SPECIFICATION FOR ADVANCED TRANSPORTATION MANAGEMENT SOFTWARE (ATMS)

1. INTRODUCTION

The client intends to provide Advanced Transportation Management Software to be able to monitor and control the ITS equipment deployed in their organization. This discussion paper is a contribution towards establishing the requirements for the software system.

2. REQUIREMENTS

2.1. NTCIP REQUIREMENTS

The client is committed to the use of the NTCIP standards to facilitate the deployment of a wide variety of ITS devices in their organization. In order to provide NTCIP consistency throughout the application, the ATMS shall:

a) Support NTCIP communications for signs, sensors, environmental sensor stations and any other type of NTCIP device.
b) Use NTCIP data structures (MIBS) in the database to define the attributes of the Device Types in NTCIP terms.
c) Store logged data in database tables in the NTCIP format, so that fields are defined in terms of the NTCIP Object names, and the values are stored in NTCIP units.
d) Use NTCIP object identifiers for internal communication between system components (e.g. between clients and servers) so that any new applications can be established with these components, using Properties, Methods and Events that use NTCIP object identifiers as parameters.

2.2. COMMUNICATION REQUIREMENTS

The client will be using a variety of communication sub-systems to monitor and control the ITS devices contemplated. These include wireless, network, dial up and serial connections. The ATMS shall support as a minimum the following communication channels:

a) Ethernet connections, using both TCP/IP and UDP/IP transport, including support for wireless modems
b) Serial connections, using PMPP transport.
c) Ethernet connections, with PMPP serial embedded within either TCP/IP or UDP/IP.
d) Dial up connections using either PMPP or PPP protocols.
e) Support for a modem array, where a bank of dial up modems is supported, using PMPP.
f) The ATMS shall maintain communication statistics for each device, so that the number of dropped packets and other communication errors can be readily determined.
g) The communication parameters shall be settable in the software for time to establish a connection, time for a device to reply, and the number of re-

tries the server makes before raising a timeout error. These parameters shall be individually adjustable for each communication channel.

h) It shall be possible to establish log polling to each device, with the following parameters configurable:
    a. The frequency of polling shall be adjustable between 1 minute and 24 hours. It shall also be possible to disable log polling of selected devices.
    b. The user, for each device type, shall be able to select which NTCIP objects are to be included in each log poll.
    c. The system shall log the results of each poll in the database, where it shall be available for inspection and report.
    d. As part of the polling process, it shall be possible to cause the ATMS to synchronize the time in the device controller to the server time of the ATMS.
i) It shall be possible to establish real-time polling to each device, with the following parameters configurable:
    a. The frequency of polling shall be adjustable between 1 second an 60 minutes.
    b. The user, for each device type, shall be able to select which NTCIP objects are to be included in each real time poll.
    c. It shall be possible to configure NTCIP STMP (Dynamic Objects) for real time polling, and the ATMS shall automatically manage the refresh of these objects to ensure correct STMP operation.

2.3. DATABASE LOGGING REQUIREMENTS

The ATMS shall support the polling of devices, to monitor their status, value and health. This logging shall include:

a) The ability to configure the logging period for each device, from 30 seconds to 12 hours.
b) The ability to configure, for each Device Type, which NTCIP objects are logged into the database at each poll.
c) The ability to configure, for each Device Type, the length of the logs that are to be kept in the database, before the oldest logs are overwritten.

2.4. FUNCTIONAL REQUIREMENTS

2.4.1. USER INTERFACE

2.4.1.1. GIS MAPPING

The ATMS shall support Geographical Information System (GIS) mapping, as part of the user interface. This support of GIS shall include the following:

a) The ability to access the client supplied ESRI shape files for GIS data.
b) The ability to provide configurable “zoom-based detail” for shapes and labels independently.
c) The ability to configure the render colors, shapes, labels, fonts, size and all other render attributes.

d) All Devices shall be geo-located. The appearance of devices on a particular map view shall be controlled by a combination of zoom control and layer control.
e) Devices that include GPS units, where the latitude and longitude are returned as part of the polling process, shall automatically update their geo-locations on the maps. It shall be possible to configure a “bread crumb” trail on the GPS, to show the recent path of moving devices.
f) When a Device is moved on a map display (perhaps for aesthetic reasons, to make an area of the map less crowded) the Device shall indicate its actual geo-location with a line (a “rubber band”) from the Device icon to the actual geo-location.
g) The overall “look and feel” of the GIS interface shall make it possible for an operator to navigate around the maps, and select devices, based on their position, and then navigate to that device using right-click menus or similar.

2.4.1.2. ACCESS LEVELS AND SECURITY

The ATMS shall support multi-level User Level security levels, as follows:

a) A User Name and Password shall be required before being able to access any ATMS function
b) The password shall be encrypted in the database.
c) It shall be possible for an administrator to see which users are logged on to ATMS, and on which computers (client workstations) they are logged on.
d) It shall be possible for an administrator to force a log off of any ATMS user.
e) An inactivity timer shall cause an inactive user to be logged off after a configurable time.

2.4.1.3. GROUPS

It shall be possible to assign devices to groups as defined by the Administrator, as outlined below:

a) These groups shall only be accessible based on the security level of the user groups that are defined.
b) It shall be possible to assign read/write, read only or not accessible permissions to groups. So, for example, a “North Sign Group” shall be controllable by the “North Operators”, but only viewable by the “South Operators” and a “South Sign Group” shall be controllable by the “South Operators”, but only viewable by the “North Operators”.

2.4.1.4. AUDIT TRAIL

All user activity shall be logged for audit trail purposes, as follows

a) Any changes to configuration, or operation, shall be logged
b) All logs shall include a User Name, Device ID and a Date Timestamp of user activity.

c) It shall be possible to view and print reports of User Activity, filtered by Date and/or User and/or Device

2.4.1.5. THRESHOLDS AND ALARMS

Thresholds shall be measured as to whether a level or limit has been either exceeded or fell below a certain point. These thresholds shall be configurable by using:

a) Comparative measures such as greater than, less than or equal to, as well as comparing two values.
b) Binary comparatives

Alarms shall have the ability to notify users if a sign is not operating properly when the status is measured. The alarms feature should be extensive and include such items as:

a) User defined parameters that alarms will use to trigger and display for the operator when an alarm threshold is reached. For example: low battery voltage warning for portable signs, pixel failure, etc.
b) A diagnostic display (grid) shall be opened for each sign showing current failures and/or current status etc.
c) Alarms will be raised if a fault is detected by the system during the polling process and the fault will be displayed on the grid in red, and if desired with an audible warning, to focus the attention of the operator.
d) Diagnostic alarms can also be reported by e-mail to designated users on the system.

2.4.1.6. LINKS

It shall be possible to assign color bands alongside any of the roadways as displayed on the GIS display, so that the level of service (availability) of the roadway can be displayed. These graphical widgets shall have the following characteristics:

a) The Links shall follow the geo-location of the road when the map is panned, or zoomed in or out.
b) It shall be possible to set the transparency of the Link, so that the visual interaction with the underlying GIS data can be modified.
c) It shall be possible to assign default colors to Links, and then have these colors automatically changed by means of Alarms that occur when thresholds (e.g. road temperature) cross a threshold.
d) When an update to a Link occurs, this update shall occur on all client computers that are displaying the GIS map on which the Link exists.

2.4.1.7. SCHEDULING

The ATMS shall have the ability to schedule messages for deployment at specific times (start and end times). It shall be possible for scheduling to be done from a central location. Scheduling can be done on a per sign basis or for a selected group of signs. The actions scheduled shall be set at predetermined dates and

times that are configurable by day, day of week, month or any combination thereof. The types of actions that will be available for scheduling includes:

a) Activate a selected message or sequence of messages
b) Activate a scenario
c) Activate a Standard Operating Procedure (SOP)
d) Activate an ASC Timing Plan
e) Activate a manual polling process
f) Activate a camera preset
g) Blank a Sign
h) Download and Activate a changeable message
i) Download new event logs and append to an event log table
j) Perform a backup
k) Run a report

Any number of schedules shall have the ability to be configured and run from the central server. A log of current activity for each schedule should be available. Schedules should be easily editable, including adding actions to and removing actions from a previously saved schedule.

2.4.1.8. REPORTS

ATMS shall support user configurable reports, as follows:

a) This report writer shall be Microsoft Access, or equivalent, and shall support connection to the main ATMS SQL Server database
b) The report writer shall support the display of tables, graphs and any other data that is located in the ATMS database.
c) The ATMS shall provide as standard filters for date ranges, device types, devices and users so that any or all reports can be filtered with these parameters.

2.4.1.9. REAL-TIME GRAPHING

ATMS shall provide real-time graphing of sensor information, as follows:

a) Line graphs that depict speed, volume and occupancy shown real-time at a user-definable polling period.
b) Scatter graphs that chart out volume versus speed real-time at user-definable intervals.
c) It shall be possible to aggregate the volume (sum), speed (weighted average) and occupancy (average) across a user definable number of lanes.
d) It shall be possible to aggregate the sensor graph, so that one NTCIP Sensor device can be configured to aggregate for displaying North bound lanes separately from South bound, for example. All lane detail shall continue to be logged for analysis purposes.
e) A graphical widget shall be displayed on the maps where a recent history of speed, volume and occupancy can be displayed. These displays shall be updated dynamically on an event driven basis, as new detector data is received. It shall be possible to:

a. configure the graphical parameters to modify the time range of "recent history"
b. Display Speed, Volume and Occupancy as three different color traces versus Time, or
c. Display Speed versus Volume.

2.4.2. ENVIRONMENTAL SENSOR STATIONS

ATMS shall support NTCIP Environmental Stations, as follows:

a) It shall be possible to configure the ESS MIB in ATMS to support the actual instrumentation deployed on the ESS.
b) It shall be possible, at a configurable period, to poll an ESS for a configurable set of data and the ATMS shall then log the results of this poll, including any errors, in the database.
c) The ATMS shall be able to display the weather data on the GIS map, using a set of configurable icons to reflect the current weather.
d) The ATMS shall be able to display the current weather data in a grid format.
e) The ATMS shall be able to display the current and recent historical weather data in a graphical format for each ESS device on the Map so that trends in weather data can be observed in real-time.
f) This real-time weather data can be factored into any incident algorithm or travel time algorithm through the ATMS system.
g) The ATMS shall support the retrieval and display of traffic speed, volume and occupancy from radar traffic detectors located at the ESS site. The ATMS shall support NTCIP 1209 data elements in this regard.
h) The ATMS shall support the retrieval, archive and display of static JPEG images from cameras located at the ESS site. ATMS shall use HTTP protocol to retrieve these images.

2.4.3. SNOW PLOWS, EMERGENCY RESPONSE VEHICLES, OR OTHER GPS ENABLED MONITORING EQUIPMENT

ATMS shall support NTCIP communications with Mobile Data Collection Devices (MDC). These devices, which can be installed in any unit that needs to be tracked and monitored, are configured to support the client's MIB for MDC devices.

a) It shall be possible to configure the MDC MIB in ATMS to support the actual instrumentation deployed on the MDC.
b) It shall be possible, at a configurable period, to poll the MDC for a configurable set of data, and the ATMS shall then log the results of this poll, including any errors, in the database.
c) The ATMS shall support the "store and forward" scheme for data logging on the MDC. The MDC may be out of wireless communication range for a period. The MDC will store the poll data while it is out of communication range. The ATMS shall then "bust poll" the MDC when communications is established, so that the stored data can be retrieved, and then normal polled communication re-established.

d) The ATMS shall be able to display the MDC data on the GIS map.
e) The ATMS shall be able to display the current MDC data in a grid format,
f) The ATMS shall be able to display the current and recent historical MDC data in a graphical format, for each MDC device, on the Map so that trends in MDC data can be observed in real-time.
g) The ATMS GIS Map shall re-position the MDC device each time poll data is received with latitude and longitude parameters from the GPS unit on the MDC.
h) The ATMS GIS Map shall support “bread crumbs” display of the recent track of the MDC, for a configurable historical period.

2.4.4. DMS SIGNS

The ATMS shall include the ability to select any one of the available signs and control it through the use of a user interface that includes the following:

a) Current data for the sign selected will be displayed on the interface.
b) All the available pre-programmed or changeable messages will be displayed, depending on which message type is selected.
c) Ability to check the content of these messages, change them and/or download them to the sign for future or current display.

The DMS Signs user interface should include the ability to:

a) Preview the message that is being edited in a WYSIWYG (what you see is what you get) format.
b) Change a message on multiple signs at the same time.
c) Send messages out to the sign; be displayed on the sign or both.
d) Blank a sign.
e) Set the priority and duration for the sign message.
f) Limit the words used on a sign to those available on a pre-determined approved word list.
g) Sequence more than one message on a sign and set the display rate for each page

When a message is edited, the following options shall be available:

a) Font selection with up to 4 choices
b) Line Justification
c) Page Centering (Top, Bottom, Middle)
d) Page Breaks
e) Flashing
f) Timers
g) Background / Foreground Color
h) Moving Text
i) Insert date, time, speed or temperature information
Word checking capabilities shall include the ability to offer an approved list of words and/or a disapproved list of words.
j) The ATMS shall enable the user to modify the list of signs and the selected message(s) prior to display. A mechanism shall also be included to terminate a message and restore the next highest priority message that

was previously displayed until the duration time of said message expires. The opportunity to select a different message will also be provided.

k) The ATMS shall display the highest priority message when multiple messages are being requested for display on the same sign at the same time. The message shall continue to be displayed until a higher priority message is requested, the message is terminated or the message duration time expires.
l) Prior to expiration of the message duration time, the ATMS system shall notify the user of the imminent expiration of the message duration time and allow the user to extend the message display or extinguish the message.
m) The ATMS will retain the current message up to 10 minutes beyond the expiration duration time while waiting for the operator's response before extinguishing a message with an expired duration time or sooner if the operator indicates that the message can be extinguished.
n) Once the operator terminates the message or when it is overridden by a higher priority message, the ATMS shall display the highest priority message competing for display on the sign.

The ATMS shall also include the ability to create scenarios or Amber Alerts that can be activated immediately on one or more signs or that can be scheduled at pre-determined dates / times. Scenarios or alerts shall include:

a) Pre-prepared procedures that can be implemented, providing extensive and accurate incident management.
b) Permissions for the administrator to set up the pre-prepared procedures so that operators will be able to activate the correct messages on the correct signs for any given scenario.
c) Selecting messages from those prepared using the Sign interface.
d) Capacity to verify a scenario before sending it out to the signs
e) Ability to cancel a scenario
f) Capability to add any number of Standard Operating Procedures as part of the scenario
g) Creation of a log of the scenario actions.

The ATMS shall include the ability to manage a Message Queue for each sign device on the system.

a) The intention is to provide Travel Time messages as the default message on the system.
b) In the event of an incident, it shall be possible to display incident messages, which as a higher priority message, will displace the lower priority Travel Time message on the sign, for the duration selected.
c) When the duration of the message, is set to expire, the ATMS shall, 10 minutes before the expiry time, alert the operator that the message is due to expire. The operator may elect to extend the message duration.

d) If the message is allowed to expire, then the message queue shall remove the message from the sign, and replace it with the next highest priority, non-expired message that is on the Message Queue.
e) It shall be possible to manage the message queue, by deleting messages, changing duration, or changing the sequence of messages of the same priority.
f) The operator shall be alerted when a message that the operator tries to display will not be displayed as there is a higher priority message already on the sign.
g) The operator shall be prompted to resolve the conflict that occurs when a message is placed on the queue, where there are already messages of the same priority. The operator shall be allowed to place the message at the front of the queue, the back of the queue, or allow the ATMS to auto-resolve based on user defined auto-resolution rules previously configured.

2.4.5. TRAFFIC SIGNALS, RAMP METERING, OVERHEAD LANE CONTROLS AND DYNAMIC SPEED CONTROLS

ATMS shall support the display of graphical representations of signal intersections, as follows:

a) It shall be possible to configure the graphical representation of a device, including signal controllers and ramp meter devices, so that the device status can be readily determined. This shall include arrows of different colors, stop bars, detector indicators, pedestrian signal indicators and any user defined graphical representation of a device feature.
b) The visibility of each of these graphical indicators shall be associated with the state of an NTCIP object.
c) The graphical indicators of the device state shall be superimposed on a drawing, graphic or photograph of the intersection or ramp meter.
d) It shall be possible to fully configure the appearance of this graphical representation, at a minimum of four different zoom levels.
e) The graphical representation of an intersection or ramp meter shall respond to the results of real-time polling, and log polling, as described elsewhere.
f) It shall be possible to use this general purpose graphical device representation tool to represent any device that can be described in NTCIP terms, including Lane Control Signals, Mobile Emergency Vehicles and Snow Plows.

ATMS shall support the upload and download of configuration data to traffic signal controllers, ramp meters and any NTCIP device, as follows:

a) It shall be possible to configure a series of upload/download screens for each device type, where the screens can be configured to correspond to data stored in the device.
b) Using these screens, it shall be possible to upload any data to, or download any data from, any NTCIP conformant device.

c) It shall be possible to configure this utility to use to NTCIP Block objects for increase communications efficiency.
d) It shall be possible to retrieve data from the database, and sent to a device. It shall be possible to retrieve data from a device, and save to the database.
e) It shall be possible to copy the data from one device to another, and save in the database.
f) It shall be possible to configure the text enumeration of enumerated values.
g) The user shall be offered a list a enumeration from which to select, for enumerated items.
h) The color background of cells shall change to indicate that the user has changed a value, and not yet sent to the device, or has retrieved a value from the device which is different to the value saved in the database.

2.4.6. FOREIGN LANGUAGE, LOCAL DIALECT OR USER INTERFACE PREFERENCE SUPPORT

a) The ATMS shall support the ability for an administrative user to modify the text value of any label or text field, on any user interface, within the ATMS.
b) This feature shall allow the user to translate the user interface into a foreign language.
c) Multiple simultaneous foreign languages shall be supported. The user shall be able to select, on any client workstation, which foreign language shall appear on that workstation.
d) It shall be possible to use this feature to adjust the wording that appears on forms and menus to suit local preferences.

2.4.7 STATUS AND HEALTH

The health of ITS devices is important to the client; therefore, the ability to monitor the status and health of said equipment is vital to their operation. The ATMS shall be able to monitor equipment using alarms, communication statistics, as well as diagnostic grids. The monitoring can be done on a polling or real time basis. The status can be viewed in one of three ways: viewing the status grid, displaying device objects on a map view or running a statistical or activity log report.

Alarms can be set for any number of NTCIP compliant objects and thresholds established for them as outlined under the Thresholds and Alarms section previously stated. Once the alarms have been established, monitoring will begin and shall include:

a) Raising an alarm automatically when a threshold has been exceeded.
b) Allowing the operator to respond to the alarm by acknowledging the alarm, queuing it up for a certain amount of time or resetting it.
c) Masking alarms for certain days and/or times of day.
d) Automatically activating applicable Standard Operating Procedures for the alarm.
e) Logging of all alarms and subsequent actions taken for said alarm.

Communication Failures shall be handled through the polling of devices either as scheduled (log polling) or on a real time basis. Communication failures shall be dealt with in the following manner:

a) The configuration parameters shall be set by the user so that when a device misses a certain number of polls, the device goes to a marginal state (reduced frequency polling) and then finally offline.
b) When a device fails to respond to a poll for the configured timeout and after the configured number of retries, an alarm shall be raised.
c) The occurrence of an online, marginal or offline state shall raise appropriate alarms in the client so that the status and health of these devices shall be readily displayed, monitored and reported.
d) Communication alarms shall be viewable on the map view of the devices.
e) A log shall be kept of all communication failures.

Diagnostic grids shall be configurable for all devices and shall visually show the health and status of said devices. These grids shall include:

a) Any applicable NTCIP object
b) Thresholds for these objects that will be used as the trigger for any alarms needed.

Once the grids have been configured, they shall be available for display on the map view and will alert the operator by beeping, flashing and/or color coding of the grid that a threshold has been reached. This is essentially the same as having an alarm go off and should be dealt with in the same way as described above.

2.4.8 INCIDENT MANAGEMENT

ATMS shall support sophisticated incident management, as follows:

a) ATMS shall include the capability to schedule incidents for the attention of operators and to log information about incidents. These logged incidents shall then be available to be validated and classified.

b) The ATMS Manual Incident Logging user interface shall support the linking, via means of a pointer, the reference source of the information about the incident.

c) ATMS shall support a multiple client architecture so that the process for incident logging, incident validation and classification, and incident response and advisory can be handled by one user in quiet times and by an unlimited number of users in times of emergency. For example, in an emergency weather incident one ATMS operator will only log incidents, another will only validate incidents, and another two ATMS operators manage the incidents.

d) ATMS shall support the following feature: When logging an incoming call (e-mail, telephone, radio, or other source requiring manual logging), there will be a reference to the current incidents table and map so that the user can check whether the incident already exists. If it is a new incident, the

incoming call is logged, and immediately passed on for validation. The user interface shall be quick and easy to use, so that incident management can start a.s.a.p. If the incident already exists, the incoming call is linked to the incident and no further validation is done.

e) The ATMS shall support the ability to configure the scheduling and priority of incident management.

f) ATMS shall include a user interface, with multiple tabs, to manage the Incident Table. The Incident Table shall contain the details of the unconfirmed incidents, the current confirmed incidents, the incident type, the incident impact, the expected duration, and the historical cleared incidents.

g) The incident table shall be capable of being populated (i.e. new incidents inserted) from a number of sources. These sources include manual incidents via operator input (such as telephone, radio, video surveillance and other sources), automatic incidents from Incident Detection (say Weather Threshold exceeded), scheduled incidents from the Central Scheduler, and any other third party source of Incidents.

h) The Incident Table component shall raise an incident event in connected clients, to alert the validation and classification operator that a new unconfirmed incident has occurred. The operator shall be able to view the details of the incident, and change the incident status to confirmed, pending, cleared and closed as appropriate, with annotations as applicable.

i) The change in status of any item in the Incident Table shall also cause an event to be raised that will result in all the visual displays, and operator interfaces, displaying the latest incident information on a system-wide event driven basis.

j) The user interface shall allow the incident manager to validate incidents, check on overdue incidence clearance, and all other factors relating to managing the current incident table. ATMS shall allow duplicate incidents to be combined during the validation process.

k) The data in the Incident Operator user interface of all connected clients shall be automatically refreshed whenever an Incident Event occurs (e.g. an operator changes an Incident status) to ensure that all operators are dealing with the latest incident data.

2.4.9 TRAFFIC RESPONSIVENESS

ATMS shall provide the ability for a traffic system to adapt to events and shall be used to alert operators of the ATMS to a variety of situations. User interfaces shall be provided to:

a) Configure parameters, variables and thresholds for algorithms in other modules, such as:

Alert Level Algorithms
Incident Detection (ie: minimum speeds)
Travel Time Predictions
Impact Predictions
Weather Algorithms

c) Information for the above shall be scheduled at a user-definable period
d) Shall set up and modify standard operating procedures (SOP) to be used.
e) Shall schedule holidays, etc. through a calendar set-up.

Incident Management shall be able to access all incidents, alert levels, traffic and weather data in the database as configured.

2.4.10 Alert Level Algorithms

Incident Management shall be capable of being configured to trigger Alert Levels in accordance with a User requirement.
This module shall be implemented as a utility module. The alert level algorithm shall use input variables to set the alert level for a specific period. The algorithm shall be refined and configured by the client. Thus, the ATMS shall provide for the configuration of the different input variables (which input variables to be used, threshold values, etc.).

This module can implement whatever algorithm is desired to achieve triggering of Alert Levels as specified.

2.4.11 Incident Detection

Incident Management shall be capable of implementing incident detection algorithms based on the following:

- Pattern-Based algorithms: Incidents are recognized from patterns in data that are not normal for a particular stretch of road for the time of day/day of week.
- Catastrophe Theory: Incidents are recognized from a sudden change in one variable of interest, whilst other related variables show smooth and continuous change
- Statistical methods: Incidents are recognized from any changes in traffic compared to the forecasted flows.
- Artificial Intelligence: Incidents are recognized by a rule-based algorithm.
- Other algorithms such as:
    - At each traffic detector, the flow and the speed is measured in typical 5 minute intervals. The values in consecutive 5 minute intervals are smoothed and compared over 3 intervals. If a change

exceeding a specific percentage occurs, an unconfirmed incident is created.
- The flows at 2 adjacent detectors are measured and compared (upstream and downstream). If the values differ by a certain percentage, an unconfirmed incident is created.

2.4.12 Travel Time Predictions

The Incident Management travel time prediction module shall consist of one of the following:

A complete module provided by the client, based on the weight detector transit time method below, with the configuration parameters customized based on input from the client.

The travel time algorithm shall be based on the following:

- The freeway is divided into links and routes.
- Links have similar flow characteristics and/or speed characteristics. Typically, this is a section between on- and off-ramps, of similar grade, etc.

A number of links in a travel direction added together shall form a route, e.g. highways with several exits shall be a route consisting of several links.

Functionality of the travel time algorithm shall include:

- The module should allow for full configuration of all the variables as required to calculate the travel time.
- The user shall be able to specify which input variables are to be used in the travel time prediction algorithm, e.g. flow and speed, or flow only.

The TTP shall be able to access all traffic parameters for all detectors as configured in the configuration and admin module.

2.4.13 Impact Predictions

Incident Management shall make impact predictions based on:

a) Comparison of current incident information with historical incident information for similar incidents (time, extent and location) in order to predict response and clearance times
b) Determine effect of these times on travel times of vehicles
c) Issue advisories on appropriate incident response (SOP's)
d) Issue advisories on appropriate traffic management strategies

Based on the historical time for the clearance of impacts, it shall be possible to prepare an advisory to the operator of the probable impact of each type and category of incident.

The ATMS shall provide a method to implement a tabular rule-based display of probable impacts, based on User provided rules.

2.4.14 Weather Algorithm

The weather module of the ATMS shall include input from the following three sources:

1) Reading data from NTCIP compliant weather and environmental stations and writing it into the database. Parameters shall include the following:
   - Wind velocity (instantaneous and average)
   - Wind direction
   - Air temperature
   - Total precipitation (6,12, and 24 hour period)
   - Dew point
   - Humidity
   - Visibility
   - Pollution levels

2) Automated reading of weather forecasts from an outside source, such as a weather forecasting website. The parameters obtained automatically shall include:
   - Wind velocity
   - Wind direction
   - Air temperature (min and max for the period)
   - Conditions (Wind/Rain/Clouds/Mist)
   - Time of Sunrise and Sunset
   - Mist

3) Manually input weather and environmental conditions per town and/or location and/or region for a certain period, including a manual forecast.

The summary of forecast and actual weather for the region and area shall be displayed in a tabular format (Excel like).

The ATMS shall support the display of weather data on the map display or other user interface. This includes graphical wind speed/direction indicator, rainfall indicator and visibility condition indicator. This graphical widget shall have the option of being able to display other user-definable numeric data in an associated Grid Display. In addition to the graphical widget for the display of weather data, the ATMS shall support the display of a recent history of the weather from a weather device, which is dynamically updated each time new poll data is received.

The ATMS shall support the following user configurable parameters:

- Intervals at which data from the weather and environmental stations is read and recorded into the FMS database

- Time span/period for which the forecast is entered.

The ATMS shall support the real time polling of data that could be required for alarm purposes (say high wind warning).

The ATMS shall provide the current status, and historical report of weather information, of any connected NTCIP weather device.

The ATMS shall support the configuration of the current weather condition display (on the map) to suit the actual instrumentation deployed on the NTCIP Weather device.

The ATMS shall support the reporting of historical data through the report writer.

The ATMS and Incident Management, through the Alarms capability, shall have the capability to factor any real time or log data into any incident algorithm, travel time algorithm, or trigger a scenario.

2.4.15 MAINTENANCE MANAGEMENT

ATMS shall support sophisticated maintenance management, as follows:

a) ATMS shall include the capability to schedule maintenance and support, both routine and on-demand on the infrastructure of the road network. The infrastructure comprises the ESS with traffic detectors and cameras, variable message signs, communications network, MDC equipment, and any equipment installed in the NMC.

b) Schedule and carry out planned maintenance.

c) Initiate and carry out remedial maintenance.

d) Initiate and carry out emergency repairs.

e) Update and improve maintenance systems and procedures.

f) Keep records and provide an audit trail of all scheduled and unscheduled maintenance.

g) In order to achieve this, ATMS shall provide the following minimum functions and capabilities:
    a. An asset management database with spatial display capabilities.
    b. A planned maintenance scheduling system.
    c. A job card/work order system for the carrying out of scheduled and unscheduled repair and maintenance.

d. A maintenance record keeping and reporting system linked to the asset management database.

h) Additional database tables, linked to the device table, shall provide information on manufacturer, model numbers, references to documentation, and reference to maintenance instructions. This capability provides linkage to the documentation from the original equipment supplier.

i) Each maintenance activity shall be an entry in the Maintenance Table. The status of each entry shall be maintained (e.g. scheduled, held, in process, completed) and shall be managed through the Maintenance Management form.

j) Virtual devices (e.g. System Database, communication system, etc.) shall be created in the maintenance system.

k) Maintenance management is provided in the following areas:

a. Routine or Scheduled maintenance
b. Remedial Maintenance
c. Maintenance Alarms
d. Maintenance Manager

l) Devices shall inherit the geo-location of the Device from ATMS GIS. This means that the Devices shall be displayed on the GIS map in ATMS, and that the user can “drill down” into the Maintenance Table, and maintenance activities, from the GIS user interface.

m) The application shall be configurable so that communication failures from devices, as well as the devices going offline, shall automatically trigger the creation of an unconfirmed maintenance incident.

3 IMPLEMENTATION INFRASTRUCTURE

3.1 NETWORK INFRASTRUCTURE

ATMS shall be configured as a client-server application running on the client’s network infrastructure. All computer server and computer client workstations will be provided by the client.

3.2 DATABASE INFRASTRUCTURE

ATMS shall be configured to run on Microsoft SQL Server database as the preferred database, but can be run on Access or Oracle as well. The SQL Server used shall be the client’s SQL Server infrastructure, as administered by the client. The ATMS software shall be capable of running on this infrastructure. A script shall be provided by the ATMS provider, to insert the necessary database

tables into the SQL Server database. No stored procedures, or other SQL Server infrastructure, shall be required.

3.3 COMMUNICATIONS INFRASTRUCTURE

ATMS shall be configurable to run on a variety of communications infrastructure. It is envisaged that most of the connections to field devices will be via wireless cellular network link. However, some DSL modem connections, serial network connections, and conventional analog dial up modems can also be used. It shall be possible to configure ATMS to use any of these different communication media on a communications channel.