City of Lawrence
KANSAS

Proposal in Response to:

City of Lawrence

Request for Proposal (RFP)

GPS based Traffic Signal Preempt and Remote Monitoring System

Prepared for:

City of Lawrence, Kansas

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1.0 Introduction and Company Qualifications

GTT is pleased to present this proposal in response to the City of Lawrence's RFP for GPS based Traffic Signal Preempt and Remote Monitoring.

As a solutions-based business, GTT provides its customers with configurable solutions to meet their unique priority control requirements. These solutions are designed and implemented with a focus on quality, performance and meeting timelines; a testament to GTT's technical expertise and responsive focus. GTT is an operating company within the Fortive Corporation. Fortive is a publicly traded company and component of the S&P 500, with 2016 revenue of $6.2B and 24,000 employees.

GTT's Opticom brand (manufactured by GTT) has been providing best-in-class priority control solutions for nearly 50 years. Beginning with first-generation optical-based technology in the 1960s, Opticom has been at the forefront of each major technical advancement in the industry, as illustrated in Figure 1 below. Each of these milestones represents a significant technical advancement that has provided Opticom customers with leading-edge priority control solutions. It also serves to demonstrate a culture of aggressive customer driven innovation within GTT that fosters forward-thinking approaches to priority control solutions and conclusively establishes GTT's leadership in the priority control industry.

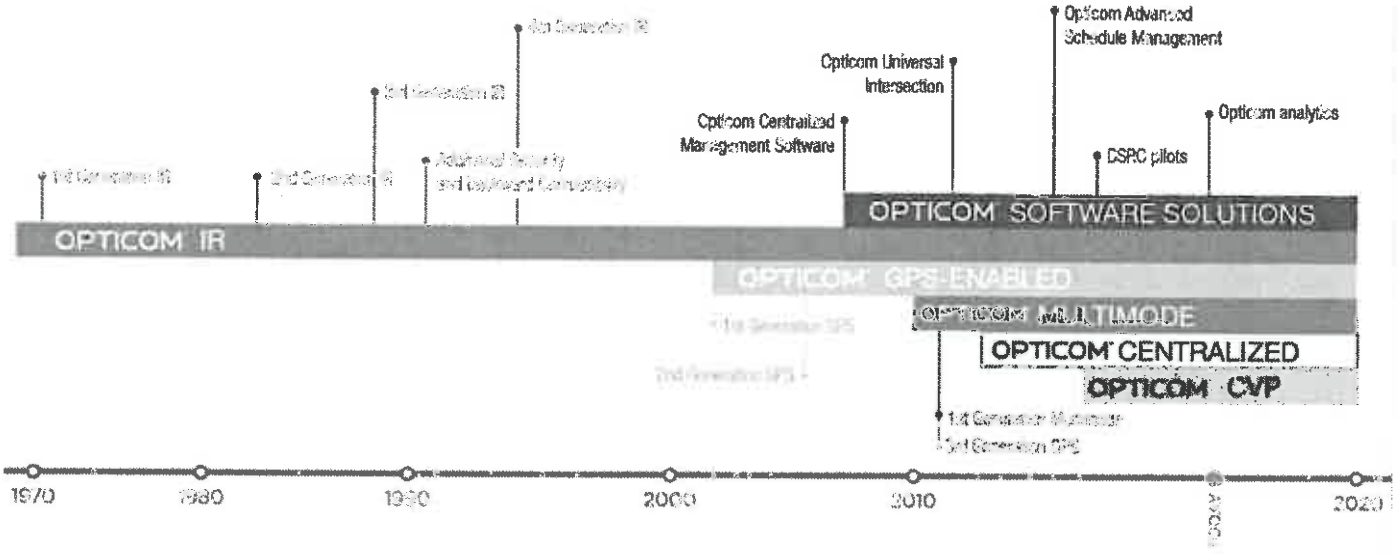

Figure 1. Major Opticom Innovations.

GTT's GPS-enabled Opticom solution, first introduced in 2002 and now in its third generation, was the first commercially viable GPS/radio based solution. It is the most widely deployed GPS based priority control solution in the world.

GTT was one of the first vendors to demonstrate priority control over DSRC (V2I) in 2011 and then again in 2014, both in real-world environments. GTT is also an active voting member on the DSRC committee.

GTT was the first to introduce a seamless upgrade from infrared-based systems to GPS (avoiding the stranded investment of a "forklift" upgrade). The resulting multimode capability was recently patented and is now deployed in tens of thousands of intersections around the world.

GTT was the first to introduce highly-reliable, feature-rich, cellular-based centralized priority control. This solution has been successfully operating in the harsh environment of Manhattan for the past four years. GTT received a patent for the unique and critical algorithms that allow the solution to provide consistent performance despite the harsh cellular, urban canyon and traffic conditions of this region.

While others may promise unproven capabilities and technologies, GTT focuses on innovation that truly makes a difference and then tests its new offerings thoroughly, in all kinds of conditions, before any parts of its solution leave its facilities.

A demonstration of GTT's successful innovation, quality and durability is the continuing growth in its customer base, now comprising over 90,000 intersections and 90,000 vehicles with more than 3,100 customers worldwide. These customers include 41 of the 50 largest cities in the United States and more than 500 of these customers are currently using the GPS/radio-based priority control solution presented in this proposal.

Opticom priority control solutions have been the subject of numerous government, industry, and customer studies over the past several decades and consistently demonstrate compelling benefits to the user agencies – whether it is improving the speed and safety of an emergency response, improving the on-time performance and operating cost of a transit fleet, allowing municipal services such as snow plows and street sweepers to be more efficient, or improving the security of VIP convoys, GTT's Opticom delivers.

GTT's Opticom solutions are also highly scalable, having been cost effectively deployed in systems ranging from a handful of vehicles and intersections to many hundreds of vehicles and intersections.

As a customer-centric organization, GTT continually strives to provide the most reliable and technologically-advanced systems to its customers and to ensure its products and services perform as they are advertised, meeting and/or exceeding customers' expectations. GTT is committed to utilizing these resources and skillsets to develop a leading-edge priority control solution across the 120 intersections and 40 vehicles within the City of Lawrence, Kansas.

2.0 Opticom GPS-enabled EVP System Overview

GTT is proposing the GPS-enabled Opticom solution in response to the request for proposal.

The GPS-enabled Opticom solution was first introduced to the market in 2002. Since that time, it has proven to be a workhorse of the industry and has been adopted by over 500 user agencies around the world. Now in its third generation, the platform is being continually evolved to take advantage of the latest in technology and to incorporate enhancements to support GTT's customers' ever-evolving needs. The GPS-enabled Opticom solution is a highly-scalable, highly-reliable platform that can be cost-effectively applied in situations with as little as one vehicle and one intersection to thousands of intersections and vehicles. The system equipment requires no preventative maintenance and has no associated recurring cost. Installation is very simple, with the system coming equipped with out of the box defaults that can be used if the customer does not wish to tailor the operation to their specific needs.

The GPS-enabled Opticom solution uses state-of-the-art GPS devices in both vehicle and intersection elements. These GPS devices are being continually updated to reflect the best the industry has to offer. The GPS devices used in the Opticom equipment today have successfully demonstrated the necessary precision and resilience in some of our most extreme applications – such as GTT's systems deployed in the deep urban canyons of New York and the hilly urban canyons of San Francisco. The GPS-enabled Opticom system also supports dead-reckoning should it be required.

The key components that make up a typical GPS-enabled Opticom system implementation include:

1. Embedded Opticom radio network
2. Vehicle equipment
3. Intersection equipment
4. Central Management Software (CMS)

Figure 2 illustrates the elements of the system proposed for the City of Lawrence, Kansas.

2.1 Embedded Opticom 2.4GHz priority control radio

Embedded in both the intersection and vehicle components of the Opticom GPS system is the purpose-built Opticom 2.4 GHz frequency-hopping, time-division multiple access radio, which enables robust, secure and flexible communications links from vehicles to intersections, intersections to vehicles and intersections to intersections. The Opticom radio was purpose built by GTT for the Opticom priority control products to provide highly deterministic operation and is not simply a repurposed off-the-shelf commercially available radio. This embedded, self-assembling and self-regulating radio technology eliminates the need for system implementers to set up and maintain databases for each of the intersection's frequency and timeslot schedules. It also eliminates the need for system operators to design, procure and maintain a separate radio network to support priority control, thus ensuring the seamless operation between different agencies and jurisdictions required for regional integration of Transit Signal Priority (TSP) and/or Emergency Vehicle Preemption (EVP) operations. The radio carries all the vehicle to intersection communications necessary to initiate and perform priority control.

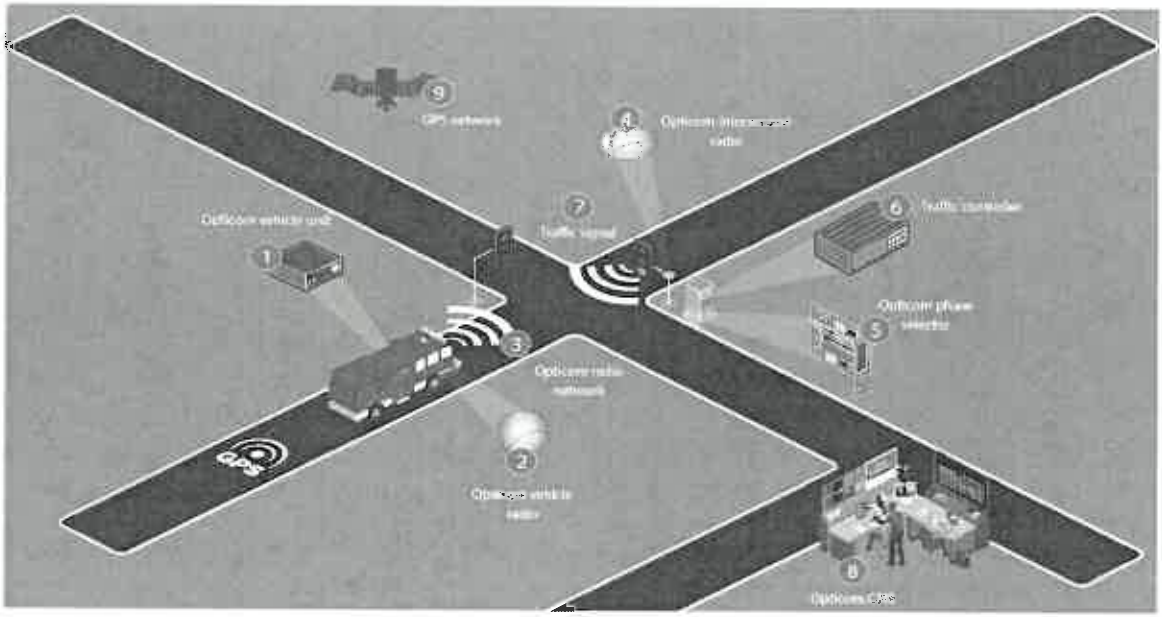

Figure 2. Emergency Vehicle Preemption (EVP) via the GPS-enabled GTT Opticom System.

2.1.2 Benefits of the Opticom radio technology

The 2.4 GHz frequency band was selected for the Opticom radio implementation because mobile transmitters using this frequency band are less likely to experience data dropouts caused by radio wave multipath reflections, as compared to lower frequency bands. The Opticom system has been tested and meets all conducted and radiated emissions standards (ETSI (when required), FCC, IC) to ensure proper operation on a standalone basis or when co-resident with other systems, as proven by GTT's extensive field deployments.

2.1.3 Opticom radio attributes

While some claim that radios operating at lower frequencies provide better preemption performance due to greater range, GTT believes that submitting preemption requests over a longer distance does not provide improved system performance. The Opticom radio operates at 2.4 GHz, providing a 2,500 feet preemption range. This distance is an industry standard that has been proven over almost half a century of priority control usage to provide effective preemption performance, while minimizing the impact on the overall flow of traffic. Typically, when configured for estimated time of arrival (ETA)-based triggering, less than 2,500 feet is required. Additionally, the higher bandwidth of the 2.4 GHz radio allows more data to be transmitted between the vehicle and intersection, to provide a richer feature set and a more deterministic operation.

Additional benefits of the Opticom radio include:

- **Proven performance.** With more than 500 agencies currently using the GPS-enabled Opticom system, with tens of thousands of embedded radios, the solution has demonstrated its performance and resiliency.
- **Access time:** The Opticom radios are purpose built for ultra-fast acquisition whenever two nodes come into range of each other. A communication path is established in less than 300 milliseconds – something that is critical for high speed emergency vehicles approaching an

intersection – unlike collision based radio technologies that can take several seconds or even minutes to acquire.

- **Deterministic access**: The proprietary algorithms built into the radios automatically assign specific timeslots for each intersection and vehicle within the established network of connected devices. New system entrants are handled immediately and in a deterministic manner.

- **Number of users**: Each Opticom intersection radio has the ability to connect simultaneously with more than 100 vehicles within its range of communications; an urban center may be expected to have a large number of emergency vehicles requiring service within the network at any one time and for the mix of vehicles to be constantly changing. The capacity of the intersections' radios to reliably establish and maintain communications with over 100 vehicles offers a particularly robust solution. *Note: These limits apply to individual radio nodes; there is no limit to the number of vehicles or intersections in the overall Opticom system.*

- **Secure, reliable data transfer**: The Opticom radio breaks the signal into message packets that are continually "hopped" between different frequency bands and time slots based on proprietary algorithms to improve security and performance. The RF portion of the message is Manchester-encoded. The message structure and protocol is not published. This makes locating and locking onto a transmission by an unauthorized user extremely difficult and successful decoding very unlikely. Each message is transmitted three times per second to ensure against data dropouts. The use of a frequency-hopping, time-division method of access also eliminates the possibility of interference from public and private networks (e.g., Wi-Fi) transmitting within the same 2.4 GHz operating band.

- **No single point of failure**: The fully distributed nature of the signaling radio ensures that even if a single node should fail, the rest of the priority system will be unaffected and will continue to operate normally.

- **Compatibility between TSP and EVP operations:** The Opticom system uses the same radio system for all priority control applications (e.g. including TSP and EVP operations), ensuring seamless interoperability.

- **Autonomous/self-establishing**: Eliminates the need for intersections or vehicles to know the communications addresses or geographic locations of other intersections or vehicles. This is especially convenient for mutual aid and it greatly reduces the time associated with system setup and maintenance.

2.1.4 Cellular-based priority control solutions

GTT has extensive experience deploying cellular-based priority control solutions, including in both New York City and Washington D.C. While these systems can be very efficient in the right circumstances, they do create several disadvantages compared with a dedicated, purpose-built radio:

- In times of significant crisis, cellular networks tend to get overloaded and "collapse," making them an unreliable communications mechanism
- Cellular necessitates a recurring cost

- Cellular is vulnerable to the technology evolution path of the carrier (e.g., dropping 2G to free up bandwidth for 4G) exposing the user to the need for a hardware technology retrofit and potentially significant increases in recurring costs
- Unless advanced algorithms are employed (such as with GTT's cellular-based systems), transmission latency can be very unpredictable and problematic

2.2 Vehicle Equipment

The vehicle components of the GPS-enabled Opticom priority control system consist of the Opticom radio/GPS vehicle unit with the embedded 2.4 GHz radio and the Opticom radio/GPS antenna (reference section 9.2).

The Opticom GPS vehicle unit's primary functions are to query the internal GPS receiver for the vehicle's current latitude, longitude, speed and heading; and to pass the information along with the vehicle's unique identification information, to the internal Opticom radio for transmission to receivers located at priority control-equipped intersections. The Opticom GPS vehicle unit also gathers and routes vehicle data to the internal radio, configures the GPS module for optimal performance and monitors the vehicle's interfaces, such as AVL inputs, left and right turn signals and activation and deactivation points. By monitoring the vehicle's turn signals, the system is able to provide advanced turning movement information to the controller, enabling it to optimize the vehicle's progression through the intersection (including bringing up advanced greens for left turns and activating queue jumps).

Some of the key vehicle equipment features are as follows:

- 4 configurable outputs, used for example to signal other on-board equipment, such as the AVL or to actuate user-defined indicators.
- 2 configurable inputs, which can be used to monitor other on-board equipment for status, such as additional door switches, bell cords, etc.
- Multiple indicators for GPS status, radio link status, power-on indication and priority enabled or disabled status. While these indicators can also be used by the vehicle's operator to identify acceptance of the request by the intersection equipment or priority request conflicts at the intersection, GTT always recommends that vehicle operators drive the intersection lights (e.g., red/green) and not be distracted by in-vehicle equipment.
- J1708, RS-232, Ethernet and USB communications ports for communications with other on-board systems, such as AVL systems and/or passenger counters or for communication with the Opticom CMS for data or software updates or log retrieval.
- Vehicle identification encoding – Unique identification for each vehicle allows the system to enable or disable priority for individual vehicles or groups of vehicles.
- Additional GPS output in NMEA format for other on-board uses.
- Available Windows™ configuration and maintenance software.
- Configurable remote activation mode, which allows the system manager to select either a logic-high or logic-low setting; or a logic transition from either high-to-low or low-to-high for activation of the priority request. This greatly eases integration with on-board systems.

- Configurable operating mode of disable inputs, which allows the system manager to select either a logic-high or logic-low; or a logic transition from either high-to-low or low-to-high for disabling of priority requests. This greatly eases integration with vehicle systems.
- System activity logging.

2.3 Intersection equipment

The intersection portion of the Opticom priority control system consists of two main components:

1. The Opticom multimode phase selector located in the cabinet of the controlled intersection
2. The Opticom intersection radio located on the controlled intersection's mast arm

Section 9.1 provides the detailed specifications for the GPS-enabled Opticom intersection equipment.

The phase selector is the heart of the system. It collects vehicle information via the radio receiver. Based on various pre-provisioned or default settings, it then decides which vehicles are eligible for priority and within the eligible set, which vehicle should be granted priority at that point in time. It then communicates directly with the intersection's controller via discrete outputs to initiate the appropriate action. The phase selector also includes RS-232, Ethernet and USB capabilities, which greatly simplifies connectivity within the traffic cabinet and enables remote management and software upgrades. Over the 50-year history of the solution, Opticom phase selectors have been used successfully in all major brands of traffic controllers, both domestically and internationally.

The Opticom intersection radio is another key component of the intersection system. It transmits a beacon every 1/3 of a second to let other equipped intersections and vehicles within its radio range know that it is on the air and ready to respond. It also receives data transmitted by equipped vehicles within its radio range and relays this information to the phase selector for processing and to other system-equipped intersections within radio range. The Opticom intersection radio also contains a GPS unit which is used to obtain location and timing information from GPS satellites. This signal is also made available to other devices in the traffic cabinet.

The Opticom auxiliary interface panel (AIP - included with this proposal) is an extension of the phase selector to provide additional I/O – including ports to monitor signal phase and additional outputs to drive up to 16 preempt phases (4 phase selector, 12 AIP).

2.4 Opticom Central Management Software (CMS)

The Opticom CMS was first introduced in 2009 and has been deployed in over 100 customer sites.

CMS provides seamless, remote management of an Opticom priority control system from the traffic management center, transit operations center, or emergency management center (or from other locations). This unique software solution provides the ability to manage multiple generations of the Opticom system from a central site (or optionally, directly at the intersection), resulting in operational optimization and reduced maintenance costs. The CMS utilizes the customer's existing communication networks at the intersection to connect with the Opticom phase selector and optionally can connect with the Opticom vehicle equipment over a customer's existing cellular or Wi-Fi network.

With CMS, the System Manager can:

- ***Manage*** equipment inventory, configuration and system security. Data regarding the state of

configurable intersections, vehicle parameters and firmware versions can be retrieved and adjusted, all from a central facility.

- ***Maintain*** system performance, both proactively and reactively. CMS provides for system optimization through parametric updates, as well as fast, easy firmware updates from a central location.
- ***Monitor*** usage across the system and at each intersection and vehicle. Data reflecting priority control performance, including intersection and vehicle states during current and past events, is continuously retrievable via communications networks connected to the intersections and/or vehicles.

2.4.1 Key Features of CMS

- Remotely connects to intersections' phase selectors over a customer-supplied network, to permit centralized configuration of system parameters.
- Remotely connects via Wi-Fi with Opticom-equipped vehicles when in their garage or depot or over a cellular connection.
- Provides a repository for system configuration data (files), to permit bulk updates of phase selectors and vehicles.
- Audit trails - Tracks and reports changes to priority control settings, including when and by whom; and restoration support if a change needs to be backed out.
- Provides overall system level security by the use of regional coding plans, to allow for control of which vehicles and agencies are permitted to activate specific intersections. Access can be controlled down to individual intersection and vehicle granularity.
- Provides remote access to perform proactive maintenance when reports indicate a system anomaly, for both vehicles and intersections.
- Aggregates intersection and vehicle activity logs, to permit detailed analysis and reporting.
- Provides remote access for troubleshooting and correcting system failures, for vehicles and intersections.
- Provides remote firmware updating, for vehicles and intersections.
- Provides usage reports at the overall system, agency, vehicle and intersection level.
- Provides a central repository for system activity and performance indicators. These can be analyzed at the system, agency, vehicle, or intersection level. This data can also be used to determine the transit time of specific vehicles between priority control points.
- Evacuation Mode: This optional package allows the user to designate evacuation corridors on which specific vehicles (typically transit buses) will automatically have their priority elevated when evacuation mode is active. This gives these vehicles faster passage through intersections, to allow the faster movement of passengers in the case of major events or emergency evacuations. CMS allows evacuation corridors to be identified in advance and then activated automatically based on date and time; or to be activated manually.
- CMS, using TCP/IP-based messaging provides push notifications of priority control events to external systems, such as an ATMS or video surveillance systems.
- Time Plans: The Opticom priority control algorithm (resident on the phase selector) incorporates the ability to modify priority control parameters automatically, based on the time of day, day of the week, specific dates, specific vehicles, specific intersections and/or relative and directional priority. For example, approach maps can be modified based on time of day to increase the activation distance to overcome rush hour congestion impacts on emergency vehicles, or directional priority can be given to transit during rush hour. Time plans can be programmed uniquely at each phase selector using CMS.

- Provides alerting via SMS or e-mail if anomalies have been detected or pre-defined thresholds have been crossed.
- CMS security configuration to grant different access rights to different users (e.g., admin read/write, read-only, etc.), including defining login credentials such as user ID and passwords.

2.4.2 CMS report generation – Built-in reports

CMS currently generates the following standard reports:

- System Usage report
  The System Usage report is a report of all preemption/priority requests on the entire system. The user can determine which dates, priority levels and jurisdictions are included in this report.

- Agency Usage report
  The Agency Usage report identifies per agency usage across the region or within selected jurisdictions. This information can be used to monitor preemption/priority activity by agency and as a percentage of the overall system's usage.

  Note: Only agencies with granted preemption or priority calls within the selected intersection jurisdictions and date ranges are included in the report.

- Unregistered Vehicles report
  The Unregistered Vehicles report lists all preempts or priority calls attempted by vehicles not registered in the Opticom CMS database during the selected date range.

- Unauthorized Vehicles report
  The Unauthorized Vehicles report lists preempts or priority calls attempted by vehicles not authorized by the intersection's security settings during the selected date range.

- Long-call Duration report
  The Long-call Duration report lists all calls where the duration is abnormal and potentially in need of adjustment. For example, if a particular vehicle appears on this report consistently and at multiple intersections, the vehicle's disable function may not be working properly.

- Inactive Vehicle report
  This report identifies vehicles that have not had any priority control activity for a predetermined amount of time. This can also be used to identify relocated, failed or disabled vehicles.

- Event Log report
  This report summarizes CMS's event log entries. For example, the report can be used to notify system users of errors and warnings detected over a period of time.

- Top Preempted Intersections report
  The Top Preempted Intersections report identifies intersections with the most granted preempts or priority calls within the selected date range. Activity is calculated for all approaches of an intersection and all priority levels.

- Inactive Intersection report

This report identifies intersections that have not had any priority control activity for a predetermined amount of time. This can also be used to identify failed or disabled intersections

See section 10 for images of the CMS screens used to generate, refine and schedule reports. CMS also captures the raw log data from vehicles and intersections.

- Vehicle ID
- Vehicle type
- Position
- Speed
- Heading
- Priority level
- Estimate time of arrival (ETA)
- Name of intersection
- Date
- Start time
- End time
- Duration
- Channel (intersection only)
- Agency
- Conditional priority
- Preempt made
- Authorized (intersection only)
- Green time – if green sense purchased (intersection only)
- Final green status – if green sense purchased (intersection only)

The data listed above can be viewed directly in CMS and can be sorted and filtered as needed to extract the appropriate view. A pivot table capability is also available, to permit highly-customized reports utilizing any of the data collected by CMS. Generation of reports can also be automated to alert users via text messaging or email.

2.4.3 CMS report generation – User defined reports

CMS allows the user to export data (e.g., logs) for analysis outside of CMS. A common method is to export the data to Excel for further manipulation and analysis.

Future customer-specific reports can be developed quickly. The following are examples of reports that could be generated from the data collected by the Opticom system:

- Number of preemption requests by vehicle class
- Intersection crossing speeds by vehicle class
- Top vehicles by preemption requests
- Bottom vehicles by preemption requests
- Top intersections by preemption requests
- Fastest intersection crossing times by maximum speed
- Slowest intersection crossing times by average speed

- Preemption denials

2.4.4 Regional coding plans

The ability of CMS to manage illegal and unauthorized users goes far beyond simply detecting and blocking the offending vehicles. When first introduced in 2009, the principal purpose of CMS was to manage coding. In the seven years of deployments since it was first introduced, CMS functions related to coding management have undergone continuous advancements.

The first step in any effective coding scheme is to be able to define and manage a regional coding plan, thus allowing consistent and systematic management of coded vehicles both within and outside of the local jurisdiction. Figure 4 in section 10 shows the CMS window used to enter and manage a regional coding plan. Vehicle ranges are defined for each agency and class of vehicle and then as vehicles are added, they are given a slot in the agreed upon range. Once these codes are defined, the user then determines how rigorously the coding rules are to be enforced for each agency. This can range anywhere from a wide open system (all vehicles are able to activate the system) to only specific vehicles and classes being allowed to activate the system. Given that many jurisdictions participate in mutual aid, it is important to have a mechanism for controlling vehicles entering the jurisdiction that may not be directly under the jurisdiction's control. CMS allows the user to define mutual aid partners and control how they use the system (see Figure 5).

Periodically, it's necessary to lock out certain vehicles, either for maintenance reasons or because a vehicle or vehicle unit was stolen. Figure 6 illustrates how CMS can be used to block specific vehicles from activating the system.

Once the system is configured, it can then be used to manually or automatically provide notification of unauthorized vehicle attempts to activate the system. Figure 7 illustrates a typical report identifying the time of the request, the intersection, the direction, the code used and whether or not preemption was granted.

Figure 8 illustrates the appearance of unauthorized requests when real-time priority control activity is being monitored. By providing these functions, the Opticom system does much more than simply capture illegal requests; it allows agencies to provide a fully-managed and secure environment.

Note: CMS is a management tool and it does not participate in the real-time processing of priority requests between equipped vehicles and intersections.

2.5 Opticom Analytics (Optional – excluded from this proposal)

In response to customers' requests to leverage the wealth of information collected by the GPS-enabled Opticom system, GTT has developed a SaaS-based analytics package that allows agencies to identify bottlenecks in overall system performance. This powerful tool can be accessed from any browser.

As with any system, the operational environment of EVP (or TSP) can change gradually over time, resulting in the system operating at less than peak performance through no fault of the EVP system itself. Given the complexity of the vehicle and intersection environments in which EVP operates, it is common for changes not directly related to EVP to unexpectedly impact the performance of the EVP system. Examples of such changes could include changes in pedestrian crossing times at an intersection, changes in traffic patterns that exceed the original assumptions used when the EVP system was initially configured, changes in timing plans, etc. The EVP system may be overlooked when such changes are

made. Without an easy tool to flag these bottlenecks as they are introduced, the impact to performance may go unnoticed over time. Classic methodologies such as measuring overall travel times, may or may not be able to indicate an issue (especially on infrequently travelled routes), but they won't pinpoint the source.

With the Opticom analytics tool, the bread-crumbing feature of the Opticom GPS system is used to measure system performance to expectation in 1 second granularity, instantly flagging unexpected behavior. Because the tool looks at the problem from a user (e.g., Fire/Transit) perspective, a change that may look harmless from an individual intersection or bulk traffic perspective, may look very different from the perspective of an agency with very different requirements from a "traffic" infrastructure perspective.

To simplify access to the data by individual agencies, the data used by the analytics tool is collected and stored on individual vehicles. This avoids the need for an agency to burden the traffic department with continual requests for performance data. When an agency's vehicle returns to the station, the data is automatically uploaded via Wi-Fi to the "cloud" and used for analysis. Cellular can also be used, but the use of Wi-Fi eliminates the recurring cost of cellular networks. Once in place, the Wi-Fi network can also be used to modify the configuration and to provide software updates on the Opticom-equipped vehicles.

The analytics tool is not included in this proposal, but would GTT would be happy to provide more information and an all-encompassing proposal if/when appropriate.

3.0 Opticom GPS system operation

Operation of the Opticom system is as follows (reference Figure 2).

When a vehicle's Opticom Vehicle Unit **(1)** is activated upon vehicle power-up and comes within radio range of an Opticom intersection radio **(4)**, the vehicle continuously transmits its location, heading, speed, turn-signal information and identification on a frequency channel and time slot automatically assigned to it by the Opticom radio network **(3)**. The Opticom intersection radio **(4)** relays the received priority data to the Opticom phase selector **(5)** located at the intersection. The phase selector **(5)** receiving this data compares the locations received (once per second) with a stored approach map. If the received message is from an authorized vehicle, if that vehicle is within the predefined intersection approach map and if that vehicle is the highest priority vehicle requesting priority, the phase selector **(5)** communicates the request for preemption to the traffic controller **(6)** over signaling wires at the intersection, which activates its algorithm and requests the signal (7).

As soon as the vehicle exists the pre-defined approach zone (typically the intersection center line), the phase selector drops the request to the controller.

3.1 Minimizing the effect of priority requests on other vehicular traffic

The following capabilities and parametric settings allow the Opticom GPS-enabled priority control system to offer optimized system response to vehicle priority requests, with the minimum possible impact on other vehicular traffic.

- Relative (class) and directional-based priority ensures the right vehicle gets the green. This capability allows the preemption behavior of the intersection to vary based on either the class of vehicle requesting the intersection, the direction from which the call originates, or a combination of any or all of these factors. These configurable rules allow the system operator to optimize and define the performance of priority service for each intersection and can include the following factors:
    - Activation ranges can be based on the class of the vehicle.
    - Contention between simultaneous competing requests from multiple vehicles at the intersection can be resolved by the class level of the vehicle or direction of travel. This is termed relative priority and the Opticom system allows 15 levels of priority (classes) each for high- (typically emergency vehicles) and low- (typically transit vehicles) priority vehicles.

- Limit-low activation or "lock-out" enables the ability to limit the number of priority control requests that can be made to an intersection within a selectable time period. This feature, called limit-low priority, can be configured independently for each approach to an intersection and is typically used in transit applications during high traffic periods.

- Time plans to modify system's behavior as a function of time of day or day of week enables activation points or ETAs (as well as virtually any system configuration parameter) to be varied by time of day and or day of the week. This allows the system operator to optimize priority operations based on known or expected traffic volumes or other factors, which can vary with the clock and calendar.

- Logging of all priority activity (for analysis, system optimization and performance measurement)

allows the system operator to analyze performance data for intersections with a focus on possible controller timing optimizations, or Opticom parametric settings. For example, if the operator determines that green phases are being activated sooner than required, based on vehicle speeds and intersection timing, the range point can be moved in to minimize the time taken from side streets.

- ETA-based triggering of the call request allows the system to adapt to changes in traffic flow rates automatically. Slow travel speeds will result in an activation closer to the intersection versus what a faster vehicle would have. This automatic adaptive behavior contrasts with a fixed distance trigger point, which is optimal for only one speed. Further, the ETA trigger can be set so that enough time is allotted for worst-case timing return to green and pedestrian clearances, without the need for additional buffer time due to approach speed uncertainty. This ensures the minimum preemption green time is used. ETA can be set up to 256 seconds.

- Turn-signal-dependent mode allows for more precise system control at the intersection, based on the vehicle's turn-signal state. This information is transmitted to the intersection, where the Opticom phase selector uses this information for two separate features:
    - The intersection that the vehicle is approaching can relay the priority request to the nearby intersection in the direction that the vehicle will be turning, to reduce coordination impacts and missed preemptions on short blocks.
    - The outputs of the phase selector can also be varied depending on the state of the turn-signal, allowing different greens to be displayed depending on the intended direction of the vehicle (left arrow, right arrow).

- Call bridging links the priority requests of two vehicles traveling in the same direction and in close proximity to one another. This is applicable to EVP systems and prevents the intersection from momentarily dropping the green in the direction of travel between vehicles.

- Call forwarding is a feature that allows the preempting vehicle to call not only the immediate intersection in the direction of its travel, but also have that intersection forward the call to the next intersection in the downstream path. This extends the preemption range of the vehicle and is often used for vehicles such as VIP motorcades where a pre-cleared road is desired long before the preempting vehicle arrives for security reasons.

- Approach zones are geographical areas drawn on a map via mouse clicks in CMS that determine when a vehicle is to be considered "on approach" to an intersection. These can be built up to take on virtually any shape. By varying the length and width of these approach zones, more precise control of the intersection can be achieved to provide both more reliable control of the intersection and reduced impact on other vehicular traffic.

4.0 Summary

GTT has a proven track record of working in partnership with customers and third-party hardware and software vendors to ensure that the priority control solutions deployed are always the most effective, efficient and feature-rich solutions available on the market today. GTT also designs solutions to evolve with the customer's needs and support backwards compatibility to minimize stranded investments.

GTT has developed a very broad portfolio of priority control products and has a long history of performance, enabling the ability to provide the solution that best fits a particular need.

GTT believes that the GPS-enabled Opticom solution proposed will provide the City of Lawrence with years of trouble free EVP performance that exceeds expectations. GTT therefore requests that the City of Lawrence consider this solution to meet the EVP portion of the City's requirements.

5.0 Case Studies and References

The case studies and reference list below includes customers that have utilized GTT as their prime contractor for both GPS/radio-based projects. Please contact GTT if you would like any further information concerning these references or any other references.

Company Name/Address, City, State	Date of Installation/# Vehicles	Contact Name, Phone #, Email address	Identify Product Installed
City of Hudson FD 40 South Oviatt Street Hudson OH 44236	12-31-2014/18 vehicles	Bob Carter Phone: 330-342-1870 Email: bcarter@hudson.oh.us	Model: Preemption/Priority Radio/GPS Unit
Miami Township Fire & Rescue 5888 McPicken Drive Milford OH 45150	2-27-2009/20 vehicles	Dan Mack Phone: 513-248-3700 Email: Daniel.Mack@miamitwpoh.gov	Model: Preemption/Priority Radio/GPS Unit
Liberty Township FD 6682 Princeton Glendale Road Liberty Township OH 45011	9-25-2010/18 vehicles	Mickey Smith Phone: 740-938-2021 Email: msmith@libertytwp.org	Model: Preemption/Priority Radio/GPS Unit
Mason City Fire Department 350 5th St SW Mason City IA 50401-3822	5-31-2012/21 vehicles	Bob Platts Phone: 641-421-3640 Email: bplatts@masoncity.net	Model: Preemption/Priority Radio/GPS Unit
Iona-McGregor Fire Rescue 6061 South Pointe Boulevard Fort Myers FL 33919	10-2-2009/60 vehicles	William Elliott Phone: 239-433-0660 Email: welliot@ionafire.com	Model: Preemption/Priority Radio/GPS Unit

5.1 Broward County, FL: TSP & EVP project

Broward County Traffic has installed Opticom GPS-enabled equipment in over 689 of their intersections. This project took place in phases, over the last 14 years. Opticom is used to support EVP for the 31 communities within the county. Cities such as Fort Lauderdale, Hollywood, Pembroke Pines, Sunrise, Plantation and Coral Springs, as well as others, continue to implement the Opticom system within their emergency response fleets, with over 250+ emergency vehicles now equipped.

Because of the successful EVP implementation, Broward County Transit initiated its own efforts to expand the use of the Opticom system for transit operations. GTT, working with Broward County Transit, supported the implementation of GPS equipment on 225 of its buses across two phases.

These combined projects have included performing the following tasks:

1. Completed vehicle surveys to determine the optimal vehicle equipment placement, activation points and deactivation points. This task also included the planning needed to integrate TSP into an upcoming CAD/AVL implementation.
2. Developed the coding plan needed to facilitate tracking of emergency and transit vehicles throughout Broward County.
3. Completed vehicle installation and turn-on services for TSP & EVP vehicles.
4. Performed vehicle installation and maintenance training for Broward County's fleet maintenance personnel.
5. Developed and implemented an on-site vehicle logging/verification system that enables vehicle performance monitoring at the maintenance depot (for TSP).
6. Completed a vehicle documentation package, including all manuals, warranty information, user information and contact information.
7. Developed the intersection and vehicle Verification & Validation Test procedures used to document installation and performance compliance.

Contacts:

Mike Manchi
Broward County Transit
Project Manager
Work Phone: 954-357-8363
Mobile Phone: 954-553-0590

Scott Brunner
BC Assistant Director, Traffic Engineering
2300 West Commercial Blvd.
Fort Lauderdale, FL 33309
Work Phone: 954-847-2617

5.2 Case Study: Faster and Safer: Opticom's GPS Preemption System Helps Emergency Responders on the Las Vegas Strip

CASE STUDY

OPTICOM Emergency Vehicle Preemption

Faster and Safer: Opticom's GPS Preemption System Helps Emergency Responders on the Las Vegas Strip

Las Vegas Boulevard, also known as "The Strip," is one of the most iconic stretches of roadway in the world and has been featured in countless movies, TV shows and music videos. Over 43 million visitors flock to The Strip each year, taking in sights like dancing fountains, a replica Eiffel Tower, an erupting volcano and some of the world's largest and most impressive resort hotels and casinos.

With so many visitors, street congestion inevitably causes Las Vegas Boulevard to be one of the busiest roadways in the country.

With responsibility for the safety of citizens, entertainers and visitors, Clark County Fire Department (CCFD) needed help to ensure that emergency vehicles were able to reach their destinations swiftly and safely, even when traversing The Strip. CCFD reached out to Global Traffic Technologies (GTT) and invested in the Opticom GPS Emergency Vehicle Preemption system.

Clark County

Clark County is responsible for an area the size of New Jersey and is the USA's 13th largest county. In addition to the Las Vegas Strip, it includes the nation's 8th busiest airport and Nevada's largest hospital, University Medical Center. There are in excess of 150,000 hotel and motel rooms in Clark County to accommodate those 43 million-plus visitors.

Municipal services, including fire protection, are provided to more than 900,000 permanent residents. The Clark County Fire Department protects an area of 7,420 square miles and operates 30 paid fire stations, staffed by 667 firefighters and 13 volunteer fire stations, with 180 volunteer firefighters.

It goes without saying that the Fire Department plays a vital role in the safety of Clark County, responding to emergencies of all types. To illustrate the importance of its role, in 2013 the Fire Department responded to 143,283 calls, of which 7,834 were fire incidents and 132,963 were medical needs.

Opticom Heritage

When responding to emergency calls on the congested Las Vegas Strip, the key objective is focused on fast, safe passage of emergency vehicles – in this case fire trucks and rescue vehicles – through decidedly busy intersections.

Previously, to address this issue, many agencies throughout the Las Vegas area, including the Clark County Fire Department, the City of Las Vegas Fire and Rescue, the Regional Transportation Commission of Southern Nevada and the Metro Area Police, invested in Opticom Vehicle Preemption systems from GTT.

LOCATION

Las Vegas, NV

MUNICIPALITY

- Clark County Fire Department
- City of Las Vegas Fire and Rescue
- Regional Transportation Commission of Southern Nevada
- Clark County Public Works Department

CHALLENGE

- Navigate through highly congested areas
- Prevent crash through obstructive

SOLUTION

- Upgrading existing Opticom infrared technology to Opticom GPS

PERFORMANCE

- Improved response times by greater than 30%
- Obstacles are no longer a problem
- Safer crash and collision rates
- Vehicles are able to better accommodate to emergency vehicles

The Opticom Emergency Vehicle Preemption systems work by sending a request to provide emergency vehicles with green lights at the intersections – as required – to pass through swiftly and safely. As a result, agencies can improve response times while reducing the potential for costly accidents.

CHALLENGE

The original systems installed throughout Las Vegas used Infrared (IR) communication between authorized vehicles and intersection controllers. But over time, the Clark County Fire Department recognized that there was a need to upgrade the system.

GTT's Dewey Garner explains, "The problem was that rescue vehicles and fire apparatuses were turning onto Las Vegas Boulevard and going right into traffic gridlock. They were then often sitting too far back from the intersections to trigger the infrared detectors to change the lights in front of them. The result was that traffic was just stuck. They were dead in the water and couldn't move, sometimes for two or three light cycles.

"So the challenge was thrown out by the Clark County Fire Department for the problem on The Strip and then we'll find the money to upgrade all the other challenging intersections too. So they worked with us and our authorized dealer, Advanced Traffic Products, to begin the transition."

Unique Challenges

Senior Deputy Fire Chief at the Clark County Fire Department, Eric Newman has worked closely with GTT and likes to monitor new technology developments. "We knew that the City of Henderson Fire Department was using the Opticom satellite GPS equipment and we saw from their reports that they were getting better harry for their buck in terms of moving traffic quickly," he says. "That's how the Opticom GPS solution first came to my attention."

"I had the opportunity to be in front of a Henderson rescue vehicle as it was coming up Eastern, which is a very busy intersection for the City of Henderson and I saw how the sets of lights – two or three sets ahead- started turning green and moving traffic."

Garner says Las Vegas Boulevard presents its own set of unique challenges for EVP systems. "Pedestrian bridges, which go up and over the top of the road, sometimes have a tendency to block the infrared signaling coming from the fire apparatus to the intersection."

"There we also huge planter boxes right down the middle of Las Vegas Boulevard, which create issues with palm trees and palm fronds growing over and blocking the IR signal. The planter boxes also mean that the fire vehicle cannot jump into opposing lanes of traffic when responding to an emergency call. The infrared system is also susceptible to dirt in the air, meaning lenses needed to be cleaned regularly to ensure proper operation. But by switching from infrared to GPS, we overcame some of those obstacles and were able to move traffic much more smoothly."

Parting the Red Sea

During the pilot project, 12 intersections were installed on The Strip. The intersections covered in the project run from Tropicana Avenue to Spring Mountain Road: the most popular stretch of Las Vegas Boulevard.

"Our Friday, Saturday night and Sunday traffic is as bad, or perhaps worse than Times Square in New York," Chief Newman says.

"So we thought it would be quite a challenge for GTT. Once we got the buy-in from the Public Works Department, the new system was installed pretty quickly and during the trial the GPS units were fitted to three fire engines and three rescue vehicles.

"The initial data looked very encouraging, but GTT listened to our feedback and made further adjustments. For instance on one specific intersection, the system was turning lights green, but it wasn't triggering the other lights for left turning; so we had to make some minor adjustments. After those adjustments were made, performance shot up 30% or so."

The Opticom GPS system incorporates vehicle turn signals in two modes: to select a turn arrow at the next intersection, or to communicate with the next intersection in the direction of the turn signal – or both.

Chief Newman continues: "One day I just happened to be at an intersection when our vehicles were going on a call. They came around the corner and I saw every light turn green and I thought: this is like parting the Red Seat Cars were moving, the engines and rescue vehicles were making down the Boulevard – and this was about 7 o'clock at night on The Strip. It was amazing."

PERFORMANCE

Outstanding Results

The new system has been in use on The Strip since March of 2015. "It took 30-45 days to install and configure everything," Chief Newman says. "At that point, we trained all the shifts of users, which occurred over a period of about 60 days, which also served as an evaluation period."

A key element of the design and installation process was the ability to define "approach zones" – the areas where the vehicles begin communicating with the next intersection.

"We had to adjust the approach zones to accommodate the traffic patterns," Chief Newman says, "so that lights wouldn't turn to green too early or too late. Because of the traffic congestion, the approach zones are almost touching each other at this point."

Early data indicates a 32% reduction in the time taken for emergency vehicles to move through the intersections.

"The value for any emergency agency is to get to the incident faster," Chief Newman says. "A 32% reduction in time will save lives, because seconds can count when somebody is ill or has been in an accident. But we need to get there safely too, to avoid secondary damage and the expense that can lead to."

The Opticom system is monitored by Control Management Software at the Regional Transport Commission of Southern Nevada. Public Works, Clark County and the City of Las Vegas all have access to the system and data.

Future Expansion

Chief Newman says the new system has been 100% reliable. "It has helped the public and our visitors to get out of the way a bit more quickly," he says. "Because sometimes, if you're in a car and a fire truck comes screaming up on you, you panic and you don't know where to go. So the system has now allowed people to move forward and pull over to the right. I think that is the biggest assistance that has helped our drivers, giving the public more time to move forward and get out of the way of the emergency responders."

And Chief Newman is glowing in his appraisal of the experience of working with GTT: "They're a great company to work with. They listen, pay attention to detail and truly care about building an ever-increasing list of satisfied customers. They've been doing this a long time and they wouldn't have survived if they didn't partner with their customers to ensure success."

"...the system has now allowed people to move forward and pull over to the right. I think that is the biggest assistance that has helped our drivers, giving the public more time to move forward and get out of the way of the emergency responders."

Bill Newman,
Assistant Chief
Clark County Fire Department

Clark County Fire Department
http://www.clarkcountynv.gov/fire/Pages/default.aspx

[redacted]

5.3 Case Study: Brookhaven, NY Upgrades to Maintain Fast, Safe and Affordable Emergency Response

CASE STUDY

CHALLENGE

Safety comes at a price

Brookhaven comprises eight incorporated villages and 52 hamlets in Long Island, a short drive from New York City. With nearly 500,000 residents the region is densely populated, but public transportation is limited. Less than five percent of residents use public transportation, so gridlocked roadways and thoroughfares are common.

To help alleviate the gridlock and to help first responders reach emergencies safely and quickly — city officials implemented an Opticom™ infrared (IR) priority control system for nearly 500 intersections and nearly 3 000 miles of town, county and state roads.

For more than 10 years the IR system operated exceptionally well. "The system improved emergency response times by 25 to 40 percent," said Chief Fire Marshall Salvatore Gerbasio.

More than 500 fire department vehicles and ambulances were equipped with IR emitters. Every intersection had its own equipment, including detectors, phase selectors and more.

"Brookhaven has more roads than any other municipality on Long Island," said Daniel P. Losquadro, Town of Brookhaven Superintendent of Highways. "It is imperative for our emergency services to navigate these roads as safely and quickly as possible. When it comes to emergency response, every second counts and Opticom™ has certainly contributed to improving response time."

Town officials also wanted a system that could accommodate the unique terrain of the region.

"Due to Brookhaven's unique geography we needed a system that could deliver signals from a greater distance and allow emergency crews to respond as efficiently as possible," said Losquadro.

SOLUTION

Finding support on every corner

Brookhaven chose to install Opticom™ GPS priority control technology. Town officials were impressed with the legacy Opticom™ IR system and with the responsiveness and support from GTT representatives, but they also marveled at the newer Opticom™ GPS traffic signal priority control system. In fact, a few Brookhaven officials met with GTT representatives in Broward County, Florida to see it in action.

LOCATION

Brookhaven, NY

SUSCEPTIBILITY

52 incorporated villages and districts and 13 additional districts.

CHALLENGE

A large metropolitan town wanted to upgrade to new technology to address unique terrain issues and reduce maintenance costs for intersections and vehicles equipped with current optical priority control equipment.

SOLUTION

The town upgraded to Opticom™ GPS technology with Opticom™ Central Management Software (CMS). Nearly 500 intersections and more than 500 fire trucks and ambulances are equipped with this easy-to-maintain traffic preemption system.

PERFORMANCE

The majority of maintenance tasks can be completed remotely using Opticom™ CMS. Plus, it helps first responders reach emergency scenes more quickly and safely.

GTT GLOBAL TRAFFIC TECHNOLOGIES

OPTICOM SOLUTIONS

The innovative GPS technology offers reliable, radio-based communications, so the town can minimize maintenance costs and gain more control of intersections for faster, safer emergency response.

Fortunately, many town officials had extensive experience acquiring grant funding for traffic signal priority control systems from the previous IR deployment.

Losquadro noted that each of the 42 fire departments in the greater Brookhaven area provided a letter, with universal support from its volunteer force, endorsing an upgrade to Opticom™ GPS technology. The letters represented fire department volunteers who wanted to protect the welfare of Brookhaven residents more effectively.

"Emergency preparedness has been my top priority," said Losquadro. "To minimize risks and liabilities, we use Opticom™ GPS at every intersection. This gives residents and responders confidence that our emergency services have the resources to operate as safely as possible throughout Brookhaven."

Putting first responders in position to succeed

First responders face risks before they reach the scene of an emergency, often before they arrive at the first intersection. Because of the unique terrain of Long Island, the IR system limited preemption to 300 feet or less at about 40 percent of the intersections.

Tight turns and obstructions compromised traffic signal preemption, too. First responders had to reduce speeds significantly to navigate around cars and pass through the intersections. Response times lagged.

The Opticom™ GPS system uses a global network of GPS satellites that can calculate vehicle speed, direction and precise location to ensure traffic is cleared and first responders can drive safely through upcoming intersections.

It uses radio technology to send updated information — including turn signal status — every second to the equipment at the intersection. An Opticom™ Phase Selector in the intersection controller cabinet recognizes this information, analyzes it and requests the appropriate timing modification from the traffic controller. Cross-traffic has time to pass through the intersection and other traffic can prepare for the approaching emergency response team.

"The last thing anyone wants happening is an accident occurring during the response to an emergency," said Losquadro. "The Opticom™ GPS system provides a clear path for emergency vehicles, resulting in faster and safer response."

PERFORMANCE

Reducing more than response times

Brookhaven receives nearly 5,000 fire and EMS calls every month. One particularly busy corridor has more than 100 ambulances driving through every day. Town officials don't expect fewer emergency calls, but they do expect improved performance and less of an impact on the budget.

Losquadro noted that the Opticom™ GPS system and Opticom™ CMS are inexpensive to maintain, making them excellent investments. "Maintenance tasks can be performed in-house without sending employees out to a location," said Losquadro. "This allows our resources to be used more efficiently, thus saving taxpayers money."

"We can be proactive with this new system," said Losquadro. "More importantly, first responders aren't racing either. We can control traffic signals to get them to the scene quickly without compromising safety for anyone. As Superintendent of Highways, I'm always researching how technology can improve Department operations. By using the Opticom™ GPS system, it not only helps protect residents by improving response times, it also contributes to keeping emergency responders safe."

"The more and sooner we can provide vital emergency services to our communities and loved ones. The Opticom™ GPS system helps them fulfill their mission of saving lives."

- David Losquadro, Superintendent of Highways, Town of Brookhaven

Global Traffic Technologies, LLC
7800 Third Street North
St. Paul, Minnesota 55128-5441
1-800-258-4610
651-789-7333
www.gtt.com

5.2 Case Study: Bellevue, WA Improves Maintenance, reduces operating costs

CASE STUDY

OPTICOM | Central Management Software

Bellevue improves maintenance, reduces operating costs

CHALLENGE

Calling for a new maintenance strategy

With population surpassing 130,000, a thriving downtown business district and the bustling city of Seattle just across Lake Washington, Bellevue is experiencing increased traffic pressures. The challenge has been to accommodate the growing number of motorists without taxing resources.

For the past several decades, Bellevue has used Opticom® traffic signal priority control at each of its 185 intersections to help the Bellevue Fire Department drive through intersections safely and reach emergencies more quickly. The Bellevue Police Department was added to the system after a couple of its officers were involved in serious accidents at intersections. Response times and safety metrics improved significantly for each agency.

The Bellevue Traffic Department manages maintenance for all traffic signal operations, including Opticom® equipment. With more motorists on the roads, more efficient maintenance programs are required. Bellevue needed to streamline routine maintenance tasks at intersections and maximize its resources without compromising its budget.

"We had full confidence in the effectiveness of the Opticom® traffic signal priority control system when properly maintained" said Mike Whiteaker, Bellevue Intelligent Transportation Systems Manager. "It improved our response times. We just needed to find a more effective way to manage and maintain it."

SOLUTION

The next phase of signal priority

The city began to transition from Opticom® Infrared (IR) System components to Opticom® Multimode as part of its equipment replacement strategy. The first replacement stage included new phase selectors placed in the cabinets at 11 intersections.

The new models — Opticom® 764 Multimode Phase Selectors — are compatible with current IR technology and GPS traffic signal priority control technology. As a result, emergency responders from neighboring communities with GPS equipment can trigger signal preemption as easily as Bellevue agencies can with IR technology. The new models also allow for a seamless transition to GPS technology in the future.

"We conduct extensive mutual aid operations with several agencies in the area, from Redmond right next to us to Mercer Island across the bridge," said Whiteaker. "Some of those communities are deploying GPS technology already. Our new interoperable

LOCATION

Bellevue, WA

MUNICIPALITY

- Bellevue Fire Department
- Bellevue Police Department
- Bellevue Transportation Department

CHALLENGE

- Streamline maintenance processes
- Maximize resources without compromising budget

SOLUTION

- Opticom® Model 764 Multimode Phase Selectors
- Opticom® Central Management Software (CMS) for remote, streamlined management

PERFORMANCE

- Manage traffic signal priority control maintenance more quickly
- Real-time monitoring
- Identify and resolve issues quickly and efficiently
- Ensure smooth transition for mutual aid

equipment ensures their response teams won't be slowed when riding our citizens."

It's the city's deployment of another Opticom® solution, however, that has revolutionized the way traffic signal priority control in Bellevue operates moving forward.

Bellevue implemented Opticom® CMS — which works with ethernet connections at the city's intersections — so phase selectors can relay critical data back to traffic engineers at the centralized traffic management center (TMC).

PERFORMANCE

More data, less guesswork

Within moments of activating CMS, Whiteaker and his team received an array of information about signal preemption at each intersection, and technicians could generate customized reports on selected criteria.

"The benefits were immediate," said Whiteaker. "We can check out activity logs and preemption activity and even identify specific vehicles using signal preemption. We can isolate issues in real time and make smarter and faster maintenance decisions."

Bellevue is committed to using traffic signal preemption judiciously. Now that engineers can measure efficiencies and plan ahead, it's no surprise that CMS has become part of the daily routine.

CMS is used to discover other issues, too. For example, it reported long duration signal preemptions for a few intersections. The problem was traced to incorrect emitter installation. As a result, emitters on vehicles didn't shut off even while parked. The team also uses CMS to improve accountability. Specific vehicles can be identified, so system abuse is easier to resolve.

Automation simplifies tasks and reduces operating costs. Technicians know what is wrong at an intersection before they get there. They can repair equipment faster and minimize traffic flow interference. In fact, many time-consuming and expensive trips to the intersection can be averted entirely.

"Opticom® CMS is saving us money," said Whiteaker. "We can perform a lot of maintenance tasks, including firmware upgrades, from the TMC or from any remote centralized location. We're only sending technicians to intersections when absolutely necessary."

Improvements expanded throughout region

More than 75 intersections have been outfitted with the new Opticom® equipment. Every year, up to 30 additional intersections will receive new equipment as part of the city's equipment replacement strategy. Each of those intersections will be connected directly to Opticom® CMS so real-time data can be used to improve emergency response service levels and reduce operating costs.

Bellevue won't be alone. City officials have spoken to representatives from neighboring communities about how Opticom® CMS has streamlined maintenance. Opticom® traffic signal priority control offers a seamless system that holds users accountable, simplifies maintenance and improves performance from one town to the next.

"Our primary goal is to use signal preemption to reach those in need faster," said Whiteaker. "Opticom® CMS allows us to do that more cost-effectively. It lets us be proactive to ensure more consistent performance."

As a burgeoning community, Bellevue continues to seek new innovations to maximize traffic operations without compromising resources. City officials plan to leverage Opticom® traffic signal priority control and CMS to introduce new strategies in the future. And, it will work with neighboring communities to improve emergency response services for the entire region.

"Our primary goal is to use signal preemption to reach those in need faster. Opticom® CMS allows us to do that more cost-effectively."

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[redacted]

6.0 GTT Personnel

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Kyle Holgate

Technical Service/On-site support Engineer

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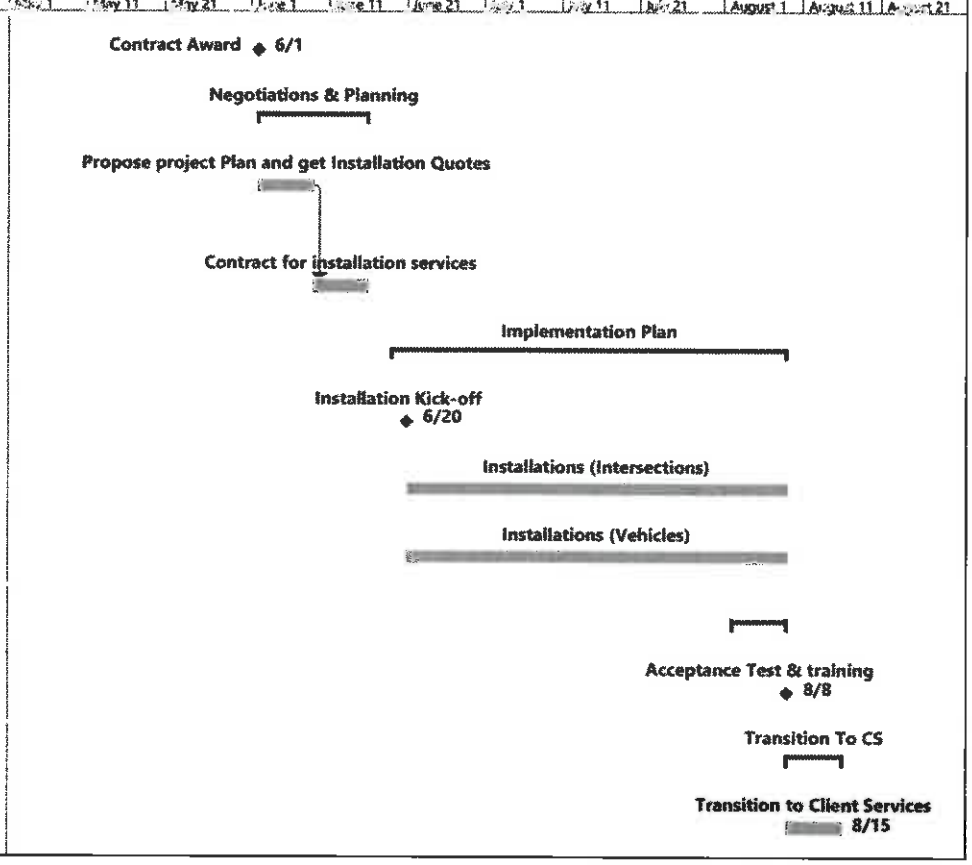
7.0 Description of Services

The project plan below represents the list of activities and timing associated with equipment delivery, installation, deployment and training. The current project plan assumes a start date of June 1st, 2017. However, this start date can be moved up or pushed back, based on the timeframe required by the City of Lawrence. Regardless, GTT is more than capable of completing these activities within the 90-day window specified and has completed much larger projects in less time.

Lawrence, Kansas EVP

ID	Task Name	Duration	Start	Finish
1	Contract Award	1 day	Thu 6/1/17	Thu 6/1/17
2	Negotiations & Planning	10 days	Fri 6/2/17	Thu 6/15/17
3	Propose project Plan and get Installation Quotes	5 days	Fri 6/2/17	Thu 6/8/17
4	Contract for installation services	5 days	Fri 6/9/17	Thu 6/15/17
5	Implementation Plan	37 days	Mon 6/19/17	Tue 8/8/17
6	Installation Kick-off	2 days	Mon 6/19/17	Tue 6/20/17
7	Installations (Intersections)	35 days	Wed 6/21/17	Tue 8/8/17
8	Installations (Vehicles)	35 days	Wed 6/21/17	Tue 8/8/17
9	Project Completion & Acceptance	5 days	Wed 8/2/17	Tue 8/8/17
10	Acceptance Test & training	5 days	Wed 8/2/17	Tue 8/8/17
11	Transition To CS	5 days	Wed 8/9/17	Tue 8/15/17
12	Transition to Client Services	5 days	Wed 8/9/17	Tue 8/15/17



8.0 Pricing

GLOBAL TRAFFIC TECHNOLOGIES

Proposal

Direct Customer

Global Traffic Technologies, LLC
7800 Third St., N.
Saint Paul, MN 55128
United States

800-258-4610 or 651-788-7333

Bill To	Customer	Purchase Order #	Date	Expires
City of Lawrence	City of Lawrence	Pending	10-Apr-17	9-Jul-17

Ship To	Solution/Purchase Type		
City of Lawrence 6 East 6th Street Lawrence, KS 66044 Attn: Mr. Todd Lohman	Purchase Emergency	Intersections 120	Vehicles 40

Items	Qty	Description	Price Per Item USD	Extended Price USD
Intersection components:				
	120	Model 764 multimode phase selector	$ 900.00	$ 108,000.00
	120	Model 768 auxiliary interface panel	$ 210.56	$ 25,267.20
	120	Model 3100 series mast-mount radio receiver	$ 1,100.00	$ 132,000.00
	1	Intersection cable (GPS, 500 ft roll)	$ 272.58	$ 272.58
	1	Intersection cable (GPS, 1,000 ft roll)	$ 515.13	$ 515.13
	9	Intersection cable (GPS, 2,500 ft roll)	$ 1,304.10	$ 11,736.90
Vehicle components:				
	40	Model 2101/2101 series vehicle kit	$ 1,500.00	$ 60,000.00
Back-office components:				
	125	Central Management Software (CMS - per intersection)	$ 22.50	$ 2,812.50
Services:				
	1	Site survey (intersections and/or vehicles)	$ 10,734.75	$ 10,734.75
	1	Project management	$ 10,400.00	$ 10,400.00
	120	Installation, intersections (GPS - includes hardware and software configuration)	$ 1,300.00	$ 156,000.00
	40	Installation, vehicle computer (includes hardware and software configuration)	$ 900.00	$ 36,000.00
	1	Installation, CMS software	$ 5,400.00	$ 5,400.00
	1	Training (up to 1 week on-site incl. T&L)	$ 10,000.00	$ 10,000.00
Software maintenance:				
	125	Annual SW maint: CMS	$ 16.88	$ 2,109.38

Proposal notes:

Real-time vehicle analytics are available as a service for an additional cost of $10/vehicle/month. Requires cellular and/or Wi-Fi connectivity on each vehicle (not included).
Data communication fees are out of scope for this proposal and therefore not included.
Installation has been included, but standard warranty terms apply once installation has been completed.
Software maintenance has been included for year 1 only. Rates in future years may vary. Optionally, customer may pay for up to five years up-front, at year 1 prices.
Labor rates for out of scope services will be $150/hour, plus travel. All labor rates are subject to change.

8.1 Pricing Notes

- Data communication fees are out of scope for this proposal and therefore not included.
- Installation has been included, but standard warranty terms apply once installation has been completed.
- Software maintenance has been included for year 1 only. Rates in future years may vary. Optionally, customer may pay for up to five years up-front, at year 1 prices.
- Labor rates for out of scope services will be $150/hour, plus travel. All labor rates are subject to change.

8.2 Terms and Conditions

In the U.S. and Canada, terms of sale are net 30 days and apply from date of invoice, contingent upon credit approval and acceptance by GTT.
All prices are in U.S. Dollars, except as indicated otherwise (above).
This proposal supersedes all previous proposals for this project and if applicable, this customer.
All orders following this proposal are final and not subject to change or cancellation unless identified as cancelable, tentative or contingent on the purchase order or agreement between GTT and the purchaser.
Pricing is based on the complete solution being procured on a single purchase order and/or agreement. Prices may vary if quantities ordered are less than originally quoted. Errors and omissions will be rectified with no penalty to GTT or the purchaser.
The shipment must be inspected prior to acceptance and claims for any loss or damage filed by the consignee with the carrier within fifteen days of delivery, in accordance with current I.C.C. regulations. Any claims of shortage must be based on complete inspection of the shipment and accompanying papers; and reported to Global Traffic Technologies' customer service department within 30 days of receipt.
Quote is based on information provided by the purchaser. GTT is not responsible for any shortage or excess quantity of material required. Pricing is good for the corresponding contract or indicated order release associated with the authorized price quote only. Pricing expires as indicated above.
Where conformance to a country's, province's/state's, local municipality's or other applicable agency's specifications (or special provision) is a condition of acceptance of Global Traffic Technologies' shipment, the purchase order must so indicate, in addition to listing the specific requirement(s) concerned.
Purchaser is responsible for ensuring that the traffic infrastructure, including the traffic controller, is compatible with the purchased products and correctly programmed.
Any products or services not explicitly quoted above are hereby excluded (i.e., out of scope), except that all software purchases require at least one year (first year) of software maintenance, which is to be invoiced in advance of use of the software.
Shipment is made F.O.B. factory, prepaid, to the indicated destination within Canada and the 48 contiguous states within the United States. Shipping outside of Canada and/or the 48 contiguous states within the United States is not included. Routing is at the shipper's option. Where special routing, express or air shipment is specified by the purchaser, the cost of premium routing will be added to the invoice.
National, state/province and/or local sales and use taxes, or other similar taxes imposed by law, will be added to the invoice unless a waiver, exemption or permit has been granted, with notice filed with Global Traffic Technologies and a permit number shown on the order.
Material specified on this quote must not be shipped to, or installed in, any other country than that of the warranty customer specified on this quote.

When sold to a reseller, materials and services quoted are for resale only. By issuing a purchase order for this quote, dealer/reseller accepts responsibility for only selling products to end-users as permitted by federal, state/provincial and local laws to utilize the product. Global Traffic Technologies reserves the right to have full visibility of all documentation and contracts, including quotations and commercial proposals associated with this project.
When sold to a reseller, Global Traffic Technologies assumes no responsibility for determining the requirements of the end-user, including, but not limited to, color, configuration, quantities, accessories, installation or use. Global Traffic Technologies disclaims any obligation of any purchaser, including that of delivery.
By issuing a purchase order against this quote, purchaser certifies that use of the Global Traffic Technologies' products are permitted by federal, state/provincial and local laws.
Where Global Traffic Technologies' North American variant has been requested, purchaser acknowledges that north American radio equipment is certified to North American standards (e.g., the FCC) and not international standards (e.g., ETSI). Purchaser has specifically requested the North American variant and accepts all responsibility for obtaining the necessary waivers from the appropriate agencies in the country in which the equipment will be operated, before the equipment is installed and/or made operational; and purchaser accepts all associated liability for not doing so.
The standard Opticom product warranty is five (5) years from the date of shipment from the GTT factory, however some models vary. Purchaser is responsible for obtaining information specific to what is being purchased. Warranty information can be found at: http://www.gtt.com/?s=warranty. Extended warranties are available for some models. Contact Global Traffic Technologies for more information.
If ongoing services have been proposed (but hosting services have not), pricing assumes customer will host CMS and give GTT remote access.
For services, a signed master services agreement (MSA) must accompany the order; for software, a signed software licensing agreement must accompany the order. Terms and conditions can be found at: http://www.gtt.com/servicesagreement/ and http://www.gtt.com/software-terms-conditions/.

9.0 Appendix A – Technical data sheets

9.1 Opticom GPS System Intersection Equipment

OPTICOM™ PRIORITY CONTROL SYSTEM
OPTICOM™ GPS SYSTEM INTERSECTION EQUIPMENT

Description

The Opticom™ GPS System assists authorized vehicles through signalized intersections by providing temporary right-of-way through the use of common traffic controller functions.

The Opticom™ GPS system consists of the following matched components:

Intersection Equipment

- Opticom™ Model 3100 GPS Radio Unit containing a GPS receiver with antenna and a 2.4 GHz spread spectrum transceiver with antenna

  –OR–

  Opticom™ Model 3101 GPS Radio Unit containing a GPS receiver and a 2.4 GHz spread spectrum transceiver, with Opticom™ Model 1050 GPS/Radio Antenna and Opticom™ Model 1072 GPS Cable Assembly
- Opticom™ Model 764 Multimode Phase Selector
- Opticom™ Model 768 Auxiliary Interface Panel
- Opticom™ Model 1040 GPS Card Rack or Opticom™ Model 760 Card Rack or Opticom™ Model 770 Card Rack
- Opticom™ Model 1070 GPS Installation Cable

Vehicle Equipment

- Opticom™ Model 2100 High Priority Radio/GPS Control Unit

  –OR–

  Opticom™ Model 2101 Low Priority Radio/GPS Control Unit
- Opticom™ Model 1050 GPS/Radio Antenna
- Opticom™ Model 2171 Vehicle Interface Cable

Opticom™ GPS system intersection equipment consists of the compact, weather resistant RF-energy-emitting Opticom™ Model 3100 GPS Radio Unit containing a GPS receiver with antenna and a 2.4 GHz spread spectrum transceiver with antenna. The radio unit is connected to an Opticom™ Model 764 Multimode Phase Selector via an 11-conductor radio/GPS cable.

The Opticom™ Model 764 Multimode Phase Selector can be installed directly into a CA/NEMA Type 33X input file or most NEMA traffic controllers equipped with priority phase selection software, or into virtually any other traffic controller equipped with priority phase selection inputs and related software.

When input file space is not available, an Opticom™ Model 760 Card Rack is required. An external 120 VAC power source provides the power that is required to operate the Opticom™ Model 764 Multimode Phase Selector. The phase selector provides power to the radio unit.

The Opticom™ Model 764 Multimode Phase Selector processes the signal from the Opticom™ Model 3100 GPS Radio Unit and activates outputs, which are connected to the preemption inputs on the traffic controller. There are four channel outputs accessible on the rear connector of the Opticom™ Model 764 Multimode Phase Selector and up to 12 additional channel outputs on the Opticom™ Model 768 Auxiliary Interface Panel.

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OPTICOM™ GPS SYSTEM INTERSECTION EQUIPMENT

OPTICOM™ SYSTEM COMPONENTS FOR ENHANCEMENTS WITH GPS TECHNOLOGY

Each channel output delivers a constant output for high-priority activation, and a pulsed output for low-priority activation. A high-priority signal received on a channel will override any low-priority activation. In certain modes of operation, outputs may be activated that are dependent on the state of the requesting vehicle's turn signal. Another mode provides separate constant outputs for high priority and low priority. The use of an Opticom™ Model 768 Auxiliary Interface Panel is required to access these additional modes and outputs.

Opticom™ GPS System intersection equipment has the following features:

- Four channels of detection
- Radio range of 2,500 feet
- User-settable range setting by ETA and/or distance
- Call bridging
- Precise preemption output pulse
- Optically isolated outputs
- Varied outputs depending on turn signal status of requesting vehicle
- High and low priority as well as probe frequency discrimination
- "First-come, first-served" priority within each priority level
- Low-priority output may be configured for first-come, first-served or all-channel active
- Priority-by-class and priority-by direction setting via the interface software
- 10/100Mb Ethernet and USB 2.0 communication on the front panel
- RS232 communications front port, rear backplane and Auxiliary Interface Panel
- History log of most recent Opticom™ GPS system activities (10,000 entries)
- More than 38 million agency/class/vehicle code combinations
- Customizable ID code validation
- Two character display, LEDs and keypad to enable diagnostics and place test calls to each channel
- Flexible programming options for priority control parameters
- Direct installation into CA/NY Type 332 input files
- Compatible with most traffic controllers
- Tested to NEMA environmental and electrical test specifications
- Meets FCC part 15 Class A specifications

Physical Dimensions

Opticom™ Model 764 Multimode Phase Selector
Length: 7.0 in. (17.8 cm) x 8.2 in. (20.8 cm) including handle
Width: 2.3 in. (5.8 cm)
Height: 4.5 in. (11.4 cm)
Weight: 0.60 lbs. (272 g)

Opticom™ Model 3100 GPS Radio Unit
Length: 9.0 in. (22.9 cm)
Width: 6.5 in. (16.5 cm)
Height: 6.0 in. (15.2 cm)
Weight: 1.8 lbs. (0.816 kg)

Opticom™ Model 3101 GPS Radio Unit
Length: 8.0 in. (20.3 cm)
Width: 4.5 in. (11.4 cm)
Height: 2.7 in. (6.9 cm)
Weight: 1.7 lbs. (0.771 kg)

Opticom™ Model 768 Auxiliary Interface Panel
Length: 7.25 in. (18.4 cm)
Width: 4.5 in. (11.4 cm)
Height: 1.0 in. (2.5 cm)
Weight with cable: 1.4 lbs. (635 g)
Cable: 12 ft (3.6 m)

Opticom™ Model 1040 GPS Card Rack/Opticom™ Model 760 Card Rack/Opticom™ Model 770 Card Rack
Length: 8.25 in. (21.0 cm)
Width: 5.25 in. (13.3 cm)
Height: 5.1 in. (12.9 cm)
Weight: 2.3 lbs. (1.043 kg)

Opticom™ Model 1050 GPS/Radio Antenna
Diameter: 2.85 in. (7.2 cm)
Height: 1.4 in. (3.5 cm)
Cable length: 15.0 ft. (4.6 m)
Weight with cables: 0.6 lbs. (0.30 kg)

Electrical

Opticom™ Model 764 Multimode Phase Selector
Voltage: 89 to 135 VAC, 60 Hz at up to 500mA or 24 VDC at up to 1 Amp

Environmental

Opticom™ Model 764 Multimode Phase Selector
Temperature: -37°C to +74°C (-34.6°F to +165.2°F)
Humidity: 5% to 95% relative

For complete warranty information visit www.gtt.com.

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76-0001-0343-H01

9.2 Opticom GPS System Vehicle Equipment

OPTICOM™ PRIORITY CONTROL SYSTEM
OPTICOM™ GPS SYSTEM VEHICLE EQUIPMENT

OPTICOM™ SYSTEM COMPONENTS FOR ENVIRONMENTS WITH GPS SATELLITES

DESCRIPTION

The Opticom™ GPS System assists authorized priority vehicles through signalized intersections by providing temporary right-of-way through the use of common traffic controller functions.

The Opticom™ GPS System consists of the following matched components:

Vehicle Equipment

- Opticom™ Model 2100 High Priority Radio/GPS Control Unit

  –OR–

  Opticom™ Model 2101 Low Priority Radio/GPS Control Unit
- Opticom™ Model 1050 GPS/Radio Antenna
- Opticom™ Model 2171 Vehicle Interface Cable

Intersection Equipment

- Opticom™ Model 3100 GPS Radio Unit containing a GPS receiver with antenna and a 2.4 Ghz spread spectrum transceiver with antenna

  –OR–

  Opticom™ Model 3101 GPS Radio Unit containing a GPS receiver and a 2.4 GHz spread spectrum transceiver, with Opticom™ Model 1050 GPS/Radio Antenna and Opticom™ Model 1072 GPS Cable Assembly
- Opticom™ Model 764 Multimode Phase Selector
- Opticom™ Model 768 Auxiliary Interface Panel
- Opticom™ Model 1040 GPS Card Rack or Opticom™ Model 760 Card Rack or Opticom™ Model 770 Card Rack
- Opticom™ Model 1070 GPS Installation Cable

Opticom™ GPS System vehicle equipment is mounted on the priority vehicle. Its GPS receiver obtains information from the constellation of global positioning satellites. This information is used to compute the location, speed and heading of the vehicle. This information, along with a priority request and the state of the vehicle's turn signal, is broadcast using the 2.4 GHz spread spectrum transceiver.

Opticom™ GPS System intersection equipment receives the radio transmission from the vehicle equipment. The intersection equipment then compares the information being received from the vehicle with the parameters stored in the intersection equipment's memory. If the vehicle is heading toward the intersection in a predefined approach corridor, is requesting preemption or priority and has met all other programmed parameters, the corresponding phase selector output is activated. This output is connected to the traffic controller.

When activated, the controller cycles to grant a green light to the requesting vehicle or holds the green, allowing the vehicle to pass through the intersection.

The Opticom™ Model 760 Card Rack or Model 770 Gate Cramer Card Rack provide the power and logic wiring for the Opticom™ Model 764 Multimode Phase Selector, which plugs directly into a slot in the unit. The Opticom™ Model 768 Auxiliary Interface Panel provides connections for monitoring green phases and provides additional priority control outputs as well as additional outputs for time synchronization and confirmation lights.

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OPTICOM™ GPS SYSTEM VEHICLE EQUIPMENT

OPTICOM™ EMITTER ENHANCES TRAFFIC ENGINEERING WITH GPS TECHNOLOGY

Features

Opticom™ GPS System vehicle equipment is intended for use on priority vehicles. The vehicle equipment kit consists of the compact Opticom™ Model 2100 or 2101 Radio/GPS Control Unit containing a GPS receiver and a 2.4 GHz spread spectrum transceiver, used with the Opticom™ Model 1050 GPS/Radio Antenna and the Opticom™ Model 2171 Vehicle Interface Cable.

Opticom™ GPS System vehicle equipment has the following features:

- Operates on 10-36 VDC
- Vehicle interface inputs 10-36 VDC
- Less than 2 amps peak current draw
- Configurable turn signal sense inputs with multiple activation options
- Speed pulse sense (future)
- Reverse/Neutral sense (future)
- 4 configurable outputs (future)
- 2 configurable inputs (future)
- Status indicators
  - On/Off switch
  - Status
  - Radio
  - Link
  - Priority
  - Disable
- Brightness level of indicators is photosensor controlled with separate settings for day and night
- Capability to control an Opticom™ infrared emitter through a single control module
- Meets FCC part 15 Class A specifications
- Option to add dead reckoning unit (future)
- Additional GPS output in NMEA format for other onboard uses
- Vehicle identification encoding; selectable at installation
- 25-foot interface cable for installation flexibility
- Adapter available for upgrading from previous generation equipment without rewiring
- Available Windows® Configuration and Maintenance Software
- Configurable operating mode of disable input
  - Latching or non-latching
  - Disable trigger method
    - +12 VDC to ground
    - Ground to +12 VDC
- Configurable remote activation mode
  - Apply+ 10-36 VDC
  - Apply + 5 VDC
  - Apply ground
- Configurable activation method
  - Light bar and/or manual
- Accepts Passenger Count, and Emitter Lock conditional priority input via J1708 from compatible onboard devices such as APC and passenger counters.
- Internally records each system activation. Each entry contains:
  - Intersection name
  - Date and time of the activity
  - Vehicle class code (Vehicle ID, Agency ID)
  - Channel used
  - Priority of the activity
  - Duration of the activation
  - If preempt has been requested and received if not
  - Turn signal status at the end of the call
  - Entry, exit and average speed
  - Relative priority level
  - Conditional priority level

Operating Parameters

- Temperature: -34°C to +74°C (-30°F to +165°F)
- Humidity: 5% to 95% relative
- High or low priorities selected by model
- User-programmable vehicle ID code, which is transmitted to intersection equipment:
  - 254 agency IDs
  - 15 vehicle classes
  - 9999 vehicle IDs
  - Over 38 million combinations per priority level
- User-programmable reference vehicle name (up to 40 characters)
- Self-diagnosis
- Non-obstructed transmission at least 2,500 feet (762 m)
- Turn signal monitoring transmitted to intersection
- RS485/J1708 serial interfaces
- GPS data output
- Ethernet port
- USB Port
- RS-232 serial port

The following reference model numbers appear on the shipping boxes and serial plate labels:

Opticom™ Model 1050 GPS/Radio Antenna

Opticom™ Model 2100 High Priority Radio/GPS Control Unit

Opticom™ Model 2101 Low Priority Radio/GPS Control Unit

Opticom™ Model 2171 Vehicle Interface Cable

Physical Dimensions

Opticom™ Model 2100 or 2101 Radio/GPS Control Unit

Length: 7.25 in. (18.4 cm)

Width: 5.44 in. (13.8 cm)

Height: 1.63 in. (4.1 cm)

Weight: 1.2 lb. (0.5 kg)

Opticom™ Model 1050 GPS/Radio Antenna

Diameter: 2.85 in. (7.2 cm)

Height: 1.4 in. (3.5 cm)

Cable Length: 15.0 ft. (4.6 m)

Weight with Cable: 0.8 lb. (0.36 kg)

Opticom™ Model 2173 Vehicle Interface Cable Adapter for existing previous generation harness

The Opticom™ Model 2173 Vehicle Interface Cable Adapter is available for purchase separately if you are upgrading from a Opticom™ Model 1020 or 1021 Series Control Unit using a Opticom™ Model 1071 Vehicle Interface Harness to a Opticom™ Model 2100 or 2101 Radio/GPS Control Unit. By using the Opticom™ Model 2173 Vehicle Interface Cable Adapter, you will not need to rewire the vehicle. In this case, you will not need the Opticom™ Model 2171 Vehicle Interface Cable that is included with your new vehicle kit.

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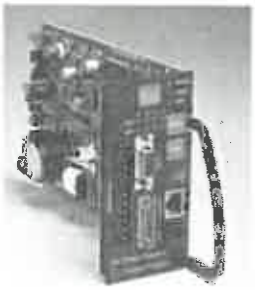
9.3 Opticom Model 764 Multimode Phase Selector

OPTICOM™ PRIORITY CONTROL SYSTEM
OPTICOM™ MODEL 764 MULTIMODE PHASE SELECTOR



Description

The Opticom™ Model 764 Multimode Phase Selector is a plug-in, four-channel, dual-priority, multimode encoded signal device designed for use with both Opticom™ infrared system (IR) emitters and detectors and Opticom™ GPS radio/GPS intersection units and vehicle equipment. It can be installed directly into the input files of Type 170 traffic controllers equipped with priority phase selection software and in virtually any other traffic controller equipped with priority phase selection inputs and related software. Phase selectors are powered from AC mains or 24 VDC and contain their own internal power supply to support Opticom™ IR detectors and Opticom™ GPS radio/GPS units.

The Opticom™ Model 764 Multimode Phase Selector may be used in IR only applications, GPS only applications, or IR and GPS applications simultaneously.

The Opticom™ Model 760 Card Rack is required when input file space is not available. When used in GPS only mode, the Opticom™ Model 1040 Card Rack may also be used.

Opticom™ Model 764 Multimode Phase Selector recognizes and discriminates among three distinct Opticom™ IR emitter frequency rates via Opticom™ detectors: high priority, low priority and probe priority. Within each of these three frequency rates, the phase selectors further discriminate among 16 classes of vehicle identification codes, with 1,000 individual vehicle codes per class — 16,000 total per frequency rate. The Opticom™ Model 764 Multimode Phase Selector also recognizes three different priority levels transmitted by Opticom™ GPS vehicle equipment: high priority, low priority and probe priority. Within each of these three priority levels, the phase selectors further discriminate among 254 agency IDs, 15 classes of vehicle identification codes, with 10,000 individual vehicle codes per class — for more than 38 million total per priority level.

Opticom™ Model 764 Multimode Phase Selector internally records each system activation. Each entry contains:

- Intersection name
- Date and time of the activity
- Vehicle class code of the activating vehicle
- Activating vehicle's ID number
- Agency ID (GPS only)
- Channel called
- Priority of the activity
- Final green signal indications displayed at the end of the call
- Time spent in the final greens
- Duration of the activation
- If preempt has been requested and reason if not
- Turn signal status at the end of the call (GPS only)
- Entry, exit and average speed (GPS only)
- Relative priority level
- Conditional priority level

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OPTICOM™ MODEL 764 MULTIMODE PHASE SELECTOR

OPTICOM™ SYSTEM COMPONENT FOR EMERGENCY VEHICLES WITH INFRARED AND GPS TECHNOLOGY

Features

- IR only operation, GPS only operation, or simultaneous IR and GPS operation
- Four channels of detection
- Two auxiliary detectors per channel (IR)
- Records green signal displayed at end of preemption
- Compatible with encoded signal and non-encoded signal Opticom™ IR Emitters
- High and low priority as well as probe frequency discrimination
- Conditional priority for Transit Signal Priority (TSP) (when used with compatible AVL and/or passenger counter)
- "First-come, first-served" priority within each priority level
- Priority-by-class setting via the interface software
- Priority-by-direction setting via the interface software
- Direct installation into CALTRANS Type 170 input files
- Automatic range setting using an encoded emitter (IR)
- Call bridging for both IR and GPS calls including mixed mode
- Low-priority output may be configured for first-come, first-served or all-channel active
- User adjustable range setting up to 2,500 feet of operation
- Compatible with most traffic controllers
- 10/100Mb Ethernet communication on the front panel
- USB 2.0 communication on the front panel
- RS232 communications front port, and rear backplane and Auxiliary Interface Panel
- User-selected communications baud rate of 1,200 to 230,400 bits per second
- Customizable ID code validation
- Flexible programming options for priority control parameters
- Detailed current Opticom™ System parameter information
- History log of most recent Opticom™ infrared and GPS system activities (10,000 entries)
- 30,000 frequency/class/vehicle code ID combinations (IR)
- More than 38 million agency/class/vehicle code combinations (GPS)
- Front panel switches and diagnostic indicators for testing
- Accurate infrared signal recognition circuitry
- Precise output pulse
- Definitive call verification
- Regulated detector power supply (IR)
- Optically isolated outputs
- Two-character display and keypad to enable diagnostics and test calls to each channel
- Display LED indicators
  - High- and low-priority test calls
  - Reset to default parameters
  - Range setting
- User-settable range setting by ETA and/or distance (GPS only)
- Varied outputs depending on the signal status of requesting vehicle (GPS only)
- IR detector inputs may be mapped to any channel
- Diagnostic test
- Advanced built-in diagnostics and testing
- Tested to NEMA environmental and electrical test specifications

Accessories

- Opticom™ On-site interface software package
- Opticom™ Model 768 Auxiliary Interface Panel
- Opticom™ Model 755 Four-Channel Adapter Card (optional)
- Opticom™ Model 760 Card Rack

Operating Parameters

- Four dual-priority and probe frequency channels
- "First-come, first-served" for vehicles with the same priority level (high or low)
- Priority override: always higher over lower
- Opticom™ GPS Radio/GPS Unit input
- Opticom™ Infrared System Detector input(s): one per channel on the card edge connector and two auxiliary per channel through the Opticom™ Model 768 Auxiliary Interface Panel
- Optional interface software for flexible programming options and call history
- LED indicators
  - Status
  - Radio (GPS mode)
  - Link (GPS mode)
  - High signal/call per channel
  - Low signal/call per channel
  - Two-digit status display
- Two character display and keypad to enable diagnostics and test calls to each channel
- Voltage: 89 to 135 VAC, 60 Hz at up to 500mA or 24 VDC at up to 1 Amp
- Temperature: -37°C to +74°C (-34.6°F to +165.2°F)
- Humidity: 5% to 95% relative
- CE certified
- NEMA TS-2 compliance
- FCC compliance

Physical Dimensions

Length: 7.0 in. (17.8 cm) x 8.2 in. (20.8 cm) including handle
Width: 2.3 in. (5.8 cm)
Height: 4.5 in. (11.4 cm)
Weight: 0.60 lbs. (272 g)

For complete warranty information visit www.gtt.com.

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79-1000-0824-0 (A)

9.4 Opticom Model 768 Auxiliary Interface Panel

OPTICOM™ PRIORITY CONTROL SYSTEM
OPTICOM™ MODEL 768 AUXILIARY INTERFACE PANEL

Description

Opticom™ Model 768 Auxiliary Interface Panel (AIP) provides a convenient method to interconnect Opticom™ Model 762 and 764 Phase Selectors with terminals inside a traffic cabinet. The 768 AIP is designed specifically for use with the Model 762 and 764 phase selectors. It is not intended to be used with other model phase selectors.

The Opticom™ Model 768 contains terminal blocks for wiring to the traffic cabinet signals, two DB-9 RS-232 communication ports, and a 44-pin connector for connecting legacy auxiliary interface panels and auxiliary harnesses. A twelve foot cable is included which connects the AIP to the Model 762 or 764 Phase Selector.

Features

- Accessible interconnections to cabinet wiring along the edge of card
- Rugged construction - circuit card etched to 16 AWG aluminum mounting plate
- Connectors for auxiliary detector inputs and power can accommodate 16 to 28 AWG wires
- Connectors for all other inputs and outputs can accommodate 16 to 22 AWG wires
- Easy-to-read terminal designations

Applications

The Model 768 AIP is used when any of the following features and/or capabilities is needed:

- Green sensing or green light verification
- Auxiliary infrared detector inputs
- Additional preempt outputs
  - Turn signal dependent operation (For 764 in GPS operation)
  - Separate outputs for high and low priority
- Clock sync input (in IR operation)
- Clock sync output (For 764 in GPS operation)
- Confirmation light outputs
- Disable outputs
- Two additional RS-232 COM ports
  - GPS data input (in IR operation)
  - GPS data output (For 764 in GPS operation)
  - Additional Serial COM port

The Model 768 AIP includes a connector for connecting an existing auxiliary harness or auxiliary interface panel to green sense and/or auxiliary detectors. Simply remove the old AIP or harness and connect it directly to the 768. If the existing harness or AIP is being used for other functions, it will be necessary to move the wires to the Model 768 AIP.

Physical Dimensions

Length: 7.25 in. (18.4 cm)
Width: 4.5 in. (11.4 cm)
Height: 1.0 in. (2.5 cm)
Weight (with cable): 1.4 lbs. (635 g)
Cable: 12 ft (3.6M)

For complete warranty information visit www.gtt.com.

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9.5 Opticom Model 1070 GPS Installation Cable

OPTICOM™ PRIORITY CONTROL SYSTEM
OPTICOLT™ MODEL 1070 GPS INSTALLATION CABLE

Description

The Opticom™ Model 1070 GPS Installation Cable is designed and manufactured explicitly for use with Opticom™ Radio/GPS units. The Opticom™ Model 1070 GPS Installation Cable has ten (5-pair) color-coded twisted conductors, a conductive shield and drain, and a black PVC jacket.

This durable, high-quality cable carries the appropriate power to the Opticom™ Radio/GPS unit from the Opticom™ Phase Selector and delivers the necessary quality signal to the phase selector up to 250 feet (76 m).

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Features and Benefits

- Optimized to interface Opticom™ Radio/GPS units to Opticom™ Phase Selectors
- Ensures effective range of at least 2,500 feet (760 m) with Opticom™ GPS System components
- Durable construction
  - Suitable for direct burial
  - Suitable for conduit and mast arm pull
  - Suitable for exposed overhead installation*

Operating Parameters

- 300 volt rating
- 90° C (194° F) temperature range
- Outer Jacket: Black SR-PVC, UV and moisture resistant
- Ten twisted pair conductors (5 pairs) AWG #20 (7 x 28) stranded, individually tinned copper:
  - Yellow/Yellow-Black
  - Blue/Blue-White
  - Orange/Orange-Green
  - Brown/Brown-White
  - Purple/Purple-White
- Aluminized polyester shield
- Drain wire AWG #22 (7 x 28) stranded, individually tinned copper
- Controlled electrical characteristics
- UL and cUL recognized

Physical Dimensions

- Outside diameter: 0.364 in. (9 mm)
- Minimum Bend Radius: 3.6 in (9.1 cm)
- Available in 500 ft., 1,000 ft., and 2,500 ft. (152 m, 305 m, and 760 m) spools

*Separate messenger wire required

For complete warranty information visit www.gtt.com.

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10.0 Appendix B – CMS Screenshots

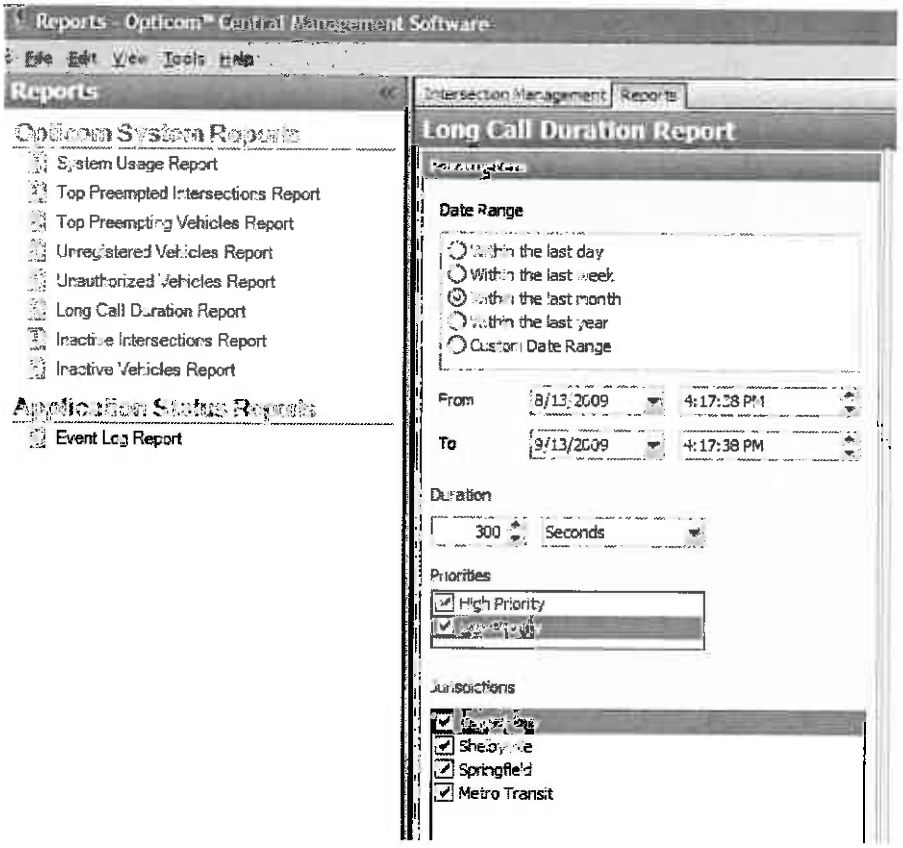

Figure 3. Report Generation Screen Shot.

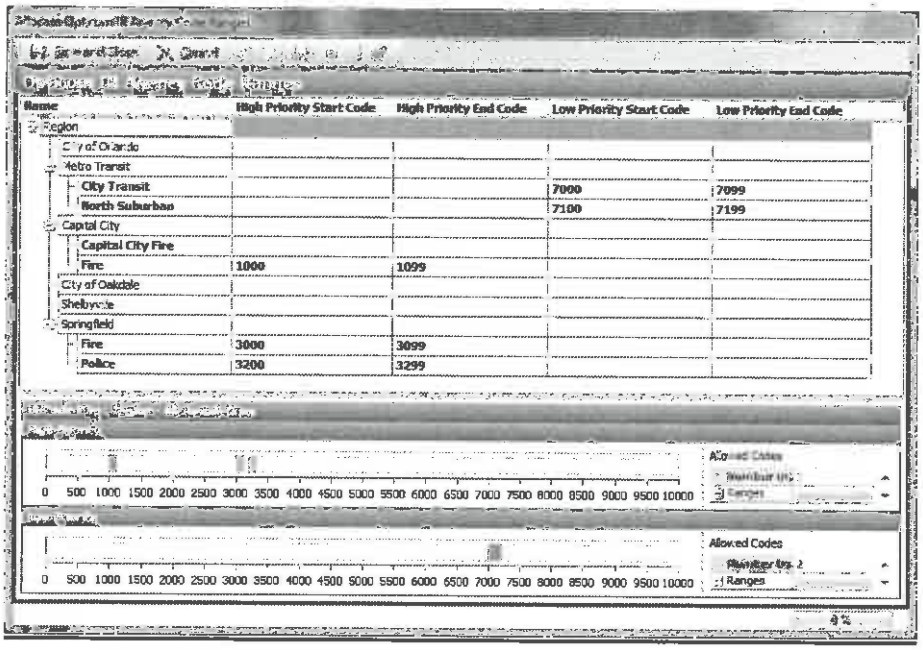

Figure 4. CMS regional coding management.

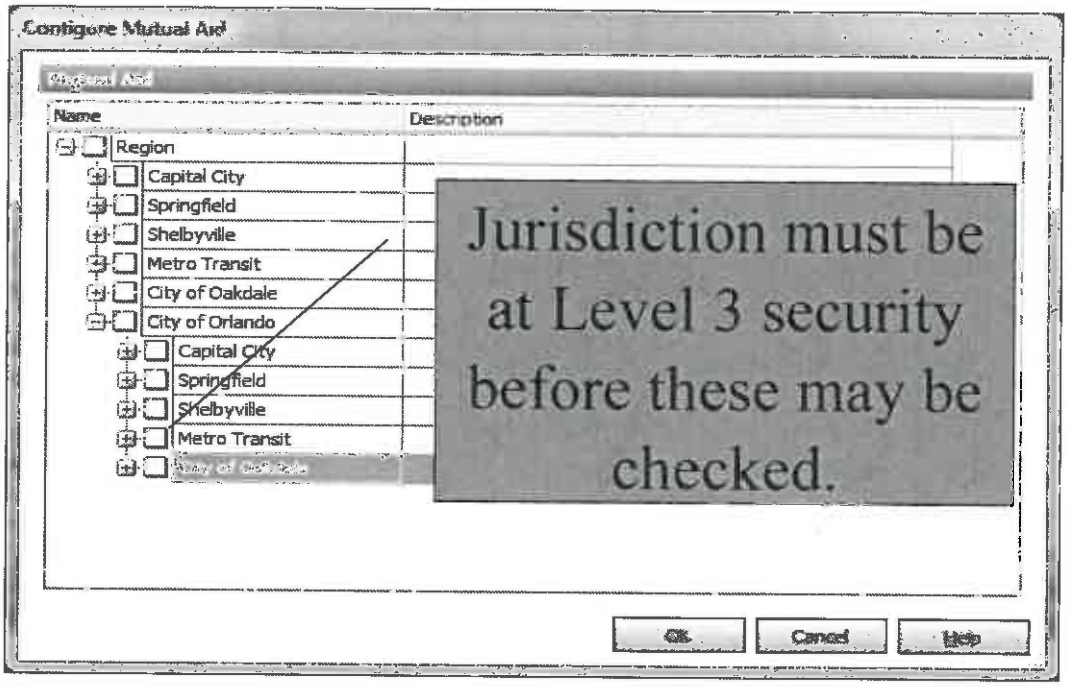

Figure 5. Defining mutual aid jurisdictions.

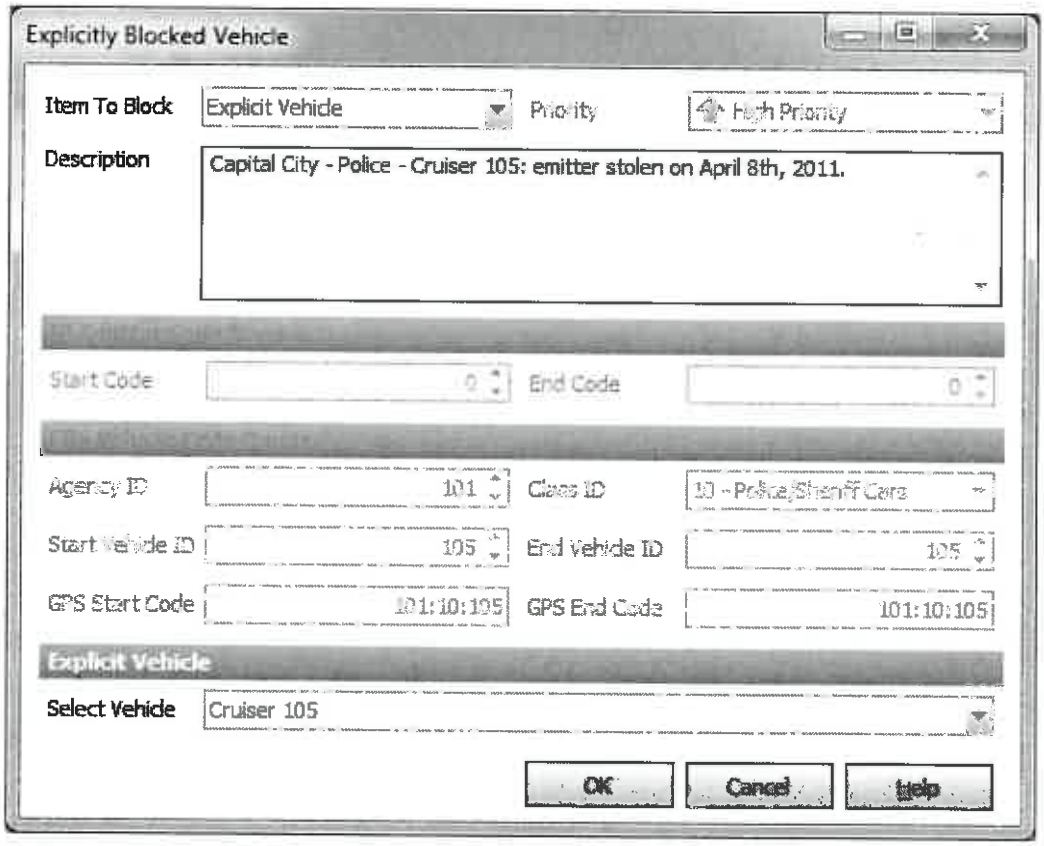

Figure 6. Blocked Vehicle Control.

Unauthorized Vehicle Preempt Report

From 3/9/2013 to 4/9/2013

Jurisdictions included: City of Peoria, Capital City, Springfield, Metro Transit

Report Generated:
4/9/2013 9:11 AM

Code	Priority	Agency Jurisdiction	Agency	Vehicle Name	Intersection Jurisdiction	Intersection	Approach	Call Start Time	Caused Preempt
1:1:21	High	Springfield	Maintenance 1	Unregistered	Capital City	American Ave @ Duff St	East Bound	4/8/2013 11:58:54 AM	No
100:3:2100	High	Metro Transit	Northtown Transit1	Unregistered	Capital City	American Ave @ Duff St	East Bound	4/8/2013 11:58:54 AM	No
110:2:5	High			Unregistered	Capital City	American Ave @ Duff St	East Bound	4/8/2013 2:29:36 PM	No
110:2:23	High			Unregistered	Capital City	American Ave @ Duff St	East Bound	4/8/2013 2:03:42 PM	No
110:2:23	High			Unregistered	Capital City	American Ave @ Duff St	East Bound	4/8/2013 2:05:28 PM	No

Figure 7. Unauthorized Vehicle Preempt report.

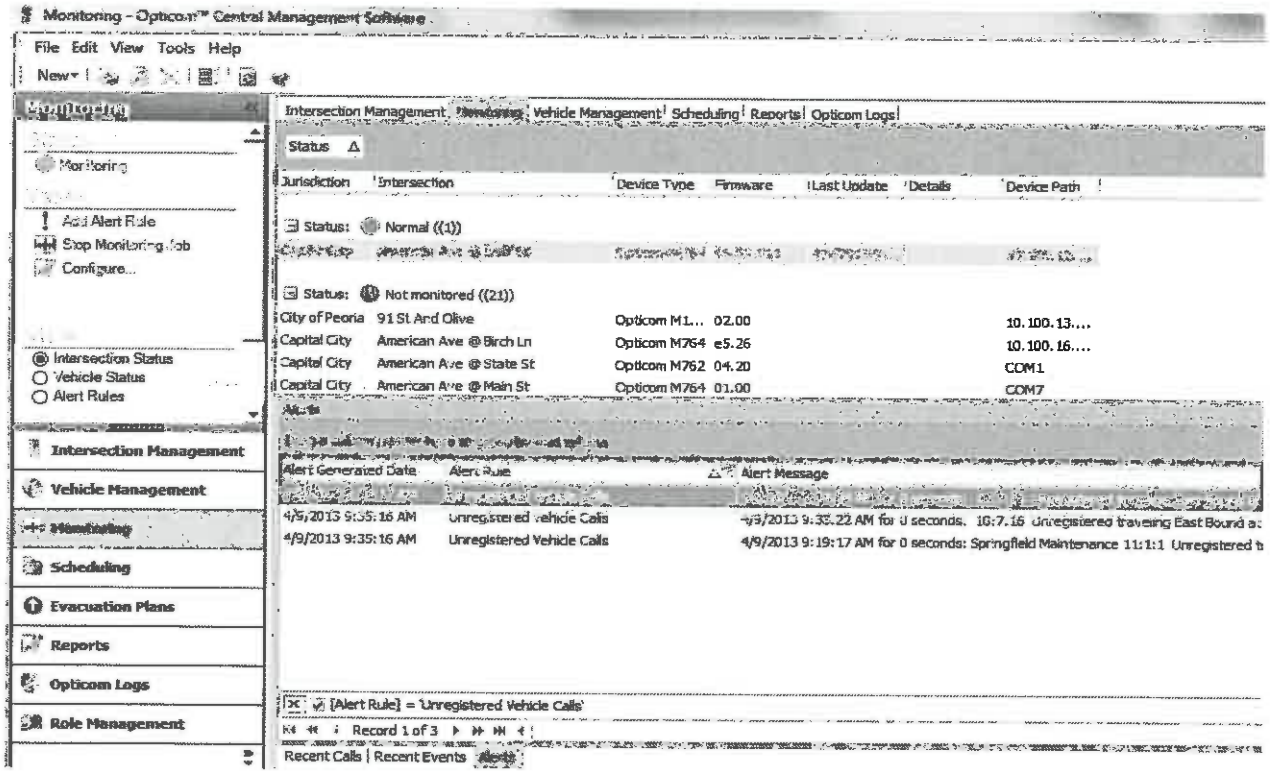

Figure 8. Real-time preemption monitoring.

11.0 Appendix C – Warranty Information

To protect the purchases made by its valued customers and as demonstration of the superb quality of its Opticom products, Global Traffic Technologies, LLC ("GTT") offers a robust warranty program with its Opticom product line, pursuant to the terms and conditions herein. This warranty is made for the exclusive benefit of the original end-user customer and shall not accrue to the benefit of any other user, third party or dealer, unless otherwise required by law.

The Opticom warranty includes all Opticom hardware products sold to an end-user customer, with coverages as follows:

Years 1-5
Should an Opticom component fail within the first five years after purchase, GTT will repair or replace (at GTT's discretion) the product at no charge to the end-user customer.

Years 6-10
Should an Opticom component fail within years 6-10 after purchase, GTT will repair or replace (at GTT's discretion) the product for a fee of 25% of the then current list price. All repairs carry a one-year warranty.

Extended Warranty
For an up-front fee of 15% of the original purchase price, any end-user customer may elect to extend the "Years 1-5" warranty to a ten year warranty, meaning should an Opticom component fail within the first ten years after purchase, GTT will repair or replace (at GTT's discretion) the product at no charge to the end-user customer.

Note: Opticom 795 emitters are excluded from the "Years 6-10" and "Extended Warranty" sections of this warranty program.

Exclusive Limited Warranty: GTT warrants that, during the warranty period described above, its Opticom system will deliver the same level of system operability and functionality as defined in the published GTT specifications applicable to the version of components purchased. THIS WARRANTY CONSTITUTES THE SOLE AND EXCLUSIVE WARRANTY RELATING TO THE OPTICOM SYSTEM SOLD OR MANUFACTURED BY GTT. GTT MAKES NO OTHER REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH RESPECT TO ITS OPTICOM SYSTEM. GTT SPECIFICALLY EXCLUDES AND DISCLAIMS ALL OTHER WARRANTIES REGARDING ITS OPTICOM SYSTEM, WHETHER EXPRESS, IMPLIED OR STATUTORY, INCLUDING ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE OR WARRANTIES ARISING FROM A COURSE OF DEALINGS OR USAGE OF TRADE.

Warranty Exclusions: This warranty shall not apply to (A) incandescent lamps (confirmation lamps) or (B) to any defect or impairment of operability or functionality resulting from or caused by: (1) alteration, misuse, incorrect installation, neglect of the system or damage due to an accident; (2) repair or modification of the system by persons not authorized by GTT; (3) extreme atmospheric or weather conditions; (4) events or use outside the normal or anticipated course; or (5) improper packaging or damage during shipment by the end-user customer or party other than GTT. In addition, the Opticom system integrates an array of matched components. GTT has designed, developed and tested Opticom system components as part of a matched component system. To ensure system integrity and optimal performance, the emitters, detectors, radios/GPS components, detector cables, phase selectors/discriminators and system software must all be GTT components. The use or integration of any GTT system with any non-GTT component shall void all GTT warranties with respect to such GTT system.

Sale and use of the Opticom system is expressly restricted to authorized agencies of government customers, within their specific jurisdictions. However, because the signal generated by the Opticom system is not exclusive, GTT does not warrant exclusive activation by purchaser. Authorized users desiring to use or coordinate use of the Opticom system with that of other jurisdictions must first obtain the prior written approval of each authorized user in the jurisdiction where use is sought.

Remedies and Limitation of Liability: In the event that any Opticom system sold or manufactured by GTT fails to conform to the terms of GTT's warranty as provided herein, the original end-user customer's exclusive remedy shall be limited to the return of the non-conforming goods to GTT for repair or replacement of the non-conforming components, as determined by GTT in its sole discretion. The cost of return shipping to GTT is the responsibility of the end- user customer. All claims for non-conformance or breach of warranty shall be deemed waived, unless the non-conforming components are returned to GTT within 30 days of discovery of the alleged non-conformance. IN NO EVENT SHALL GTT BE LIABLE FOR ANY OTHER INJURY OR DAMAGES, INCLUDING WITHOUT LIMITATION ANY SPECIAL, INDIRECT, INCIDENTAL, CONSEQUENTIAL, PUNITIVE OR EXEMPLARY DAMAGES, LOST PROFITS, LOST BUSINESS OPPORTUNITY, LOSS OF GOOD WILL, ATTORNEYS' FEES, DAMAGE TO BUSINESS OR BUSINESS RELATIONSHIPS OR OTHER FORMS OF ECONOMIC LOSS ARISING FROM, CONNECTED WITH, OR RELATING TO GTT'S ACTS OR OMISSIONS, WHETHER FOR BREACH OF WARRANTY, BREACH OR REPUDIATION OF ANY CONTRACTUAL TERM OR LEGAL DUTY IN CONTRACT, TORT, STATUTE OR OTHER THEORY OF LIABILITY. In addition, because GTT systems are installed by other parties and in a variety of end-user customer-specific applications, and because GTT's products are used by trained professionals, under often extreme emergency conditions, GTT shall not be liable for any personal injury, wrongful death or property damages caused by or arising from any alleged defect, non-conformance, or failure of its systems to function, operate or perform, whether asserted in warranty, contract, tort or other theory of liability. No action, regardless of form, arising out of or alleging either a breach of any warranty or a breach of any contractual term or legal duty by GTT may be brought more than one year after the cause of action accrues.

Warranty Claim Process: Contact your authorized Opticom dealer, or contact GTT technical service at 800-258-4610 or download a warranty & services request form at www.gtt.com. Outside of the United States, please contact our headquarters in St. Paul, MN at 651-789-7333 for assistance in locating an authorized repair facility servicing your country.

Severability: Should any portion of this warranty be declared void or otherwise rendered without effect, the remaining provisions of the warranty shall continue in full force and effect.

Lawrence, Kansas Request for Proposal for GPS Traffic based Traffic Signal Preempt and Remote Monitoring (RFP 1703, Project Number PW 1708), Section III Scope of Services, Requirement 5

As mentioned in the original proposal submission, GTT has extensive experience deploying cellular-based priority control solutions, including in both New York City and Washington D.C. While these systems can be very efficient in the right circumstances, they do create several disadvantages compared with a dedicated, purpose-built radio:

- In times of significant crisis, cellular networks tend to get overloaded and "collapse," making them a less reliable communications mechanism than a dedicated radio, especially for EVP
- Cellular necessitates a long-term recurring cost
- Cellular is vulnerable to the technology evolution path of the carrier (e.g., dropping 2G to free up bandwidth for 4G) exposing the user to the need for a hardware technology retrofit and potentially significant increases in recurring costs. Even if such changes are warranted for a period of time, there is still the inconvenience associated with a change-out.
- Unless advanced algorithms are employed (such as with GTT's cellular-based systems), transmission latency can be very unpredictable and problematic – this is especially critical in a system like EVP

GTT has investigated the possibility of incorporating cellular-based redundancy into our existing distributed GPS/radio-based priority control solutions, however when GTT performed failure decomposition analysis on a hypothetical vehicle unit containing both an embedded cellular modem and embedded 900 MHZ radio, the failure data (using typical average reliability data) does not support such a configuration. Firstly, the motherboard (shared by both radios) is twice as likely to fail as any given radio module, even ignoring any additional reliability impact associated with the software running on the motherboard. This essentially equates to providing protection for the most reliable components of the system only and ignoring the most likely components to fail. Secondly, this ignores any potential secondary impact on overall system availability if one of the radios did fail (i.e. the possibility that a failure of one of the radio modules (cell or 900 MHz) leads to a catastrophic failure of the entire vehicle kit). For these reasons, GTT does not feel that radio redundancy provides sufficient benefit.

With over 500 customers using our proprietary 2.4 GHz radio based priority control system across many thousands of deployed devices installed over the last 15 years, our experience and track record support this position.

Updated Pricing

GLOBAL TRAFFIC TECHNOLOGIES

Proposal

Direct Customer

Global Traffic Technologies, LLC
7800 Third St., N.
Saint Paul, MN 55128
United States

800-258-4610 or 651-789-7333

Bill To	Customer	NetSuite Opp't	Date	Expires
City of Lawrence	City of Lawrence	Pending	24-Apr-17	23-Jul-17

Ship To	Solution/Purchase Type	Intersections	Vehicles
City of Lawrence 6 East 6th Street Lawrence, KS 66044 Attn: Mr. Todd Lohman	Purchase Emergency	120	40

Items	Qty	Description	Price Per Item USD	Extended Price USD
Intersection components:				
	120	Model 764 multimode phase selector	$ 900.00	$ 108,000.00
	120	Model 768 auxiliary interface panel	$ 210.56	$ 25,267.20
	120	Model 3100 series mast-mount radio receiver	$ 1,100.00	$ 132,000.00
	1	Intersection cable (GPS, 500 ft roll)	$ 272.58	$ 272.58
	1	Intersection cable (GPS, 1,000 ft roll)	$ 515.13	$ 515.13
	9	Intersection cable (GPS, 2,500 ft roll)	$ 1,304.10	$ 11,736.90
Vehicle components:				
	40	Model 2100/2101 series vehicle kit	$ 1,500.00	$ 60,000.00
Back-office components:				
	125	Central Management Software (CMS - per intersection)	$ 22.50	$ 2,812.50
Services:				
	120	Installation, intersections (GPS - includes hardware and software configuration) - OPTIONAL	$ 1,300.00	$ 156,000.00
	40	Installation, vehicle kit (hardware) - OPTIONAL	$ 900.00	$ 36,000.00
	1	Installation, CMS software - OPTIONAL	$ 5,400.00	$ 5,400.00
	1	Training (up to 1 week on-site incl. T&L)	$ 10,000.00	$ 10,000.00
Software maintenance:				
	125	Annual SW maint: CMS	$ 16.88	$ 2,109.38
		Total before applicable shipping, duties and/or taxes		**$ 550,113.69**

Pricing Notes

1. All installation services are optional.
2. Software maintenance has been included for year 1 only. Rates in future years may vary. Optionally, customer may pay for up to five years up-front, at year 1 prices.
3. Labor and training rates for out of scope services will be $150/hour, plus travel. All labor and training rates are subject to change.
4. Pricing for additional vehicle and intersection equipment beyond the quantities specified above are guaranteed to be held at the above prices for 3 years from the date of this proposal.
5. Should cellular connectivity be required at any given intersection for general data transfer, the Opticom Model 7614 phase selector with embedded cellular modem can be substituted on a one on one basis for the model 764 specified above. The Model 7614 provides the same functionality as the Model 764, with the addition of the embedded cellular modem. The price of the Model 7614 is $1,163.40 per unit. If the Model 7614 is substituted, cellular service can be added for an additional price of $27.33/month per intersection. This plan would include 150 MB of data per month per intersection. The cellular service rate covers a 5 year term.