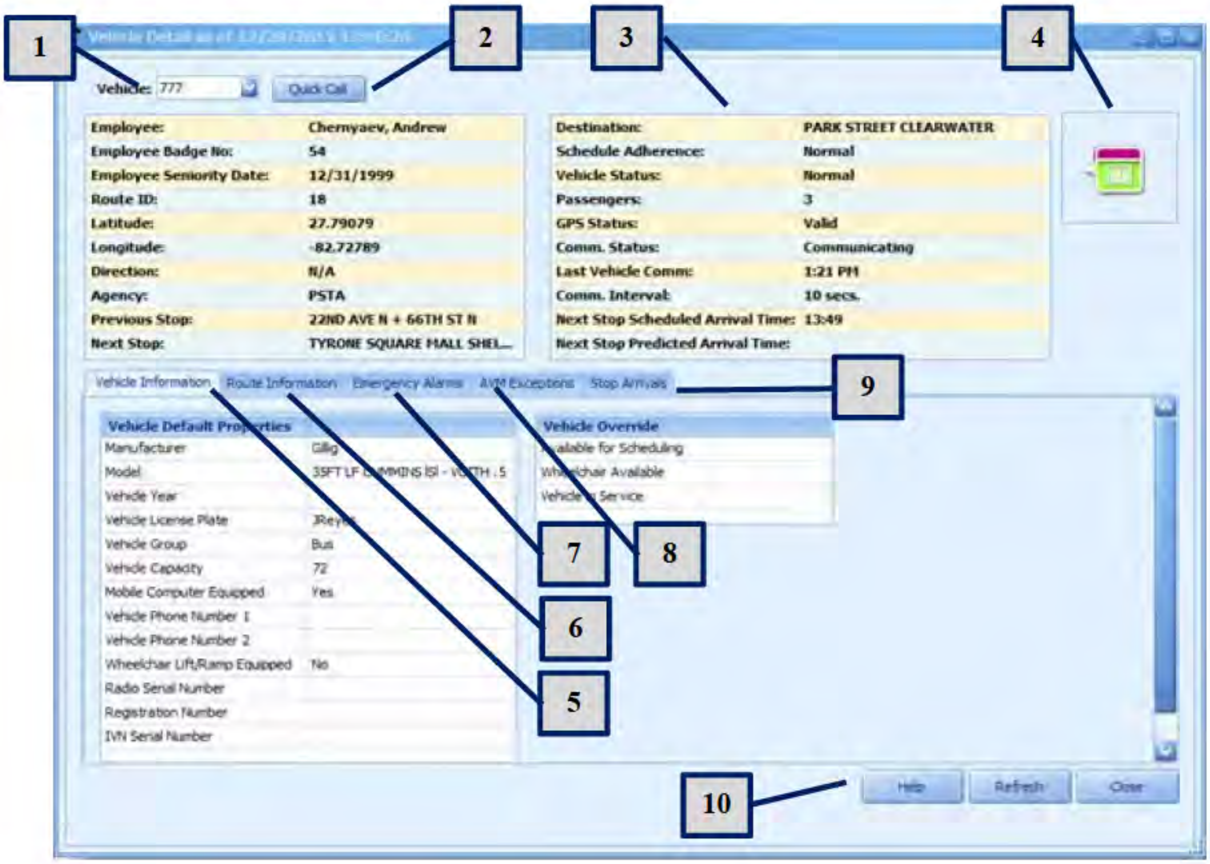


Figure 73: Vehicle Details Window

1)	**Vehicle Drop down**	Dispatcher has the option to select a different vehicle without exiting the vehicle details window.
2)	**Quick Call**	Immediately instantiates a voice call to the selected vehicle.
3)	**Current Status**	These two tabular views provide current status of the vehicle including operator, location, route, current, next and last stop and much more.
4)	**Vehicle Icon**	Displays icon of the vehicle as seen on the map. The top line of the icon (red) represents the correlating route color.
5)	**Vehicle Information**	This tab provides vehicle attributes that include make, mfg., year, capacity, wheelchair, and much more.
6)	**Route Information**	This tab provides detailed information of the current route and the route history for this vehicle for its current block. This includes operator ID, block, schedule deviation and much more.
7)	**Emergency Alarm**	This tab provides details on the Emergency Alarm (EA) history including incident ID, date, time, and more.
8)	**AVM Exceptions**	This tab provides a history of all AVM® exceptions received from the vehicle. This includes date, time, incident ID if applicable, human legible description and more.
9)	**Stop Arrivals**	This tab provides the next five stops the bus is scheduled to service, the schedule time for each stop and the actual Estimated Time of Arrival (ETA).
10)	**Windows Buttons**	Quick access to help, refresh the screen if it has been stagnant for a while and close the screen.

7.3.10.14 Transfer Connection Protection (Not included)

CleverCAD [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

7.3.10.15 Playback

CleverCAD® provides a playback feature that effectively re-creates all transit service behavior including vehicle status and communication events over a selected period of time for a specified set of vehicles or routes from the operational and historical database. The playback feature, shown below, provides grids for events, communications, and status information for the selected vehicles during the dispatcher specified time window.

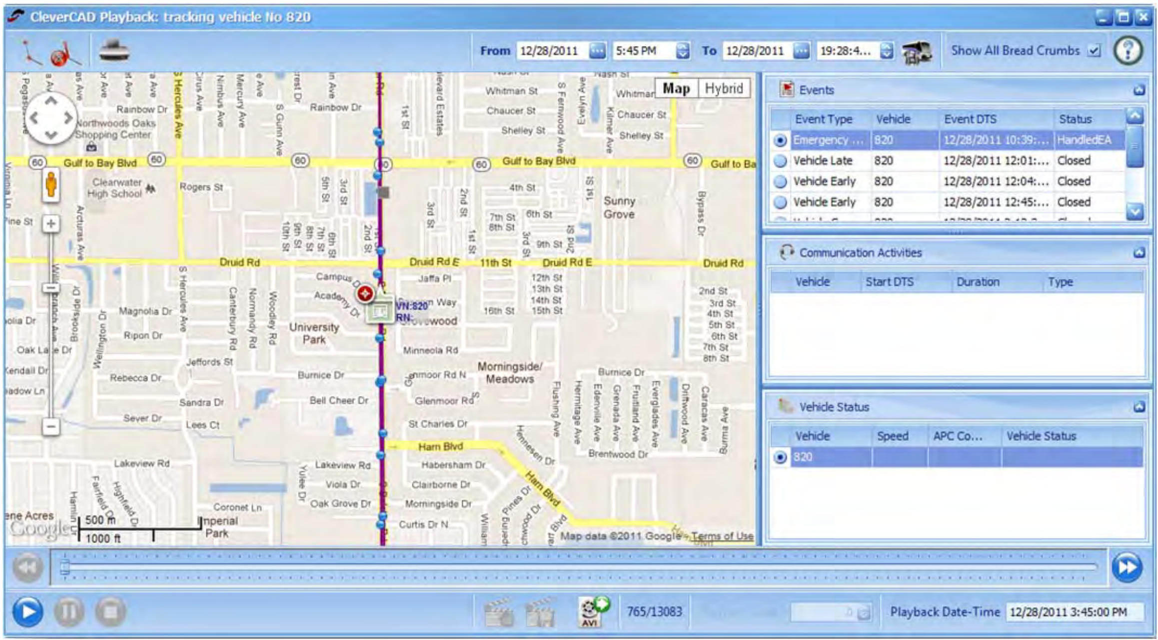


Figure 75: Playback Window

The dispatcher specifies the time period, selects the vehicle, group of vehicles or all vehicles, and presses play. One or multiple of the following criteria can select vehicles:

- Vehicle
- Routes
- Run
- Block
- Operator IDs
- Update times

When playback is active, the AVL map displays the selected route(s) overlay and populates all of the vehicles' original locations with color coordination to the route. All of the events that occurred during the selected time period are played in chronological order. This display informs the user as to any and all text messaging and voice call activity that took place during the selected time period. Finally, playback also includes the status of each of the user-selected vehicles during the playback period. The status of each vehicle is updated as time progresses through the playback time frame.

The dispatcher can play, pause, stop, fast forward, slow motion, step through, and rewind. Dispatchers can also set a playback speed of 1 to 15 times the real-time speed. Tools such as pan, zoom, and measure are available.

The playback can be recorded as a video and exported to AVI format. This allows anyone to view it through standard internet web browsers.

CleverCAD® can be configured by the MTD administrator to have 60 days of data on line and immediately available for playback. Data older than 60 days is automatically archived to CADStore, which is permanent off-line storage. The MTD administrator is notified of archive status (pending, complete). CADStore can accommodate any volume of data and is limited only by available disk space.

The advantage to MTD is the CleverCAD® Playback feature allows MTD to analyze specific issues related to bus or operator behavior. MTD can use this to help manage drivers and to manage claims against CTA.

7.3.10.16 Dispatcher to Dispatcher Communications

During normal transit service, dispatchers may require the use of built-in messaging functions to communicate with other dispatchers without having to leave their consoles or utilize the radio. CleverCAD® has two features that support this: CleverCAD™ mail client and chat.

The CleverCAD® mail client, similar to a standard email tool (outlook or other), is used as the central display for all text messaging between all dispatchers and vehicles. A dispatcher will see items specifically addressed to them within their mail client view. As shown in the mail client screenshot above, the dispatcher is reading a message from another dispatcher concerning an incident. The history and status of each mail message is saved in the system for historical reporting and viewing. A user can choose to either reply to a current message or create a new message directly from this mail client display.

Chat is an instant message feature that allows dispatchers to communicate between each other quickly and easily. Like the mail client all communications are recorded for historical reporting purposes. The chat window is shown in Figure 76.

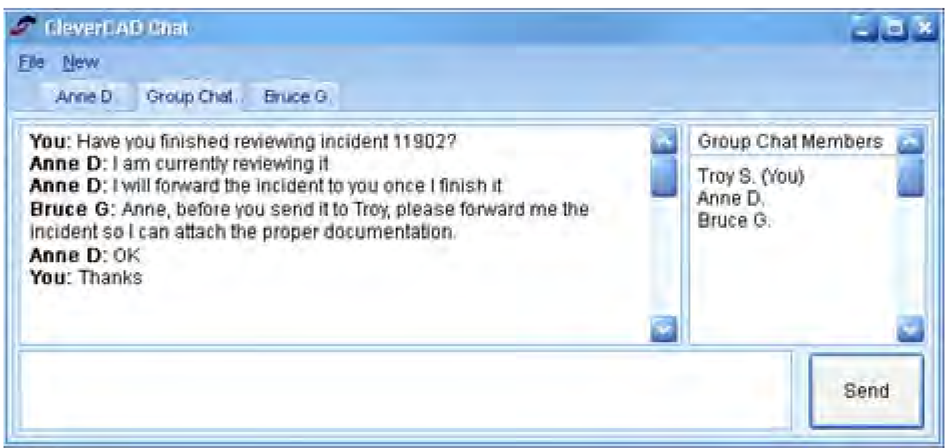


Figure 76: Dispatcher Chat Window

Users can also choose to start a group chat between two or more users. This enables coordination of dispatcher activities between multiple users.

7.3.10.17 CleverCAD® Data Correlation

Clever Devices' solution ensures data correlation within the central CleverCAD® system and within the on-board IVN® system. CleverCAD® records all data from the fleet, from other systems, and all dispatcher activity. Below is a detailed list of data collected, tracked, and managed by CleverCAD®. This is not an exhaustive list, but is intended to provide the extent of data logging provided by CleverCAD®.

Table 9: CleverCAD® Data Logged, Tracked, and Correlated

CleverCAD® Data Collected Within The System			
Badge number	BT version	Off route date/time	Direction
Vehicle ID	Bus full	On route date/time	Actual pullout date/time
Route	Last name	Coms lost timestamp	Route start date/time
Block	First name	Route status	Passing time
Run	Middle name	Trip start date/time	Event source
Trip	Driver	Logon date/time	Locked by
Current timepoint	WID1	Logoff date/time	Status
Last timepoint	WID2	Lat/long status	Event count
Next timepoint	Coms last timestamp	Service date	IR number
Previous stop	Coms current status	Schedule version	Priority
Next stop	Depot in date/time	Schedule deviation	Update DTS
Longitude	Deport out date/time	Logon invalid code	Priority color
Latitude	Speed(mph)	Work invalid code	Ack'd
APC on	Invalid logon attempts	In fallback	Icon
APC off	Invalid logon operator	Assignees	Destination
APC net	Invalid logon work ID 1	Fallback group	Relief date/time
W/C on	Invalid logon work ID 2	W/C dep	Relief location
W/C off	Operator logged on	Event	Relief run
Wheelchair count	Power off date/time	Event DTS	Response time
Vehicle status	Power on date/time	Event closed date/time	Event display DTS
Transit group			

7.3.10.18 Road Supervisor System

As an option, Clever Devices will provide Dell Latitude E6420 XFR laptops for the supervisor vehicles. The E6420 XFR includes BallisticArmor™ rugged technologies such as PR-72™ chassis material, PrimoSeal™ ingress protection and QuadCool™ thermal management that offer protection against accidental drops, water, dust, and extreme temperatures and help make the E6420 XFR suitable for virtually any working environment. Additionally, the Latitude E6420 XFR has been independently tested to MIL-STD-810G, IP-65, MIL-STD-461F and UL1604 standards.

With its blazing performance and versatile usability, the Latitude E6420 XFR offers the features you need for work in rugged environments, including a 14.0" HD antiglare LED display with DirectVue™ technology for sunlight readability and an optional resistive touch screen.

Also as an option, Clever Devices will provide the mounting hardware and docking station to be installed in each vehicle. The mounting hardware will come with a swing arm that can be adjusted and locked into a desired position, and the docking station will secure the laptop computer using a barrel key securing system.

Each supervisor vehicle unit would also include an easy-to-install auto shut-off timer designed to safeguard expensive communications devices and computers with intelligent circuitry protection. This device would automatically turn mobile equipment on when you start the engine. When you turn the engine off, the equipment would stay on for an adjustable period of time, and then is automatically disabled.

The features of this ruggedized Laptop are:

- Windows 7 Professional, No Media, 64-bit, English
- Intel® Core™ i5-2520M processor (2.50GHz, 3M cache
- 4.0GB, DDR3-1333MHz SDRAM, 1 DIMM
- 256GB Solid State Drive
- 90W A/C Adapter (3-pin), MIL-STD 461F
- 8X DVD with Cyberlink Power DVD™, no media
- Dell Wireless™ 1530 802.11a/g/n Draft Mini Card
- Triple RF-Pass-Thru
- 14.0" HD (1366x768) Outdoor Viewable with Direct Vue™ and Mic only
- Sealed Internal English Backlit Keyboard, White
- Intel® HD Graphics 3000 without Fingerprint & Contactless Smartcard Reader
- Dell Wireless™ DW5800 4G LTE Mini Card (Gobi™ 4000) – Verizon

Clever Devices has estimated the cellular data usage at 2GByte/month data to support dispatch functionality. This may change based on MTD usage. Any changes can be accommodated and may affect the monthly service charges. This can result in savings or additional costs. Any changes will be reconciled with MTD.

7.4 AIM Hardware

7.4.1 Network

A robust LAN infrastructure is required to support communications between the data center and the local bus garage to support the bandwidth required for the bulk data transfers of data and software updates to the fleet, as well as, the transfer of daily performance data from the fleet. Clever Devices has included a Buslink® server in the data center. Buses will communicate via WLAN from the garage, over the network, to this server.

Clever Devices proposes a 100Mbps link (preferably 1Gbps) from the garage to data center, and appropriate routing within MTD's network. The data center requires LAN (100Mbps -1Gbps+) connectivity to the network that will be utilized by Clever Devices applications.

7.4.2 Servers

To meet the requirements for redundancy in the application and database server systems server architecture while at the same time presenting a cost effective solution, Clever Devices proposes a Virtual Server Environment that will effectively eliminate the use of several physical hardware components. The advantages of which are easily recognized. By implementing the proposed virtual server platform to host the Central Systems, MTD will experience increased levels of performance, scalability, and availability while reducing operational expenses:

- Lowered infrastructure maintenance
- Lowered applications maintenance
- Lowered energy costs
- Reduced physical infrastructure footprint
- Reduced carbon footprint, a green datacenter

All factors lead to a highly efficient, robust yet cost effective implementation proposition that will ultimately benefit MTD by facilitating a lower total cost of ownership and eliminating the potential for lost revenue. Located within the main datacenter, MTD will have access to all equipment located in the server rooms.

Clever Devices recognizes our customers' needs to improve the efficiency and availability of IT resources and applications through virtualization. Our applications are capable of being deployed in Microsoft Hyper-V environments. Utilizing Hyper-V will help maintain a consistent virtualization platform at MTD, and is the most cost effective solution.

Utilizing Hyper-V High Availability (HA) technology in an N+1 server architecture, Clever Devices can maintain 99.9% uptime of MTD's mission critical applications. An N+1 server environment has a single spare server that is configured to provide redundancy for a group of servers, for the application servers. This N+1 server assumes the role of any failed server within that group when required. Our SQL server achieves high availability via use of an active-passive cluster. HA provides uniform, cost-effective failover protection against hardware and operating system failures within your virtualized IT environment.

- Monitors virtual machines to detect operating system and hardware failures
- Restarts virtual machines on other physical servers in the resource pool without manual intervention when server failure is detected
- Protects applications from operating system failures by automatically restarting virtual machines when an operating system failure is detected

To power the system in the back office, Clever Devices recommends HP ProLiant DL360p Gen8 servers. These servers provide industry leading 2-socket performance and efficiency in a space saving 1U size. With Gen8 enhanced serviceability and configuration flexibility, this server is ideal for dynamic computing workloads, and virtualization. Based on the available space on the existing servers at MTD, Clever Devices is proposing new HP servers to host the AIM system, and an additional half rack to mount them in.

The database approach suggested by Clever Devices will include two (2) additional HP DL360p Gen8 clustered servers to host the SQL Standard production environment.

Clever Devices also proposes the use of a separate environment to test all system changes before deploying to production. This test environment would utilize an additional HP ProLiant DL360p Gen8 server with shared storage on the SAN.

An APC Smart-UPS (Uninterruptible Power Supply) will be utilized to power the central system. The Smart-UPS will give higher application availability by correcting low and high voltage conditions without using the battery, and it maximizes battery performance, life, and reliability through intelligent, precision charging.

Clever Devices has sized the central system for capacity to support up to 110 buses. It is important to note that additional space will have to be added in case of future expansion.
Once the system has been deployed Clever Devices Implementation Engineers will provision the system as follows:

7.4.2.1 Base System

The following provides a summary of each VM environment of the base system including CPU cores, memory and storage requirements:

Production Application Servers	CPU	Memory (GB)	HDD (GB)
BusLink®	2	4	215
TOA - BusTime® Prediction	2	8	130
TOA - BusTime® Web	2	4	130
DCC	2	4	125
RSA - CleverReports™	4	12	150
VSS – ViM	4	4	1000[1]
Production Application Total	**16**	**36**	**1,750**

Note [1]: Clever Devices has estimated the storage for tagged video to be 1 TByte. This storage is estimated and may change based on MTD specific requirements. Any changes can be accommodated but may require additional storage, which is not included in our proposal.

Production SQL Standard Cluster	CPU	Memory (GB)	HDD (GB)
SQL Standard Cluster	4	16	940

Test Servers	CPU	Memory (GB)	HDD (GB)
BusLink®	1	2	100
TOA - BusTime® Prediction	1	2	100
TOA - BusTime® Web	1	2	100
DCC	1	2	100
RSA - CleverReports™	2	4	100
VSS – ViM	1	2	100
SQL Standard	1	2	300
Test Total	**8**	**16**	**900**

Clever Devices will utilize the simple and efficient EMC VNXe 3150 SAN for both the application and SQL production environments. Additional drives will be required for each optional application MTD purchases VNXe systems are uniquely capable of delivering unified IP storage for NAS and iSCSI while simplifying operations and reducing management overhead. Clever Devices is recommending a new SAN for our system as the Hitachi Adaptable Modular Storage (AMS) 2000 family of products has been retired. With the Hitachi AMS now retired, any equipment to support the current SAN in use at MTD would be difficult to procure and would not be supported or replaced through a warranty.

Production SQL Standard Cluster	CPU	Memory (GB)	HDD (GB)
SAN			5000

7.4.2.2 Optional Systems

The following provides a summary of each VM environment to support the optional systems including CPU cores, memory and storage requirements:

Optional Production Servers	CPU	Memory (GB)	HDD (GB)
VHM - AVM®	4	12	155
CAD/AVL - CleverCAD®	4	8	140
IVR - Enghouse BusLine	4	12	180
YWS - SmartYard™ Message Server	2	4	180
YWS - SmartYard™ Web Server	2	4	180
YWS - SmartYard™ RTLS Server	4	8	180
Additional SQL Standard Server Space			
VHM - AVM®	2	6	110
CAD/AVL - CleverCAD®	1	6	360
YWS - SmartYard™	1	4	100

Optional Test Servers	CPU	Memory (GB)	HDD (GB)
AVM®	2	4	100
CleverCAD®	1	2	100
Enghouse BusLine IVR	2	4	100
SmartYard™ Messaging Server	1	2	100
SmartYard™ Web Server	1	2	100
SmartYard™ RTLS Server	2	2	100
SQL Standard	1	2	300
Test Total	**10**	**18**	**900**

If the option for full video upload is selected, Clever Devices has included a Dell EqualLogic PS6500E with 150 TBytes storage for six months of video. This storage is estimated and may change based on MTD specific requirements. Any changes can be accommodated but may require additional storage, which is not included in our proposal.

VSS Full Video Storage Space			
VSS Full Video Storage	-	-	150,000

7.4.2.3 Production Environment VM COTS Software

The following commercially off the shelf (COTS) software is required for each virtual machine (VM) of the base solution and optional systems installed in the production environment:

- **Operating System** is Windows 2008 R2 (x64) with Service Pack 1
- **Antivirus Utility**
- **Adobe Acrobat Reader to view**
- **BGInfo Utility** to quickly collect and view system detail information
- **PA Monitor** to monitor the VM system
- **BareTail** for real time log file monitoring, searching and filtering
- **WireShark** for diagnostic monitoring of network
- **Winzip** for compression and decompression of files

7.4.2.4 Production Environment SQL Standard Cluster

All Clever Devices' applications requiring a database will utilize Microsoft SQL 2008 R2 technologies. SQL Server Standard Edition includes both the core database engine and add-on services, with a range of tools for creating and managing a SQL Server solution. It can manage databases as large as 524 petabytes and address 64 GB of memory and supports 4 physical processors or 16 cores. SQL Server 2008 Standard Edition will sufficiently power the MTD solution and any additional expansion that may be realized over the next several years.

The proposed SQL solution for the production environment will consist of two clustered servers in an active-passive environment to achieve high availability (HA) and to improve performance. Two identically configured SQL servers will share ownership of the databases. However, only one server node will accept transactions. The SQL cluster scenario provides high availability at the database level within the data center.

The following commercially off the shelf (COTS) software required for the SQL cluster in the production environment includes:

- **Operating System:** Windows 2008 R2 (x64) with Service Pack 1
- **Database Engine:** Microsoft SQL 2008 R2 Standard Edition with Service Pack 2
- **Antivirus Utility**
- **PA Monitor** to monitor the VM system

7.4.2.5 Test Environment VM COTS Software

The following commercially off the shelf (COTS) software is required for each virtual machine (VM) of the base solution and optional systems installed in the test environment:

- **Operating System** is Windows 2008 R2 (x64) with Service Pack 1
- **Antivirus Utility**
- **Adobe Acrobat Reader to view**
- **BGInfo Utility** to quickly collect and view system detail information
- **BareTail** for real time log file monitoring, searching and filtering
- **WireShark** for diagnostic monitoring of network
- **Winzip** for compression and decompression of files

7.4.2.6 Additional Server Hardware/Software Requirements

- Windows, AVM data and application log partitions should be installed on SAS 10k or faster drives configured for RAID 1 or RAID 5
- Databases and database log partitions should be installed on SAS 15k or faster drives.
- Java runtime will be disabled during system configuration
    - Java 6, update 26 is installed with AVM
    - Clever Devices to verify newer builds
- Software Versions:
    - IIS, Enable FTP, disable all other components
    - JSP
    - .Net Framework 3.5 SP1
    - Apache Tomcat 6.0

7.4.2.7 Monitoring

For system monitoring, Clever Devices utilizes PA Server Monitor Pro. PA Server Monitor Pro identifies system usage, anomalies, or abnormalities. This software can monitor many types of server and network resources with a variety of monitors including:

- Event logs
- CPU, Memory and Network usage
- Disk space
- Running services
- Log files
- Server & room temperature
- SNMP object values
- Running processes
- Ping response times
- Directory quotas
- Changed files and directories
- FTP servers
- POP, IMAP and SMTP mail servers
- Web page content and load times
- TCP port response
- Citrix Monitoring
- Additional resources via user scripts

Clever Devices application logs will also help to identify and address issues.

7.4.3 Workstations

Clever Devices' Client application(s) require the following minimum system requirements for software compatibility and functionality:

CPU: 1.5 GHz or faster
Memory: 4 GB of RAM
HDD: 200 GB free disk space for applications
Operating System: Windows 7
Processor: Dual-core processor (Quad-core processor recommended)
COTS:

- Anti-Virus Utility
- Adobe Acrobat Reader
- WinZip
- The installation must be run as Administrator
- .Net framework 3.5
- Internet Explorer 9 or higher

All users must be granted full access to the application folder.

Microsoft's Internet Explorer 9 is the only web browser supported for all Clever Devices applications. Using Firefox, Google Chrome, or any other type of browser may result in display anomalies. Internet Explorer's Compatibility Mode should be used for the proper display of Clever Devices applications. Refer to the hardware manufacturer's documentation for instructions on properly operating and maintaining the hardware platform.

Clever Devices applications are capable of granting access through Microsoft's Active Directory.

7.4.4 On-Board

7.4.4.1 On-Board AIM System – IVN®

The following is standard documentation, which may include features and functions not required by MTD. These afford MTD the opportunity to understand the full capability of the on-board system. Clever Devices' proposal includes the costs of only those features and functions specified in the RFP.

Clever Devices' on-board system is Intelligent Vehicle Network® (IVN®). IVN® is an industrialized computer designed specifically for the transit marketplace. It combines a plethora of processing power for future growth, a comprehensive set of industrial communication interfaces to all on-board systems, state of the art network interfaces for on and off-board communications, multi-media capability for audio and video, the most accurate navigation system available - PerfectNav™, and most importantly an extensive and proven library of expert algorithms to meet all your ITS needs. IVN® is based on open standards and is the primary data processing and central communications hub on the vehicle. It connects to all your equipment to:

- Manage and control the operator interface provided by the color VGA touchscreen Mobile Data Terminal (MDT)
- Initialize and control the head/destination sign
- Initialize and interface with the farebox and/or fare system
- Initialize and interface with the DVR/camera system
- Initialize and control a transfer printer for operator to print transfer tickets
- Initialize and control the automatic passenger counter (APC)
- Provide TSP algorithms and interface with TSP equipment or systems
- Monitor performance and fault data for AVM® reporting
- Monitor acceleration and performance data for incident analytic reporting
- Monitor critical bus system inputs that represent the current bus state and operator behavior (door status, run switch, speaker select, and more)
- Provide all real time data communications for CAD/AVL and RTPIS
- Control the private voice radio under CAD control
- Provide the VoIP solution for all voice communications
- Provide the bulk transfer of data and software updates via WLAN or other IP technology
- Interface with and support the following standards:

Radio Communications Standards	Transit Communications Standards	PC Software Standards	PC Hardware Standards	PC Communications Standards
VoIP	SAE J1708 (x2)	Windows 7 (Embedded)	Atom™ Class Processor	Ethernet (x4)
M/A-COM OpenSky	SAE J1939 (x2)	.NET	mSATA Flash Drive	USB (x7)
SLIP	RS485 (x3)		Mini-PCIe (x2)	802.11a/b/g/n
PPP	RS232 (x3)		DVI Video (2x)	TCP/IP & UDP

Figure 77: IVN® Standard-Based and Open Architecture

All of the processing necessary to meet MTD's requirements are provided in IVN®. No reliance is made on other vehicle equipment or software to determine position or provide control over the IVN® system. It is a fully contained, operational, and reliable solution.

IVN®'s embedded hardware and expert algorithms include the following ITS features:

AVL

- PerfectNav™ navigation system that incorporates GPS, gyro, odometer, kalman filters, map matching, and our proprietary navigation algorithms to ensure the fleet location is accurate and reliable
- Optional on-board maps with turn by turn instructions
- Monitor location and trigger events associated to user configured geofences

CAD	•	Full support of all on-board CAD (Computer Aided Dispatch) functionality ➢ Logon ➢ Voice calls ➢ Text messaging ➢ Emergency alarm ➢ AVL location updates ➢ Start of trip ➢ Timepoint encounter ➢ AVM® exceptions ➢ APC counts ➢ Power status ➢ Time Sync ➢ Transfer Connection Protection
Single Point Logon	•	Provide a single point logon for all on-board systems with local logon validation and centralized validation by CleverCAD®
BSA	•	Provide all bus stop announcement (BSA) functionality for audible and visual announcements for the interior and exterior of the vehicle including automatic volume control (AVC)
AVM®	•	Process the user specified data points and algorithms to collect all performance and fault data for AVM® reporting
APC	•	Correlate all on-board data for performance and APC historical reporting
Fare system	•	Share information and can provide full single user interface
Hard Brake & Incident Analytics	•	Monitor accelerometer for hard brake, hard acceleration, and hard turn events for reporting through Incident Analytics™
TSP	•	Advanced algorithms to automate TSP with measurable results
Idle Monitoring	•	Monitor vehicle engine idle times for the ability to manage operator behavior
EcoDrive™	•	Collect fuel information and correlate to route, fleet and operator
Power	•	Automatically power down after a user configured time

The IVN® hardware specification is shown here:

All system status LEDs are displayed on the front panel. The rear of IVN® provides connectivity to all on-vehicle systems including antennas. The following are the front and rear view of IVN®.

The IVN® environmental qualifications are shown here:

Test Description	Environmental Qualifications and Details
Temp	SAE J1455 4.1.3.1, 4.1.3.2 -30°C to +60°C
Humidity	SAE J1455 4.2
Splash	SAE J1455 4.4
Vibration	SAE J1455 4.9.4.1, 4.9.4.2
Shock	SAE J1455 4.10.3.1, 4.10.3.4
Load Dump	SAE J1455 4.11.2.2.1
Inductive Switching	SAE J1455 4.11.2.2.
Mutual Coupling	SAE J1455 4.11.2.2.3
Radiated Emissions	SAE J1113/41 SAE J1455 4.11.3.3.1
Conducted Emissions	SAE J1113/41
Radiated Interference Susceptibility	SAE J1455 4.11.3.3. SAE J1113/22/24
Conducted Interference Susceptibility	SAE J1113/2
ESD Handling	SAE J1455,J1113,J1211
ESD in Vehicle	SAE J1455,J1113
FCC Certification	Emission FCC Part 15 Class A

7.4.4.2 Mobile Data Terminal (MDT)

Clever Devices' operator interface is the Mobile Data Terminal (MDT). This equipment provides a visual display of current status and incoming messages as well as access to maintenance personnel for diagnostic information to help maintain the system and diagnose problems. The MDT is the single point operator interface to the IVN® system and complies with ITS single point logon.

The MDT is a DVI color monitor. It incorporates high reliable touch-screen and utilizes a large 9" screen. The system is tightly integrated with IVN®. All text is in a large font, quickly available, and easily accessible. The display is backlit, and easily readable under any ambient light conditions, including brightness control and an anti-glare coating. The screen navigation is intuitive for all transit personnel and is quickly learned by transit operators.

The MDT is a fully graphical, color display, and Clever Devices has selected the color palette to be acceptable to users with all types of color blindness. Over 20 touch-screen soft keys with visual and audible feedback are possible, whose functions are software-programmable based on the displayed screen. These keys provide direct access to functions and menu listings for all operator and maintenance activities.

The operator is not able to shut off the operator terminal (MDT) or manually shutdown the application software. IVN® and the MDT power down a configurable amount of time after the run switch (Power switch) of the bus is turned off. There are no power switches on the MDT.

Clever Devices will work with MTD to identify desired locations for proper installation of the MDT. Normally, this location is somewhere comfortable within safe reach of the driver.

The MDT mounts on a user-adjustable arm. The arm as shown in Figure 78 is designed to allow a 1.5–inch diameter ball accessory to be connected at either end. The 2.5–inch round plates of these accessories are drilled through their AMPS hole patterns to their respective mounting surfaces. A tightening knob on the side of the arm enables the sock to clamp firmly to the attached accessories. The arm allows for easy adjustment by loosening of the side knob. A single spring inside the arm opens the sock, allowing the arm to pivot on the attached accessory. This enables the arm and accessories to be positioned at various angles allowing MTD drivers to ultimately position the MDT with much flexibility.

Figure 78: MDT Mounting Bracket

The MDT has a rugged aluminum housing that meets all NEMA-4 specifications for hose-down, icing, and salt spray, including the sealed covert microphone. The MDT measures 10.63"x2.52"x7.99". The environmental specifications for the MDT are shown here.

Test Description	Environmental Qualifications and Details
Temperature Operating	-30 ^{0}C to +60 ^{0}C
Temperature Storage	-40 ^{0}C to +80 ^{0}C
Temperature	J1455 – 4.1.3.1, 4.1.3.2
Splash	NEMA 4
Operating Shock	J1455 – 4.10.3.1, J1455 – 4.10.3.4
Operating Sinusoidal Vibration	J1455 – 4.9.4.1, J1455 – 4.9.4.2
Electrostatic Discharge	J1112/13 (ESD)
FCC Certification	Emission Part 15 Class A

7.4.4.3 IVN® ITS Functionality

The following is standard documentation, which may include features and functions not required by MTD. These afford MTD the opportunity to understand the full capability of the on-board system. Clever Devices' proposal includes the costs of only those features and functions specified in the RFP.

Clever Devices' operator interface is available through the MDT. The screens and user interface have been custom designed for transit taking into account ergonomic factors and input from many customers. With full color and touchscreen technology, the result is an iconic and graphic based representation for the soft keys and functions. All images displayed are customizable and can be replaced with text, images, or a combination of both. The interface is simple and intuitive, which makes it quick to learn and use. Controlled by IVN®, the MDT functionality is full featured and supports all ITS applications provided by Clever Devices.

7.4.4.3.1 Power Up

Upon power up, the following screen is displayed. For safety, only the logon, RTT, PRTT and lock keys are available.

Figure 79: Power on Screen

- 1 Logon key
- 2 Client logo or other graphic
- 3 Lock/unlock screen
- 4 Priority request to talk
- 5 Request to talk
- 6 Time and date
- 7 Real-time data connectivity indicator
- 8 Wi-Fi connectivity indicator
- 9 Wheelchair deployment indicator
- 10 Head/Destination sign status indicator
- 11 GPS Status indicator
- 12 APC status indicator
- 13 Odometer status indicator

7.4.4.3.2 Screen Behavior for Operator Safety

Many transit agencies require a safety feature to prevent operator interaction with the MDT while driving the bus. To support this, IVN® has an operator safety features through MDT behavior. IVN® can be configured to disable all MDT keys and display the map screen when the bus speed is over a configurable speed threshold. Once the bus stops, the screen returns to the default screen or fare screen for full access.

7.4.4.3.3 Logon

The logon screen provides the operator up to three fields to be entered. The first field is for the operator ID and the last two fields are for the work ID. The icons for each are configurable. There can be one or two work ID fields to represent your logon credentials and can be garage/run, route/block, run, or other. The logon screen will display only the required fields to support each logon scenario described in later sections. IVN® guides the operator through the process making it intuitive and easy to use.

To accommodate MTD, Clever Devices system solution provides a fully automated and simple vehicle operator logon with manual override to support abnormal situations. In the detailed scenario provided, the term “work” and “work ID” are used. Work can be anything MTD wants it to be for operator entry and display. The work ID has a one to one correlation to a scheduled run or block based on MTD business rules. The operator logon functionality proposed for MTD includes:

- Automated logon using the operator ID and the work ID, as entered via the MDT
- Manual logon using the operator ID, work ID and route ID, which allows operation of unscheduled trips and routes

In support of a secure environment, IVN® provides three levels of logon security:

- Operator logon: Those listed above
- Maintenance logon See section 7.4.4.3.22 on page 257
- Diagnostics and Maintenance See section 7.4.4.3.22 on page 257

The following logon rules apply to the MDT behavior:

- Must logon to access the screen
- The operator/home screen is displayed after logon
- May be configured to alert operator with a beep tone until logon occurs

The following sections provide a description of each operator logon process. The term “work” and “work ID” are used frequently. These represent the operator work as managed by MTD and can be associated to the run (operator work) or block (bus work).

7.4.4.3.3.1 Automated Logon using only the Operator ID and Work ID

In this scenario the operator enters their operator ID via the MDT and then their work ID. Once entered, IVN® validates the work ID exists in the current schedule and starts the work. When validation is complete, the farebox and any optionally integrated systems will be initialized. IVN® provides full automation for the remainder of the day. This means that the farebox will be automatically initialized at the start of each trip and all optionally integrated systems will be initialized based on the configuration of the system to MTD business rules. The optional systems include BSA, AVM® and the head/destination sign.

If the CAD option is selected, IVN® will retry forever to send a logon request which includes the operator ID and work ID to CleverCAD®. Once received, CleverCAD® validates the logon based on the interface to Trapeze OPS and compares to the current fleet status to ensure no duplicate work is being conducted. Once validated, CleverCAD® will acknowledge to the bus that logon is good. In the event of an anomaly, the dispatcher can always override the system.

7.4.4.3.3.2 Manual Logon

With all systems, there is always a manual logon process. Although a few more steps are required, to minimize use, manual logon is used to assign unscheduled work or to run special services. In this scenario, the operator enters their operator ID, work ID, and route ID. Once their credentials have been entered and validated locally on IVN®, the Rt:Var (route variation) selection screen is displayed as shown to the right. The operator can view and scroll through the different variations for the route and select the appropriate one. Once selected, the default screen is displayed and the operator may begin to complete their new work.

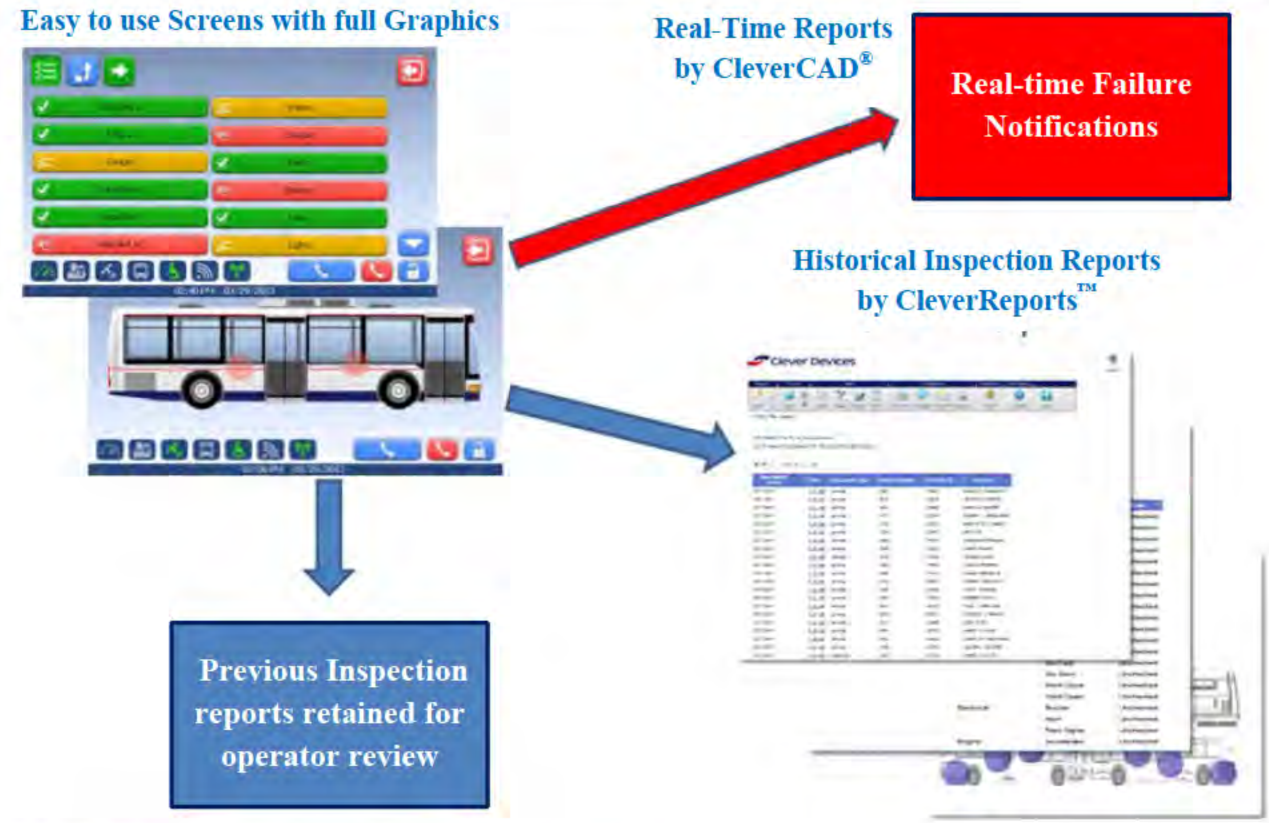
Figure 80: Route Variation Selection

7.4.4.3.3.3 Pre & Post Trip Inspection (Not included)

[redacted]

[redacted]

[redacted]



7.4.4.3.3.4 Additional Logon/Logoff Features

- CleverCAD® manages all vehicles installed with IVN® and monitors all other vehicles configured appropriately.
- In the event communications are lost between IVN® and CleverCAD®, the Operator can logon using manual mode and begin work. When communications are re-established, IVN® sends the logon credentials to CleverCAD® for validation.
- If the vehicle loses power and causes the on-board IVN® to reset, IVN® automatically initializes on system restart by sending the logon credentials to CleverCAD® for validation. The restart must be within a configurable amount of time after the unsolicited power down.
- The dispatcher can issue a remote logon with Operator ID and Work ID to a vehicle. This is sometimes necessary in the situation where an operator either forgot to logon or accidently pressed logoff without noticing.
- The dispatcher can issue a remote logoff to vehicles for situations where the driver used the wrong logon credentials, logged on with the incorrect work assignment, or inadvertently departed the vehicle without logging off.
- If a vehicle reaches the last timepoint of its assigned block, the work is automatically logged off, after a configurable time period.
- If a vehicle is off route and does not reach its last timepoint within a configurable amount of time, the work is automatically logged off.
- If a vehicle is in a depot and initiates shutdown, the work is automatically logged off.

7.4.4.3.3.5 *Secure Bus Access (Not included)*

[redacted]

[redacted]

[redacted]

7.4.4.3.4 *Single Point Logon*

Upon successful logon all interfaced systems are automatically initialized and fully automated requiring no operator interaction the remainder of the day. IVN®'s expert algorithms take into account the schedule data and the current operating environment to ensure the fare system (if applicable), APC, BSA, and head/destination sign systems are updated in a timely manner to reflect what is being done. This level of automation off-loads operator interaction with the system so focus can be placed on driving the vehicle and the safety of the riders.

7.4.4.3.4.1 *Ticketing/Fare System Interface*

IVN® interfaces with the ticketing/fare system to support the following functions:

- Time synchronization
- Logon (route, trip, block/run)
- Power on notification
- Faults from the fare system
- GPS data to the fare system

Clever Devices has integrated to different fare systems and has provided customized solutions to support:

- Faresets based on geofence area or by route
- Use of the MDT to support all fare system interaction and to eliminate the fare system operator interface

Because IVN® has the entire schedule data (runs, blocks, trips, timepoints, time), routes and stops stored on-board, it automates the fare system initialization as well as the typical operating changes during the course of the day. This solution minimizes operator interaction with the fare system as the operator simply needs to logon once per day and the system is fully automated. Of course, manual override is always available to address anomaly conditions.

A typical farebox externalizes the following faults as defined by the SAE J1587 interface specification which are captured by IVN®.

0 = Voltage dropout
1 = Voltage restored
2 = Probe started
3 = Probe completed
4 = Cashbox removed
5 = Cashbox restored
6 = Cashbox door timeout
7 = Cashbox opened in service (see note)
8 = Insufficient fare accepted
9 = Coinbox 75% full
10 = Coinbox full
11= Currency box 75% full
12= Currency box less than 75% full
13= Currency box full
14= Card/pass box 75% full
15= Card/pass box less than 75% full
16= Card/pass box full
17= Coin de-jam operated
18= Farebox set in manual bypass
19= Farebox reset to automatic mode
20 =Pass/transfer jam
21= Pass/transfer jam cleared
22= Paper currency jam
23= Paper currency jam cleared
24 = Maintenance access—in service (see note)
25 = Maintenance access—out or service

Clever Devices has extensive experience with the interface to fare and ticketing systems. We fully understand the level of reliability and availability of the on-board system to ensure revenue can be collected at all times. Clever Devices' solution has fail safe scenarios to ensure that as long as the ticketing and fare system are available, fares can be collected.

7.4.4.3.4.2 APC Interface (Optional)

Clever Devices' has extensive experience with automatic passenger counting (APC) systems. We have deployed in large quantities: Clever Devices side, Clever Devices' overhead, IRIS, Dialax and UTA APC systems. Clever Devices interfaces with all these devices using the J1708 standard protocol or through Ethernet.

Because IVN® has the entire schedule data (runs, blocks, trips, timepoints, and time), routes and stops stored on-board, it has full and automatic control of the APC system from initialization through typical operating changes during the course of the day. While the operator is notified of the APC system status, there is no operator interaction required. This minimizes any impact to the APC system and continues to provide quality APC reporting through the UTA reporting software. IVN® collects the boarding and alighting counts and correlates them to the current status of the bus, schedule data, spatial data, head sign and many other data points. The collected data is transmitted to the fixed end via WLAN, ingested into a database and available for reporting.

The APC counts are also made available to CleverCAD® to present load or percent load to the dispatchers.

7.4.4.3.4.3 Head/Destination Sign Interface (Optional)

IVN® interfaces with the existing head/destination signs on the MTD fixed-route vehicles to support single-point logon as well as automatic update of the sign for each new revenue or non-revenue trip. Because IVN® has the all head/destination data, entire schedule data (runs, blocks, trips, timepoints, and time), routes and stops stored on-board, it has full and automatic control of the head/destination sign system from initialization through typical operating changes during the course of the day.

Clever Devices' BusTools® data management tool allows the user to configure and define when the destination sign changes. Clever Devices' expert algorithms and configuration flexibility available to MTD are very sophisticated and take into account the current operational environment to ensure the head/destination sign system is always displaying the correct information. IVN® has a configurable override feature that allows the operator to manually control the head/destination sign if required. IVN® also provides control to the operator to display a specified message in the event of an emergency alarm.

As routes and stops change, so does the message displayed on the head/destination sign systems. The proposed data management system, BusTools®, supports obtaining the data required on-board the vehicle to support the interface to the destination sign, provided the destination signs on the County fleet meet the following requirements:

- The head/destination sign system for each vehicle has a single physical port to interface with the IVN® for control during normal operation.
- Access to data from the associated head/destination sign manufacturer's data support tool for import and correlation to routes with BusTools®.

During the design phase of this project, Clever Devices will verify the actual configuration of the existing installed head/destination signs on the MTD fleet, their interface protocols, model and software version, and provide an assessment report on their capabilities.

7.4.4.3.4.4 BSA System (Optional)

IVN® is the bus stop announcements (BSA) system. This integrated feature is fully described in section 7.3.7 on page 161. When logon is complete, the BSA system is fully automated triggering audio and visual messages on the interior and exterior of the bus. Because IVN® has the all head/destination data, entire schedule data (runs, blocks, trips, timepoints, and time), routes and stops stored on-board, it has full and automatic control of the BSA system from initialization through typical operating changes during the course of the day.   There is no required operator interaction beyond logon to support the BSA system. Of course the operator has control to repeat announcements and trigger public service announcements.

7.4.4.3.5 Default Screen

Upon successful operator logon, the default information screen is displayed as seen in Figure 81.

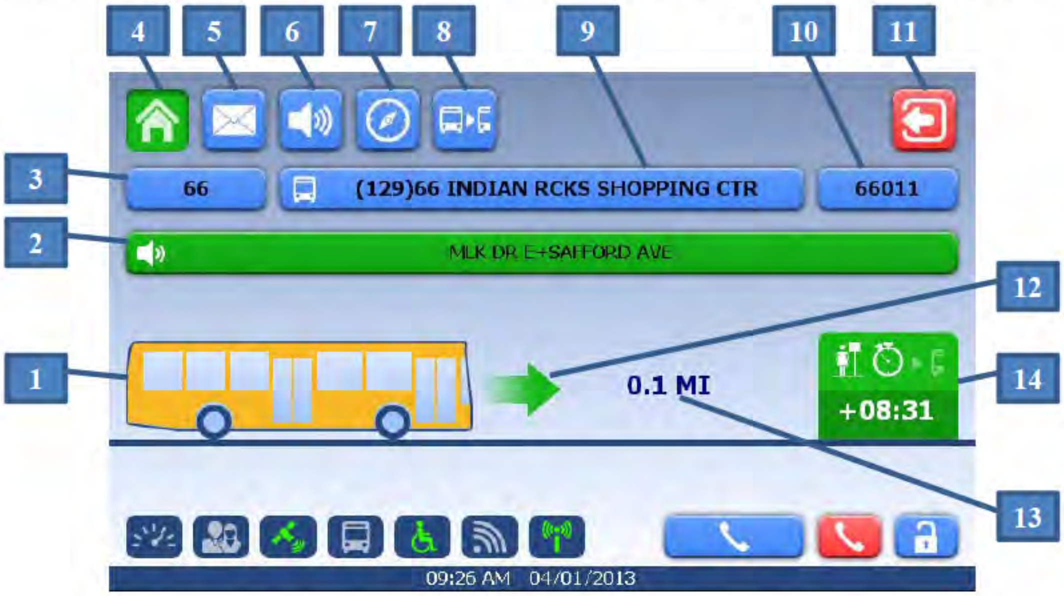


Figure 81: MDT Default Screen

1	Route & schedule adherence are by bus color green=good, yellow=late, red=early, Gray =off route	8	Touch for transfer connection protection
2	Touch to repeat audio-displays stop text	9	Touch to access head sign screen
3	Touch for route details-displays route text	10	Touch to access paddle for work ID
4	Green indicates operator screen is active	11	Logoff
5	Touch to go to text messaging screen	12	Vehicle movement indicator
6	Touch for PSA and volume screen	13	Distance to next point (see 14)
7	Touch to go to map screen	14	Next point indicator (stop, TP, TCP, Garage) and schedule adherence

7.4.4.3.6 Map Screen (Not included)

[redacted]

[redacted]

[redacted]

[redacted]

1	[redacted]	8	[redacted]
2	[redacted]	9	[redacted]
3	[redacted]	10	[redacted]
4	[redacted]	11	[redacted]
5	[redacted]	12	[redacted]
6	[redacted]	13	[redacted]
7	[redacted]	14	[redacted]
		15	[redacted]

[redacted] [redacted]

7.4.4.3.7 Route and Paddle Screens

It is important for the operator to be able to review their work for the day. The paddle and route screens are provided for this purpose. Because IVN® has the entire schedule data (runs, blocks, trips, timepoints, and time), routes and stops stored on-board, it can provide the operator with a list of all stops and timepoints within a route, as well as, a list of all the trips for this operator. This eliminates the need for the operator to carry paper paddles with them at all times.

The paddle screen displays all the trips associated with the logon credentials, the associated routes and the trip start/departure time. The current trip is identified and the operator can select the current trip or any trip to review the stops and timepoints as described above.

Figure 83: Paddle Trip Screen

The route screen displays all the stops and timepoints for the current route with the ability to toggle between timepoints only or both. All timepoints have their scheduled time displayed on the screen.

Figure 84: Route Screen with Timepoints

7.4.4.3.8 Route and Schedule Adherence

It is important for the operator and system to understand whether the route and schedule are being adhered too. Schedule and route adherence are shown in the middle left of the screen by the color of the bus. When the bus is on-route the bus color is yellow when the bus is late, green when the bus is on-time and red when the bus is early. When the bus is off-route the bus color is gray. The thresholds for on-time, early and late are configurable through the BusTools® data management tool.

The middle of the screen shows the distance to the next point (stop or timepoint) in miles or kilometers. The right part of the screen has a green box with three icons on top and the schedule deviation on the bottom. The left icon (person and bus stop sign) represents a bus stop and is bright when the next point is a bus stop. The middle icon (clock) represents a timepoint and is bright when the next point is a timepoint. The right most icon brightens when approaching a transfer connection point.

Figure 85: Route and Schedule Adherence

Figure 85 shows the bus as late by 8 minutes and 31 seconds and is 0.1 mile from the next stop/timepoint.

7.4.4.3.9 Vehicle Registration

Upon power up, IVN® immediately establishes data communication with the data communications controller (DCC). The registration process includes version validation and time synchronization.

7.4.4.3.10 Time Synchronization

This feature is available independent of the CAD option.

Upon power up, IVN® synchronizes time with the DCC (Data Communications Controller). The DCC is in constant time synchronization with a time server. Clever Devices ensures that the fleet is synchronized. The goal is to be within 2 seconds of the server at all times.

7.4.4.3.11 CAD (Optional)

IVN® provides all computer aided dispatch (CAD) functionality on the bus through communication to CleverCAD® over the real-data communication network. Details on the real-time data communication network are available in section 7.4.4.3.20 on page 255.

The following sections provide details on the CAD functionality provided by IVN® for operator interaction with the AIM system. The associated fixed end functionality is provided by CleverCAD® and is documented in section 7.3.10 on page 189.

7.4.4.3.11.1 RTT/PRTT & Voice Call

With most transit agencies radio bandwidth between dispatch and the fleet is a premium. Radio bandwidth is conserved by the use text messages. The efficient use of the voice bandwidth is controlled by preventing the operator from picking up the handset and talking. The operator must send a request to talk data message to the dispatcher by pressing the RTT key on the MDT as shown in Figure 79 on page 231. Once received, the dispatcher will establish a voice call to the operator using CleverCAD®. IVN® provides two keys – RTT & PRTT – available on all screens.

RTT – request to talk. When operator presses this key a message is sent to CleverCAD® to notify the dispatcher that the operator needs to talk

PRTT – priority request to talk. When operator presses this key a high priority message is sent to CleverCAD® to notify the dispatcher that the operator needs to talk. This message is viewed as a higher priority event in CleverCAD® to get the attention of the dispatcher.

When the dispatcher establishes a voice call to the vehicle, a pop-up is displayed showing the current volume on the driver speaker and the remaining time available for the voice call as shown in Figure 86.

Figure 86: IVN® Voice Call

If for some reason the operator is unable to answer the voice call, IVN® will record a text message indicating a missed call, the time and who the call was from. The user simply presses the InBox key (Figure 86 1) and the user can see the missed voice call message.

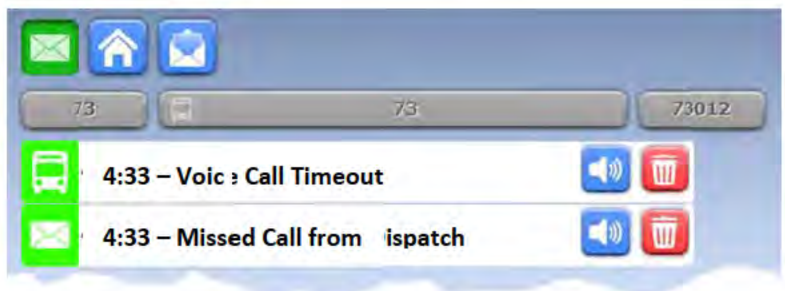


Figure 87: IVN® Missed Call

7.4.4.3.1.2 *IVN® Support for Text Messages from Dispatch*

All received text messages are accessible to the operator by touching the messaging key. The operator is immediately brought to the InBox screen as shown in Figure 88. IVN® has an optional text to speech (TTS) engine to audibly playback the text message. The user can delete a message by pressing the red icon with a trash can. The green box icon indicates a standard text message while the tan box with a squiggly line represents a detour. The scroll up and down functionality is shown when applicable and is visible in the bottom right corner of the screen.

Figure 88: InBox Screen

IVN® can support hundreds of text messages received from dispatch. All types of text messages are viewed in the Inbox including dispatcher generated canned, ad-hoc and those requiring a response, as well as IVN® generated event messages. IVN® will prompt the operator visually and audibly when a text message from dispatch that requires a response is received, no matter what screen is currently active. In Figure 89 the dispatcher is requesting a Yes or No response. The operator simply presses the green check mark or the Blue X.

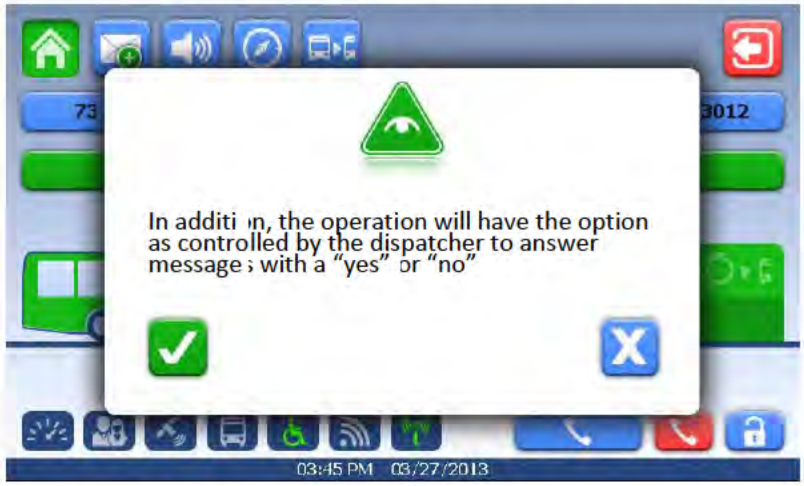


Figure 89: InBox Text Message Response Required

7.4.4.3.1.1.3 IVN® support for Text Messages to Dispatch

To minimize voice communications, Clever Devices' system solution supports the use of canned or pre-defined text messages for the dispatcher to send to the operator and for the operator to send to dispatch.

All canned text messages are centrally managed (create, modify, delete, enable/disable) by Clever Devices' BusTools® data management tool, which allows the definition of 100's of canned text messages. Although not expected to have this many, the system is capable of supporting this many. To handle this many canned messages, Clever Devices provides a two level hierarchy of text messages. The first level is a group and the second level is a list of text messages for that group. This provides organization and quick access to all the text messages you define.

Once defined and distributed to the fleet, canned text messages are available through the OutBox screen.

To access the OutBox screen, as shown in Figure 90 the operator presses the messaging key  and then the OutBox key . The OutBox screen displays all the groups. The operator then selects the appropriate group to get a list of the text messages assigned to that group.

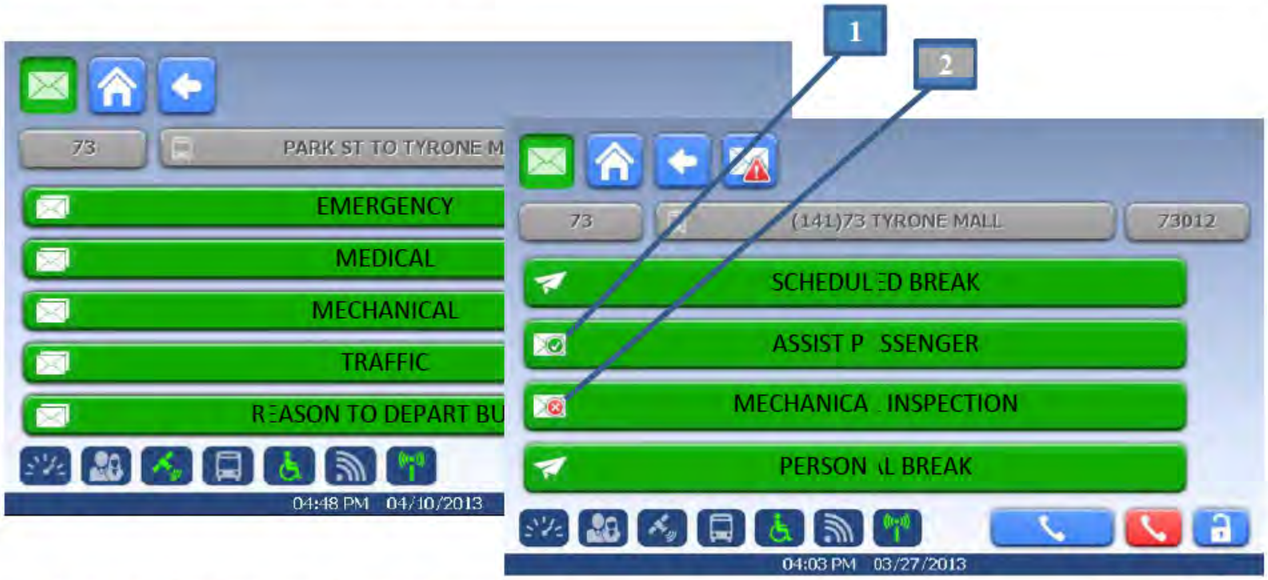


Figure 90: OutBox Screen Showing Groups

Figure 91: OutBox Screen Showing Canned Messages

1 Indicates text messages status of successfully sent

2 Indicates text message status of unsuccessfully sent. This icon  indicates a text message was automatically created in the InBox to reflect the canned message failed to be delivered.

7.4.4.3.1.4 Transfer Connection Protection (TCP) (Not included)

[redacted]

7.4.4.3.1 .5 Emergency Alarm and Cover Monitoring

As a safety feature, the operator can covertly notify dispatch that there is an emergency situation by pressing the emergency alarm (EA) switch. In this scenario the operator is assumed in a dangerous situation and must be able to press the EA switch without notifying the offender and must receive subtle indicators that the situation is being closely monitored by dispatch.

When pressed the following occurs:

- Dispatch is immediately notified
- IVN® disables receiving any voice or text messages that would require operator interaction

During the process of handling the emergency situation, the operator is given subtle indications of the EA status along the way. The MDT time and date separators, at the bottom of the screen, change to reflect the different status.

Figure 94 shows how the subtle indicators are shown. The left most timestamp is normal and is displayed under all normal conditions. Once the operator presses the EA switch, the colon in the time changes to a period as illustrated in the middle timestamp (09.49). This notifies the operator that CleverCAD® has received the EA event. When the dispatcher initiates covert monitoring by enabling the covert microphone, the slash in the date changes to a dash as illustrated in the right most timestamp (04-03-13). This notifies the operator that the situation is being actively monitored by a dispatcher. These subtle indications inform the operator of the status of their emergency alarm while not providing riders or offenders any indication that they are being monitored.

09:49 AM 04/03/2013	09.49 AM 04/03/2013	09:49 AM 04-03-2013

Figure 94: EA Subtle Indicators

Clever Devices understands that the EA event is mission critical and delivery of the EA message to dispatch is of the highest priority and must be delivered successfully. Therefore, Clever Devices' system solution includes additional system status alarms, such as "loss of communications" between CleverCAD® and IVN®. These alarms are events that can be configured by MTD for priority and can also be configured for automatic incident creation. This ensures dispatch is fully aware of the current situation on the fleet.

In emergency situations, the dispatcher can enable the on-board covert microphone through CleverCAD®. This will allow the dispatcher and emergency personnel access to audio from the inside of the bus. This allows the dispatcher to determine if the emergency situation is real and how to dispatcher police or other emergency personnel to help with the situation. If an on-board camera system is available, the dispatcher can also access the on-board camera system to see what is going on inside the bus.

7.4.4.3.11.6 IVN® Support for Dispatch Initiated Public Service Announcements to the Bus

IVN® supports the dispatcher making audible announcements to riders on the bus. This can be done by the dispatcher establishing a voice call to the inside speakers.

Additionally the dispatcher can send a public service text message for IVN® to display on the interior sign of the bus and convert to audio via IVN®'s text to speech (TTS) feature and played over the inside speakers. The TTS is an optional feature that is provided only upon request.

7.4.4.3.11.7 IVN® Support for Dispatch Initiated Text Announcements to the Interior Sign

IVN® supports the ability to receive canned and ad-hoc text messages from the dispatcher to be displayed on the inside sign of the bus. These messages are limited length messages. Upon receipt IVN® will manage and display them on the interior sign using the text message queue technique as described in section 7.3.7.3 on page 165 for details on how IVN® handles multiple text messages.

7.4.4.3.11.8 Excessive Speeding (Not included)

[redacted].

7.4.4.3.12 BSA (Optional)

The BSA functionality is fully described in section 7.3.7 on page 161.

7.4.4.3.13 AVM® Data Collection & Equipment Interfaces (Optional)

IVN® has the most sophisticated vehicle health monitoring system available. IVN® supports the collection of 1000's of faults and performance data points. This data is stored on IVN® and transferred to the fixed end AVM® business intelligence system for reporting. To achieve this level of integration IVN® interfaces and integrates with all other systems and equipment on-board the vehicle. Clever Devices maintains relationships with several technology providers to enrich our AVM® solution. Our relationships and ability to integrate AVM® to a variety of supporting systems include:

- Automatic Vehicle Monitoring (AVM) standard of f-the-shelf system includes interfaces to the following bus subsystems
  - ✓ Cummins Engine
  - ✓ Detroit Diesel Engine
  - ✓ Caterpillar Engine
  - ✓ John Deere Engine
  - ✓ Navistar Engine
  - ✓ I/O Controls Multiplex
  - ✓ Vansco Multiplex
  - ✓ Allen Bradley Multiplex
  - ✓ Siemens Multiplex
  - ✓ Volvo Multiplex
  - ✓ Actia Multiplex
  - ✓ EMP Cooling Fans
  - ✓ Hubner Articulated Joint
  - ✓ Meritor Wabco ABS
  - ✓ SmarTire Tire Pressure Monitoring
  - ✓ ZF Friedrichshafen AG Transmission
  - ✓ Allison Transmission
  - ✓ Voith Transmission
  - ✓ Geoguidance Break Monitoring
  - ✓ Thermo King Air Conditioner
  - ✓ MGB Brake Monitoring E-Stroke
  - ✓ Vanner Battery Equalizer
  - ✓ Tacholink Event Data Recorder
  - ✓ Proheat Supplemental Heater
  - ✓ Webasto Supplemental Heater
  - ✓ ESW Diesel Particulate Filter

    And Many More

- Clever Devices is promoting the concept of managed surveillance systems for transit and has been selected to validate transit camera systems capability to integrate to and provide fault messages over, the SAE J1708 and SAE J 1939 networks so agencies can ensure their surveillance is working prior to pullout. Data is also supplied to the DVR for time/clock synchronization, location tagging, driver, route, run, trip correlation. We currently support integration with the following camera/DVR systems:
  - ✓ GE/UTC MobileView II, III, Quatro
  - ✓ Apollo
  - ✓ March Networks
  - ✓ Safety Vision
  - ✓ Dedicated Micros

7.4.4.3.14 Hard Braking Data Collection (Not included)

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7.4.4.3.16 *Performance Data and APC Data Collection*

IVN® records all on-board events in the BusState logfile. This data is transmitted to the BusLink® server when the vehicle comes in WiFi range. This data is used extensively by CleverReports™ business intelligence reporting solution. There are over 70 events and with each event there are over 62 data fields recorded, as shown in Table 10.

Table 10: BusState Performance Data Fields

BusState On-Board Performance and APC Data Capture Points				
Data Version	Front Pass Off	Latitude	Pattern ID	Wheel Chair
Route ID	Rear Pass Off	Longitude	TA Schedule	Route Direction
Stop Sequence	Odometer (Feet)	Heading	Work ID Status	Demographics
Bus ID	Route status	Navigation State	Trip ID	APC Type
Destination Sign Code	Operator ID	Record Event Type	Trip Type	Schedule Mode
Dest sign type	Run ID	APC Blocked	Departure Time	IVN® App Ver
Event TimeStamp	Stop dwell time	Passenger Load	TimePoint ID	Trip Start Time
Event TimeStamp	Schedule Deviation	WorkID1	TimePoint Type	GeoFenceID
Rear Pass On	Vehicle Speed	WorkID2	TimePoint Dwell	Text Msg
Front Pass On	MDT Route Text	Block ID	TimePoint Status	

Each record represents an event. Table 11 shows all events that are used to record data in the BusState file. As you can see there is a comprehensive set of events that are supported.

Table 11: Events that Trigger BusState data to be Collected

[redacted]

BusState Events that Trigger On-Board Performance and APC Data Collection				
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

7.4.4.3.17 Geofencing

Clever Devices supports multiple functions with geofencing. A geofence is a geographic area. Geofencing is the ability to define a geographic area and associate a specific action for IVN® to take when entering or exiting the geofence. The geofence data is defined in BusTools® and distributed to the fleet. Clever Devices' generic solution allows functionality to be added and new geofence types to be easily created. The following are the existing geofence types supported by IVN® and managed by BusTools® data management tool

Diesel Particulate Filter	To address an issue with the diesel particulate filters (DPF) on buses at NYCT (New York City Transit) Clever Devices developed a safety system to disable the DPF regeneration while in depots and other locations. IVN® is a critical component to control the regeneration process specifically so that the engine does not enter a high intensity burn near an overpass where passer-byes would be burned, while inside a depot where the heat could start a fire and other location. Ottawa uses a GeoFence safety solution that warns the driver prior to driving under a low bridge or obstacle.
Low Object Detection	This geofence is used to detect that a bus is approaching a low object. Originally implemented for double decker buses, this can be applied to any situation when the bus is approaching a low object. When the geofence is detected, IVN® sends an event to CleverCAD® and warns the operator to pull over to the side of the road and contact dispatch for instructions.
Depot Geofence	This geofence is used to outline the entire depot area. This is used to notify CleverCAD® that the bus has entered or exited the depot area. It also is used to notify CleverCAD® if the bus exits this geofence without a logon.

7.4.4.3.18 PerfectNav™ Navigation

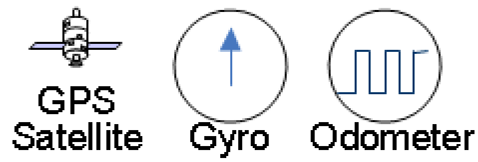
IVN® comes with the PerfectNav™ navigation system which incorporates an embedded GPS receiver, an embedded gyro, interfaces with odometer and reverse, map matching and other expert algorithms to provide the most accurate and reliable GPS location. The location is updated every second on-board the vehicle and used to calculate route and schedule adherence, trigger all passenger information, and is recorded in the BusState performance log with every event on the bus. The vehicle location from PerfectNav™ is transmitted to CleverCAD® with every message. The DCC also polls the vehicle every 30 seconds or as configured.

PerfectNav™ is a proven solution that is operational in over 10,000 vehicles in North America from cities as large as New York City to cities as small as Chattanooga, Tennessee. It is independent of any specific location, yet meets and exceeds every location's mobile vehicle location requirements.

To achieve the reliability and level of accuracy required for the urban environment, PerfectNav™ uses a two-tier technical approach to achieve optimum performance: sensors and expert algorithms.

7.4.4.3.18.1 Sensors

PerfectNav™ utilizes three sensors: Odometer, Gyro, and global positioning system (GPS). The odometer is by far the most reliable and precise sensor. However, it is only one dimensional, meaning it only provides distance traveled. The Gyro is two-dimensional but only provides change in heading. Thus you never get absolute heading from the Gyro, but rather, as an example, you get a 5 degree turn to the left. The GPS is a three-dimensional solution providing an absolute position, yet is fraught with error and is by far the most unreliable and inaccurate solution by itself.



Clever Devices' on-board system utilizes a GPS receiver that can simultaneously tracks 20 satellites and uses all available to calculate and statistically average the best solution possible. The GPS receiver transmits the latitude, longitude, speed, time, direction of travel and GPS position lock.

The three sensors described above are brought into a digital signal processor (DSP), which utilizes a Kalman filter to manage and reduce the errors of each individual sensor. The purpose of a Kalman filter is to estimate the state of the system solution from measurements which contain random errors. This means that the best characteristics of each sensor are used to reduce the errors in the other two sensors. The Kalman filter applied by PerfectNav™ is the first level software attack to provide a navigation solution. The output from the Kalman filter is the latitude, longitude, and heading. This data is very reliable and has proven to be accurate "99.5% of the time." However, accuracy can still be even further improved through Clever Devices' expert algorithms.

7.4.4.3.18.2 Expert Algorithms

After minimizing the error in the sensors and providing a reliable GPS location, additional tuning is accomplished with expert algorithms using map matching techniques and logic. Clever Devices has perfected these algorithms over years of experience to ensure the most reliable and accurate location system. PerfectNav™ encompasses five data algorithms. They are odometer self-calibration, map matching, waypoint processor, logical positioning system and GPS quality indicator. Also a significant benefit is that the GPS is powered 24x7.

7.4.4.3.18.3 Results

The resulting location accuracy and reliability of PerfectNav™ is within 3 meters 65% of the time and within 10 meters 99.5% of the time. Also, PerfectNav™ ensures a quality GPS location when in tunnels, buildings and where heavy multi-path conditions exist.

The best way to explain accuracy and reliability of PerfectNav™ is to show real data in one of the worst urban canyon environments in the world: New York City. The data has not been edited in any way and represents actual performance of Clever Devices' PerfectNav™ solution in New York City. Although there are unique conditions in every city, including long tunnels causing extensive GPS outages, New York City's urban canyons combined with GPS outages make for a significant challenge.

The blue lines outline the route the bus traveled across midtown Manhattan, NY. Figure 95 shows how inaccurate the raw GPS can be in an urban environment. Although Manhattan, NY is probably the worst environment for multiplath in the US, it is the ideal place to test and qualify any GPS receiver and navigation solution. **If it works here, it can work anywhere.** The red dots indicate raw data from the GPS receiver. As can be seen, the raw gps can be off as much as 2000 ft and jumps erratically.

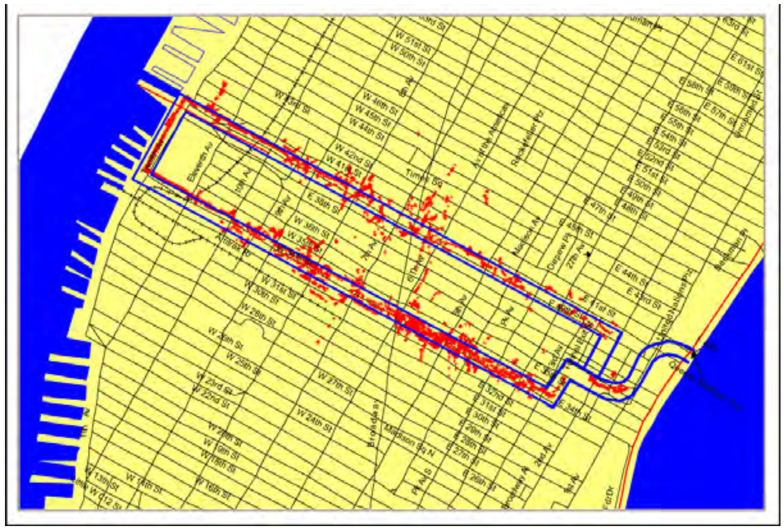


Figure 95: Raw GPS Data

Figure 96 shows the results of Clever Devices' PerfectNav™ navigation solution for the same trip as shown above. The PerfectNav™ output is shown in green. As shown here, the PerfectNav™ solution is reliable continuous and within the specified accuracy.

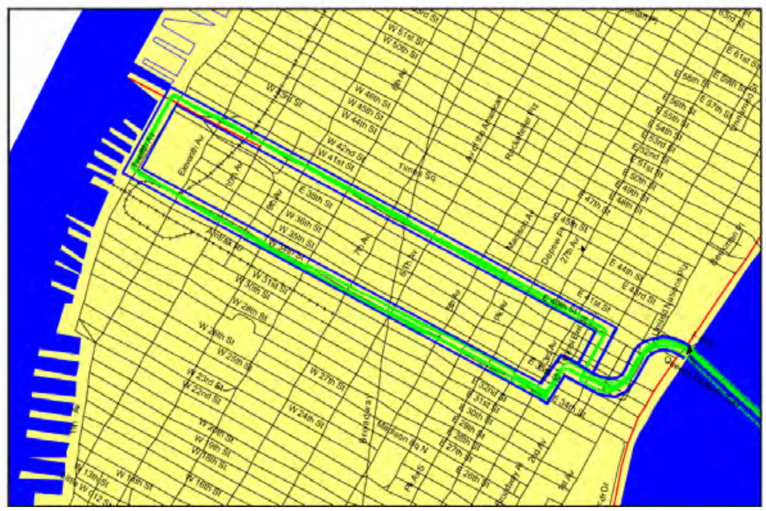


Figure 96: PerfectNav® Output

The final diagram shows that PerfectNav™ works while driving through a tunnel and raw GPS does not. As before, GPS raw data is shown in red, and PerfectNav™ output is shown in green.

Figure 97: PerfectNav® Works in a Tunnel

7.4.4.3.19 WLAN Data Communication for Bulk Data Transfers

IVN® includes an embedded WLAN adapter to support 802.11 a/b/g/n wireless LAN communications to the depot/garage systems. When IVN® detects a heartbeat from any BusLink® server, it goes through a secure registration to establish a connection. It then transfers any performance data and logfiles off the bus and downloads any software or updates to be applied. The system is fully automatic and requires no operator interaction. IVN® logs all transmissions for diagnostic purposes.

7.4.4.3.20 Real Time Data Communication

IVN® communicates to the fixed end DCC in real-time over a cellular data network. IVN® and DCC use a highly compact and efficient protocol for all real time data communications called OTA protocol. The DCC handles all critical timing, translates the data to transit specific information, and interfaces with the enterprise systems such as CleverCAD® and BusTime® and as shown in Figure 98.

Clever Devices employs a combination of polled AVL data and random access incident and alarm messaging. This data protocol structure provides for efficient and timely AVL data reporting at fixed intervals from each vehicle while allowing for immediate transmission of incident and alarm messages to the dispatchers. Vehicle polling rates for AVL data are typically 30-seconds and are configurable. The Clever Devices data messaging protocol also provides for application level acknowledgements and retry of incident and alarm messages to insure reliable delivery.

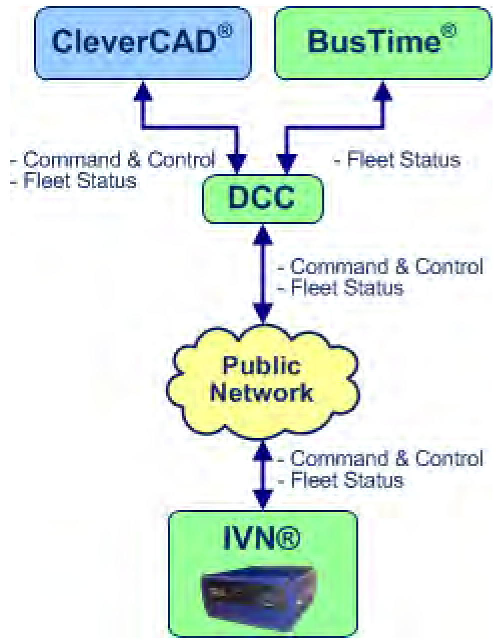


Figure 98: Real-Time Data Communications

AVL reports from vehicles with no logon still continue to be received and processed by CleverCAD® as will alarms and operator initiated messages. In this scenario route and schedule adherence events and other messages that are dependent upon a valid work logon will not be generated by the system.

Real-time data communications to and from the fleet minimally includes:

CleverCAD® to IVN®	IVN® to CleverCAD®
• Trigger PS messages	• Registration & power status
• Dispatcher initiated public service announcement	• Version information
• Covert monitoring	• Route and schedule adherence
• Logon (remote logon)	• Emergency alarm notification
• Timesync	• Trip start
• Poll request for AVL	• Timepoint/station
• Text messaging	• Poll Response for AVL
• VoiceCall	• Text Messaging
• Schedule adherence	• VoiceCall request (RTT/PRTT)
• Route adherence	• AVM® faults

The (OTA) protocol is the communication link between the bus and the DCC on the fixed end. The OTA is a highly condensed and efficient data protocol designed specifically for transit and follows the open systems interconnection (OSI) model that characterizes and standardizes the internal functions of a communication system by partitioning it into abstraction layers, as shown in the following diagram.

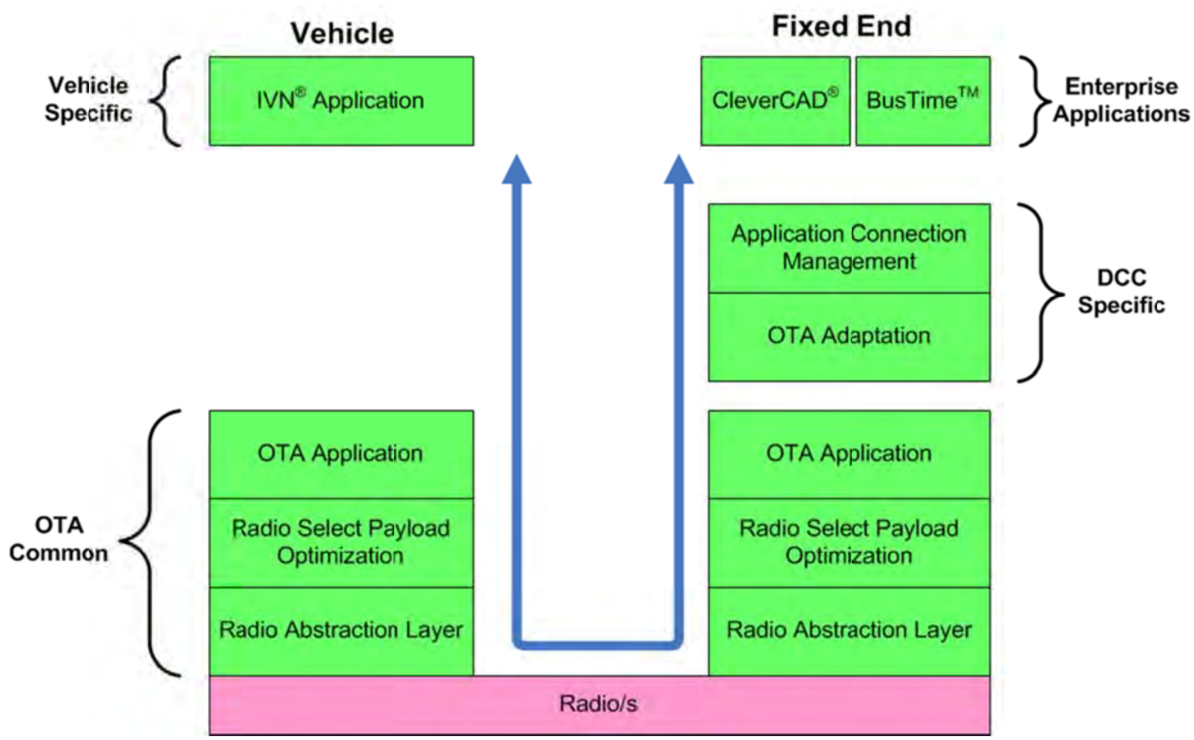


Figure 99: OTA Protocol - OSI Model

7.4.4.3.2 Voice Radio Communication (CAD Option)

Clever Devices supports integration of a private radio system or the use of VoIP over a digital IP based data communications solution. The use of the MotoTURBO voice radio is described here.

7.4.4.3.2.1 Private Radio Control

Clever Devices has extensive experience interfacing with and controlling private voice radio systems including conventional and trunked systems. IVN® interfaces with the on-board voice radio. As each private radio system and on-board radio has unique characteristics, IVN® has sufficient IO, communications interfaces and functionality to support any private radio. The interface can be from simply controlling the PTT input so that the radio is only available after a voice call is established from dispatch to a fully integrated solution that includes channel or talkgroup selection through a radio proprietary interface.

In all system solutions, Clever Devices' includes a fallback mode to ensure voice communications is available for all failure scenarios such as unexpected loss of data communications, loss of DCC, and loss of CleverCAD® or administrator authorized fallback. In fallback mode full voice radio communications is available. This means the operator will be able to contact dispatch simply by lifting the provided handset, pressing PTT and talking. Dispatch can contact the vehicle by simply calling the operator on the appropriate channel or talkgroup via the voice console.

7.4.4.3.22 Diagnostics & Maintenance

IVN® provides MDT screens for maintenance personnel to help diagnose system problems. This is accessible through a unique operator ID and password and is only made available to those personnel trained to maintain the system. Each screen is unique to address maintenance activity for the associated equipment. As more equipment is monitored by IVN®, more screens are created. Clever Devices philosophy is for IVN® to contain the intelligence to automate all functionality including failures. IVN® does report failures of all types through AVM® and provides manual diagnostic screens to verify faults and to help solve infrequent and hard to find problems. Some of the diagnostic screens are listed here:

- Destination Sign Screen
- APC Diagnostic Screen
- IVN® IO Sensor Screen
- J1708 Drivetrain Screen
- TSP Screen
- Public Address screen
- Camera System
- Multiplex
- GPS Screen
- J1939 Drivetrain Screen
- Engine
- Transmission
- Brakes
- Brake Wear Monitoring
- Battery Equalizer
- Supplemental Heater
- Odometer Calibration Screen
- Set BusID, BusType Screen

IVN® also provides a detailed diagnostic screen which is used for reviewing and modifying the on-board configuration. The diagnostic screens are available after logging into the maintenance screens and selecting the “Diag” screen. An additional and unique password is required. The diagnostic screens are only made available to Clever Devices personnel, as inadvertent changes can render the system inoperable.

7.4.4.3.23 Turn Warning System (Not included)

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

7.4.4.3.24 Traffic Signal Priority (Not included)

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

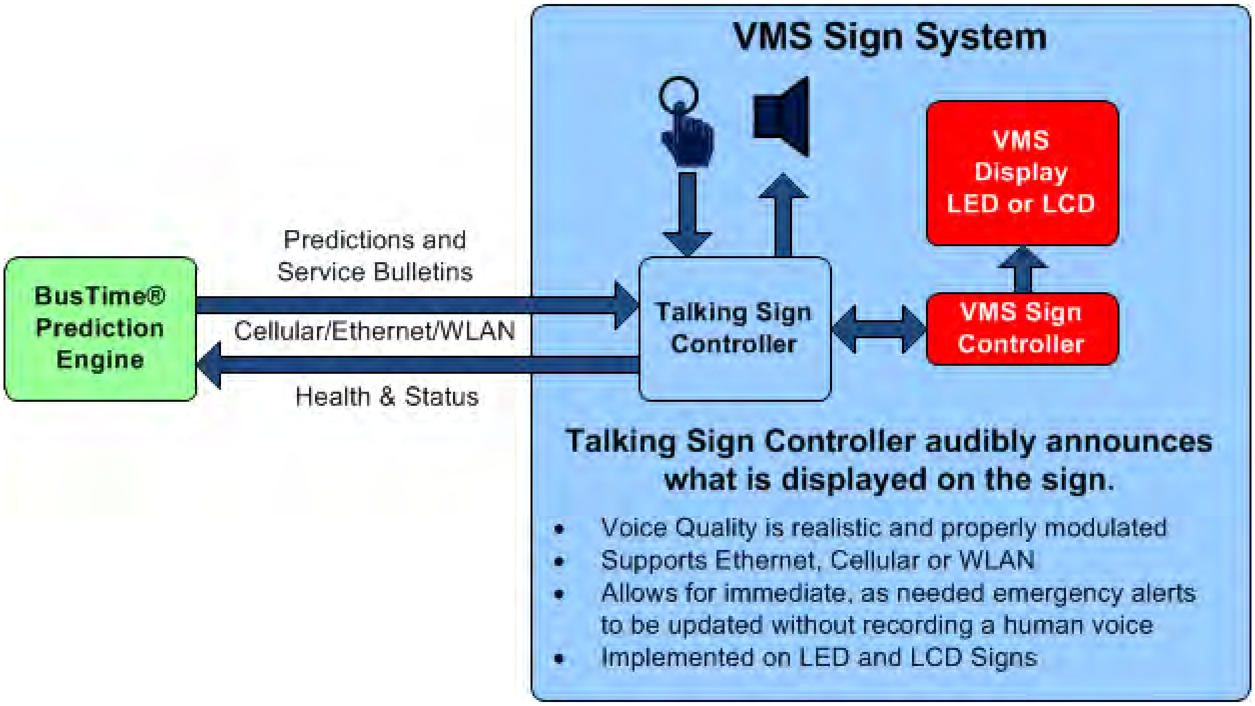
7.4.5 Electronic Display Signs

This section describes the features of Clever Devices' proposed signage solution, as well as the specific sign configurations.

7.4.5.1 Audio Announcements

The electronic display signs include a manually-activated audio announcement system, which will read out the sign text in multiple languages if desired successively after a pushbutton has been pressed. Clever Devices will be using state of the art text-to-speech technology. Our sign BusTime® controller in the sign "reads" and announces what is displayed on the sign. The voice quality is realistic and properly modulated. The volume is automatically configured through the BusTime® Administrator Console. Once configured, the signs will automatically adjust to the ambient noise level. Our text-to-speech (TTS) engine supports 17 languages through 60 unique voices and allows for immediate, as needed emergency alerts to be updated without recording a human voice.

The pushbutton itself will be conveniently located and easy to use. It will be mounted no higher than 48 inches and no lower than 15 inches from the finished floor of the station. The pushbutton can be activated by a simple press of a finger and requires less than 22 newtons of force. This pushbutton will be easily accessible and there will be enough space surrounding the sign for a person in a wheelchair to reach the pushbutton. Optionally, to assist the visually impaired in locating the pushbutton, the wayside sign can also be fitted to emit a brief low volume chirp every few seconds.



7.4.5.2 Electronic Display Sign Enclosures

All signs are easy to service, should maintenance become necessary. The display housing has safe and convenient front service access for all modular assemblies, components, wiring, and other materials. Access involves unlocking and opening the vandal resistant locking mechanism. All internal components are removable and replaceable by a single technician with basic hand tools. The display module does not have to be removed to access the internal components of the display, as the display module is conveniently hinged to the rest of the unit. A local computer equipped with diagnostics/control software can be used to communicate with the sign's controller through a serial connection port.

7.4.5.3 Electronic Display Sign Controller

The electronic display signs will display important settings information when they are powered on. Initially, when each sign is turned on, the firmware version number is displayed, followed by the communication port configuration information. The sign then displays the confirmation that there are no faulty LED's (if there are any malfunctioning LED's, this number will be shown). Finally, the time is displayed along with the date, month, and year from the internal clock and calendar which will be synchronized to MTD's local time. Even though the sign controller receives updated date and time data from BusTime®'s central software, the clock can maintain the accurate time independently for well over 14 days without an external power source.

If a power failure occurs, the sign reconnects to the BusTime® server and is able to display updated messages within roughly 30 - 90 seconds after power is restored. In the case of a communications link failure, the sign can store static schedule and a canned message until the communication link is re-established. This ensures that stale information is not displayed and that riders continue to see relevant information displayed.

The electronic display signs will provide all relevant real-time arrival information for their respective stops. Along with the date and time, arrival prediction messages will be displayed. These messages are completely configurable and can be in any format MTD chooses. For example, the messages can display “route number, route/destination name, and countdown minutes.” These next vehicle arrival messages are generated by the sign controller and incorporate the real-time AVL data from BusTime®’s central software. If AVL vehicle data and associated predictions are not available for a specific vehicle, the sign can still autonomously count down the arrival predictions as time progresses even though it is not receiving further updates. Additionally, the sign can show the scheduled arrival time when AVL prediction data is not available, which is triggered after a configurable time period.

Clever Devices’ time of arrival system offers unmatched configurability for signs. For example, messages can be displayed in multiple sequential “pages” to vary the display, such as showing a next vehicle arrival message and a date/time message, each within a single row, while using an alternating sequence of two, one row message “pages.” Further, the hold time for each message and the blanking interval between messages is variable down to 0.1 second increments.

BusTime® can be set up to alert MTD authorized personnel through email when a fault in a sign is detected, so maintenance is prompt and efficient. The signs can also be accessed remotely by MTD personnel to perform firmware upgrades.

7.4.5.4 Data Communications for Electronic Display Signs

The proposed electronic display signs come with embedded Ethernet and can optionally be outfitted with Wi-Fi and/or embedded wireless cellular modem to support data communications to the BusTime® central system. Clever Devices will configure the signs to meet the MTD IT standards and desired communications technology. Each sign will have a unique ID in the form a static IP address.

The proposed signs can utilize National Transportation Communications for ITS Protocol (NTCIP) standards for communications to the BusTime® central system. Clever Devices has had many successful implementations using an enhanced protocol based on NTCIP that increases efficiency and functionality and can support a wide variety of vendor sign types.

In the event that a sign loses communication with the BusTime® central software, an alternate message can also be displayed to inform riders, such as “Prediction status currently not available”. This message is completely configurable and will be approved by MTD before use.

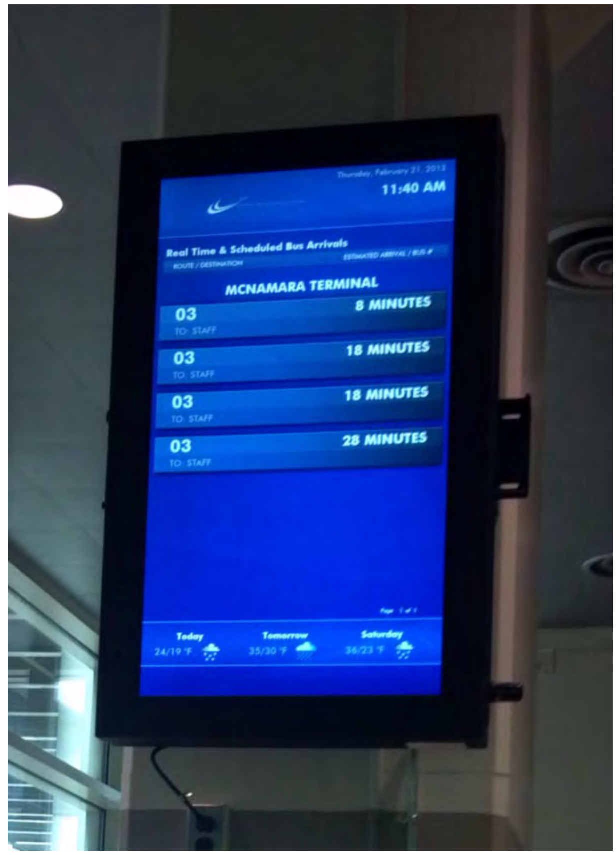
7.4.5.5 Installation/Integration

The installation location of each electronic display sign will be determined by MTD. Clever Devices will connect the signs to a local power supply within the Transit Center, mount the hardware and provide a power disconnect at a location that is near but not touching the sign enclosures. Although not included, Clever Devices can alternatively supply solar powered signs. Solar signs can be configured for on-demand or full/partial day work period and must have an appropriate sized solar kit to support the desired duty cycle.

7.4.5.6 Transit Center Interior Signs

During the pre-bid meeting Clever Devices was able to visit and assess the MTD Transit Center for mounting signs. Clever Devices has selected a 42” LCD sign for the interior of the transit center.

Clever Devices will provide digital signage hardware and software to provide client ridership with visual and auditory information. The digital signage software is capable of delivering not only the RTPI but also messaging, advertising or other information to ridership at wayside locations. Clever Devices will supply and install one 42” LCD display in the transit center above the counter in the main lobby.



<u>Additional Features:</u>

- Vandal resistant cover
- Tamper proof
- Corrosion resistant
- Galvanized treated steel heat sink on back
- Easy accessibility for maintenance
- Automatic adjustment for brightness
- Configurable visual display area
- Wireless and cellular communication capability
- Temperature sensors
- Sealed I/O
- ADA compliant
- Auto-dimming/brightness
- Capable of being pole mounted or directly fixed to structure
- Humidity 10-90% (non-condensing)
- Backlight lifetime >50,000 hours
- Aspect ratio 16:9, can be used for landscape/portrait

7.4.5.7 Transit Center Exterior Signs

During the pre-bid meeting Clever Devices was able to visit and assess the MTD Transit Center for mounting signs. Clever Devices has selected two double sided LED sign for the exterior of the transit center. The proposed sign is designed for the harshest of environments with a NEMA 4x cabinet and an estimated LED lifetime of over 100,000 hours. The sign is emits an amber color runs off of AC power and includes Ethernet and optional cellular and WLAN communications to BusTime®. This sign is equipped with Clever Devices’ talking sign controller to support audio and integration to BusTime®.

Clever Devices will also provide other types of digital signage hardware and software to provide client ridership with visual and auditory information. This signage is designed to show up-to-the minute schedules/destination information. Clever Devices will provide “2” Double Faced 48” signs on the outside walkway of the transit center and “5” Single Faced signs for the optional request.

Additional Features:

- Vandal resistant cover
- Tamper proof
- Corrosion resistant
- Easy accessibility for maintenance
- Automatic adjustment for brightness
- Configurable visual display area
- Wireless and cellular communication capability
- Temperature sensors
- Sealed I/O
- ADA compliant
- 64 Levels of Auto-dimming/brightness
- Capable of being pole mounted or directly fixed to structure or hang from any structure with custom brackets
- Humidity 10-90% (non-condensing)
- Estimated LED Lifetime >100,000 hours
- 8mm Center to Center 1600 pixels per sq ft

7.4.5.8 Remote Bus Stop Displays (Optional)

The proposed electronic display signs for the five non-Transit Center bus stops are identical to those proposed for the exterior of the Transit Center, which are described in section 7.4.5.7 on page 262. The only difference is that the remote bus stop signs are single sided and do not include installation. These signs will come with an internal modem for communications to BusTime® via a cellular network.

The proposed remote bus stop electronic display signs are powered with 120 VAC. Maximum power is 156 watts with full illumination of all LEDs at full intensity. Typical power consumption is significantly less than this. For remote locations or any location where AC power is not available, a solar panel power kit is available (not included in our price). Clever Devices will work with MTD to evaluate the location for each of these signs and recommend an appropriate and cost effective solution

7.4.6 Installation

General Requirements: Clever Devices will ensure that installation of all AIM equipment including necessary labor, mounting devices, wiring, fasteners, materials, supplies, and tools are performed in a workman-like and expeditious manner using industry standard practices and procedures.

Yard WLAN: Clever Devices will provide the detailed description of the installation plans for the yard wireless LAN to MTD for approval. Design drawings will show installation details of all the equipment, cables, conduits, power connections and associated work. Clever Devices will coordinate the schedule of installations at the yard with MTD, giving at least seven days notification prior to installations. The AIM yard subsystem will be installed in a manner to protect the equipment from vandalism and the elements, and provide reasonable access. Connectors that are exposed to the elements will be of the weather pack type.

Onboard Equipment: Clever Devices will provide a detailed description of the installation plans by class of vehicle. This will include the location of drilled holes and power feeds. Clever Devices will submit the installation plan for MTD's approvals no less than 30 days prior to the installation of the AIM equipment. Clever Devices will make available one prototype installation on each vehicle type for MTD to inspect and approve before any other installation work is performed.

Wiring: Clever Devices will provide wiring to the mobile data terminal externally as per the RFP section 5.3.1.2. Additionally, the power conditioning supply will be designed, reviewed and approved by MTD prior to vehicle installation.

Wiring for Clever Devices' equipment installed for this project on the vehicle will be designed, drawn, and reviewed with MTD prior to installation. We understand that the vehicle maintenance team and others have a critical interest in the wiring of the devices and therefore will work closely with your team to gain approval of all wiring before installation takes place.

Clever Devices agrees to the following requirements found in RFP section 5.4.3.1 – Wiring:

- All wiring in buses will properly ground and protect from chafing, and installed in the plenum (air handling) spaces, except as approved by MTD.
- Cabling will be appropriately rated for the plenum installation.
- No PVC jacketed cable will be utilized within the vehicles.
- Any undercarriage wiring will be suitably protected against the road elements and fastened in a manner so that it will not to sag or interfere with normal bus operation and/or maintenance.
- No "butt connectors" will be utilized under the bus.
- Exposed wire bundles inside the vehicle will be securely anchored and carried in loom, plastic sleeve, or tightly laced.
- All cable assemblies will be secured to minimize failure due to vibration and chafing.
- Grommets will be used in all holes used by contractor to minimize cable damage due to chafing. All wiring exposed within the passenger compartment of any bus will be armored, isolated, and protected when going through drilled holes, through bulkheads, and within brackets.
- Clever Devices will install or verify previously installed DC wiring to ensure integrity, fusing and current capacity for the installation.
- All DC wiring will be direct from the battery distribution block and shall include both A+ and A- cables.
- Both A+ and A- cables will be adequately fused at both the battery end and the AIM end with replaceable fuses.
- Signal and power cables will not be intermingled in cable runs.

Bus Availability and Installation Log: Clever Devices will perform all vehicle installations at the Olive Terminal. We find that on-site vehicles installations are the most convenient and cost-effective way to complete this work. We request that MTD provide at least three vehicles per installation per work day in order to meet the installation schedule. Our project manager will notify you if more buses need to be available during the weekends and at night in order to meet the schedule. Our project manager will work with your team to fully schedule the installations and document the schedule within the project plan. It is understood that your normal business hours are between 6 a.m. and 7 p.m. Monday through Friday, and that a MTD resource will be utilized to move the buses to the installation area.

Clever Devices asks that MTD conduct a pre-installation survey of each vehicle before release to us for installation. This will not take a long time and will ensure that the vehicles are returned with the new modules installed and in the same good condition it was in before our installation activities.

The Clever Devices installation will keep a complete log of vehicle installations throughout this project. The log will document the vehicles installed each day and other pertinent information that the project managers agree to during the design phase of the project.

<u>Equipment Modification and Removal</u>: Clever Devices agrees that we will provide any equipment that is required for installation of the AIM system. This includes handrails, power supplies, and mounting brackets. If any equipment is removed from the vehicle to complete the installation, we will label by vehicle number and box up in containers for storage by MTD unless directed otherwise by MTD. Clever Devices will use care in removing equipment in order to maintain the intrinsic value for later sale or disposal and will not damage the vehicle or other MTD property. Cables will be removed intact where possible and severed only when necessary.

7.4.7 Delivery

Clever Devices will notify MTD in writing at least one week in advance of each proposed delivery date of AIM equipment, materials, and supplies. They will be shipped to MTD FOB Santa Barbara in heavy duty boxes as specified in the RFP section 5.5.

7.5 Training

7.5.1 General Requirements

Clever Devices will provide training on the setup, installation, configuration, administration, operation, and maintenance of all AIM systems and equipment. General training requirements include the following:

- All training will be onsite, live instructor lead sessions at MTD's Olive Terminal, except for courses that have been proven to be just as effective via remote, live instructor lead sessions
- Training courses will have been professionally developed
- Course materials will accurately reflect the MTD-specific policies and equipment configuration
- Training will be hands-on using the same equipment and configurations that will be used live
- Clever Devices will provide training materials, tools, and equipment in sufficient quantity to support effective, hands-on training for all course attendees
- Course documentation will be of sufficient quality for long-term usage

7.5.2 Training Plan

Clever Devices will submit a proposed training plan to MTD at least one month prior to the beginning of training. The training sessions will be scheduled to be as close to but not before any AIM systems go live. Clever Devices' training plan will include the following information:

- A proposed schedule for all training sessions taking into account employee availability
- An electronic version of actual training documentation and materials to be used in each course
- A list of Clever Devices-provided equipment, tools and test equipment, manuals, etc. to be used

- A list of any training site requirements (e.g., class sizes, equipment needs, internet access, etc.)

7.5.3 Courses & Trainees

Clever Devices will base training courses on the manual types and user groups identified in section 7.6 on page 272 below. There will be two exceptions:

- The Onboard Equipment & Systems Operation class will be with up to five MTD trainers rather than directly with bus operators. MTD trainers will be responsible for providing the driver training
- There will be an additional course for managers that provides an overview of the AIM systems including capabilities and limitations, data collected, and how to access and run reports

Some courses, mostly IT related, can be delivered remotely with live instructors.

7.5.4 Clever Devices' Training Program

Philosophy of Education

Clever Devices uses an objective-based education approach for instructional design. We use the ADDIE model for analyzing the outcome needed, and we then design and develop the course contents and materials to support the objective. With this approach, we focus on the job function of each type of student, and organize the training to maximize their ability to perform these job functions efficiently and accurately.

Quality

Effective training is essential to any system's successful operation. Clever Devices will provide a high quality professional training program that will transfer technical and system operations knowledge to the operators and managers of the MTD bus ITS System. Our proposed training plan includes all labor, instruction, materials, and services necessary to provide MTD personnel with the means to transition to and operate the new system without impact to operating capabilities or patron services.

Approach

The student's ability to perform job related tasks will be used to demonstrate successful completion of the training. CD products are intuitive to use; therefore, operations staff are not required to spend large amounts of time in training. Most modules can be taught in half of a shift. Our lesson plans will be carefully reviewed to ensure that safety is properly addressed and that system security is not compromised.

Customization

Clever Devices custom tailors our training programs to match the needs of each transit authority. Our proposed program is based on our current understanding of the system solution and needs. During contract negotiations and throughout the project, training requirements may evolve, so Clever Devices will work closely with MTD to make adjustments to the training program as necessary to ensure the success of the training deliverables.

Training Plan Deliverable Document

During the project development phase, we will create a written training plan as a formal project deliverable to document the training approach and submit it to MTD for approval prior to conducting any training. The training plan will include course syllabi including course descriptions, format, length, frequency, instructor, and schedule.

Management and Scheduling

Under the direction of our project manager, our training personnel will be responsible for preparing course material and managing training delivery. Working in concert with your project manager, Clever Devices will set the time and location of the training courses. It will be the responsibility of MTD management to schedule MTD personnel to attend these training sessions. Clever Devices will keep attendance records and will issue training certificates to students after they complete the classes.

Materials

The training will use Clever Devices provided documentation together with topic specific training materials to support each course in the training program. MTD will be provided with printable softcopies of training materials which may include instructor guides, PowerPoint presentations and workbooks. The MTD may reproduce and distribute unlimited copies of these for use by all internal personnel.

Trainers

Clever Devices will provide an instructor with both extensive ITS transit experience and training expertise. Our instructors have successfully provided training to hundreds of customers. The training methods and materials are created and managed as part of a comprehensive, structured program which supports our field trainers in delivering high quality content for effective training. These same methods are taught to our customers by our trainers when delivering a train-the-trainer program so that both technical content and instructional guidance are provided.

Clever Devices Corporate Level and IT Training Courses				
Course Name	**Format**	**Class Size**	**Class Duration (hours)**	**Manuals Utilized**
Management Overview Training	Standard	8	2-4	CleverCAD® System Admin Guide BusTools® System Guide BusLink® System Guide CleverReports™ User Guide AVM® User Guide BusTime® Admin Guide Scheduling System User Guide
Frequency:	Once, upon initial installation of system			
Location:	On site at a customer provided training room			
Prerequisites:	Familiarity with bus operations management; Windows operating system experience.			
Overview:	This is an instructor-led course which provides the transit authority management with an overview of products and systems used. The design of this course is to provide a high-level understanding of entire system and components that make up the system.			
IT Support Training	Standard	6	3	CleverCAD® System Admin Guide BusTools® System Guide BusLink® System Guide CleverReports™ User Guide AVM® User Guide BusTime® Admin Guide Scheduling System User Guide
Frequency:	Once upon initial installation of system.			
Location:	On site at a customer provided training room.			
Prerequisites:	Advanced IT system knowledge.			
Overview:	This is an instructor-led course for technical support and system administration staff that will be supporting the computer systems. Topics include the network topology, computing platforms, operating systems, storage, data flow, database structure, diagnostics, system utilities, data backup, system health monitoring, facilitating remote support, preventive maintenance and interfaces to third-party systems.			

<table>
<tr><th colspan="5">Onboard Equipment Training Courses</th></tr>
<tr><th>Course Name</th><th>Format</th><th>Class Size</th><th>Class Duration (hours)</th><th>Manuals Utilized</th></tr>
<tr><td>Bus Operator Trainer Training (Onboard Equipment)</td><td>Train-the-Trainer</td><td>6-8</td><td>4</td><td>IVN® Operator Instructor Guide</td></tr>
<tr><td>Frequency:</td><td colspan="4">Once, upon initial installation of the system</td></tr>
<tr><td>Location:</td><td colspan="4">On site at a customer provided training room</td></tr>
<tr><td>Prerequisites:</td><td colspan="4">Familiarity with bus operation, dispatch operations, safety policies, third party bus equipment and authority business rules; training experience a plus</td></tr>
<tr><td>Overview:</td><td colspan="4">This instructor-led course will be a classroom and lab style training session. The training will be conducted with a simulator and/or on vehicles with “live” equipment. Instruction will be provided enabling the attendees to conduct operator training of the onboard equipment to bus operators. The first portion of the class provides an overview of the training methods to be used and the instructor training objectives. Next presentation of the course content is covered for the mobile data terminal operations to gain a familiarity with the controls. In the second portion, scenarios for common events are presented. Next methods of instruction for onboard hands on, practical training is given. Finally student assessment is explained including testing and evaluation procedures.</td></tr>
<tr><td>Vehicle Equipment Maintenance Training (Onboard Equipment)</td><td>Standard</td><td>6-8</td><td>4</td><td>IVN® Maintenance Guide
IVN® Installation Guide</td></tr>
<tr><td>Frequency:</td><td colspan="4">Once, upon initial installation of system</td></tr>
<tr><td>Location:</td><td colspan="4">On site at a customer provided training room and on vehicle with Clever Devices equipment installed</td></tr>
<tr><td>Prerequisites:</td><td colspan="4">Knowledge of electronics and electrical test equipment, familiarity with maintenance of bus electronics and Windows computer operations. Bus Driver Training.</td></tr>
<tr><td>Overview:</td><td colspan="4">This instructor-led course will review diagnostic and debugging techniques to allow students to isolate problems, repair, remove and replace the hardware on buses. Additionally, the course will outline and explain the capabilities of the IVN® system including IVN® diagnostic features, setting parameters through the bus operator’s interface, and analysis of fault data for diagnosis and evaluation. The first two hours are conducted in a classroom setting to provide an overview of the equipment, safety procedures, theory of operation, overview of diagnostic procedures, overview of maintenance and installation documents, and approach. The balance of the day is a combination of laboratory style hands-on training and question and answer interaction.</td></tr>
</table>

BusTime® Training Courses				
Course Name	**Format**	**Class Size**	**Class Duration (hours)**	**Manuals Utilized**
BusTime® Dispatcher/ Supervisors Training	Standard	10	4	BusTime® User Scheduling System User
Frequency:	Once, upon initial installation of system			
Location:	On site at a customer provided training room			
Prerequisites:	Knowledge of Microsoft Windows; working knowledge of administrator functions on Microsoft SQL Server; experience in LAN environment on setting up user groups and security levels for users; maintenance procedures for backup, recovery, etc.; Vehicle Operator Training.			
Overview:	This instructor-led classroom training is designed for dispatchers and help desk personnel who are responsible for BusTime® operations. The course covers a complete system overview and explanation of all BusTime® functions used by customer service staff to enable the trainer to train users to support, manage, change and administer the systems underlying the BusTime® implementation including all screens and reports. It covers end-user functionality of the BusTime® product for the dispatchers to understand its role in their day-to-day work environment. Training will be onsite at an MTD location.			
BusTime® Admin Console Supervisors Training	Standard	6	2	BusTime® Admin Console User Guide
Frequency:	Once, upon initial installation of system			
Location:	On site at a customer provided training room			
Prerequisites:	Basic to advanced knowledge of Microsoft Windows			
Overview:	This is an instructor-led course. It covers end-user functionality of the BusTime® admin console for the RTPIS system administrator to understand system configuration and management in their day-to-day work environment. Hands-on skill training will be done with a workstation and actual software.			

BSA BusTools® Training Courses				
Course Name	**Format**	**Class Size**	**Class Duration (hours)**	**Manuals Utilized**
BSA BusTools® Training	Standard	8	8	BusTools® System Guide
Frequency:	Once, upon initial installation of system			
Location:	On site at a customer provided training room			
Prerequisites:	Basic to advanced knowledge of Microsoft Windows			
Overview:	The BusTools® software products and their functionality for route mapping are taught by an instructor. These classes are hands-on and in the field, using actual situations to reinforce the material taught. Managing the bus stop inventory, managing audio files, version control, and multiple reporting functions will be covered. A member of the Clever Devices data team will work hand in hand with MDT while implementing their scheduling data into the Clever Devices solution.			
BusLink® Administrator Training	Standard	8	2	BusLink® System Guide
Frequency:	Once, upon initial installation of system			
Location:	On site at a customer provided training room			
Prerequisites:	Basic to advanced knowledge of Microsoft Windows; Vehicle Operator Training			
Overview:	The BusLink® software product and functionality is taught by an instructor These classes are hands-on. BusLink® is utilized to transfer data between the server and the fleet.			
CleverReports™ Training – Applications/ Systems Administrators	Standard	8	3	CleverReports™ User Guide
Frequency:	Once, upon initial installation of system			
Location:	On site at a customer provided training room			
Prerequisites:	Basic to advanced knowledge of Microsoft Windows			
Overview:	This is an instructor-led course covering the use and operation of CleverReports™ functionality. Topics include dashboards, key performance indicators, graphic reports, tabular reports, setting up favorites, configuring report automatic emailing, drilling down into data and ad-hoc queries. The course material is presented with a combination of slides and live software screen demonstration. Formal instruction is followed by hands-on, practical learning on the system software coupled with question and answer interaction throughout.			

7.6 Manuals

7.6.1 General Requirements

Clever Devices will provide manuals that will support MTD personnel in the setup, installation, configuration, administration, operation, and maintenance of all AIM systems and equipment. All manuals will meet the following requirements:

- Manuals will be organized in a clear, logical fashion with table of contents, index, and definitions
- Manuals will be sufficiently comprehensive and detailed to enable MTD to fully operate and maintain AIM systems with little or no assistance from or reference to outside sources
- Manuals will be specific to the MTD installation and incorporate information gathered during installation and acceptance testing
- Manuals will provide MTD unlimited rights for duplicating and disseminating manual information for purposes related to the MTD AIM installation
- Manuals will include safety procedures and precautions necessary to prevent damage to equipment, injury to personnel, and unsafe operational conditions

7.6.2 Hardcopies

Clever Devices will deliver to MTD the quantities of manuals specified in Section 6.2.2 of the RFP in hardcopy format. Manuals will be designed for continuous, long term service in its intended environment (e.g., a bus or shop). Manuals will be double-sided, lie flat when opened; and permit adding and replacing pages.

7.6.3 Softcopies

Clever Devices will deliver to MTD an electronic version of all manuals that are equivalent to the hardcopy versions. The files will be in Adobe PDF format created from original electronic documents, not from scanned documents. Two full sets of the electronic manuals will be provided via CD-ROMs or DVD-ROMs which will be accessible on an MS Windows-based personal computer.

7.6.4 Manual Types and Users

Manuals for AIM systems will be developed with specific MTD user groups in mind differentiating between administration, operation, and maintenance. The types will generally cover the following:

Manual Type	Primary User Group	Copies
Onboard equipment and systems operation	Bus Operators	170
Dispatch Center equipment and systems operation	Driver Supervisors	25
Onboard equipment and systems operation	Road Supervisors	25
Yard location equipment and systems operation	Driver Supervisors & Mechanics	38
Onboard and yard equipment maintenance	Mechanics	20
Report creation, generation and administration	IT and Staff (varies by AIM System)	TBD
AIM system applications administration	IT and Staff (varies by AIM System)	TBD
Server, network, database admin and maintenance	IT Personnel	3

7.7 Spares

As part of the solution for MTD, Clever Devices has provided a quantity of spare parts that will be used by MTD in the removal and replacement of defective components. The table below identifies each spare component and quantity:

MTD - Spare Parts List (Base)	
Description	**Quantity**
Fixed route IVN® system • IVN® with cellular & GPS • MDT • WLAN modem • Quad band antenna	10
Fixed route video DVR	10
Fixed route cameras with enclosure	80
Supervisor system • Harness • Antenna	1
LCD electronic display	1
LED double sided electronic display	1
WLAN access point	1
WLAN controller	1
MTD - Spare Parts List (Options)	
Description	**Quantity**
BSA interior sign & AVC mic and speakers	10
SmartYard™ tags	10
Luminator destination (Nova)	2
APC hardware	22
URLC hardware	10
Silent alarm switch	10
Supervisor system modem with GPS	1

At any time during the warranty period, MTD can opt to purchase additional spare components.

7.8 Test Equipment

The following test equipment is included with our system.

7.8.1 Bus-in-a-Box (BIB)

To support maintenance activity and hands-on training in the classroom, Clever Devices has included the bus-in-a-box (BIBs) training equipment identical to the equipment in the field on a cart. Dispatch and system administrative training will be conducted using this equipment. The BIBs and other training materials will become property of MTD at the conclusion of training.

Figure 100: Test Bench - Bus In a Box

Maintenance training will similarly be done on test bench BIBs. Each BIB will include an IVN® controller, VGA mobile data terminal, power supply, and other components selected after final design approval, to permit maintenance personnel to perform test and diagnostic operations as well as maintenance training.

7.8.2 Ruggedized Laptop

IVN® has fully automated retrieval of performance data and distribution of software and data updates, this can also be done manually with a USB flash drive. However, Clever Devices has included with our proposal the Dell latitude E6420 XFR ruggedized laptop to be used by service personnel as requested in the RFP. If desired by MTD, a price reduction can be achieved with the removal of the ruggedized laptop.

The features of the ruggedized Laptop are:

- Windows 7 Professional, No Media, 64-bit, English
- Intel® Core™ i5-2520M processor (2.50GHz, 3M cache
- 4.0GB, DDR3-1333MHz SDRAM, 1 DIMM
- 256GB Solid State Drive
- 90W A/C Adapter (3-pin), MIL-STD 461F
- 8X DVD with Cyberlink Power DVD™, no media
- Dell Wireless™ 1530 802.11a/g/n Draft Mini Card
- Triple RF-Pass-Thru
- 14.0" HD (1366x768) Outdoor Viewable with Direct Vue™ and Mic only
- Sealed Internal English Backlit Keyboard, White
- Intel® HD Graphics 3000 without Fingerprint & Contactless Smartcard Reader
- Dell Wireless™ DW5800 4G LTE Mini Card (Gobi™ 4000) – Verizon

This laptop does not come with a data service plan.

7.9 Project Management

The Clever Devices project manager will work closely with the AIM project team and will provide or meet the following requirements:

1. Coordinate design and engineering activities and provide a technical liaison to MTD
2. Have the authority to assign and schedule contractor personnel to perform all of the work required to deploy the project
3. Provide a single point of contract for MTD to resolve all issues related to the contract
4. Be responsible for directing all subcontractors designs and work
5. Conduct project status meetings with MTD staff
6. Have a full and complete understanding of the contract documents and site conditions sufficient to provide adequate direction for coordination of work
7. Have at least three years' experience in the implementation and management of mobile ITS projects and have completed at least one such project for a fleet in excess of 50 vehicles
8. Be on site during all significant project events including installation and testing as necessary to facilitate meetings, project activities, and information between Clever Devices and MTD

The senior technical staff member will work closely with the AIM project team and will provide or meet the following requirements:

1. Act as a technical resource for coordinating all system design and implementation issue.
2. Check each technical submittal prior to its being sent to MTD for approval.
3. Check factory wiring and field work to assure quality.
4. Have sufficient understanding of the technical requirements of these specifications

Clever Devices provides single point management of the MTD project and provides the end-to-end compliant technical solution. Clever Devices has selected Mr. John Nilson as the Program Manager and Mr. Ross Sinclair to be the project manager of this AIM project. He will have the authority to make commitments and decisions for the project that bind Clever Devices.

The project manager is the key point of contact for the MTD and for the Clever Devices project team to implement the project approach. He provides several functions in planning to ensure team progress in deployment of the system. The project manager is responsible for the following management functions that keep the team focused and the project moving forward:

Scope Management: The project manager will:

- Track and manage the technical and contract requirements
- Work with Clever Devices product managers to interpret the product specifications and determine the tasks and deliverables necessary to deploy a successful and compliant solution
- Work closely with the systems engineer to configure, test, and deploy the system
- Ensure the project team maintains focus in delivering the solution in an efficient and compliant manner

Risk Management: As an integral part of project management planning, risk management is often overlooked, yet it is a critical element of the project manager's role. Risk management is incorporated into Clever Devices' project management plan and is addressed monthly on each program. This assessment reviews the current status of the program's technical, resource, schedule and budgetary elements to anticipate, identify, measure, and mitigate each identified risk.

Deployment Management: The project manager is responsible for understanding every aspect of the project and ensuring tasks and deliverables are completed in the right sequence to deliver a successful and operational system. The project manager is supported by technical experts; however, he alone is ultimately responsible for delivery of the successful project.

Information Management: The project manager is responsible to maintain the library of records for the project, and is the key to effective information flow between MTD and the Clever Devices project team. He is responsible to ensure timely communication of technical and project-related information to the appropriate team members, including subcontractors as necessary. The project manager uses tools to support completion of this important role, such as action item lists, progress reports, schedules, teleconferences, and meetings.

Project Management Plan

Project planning is a key element to reducing program deployment risk. Our project manager is responsible for developing a system Project Management Plan. The initial draft will be delivered to MTD within two weeks from notice to proceed. The plan communicates the work approach to meeting program requirements. It includes the following content:

This plan will leverage much of the preliminary work completed in developing the concepts, and planning for the proposed solution. Comments from the MTD will be incorporated into the plan after the first onsite meeting, and returned for approval within two weeks of the meeting. Updates to the PMP will be provided at the beginning of each month.

The Project Management Plan is the first deliverable of this project and will be invoiced by March 31, 2014 in order for MDT to meet their target of spending $375,000 by this date as per the RFP addendum of November 11, 2013.

Clever Devices proposes the following phases for this project:

- Project Planning and Kick-off
- Design: Preliminary Design and Final Design
- MTD - AIM Solution Build (Specify which components are to be deployed)
- Factory Acceptance Test
- Mini-Fleet Testing
- Field Deployment
- System Acceptance Test
- Transition to Warranty

The high level project plan submitted with this proposal outlines this phased approach. The final schedule will be determined based on the options that are chosen for this project as well as additional schedule inputs and mutually agreed upon target dates for completion. The preliminary project schedule included with this response, not only complies with the RFP objectives for milestones and completion dates, but also takes into consideration the Progress Review Meetings, Schedules and Project Control. Clever Devices will use Microsoft Project to create and maintain the project schedule. The plan will be sent to MTD in MS Project, pdf and html format for those team members who do not have MS Project. Clever Devices will work closely with MTD to identify MTD inputs and other schedule constraints in order to present a “full picture” of the schedule. Clever Devices will update the schedule and submit it for the MTD’s review at the beginning of each month.

Preliminary planning begins upon receipt of the RFP, and includes identifying the necessary interface(s), defining the system architecture, and developing a preliminary project schedule with deliverables and milestones for major tasks. Upon contract award, Clever Devices commences detailed project planning and coordination. Clever Devices’ project team and the MTD’s staff members will jointly clarify their respective roles and responsibilities, discuss the overall project, review the critical program milestones and deliverables, and begin the relationship building process between Clever Devices, the MTD’s staff, and other vendors and partners. Clever Devices recognizes that, while we have successfully deployed similar projects, the AIM project is unique to the MTD and will require Clever Devices’ close cooperation and responsiveness to the MTD’s unique requirements and needs for this specific project.

The MTD AIM system build will be accomplished at the Clever Devices Woodbury location. The system will be staged and tested by the Clever Devices engineers. A" dry" FAT test acceptance test procedure that has been reviewed and approved by MDT is completed by our testing engineers in order to fully validate the features and functionalities required by the contract and final system design. Once the MTD AIM system is approved by our management team, the project manager schedules the factory acceptance test witnessed by MTD.

Factory Acceptance Test (FAT) is completed at Clever Devices Woodbury, NY location. The MDT AIM team attends and witnesses the full test of the system. The FAT is run by the Clever Devices System Engineer following the approved testing procedure used in the "dry" run. We ask that all appropriate MDT team members fully follow along with the FAT testing, which will take 3 days to 1 week to complete. All issues will be documented and prioritized. Items that are deemed to be critical in nature as well as those which do not meet the requirements of the contract or the accepted design will be fixed before the next step of mini-fleet testing. It is the goal of our team that MDT is fully confident in the solution before on-site installation and testing.

Mini-fleet testing is the next phase in the deployment process. All of the base contract elements and the options picked by MDT at the beginning of the contract will be tested on a smaller subset of the MDT vehicles. The system server and backend elements are installed and tested in parallel to the vehicle equipment installation. The backend system, including the WLAN access points, will need to be fully operational and tested at the site prior to the actual mini-fleet test. Once the backend system and the vehicle equipment are installed, the mini-fleet vehicles will be conducted on one each of the nine (9) vehicle types at the site. Mini-fleet testing and monitoring normally lasts 2 weeks depending on features/options of the system.

Full fleet deployment begins once the mini-fleet test is fully approved by MDT. The Clever Devices deployment team will fully install and test every hardware and software component of the system. Each vehicle will be installed according to the approved installation drawings and final system design. Each vehicle is fully tested and approved by MDT before the vehicle is released for service. Clever Devices asks that a full inspection of the vehicle is completed before the new hardware is installed.

System Acceptance Testing is performed once all of the vehicles are installed and in service. The System Acceptance Test will last for 30 days. The Clever Devices team will monitor the site and document any issues. All issues will be addressed before approval of the System Acceptance Test.

They AIM system is transitioned to warranty service and into the hands of our Clever Care team after System Acceptance Test is approved by MDT. The Clever Care team is introduced to the MDT team during System Acceptance Test phase so that all of the contacts and instructions on how to utilize the Clever Care team are clear to the MDT staff. The Clever Devices project manager and the Clever Team representative will conduct a transition meeting with MDT.

7.10 Design Review

The design of the MTD AIM system will be conducted in two phases with two document deliveries. They are the Preliminary Design and Final Design documents. The submittals for the MTD AIM design will be in accordance with all requirements as per Section 8.4 of the RFP. The following sections describe the Clever Devices Process to complete the system design for the MTD AIM project.

Clever Devices' will deliver the Preliminary Design Document within 60 days of the Notice to Proceed as per section 9.1 of the RFP. Clever Devices will follow proven system engineering and design practices and processes to incorporate any MTD specific features into Clever Devices' standard products, and to develop, test, and deploy the completed system. At a minimum, Clever Devices agrees to provide the following elements of the Design as per section 9.1 of the RFP:

- Clever Devices will provide a draft software requirements specification document for any new functionality that is being developed for AIM with an emphasis on the user interfaces and interfaces to external systems.
- Clever Devices will provide data sheets for all major hardware and off-the-shelf software components.
- A description of the computer subsystem including servers, dispatcher workstations, monitoring workstations, yard workstation, interfaces, data archival, TDB, and installation information.
- A description of radio or wireless data communications systems including anticipated coverage maps. If applicable, the coverage map will indicate the overlap coverage areas and areas where phasing delay will inhibit data.
- A description of the methodology for maintaining MTD's current route and schedule database in Trapeze and its interface with AIM. This description shall include how the database will be edited, handled, and interfaced to AIM; and the methodology for providing the database onboard each bus for tracking route and determining schedule adherence.
- Scaled drawings showing details of the passenger information electronic display sign hardware. The submittal shall also include a description of the display interface with the wired and/or wireless data network used to provide data to the sign and the details for the data network.
- Mockups of web pages for the time of arrival passenger information including a description of the website, a list of the pull down menus and items, a sample map display time of arrival tables.
- Optional: A description of the CAD user interface including AVL map displays, tabular displays, incident reports, SAS functionality, data communication functions, fleet management reports, AVL playback, incident reports, sample screens, a list of the pull down menus and items.
- Scaled drawings of the MDT with the exact key labeling and typical screen displays; and a description of the operator interface with the MDT including all prompts, displays, and menus.

<u>Requirements Review (RR)</u>: Clever Devices will conduct requirements review sessions very early in the design process as part of the weekly conference calls, the progress review meetings, or ad-hoc meetings as required. These requirements reviews will be essential to insuring a clear and accurate understanding of the MTD RFP requirements and to establishing the requirements baseline for the final design document.

MDT Technical Reviews: In addition to the planned technical discussions during the progress meetings, Clever Devices will conduct technical design document reviews with the MTD's staff. The Preliminary Design Document will be submitted and the technical review session will be conducted no later than 1 week after the presentation of materials to MDT. The same process will be followed for the Final Design documents. A mock up or demonstration of the custom user interfaces will be presented during the design process for review and approval by MDT. The Preliminary Design Review (PDR) and the Final Design Review (FDR) will be followed by the formal submission of all finalized Design Documents. The formal final submissions are based on any changes required by MDT during their review process.

During the Preliminary Design Review, Clever Devices will provide and review in detail the following items as part of the in-process Final Design Document:

- Overview of system architecture
- Requirements traceability matrix
- Detailed hardware description, to include interface and configuration
- Detailed software description, to include user interface, data base design and configuration
- Detailed description of all 3rd party interfaces
- Detailed description of central system equipment/servers configuration and reliability figures
- Major assumptions and risks

The technical design reviews will be conducted by the Clever Devices team, who will also ensure that meeting minutes are created as required in section 9.1 – Design Review of the RFP.

The Final Design Review will be conducted when the system design has reached the final or "build to baseline" design stage. Clever Devices agrees that the Final Design will be submitted within 3 months of Notice to Proceed. The Final Design Document will be reviewed in its entirety during the Draft Final Design review meeting and will include the following items:

- Refined or revised design details as presented during the preliminary design
- Detailed locations and mounting information for equipment specified for in-vehicle, at the garage and the central system applications
- Detailed installation design drawings for each bus type
- Detailed descriptions of information and materials required by third parties
- Final and complete description of each AIM system and sub-system
- Revision project plan based on the Final Design Document

The final design package will incorporate changes discussed and approved during the design review and meetings.

7.11 Testing and Acceptance

Clever Devices will fully test the MTD AIM system and subsystems, components, equipment, hardware, software, interfaces, databases, reports, networks, communications coverage, map accuracy, or any other items or services provided under this Contract to assure that the system is compliant with all of the MDT specifications, approved design concepts, and is free of manufacturing and/or material defects.

Clever Devices will include testing, with fully trained testing personnel as part of the acceptance procedures for the project.

The testing phases provided by Clever Devices as part of our normal project management process are completely in line with the requirements outlined in section 10 – Testing and Acceptance of the RFP. The Clever Devices Testing Process in accordance with the MTD requirements is described below:

Pre-Delivery Testing:
Clever Devices will fully test the MTD system during our Factory Acceptance Test Phase at our Woodbury, NY facility. The MTD system will be fully configured, "dry-run" tested by our engineering staff and approved by our management team before the testing with the MTD team at our facility. A Factory Acceptance test plan will be provided to MTD prior to the test. This test plan will fully test all features and functionalities required and documented within the Final Design Document. Complete testing records, including failures, will be maintained for review by MTD.

Core First Article Testing (CFA):
Core First Article Testing (CFA) will be conducted at MTD's site. The testing will be conducted based upon the accepted test plan developed for Pre-Delivery Testing. One of each of MTD's vehicle types will be tested during this period. Each vehicle will be fully installed will required components as per the Final Design Document. The MTD IT system infrastructure will be installed and tested with the existing MTD environment prior to the connection of the vehicles to the system. Once the IT systems and CFA vehicles are installed, a full test of the system will be conducted with MTD present. Clever Devices will provide MTD at least 1 week advance notice of the field test as required in section 10.2.2 – Core First Article Testing of the RFP.

Clever Devices and MTD will determine the classification of testing failures during the testing planning prior to the CFA testing. Clever Devices agrees that repeated malfunctions of similar system components or subsystems shall be considered as a Class Failure. In the event of a Class Failure, the CFA testing will be terminated and the cause of the Class Failure shall be determined and corrected by Clever Devices. All system components that experience a Class Failure during testing shall be replaced by Clever Devices prior to acceptance by MTD.

Once the CFA testing is completed to the satisfaction of MTD, the AIM system will be implemented on the full MTD fleet according to the accepted project plan.

Final Acceptance Testing:
Final Acceptance Testing will be performed for a period of 30 days after the complete fleet is installed with the new system. Clever Devices will closely monitor and report on the operation of the 30 day

acceptance testing. At the end of the 30 day acceptance test, Clever Devices will prepare a full report of the performance of the system. The system must perform as specified in the Final Design Document and as per the acceptance testing plans and procedures agreed to during Pre-Delivery test and Core First Article Testing process. If any deviations are found during the testing period, they will be addressed and fixed by Clever Devices. MTD will review the Final Acceptance Test Report, including any recommended corrections of any deviations, and provide guidance to Clever Devices on those corrections if necessary. MTD will approve the final acceptance report provided it is in compliance with all of the AIM specifications.

7.12 Preliminary Project Schedule

Clever Devices has provided our preliminary project schedule on the following page.

Clever Devices

Preliminary Project Schedule
Santa Barbara - AIM Project

ID	WBS	Task Name	Duration	Start	Finish
1	**1**	**Santa Barbara (MTD) AIM Project**	**209 wks**	**Mon 2/3/14**	**Fri 2/2/18**
2	1.1	Contract Award	0 days	Mon 2/3/14	Mon 2/3/14
3					
4	**1.2**	**PROJECT MANAGEMENT - DEPLOYMENT OF AIM**	**52 wks**	**Tue 2/4/14**	**Mon 2/2/15**
5	**1.2.1**	**Project Planning**	**1.8 wks**	**Tue 2/4/14**	**Fri 2/14/14**
6	1.2.1.1	Kick-Off Prep	2 days	Tue 2/4/14	Wed 2/5/14
7	1.2.1.2	Subcontract Execution	1 wk	Thu 2/6/14	Wed 2/12/14
8	1.2.1.3	Kickoff meeting with MTD	2 days	Thu 2/13/14	Fri 2/14/14
9	1.2.1.4	Deliver Approved Project Plan	0 wks	Fri 2/14/14	Fri 2/14/14
10	1.2.2	Monthly Project Progress Meeting	52 wks	Tue 2/4/14	Mon 2/2/15
11	**1.3**	**System Design**	**11 wks**	**Mon 2/17/14**	**Fri 5/2/14**
12	**1.3.1**	**Preliminary Design**	**5 wks**	**Mon 2/17/14**	**Fri 3/21/14**
13	1.3.1.1	Design Development	21 days	Mon 2/17/14	Mon 3/17/14
14	1.3.1.2	Review (MTD)	4 days	Tue 3/18/14	Fri 3/21/14
15	1.3.1.3	Preliminary Design Complete	0 wks	Fri 3/21/14	Fri 3/21/14
16	1.3.1.4	MTD Acceptance of PD	0 wks	Fri 3/21/14	Fri 3/21/14
17	**1.3.2**	**Final Design**	**6 wks**	**Mon 3/24/14**	**Fri 5/2/14**
18	1.3.2.1	Design Document Updates	3 wks	Mon 3/24/14	Fri 4/11/14
19	1.3.2.2	Review (MTD)	1 wk	Mon 4/14/14	Fri 4/18/14
20	1.3.2.3	Final Updates	2 wks	Mon 4/21/14	Fri 5/2/14
21	1.3.2.4	Design Document Complete	0 wks	Fri 5/2/14	Fri 5/2/14
22	1.3.2.5	MTD Acceptance of FD	0 wks	Fri 5/2/14	Fri 5/2/14
23	**1.4**	**MTD AIM System Build**	**14.6 wks**	**Fri 5/2/14**	**Wed 8/13/14**
24	1.4.1	Order Equipment	2 wks	Mon 5/5/14	Fri 5/16/14
25	**1.4.2**	**Staging of MTD System**	**14 wks**	**Mon 5/5/14**	**Fri 8/8/14**
26	1.4.2.1	AVL - BusTime	11 wks	Mon 5/5/14	Fri 7/18/14
27	1.4.2.2	Route and Schedule Adherence Analysis - Clever Reports	11 wks	Mon 5/5/14	Fri 7/18/14
28	1.4.2.3	On-Board Video Surveillance System	11 wks	Mon 5/5/14	Fri 7/18/14
29	1.4.2.4	BusLink - Yard Wireless System	11 wks	Mon 5/5/14	Fri 7/18/14
30	1.4.2.5	Transit Center Customer Information Signs	11 wks	Mon 5/5/14	Fri 7/18/14
31	1.4.2.6	Dry-run test (based upon the ATP)	3 wks	Mon 7/21/14	Fri 8/8/14
32	**1.4.3**	**Contract Options (Timeline to be adjusted for each Options as executed)**	**0 wks**	**Fri 5/2/14**	**Fri 5/2/14**
40	1.4.4	Clever Devices Executive Approval of Dry-Run	3 days	Mon 8/11/14	Wed 8/13/14
41	**1.5**	**Factory Acceptance Test**	**2 wks**	**Wed 8/13/14**	**Wed 8/27/14**
42	1.5.1	MTD at Woodbury for FAT	0 days	Wed 8/13/14	Wed 8/13/14
43	1.5.2	Conduct FAT	1 wk	Thu 8/14/14	Wed 8/20/14
44	1.5.3	MTD Acceptance of FAT	1 wk	Thu 8/21/14	Wed 8/27/14
45	**1.6**	**Deployment (Including Core First Article Testing)**	**17.7 wks**	**Thu 8/28/14**	**Tue 12/30/14**
46	1.6.1	Equipment beginning on Site	2 wks	Thu 8/28/14	Wed 9/10/14
47	1.6.2	Install central back end systems	2 wks	Thu 9/11/14	Wed 9/24/14

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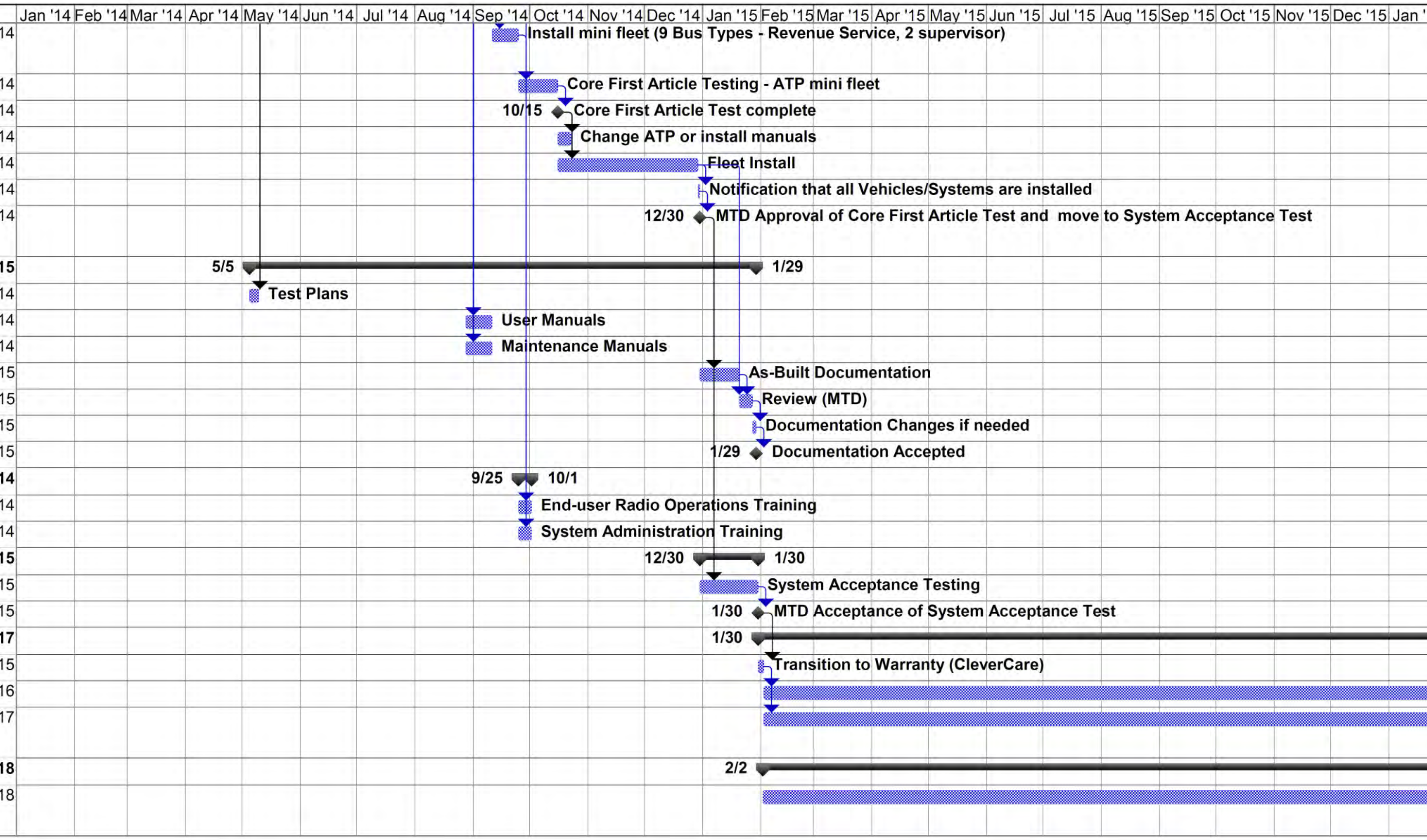
Clever Devices

Clever Devices

Preliminary Project Schedule
Santa Barbara - AIM Project

ID	WBS	Task Name	Duration	Start	Finish
48	1.6.3	Install mini fleet (9 Bus Types - Revenue Service, 2 supervisor)	2 wks	Thu 9/11/14	Wed 9/24/14
49	1.6.4	Core First Article Testing - ATP mini fleet	3 wks	Thu 9/25/14	Wed 10/15/14
50	1.6.5	Core First Article Test complete	0 wks	Wed 10/15/14	Wed 10/15/14
51	1.6.6	Change ATP or install manuals	1 wk	Thu 10/16/14	Wed 10/22/14
52	1.6.7	Fleet Install	10.5 wks	Thu 10/16/14	Mon 12/29/14
53	1.6.8	Notification that all Vehicles/Systems are installed	1 day	Mon 12/29/14	Tue 12/30/14
54	1.6.9	MTD Approval of Core First Article Test and move to System Acceptance Test	0 days	Tue 12/30/14	Tue 12/30/14
55	**1.7**	**Documentation**	**38.7 wks**	**Mon 5/5/14**	**Thu 1/29/15**
56	1.7.1	Test Plans	1 wk	Mon 5/5/14	Fri 5/9/14
57	1.7.2	User Manuals	2 wks	Thu 8/28/14	Wed 9/10/14
58	1.7.3	Maintenance Manuals	2 wks	Thu 8/28/14	Wed 9/10/14
59	1.7.4	As-Built Documentation	3 wks	Tue 12/30/14	Tue 1/20/15
60	1.7.5	Review (MTD)	1 wk	Tue 1/20/15	Tue 1/27/15
61	1.7.6	Documentation Changes if needed	2 days	Tue 1/27/15	Thu 1/29/15
62	1.7.7	Documentation Accepted	0 wks	Thu 1/29/15	Thu 1/29/15
63	**1.8**	**On-site Training (Schedule to be mutually agreed)**	**1 wk**	**Thu 9/25/14**	**Wed 10/1/14**
64	1.8.1	End-user Radio Operations Training	1 wk	Thu 9/25/14	Wed 10/1/14
65	1.8.2	System Administration Training	1 wk	Thu 9/25/14	Wed 10/1/14
66	**1.9**	**System Acceptance Testing**	**4.6 wks**	**Tue 12/30/14**	**Fri 1/30/15**
67	1.9.1	System Acceptance Testing	23 days	Tue 12/30/14	Fri 1/30/15
68	1.9.2	MTD Acceptance of System Acceptance Test	0 wks	Fri 1/30/15	Fri 1/30/15
69	**2**	**Warranty Period**	**104.6 wks**	**Fri 1/30/15**	**Wed 2/1/17**
70	2.1	Transition to Warranty (CleverCare)	1 day	Fri 1/30/15	Mon 2/2/15
71	2.2	1 Year - On-Call and On-site Warranty Period	52 wks	Mon 2/2/15	Mon 2/1/16
72	2.3	2 year - Repeater, Interface, Radiio,Handheld and Mobile	104.4 wks	Mon 2/2/15	Wed 2/1/17
73	**3**	**Support Services**	**156.8 wks**	**Mon 2/2/15**	**Thu 2/1/18**
74	3.1	On-Going Maintenance Support, firmware upgrades, repairs for Radio System	156.8 wks	Mon 2/2/15	Thu 2/1/18



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7.13 MTD Responsibilities

One of the many key aspects to a successful project is a clear definition of roles and responsibilities. It is very important that there is a clear communication between Clever Devices and MTD to ensure a successful deployment of the project in an on-time and within budget manner. To that end, listed below are MTD's responsibilities to help ensure this success. Depending on the final contract Statement of Work, this list may change to meet additional project requirements.

1. Assign a project manager who will have the ability to coordinate on behalf of MTD
2. Provide basic infrastructure (power, work space, access to facilities, equipment storage area, suitably equipped training room) required at each facility for installation of the system and provide support in coordinating logistical arrangements for receipt and storage of project-related equipment into project facilities
3. Assemble a project team (stakeholders and user representatives from various scope areas like Maintenance, Operations, Marketing (for RTPIS), IT, Scheduling, database and system maintenance (post deployment) etc.
4. Provide work rules, documented business practices, payroll rules, reporting requirements, interface requirements, and any pertinent business requirement information
5. Ensure all relevant team members participate in period project status conference calls and attend all project meetings such as the on site assessment and design meetings so that the project stays on schedule
6. Provide support in the scheduling of training and related logistics and ensure that necessary staff participates in training sessions
7. Provide timely review (within 2 weeks), comment, and approval of all requisite documentation
8. Provide information on bus stop locations and bus route data such as GIS data layers for the entire serviced area
9. Provide a person to act as a driver for field data collection of routes and stops spatial data. The collection will be done by a Clever Devices person using a Clever Devices van
10. Provide error free schedule exports to be consumed by the ITS solution
11. Provide a complete list of all vehicle types and configuration used in service (including spares), including vehicle numbers, year, make and model, mechanical sub-systems (including make and model), schematics, seating capacity (jump seats, Wheelchair positions, etc.)
12. Coordinate and provide vehicles to and from the equipment installation location and provide a driver(s) to support installation test and field test as part of test procedures
13. Access and involvement to a mechanic(s) with a high-level of knowledge of each vehicle type to provide bus technical support, access to bus design documentation and knowledge of equipment configuration for each bus type to support the equipment installation design by Clever Devices' application engineer
14. Provide all current transit scheduling and geographic data for scheduling system. Data must be in a suitable format (MS Excel, MS Access table, .csv) and free from extraneous information in the fields
15. Validate and complete data as required. Define or enter missing data
16. Arrange for wired network connections to within 10 yards of wireless LAN (WLAN) access points

17. Provide Clever Devices and its subcontractors with remote access to work stations and servers for central system deployment as well as support and troubleshooting.
18. Participate in all stages of testing and provide approvals
19. Report problems using standard format agreed at the onset of the project
20. Provide necessary permits or permissions for any activities requiring outside authorization as specified in the RFP
21. Provide support for installation of optional TSP intersection software updates
22. Our proposal is based on the fact that all existing or 3rd party software, systems, components and equipment are functioning properly and to manufacturers' specifications during all phases of the project. If this is not the case, it is presumed that MTD will work directly with its provider to resolve any issues
23. Provide detailed maps of the complete areas intended for the Yard Wireless System Location and Status coverage, both inside and outside the depot buildings. The maps must be drawn to scale and clearly identify the parking spots for buses with accurate dimensions for all of the parking areas, structure walls, wash bays, fuel bays, maintenance areas, and also show crosswalks, traffic flow, entrances, exits, curb areas, no parking areas, etc.
24. Clever Devices' philosophy is to implement the AIM solution to accommodate MTD's business practices. However, the integration of new ITS technologies may require MTD to embrace new business processes that effect current operational activities. During the design phase, Clever Devices' project team will identify these and work with MTD to an amicable solution.

8 Maintenance Agreement

Clever Devices prides itself on providing the best service and support in the industry. In order to ensure that our hardware and software, which are designed to be free from defects, continue to function properly and be in conformance with the technical requirements, Clever Devices has developed a maintenance plan that reflects MTD's needs as expressed in the RFP. Clever Devices' commercial off-the-shelf (COTS) system solution is highly reliable, which minimizes warranty and results in a low total cost of ownership. MTD can confidently deliver improved service to its ridership and derive maximum return on its investment in technology.

8.1 Warranty and Maintenance Overview

Clever Devices' proposed COTS system complies with MTD's business and technical requirements and is designed to be fit for such intended uses. The system also complies with all applicable laws and regulations relating to the project. MTD will acquire permanent title to all of the system's hardware and non-proprietary software provided under the contract, free and clear of all liens and encumbrances.

During the warranty period, Clever Devices will furnish at no cost any materials, labor, equipment, software, documentation detailing the operation and maintenance of the system hardware and software necessary to maintain the system in accordance with the warranty. Clever Devices will also provide any software updates and patches while under the warranty period. In addition, the periodic updates may include enhancements to the software that are implemented at the sole discretion of Clever Devices.

To perform services under the contract, Clever Devices will provide dedicated service employees, agents, and subcontractors that have the necessary skills, training, and background to competently and professionally provide support for the Clever Devices system. Clever Devices offers reliable support to our customers in order to maintain each system to its fullest functionality and specified performance requirements.

During the warranty and maintenance periods, Clever Devices' Customer Care team ensures MTD is getting an optimal return on investment by proactively identifying that Clever Devices' software and hardware products are being utilized according to their given functionalities. At no additional cost to MTD, the team will work directly with you at your facilities several times a year to identify needs, and will process your feedback and overall satisfaction.

8.2 Terms of Warranty

Clever Devices will provide one (1) year of warranty and support services on all deployed hardware and software components under this proposal. As requested in Addendum 1 of the RFP, two (2) additional one-year periods of warranty and support services are included in our proposal as options. The warranty period commences at Final System Acceptance.

During the warranty and maintenance periods, the single point of contact for all warranty administration will be Robert Manaseri, Director of Service, who can be reached via phone, email, or mail:

- Telephone: (516) 433-6100
- E-mail: rmanaseri@CleverDevices.com
- 300 Crossways Park Drive, Woodbury, NY 11797

8.3 Support

Clever Devices' Technical Support department is available by phone 24 hours a day, 7 days a week, and 365 days a year to assist our customers with issue resolution and to answer any questions. The Technical Support department is located at Clever Devices' main office in Woodbury, NY. MTD will be able to report incidents to Clever Devices' Technical Support department via phone or email:

- Toll-free Technical Support Service: 1-888-478-3359
- E-mail: TechnicalSupport@CleverDevices.com
- 300 Crossways Park Drive, Woodbury, NY 11797

Clever Devices' Technical Support will provide remote support through a MTD approved and authorized network access to assess issues, diagnose problems, update software and data, and retrieve log files. Clever Devices' support technicians are available 24 hours a day, 7 days a week, and 365 days a year to assist customers with hardware and software incidents. Backed by Clever Devices' software, deployment, and application engineers, Technical Support provides our customers with prompt service and incident resolution. The costs for remote support is included as part of Clever Devices' hardware and software warranty and maintenance solutions.

Clever Devices routinely uses a Virtual Private Network (VPN) connection with permission from the transit agency to gain access to their internal network. Clever Devices will not access MTD's internal network for any purpose other than for technical online support. If all attempts to troubleshoot an incident fail, at the discretion of Clever Devices, an employee will be dispatched to MTD to help resolve the issue.

Clever Devices' Technical Support personnel will assign each reported incident a Customer Resolution Tracking Number. The Technical Support department will be responsible for tracking, escalating, and resolving the incident ticket.

8.4 Warranty and Maintenance

Prior to System Acceptance, Clever Devices will support MTD via phone, email, and text message. Requests for assistance will be responded to within one hour of issue receipt. Critical issues that occur after hours are to be directed to Clever Devices via toll free phone. After hour calls will be routed to an on call technician who will respond within one hour of issue escalation. If all efforts to resolve an issue remotely fail and on-site support is required, Clever Devices will dispatch a technician to arrive on-site within two hours of the service call being received.

After System Acceptance, the Warranty and Maintenance period, Clever Devices will repair or replace any faulty components. The cost of repairing or replacing a component is included in the warranty price. MTD will report issues into Clever Devices' Technical Support department.

During the maintenance period, a MTD technician, trained by Clever Devices, will provide repair including removal and replacement of a defective component with a spare. If first line repair is not successful in resolving the issue, MTD is to contact Clever Devices' Technical Support who will assist with remote diagnostic and troubleshooting.

During the warranty period, Clever Devices will provide MTD with remote on-call support and a maximum of three one-day trips onsite to support to assist in keeping AIM operating to specifications.

During the two optional one-year periods following warranty, Clever Devices will provide MTD with remote on-call support and a maximum of three one-day trips annually onsite to support to assist in keeping AIM operating to specifications.

MTD will send the defective component to Clever Devices for analysis and repair or replacement via a Returned Merchandise Authorization (RMA) process. MTD will pay the shipping charges when sending components to Clever Devices, while Clever Devices will pay for the shipping charges when returning components to MTD, along with any applicable duties associated with the repair or replacement of faulty components. MTD will be provided with maintenance and support documentation and can contact Clever Devices at any time during the repair/replacement process to check the status of the component. Clever Devices will provide MTD with a detailed quotation and/or invoice for all costs associated with non-warranty repairs.

Santa Barbara will be entitled to software upgrades for all licensed products as long as you maintain a software warranty program. Clever Devices is continually investing in its products and solutions to satisfy the evolving needs of our clients. Santa Barbara will have access to these enhancements with no additional costs for software licenses. If Santa Barbara decides to upgrade, Clever Devices' staff will evaluate the effort required to aid in the implementation, validation, and training (if required) for the use of new features. Additional services and/or upgrades in hardware may be required in order to effectively implement an upgrade. This will be discussed with Santa Barbara at the time of request.

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9 Price Proposal Form

Clever Devices has provided the fully completed and signed *Price Proposal* form on the following separately numbered pages. This pricing is confidential and proprietary to Clever Devices. The *Price Proposal* form has been signed by Clever Devices' president in the upper right corner of the Summary Sheet. Pricing notes have been included immediately after the *Price Proposal* form.

To meet the proposed schedule and pricing, it is important that Clever Devices receives timely response to questions and access to necessary personnel. Additionally, our proposal also assumes that all third-party software, systems, components, and equipment are functioning properly and to manufacturers' specifications during all phases of the project. If this is not the case, it is presumed that MTD will work directly with its provider to resolve any issues.

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need to describe existing fiber optic network
MDT even if no CAD?
interface cost with GFI & Trapeze
submit proposed installment schedule (in BAFO?)
list of which buses have equipment boxes
language that prefer perpetual license in Specs
NTD cert is option
demo: bring hardware & software
constrain license fee growth
don't include shuttles with VHM
confidentiality: what is or is not? Reminder to mark as such; need clause in agreement
state that license fees include all updates
add sig to each pp form sheet?
include computer system description: how many servers and what apps on each
Using existing MTD physical server(s)?
Using existing MTD SAN for data storage?

Notes
Include overhead and profit within Price Proposal figures
Include cost of Transit Database in separate worksheet
Entries allowed only in green shaded cells
Leave cells blank as necessary; do not put text in numeric cells will result in error
sales tax column does not include T&M, S&TE, which have it included in their columns
print summary sheet for legal size
must manually calculate sales tax
enter company name on summary sheet and will populate other sheets

Pricing Notes

General:	Unit Prices provided only apply to the purchase of the quantities defined, as Unit Prices may include fixed costs or quantity discounts which can be affected by changes in quantity.
Option items:	The prices for all optional items are applicable only if exercised concurrently with the base contract award. Options exercised separately may incur an increase in price due to factors such as additional travel and additional hours needed to complete work. If one or more options are selected, there may be a reduction in labor price.
Summary Sheet:	The formula originally found in Cell I-20 in the provided Excel file has been moved to Cell I-18 “Data Comm & AVL System-Service Vehicles-Cellular” to correctly capture the price included for project management for the “service vehicles”.
L&M-3 Price Sheet:	Base AIM Systems maintenance agreement includes base hardware warranty for Years 2 and 3, as well as on-site support for Years 2 and 3 which includes three one-day trips per year.
S&TE-34-36 Price Sheet:	Under Spares & Test Equipment (page 2 of 3), the Bus Stop Announcement System Spare Parts Subtotal originally linked to Cell E-9 in the provided Excel file has been linked to Cell E-13.

10 Acknowledgement of Addenda Form

Clever Devices has provided the *Acknowledgement of Addenda* form on the following unnumbered page.

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SANTA BARBARA METROPOLITAN TRANSIT DISTRICT

Request for Proposals for AVL & ITS Management Systems (AIM)

ACKNOWLEDGEMENT OF ADDENDA

The undersigned acknowledges the Bidder's receipt of the following addenda to this RFP and has incorporated information or changes in said addenda within its proposal (if no addenda were received, write "None" in the first blank):

Addendum No. 01 dated 10 November 2013

Addendum No. 02 dated 13 November 2013

Addendum No. 03 dated 22 November 2013

Addendum No. ______ dated ____________________

Addendum No. ______ dated ____________________

Note: It is the Bidder's responsibility to ensure it receives all addenda which are posted on the MTD website at *http://www.sbmtd.gov/business-and-employment/active.html.*

Fran J Ingrassia
Authorized Official Signature

4 December 2013
Date of Signature

Francis J. Ingrassia
Authorized Official Name

President
Authorized Official Title

Clever Devices Ltd.
Business Name of Bidder

(Signer must match authorized official shown on Bidder Information form)

11 Bidder Information Form

Clever Devices has provided the completed *Bidder Information* form on the following unnumbered page.

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SANTA BARBARA METROPOLITAN TRANSIT DISTRICT
Request for Proposals for AVL & ITS Management Systems (AIM)
BIDDER INFORMATION FORM

General Information

Business Name of Bidder: ______________________________

Business Type: ☐ Corporation (State of Incorporation: ______) ☐ Partnership

☐ Sole Proprietorship ☐ Other: ____________

Business Federal Tax ID Number: ____________ (provide SSN if sole proprietorship)

Corporate Headquarters

Street Address: ______________________________

City: ____________________ State: ______ Zip Code: ________

Local Office ☐ (check box at left & leave below blank if the local office is the HQ or there is no local office)

Street Address: ______________________________

City: ____________________ State: ______ Zip Code: ________

Authorizing Contact (person authorized to bind the firm contractually, including change orders)

Name: ____________________ Title: ____________________

Location: ☐ HQ ☐ Local Office ☐ Other: ____________________

Telephone: __________ Cell: __________ E-Mail: ______________

Project Manager (anticipated primary contact during implementation of projects)

Name: ____________________ Title: ____________________

Location: ☐ HQ ☐ Local Office ☐ Other: ____________________

Telephone: __________ Cell: __________ E-Mail: ______________

12 Credit & Work References Form

Clever Devices has provided the completed *Credit & Work References* form on the following unnumbered page. Immediately following the *Credit & Work References* form, Clever Devices has provided a letter from our previous bank showing our track record of financial responsibility and a letter from our current bank showing our good standing. These letters and references demonstrate that Clever Devices has the credentials and financial strength necessary to fulfill the project requirements completely.

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SANTA BARBARA METROPOLITAN TRANSIT DISTRICT

Request for Proposals for AVL & ITS Management Systems (AIM)

CREDIT & WORK REFERENCES

Business Name of Bidder: ____

Credit References

Include your primary bank and two firms that you **<u>currently</u>** purchase materials or services from on credit:

Work References

Include five recent clients for which you have provided **<u>similar services</u>** to the project work:

M&T Bank

Lisa M. Congemi-Doutney
Vice President
Commercial Banking

401 Broad Hollow Rd., Suite 100
Melville, NY 11747

Phone (631) 501-4138
Fax: (631) 501-4131
Email: lcongemidoutney@mtb.com

March 5, 2013

Re: Clever Devices Ltd
300 Crossways Park Dr.
Woodbury, NY 11797

To Whom it May Concern:

Please accept this letter as confirmation that Clever Devices Ltd has a long term relationship with M&T Bank. Clever Devices has a moderate 8 figure line of credit which has always been paid as agreed and within terms.

M&T Bank holds Clever Devices in the highest regard.

Yours truly,

Lisa M. Congemi-Doutney
Vice President

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HSBC

534 Broad Hollow Rd. Suite 130

Melville, NY 11747

October 4, 2013

Re: Clever Devices Ltd
300 Crossways Park Dr.
Woodbury, NY 11797

To whom it may concern:

This letter is being provided to confirm that Clever Devices Ltd has recently established a depository and credit relationship with HSBC Bank USA,NA. Clever Devices Ltd has a moderate 8 figure line of credit, and a low 8 figure term loan with HSBC Bank USA, NA. Clever Devices Ltd. always handled its banking and payments in a satisfactory manner. HSBC holds Clever Devices in high regard.

Regards,

Cristina Givelechian,
Vice President

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13 Partner, Subcontractor, & Supplier Listing Form

Clever Devices has provided the completed *Partner, Subcontractor, & Supplier Listing* form on the following unnumbered page.

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SANTA BARBARA METROPOLITAN TRANSIT DISTRICT

Request for Proposals for AVL & ITS Management Systems (AIM)

PARTNER, SUBCONTRACTOR & SUPPLIER LISTING

Business Name of Bidder: ____

List all partners or joint venturers; and any significant subcontractors or suppliers that would be participating in the project. Include all parties that would be supplying the major mandatory and optional AIM systems.

Company Name: ______________________________ Nature of Relationship: ______________

Description of Supplies/Services: ____

Company Name: ______________________________ Nature of Relationship: ______________

Description of Supplies/Services: ____

Company Name: ______________________________ Nature of Relationship: ______________

Description of Supplies/Services: ____

Company Name: ______________________________ Nature of Relationship: ______________

Description of Supplies/Services: ____

Company Name: ______________________________ Nature of Relationship: ______________

Description of Supplies/Services: ____

Company Name: ______________________________ Nature of Relationship: ______________

Description of Supplies/Services: ____

Company Name: ______________________________ Nature of Relationship: ______________

Description of Supplies/Services: ____

Contact: ____________________ Phone: ________________ E-Mail: ____________________

(Use additional sheets as necessary)

14 Noncollusion Declaration/Compensation Certification Form

Clever Devices has provided the completed *Noncollusion Declaration/Compensation Certification* form on the following unnumbered page.

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SANTA BARBARA METROPOLITAN TRANSIT DISTRICT

Request for Proposals for AVL & ITS Management Systems (AIM)

NONCOLLUSION DECLARATION

The undersigned declares:

I am the President (title) of Clever Devices Ltd. (business name of bidder), the party making the included bid.

The bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation. The bid is genuine and not collusive or sham. The bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid. The bidder has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or to refrain from bidding. The bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other bidder. All statements contained in the bid are true. The bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, to any corporation, partnership, company, association, organization, bid depository, or to any member or agent thereof, to effectuate a collusive or sham bid, and has not paid, and will not pay, any person or entity for such purpose.

Any person executing this declaration on behalf of a bidder that is a corporation, partnership, joint venture, limited liability company, limited liability partnership, or any other entity, hereby represents that he or she has full power to execute, and does execute, this declaration on behalf of the bidder.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this declaration is executed on 4 December 2013 (date), at Woodbury (city), New York (state).

Fran J Ingr
Authorized Official Signature

Francis J. Ingrassia
Authorized Official Name (printed)

COMPENSATION CERTIFICATION

I am aware of the provisions of Section 3700 of the California Labor Code which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the work of this contract.

Fran J In
Authorized Official Signature

4 December 2013
Date of Signature

Francis J. Ingrassia
Authorized Official Name

President
Authorized Official Title