City of Brampton ATMS Software Specifications

APPENDIX A

CITY OF BRAMPTON

ADVANCED TRAFFIC MANAGEMENT SYSTEM (ATMS) CENTRAL SOFTWARE SPECIFICATIONS

SYSTEM FUNCTIONAL REQUIREMENTS

May 15, 2024

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PART A: SYSTEM FUNCTIONAL REQUIREMENTS

1. ATMS CENTRAL SOFTWARE

The functional requirements of the central software are presented in four categories: traffic management functions, system integration, user interface functions, and maintenance/support. The following document will describe the requirements of the traffic management functions.

1.1 Traffic Management Functions

1.1.1 System Status Monitoring

The central software shall monitor the traffic signal controllers on second-by-second basis, or at a user defined rate. If polling rates are restricted by elements of the field communications infrastructure or City's computer network, the central software shall monitor the traffic signal controllers at the most frequent rate possible within the existing communication network, at a maximum rate of second-by-second. At start-up, the central software shall establish communications with all intersection controllers via the central communication system and begin second-by-second monitoring. The central software shall simultaneously process both incoming system data from controllers and other devices and well as user requests. The system should be capable to re-establish communication automatically with field controllers and other devices after a communication outage.

1.1.2 Control Sections/Zones

The central software shall enable the traffic signals technologist to define a minimum of fifteen control sections/zones, or subsystems or subgroups, each of which shall be completely independent of the connection of any particular controller to the communications network. The number of controllers in a subsystem shall be programmable from a minimum of one controller to a maximum of the total number of controllers in the system.

1.1.3 Modes of Operation

The central software shall operate in a centralized distributed mode, making use of the intelligence in the local intersection controllers. The central software shall upload and download to local controllers the timing plans, time-of-day/day-of-week (TOD/DOW) schedules, and all other parameters required to operate the local intersections. The traffic signals technologist shall have the capability to upload and download to a single intersection. All intersection controllers shall be monitored on a real-time basis by the central software. The central software shall communicate with the field controllers at a minimum 19.2 kbps rate. The central software shall simultaneously process both incoming data and traffic signals technologist requests/commands. Any upload, download, or time/date requests shall take precedence over real-time monitoring. The central software shall be capable of collecting data and operating twenty-four (24) hours per day, seven (7) days a week, without requiring a traffic signals technologist to be logged into the system. The central software shall provide remote system control by coordinating intersection operation on an individual, section, subgroup, or system-wide basis for selected features. The system shall provide the

flexibility to define traffic signal coordination zones from the City's Traffic Management Center and allow modification of coordination zones during time of day, day of week per predefined parameters. The central software shall include at least the following control modes, which shall be traffic signals technologist - selectable from the Graphical User Interface (GUI): TOD/DOW, Special Event, Manual, Traffic Responsive, Standby, and Flash. In addition, the software must include an Adaptive mode as an extra modular feature to be added as part of the City of Brampton's ATMS Road Map. This feature must be easily enabled and monitor from the main ATMS Central Software.

Upon system start-up, the control mode shall always be local TOD/DOW. If the event scheduler is calling for traffic responsive mode at the time of system restart, the system shall transfer to traffic responsive mode after a traffic signals technologist -selectable amount of time.

For modifying an intersection timing plan to be different than the TOD/DOW, either by manual override or through the traffic responsive algorithm, the controller shall modify timing parameters to the appropriate plan. The central override shall be allowable on an intersection, section, subgroup, or system-wide basis as defined in Section 1.1.3.3. In the event of a failure other than power failure or the severing of communications between the central software and the controller, the traffic signals technologist shall have manual remote control over the intersection.

1.1.3.1 Time of Day/Day of Week

TOD/DOW mode shall be used for controlling traffic conditions that occur regularly. In this mode, each controller shall automatically select and implement traffic signal timing plans in accordance with the defined schedule, locally stored, on a TOD/DOW basis. TOD/DOW plans shall be downloadable from the central software to the controller in the field. Any timing plan found in the central software database shall be downloadable to any available slot in the local controller's database. This shall enable the traffic signals technologist to initiate one download per controller to download all timing plans and time-of-day events. Therefore, the traffic signals technologist shall have the ability to download entire preconfigured signal timing databases to field controllers with a single download command.

1.1.3.2 Special Events

The traffic signals technologist shall be able to schedule any system command for execution at any time using a special events scheduler module. The entries in the event scheduler shall be automatically sequenced in ascending order by TOD/DOW, regardless of the order in which the entries are made.

Traffic signals technologist commands shall have priority over scheduled entries in an event scheduler. The traffic signals technologist shall be able to make entries into the event scheduler for up to a minimum of one year in advance. The scheduler shall have the capability to load multiple system commands for the same time and to execute those system commands at the same time. For events schedules executed at the same time, the execution shall be sequential, and the reliability will be dependent on quality of communication link between central system and the field controller.

Commands entered into the event scheduler shall be of two types, recurring and single event. Recurring commands shall be performed every time the matching of time parameters and inputs/triggers occurs. Single commands shall be performed once and then be automatically deleted from the scheduler database. The

traffic signals technologist shall be able to enter the following recurring and single event command times as a minimum:

Recurring events commands:

- Everyday basis (i.e., every day of the year);
- Every week basis (i.e., on a given day or days of every week);
- Every time duration basis (i.e., every hour);
- Every weekday (i.e., given weekday from Monday through Friday);
- Every weekend (i.e., given weekend day such as Saturday or Sunday); and
- Every holiday (i.e. December 25th, January 1st, July 1th, etc.).

Single event commands:

- Specific date basis (e.g., December 25, 2023);
- Specific time basis (e.g., at 2:00 PM or 1400 hours); and
- Specific date/time basis (e.g., on 4/15/2001 at 11:00 AM).

1.1.3.3 Manual Commands

The traffic signals technologist shall be able to invoke manual override of any active plan in effect for the entire system, for a subsection of the system, or for individual intersections (system-wide, section, or intersection basis) and thus giving traffic signals technologist's the ability to reset the entire system to a different TOD timing plan on demand. Manual selection of timing plans shall have a higher priority than all other modes of timing plan selection.

The traffic signals technologist shall have two options for implementing manual override:

- Setting the manual override and later releasing the override manually; and
- Setting the manual override with a specified time frame for automatic termination during preplanned special events.

Under the second option, the manual override shall terminate automatically at the end of the specified time. When manual override is terminated, each affected controller shall revert to its previous scheduled TOD mode of operation.

The intersection display shall have special function buttons for controlling the stop time and release time for a specific phase or phases (when the controller firmware supports this functionality). The Successful Bidder may be requested by the City to add additional special function buttons or manual commands to the intersection display. The central software shall include up to sixteen (16) such special functions at the request of the City.

1.1.3.4 Traffic Responsive Control

In the traffic responsive mode of operation, the central software shall select the timing plan that is best suited to the existing traffic conditions as measured by the system detectors and analyzed by the system's traffic responsive processes. The conditions and associated timing plans would be set up during the configuration of intersections. Once the traffic responsive process has selected the appropriate timing plan, the pattern

number shall be commanded to the intersections on a continuous basis until the traffic responsive process recognizes, based on sufficient change in traffic conditions, the need to command a different timing plan or to revert back to TOD.

The traffic signals technologist shall be able to define sections (as little as a single detector station as a section) for traffic responsive operation. When the traffic responsive process detects that a detector station has exceeded traffic signals technologist -defined thresholds, the associated sections shall automatically change to the appropriate traffic responsive plan. This process is intended for use in conjunction with special events (such as to detect and respond to a surge of traffic leaving the parking facility of a stadium or arena following the end of a sporting event).

1.1.3.5 Stand-by

It shall be possible to place controllers in a standby mode on system-wide, section, or intersection basis. The traffic signals technologist shall be able to place these components into a stand-by mode through the user interface. When in stand-by mode, the central software shall not command any plans to the intersection therefore allowing the controller to run the TOD/DOW plans in a central distributed manner. This is the default mode of operations for central scheduling.

1.1.3.6 Flash and Free/Flash

In the flash mode, the controller shall run uncoordinated and will not provide green time to any movements at the intersection. To initiate flashing operation remotely, the controller shall be commanded to flash from the central software.

If the controller has been commanded to be in flash mode and remains on-line, it shall be shown as being in flash mode in the GUI. Controller monitoring shall not be lost during Flash and Free/Flash mode

1.1.3.7 Adaptive Signal Control

The Bidder shall indicate in the cost proposal any costs associated with the future use of traffic adaptive functionality. The system must have the option to add adaptive control as a module of the ATMS Central Software.

Adaptive control functionality shall be an optional add-on feature. The Bidder shall provide additional pricing under the price schedule under 'Additional Prices' for Adaptive Signal Control (ASC). Additional services may not commence without the City's prior written approval, and the City's must approve any claim for such additional service in writing. Where the Bidder receives written instructions from the City to provide services that are clearly in addition to the scope of work described in the Bid Document.

In the adaptive control mode, the central software shall generate and implement timing plans in real-time based on detector data acquired from the City's existing detection systems. The adaptive Signal Control (ASC) will use detector data to determine the characteristics of traffic approaching a traffic signal and then adjust the signal timings according to real-time predictive algorithms in order to optimize their performance. In this regard the City requires the system to be capable of collecting, analyzing and summarizing high resolution data in accordance with the Purdue University data logging standard.

The Bidder shall state which ASC algorithm it has packaged with its central software in prior installations and/or tests. Subsequent to the award of a contract, if the City so specifies, the functionality to provide an

ASC shall be demonstrated by the Successful Bidder. The City may choose to add ASC functionality to the central signal system as a module at a later time.

1.1.4 Traffic Database

The Successful Bidder shall furnish and implement a City approved database package. The Successful Bidder shall provide a database interface, which shall be integrated into the central software to provide seamless operation for the traffic signals technologist. The resulting combination of central software and database software shall provide for off-line and online database generation and maintenance.

The database package/interface shall include the ability for loading, modifying, examining, copying, and retrieving the data used to operate the central software. These data include traffic system configuration, timing plans, TOD/DOW schedules, traffic signals technologist databases, and alarm databases. Traffic system configuration shall include channel assignments, communication parameters, and included intersections. Any database changes shall be achievable without having to restart the central software.

All tables in the database shall be printable/exportable in the same form as shown on the computer screen for use by the traffic technologist and maintenance technicians in the field. In order to alleviate repetitive data entry, the central software shall allow the traffic signals technologist to copy and paste data tables for use with other WindowsTM-based applications. The central software shall copy the database fields from one controller to another controller when commanded by the traffic signals technologist.

A search engine shall be provided that identifies and displays all intersection or section/zone data.

Database generation of traffic control operations shall include automated safeguards to preclude dangerous or undesirable intersection operation. These safeguards shall, as a minimum, include range checking.

1.1.4.1 Database Reports

The traffic signals technologist shall be able to generate custom reports using a Successful Bidder's supplied custom report utility. The central software shall provide a seamless interface to this utility. The Successful Bidder shall provide standard pre-formatted reports for use upon start-up of the central software.

The central software shall have the ability to create user-defined pre-formatted reports. The user shall be able to print a user-defined selection of the reports.

The traffic signals technologists' license for this utility shall permit stand-alone use of the utility without the central software.

1.1.5 Central Signal System Operation

1.1.5.1 Distributed Operation

The central software shall operate in a centralized distributed mode. The intelligent local controllers shall be programmed with timing plans, TOD/DOW schedules, and all other parameters required to operate the local intersection. This programming shall be done by downloading at least the timing plan and schedule parameters using the central software. The central software shall monitor all intersection controllers at a maximum of second-by-second basis. The central software time and date source shall be preferably a Network clock or Internet clock provided that the time source that is reliable enough for an ATMS application.

1.1.5.2 Upload/download

The central software shall allow a full or partial (i.e., a single page) upload/download on a system-wide, section, group or intersection basis. Upload/download commands shall be executed instantaneously at a minimum communication rate of 19.2 kbps between the central software and the field controllers.

The central software shall upload and download the following data, at a minimum:

- Intersection timing parameters
- Detector data from as many detectors as controller firmware supports per intersection controller
- Controller and cabinet alarm data
- Event data
- Preemption data
- TSP Data from Zum Corridors
- TSP/LRV Data from Hazel McCallion LRT Systems
- Universal date and time
- High resolution controller data
- TSP MOE reports
- Controller date and time; and,
- Other data specified elsewhere in these System Requirements.
- PTZ Camera snapshots with traffic incident tags

The central software shall highlight errors or missing data in timing plans prior to permitting download of the timing plans to a controller. The central software shall generate a comparison report listing all data discrepancies between the database and controller. The central software shall write this report to a text file for printing or editing.

1.1.5.3 Failure monitoring

The controller hardware and central signal system shall monitor the system to diagnose and report on detector and controller output. The diagnostics shall compare controller settings in the field compared with database parameters, highlight differences and identify failures. Failures shall be defined by traffic signals technologist - definable error thresholds designed to identify erratic detector operation. Upon failure, the central software shall log the event, display a visual/audible alarm to the traffic signals technologist and send an alphanumeric or audio message to traffic signals technologists (see Section 1.1.6). The event log shall include the controller time, the central software time and a reference to the intersection name and number with which the given event is associated. The central software shall continue to attempt communication with

the failed component. If the failed component communicates successfully for a specified amount of time, the component shall be considered operational. This event shall also be logged, along with the clearing of the alarm for the failed component.

1.1.5.4 Timing Plans

The new central software shall provide for a minimum of 16 unique timing plans for each intersection to be stored in the central database (if supported by the firmware at the controller). At any one time, it shall be possible for a minimum of twelve (12) of these plans to be stored in the local controller's database and implemented upon command by the central software (if supported by the firmware at the controller). The number of timing plans, timing plan pages, and coordination plan pages that can be stored by the central software shall only be limited by the physical storage capabilities of the controller hardware.

Automatic permissive windows shall be the default/preferred mode of operation to facilitate the implementation of new splits and offsets. Special event timing plans may be included within the 12 local timing plans.

The central software shall copy the timing plans, tables and coordination tables from one controller to another when commanded by a traffic signals technologist.

1.1.5.5 Phase sequence flexibility

The central software shall be capable of variable left-turn phasing including lead, lag, lead/lag, and exclusive phasing. The form graphically depicting timing plan phase sequence will account for lead, lag and exclusive phasing.

1.1.5.6 Controller Pre-emption Operation

Traffic signals technologists with a certain security level shall be able to pre-empt controller by commanding a pre-emption command.

1.1.5.7 Vehicle Pre-emption EVP/TSP

The central software shall recognize the occurrence of locally initiated preemption (EVP Request) and thereby not erroneously diagnose a coordination failure because the local controller has been pre-empted and operation dropped down to local control. The beginning and ending times of all preemption events shall be recorded in the system logs. The central signal system shall include reports and displays that show the beginning and ending times (or alternately, the beginning time and duration) of all preemption events for a selected time period. Types of preemption (e.g., emergency vehicle or other such as TSP) shall be differentiated and coded with identification within the central software. Vehicle preemption shall be reported by intersection approach. The central system map shall have the ability to track vehicle preemption on a road network by changing the signal status indication to a pre-empted status indicator.

The system shall be able to support local Transit Signal Priority (TSP) for both bus and LRV operations. The system shall allow traffic signals technologists to monitor, modify settings and retrieve TSP performance data from traffic signal controllers.

The central software shall have the capability to upload/download transit priority settings to a compatible ATC controller but in particular all Intelight MaxTime TSP controller pages must be available. The central

software shall have the capability to log transit priority events from the local traffic signal controller's event log. This data must be used to generate TSP performance metrics.

In addition, the system must have the ability to retrieve and log all local controller transit priority events with transit priority signal ID and time stamp data into the system's database.

It should be noted that the central software is a passive component that will not be sending TSP commands to fiend controllers. All TSP functionalities will be handled by the field traffic signal controllers. However, TSP requests from a field priority request generator can be sent to field controllers via C2C network connection.

The system must also display real time transit priority information, including transit priority signal ID, granted/denied transit priority calls, and controller in transit priority, from local controllers on the corridor and intersection display. The system must be able log the number of LRV requests placed through the PRG units on the Hazel McCallion LRT corridor.

The central software must be able to exchange data over the NTCIP 1211 – Transit Signal Priority TSP communication protocol. In addition, the system must also be able to exchange data over the NTCIP 2306 – C2C Centre to Centre communication protocol in the event that data needs to be exchanged between data centres.

1.1.5.8 AVL Cloud Based Transit Signal Priority

The Bidder shall provide additional pricing under the price schedule under 'Additional Prices' for "Cloud - based Transit Signal Priority Module" and any future cost associated with a centrally supported transit priority module. A Central Transit Priority module that utilizes AVL data shall be an optional add-on system module.

Under this type of TSP operation, the central software shall have the capability to enable and log transit priority events at the local traffic controller.

The central software shall include the following features:

- Contain interface that will receive messages from transit vehicles in XML format and process that information to grant or deny priority at requested location.
- Enable/disable transit priority of individual controller or groups of local controllers manually or by time-of-day (TOD) schedule;
- Upload/download of transit priority parameters (i.e., delay time, green extension time, free hold time, minimum time interval to serve consecutive calls, etc.) to local controllers;
- Retrieve and log all local controller transit priority events with transit priority signal ID and time stamp data into a database;
- Retrieve and log granted/denied transit priority requests from local controllers into a database;
- Display real time transit priority information, including transit priority signal ID, granted/denied transit priority calls, and controller in transit priority, from local controllers on the corridor and intersection display;
- Duration of each transit priority event; and
- Priority type (early/extension of green) granted.

This feature is not required for phases 1-3 but the system must offer this feature as a future modular option.

1.1.5.9 Railroad Preemption

The central software shall have the capability to enable, process, and log railroad preemption events at the local traffic controller. The central software shall recognize the occurrence of locally initiated railroad preemption and thereby not erroneously diagnose a coordination failure because the local controller has been pre-empted. The beginning and ending times of all preemption events shall be recorded in the system log. The central signal system shall include reports and displays that show the beginning and ending times (or alternately, the beginning time and duration) of all preemption events for a selected time period. The preemption shall be coded with identification within the central software. The intersection map indicator shall change color to indicate a railroad preemption event in progress if the firmware provides that information in NTCIP 1202 objects.

1.1.6 Traffic Alarms

The central software shall have the capability to automatically send text and audio messages to traffic signals technologists and maintenance personnel upon detecting critical problems with the central software. Upon detection of the critical event, which triggers a system event, up to 10 designated phone numbers shall be dialed and/or text messages sent. This feature shall be fully programmable allowing designation of TOD/DOW, phone number, and which critical event to trigger.

Alarms shall be displayed in the active window on the central software screen. The alarm window shall be displayed in a position defined by the traffic signals technologist and at a size defined by the traffic signals technologist. The alarm should also include an audio alert that can be configured to play any Windows .wav file and will be automatically played on the Traffic Management System's sound system.

1.1.7 Detector Data Processing

The central software shall process detector data at a minimum of once per minute for traffic responsive operation. The central software shall re-evaluate the traffic responsive data every five (5) minutes to determine the appropriateness of the timing and make changes.

The field hardware is expected to include both system and local detectors that shall be used for both traffic counting and traffic responsive operation. The central software shall process and maintain detector count and occupancy data on a continuous basis to be used for various traffic control strategies and/or reporting tasks. Detector feedback shall be obtained on a user definable time frame. The time frame shall not be shorter than once per minute. This requirement is dependent on the Houston Radar integration task.

1.1.7.1 Detector Data Types

The central software shall recognize, process and display detector information including traffic volume, occupancy and speed.

- Volume: The number of vehicles counted in an interval of time. Raw and smoothed volume shall be displayed in user-defined intervals.
- Occupancy: The percentage of time the detector loop is occupied.
- Speed: Calculated based on the output from detector loops or video detection loop emulation if that data is provided through NTCIP protocol.
- TSP check in and check out detectors.

1.1.7.2 Collection and Retrieval

The central software shall automatically record detector data in the database and archive the data onto external media. Raw detector data shall be stored in memory on a five minutes basis. Up to four weeks of five-minute detector data for each intersection shall be stored on the system's application virtual server, by the database program. If bad data are received from the detector loops, radar detectors or video detection equipment during any of the five-minute collection time periods, the data will be tagged as questionable or not available in the database. If no data are received from the detector loops, radar detector or video detection equipment during a five-minute collection time period, the data will be tagged as questionable or not available in the database. A user-definable filter shall be used to set the threshold of when detector data is considered not usable. The user shall have the ability to enable or disable the detector data collection feature.

Every twenty-four (24) hours the five-minute detector data shall be automatically compressed and written to the storage media. Each twenty-four hour history shall be date tagged. The compression shall be done using a commercial off-the-shelf (COTS) software package. Detector data shall be retrievable from the storage media for use with the relational database or traffic modeling packages. Upon retrieval the detector data shall be automatically expanded from the compressed format.

1.1.7.3 Detector Monitoring and Automatic Reporting

The detector feedback from radar detectors, video detectors and legacy inductance loops shall be continuously monitored for proper operation. Detectors shall be classified as acceptable, marginal, disabled, and failed. Detector failures shall be reported to the system log and the system workstation.

The central software shall have user-definable failure filters that define the thresholds that a detector must exceed to be considered failed. The following failure types shall be provided at a minimum:

- Maximum Presence: If an active detector exhibits continuous detection for a program entered period (0-255 minutes in one minute increments);
- No Activity: If an active detector does not exhibit an actuation during a program period (0-255 minutes in one minute increments);
- Erratic Output: If an active detector exhibits excessive actuation (program entered maximum counts per minute 0-255 in increments of one); and

1.2 System Integration

1.2.1 Time Synchronization

The Successful Bidder shall provide the means by which the central software's time clock is automatically synchronized with universal time through the WWV radio broadcast, WWV Internet source, or GPS clock. Such automatic synchronization shall occur up to 4 times per day. The central software shall provide for the automatic downloading of clock updates to each field controller. The central software shall interface preferably with a GPS Clock through domain controller or Windows Operating System to synchronize all field controllers at a user-defined frequency (up to 6 times daily). The central software shall also permit the controller clock to be updated when a controller is brought online.

1.2.2.1 System Scalability

The central software shall be capable of handling at least 1,000 intersections on the day the system goes live.

1.2.2.2 Windows Operating System

Windows 10 shall be the operating system on which the central software is currently based. The City currently uses Windows 10 but plans to migrate to Windows 11 and therefore the ATMS-CENTRAL SOFTWARE shall be future proofed to operate in future Windows based environments.

1.2.3 Communications Protocol Types

The central software communications protocol shall be based on the following National Transportation Communications for Intelligent Transportation Systems (ITS) Protocol, (NTCIP) and data format standards:

- NTCIP 1101 - Simple Transportation Management Framework (STMF)
- NTCIP 1102 - Base Standard: Octet Encoding Rules (OER)
- NTCIP 1103 - Simple Transportation Management Protocol (STMP)
- NTCIP 1201 - Global Object Definitions
- NTCIP 1202 - Object Definitions for Actuated Traffic Signal Controller Units
- NTCIP 1210 - Objects for Signal System Master
- NTCIP 1211 – Transit Signal Priority TSP
- NTCIP 2104 - Subnetwork Profile for Ethernet
- NTCIP 2202 - Internet (TCP/UDP/IP) Profile
- NTCIP 2301 - Application Profile - STMF
- NTCIP 2306 – C2C TMDD standard
- SAEJ2735 format messages
- Signal Phase and Timing (Spat) and MAP data

It is expected that the Successful Bidder will identify and document any messaging protocols or objects that are not covered by the above-mentioned NTCIP standards. The Successful Bidder shall use the standard Protocol Implementation Conformance Statement (PICS) format to document their level of NTCIP compliance.
PICS requirements are discussed at the end of these System Functional Requirements. A copy of the PICS format is available on the www.ntcip.org web site. The Successful Bidder shall include documentation of any messaging protocols or objects that are not covered by the above-mentioned NTCIP standards along with the PICS.

1.2.4 Security

The central software shall provide and maintain a security system to prevent unauthorized access to the system. Traffic signals technologist privileges shall be definable on a functional level. The security levels shall include, at a minimum: no access, view only, upload only, download only, and full access and System Supervisor Administration Access. Each traffic signals technologist shall have a privilege level mask defined by the traffic signals supervisor. The mask shall define the specific functions that the particular traffic signals technologist is authorized to perform. For example, a particular traffic signals technologist may be given the ability to view all reports, but not to modify some or all levels of the database. This shall allow for any number of different levels of traffic signals technologist access capability. The system administrator level shall have full access to the system as well as the responsibility for maintaining account and privilege level masks.

The central software shall validate the code against an encrypted database of authorized traffic signals technologists. Successful completion of the log-in shall result in execution of a session start-up procedure. The start-up procedure shall establish the privileges, object menu options, windows, and tools the traffic signals technologist may utilize. Any functions that a particular traffic signals technologist is not authorized

to access shall either not be shown or shall be “grayed out” so that the traffic signals technologist can easily distinguish the functions to which he/she has access.

Local area network (LAN) access shall be limited to those activities that support the central software.

Unsuccessful log-in attempts shall be logged to the central software log.

1.3 User Interface

1.3.1 General Ease of Use

The Graphical User Interface (GUI) software shall provide the traffic signals technologist with a graphical operating environment. The GUI shall be easy to use while providing a fast and efficient way to control and monitor the traffic signal system in real-time. The GUI shall allow the traffic signals technologist to intuitively select objects on the screen by point-and-click manipulation with the mouse and/or touch screen, thereby minimizing typing and the need to memorize lengthy commands. It shall be easy, for example, to add or delete a given intersection from a section through point-and-click manipulation of the intersections on a map. The traffic signals technologist shall be able to double-click on a section of the main map area to maximize the previously minimized intersection graphics.

The GUI shall include standard WindowsTM printer interfaces and utilize standard WindowsTM printer drivers. The GUI shall incorporate the following:

- Pop-up multiple display objects and windows;
- Menu icons and controls;
- Dialog boxes;
- Push button and other active commands;
- Visual and audio alarms;
- Roll over icons; and
- Use of object characteristics such as colors, highlighting, and flashing to alert the traffic signals technologists of status changes.

The GUI shall be oriented around graphic tools and based on the principle of direct manipulation. Several windows may be active at the same time and may overlap on the screen; however, the traffic signals technologist shall be able to interact with only one window at a time. The traffic signals technologist shall be able to easily switch from one window to another, such as by pointing with the mouse cursor to the uncovered part of another window. The intersection graphics shall fill the entire screen when commanded by the traffic signals technologist. The traffic signals technologist shall be able to move any window on the screen, to change window size, and to collapse a window to an icon. The intersection graphics window shall include a window header with the standard intersection name and number in it.

1.3.2 Multi-user Capability and Remote Access

The operating system and software shall support a multi-terminal, multi-user interface and the software shall allow access to multiple levels of the central software simultaneously. A minimum of 10 and up to 60 users depending on system bandwidth and computing power, each one of whom can be assigned a specific level of access privilege (described in Section 1.2.4), shall be able to access the central software concurrently.

Common icons shall be used as much as possible for all display levels. All colors shall be selectable by the traffic signals technologist. The same colors and icons shall also be used in display/report screens. A legend shall be available within the display window, defining the meaning of each icon and color.

When a traffic signals technologist opens a controller database that is in use, the central software shall display a message explaining to the traffic signals technologist that the database is already open.

A list of the traffic signals technologist s that are currently logged onto the central software shall be available to be viewed by a user-defined set of traffic signals technologists.

The remote access capability shall include workstations or laptops that are physically connected to the LAN as well as remote access computers/laptops. All connected computers, including those connected by VPN, shall be capable of concurrent operation.

1.3.3 Dynamic Displays

1.3.3.1 System Map

When maximized, graphical views on the system map shall return to the scale at which they were displayed immediately prior to being minimized.

Zoom/pan

The dynamic mapping shall incorporate full pan/zoom capability.

Bing Maps and Open Street Maps Compatibility

The graphic system shall have a base map that is derived access from one of the above web-based mapping options. The map shall cover the entire limits of the City's jurisdiction. The dynamic layers of the web-based map shall be incorporated onto the base map by the Successful Bidder. As a minimum, the base map shall show the roadway road edges of arterials and collector streets, freeway centerlines, freeway ramp terminus, rail lines, and major landmarks. Furthermore, the map shall be capable of displaying web-based map information such as current traffic conditions.

1.3.3.2 Intersection Status

The central software shall allow traffic signals technologists to view real-time intersection status and detector (volume, occupancy, and speed) data overlaid on the system map or hyperlinked files.

The central software shall provide the means to keep multiple intersection database windows open simultaneously to facilitate comparison and data manipulation. It shall be possible to drag-and-drop these windows throughout the entire monitor screen.

In all menu selections, the central software shall include a list of intersections by standard name and 6 (e.g. 1-2010) character user definable Asset number.

The central software shall permit the traffic signals technologist to view the status of equipment on a filtered basis. The following elements shall be selectable on a system, section, intersection or individual detector basis for use as filters in the display of system, communications, or equipment status: (a) Communications;

(b) Power up/down; (c) Detector events; (d) Time download – local controller clock; (e) Transition; (f) Timing plan changes - scheduled, manual, special event, holiday; (g) Flashing operation - police flash, scheduled flash; (h) Preemption operation – fire truck preempt, fire station preempt, railroad preempt; transit priority; (i) Cabinet door; (j) Special functions; (k) Controller event log; (l) Detector event log; (m) MMU events log.

Intersection displays shall depict roadway curb lines and lane lines and shall include static displays of the following:

- Street names;
- Intersection number;
- Vehicle, pedestrian and bicycle phase numbering;
- Intersection phase movement arrows;
- Special function definition;

The intersection display shall also include dynamic indicators. The intersection display shall indicate the status of the following:

- Controller operational mode (TOD/DOW), special events, traffic responsive, manual, stand-by, free/flash, police flash, technician flash, and adaptive, if used;
- Changes to the timing pages;
- Controller status (offset transition, pre-empted, type of preemption, conflict flash, etc.);
- The intersection display shall indicate the difference between the programmed offset and the actual timed offset. The displayed difference shall be indicated as positive or negative;
- Communications status (e.g., on-line, bad communication, or no communication);
- Pedestrian push button call status;
- Cabinet door status;
- Timing parameters currently in effect (e.g., controller clock, control mode, transition status, control section assignment, timing plan number, cycle length, offset, and split values);
- Color status of all vehicular phases and overlaps (including the circular red, yellow, and green indications and all arrows);
- Color status of all pedestrian phases (including walk, flashing don't walk, and steady don't walk);
- Actuation status of all local detectors (vehicular and pedestrian) and all system detectors associated with the intersection;
- Pre-emption in effect, and what preemption mode;
- Special function status;
- Indication of failure, and type of failure;
- Permissive windows opening and closing times
- TSP check-in and check out status
- TSP request status
- Count-up of cycle clock;
- Count-down of the number of seconds remaining for the split of the phase in service; and
- Dynamic split values.

The detector status for a given intersection shall be displayed on the screen with the intersection graphics. Traffic counts from system (count) detectors shall be displayed within user-definable count intervals.

The detector status that shall be depicted includes the following:

- Operational;
- No activity;
- Erratic output;
- Maximum presence;
- Failed communication; and
- Real-time feedback pre-empted.

The status of pedestrian push button calls shall be displayed as part of the intersection graphics.

1.3.3.3 Communication Statistics

The central software shall have the capability of developing a display/report that shall show the communications throughput. The display shall include number of communication attempts, number of successes, number of failures, and percentage of successful communications per intersection, per channel, and per system.

The communications status views shall include a reference to the standard intersection name and number.

The central software shall permit the traffic signals technologist to select the method by which sections are sorted. The choices of methods of sorting shall include by communications circuit, by communications addresses, by communications channels, or by intersection name (alphabetically) or number.

1.3.3.4 Time-space Diagrams

The central software shall have the ability to generate time-space diagrams from both real-time data and from historical data contained in the database and to display such time-space diagrams on-screen. The traffic signals technologist should then be able to perform “on-screen fine-tuning”, using click and drag methods to adjust the offsets, with the resulting changes in the widths of the progression bands being displayed. The traffic signals technologist must then be able to save to the database and the resulting changes in offset for that timing plan.

To fine-tune crossing arterial progression, the traffic signals technologist shall be able to generate and display the time-space diagram for each street in a separate window. The on-screen adjustment of the offset of the common window should result in changes in the widths of the progression bands in both windows.

1.3.3.5 Measure of Effectiveness - MOEs

The central software shall have the ability to generate measures of effectiveness (MOE) for arterials and intersections from both real-time data and from historical data (offline) contained in the database on-screen and in printed copy.

MOE reports shall consist of a minimum of the following items collected each sampling period.

- Date and time of day of record;
- Number of whole cycles;
- Sample period;
- Active Cycle/Offset/Split Mode (System or Free);
- Active Cycle/Offset/Split Pattern;
- Seconds average green used per phase per cycle;
- Maximum Green available per phase per cycle based on split or max;

- Phase Green Utilization as a percentage of available green;
- Seconds of average delay per phase;
- Number of Walks per phase per period;
- Number of Gap-outs per phase per period;
- Number of Force offs per phase per period;
- Number of Max-outs per phase per period;
- Cycle length tuning recommendations based on historical data

1.3.3.6 Failure Summary

Malfunction detection and diagnosis and automatic status logging shall be provided to minimize the time-to-repair of critical components of the central software. Upon detection of the failure of a critical component or subsystem, the central software shall automatically enable an alarm and initiate the notification of a traffic signals technologist. The occurrence of each such alarm shall be recorded in the system log.

1.3.4 History Reports

The central software shall generate user selectable formatted reports for traffic events, detector data, measures of effectiveness, and/or communications statistics. The reports shall be generated on a systemwide, section or intersection basis. The system should be capable of auto generating standard reports for daily review by traffic signals technologists.

1.3.5 Audible Alarms

The central software shall generate audible alarms for specified, user-defined failures, concurrent with graphical alerts and alphanumeric paging. Traffic signals technologists shall be able to disable/enable the audible alarm feature quickly and easily. The audible alarms shall come from individual workstations. The central software shall log the disabling of an alarm. Audible system alarms shall be played on the Traffic Management Centre sound system.

1.3.6 Global Parameter Changes

Global changes to control parameters are desirable to be made on a system-wide, section, or intersection basis without requiring the traffic signals technologist to enter data one intersection at a time. The software shall provide an option to make global changes to the entire network or selected corridors.

1.3.7 Help Menus

The software shall offer a built-in, on-screen help menu to assist the traffic signals technologist in using the software without requiring the use of hard copy documentation.

1.4 Maintenance and Support

1.4.1 Expandability

The central software shall be capable of handling at least 1,000 intersections.

The City shall be able to input additional intersections (geometry and configuration) or edit existing intersection data without requiring assistance from the Successful Bidder.

1.4.2 Industry Standards

The Successful Bidder must meet enhancements to industry standards, including approvals of amendments to the NTCIP standards previously discussed. As new NTCIP standards are adopted and existing standards are amended, the Successful Bidder shall ensure that the system meets these standards. Furthermore, the central software must also remain compatible with the latest versions of the ATC controller standard and controller firmware's as it relates to NTCIP 1201, 1202 and 1211 objects.

1.4.3 Documentation

The delivered central software shall be fully documented. This documentation shall consist of pertinent technical documentation and user documentation. The documentation shall include:

- System architecture and block diagram;
- Hardware requirements;
- Program source libraries and source code in escrow account (see Section 12);
- Database definitions and file structures;
- Interface specifications;
- Functional Requirements compliance matrix;
- Communication protocols including field device protocol;
- Variable descriptions, variable cross-references and subroutine calling sequences;
- Security documentation;
- System backup and recovery procedures;
- System operational procedures and error handling;
- Operational options;
- 10 hardcopies and one electronic copy of the traffic signals technologist's manual and 10 hardcopies and one electronic copy of the training manuals for each installation of the central software; and,
- Online user's manual or help facility.

All documentation shall, at a minimum, be submitted in electronic copy. All documentation shall be submitted to the City for final approval.

1.4.4 Software Training

Central software training shall be provided as detailed in Section 2.6 of this document.

1.4.5 Recovery

The central software shall automatically recover from a power failure. The central software shall automatically begin communications with all field equipment via the central communications system.

If the central software detects a non-fatal error within one or more of its processes, it shall alert the user via an alarm on the traffic management centre's sound system and log a message to the system log. The system shall continue to operate in a degraded state. The City shall have final determination on what is considered a non-fatal failure.

If the central software detects a fatal error within one or more of its processes, it shall attempt to alert the user via an alarm on the traffic management centre's sound system and log a message to the system log. The central software shall then attempt an orderly shutdown of the system.

1.4.6 Technical Support

The Successful Bidder shall offer online help for controller and software. The Bidder shall document in the proposal what type of online support is available and include any associated costs in the Price Schedule.

1.5 Business Requirements

Item #	Minimum Requirements	Priority Type (High/Medium/Low)
Functional Requirements (FR)		
FR-01	System must have the capacity to handle up to 1000 traffic signals.	High
FR-02	System must be agnostic and centrally commanded.	High
FR-03	The software shall be based on an open-source model with access to an Application Programing Interface (API).	High
FR-04	System must operate in real-time (second by second) within a centrally distributed system topology.	High
FR-05	System modularity shall allow for additional software modules to be purchased separately from the ATMS-CENTRAL software	High
FR-06	System must have multiple user definable access levels.	High
FR-07	Component exchangeability (system is designed on a hardware agnostic platform) which allows the system to interface with any ATC compatible controller brand and firmware.	High
FR-0S	The system shall be able to use detector data from the City's existing inductive-loop, radar and video detection deployment.	High
FR-09	The system shall not require the use of proprietary detection systems	High
FR-10	The system shall not require the use of in-cabinet "black box" hardware or replace existing controllers. Communication with the system must be direct to traffic signal controller.	High
FR-11	The system shall not render the controller a "dumb device" by overriding operations with holds, force-offs, or withhold/apply detection inputs	High
FR-12	System shall be able to support local Transit Signal Priority (TSP) for both bus and LRV operations. The system shall allow traffic signals technologists to monitor, modify settings and retrieve TSP performance data from traffic signal controllers.	High

	The system will not command TSP operations in the field which will be handled by the traffic signal controller.	
FR-13	The system shall be capable of modifying its operational parameters via triggers from external data sources including Azure maps and Waze data.	High
FR-14	System must be fully compatible with the following industry communication and data format standards: • NTCIP 1101 - Simple Transportation Management Framework (STMF) • NTCIP 1102 - Base Standard: Octet Encoding Rules (OER) • NTCIP 1103 - Simple Transportation Management Protocol (STMP) • NTCIP 1201 - Global Object Definitions • NTCIP 1202 - Object Definitions for Actuated Traffic Signal Controller Units • NTCIP 1210 - Objects for Signal System Master • NTCIP 1211 – Transit Signal Priority TSP • NTCIP 2104 - Subnetwork Profile for Ethernet • NTCIP 2202 - Internet (TCP/UDP/IP) Profile • NTCIP 2301 - Application Profile - STMF • NTCIP 2306 – C2C TMDD standard • SAEJ2735 format messages • Signal Phase and Timing (SPaT) and MAP data	High
FR-15	System must be compatible with any traffic controller hardware that meets the latest approved ATC controller standard and NEMA standard.	High
FR-16	System must be field proven with the following types of controller firmware: Intelight MaxTime Fourth Dimension – D4 Siemens SEPAC	High
FR-17	System must have a responsive traffic control module built in with the main ATMS Central Software	High

FR-18	System should have an adaptive control module that can be added on as part of the City's ATMS road map.	Medium
FR-19	Must be deployed in at least twenty (15) municipalities across North America. These systems must manage a minimum of 300 signals each.	High
FR-20	System must be accessible by multiple users with different levels of access at the same time	High
FR-21	System should provide prompts and instructions to assist with data entry.	Medium
FR-22	System must have the ability to audit, manage, track user activity.	Medium
FR-23	Entry, modification and deletion of certain fields shall be time-stamped with the ability to query this information.	Medium
FR-24	System shall allow authorized users to create custom signal timing reports.	High
FR-25	System must have automatic and escalating email notifications which are 100% configurable and can be tied to any file in the system.	Medium
FR-26	System must be fully upgradable, scalable, and customizable to accommodate future requirements. The system design must be modular in nature.	High
FR-27	System should have a camera module to view and manage CCTV camera equipment.	High
FR-28	The camera module shall be compatible with the following camera protocols: • Axis RESTful API • Axis RESTful API Web Interface	High
FR-29	The system must be capable of communicating via TCP/IP and UDP/IP protocols.	High
FR-30	It shall be possible to place controllers in a standby mode on system-wide, section, or intersection basis.	High
FR-31	The intersection display shall have special function buttons for controlling the stop time and release time for a specific phase or phases.	High

FR-32	It is expected that the Successful Bidder will identify and document any messaging protocols or objects that are not covered by the NTCIP standards covered in this document.	High
FR-33	If the controller has been commanded to be in flash mode and remains on-line, it shall be shown as being in flash mode in the GUI.	High
FR-34	Database generation shall include automated safeguards to preclude dangerous or undesirable intersection operation. These safeguards shall, as a minimum, include range checking.	High
FR-35	The central software shall monitor all intersection controllers at a maximum of second-by-second basis.	High
FR-36	The central software time and date source shall be preferably a GPS Clock but can also be Network clock or Internet clock provided that the time source is reliable enough for an ATMS application.	High
FR-37	The number of timing plans, timing plan pages, and coordination plan pages that can be stored by the central software shall only be limited by the physical storage capabilities of the controller hardware.	High
FR-38	The central software shall be capable of variable left-turn phasing including lead, lag, lead/lag, and exclusive phasing.	High
FR-39	Traffic signals technologists with a certain security level shall be able to pre-empt controller by commanding a pre-emption command.	Medium
FR-40	System must provide the option to communicate with traffic signal controllers over the AB3418E protocol.	High
FR-41	Upon detection of the critical event, which triggers a system event, up to 10 designated phone numbers shall be dialed and/or text messages sent.	High
FR-42	System alerts shall include an audio alert that can be configured to play any Windows .wav file and will be automatically played on the Traffic Management System's sound system.	Medium

FR-43	When maximized, graphical views on the system map shall return to the scale at which they were displayed immediately prior to being minimized.	High
FR-44	The dynamic mapping shall incorporate full pan/zoom capability.	High
FR-45	The system map display must be capable of using Bing Maps and Open Street Maps.	High
FR-46	The system software shall have the ability to generate time-space diagrams from both real-time data and from historical data contained in the database and to display such time-space diagrams on-screen.	High
FR-47	Time-space diagrams must allow traffic signals technologists to perform “on-screen fine-tuning”, using click and drag methods to adjust the offsets, with the resulting changes in the widths of the progression bands being displayed.	High
FR-48	To fine-tune crossing arterial progression, the traffic signals technologist shall be able to generate and display the time-space diagram for each street in a separate window.	High
FR-49	Malfunction detection and diagnosis and automatic status logging shall be provided to minimize the time-to-repair of critical components of the system software.	High
FR-50	Upon detection of the failure of a critical component or subsystem, the system software shall automatically enable an alarm and initiate the notification of traffic signals technologist.	High
FR-51	The system software shall generate user selectable formatted reports for traffic events, detector data, measures of effectiveness, and/or communications statistics. The reports shall be generated on a system-wide, section or intersection basis.	High
FR-52	The system shall be capable of auto generating standard reports for daily review by traffic signals technologists.	Medium
FR-53	The system must be capable of Global changes to control parameters on a system-wide, section, or intersection basis without requiring the traffic signals technologist to enter data one intersection at a time.	High

FR-54	The system must have the ability to interface with virtual D4 controllers connected to Visum for the purposes of running real-time traffic models.	High
FR-55	System must be able to Integrate with Houston Radar sensors via RTMS over TCP/IP.	High
FR-56	System must be able to integrate with SAML, ADFS, Azure AD or Active Directory.	High
	Detector Data Processing Compliance	
DC-01	The central software shall process detector data everyone (1) minute for traffic responsive operation.	High
DC-02	The central software shall re-evaluate the traffic responsive data every five (5) minutes to determine the appropriateness of the timing and make changes.	High
DC-03	The central software shall process and maintain detector count and occupancy data on a continuous basis to be used for various traffic control strategies and/or reporting tasks.	High
DC-04	The central software shall recognize, process and display detector information including traffic volume, occupancy and speed.	High
DC-05	Raw detector data shall be stored in memory on a five minute basis. This data must be stored up to four weeks for each intersection on the system's application virtual server, by the database program	High
DC-06	If bad detector data is received from vehicle detection equipment during any of the five-minute collection time periods, the data will be tagged as questionable or not available in the database.	High
DC-07	If no detector data is received from loops, radar and video detection equipment during a five-minute collection time period, the data will be tagged as questionable or not available in the database.	High
DC-08	Every twenty-four (24) hours the five-minute detector data shall be automatically compressed and written to the storage media. The compression shall be done using a commercial off-the-shelf (COTS) software package.	High

DC-09	Detector data shall be retrievable from the storage media for use with the relational database or traffic modeling packages.	High
DC-10	The system shall have user-definable detector failure filters that define the thresholds that a detector must exceed to be considered failed.	High
DC-11	The system must support the following UDOT ATSPM corridor wide metrics: 1. Throughput 2. Arrivals on Green 3. Progression Ratio 4. Queue Spillback Ratio 5. Peak Period Split Failures 6. Off-Peak Split Failures 7. Travel Time Index 8. Planning Time Index 9. Approach Delay 10. Ped Delay 11. Time in Transition The system must be able to report/summarize these metrics in a corridor wide format.	High
	Intersection Status Requirements	
IS-1	The central software shall allow traffic signals technologists to view real-time intersection status and detector (volume, occupancy, and speed) data overlaid on the system map or hyperlinked files.	Medium
IS-2	The central software shall provide the means to keep multiple intersection database windows open simultaneously to facilitate comparison and data manipulation.	High
IS-3	The central software shall permit the traffic signals technologist to view the status of equipment on a filtered basis.	High
IS-4	The following elements shall be selectable on a system, section, intersection or individual detector basis for use as filters in the display of system, communications, or equipment status: (a) Communications; (b) Power up/down; (c) Detector events; (d) Time download – local controller clock; (e) Transition; (f) Timing plan changes - scheduled, manual,	High

	special event, holiday; (g) Flashing operation - police flash, technician flash, scheduled flash; (h) Preemption operation - optical preempt, fire station preempt, railroad preempt; transit priority; (i) Cabinet door; (j) Special functions; (k) Controller event log; (l) Detector event log; (m) MMU events log.	
IS-5	The system software shall have the capability of developing a display/report that shall show the communications throughput.	High
IS-6	The display shall include number of communication attempts, number of successes, number of failures, and percentage of successful communications per intersection, per channel, and per system.	High
IS-07	The central software shall permit the traffic signals technologist to select the method by which sections are sorted. The choices of methods of sorting shall include by communications circuit, by communications addresses, by communications channels, or by intersection name (alphabetically) or number.	Medium
IS-0S	Provide real-time retrieval and viewing of signal performance measures (i.e., volume, occupancy, speed, queue length, delays, and arrival on green).	High
Analytics and Reporting		
AR-01	The system shall have the capability to collect ATSPM data for “before and after “operational comparisons when the system is "off".	High
AR-02	The system shall automatically collect, summarize and archive event logs and performance measures.	High
AR-03	The system software shall have the ability to generate measures of effectiveness (MOE) for arterials and intersections from both real-time data and from historical data (offline).	High
AR-04	The traffic signals technologist shall be able to generate custom reports using the Successful Bidders supplied report utility. The Successful Bidder must provide the City with five customized system reports.	High
AR-05	The Successful Bidder shall provide routine pre-formatted reports for use upon start-up of the central software.	High

AR-06	The central software shall have the ability to create user-defined pre-formatted reports. The user shall be able to print a user-defined selection of the reports.	High
AR-07	Upon a device failure, the central software shall log the event, display a visual/audible alarm to the traffic signals technologist and send an alphanumeric or audio message to traffic signals technologists.	High
AR-0S	The central software shall have the ability to generate measures of effectiveness (MOE) for arterials and intersections from both real-time data and from historical data (offline) contained in the database on-screen and in printed copy.	High
AR-09	The system shall provide real-time retrieval and viewing of signal performance measures (i.e., volume, occupancy, speed, queue length, delays, and arrivals on green).	High
AR-10	The system must provide system reports for traffic responsive plan selection actions, split monitoring, and signal performance measures	High
AR-11	The system must support the use of traditional ATSPM data as per the UDOT open-source standard. The system must be able to use ATSPM data to generate corridor-wide-metrics.	High
AR-12	The system must be able to export signal timing data in UTDF format to be compatible with Synchro.	High
	Traffic Signal Database Backup Requirements	
DB-1	The system will perform regular automated backups of the complete system to support ongoing signal database maintenance.	High
DB-2	Ability to schedule full system backups.	High
DB-3	All system functions must be available during backups.	High
BD-4	Upload/download commands shall be executed instantaneously at a minimum communication rate of 19.2 kbps between the central software and the field controllers.	High
DB-5	The central software shall highlight errors or missing data in timing plans prior to permitting download of the timing plans to a controller.	Medium
DB-6	The central software shall generate a comparison report listing all data discrepancies between the database and controller	High

DB-07	Ability to retrieve historical reports from the system's inception date to present, this shall be limited by storage capacity only.	High
DB-08	Ability to import the City's current MaxView database via a csv file import.	High
DB-09	Ability to perform an automatic daily database export to a server folder to be accessed by maintenance staff for the purposes of creating a database copy on a USB stick.	Medium
	Bus and LRV TSP Compliance	
TC-01	The central software shall have the capability to upload/download transit priority settings to the following NEMA ATC controllers: 1. Intelight X3 2. Intelight XN2 3. D4 controllers	High
TC-02	The central software shall have the capability to log transit priority events from the local traffic signal controller event log. It must use this data to generate TSP performance metrics.	High
TC-03	System must have the ability to retrieve and log all local controller transit priority events with transit priority signal ID and time stamp data into a database.	High
TC-04	System must retrieve and log granted/denied transit priority requests from local controllers into a database.	High
TC-05	The system must display real time transit priority information, including transit priority signal ID, granted/denied transit priority calls, and controller in transit priority, from local controllers on the corridor and intersection display.	Medium
TC-06	System must be able log number of LRV requests placed through the PRG on the Hazel McCallion LRT corridor.	High
TC-07	System must be able to exchange data over the NTCIP 1211 – Transit Signal Priority TSP communication protocol.	High
TC-08	System must be able to exchange data over the NTCIP 2306 – C2C Centre to Centre communication protocol.	Medium

AR-12	The system must support MaxTime TSP controller pages for the purposes of uploading and downloading TSP settings.	High
	EVP Compliance	
EC-01	The central software shall recognize the occurrence of locally initiated preemption (EVP Request) and thereby not erroneously diagnose a coordination failure because the local controller has been pre-empted and operation dropped down to local control	High
EC-02	The beginning and ending times of all preemption events shall be recorded in the system logs.	High
EC-03	The central signal system shall include reports and displays that show the beginning and ending times (or alternately, the beginning time and duration) of all preemption events for a selected time period.	High
EC-04	Types of preemption (e.g., emergency vehicle or other such as TSP) shall be differentiated and coded with identification within the central software.	High
EC-05	Vehicle preemption shall be reported by intersection approach.	High
EC-06	The central system map shall have the ability to track vehicle preemption on a road network by changing the signal status indication to a pre-empted status indicator.	Medium
	Upgrades and Patches	
UP-01	System software upgrades shall be included free of charge during initial deployment and first year of operation. After the first year they shall be included with an active maintenance and support contract.	High
UP-02	The vendor should include all updates, enhancements, new versions, and upgrades of the ATMS-CENTRAL SOFTWARE as part of the standard software maintenance agreement.	High
UP-03	The vendor shall install all software updates on the testing/training server(s) before installing them on production servers.	High
UP-04	System must have all patches applied with minimal system downtime.	High

	System Integration	
SI-01	System shall ensure that all software modules are integrated with each other. If any modules are provided by another vendor or if third-party applications are needed these will be provided with the ATMS-CENTRAL SOFWARE.	High
SI-02	System should allow for all modules to be accessible to authorized users from the same application.	High
SI-03	The Successful Bidder shall provide the means by which the system software's time clock is automatically synchronized with universal time through the WWV radio broadcast, WWV Internet source, or GPS clock.	High
SI-04	The system software shall provide for the automatic downloading of clock updates to each field controller.	High
SI-05	The central software shall interface preferably with a GPS Clock through domain controller or Windows Operating System to synchronize all field controllers at a user-defined frequency (up to 6 times daily).	High
SI-06	The central software shall also permit the controller clock to be updated when a controller is brought online.	Medium
SI-07	The Successful Bidder shall use the standard Protocol Implementation Conformance Statement (PICS) format to document their level of NTCIP compliance. The compliance level results must be provided to the City.	Medium
	Desktop Application Requirements	
DA-02	If application is client/server based. The application must be able to run on Windows 10 and be compatible with Windows 11 in the near future.	High
DA-03	If the application is client/server based, the application must be able to run on future Windows versions (beyond 11).	High
	User Interface Requirements	
UI-01	System shall have consistent user interface design throughout all modules.	High

UI-02	System shall perform data validation/error checking for fields in the system.	High
UI-03	System shall allow for specific fields to be designated as required data entry.	Medium
UI-04	System should provide auto-completion for frequently entered data.	Low
UI-05	System shall allow the City to add, delete and rename data fields.	Medium
UI-06	System shall provide the user customizable dashboards to display summary information from modules to which the user has permissions to.	Medium
UI-07	User dashboard should allow customization and the ability to add website links such as links to device managers for other ITS devices and controllers.	Medium
UI-08	The GUI shall be easy to use while providing a fast and efficient way to control and monitor the traffic signal system in real-time.	High
UI-09	The GUI shall allow the traffic signals technologist to intuitively select objects on the screen by point-and-click manipulation with the mouse and touch screen.	High
UI-10	Several windows may be active at the same time and may overlap on the screen; however, the traffic signals technologist shall be able to interact with only one window at a time.	High
UI-11	The intersection graphics shall fill the entire screen when commanded by the traffic signals technologist.	High
UI-12	The intersection graphics window shall include a window header with the standard intersection name and number in it.	Medium
UI-13	The operating system and software shall support a multi-terminal, multi-user interface and the software shall allow access to multiple levels of the central software simultaneously.	High
UI-14	A minimum of 5 and up to 50 users depending on system bandwidth and computing power, each one of whom can be assigned a specific level of access privilege shall be able to access the central software concurrently.	High

UI-15	When a traffic signals technologist opens a controller database that is in use, the central software shall display a message explaining to the traffic signals technologist that the database is already open.	Medium
UI-16	A list of the traffic signals technologists that are currently logged onto the central software shall be available to be viewed by a user-defined set of traffic signals technologists.	Medium
UI-17	The remote access capability shall include workstations or laptops that are physically connected to the LAN as well as remote access computers/laptops. All connected computers, including those connected by VPN, shall be capable of concurrent operation.	High
	Printing Requirements	
PR-01	Ability to support network printer configuration.	High
PR-02	Ability for user to select applicable printer.	High
PR-03	The GUI shall include standard WindowsTM printer interfaces and utilize standard WindowsTM printer drivers.	High
	System Training Requirements	
ST-01	Initial training should be provided in-person.	High
ST-02	Vendor to provide end-user training.	High
ST-03	Vendor to provide administrator training.	High
ST-04	Vendor to provide advanced user training.	High
ST-05	Vendor to provide training manuals and other reference materials.	High
	System Support Requirements	
SS-01	The currently available version of software shall be supported free of charge for one year from the installation date.	High
SS-03	Remote support must be provided during weekdays between the hours of 8:30am to 4:30pm EST.	High
	User Accounts/Passwords	
UAC-01	Ability to provide Active Directory integration.	High

UAC-02	Ability to support multi-factor authentication.	Medium
UAC-03	System must provide centralized user management, so each user has a single username and password for the entire system, incorporated across all applications. Changes made to a user account should be made in a single place.	High
UAC-05	Ability to maintain an history of activation and de-activated of user IDs	Medium
UAC-06	Ability to allow authorized users to create and maintain user accounts.	High
UAC-07	Ability for the system administrator to temporarily disable an account.	Medium
UAC-08	Ability for the system administrator to permanently disable an account.	Medium
	User Access Requirements	
UA-01	The system software shall validate the logins against a database of authorized traffic signals technologists and maintenance personnel.	High
UA-02	The start-up procedure shall establish the privileges, menu options, windows, and tools the traffic signals technologist may utilize.	High
UA-03	Any functions that a particular traffic signals technologist is not authorized to access shall either not be shown or the user must be prevented from making database changes.	High
UA-04	Unsuccessful log-in attempts shall be logged.	Medium
UA-05	Support storage of all system access and entries, including user ID, date, and time of each system transaction.	Medium
UA-06	System contains intrinsic measures to prevent accidental modification or deletion of records.	High
	Rapid Deployment – Implementation Services	
RD-01	Ability to deliver a turn key solution for Phase 1 implementation with minimum City staff involvement. Implementation must be completed by January 31, 2024.	High
RD-02	Ability to dedicate staff resources to support a rapid deployment of Phase-1 implementation. This may include the	High

	need for staff resources temporarily operating in the City of Brampton.	
RD-03	Ability to deploy field application engineers to support field testing and implementation.	High
RD-04	Successful bidder must have an in-house team of software engineers that can support the rapid deployment. The team must have as a minimum 20 dedicated software engineers working on ATMS development, implementation and support.	High
RD-05	Ability to dedicate staff to the support of LRV/TSP integration for the Hazel McCallion LRT as necessary.	High
RD-06	Ability to provide remote support on weekdays between 8:30am to 4:30pm EST.	High
RD-07	The Successful Bidder shall furnish and implement a City-approved database package for Phase-1 by January 31, 2024.	High
RD-08	Rapid deployment will require staff training in advanced of system activation. The system developer shall provide training in parallel of system deployment activities.	High
RD-09	The following electronic documentation must be provided to the City as part of the rapid deployment: • System architecture and block diagram; • Hardware requirements; • Program source libraries and source code in escrow account; • Database definitions and file structures; • Interface specifications; • Functional Requirements compliance matrix; • Communication protocols including field device protocol; • Variable descriptions, variable cross-references and subroutine calling sequences; • Security documentation; • System backup and recovery procedures; • System operational procedures and error handling; • Operational options; • Online user's manual or help facility.	High