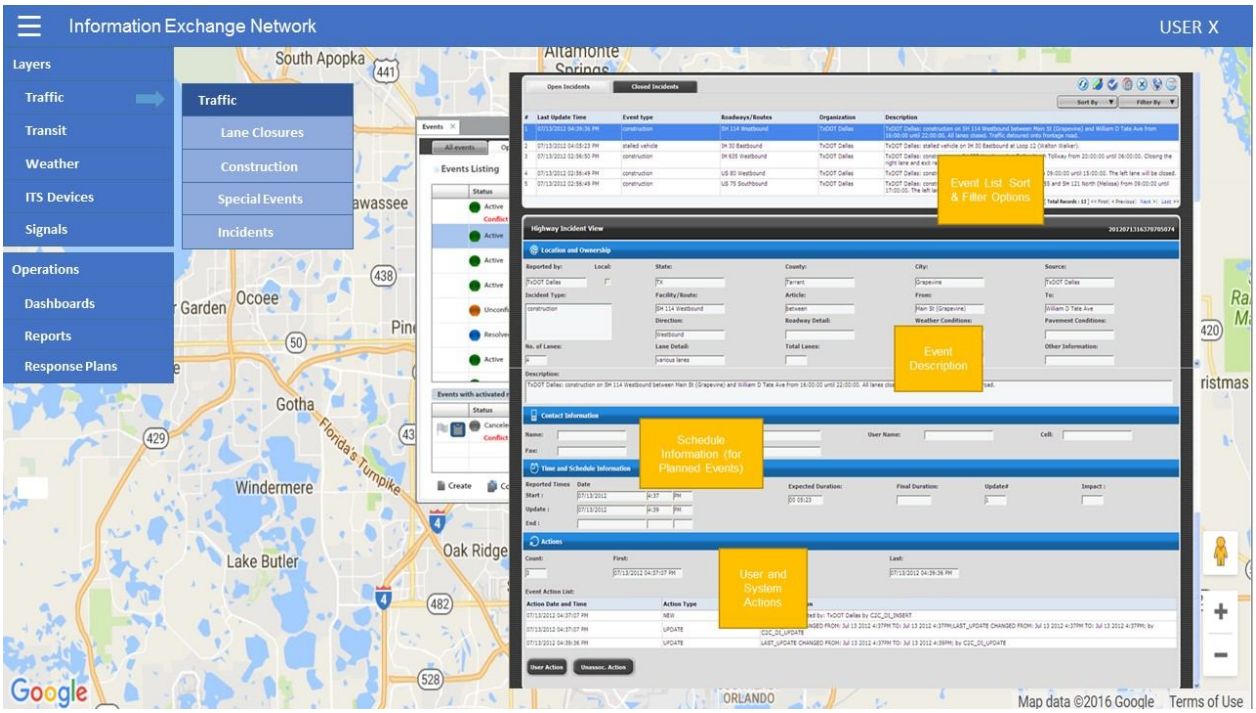

Figure 9: Event Description Interface

The IEN will also provide operators with automated notifications for the response plans and DSS dialogs. Figure 10 provides an operator with a systems notification that the signals within a corridor are operating outside of the expected parameters, and an adjusted signal timing plan is recommended. Figure 11 provides an operator with a systems notification when an event within the network has reached a level where a pre-agreed response plan should be enacted. The operator can select which actions it is completing, and the ICMS will record all actions enacted by the operator.

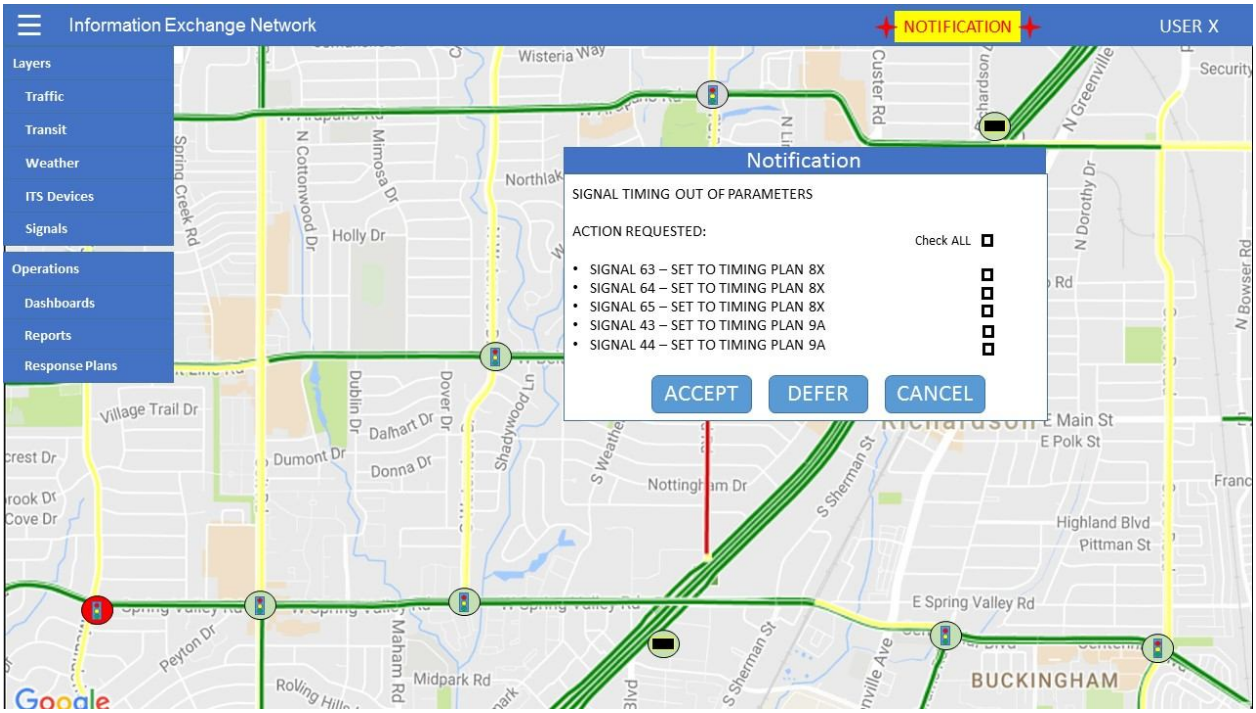

Figure 10: DSS Signal Timing Notification

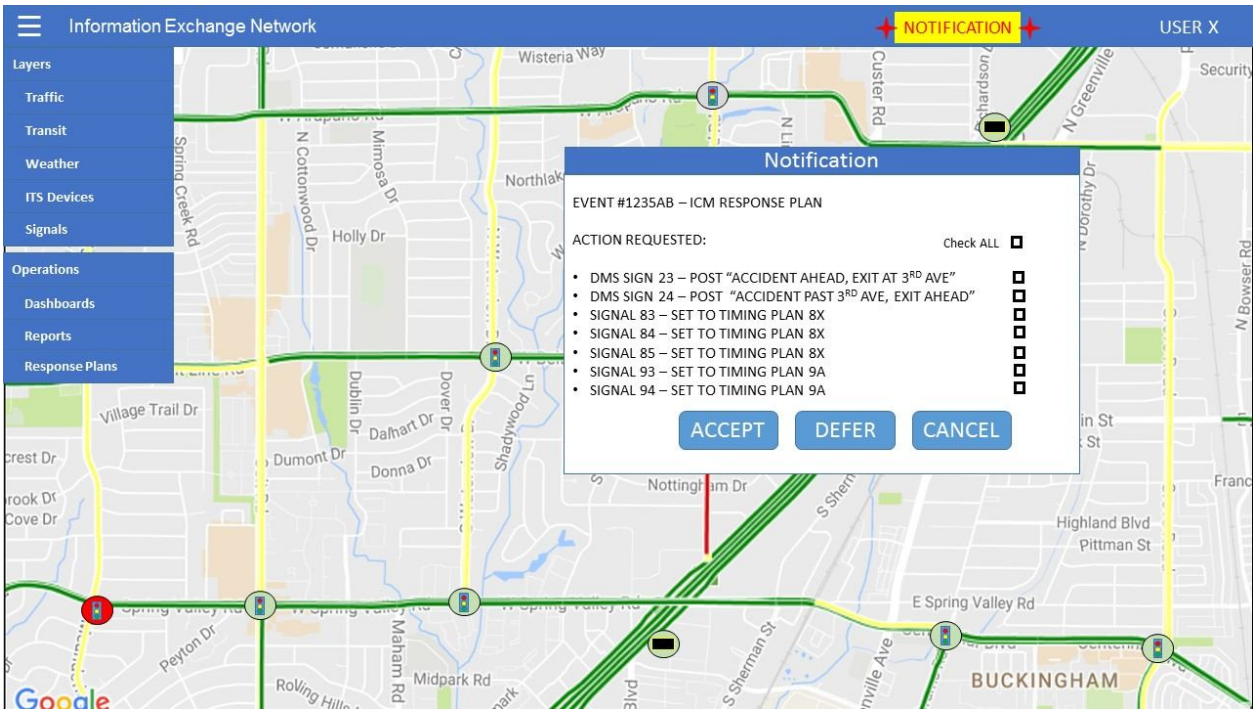

Figure 11: ICM Response Plan Notification

The IEN will extract detailed data from signal intersections from data sources such as the Signal Performance Measures system developed by Purdue, and other systems for detecting traffic signals about the intersections including the Intersection Movement

Counts project and devices from Gridsmart, Iteris, and other projects and devices available. When the traffic signal timing engineer drills down into an intersection, the view will assimilate all available real-time status, study information including traffic counts, and the geometry and design of the intersection itself, and analytics and recommendations from the DSS, and controls to all the engineer to review, fine-time, and accept the recommendation. The following mockups show an early example of how this might look, but the VENDOR will be responsible to work with the DEPARTMENT during the design phase to improve and finalize the design for all IEN GUIs.

The layout should facilitate viewing the information such that:

- The intersection can be quickly understood in terms of its geometry;
- The current status can be quickly understood;
- Its relationship within the corridor can be understood;
- Any recommendations for selecting different timing plans or creating new ones can be understood; and
- The predictions in terms of improvement of the intersection's performance can be understood.

1.7.2.1.2 DSS Operations GUI Screens

The GUI screens in the following figures show the user interaction that supports the DSS operations.

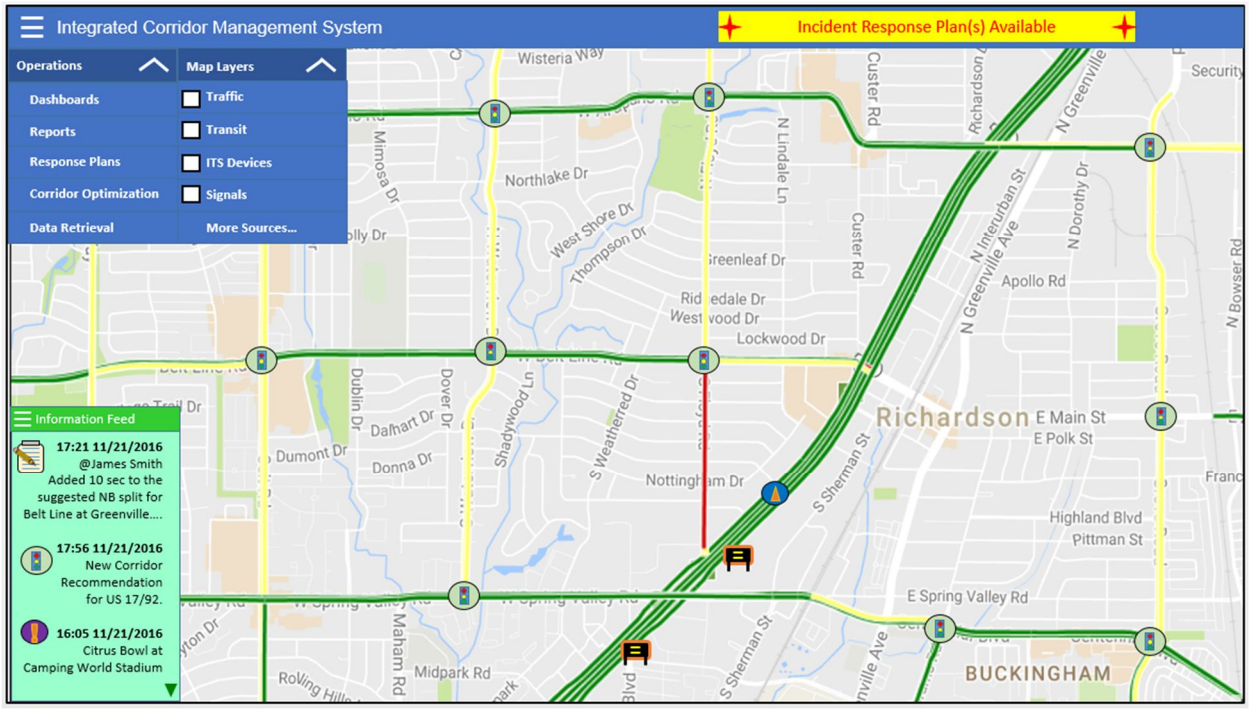

Figure 12: Operations Dashboard Home Screen

The operations dashboard contains the hub of status information, as described above, and as a starting point to access other operational information and interaction.

Map Layers can be enabled or disabled to populate the map with information from various data sources. The most popular sources will be displayed within the menu, and the many other data sources can be enabled through a separate pop-up (not shown) accessible from the menu item labelled “More Sources… .”

The information feed contains a wide variety of information relevant to the user. Incident response plans, corridor optimization recommendations, and other user’s comments to recommendations are types of information that can be included as an item in the information feed.

Pre-defined corridors are automatically analyzed in the background. The System Administrator can adjust parameters that guide the automated process (date/time, etc.)

The user can request an analysis, specifying the parameters of which corridor, signal set, date/time range/pattern, etc. A new screen and a menu item to access the new screen will need to be added for the user to request the analysis, but is not shown.

Once a periodic or manually requested corridor optimization analysis is complete and applicable to the user (permission-based), a note is added in the information feed to inform the user so that they are aware and can access the analysis as shown in the following figures.

When an incident response plan is available, an additional notification is presented at the top of the screen to indicate urgency and provide immediate access to the response plan recommendation screen.

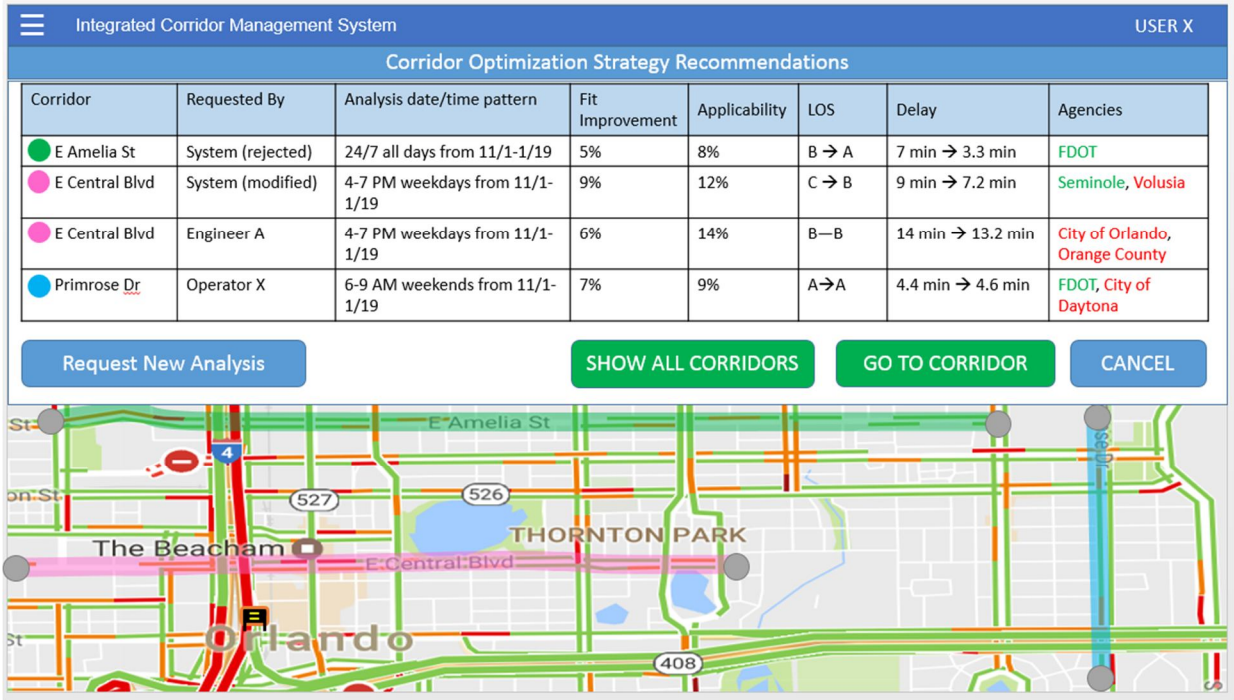

Figure 13: Corridor Optimization Strategy Recommendations

These corridor recommendations are the output of the algorithm used by the periodic corridor optimization process, or by manually requested analysis.

The System Administrator can tweak parameters that guide the automated process (date/time, etc.), while users are presented with a set of parameters for invoking the algorithm by request.

This Corridor Optimization Strategy Recommendations screen has a table of all corridor recommendations along with the analysis parameters and results, including: date/time pattern, FIT improvement, applicability, LOS, delay, and agencies who would need to be coordinated with to invoke the response plan. The values representing the agencies will be displayed with an indication of the status of the approval from that agency. Each recommendation in the table will also have the Requested By field, showing who requested the analysis. If the automated periodic optimization process requested it, System will be displayed. If a recommendation was modified or rejected, the modified recommendation will be added to the list and the original recommendation will remain, but with an indication that it was modified or rejected. Below the list of corridors, the map is zoomed and centered around all of the highlighted corridors having strategy recommendations. When the user clicks on a corridor, the GO TO CORRIDOR button is enabled and the map highlights only the selected corridor and zooms around the corridor selected. When the GO TO CORRIDOR button is pressed, the Intersection Recommendation screen appears. The SHOW ALL CORRIDORS button allows the user to zoom the map back out to show all corridors.

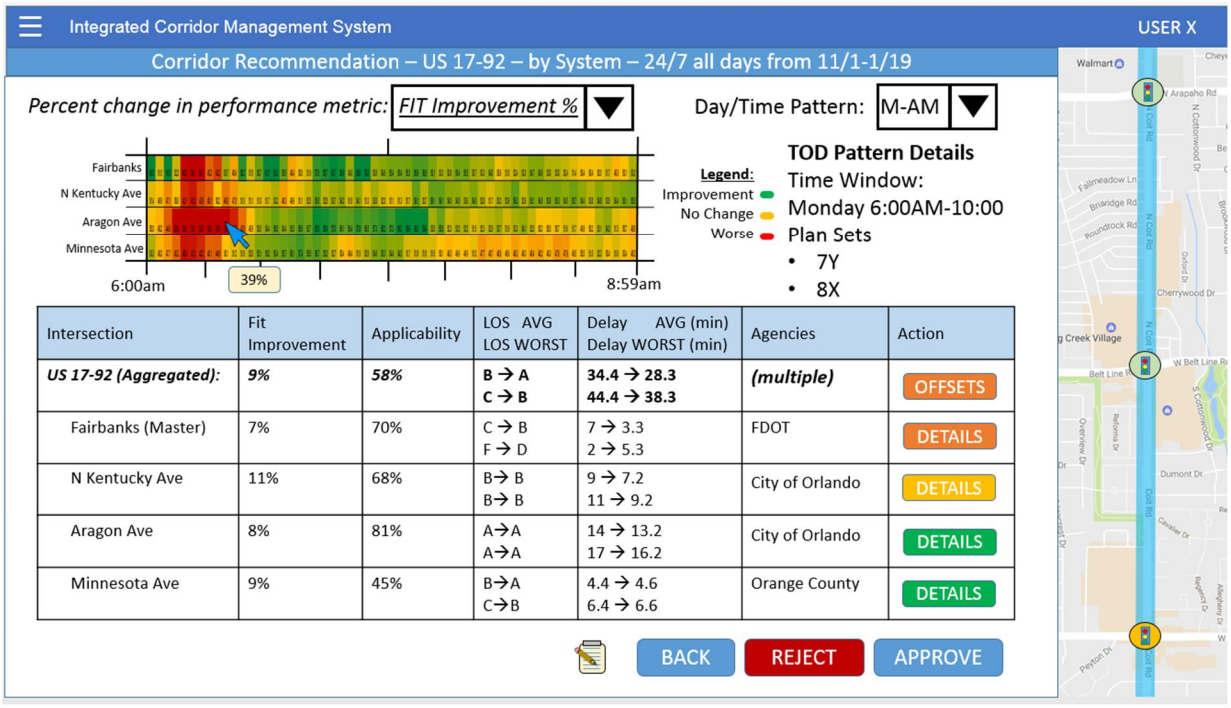

Figure 14: Corridor Optimization Recommendation

This screen shows the details and performance analysis of the recommendation for the corridor. The corridor, date range, and the date and time pattern are indicated in the screen title.

The heat map shows the selected color-coded performance metric for each intersection. Hovering over the heat map will show the numeric value represented by the color. The performance metric for the corridor can be changed by the drop down at the top. Below the heat map, the table shows performance information for each intersection and for the aggregated corridor, including the FIT Improvement, Applicability, LOS for the average and the worst time in, delay for the average and worst time interval, and the agency maintaining the intersection. The action buttons allow the user to adjust the offsets for the corridor or the splits for each intersection. The overall analysis has the date and time interval used in the recommendation, while the day/time pattern can be changed with the Day/Time Pattern drop down in order to view the performance information for specific date/time patterns in the graphs and tables on the screen.

On the screen shown in Figure 14, and many others, users may also comment using the comment (notepad) icon. Comments may also appear in the information feed shown earlier.

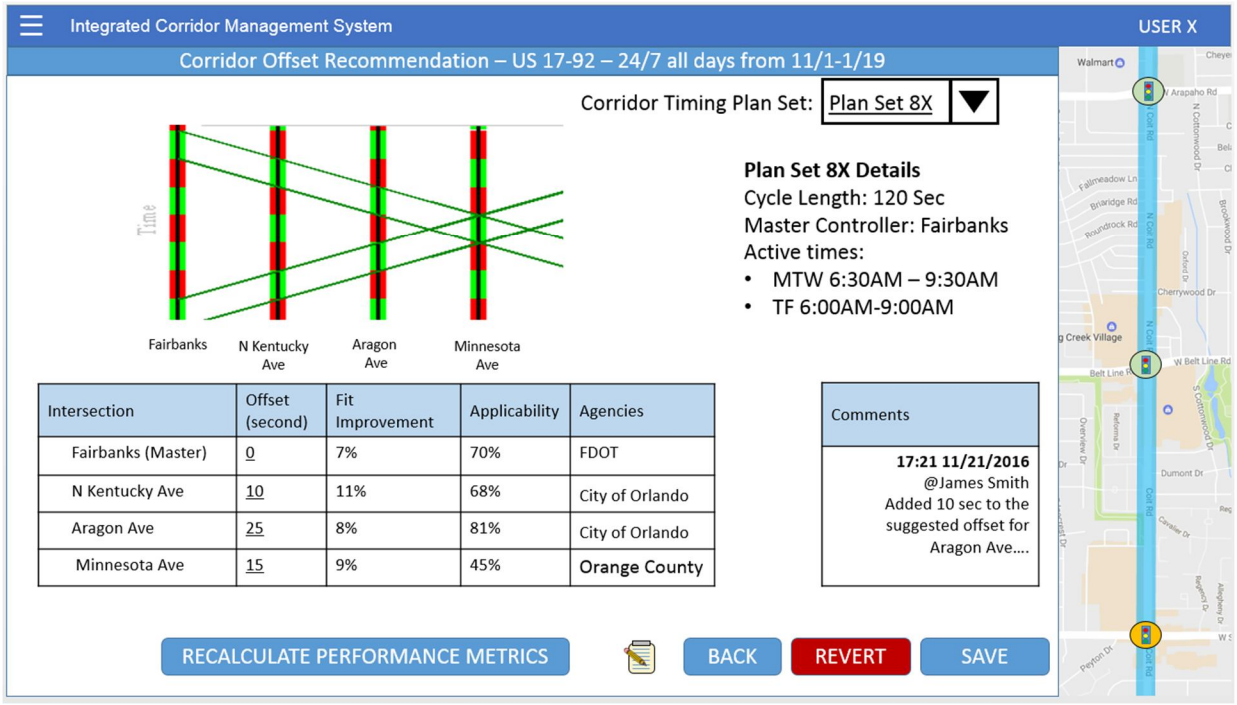

Figure 15: Corridor Offset Recommendation

The ICMS shall recommend offsets based on an algorithm, such as the Purdue system's link pivot algorithm, and display details about the recommended offset with performance or fitness information for the user to review and adjust. The corridor has recommended plan sets that include a plan for each intersection. The plan set can be selected using the drop down in the top to show details and performance information for the plan sets, and allow the user to adjust the offsets.

The RECALCULATE PERFORMANCE METRICS button will be enabled when one or more offset values are changed, and when clicked, will update the performance information using the modified offsets.

The COMMENTS button will allow the user to make a comment that will be shown to other users when they access this offset screen for this corridor recommendation. The comments can also appear in the information feed.
The SAVE button will be enabled when the user makes changes to the offsets and recalculates the performance metrics; when clicked, it will save the changes to the recommendation. Changes made to a recommendation by the same user will be saved into the current recommendation. Changes made to a recommendation requested by the system or a different user will be saved as a new recommendation and the original recommendation will be flagged as modified.

The REVERT button will be enabled when there are unsaved changes to return to the last saved state of the recommendation, or the original recommendation if no changes were saved.

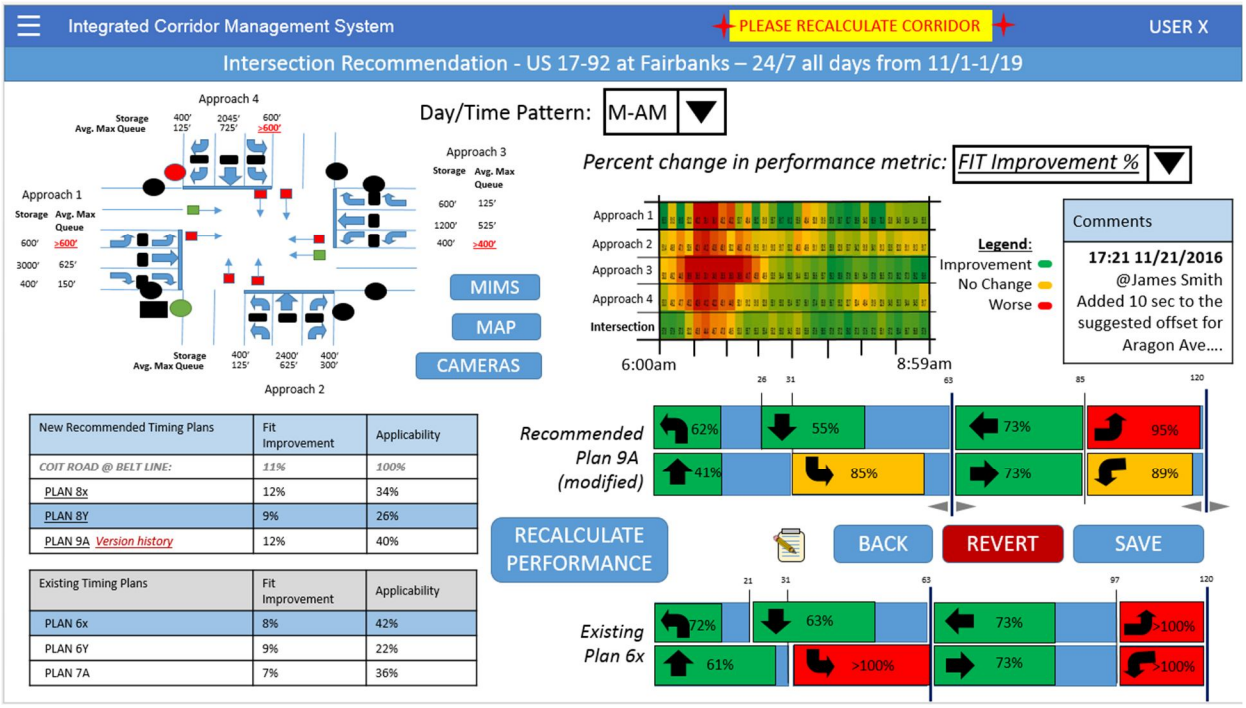

Figure 16: Intersection Plans Recommendation

The Intersection Plans Recommendations screen shows the details and performance analysis of the recommendation for the corridor. The intersection, date range, and the date/time pattern are indicated in the screen title. The overall analysis has the date and time interval used in the recommendation, while the day/time pattern can be changed with the Day/Time Pattern drop down in order to view the performance information for specific date/time patterns in the graphs and tables on the screen upon clicking the RECALCULATE PERFORMANCE button.

The intersection diagram in the upper left shows the basic geometry of the signal, including the storage and average max queue. The MIMS button allows the user to log a maintenance ticket to investigate a non-working detector within the intersection. The CAMERAS button allows the user to launch the camera videos at the intersection. The MAP button will launch a map of the intersection.

The heat map shows the value of the selected performance metric for the approaches and the aggregate for the intersection. The New Recommended Timing Plans table on the bottom left shows the new recommended plan IDs, the FIT improvement, and the applicability that shows the percent of time during the selected period that the plan would be in effect. When the user clicks on a recommended plan, the table on the bottom left shows the existing plans that would be overridden by the selected new plan and the same performance information for the time during which the recommended plan will override the existing plan. Also, when a recommended plan is selected, the splits diagram is shown for that plan with controls for the user to make adjustments. The SAVE, REVERT, and BACK buttons work the same as with the offset screen, allowing a user with permission to save a new recommendation and then modify it, or revert to the last saved state of the recommendation, and go back to the corridor recommendation

screen. When an existing plan is selected, the split diagram is shown for the selected existing plan at the bottom right. If a recommended plan is changed, the user will receive a notification depicted in Figure 17to recalculate performance along its corridor.

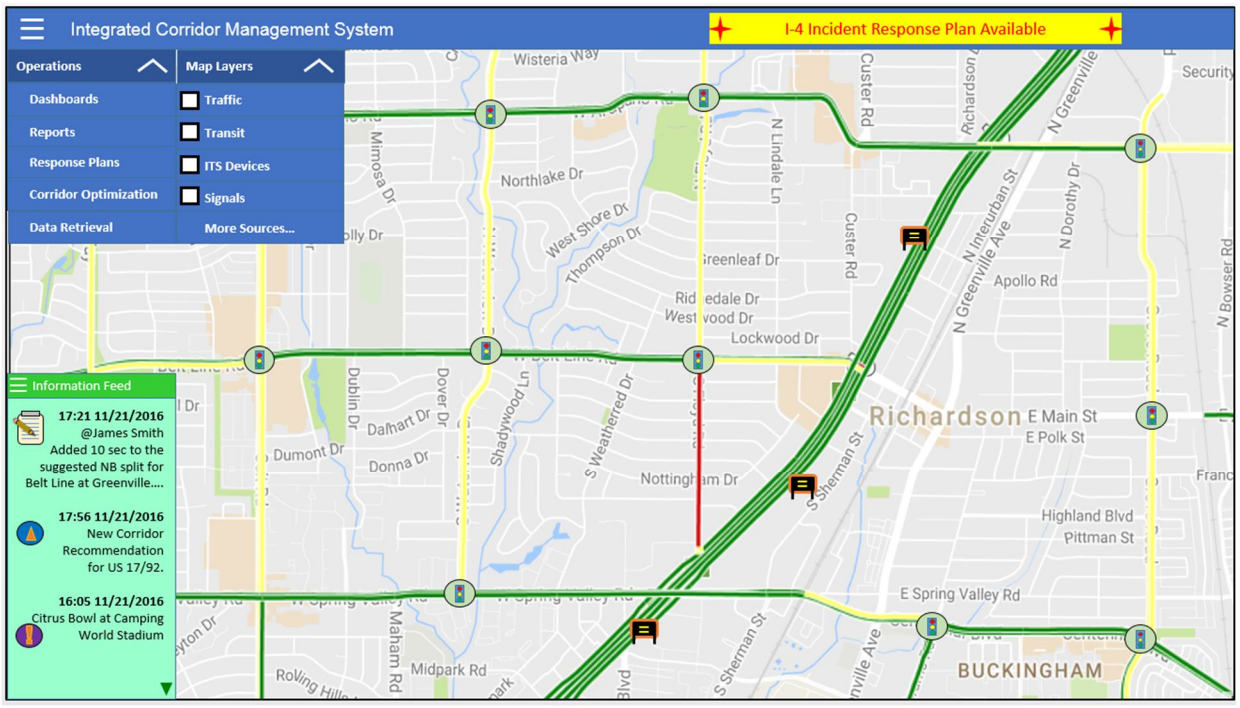

Figure 17: Home Screen with Limited-Access Roadway Incident Response Plan Notification Banner

Once the DSS identifies a limited-access roadway incident and a response plan to address the incident, the home screen will indicate that a response plan is available with a banner at the top of the screen and an entry to the Information Feed. The Information Feed can contain comments, traffic incidents, and planned events such as concerts and football games. The banner or the item in the feed can be clicked to launch a new screen with more focused details for that item.

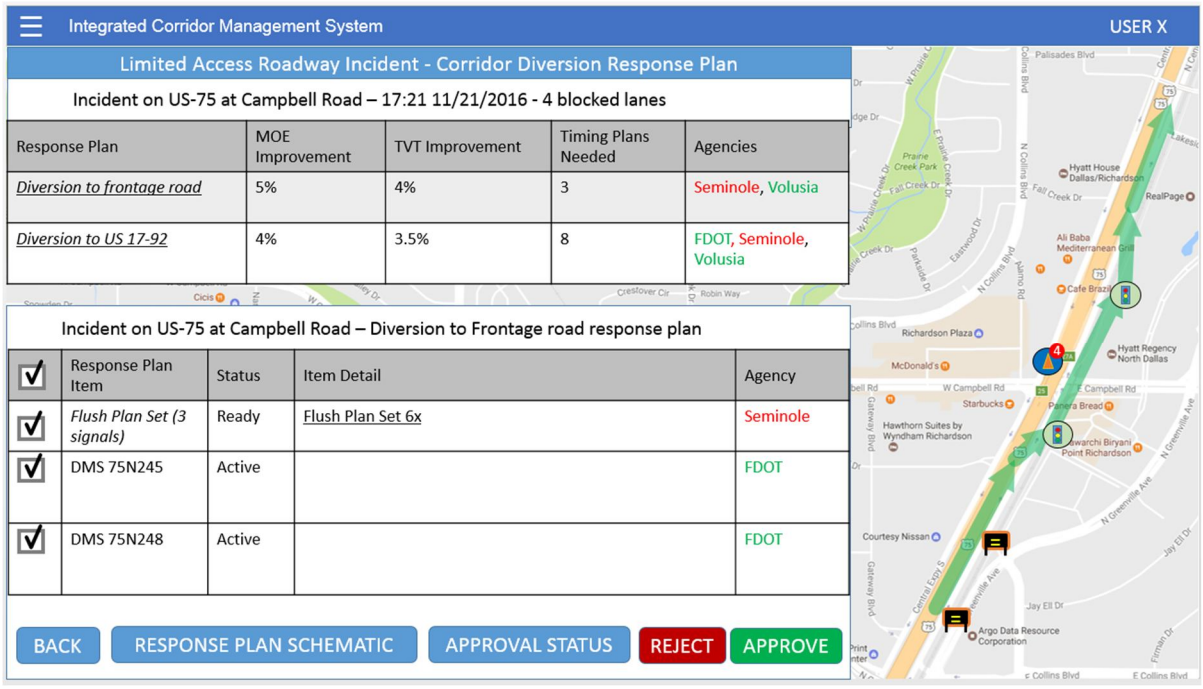

Figure 18: Limited-Access Roadway Incident - Corridor Diversion Response Plan Details

The Limited-Access Roadway Incident - Corridor Diversion Response Plan provides information regarding the response plans available to respond to the incident. The response plans are shown in the top table along with their predicted performance metrics, number of signals affected, and the agencies needing approval to invoke the plan. The selected row is highlighted gray. The top plan is the one with the highest MOE improvement over current conditions and is initially selected; however, the user can select any plan available. The selected plan will have response plan items depicted on the map and shown in the bottom list along with the item's attributes, such as the current device or system status, the proposed change or invocation to the device/system, the agency whose approval is required for that invocation, and the ability to deselect items to be included in the plan. Filtering and sorting should be provided as controls in the table header, and a scroll bar will appear if needed in either table. Once the plan is reviewed, the user can approve it based on the agency the user represents. Clicking VIEW APPROVAL STATUS will display the details of the plan's approval status. The values representing the agencies for the response plan in the top table and the agency for each response plan item in the bottom table will be displayed with an indication of the status of the approval from that agency. Green represents approved, while red represents rejected. The RESPONSE PLAN SCHEMATIC will launch a detailed response plan schematic plan for review. Other types of response plan items not shown here include hard shoulder running, bus bridge, transit signal priority, express lanes pricing deactivation, and other items included in the response plan schematic. If the user clicks on the Flush Plan 6x link in the Item Detail column, the Diversion Route Corridor Flush Plan Details screen appears.

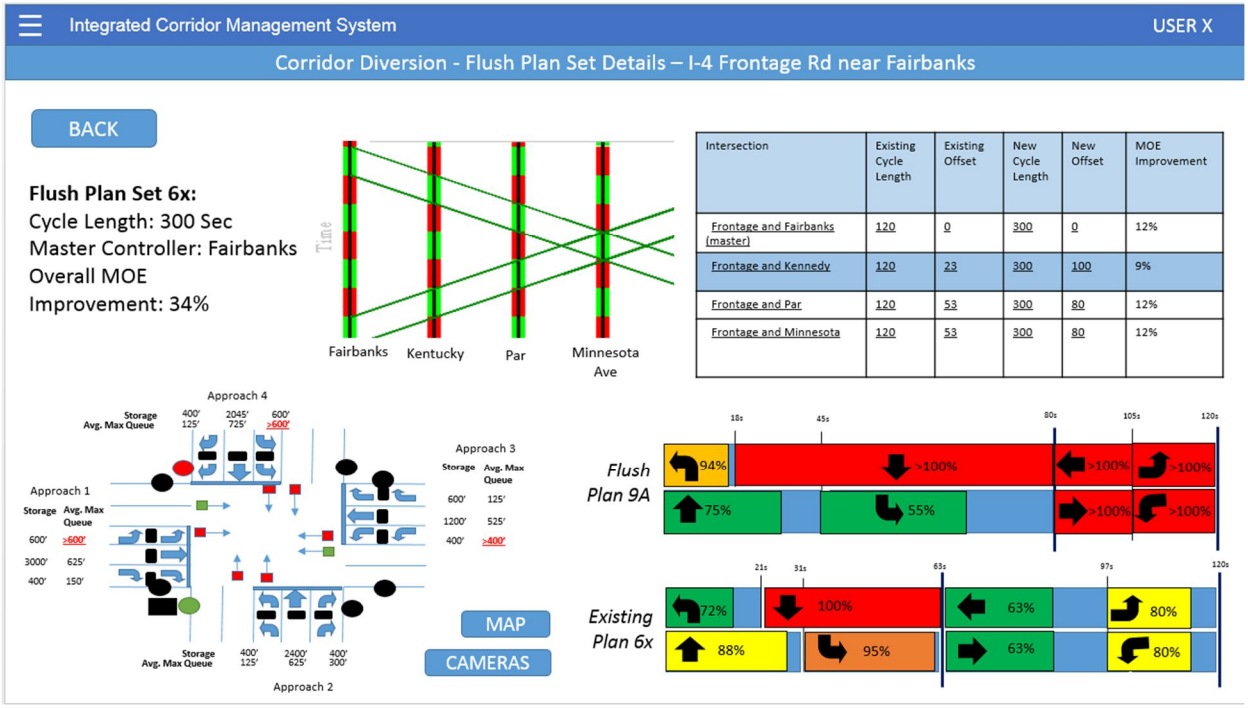

Figure 19: Corridor Diversion - Flush Plan Set Details

The Corridor Diversion - Flush Plan Set Details screen shows the details and the MOE performance analysis of the flush plan set. The table includes each intersection having a flush timing plan in the plan set, and includes the existing plan's and the new plan's cycle length and offset, and the intersection's MOE improvement. The time-space diagram in the top middle is displayed for the flush plan set and additional details including the new cycle length, master controller, and overall MOE improvement is presented to the far top left. The user can select an intersection from the table on the upper right to see details regarding the intersection's flush plan at the bottom of the screen. The intersection diagram is displayed with the storage and average max queue length for each approach, and the split diagram for the new plan and the existing plan is shown on the bottom right for the selected intersection.

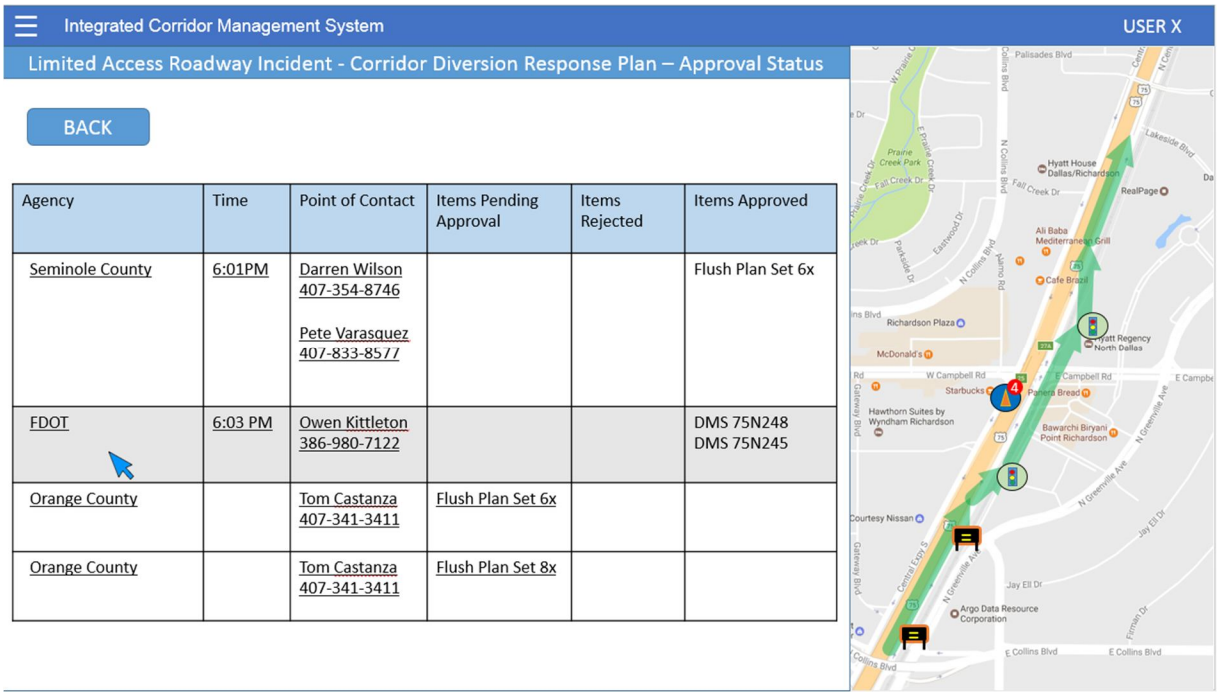

Figure 20: Limited-Access Roadway Incident - Corridor Diversion Response Plan - Approval Status

The Limited Access Roadway Incident - Corridor Diversion Response Plan – Approval Status displays a table with each agency needing approval, along with the time they approved or rejected the item(s), the point(s) of contact and phone number, and three columns in which to place the approval status. The items are either pending approval, rejected, or approved. The selected row is highlighted in gray.

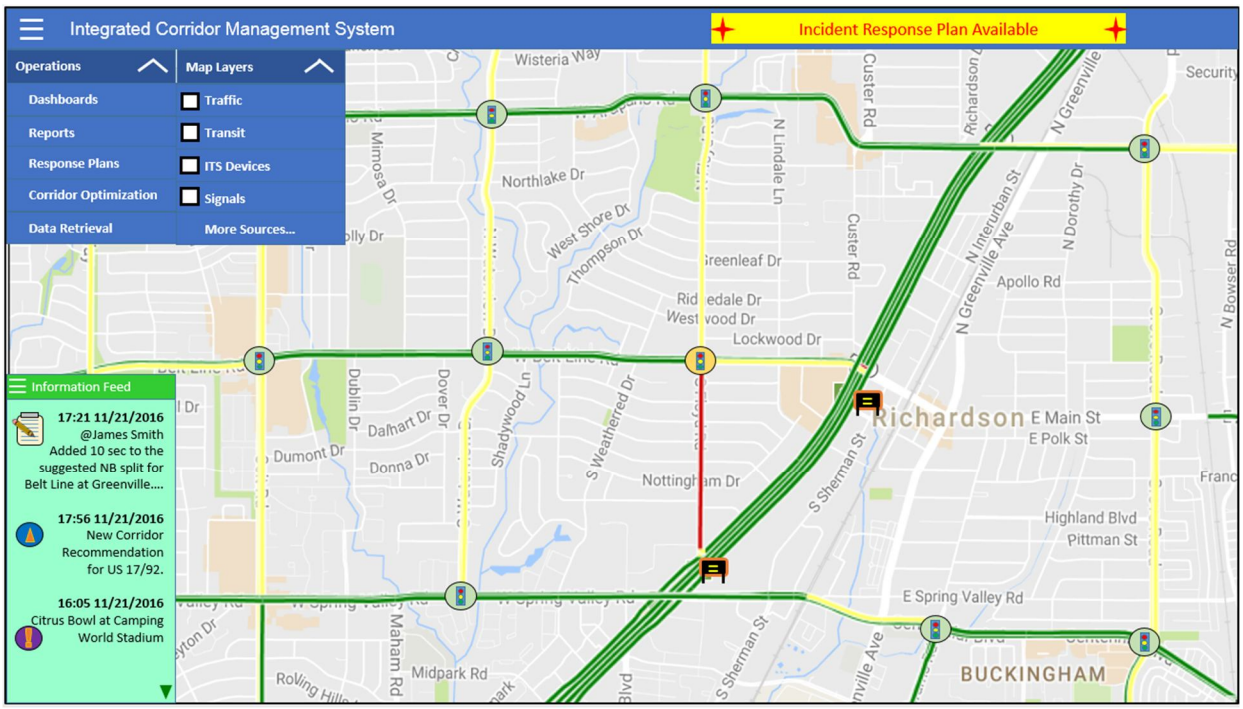

Figure 21: Home Screen with Arterial Roadway Incident Response Plan Notification Banner

Once the DSS identifies an arterial roadway incident and a response plan to address the incident, a banner at the top of the home screen will indicate that a response plan is available, and also as an entry to the Information Feed. The Information Feed can contain comments, traffic incidents, and planned events such as concerts and football games. The banner or the item in the feed can be clicked to launch a new screen with more focused details.

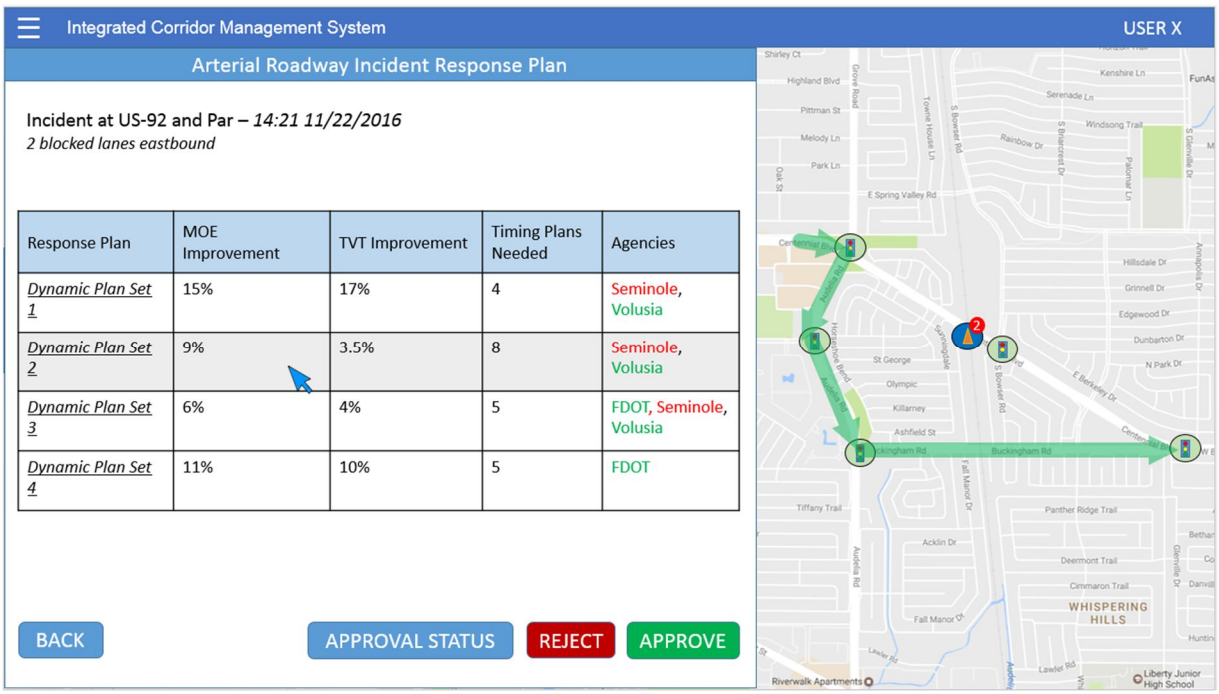

Figure 22: Arterial Roadway Incident Response Plans

The Arterial Roadway Incident Response Plans screen shows the user a set of recommended response plans to respond to an arterial roadway incident. The table contains each response plan along with the performance metric improvements predicted and other attributes of the response plan. The user can select a response plan from the list; the selected item is highlighted in gray When a response plan is selected, it is depicted on the map. The user can then click the response plan name to view more details of the timing plan set in the Arterial Roadway Incident Response Plan Details screen, approve the response plan, and check the approval status of the response plan – much like the limited-access roadway incident response plans screen.

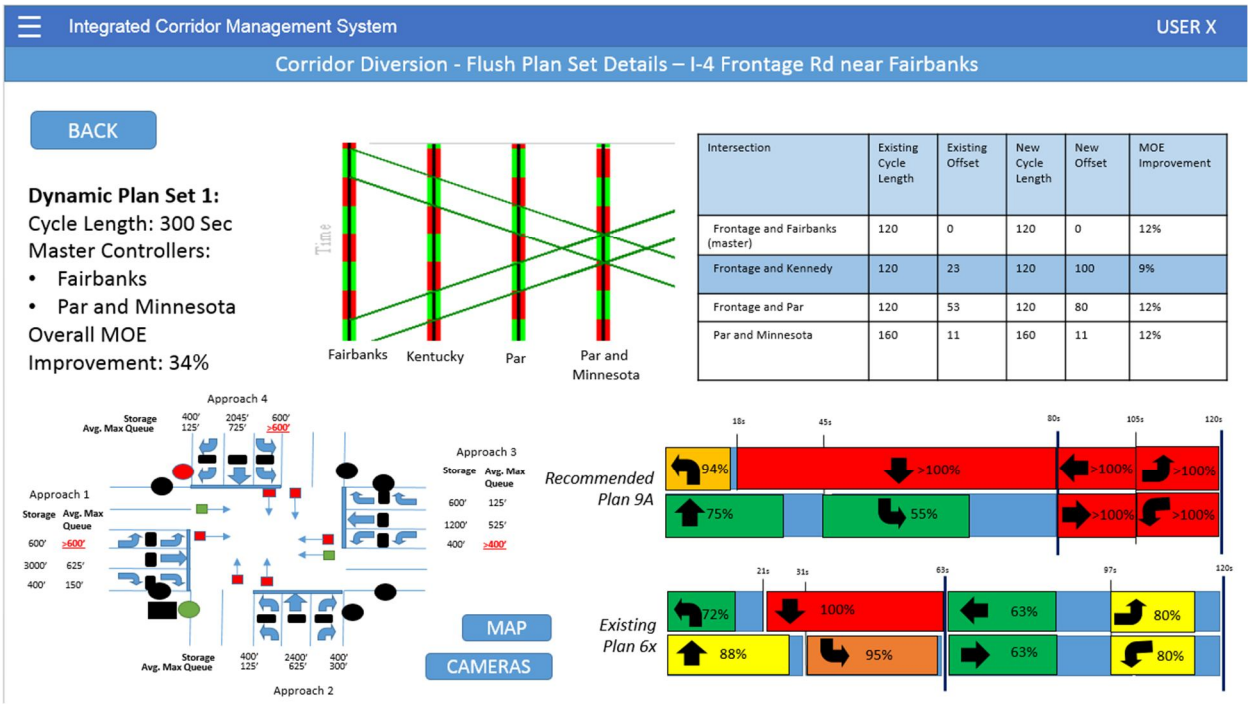

Figure 23: Arterial Roadway Incident Response Plan Details

The Arterial Roadway Incident Response Plan Details screen (Figure 23) shows the details and the MOE performance analysis of the arterial roadway incident response plan timing plan set. The table includes each intersection having a timing plan in the plan set, and includes the existing plan's and the new plan's cycle length and offset, and the intersection's MOE Improvement. The time-space diagram in the upper middle is displayed for the plan set and additional details including the new cycle length, master controllers, and overall MOE improvement is presented in the upper left. The user can select an intersection from the table to see details regarding the intersection's recommended timing plan at the bottom of the screen. The intersection diagram is displayed with the storage and average maximum queue length for each approach and the split diagram for the new plan; the existing plan is shown on the bottom right for the selected intersection.

1.7.2.1.3 Analytics & Dashboards

Performance Measures, obtained via analytics and dashboards can be used to provide important statistics that can help to detect and correct issues found within a transportation network. Under this contract, it is expected that the VENDOR shall provide analytics and graphical dashboards that will allow the DEPARTMENT to view archived, statistical data related to the DEPARTMENT'S transportation network. The data to be provided via the performance measures dashboards shall include the data as referenced in section 1.7.1 Data Fusion Environment Subsystem.

The dashboards will contain support for multiple profiles corresponding to the multiple views and roles in the system ranging from seeing high-level status, to corridor level performance, to very detailed status of intersection data.

The VENDOR can reuse specification information from the pilot project currently underway, detailed in the Project Delivery Methodology of the FDOT District 5 AAM Dashboard, Version 1.0, Revision Date: 09/30/2016, Attachment A (Software Requirement Specifications) and Attachment B (System Requirements). The document will provide guidance to the VENDOR when designing, specifying, and developing dashboard(s) for the ICMS. The core sections of the document include: Business Requirements, Data Management Requirements, Conceptual Data Model, and Reporting Requirements. These sections are briefly described hereinafter.

The VENDOR shall be responsible for developing the necessary requirements that will be used to develop the analytics and dashboards modules under this contract. The product will be used to present a variety of data to the DEPARTMENT. The product shall be approved by the DEPARTMENT.

The Business Requirements section includes definition of the business process model, and functional requirements (i.e. Use Cases). Secondly, the Data Management section will include archive/purge and auditing requirements. Moreover, the Conceptual Data Model will include Table Names and Descriptions and Integrity Constraints. Lastly, the Reporting Requirement will incorporate the report specificity, frequency, receiver of the report, sorting requirements, and/or notification that is to be sent.

1.7.2.1.4 SunGuide Integration

SunGuide is used for command and control of regional traffic operations. It is operated by traffic management center operators who use the SunGuide to view conditions in the transportation network, manage traffic events, and invoke response plans that control traffic in response to the incidents. The DSS and the IEN shall integrate with the SunGuide for implementation of response plans suggested by the DSS. The DSS shall suggest several traffic control strategies in response to a non-recurring incident, obtain the appropriate approvals via the IEN, and operate the SunGuide using the same underlying interface that the existing SunGuide GUI uses to manage events and response plans. During the design of the DSS, any needed modifications to the SunGuide shall be coordinated with FDOT D5, and detailed interactions with the SunGuide and TMC operators shall be part of the design of the DSS component of the ICMS.

There is a wealth of information about the SunGuide hosted on the http://sunguidesoftware.com website in the Document Library accessible from the Document main menu. Some details are described below. There are also concept of operations documents of several SunGuide modules and features referenced by the TSM&O Data and Systems Inventory.

The SunGuide system is architected in a modular fashion with subsystems responsible for business logic related to set of related functions typically corresponding to a type of device or operation. Examples include traffic sensor subsystem, and event management

subsystem. Each subsystem acts as a server with clients logging into the subsystem to request or subscribe to data and to request commands to be invoked by the subsystem. The clients are authenticated and authorized by another subsystem called the System Authentication and Authorization subsystem. The interfaces among all subsystems use an XML protocol whose structure is defined in the SunGuide XML Schemas available here:
http://sunguidesoftware.com/sunguidesoftware/documentlibrary/ICD/6_2/6.2%20XML%20Schemas.zip
Connection to all subsystems is facilitated by the Databus subsystem.

The DSS will interface with the SunGuide by connecting to database, logging in as a user, retrieving and subscribing to event management data, and requesting commands to be invoked by event management to modify and activate SunGuide's event management response plans, which are no to be confused with the DSS response plans and DSS response plan sets that live within the DSS Subsystem of the ICMS system.

Pure data retrieval for transportation sensors and other transportation system status will be made available by the DFE as the preferred retrieval mechanism, but command and control will be done through the aforementioned interface with the SunGuide.

1.7.3 Decision Support System Subsystem

The DSS subsystem will exchange data with the DFE, interface with other users and systems through the IEN, and implement the computational elements of the ICMS operations described in section 1.6.

The DSS is comprised of three main components:

1. ERE component – The ERE contains the logic to make determinations based on pre-defined rules. This includes monitoring current conditions to determine when a response plan needs to be created, updated, or deactivated; developing response plans from a set of rules applied to current conditions.
2. PRE component – The PRE contains the planning model and provides the function to other components for running a mesoscopic simulation of a reduced network in real-time to calculate the predicted conditions of the network for changes to signal timing plans or other response strategies that could be used in a response plan or optimization plan. The PRE component is envisioned to provide predictions of the network performance, 30 minutes into the future. These network performance measures will project how effective the ICMS response plan is expected to be and how well they enhance regional operations.
3. EVE component – The EVE contains the calculation logic to calculate overall measures of effectiveness from the output of the mesoscopic simulations, the fit score of a signal timing plan for given saturation rates, and other evaluation metrics used by the DSS subsystem. The EVE component provides the analytics to be provided to the IEN's dashboards used by DEPARTMENT and stakeholder agencies within the region to quickly display pertinent information

on the transportation infrastructure including current conditions, suggested improvements for review and approval, and performance measures of invoked strategies.

The DSS performs the computational work of the ICMS operations, including transportation incident response and periodic signal timing optimization as described in the ICMS Operation section. These core responsibilities of the DSS are handled by the DSS components as follows:

a. **Monitor, Evaluate, and Respond to Traffic Incidents on Limited-Access Facilities.** The ERE will monitor information retrieved by the DFE of the limited-access roadway events within the corridor within the Event Management Subsystem of the SunGuide software. Each event will be evaluated by the ERE and, when triggered based on configurable parameters, the ERE will determine if an adjacent corridor flush, ramp metering adjustment, hard shoulder running, and/or managed lanes pricing deactivation response is needed for this event. The ERE will then select or develop a set of response plans containing an appropriate combination of strategies to respond to the event. These response plans, along with the Do Nothing plan will be sent to the PRE to be simulated in the mesoscopic model. The results of the simulations will then be sent to the EVE to determine the overall measure of effectiveness for each plan. The EVE will determine which of the plans is the best response plan and if that plan meets the threshold of improvement over the Do Nothing plan based on the system performance indexes produced by the PRE and EVE. If the threshold is met, the selected response plan will then be sent to the IEN for approval and activation through the SunGuide software. The ERE will continue to monitor the event status and evaluate additional response plans.
b. **Monitor, Evaluate, and Respond to Traffic Incidents on Arterial Facilities.** The ERE will monitor the turning movement counts, the data from the signal performance measures system, and the ITSIQA output data stream. If the queue length or the travel time exceeds a configurable percentage of historical values, the ERE will generate an alarm condition of an arterial incident and build a response. The ERE will select from adjacent and nearby signals to formulate a corridor for modification. The vendor shall develop an algorithm for dynamically generating the network of intersections to include in the response plan for evaluation by the PRE, presentation to and approval from the user via the IEN, and invocation in the transportation system. The ERE will calculate the optimal plans for the intersection and select from available plans based on Euclidean distance from the optimal plans. The ERE will calculate the overall fit score for the selected plans and use the PRE and the EVE to calculate the measure of effectiveness of the selected plans. Should the evaluation show acceptable improvement, the ERE will send the selected plans and analysis to the IEN for approval and activation through the SunGuide software. The ERE will continue to monitor the event status and evaluate additional response plans.
c. **Periodically Optimize Signal Timing Plans for Arterial Facilities.** The ERE will periodically attempt to optimize the network in the following manner:

Definitions:

The ERE will consider corridors of signals as defined by the local agencies and their central signal software. Signals running in isolation will be treated as corridors of one intersection. The ERE will consider a historic period of time for which to run the optimization algorithm. The historic period of time will be split up into short time intervals having a volume and capacity for each movement. Each movement will have a saturation rate defined as the volume divided by the capacity. The Euclidean distance between two intervals is calculated by taking the square root of the sum of the difference of each of the movement's saturation rates as shown in the formula below:

$$I_d = \sqrt{\sum_{i=0}^{n} \left(\frac{v_{i,j}}{c_i} - \frac{v_{i,k}}{c_i}\right)^2},$$

Where I_d is the Euclidean distance between two intervals at times *k* and *j*, *i* represents each of the *n* movements in the corridor, *v* represents volume and *c* represents capacity. When two or more intervals are grouped, their saturation rates are averaged for each movement to produce the saturation rates for the centroid of the group, which will represent the saturation rates of the group for further comparison.

The optimal timing plan for an intersection is calculated by proportioning green time based on saturation rates of each movement.

The FIT Score of a timing plan is calculated as the Euclidean distance between the timing plan under evaluation and the optimal timing plan for the applicable time period, either from historical volume data, real-time data, or predicted data.

The FIT Score improvement is calculated by the percentage increase or decrease of a proposed timing plan under evaluation and a control timing plan. The control timing plan is defined as the current timing plan for which a proposed timing plan is being recommended.

The FIT Score of a corridor or network of intersections is calculated as the volume weighted average of the FIT Scores of the comprising intersections.

Aggregating:

- Signal controllers have constraints to the number of plans they can store. Furthermore, scheduling timing plans requires the aggregation of time intervals within a scheduling model that can be understood by the controller. Thus, time intervals will be aggregated according to the day of the week they fall on, unless they fall into a special day such as a holiday. For example, Mondays from 6:00 PM – 6:05 PM, Mondays from 6:05 PM to 6:10 PM, and the Fourth of July from 4:00 PM to 4:05 PM.
- Each volume value within an interval defined by the day of week or special day and the 5-minute time interval within that day, will have their approach volumes averaged to define an aggregated set of volumes for all movements for all intersections in the corridor.

Grouping:

- Each aggregated interval must be in exactly one group, corresponding to the constraint that an intersection must have exactly one timing plan activated at that time.
- Each group must have a minimum number of contiguous aggregated intervals, corresponding to the constraint to not change timing plans too frequently.
- Each aggregated interval will initially be considered as a group of one.
- Groups will be considered starting with the first group, in order, to the last group. Each group considered will be combined with the adjacent group having the smallest Euclidean centroid distance away if either the group is less than the minimum group size threshold or if the Euclidean distance between the groups is less than a standard deviation of the distances from both group's members to their group's centroids. This step will repeat until no further grouping occurs.

Clustering:

Once contiguous groups are established, the groups will be clustered by their centroids into a configurable number of groups using a clustering algorithm based on the Euclidean distance of the saturation rates of the centroid of the contiguous groups. The purpose of this is to find a set of timing patterns that can be reused for multiple contiguous groups so that a few enough timing plans can be developed that will not exceed the signal controller storage.

Analysis:

- Each of the contiguous group of intervals will be assigned to the cluster with the least Euclidean distance away. For each interval within the cluster, the fit of the timing plan of the assigned cluster will be calculated, the fit of the actual timing plan in effect during that interval will be calculated, and the fit to the closest existing timing plan (if not the one actually used, but available for use) will be calculated. From these fit scores, the percentage improvement of the new timing plan can be calculated for that interval of the actual and best available timing plan, and the number of intervals will be summed to get the applicability of the new timing plan.
- The new timing plans along with their percentage improvements over the actual used and best available plans will be sent to the IEN to be prioritized and presented to the signal timing engineer for further review as potential improvement strategies.

1.7.3.1 Evaluation Engine Component

The evaluation engine component provides the DEPARTMENT with a critique of how a response plan performed for any given event. The evaluation engine component uses the corridor data from the DFE and the Planning Model to calculate corridor performance metrics. These performance measures will allow the DEPARTMENT to refine strategies

and response plans in attempts to continually improve how the CFR-ICMS improves operations within the region.

1.7.3.1.1 Planning Model

The ICM and DSS project will require a large-scale mesoscopic simulation model. The planning level model will not be a direct input to the DSS, but is a critical tool in developing many of the components of the DSS. The model will be used to provide initial demand and network data for the real-time PRE models as well as being used to help build and test any response plans or functionality of the system prior to its implementation. It provides access to planners and engineers to fine tune strategies and understand potential impacts on a larger scale than the real-time predictive corridor. The offline model will leverage the current regional model from the area as well as the system data and inventories that will be available from the area.

The planning model will replicate the operational conditions of the real world; it is important that the model be able to replicate any special functionality with the mesoscopic framework. Some of these functionalities could include, but are not limited to:

- Traffic signal timing functionality
- Ramp metering algorithms
- Transit operations
- Dynamic routing

It is anticipated that some elements of the planning model would require the development of APIs.

As part of the PROJECT, the VENDOR will be required to develop a model development plan that is expected to outline the details for the development of the offline model. The plan should detail how the model is being developed following the United States Department of Transportation's (USDOT) guidelines and should cover the following sections:

- Network Development
- Travel Demand Development
- Value of Time
- Network Calibration Criteria
- Model Validation Criteria
- Model Enhancements and APIs
- Gap Analysis

Being an operational planning model with an origin destination-based demand matrix for multiple vehicle classes, the model should be able to complete the following tasks:

- Provide initial input files for the PRE. The PRE is designated for a sub-area of the planning model and will be able to leverage the roadway network, the traffic assignments, and vehicular demands by class;
- Analyze the impacts of planned and unplanned events throughout the network;
- Estimate diversion compliance based on modeled capacities and travel times;
- Test the effectiveness of potential response plans and demand strategies to be implemented as part of the system's DSS; and
- Review and deconstruct implemented strategies post deployment.

As maintenance of the system will be an important aspect to a successful deployment, the planning modeling component should employ smart tools to help minimize the overall workload during the maintenance process. User-friendly tools need to be developed that will:

- Help operators less familiar with modeling to use the planning model;
- Generate new response plans;
- Import updates to the inventory and roadway geometry files into the existing model to maintain an up-to-date planning and predictive tool; and
- Export files for use within the predictive tool.

1.7.3.2 Predictive Engine Component

The DSS will include a PRE component that will have two main functions. The maintenance function is internal but necessary for the PRE to maintain its calibration and readiness to provide the evaluation function to the ICMS operations.

1.7.3.2.1 Predictive Engine Maintenance Function

The maintenance function provides 30-minute horizon predictions every five minutes as well as provides a near real-time evaluation system to be used to evaluate potential event response plans and other strategies on-demand. The PRE component runs 24-hours a day / 7-days a week and is available for evaluations at any time.

The core network for the PRE component will be the planning model and represents the main corridors and parallel arterials of the Central Florida Transportation Network. As the planning model will be configured for typical day operations, the PRE component will need further refinement on the demands and operational parameters to be able to accurately represent any day of the year. The PRE component should be able to represent the following for any given day:

- Updated travel flows and demands;
- Accurate speeds and congestion;
- Correct implementation of ITS devices and systems;

- Any changes to travel patterns due to the change in demand; and
- Accurately predict queue propagation and dispersal.

The PRE component will also include a near real-time deterministic model that will work with the simulation model to evaluate and optimize the signalized intersection corridors within the network.

The PRE component will be integrated as part of the DSS subsystem and include access to several data connections that will allow the PRE to collect the status of all devices in real-time, including, but not limited to:

- Current traffic signal timing plans and operational model
- Ramp meter status and rate, if applicable.
- Detector status including flows and speeds.
- Dynamic message signs message status
- Transit automatic vehicle location and status data.
- Event and incident status messages, including start time, blockage pattern, and severity.

This maintenance function of the PRE component is to provide a rolling 30-minute horizon view of the traffic conditions on the roadway network, including a 10, 20, and 30-minute forecast. These predictions should be run in under 5 minutes using a mesoscopic simulation with enough fidelity allowing the system to calculate the benefits of changes to signals, ramps, and incorporation of strategies like transit signal priority. The rolling horizon will provide the demands and loaded network that will be the starting point for the evaluation models.

1.7.3.2.2 Predictive Engine Evaluation Function

The second function of the PRE component is to provide an evaluation tool that, upon request from the ERE, will run multiple simulations in parallel. These simulations will be triggered in response to an event in the system and would be used to run the Do Nothing scenario and the various response plan scenarios to provide the MOEs to evaluate the scenario that provides the highest benefit and best key performance indicator (KPI). Both the rolling and evaluation predictions will need to produce all levels of MOEs; these need to include the following categories and details:

- Node MOEs:
    - Turning movement counts by vehicle type
    - Approach and turn delays
    - Highway capacity manual definition of LOS
- Link MOEs:
    - Flow by vehicle type and total flow
    - Average speed

a) Average queue length and 95 percent queue length:

    - Number of stops
    - Average density
    - Volume/capacity
- Sub path MOEs:
    - Total route volume
    - Total route delay
    - Average delay
    - Average speed
    - Average travel time
- Transit MOEs:
    - Route travel time
    - Average delay
    - Average speed
- Emission MOEs
- Network Summary MOEs:
    - Vehicle miles traveled
    - Vehicle hours of delay
    - Total volume entering
    - Total volume exiting
    - Average delay

Upon completion of the simulations, the PRE component shall post the MOEs to the IEN and provide access of the MOEs to the ERE.

The third role of the PRE component will be to analyze signalized arterial corridors and, using a deterministic model, optimize the signal timings to develop an improved corridor flow. Improved timings should be evaluated using the simulation model and can be run either for the full network in mesoscopic or with a dynamically built microscopic model that would provide a higher level of signal details. This analysis would be executed for the new response plan scenarios and with the Do Nothing scenario in order to provide the percentage improvement measures of effectiveness to the user to review when selecting between the response plans and whether to approve or reject the proposed response plans.

1.8 Assumptions and Dependencies

Since the practice and concepts of ICM are relatively new, several systems, technology, and institutional assumptions were made in the development of the requirements. These assumptions may be improved upon through the development of the PROJECT.

1.8.1 System Assumptions for the ICMS Project

- The DFE system will store live data streams, historical data, and transformed data sets and streams (also referred to as analytics);
- The standards deployed as part of the DFE system will be sufficient in most cases for the data needed for the DSS;
- Communication links between all stakeholders are complete, and on a high bandwidth fiber network;
- Current deployed infrastructure and systems will be utilized;
- The ICMS will utilize COTS solutions as much as possible, including SunGuide;
- Current and proposed infrastructure will be sufficient for the data requirements of the ICMS, and specifically the DSS within the ICMS; and
- Current TSM&O will be maintained throughout the design, implementation, testing, and deployment of the ICMS and components.

1.8.2 Technology Assumptions for the ICMS Project

- Industry best practices for user account management, authentication, and authorization practices will be used for data and application resources in the ICMS and TSM&O environment.
- Information technology standards required by the DPARTMENT will be used for this PROJECT. These standards can be found in the Business Systems Support Office's *Web Application Standards* document, and documents found at http://cflsmartroads.com/projects/future_projects.html.

1.8.3 Data Quality Assumptions for the DSS Subsystem

- Timestamps associated with data provided to the DSS will be accurate;
- Data provided to the DSS will be spatially accurate;
- Static data updates from external feeds will be provided on a periodic basis for inclusion in the DFE system and the DSS.

1.8.4 Statutory Project Management and Cyber Security Standards

- Chapter 74-1 F.A.C., Florida Information Technology Project Management and Oversight Standards
    - Governed by the Agency for State Technology (AST), Chapter 74-1 F.A.C., Florida Information Technology Project Management and Oversight Standards, establishes project management principles that State Agencies are required to follow when implementing information technology projects. The Department must adhere to the State project management standards and ensure that all project documentation created by the Vendor,

Department, or in collaboration, is developed and maintained in accordance with Chapter 74-1 F.A.C. The Vendor must be familiar with the State project management standards and be prepared to work with the Department to satisfy all requirements. It is important for the Vendor to recognize that documentation, monitoring, or reporting requirements could change mid-project, based on the project's AST Risk and Complexity Assessment, outlined in 74-1.002. The Vendor must be adaptable to changes required by Chapter 74-1 F.A.C., without increasing cost to the Department.

- Chapter 74-2 F.A.C., Information Technology Security
    - Governed by the Agency for State Technology (AST), Chapter 74-2 F.A.C., Information Technology Security, also known as the Florida Cybersecurity Standards (FCS), establishes cybersecurity standards for information technology (IT) resources. State Agencies are required to follow these standards in the management and operations of state IT resources. The Department must adhere with the Florida Cybersecurity Standards for all Information Technology projects created by the Vendor, Department, or in collaboration. The Vendor must be familiar with the State cybersecurity standards and be prepared to work with the Department to satisfy all requirements.

    - Florida Cybersecurity Standards, 74-2 F.A.C. Section 74-2.002 (4) requires that agencies determine the potential security impact of all systems. If the system if found to have a categorization of moderate impact or higher, a system security plan (SSP) will be required. The SSP must address the security setup of the system, ensuring that required security controls are in place and listing the required information described in Section 74-2.003(5)(g)(4). The SSP must be submitted and approved by the FDOT Information Security Manager (ISM). An SSP template is available from the FDOT ISM.

1.9 Technical Requirements

Functional requirements that the system must meet are included in the attached *Minimum Technical Requirements Specification*. It will be the responsibility of the VENDOR to understand all requirements in the requirements specification and inferred in the descriptions within this Scope of Services document. The VENDOR shall be responsible for developing a FINAL Requirements Specification once the requirements walkthrough is completed with the DEPARTMENT.

The Requirements Specification has been developed by the DEPARTMENT and will be updated to include negotiation conclusions. Exhibit C of this document lists each requirement and identifies the responsible party.

DEPARTMENT will have responsibility for procuring all hardware and COTS software identified by the VENDOR as needed for deployment and operation and maintenance of the developed software. The VENDOR shall recommend minimum hardware and software requirements to support the PROJECT.

1.10 Software Ownership

The DEPARTMENT shall have full ownership of any works of authorship, inventions, improvements, ideas, data processes, computer software programs, source code, source code documentation, drawings, designs, specifications, documents, traffic models, and discoveries (hereafter called intellectual property) conceived, created, or furnished under this CONTRACT, with no rights of ownership to the VENDOR. The VENDOR shall fully and promptly disclose to the DEPARTMENT all intellectual property conceived, created, or furnished under this CONTRACT. The VENDOR hereby assigns to the DEPARTMENT the sole and exclusive right, title, and interest in and to all intellectual property conceived, created, or furnished under this CONTRACT, without further consideration. This CONTRACT shall operate as an irrevocable assignment by the VENDOR to the DEPARTMENT, including all rights therein in perpetuity. The VENDOR shall not copyright or patent any intellectual property conceived, created, or furnished under this CONTRACT without the express written consent of the DEPARTMENT. The VENDOR agrees to execute and deliver all documents requested by the DEPARTMENT to effect the assignment of intellectual property to the DEPARTMENT or the registration or confirmation of the DEPARTMENT's rights in or to intellectual property under the terms of this CONTRACT.

The foregoing shall not apply to any preexisting software, or other work of authorship used by the VENDOR, to create a deliverable, but which exists as a work independent of the deliverable, unless the preexisting software or work was developed by the VENDOR pursuant to a previous contract with the DEPARTMENT or a purchase of the intellectual property by the DEPARTMENT under the contract.

Any preexisting software, or other work of authorship used by the VENDOR, to create a deliverable, or integrated into the deliverable, shall require the written approval of the DEPARTMENT prior to use. Insofar as preexisting software is concerned, that intellectual property remains that of the commercial software publisher; however, all license to use that software, relative to this PROJECT will be irrevocably and perpetually conferred to the DEPARTMENT. Furthermore, the preexisting software owned by the VENDOR and licensed to the DEPARTMENT shall be placed in escrow. The Vendor shall maintain in escrow a copy of the source code for the preexisting software. With each new release of the software provided to the Department, the Vendor shall maintain the updated source code in escrow. In the event the Vendor files for bankruptcy or ceases operations for any reason, the Department shall promptly be provided the current source code in escrow. The Department will only use the source code to support the licensed software subject to the same nondisclosure provisions of this Contract.

At all times, the DEPARTMENT shall have access to the intellectual property owned by the DEPARTMENT and developed pursuant to this CONTRACT or a previous contract

with the DEPARTMENT including source code and its documentation for the purpose of modification, enhancement, or distribution. The DEPARTMENT shall distribute the software to state agencies as required and may distribute the software to other states.

The VENDOR also agrees to execute all papers necessary for the DEPARTMENT to protect their ownership of the rights in the work products.

The VENDOR shall be responsible for the preservation of any and all such work products prior to transmittal to DEPARTMENT, and shall replace any such work products that are lost, destroyed, or damaged while in its possession without additional cost to the DEPARTMENT.

2 Applicable Documents

Most documents named throughout this Scope of Services are located and viewable on one central page at http://cflsmartroads.com/projects/future_projects.html. These include, but are not limited to:

- Detour Maps – Orange County, Osceola County, and Seminole County
- TSM&O Data and Systems Inventory
- ICM Action Plan
- Business Systems Support Office's Web Application Standards
- Installation and Deployment Guide Template
- Project Delivery Methodology of the FDOT District 5 AAM Dashboard, Version 1.0, Revision Date: 09/30/2016
- AAM Dashboard Description and Requirements:
    - Comprised of the following two documents: Project Delivery Methodology of the FDOT District 5 AAM Dashboard, Version 1.0, Revision Date: 09/30/2016, Attachment A (Software Requirement Specifications) and Attachment B (System Requirements). The PROJECT will build upon this work to provide a robust production system that meets the requirements of the IEN. The above mentioned attachments can be found at the following link:

      http://cflsmartroads.com/projects/design/tsp/Regional_integrated_corridor_mgmt/FDOT_D5_AAM_Dashboards_Description_and_Requirements_and_Mockups.pdf

Other documents named include, but are not limited to:

- FDOT Systems Engineering Management Plan templates (http://www.fdot.gov/traffic/its/projects_deploy/semp.shtm), including:
    - Project Systems Engineering Management Plan Template
    - Software Development Plan Template
    - System Test Template

    - Test Procedures Template
    - Test Report Template
- USDOT's Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software (http://ops.fhwa.dot.gov/trafficanalysistools/tat_vol3/vol3_guidelines.pdf)

In the event of a conflict between the documents referenced herein and the contents of this Scope of Services, this document shall be considered the superseding requirement.

3 Scope of Work

The VENDOR is responsible for providing a detailed scope of work in a project work plan document that meets the requirements for managing the project contained in this section of the scope of services.

The scope of work described in this section is a general guide and is not intended to be a complete list of all the work necessary to complete the project. One of the early deliverables by the VENDOR will be a detailed work plan. The scope of work contains work tasks that are necessary to meet the DEPARTMENT's project requirements.

The selected VENDOR shall implement a comprehensive, fully integrated suite of software systems covering the general functional areas and specific requirements detailed in the Requirements Specification.

3.1 DEPARTMENT Responsibilities

The DEPARTMENT will be responsible to:

- Designate a project manager
- Form a project steering committee
- Provide all existing documentation in the DEPARTMENT's possession on the equipment and systems required to interface with ICSM
- Coordinate the documentation for an interface with other projects. Acquire an Interface Control Document from other projects, if required
- Review, Comment, and Approve the documentation and other deliverables
- Monitor the project's implementation progress and schedule
- Provide facility access and staff support
- Participate in requirements reviews, integration testing, acceptance testing, implementation, training, and status meetings
- Acquire all off-the-shelf hardware and software required to implement the functional capabilities of the PROJECT
- Provide hardware, commercial software, and communication infrastructure
- Provide all data interface APIs and Static Data required for the ICMS

- Create and maintain a project SharePoint site during the contract period to:
    - Update project progress
    - Post documentation
    - Post meeting agendas, minutes, and action items
- Provide an integration testbed environment for testing all software functions. Performance, security, and other system functions will be tested in a controlled pre-production environment during the system test phase which will mirror the production environment.
- Provide test systems and simulators to support the unit and system testing of the ICMS.

3.2 VENDOR's General Obligations

The VENDOR and its subcontractors will be responsible to:

- Designate a project manager and key project team members
- Provide a resource loaded Microsoft Project Schedule
- Provide detailed software design and integration with complete software system design documentation
- Identify the hardware requirements for system implementation, so the DEPARTMENT can furnish the computer-related equipment and networks for system integration and testing for the TMC
- Schedule and Coordinate with the DEPARTMENT's project manager to ensure that adequate network infrastructure and data links are provided by the DEPARTMENT
- Integrate all software into an operational system
- Test all functional capabilities of the system
- Provide network and workstation security
- Pack, ship, ensure, and deliver all parts; training and maintenance materials; submittals; and documentation to the DEPARTMENT, as directed
- Implement a rigorous, structured integration methodology
- Implement a rigorous configuration management system
- Implement and executing a formal software development process
- Complete documentation for all hardware (as applicable) and software training, including a complete operator/administrator manual; user and service documentation; and the drawings
- Train DEPARTMENT designated- personnel
- Project management and control, including attending periodic progress meetings with and reporting to, the DEPARTMENT staff
- Maintenance and support of the system for the duration of the contract
- Standard warranty services for the duration of the contract

- Post implementation maintenance support for delivered software within the contract period, renewable in one year increments
- Provide all licenses that use the public domain software in Florida before the project award. The VENDOR shall provide the DEPARTMENT with all related licenses

3.3 Other Participants' Obligations

Other agencies and contractors shall participate in the ICMS Project in the following manner:

- Contractors implementing TSM&O related systems shall work with the VENDOR to provide existing system design documents and implementations in support of the ICMS Production System and environment.
- FDOT Offices and other Agencies providing data streams and data sets shall make these data resources and associated metadata and documentation available to the VENDOR.
- ICMS Stakeholders and Users shall provide input to their needs and preferences to support the design and implementation of the ICMS system to meet their needs

3.4 Overview of the Project Steps

This project will follow an iterative development process based on the Systems Development Process, shown in Figure 24, and described in Section 3.5. Within the Design Phase, three design/ deployment iterations will be completed prior to final integration and systems acceptance:

1. Design/Deployment/Test Phase 1 – DFE shall consist of the build, setup, and configuration of the data warehousing components; building of the DI processes to extract, transform, and load data from data sources to the data warehousing components; and the build, setup, and configuration of the APIs to provide users and other applications with access to the data in the data warehousing components.
2. Design/Deployment/Test Phase 2 – Information Exchange Network shall consist of the data interfaces and IEN software development, and configuration and calibration of the models will begin;
3. Design/Deployment/Test Phase 3 – ERE shall be developed including the data interfaces from the IEN to the DSS ERE; Model Integration into DSS to include predictive network conditions and MOEs into the Rules Engine, and
4. Deployment Phase – Integration of the three phases into an integrated operational system shall be completed

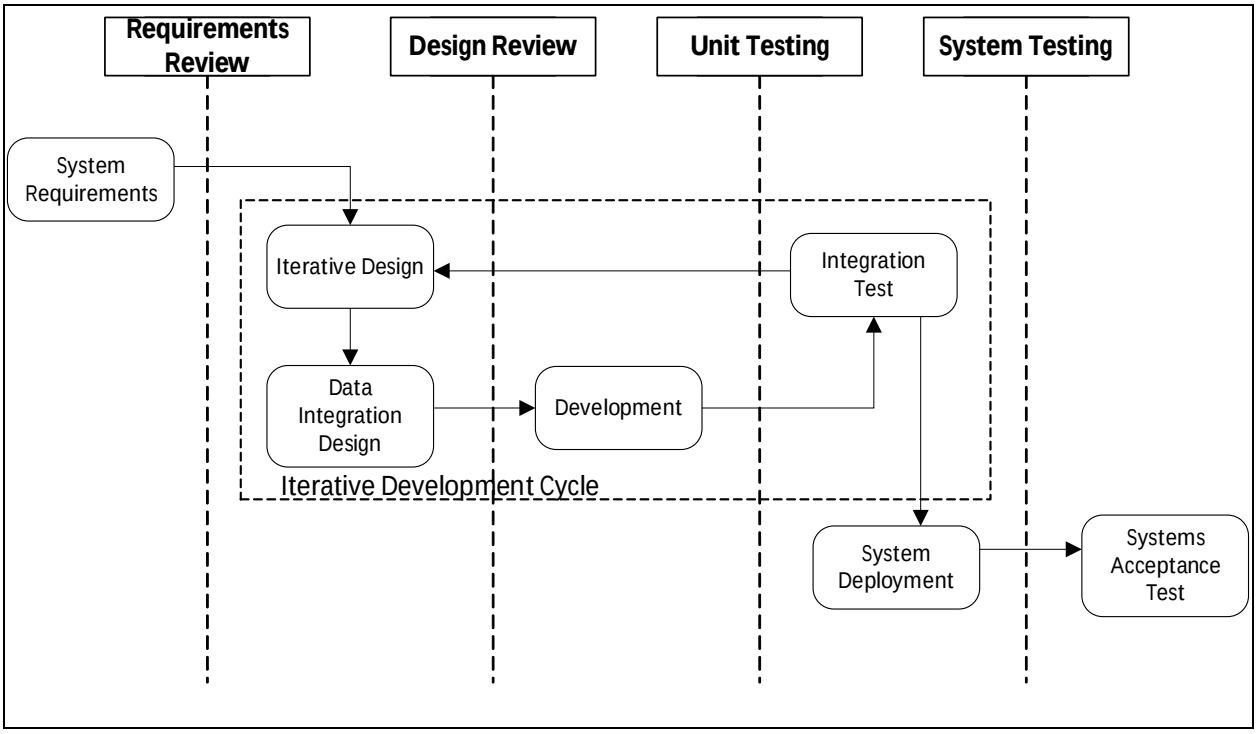

Figure 24: System Development Process

3.5 Project Tasks

This section describes all the work tasks to be performed. The VENDOR is expected to follow this structure in developing a detailed work plan. Figure 25 shows the tasks in a Gantt chart, and the sections below provide more detailed description of the tasks.

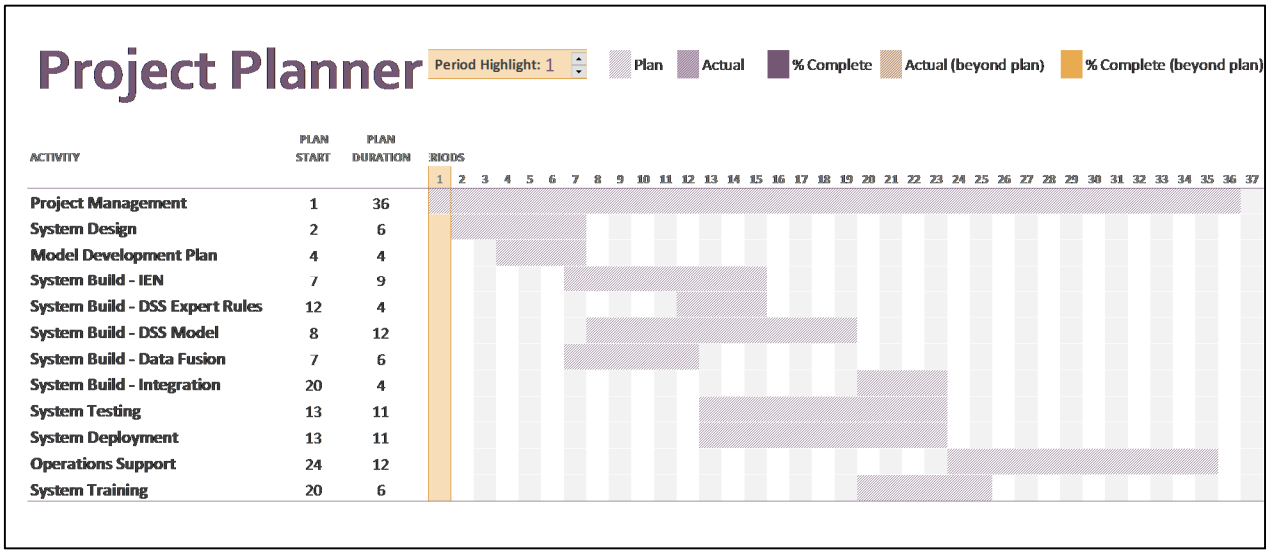

Figure 25: Preliminary Project Gantt Chart

3.5.1 Task 1 – Project Management (VENDOR)

At a minimum, the VENDOR's project manager will be responsible for:

- Organizing a project team, and identifying key team members and their specialties
- Providing periodic updates to the work plan and schedules. Changes to the work plan and schedules that exceed 10 percent of the baseline require approval by the DEPARTMENT.
- Submitting monthly project status reports detailing the following:
    - Progress towards fulfilling the objectives in the work plan and its project schedule;
    - Critical path with highlighted items;
    - Status of risk mitigation efforts; and
    - Vendor performance assessment and supporting details for determining liquidated damages as described in section 4.

3.5.1.1 Administrative Reports

The DEPARTMENT requires the deliverables indicated below from the VENDOR in order to monitor progress and ensure compliance.

- Project Systems Engineering Management Plan
- Software Development Plan

3.5.1.2 Project Systems Engineering Management Plan

The VENDOR shall develop a Project Systems Engineering Management Plan (PSEMP) document using the Project Systems Engineering Management Plan Template (http://www.fdot.gov/traffic/its/projects_deploy/semp.shtm) as a starting point in accordance with section 3.5.1.3.1 - Developed Document Deliverables.

The VENDOR shall use the PSEMP template to include the following additional sections, at a minimum. Some of these items should also be provided as stand-alone deliverables as described below.

a) Detailed Work Plan Section – The VENDOR shall develop a detailed work plan listing all the tasks the VENDOR will perform to fulfill the requirements of the ICMS. At a minimum, the work plan shall contain a detailed work breakdown structure (WBS) that is keyed to the level of cost and schedule reporting. A list of all deliverables provided under this contract. The work plan may incorporate the staffing plan and schedule, or it may reference them.

b) Risk Management Plan Section – The VENDOR shall develop a risk management plan that identifies initial project risks and possible ways to mitigate those risks. The VENDOR shall report on the status of each identified risk in the monthly progress report until that risk is fully mitigated. Risks shall be classified as: 1) cost, 2) schedule, and/or 3) technical. Even though the contract is limited to a maximum budget that may be adjusted through an amendment process, it is critical that the

VENDOR keep the DEPARTMENT informed of any potential impacts to cost and what steps the VENDOR is taking to mitigate the cost impact. It is in the DEPARTMENT's best interest for the VENDOR to meet their cost and schedule commitments, and the DEPARTMENT will actively support the VENDOR in achieving those commitments. When new risks are identified, revisions to the risk management plan section shall be issued.

(1) The VENDOR shall, at a minimum, address the following potential risk areas:

(2) Development of new software modules

(3) Platforms for integration and testing

(4) Adequate technology transfers of the system

(5) Stability of hardware suppliers

(6) System security

c) Staffing Plan Section – The VENDOR will identify the key individuals to be involved in the project during negotiations and indicate in the staffing plan the number of personnel assigned to each element of the WBS. A key individual is defined as a person who is a task leader or individual contributor with specialized knowledge applicable to the project. No key individual may be removed or substituted on the project without approval by the DEPARTMENT.

d) Detailed Schedule Section – The VENDOR shall develop a detailed schedule in Microsoft Project based on the WBS and work plan that. This will be described in and referenced by the Detailed Schedule Section. The Project Schedule will be delivered as a separate deliverable as described below.

e) Communication Plan – The VENDOR shall develop a Communications Management Plan, as defined in section **Error! Reference source not found.**.

f) Deliverable Approval Process – The VENDOR shall document the Deliverable Approval Process, as defined in section 3.5.1.3.

g) Change Management Procedures – The VENDOR shall document the Change Management Procedures within its PSEMP as defined in Section 3.5.1.2.1,.

h) Cost Management Plan – The VENDOR shall document the processes for managing and reporting costs in its PSEMP as defined in Section 3.5.1.2.3.

i) Requirements Traceability Verification Matrix Section – The VENDOR shall develop a Requirements Traceability Verification Matrix in accordance with section 3.5.1.3.1.

3.5.1.2.1 Change Management Procedures

The VENDOR shall follow a change management procedure for making changes to the ICMS after requirements have been finalized.

1 The VENDOR shall submit a change request to the DEPARTMENT for consideration. The change request shall include a description of the change, the requirement changes needed for the change, justification for the change, and the impact to the budget and schedule. The description of the change shall address

the changes to the system and the changes to the operation of the system, and may be referred to as a "mini-conops."

2 The DEPARTMENT will coordinate with stakeholders to consider the change and make a decision to accept or reject the change request.

3 If accepted, the VENDOR shall make any necessary contractual changes or amendments necessary and in accordance with the change, and proceed to implement the change.

3.5.1.2.2 Project Risk Register

The Risk Management Plan section in the PSEMP describes how risks are managed; the project risk register contains identified risks and is updated through the project. The Project Risk Register will be maintained online with a tool such as a SharePoint list so the project team and the management team can work with this register collaboratively.

3.5.1.2.3 Cost Management

Project cost control searches out the causes of positive and negative variances, and is part of the Change Management process. Project Cost Management during the controlling phase includes the processes used to control costs so that the project can be completed within the approved budget. Project cost controls include:

- Influencing the factors that create changes to the cost baseline;
- Ensuring requested changes are agreed upon;
- Managing the actual changes when and as they occur;
- Assuring that potential cost overruns do not exceed the authorized funding periodically and in total for the project;
- Monitoring cost performance to detect and understand variances from the cost baseline;
- Recording all appropriate changes accurately against the cost baseline;
- Preventing incorrect, inappropriate, or unapproved changes from being included in the reported cost or resource usage;
- Informing appropriate stakeholders of approved changes;
- Acting to bring expected cost overruns within acceptable limits.

As part of the PSEMP, VENDOR shall document how each subproject's budget will be tracked to measure the Actual Cost, Earned Value, Estimate to Complete, and Estimate at Completion. These measurements will be reported as part of the monthly project status meeting. VENDOR is responsible for tracking the subproject budgets and the overall program's budget.

3.5.1.2.4 Project Schedule

The VENDOR shall develop and maintain a detailed schedule in Microsoft Project based on the WBS and work plan that, at a minimum, identifies:

1. Earliest start dates for a tasks
2. Latest start dates for tasks
3. Earliest finish dates for tasks
4. Latest finish dates for tasks
5. Schedule float time in days
6. Duration of tasks in days, where the minimum increment is one day
7. Task names and task numbers
8. Resource loading
9. Critical path information

3.5.1.2.4.1 Monthly Progress Reports

The VENDOR shall prepare a progress report each month to be provided to the DEPARTMENT by the fifth day of the next month. The progress report shall include the following items at a minimum:

1 Work completed
2 Work planned
3 Risks and issues
4 Schedule deviations

3.5.1.2.4.2 Administrative Meetings

List all the administrative meetings that the VENDOR is expected to attend. If possible, list where the meetings will be held and the duration of each meeting.

The VENDOR shall attend the following administrative meetings. In-person meetings will be held at FDOT D5 Headquarters, 719 S Woodland Blvd., DeLand, FL 32720.

- Kickoff Meeting
  - The kickoff meeting shall last for 2 hours. It shall be in person.
- Monthly Status Meetings
  - Monthly status meetings will last 1 hour in duration. Six meetings will be person and 18 meetings will be held via screen share teleconference such as GoToMeeting or Skype Meeting.
- Project Closeout and Post-Mortem Meeting
  - Towards the end of the project, an in-person meeting with the project manager and key technical staff.

Note: Other meetings are not listed here because they are part of the other tasks.

Meeting agenda shall be provided 5 business days prior to all meetings.

Meeting minutes shall be provided within 5 business days after all meetings.

3.5.1.2.5 Communication Management Plan

The overall objective of a Communications Management Plan is to promote the success of a project by meeting the information needs of project stakeholders. The Communications Management Plan defines the project's structure and methods of information collection, screening, formatting, and distribution and outline understanding among project teams regarding the actions and processes necessary to facilitate the critical links among people, ideas, and information that are necessary for project success.

The intended audience of the Communications Management Plan is the project manager, project team, project sponsor and any senior leaders whose support is needed to carry out communication plans. The Communications Management Plan defines the following:

- What information will be communicated—to include the level of detail and format
- How the information will be communicated—in meetings, email, telephone, web portal, etc.
- When information will be distributed—the frequency of project communications both formal and informal
- Who is responsible for communicating project information
- An escalation process for resolving any communication-based conflicts or issues

3.5.1.3 Transmittal of Deliverables

3.5.1.3.1 Developed Document Deliverables

Document deliverables are an important tool to contain work plans, products, and important decisions made between the DEPARTMENT and the VENDOR and shall conform to the following process for consistent, timely development. Where document templates are available on the DEPARTMENT's Systems Engineering website, the template shall be used and may be tailored by the VENDOR in developing the document unless an alternative is agreed to by the DEPARTMENT. Where a specific document template is not available, the VENDOR shall use the DEPARTMENT's non-specific technical memorandum document template and include the sections and information specified in the scope item at a minimum.

Document Deliverable Planning:

1. The VENDOR and the DEPARTMENT agree on deadlines for the document deliverable submittal activities (described below) that fit within the project schedule.
2. VENDOR submits a document shell or outline for the DEPARTMENT's review and approval following the submittal procedure below. The document shell shall contain the outline of the document and may contain notes to guide the development of the document content.
3. The DEPARTMENT shall email the VENDOR that the outline has been accepted.

4. VENDOR submits the completed document according to the submittal procedure below.
5. The VENDOR shall provide a finalized document after all comments have been completed by the deliverable final due date. A final document shall have the DRAFT watermark removed and the version number of the document incremented to the next whole number.
6. The DEPARTMENT shall mark the document as final in the document library and email the VENDOR that the final document has been accepted.

Document Deliverable Submittal and Review Procedure:

1. VENDOR delivers draft deliverable to the DEPARTMENT by the draft deliverable due date.
2. DEPARTMENT reviews the deliverable and provides comments to the VENDOR by the deliverable review due date. Comments will be provided as comment balloons and tracked changes if using Microsoft Word; else, a comments table will be provided that will track each comment's text, reference location within the deliverable, and a place for the VENDOR's response, and a status of the comment.
3. VENDOR address comments by modifying the submittal and answering questions by the revision due date. Changes to the deliverable shall be tracked using the tracked changes feature of Microsoft Word if the deliverable is in that format, else, a list of changes made to the deliverable shall be provided with the comments responses.
4. DEPARTMENT reviews the VENDOR's comment responses and deliverable changes by the revision review due date. All comments shall be marked as completed using the "Mark as Completed" function of the comment balloon if using Microsoft Word, else by indicating in a comments table.
5. Steps 3 and 4 will repeat until the DEPARTMENT marks all comments as completed.

3.5.1.3.2 Other Deliverables

Other deliverables that are not appropriately formatted as a Microsoft Office document shall be submitted in a fashion described in the other plan documents.

3.5.2 Task 2 – System Design

The VENDOR shall develop and finalize the preliminary, critical, and final system design for the ICMS and for the new external systems that interface to the ICMS. Project files shall be set up and overall coordination of staff and all agencies involved will be maintained. The system design development tasks include:

3.5.2.1 System Requirements Specification

- The VENDOR shall conduct a one-week, in-person requirements walkthrough with the DEPARTMENT and its representatives to ensure that both have a common understanding of what will be built and what capabilities the system will include. The DEPARTMENT has sole discretion of the acceptance of any changes to the requirements.

  After this walkthrough is completed, the VENDOR shall update the System Requirements Specification with agreed changes and clarifications made during the requirements walkthrough in accordance with section 3.5.1.3.1 - Developed Document Deliverables.

  Once the System Requirements Specification is finalized, the Software Requirements Specification should be produced for the individual new software development tasks. Software requirements are derived from the System Requirements Specification by allocating functional requirements to specific software modules or subsystems and further decomposing these requirements to the software level. These documents will be controlled in a manner consistent with the configuration management plan.

3.5.2.2 Preliminary Design

- The VENDOR shall coordinate to develop the 40% Design deliverable for the DEPARTMENT review, and build upon the work done by the DEPARTMENT during the Systems Requirements. The 40% Design phase shall include the following at a minimum:
  a. Description of all subsystems and components;
  b. Architecture of all subsystems and components;
  c. Identification of all data sets used by and transferred between all subsystems and components;
  d. Identification of interfaces between all subsystems and components and users;
  e. Dependencies and modules to be used to build or support all subsystems and components, including COTS API modules, configuration data, and mechanisms;
  f. Design Methodology and Design Document Templates; and
  g. Other high-level design artifacts.
- **Preliminary Design Review** - At the completion of the 40% Design phase the VENDOR shall perform a Preliminary Design Review (PDR) to obtain verification / approval of the system architecture design. The goals of the PDR are to:
  a. Verify the technical content of the architectural design document and its interfaces are complete and traceable to requirements;
  b. Ensure the selected design methodology has been followed in producing the architectural design; and
  c. Obtain approval from the DEPARTMENT Project Manager to proceed into detailed design.

3.5.2.3 Critical Design

- VENDOR shall coordinate to develop the 90% Design deliverable for the DEPARTMENT.
- **Critical Design Review** - After completion of approximately 90% of the detailed design and prior to system build, a Critical Design Review (CDR) shall be conducted by the VENDOR to ensure the design fulfills the requirements. The CDR will serve as a baseline for all deliverables, and there will be no deviation from the final CDR without change requests being approved by the DEPARTMENT. The goals of the CDR are to:
    a. Verify the technical content of the System Design Document are complete and its functions are traceable to requirements.
    b. Ensure the selected design methodology has been followed in producing the detailed design.
    c. Obtain approval from the DEPARTMENT Project Manager; the team will proceed into the implementation phase.

  The 90% detailed design shall include the following at a minimum:
    a. Structure of all subsystems and components and shared libraries
    b. Behaviors of all subsystems and components
    c. Mockups of user interfaces
    d. Database model diagrams of databases used to support ICMS subsystems and components.

3.5.2.4 Software Coding Guidelines

- At the time of the critical design review, the software coding guidelines shall be established and submitted in accordance with section 3.5.1.3.1 - Developed Document Deliverables. The DEPARTMENT has provided some example coding standards that would be acceptable to use, but the VENDOR may propose changes or other standards to be used. This document will govern how the software source code will be developed to ensure the source code products can be understood and maintained by an entire team of developers, not just the original author. It will also provide a familiar style that will make reading code in differing parts of the system understandable without having to learn new conventions or documentation styles. The VENDOR shall follow coding guidelines that include general guidelines for all code and specific standards for code that is anticipated to comprise of at least 10 percent of the system.

3.5.2.5 System Design Document

- The final deliverable in the design phase will be the System Design Document (SDD). At the conclusion of the CDR and final design, the SDD is baselined and placed under configuration management control. The resulting SDD will identify the system design

and how it will be implemented. The software object models, data models, and dynamic models will be fully specified, including all data inputs and outputs, and software algorithms. The VENDOR shall submit a Final System Design document in accordance with section 3.5.1.3.1 - Developed Document Deliverables.

Task 2 Approach

1. Develop Design Methodology and Design Document Templates
2. System Requirements Walkthrough
3. Develop Final System Requirements Document
4. Work with Project Stakeholders, DEPARTMENT, and other vendors (suppliers) to develop a Preliminary Design
5. Provide Preliminary Design Document to the DEPARTMENT and project stakeholders for review and comment
6. Present Preliminary Design as part of PDR
7. Work with PROJECT stakeholders, DEPARTMENT, and other VENDORS (suppliers) to develop update Preliminary Design and develop Critical Design
8. Provide Critical Design Document to DEPARTMENT and project Stakeholders for review and comment
9. Present Critical Design as part of CDR
10. Submit CDR results and 90% Design to DEPARTMENT approval and Notice to Proceed to Build Phase
11. Work with PROJECT stakeholders, DEPARTMENT, and other VENDORS (suppliers) to develop update Critical Design and complete Final Design
12. Provide 100% Design to DEPARTMENT and PROJECT stakeholders for review and comment
13. Update Final Systems Design Document and submit to DEPARTMENT approval

3.5.3 Task 3 – Model Development Plan

VENDOR shall develop a model development plan document described in section 1.7.3.1 – Evaluation Engine Component and in accordance with section 3.5.1.3.1 - Developed Document Deliverables that shall outline the process for building, calibrating, and validating both the planning model and the predictive model. The model development plan shall outline accepted practices in model development and calibration as well as leveraging the outlined steps from the USDOT's "Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software," which can be found online at http://ops.fhwa.dot.gov/trafficanalysistools/tat_vol3/vol3_guidelines.pdf. Although these guidelines are designed for Microsimulation, the VENDOR should modify these steps within the model development plan to be applied to development of the Mesoscopic Simulation model. The goals and high-level details of the model development plan are to:

1. Identify any data gaps that are needed to complete the development of the base planning model. Identify and list all data sources and inventory. Data sources should include field devices (such as detectors, side radars, etc.), commercial data sources

(such as Here data), and static or manual data sources (such as turning movement counts and automatic traffic recorders [ATR]).

2. Plan to collect up to 50 12-hour turning movement counts for critical gaps. Locations will need to be approved by the DEPARTMENT.
3. Define the process for building the supply side of the base model network including identifying how existing models from the area will be incorporated into the process.
4. Define the process for the development of the demand side of the planning model including how the regional models and available data will be incorporated to generate the 24-hour demand.
5. Calibrate and assign vehicle/traveler classes including the appropriate distributions of value of time.
6. Define the network calibration process that will be applied in calibrating the base planning network. Selecting 30 arterial and 20 freeway critical locations, where data is available, define the global capacity parameters to be used within the model. Locations will need to be approved by the DEPARTMENT.
    a. Set the calibration targets to be used to show the best match possible between the performance estimates from the model and the field measurements. The VENDOR should reference Table 4, Wisconsin DOT freeway model calibration criteria, from the USDOT's "Traffic Analysis Toolbox Volume III, available online at http://ops.fhwa.dot.gov/trafficanalysistools/. The calibration targets are the criteria that will be used by the DEPARTMENT and project stakeholders to insure that the models will meet the goals of the project.
7. Define the model validation criteria that will be used by the DEPARTMENT and project stakeholders to insure that the models will meet the goals of the project. The VENDOR should expand on the guidelines provided by USDOT and define criteria for both the planning and predictive models.
8. Outline the process to be used in developing or incorporating existing tools/ APIs to replicate the advanced field applications such as adaptive signal control, and ramp metering algorithms.

3.5.4 Task 4 – System Build

The ICMS will be built and integrated one subsystem at a time in the order that provides the most value to operations the earliest possible, and allows other dependencies to be developed and provided to the PROJECT. The subsystem build tasks are ordered in the subsections below and described at a high level. The VENDOR shall prepare a software development plan to detail the plan for building and integrating the prototype system that will be used for system testing. The VENDOR shall use a test-driven approach to facilitate efficient and effective verification of the system, sub-systems, and components. This will require using simulators and test systems provided by the DEPARTMENT. This will also require tagging or identification of system components, data sets, and data streams as to which mode or purpose it belongs. Ultimately, there will be production subsystems, components, and data sets and data streams, but there may be several non-production

sets of these artifacts used through the build, test, demonstration, and training phases of the PROJECT.

The VENDOR shall develop a **Software Development Plan** using the Software Development Plan Template (http://www.fdot.gov/traffic/its/projects_deploy/semp.shtm) as a starting point in accordance with section 3.5.1.3.1 - Developed Document Deliverables.

3.5.4.1 Sub-Task 4a – System Build – Data Fusion Environment

The VENDOR shall design and deploy a DFE based on the requirements and the approved design. The VENDOR may use the prototype provided in earlier FDOT D5 efforts, but will design and deploy a solution to meet the requirements of this PROJECT. The prototype DFE will have its components and the data stored by the components labeled with prototype as its purpose.

The components will be built in the following order and manner:

1. Data sources from the data dictionary will be identified from which the data extraction component can extract data without impacting operations.
2. Simulators will be provided by the DEPARTMENT to produce data to be used by the data ingestion component when production data is not available in a manner to be extracted without impacting TSM&O.
3. The data warehousing components will be built to accommodate storing all of the types of data needed by the ICMS. This will include the SQL Server relational database management system, the unstructured data store, and the ArcGIS Data Store.
4. The data interfaces components will be built to extract, transform, and load data from the data sources into the data warehousing components.
5. The API components will then be built to provide access to data in the data warehousing components.

The VENDOR shall perform the System Integration and the System Testing and Acceptance described in sections 3.5.4.4 and 3.5.4.5 on the partial prototype ICMS containing the prototype DFE after the DFE is built.

Completed and successful system testing and acceptance of the DFE will constitute as a major project milestone.

3.5.4.2 Sub-Task 4b – System Build - IEN

The VENDOR shall develop the IEN subsystem based on the requirements and the approved design.

The VENDOR shall perform the System Integration and the System Testing and Acceptance described in section 3.5.4.4 and 3.5.4.5 on the partial prototype ICMS containing the prototype IEN and the DFE after the IEN is built.

Completed and successful system testing and acceptance of the IEN integrated with the DFE will constitute as a major project milestone.

3.5.4.3 Sub-Task 4c – System Build – DSS

The VENDOR shall develop the DSS ERE, based on the requirements and the approved design.

The VENDOR shall deploy, configure, and calibrate the DSS Predictive Model and Planning Model, based on the requirements and approved design, and approved Model Development Plan. The DSS Predictive Model and Planning Model build sub-task will, integrate all necessary static and dynamic data, and calibrate the model. The DSS Predictive Model and Planning Model build task consists of the following steps:

1. Identify all data sources and data feeds from the DFE APIs,
2. Develop all necessary DIs,
3. Integrate all necessary static and dynamic data,
4. Calibrate the model, and
5. Deploy a COTS modeling system.

The VENDOR shall perform the System Integration and the System Testing and Acceptance described in sections 3.5.4.4 and 3.5.4.5 on the prototype ICMS containing the prototype DSS, IEN, and DFE after the IEN is built.

Completed and successful system testing and acceptance of the DSS, integrated with both the DFE and the IEN, as a complete ICMS will constitute as a major project milestone.

3.5.4.4 System Integration

The VENDOR shall integrate all systems into a fully functional ICMS. Initially, simulated systems and test systems shall be used for the integration to build up towards full system testing. SunGuide test systems, ITS device simulators, ITS devices not used in production, and replicated data feeds from the DFE, and other resources shall be included during the system integration task.

Each external system will need to be considered as to how it can be used or cloned and deployed in a way to not disrupt operations while allowing the ICMS components to be tested. The following test systems will be provided by the DEPARTMENT as required resources for testing:

- A test instance of SunGuide labeled as the “D5 ICMS Test SunGuide” will be provided with simulated data inputs and simulated data outputs for testing.
- A test instance of the central traffic signal ATMS software (herein signal software) will be deployed and connected to the D5 ICMS Test SunGuide system. Currently, the TrafficWare ATMS.Now is the only signal software planned to be interfaced with SunGuide, but other signal software products should be considered for later inclusion, possibly including Econolite Centracs, Siemens Tactics, and Transcore TransSuite. However, SunGuide will be interfacing directly with the signal software products, encapsulating their specific interface protocols, and providing a single interface to the DSS through the SunGuide Event Management Subsystem.
- Other test systems needed to interface with the ICMS will be deployed and provided by the DEPARTMENT.

The subsystems will be integrated in the following order in the following manner. Each step represents a major milestone of the PROJECT and thus concludes with a system testing event described in the next section.

1. The DFE is the first needed subsystem in order to provide data to other components of the ICM and other users and stakeholders. It should collect data from sources that can be shared with other applications and users as well as a test system environment to be used for integration. The build sub-task of the DFE should result in a prototype DFE deployed with prototype data sets and data streams being ingested. The API components will be integrated into the Active Directory environment provided by the DEPARTMENT to support user access.
2. The IEN will be deployed and connected to the APIs of the DFE and to simulated interfaces of the DSS.

The DSS ERE will be deployed and connected to the APIs of the DFE, the IEN, the D5 ICMS Test SunGuide system, and the test central traffic signal ATMS software.

3.5.4.5 System Testing and Acceptance

The VENDOR shall perform system testing of the partial or complete prototype ICMS after each of the three subsystems are built and integrated into a partial or complete ICMS.

The system testing tasks include:

- **Software Unit Testing** – The software unit testing process may be initiated for a specific software unit when its software interfaces have been defined, and its detailed design has been peer reviewed, and the unit has been coded. The process is invoked for a given unit when there is sufficient information about the software unit and its relationship to other software units to initiate writing of the software unit test cases. In this process, the focus is on a particular testable unit, although previously tested units may be used. The unit testing process activities include:
    a. Reaffirm unit test environment

b. Establish unit test strategy
c. Develop test cases and procedure
d. Develop simulation software, drivers, and stubs
e. Conduct software unit testing

The unit testing will be documented and conducted without a formal event, but the unit testing procedures, scripts, simulators, and results will be provided to the DEPARTMENT so that the unit tests can be repeated by the DEPARTMENT.

- **Software Integration Testing** – The software integration testing process is invoked for a given group of software configuration items upon completion of the software unit testing process for all software units of that group. The software integration testing process activities include:
    a. Re-affirming integration test environment
    b. Establishing integration test strategy
    c. Developing simulation software, drivers, and stubs
    d. Developing software integration procedures
    e. Conducting peer review of the test procedures
    f. Coordinating effort with other teams
    g. Conducting the software integration testing

3.5.4.6 System Test Plan

- The VENDOR shall develop a System Test Plan document using the System Test Plan Template as a starting point in accordance with section 3.5.1.3.1 - Developed Document Deliverables.

3.5.4.7 Test Procedures

- The VENDOR shall develop a Test Procedures document using the Test Procedures Template as a starting point in accordance with section 3.5.1.3.1 - Developed Document Deliverables.
- **Test Readiness Reviews** – The VENDOR shall hold a two-hour, in-person, Test Readiness Review meeting prior to each major testing event. The purpose of the Test Readiness Review is to provide the DEPARTMENT with the assurance that the software has undergone a thorough test process and is ready for turnover to the next test phase. The scope of the Test Readiness Review is to inspect the test products and test results from the completed test phase for completeness and accuracy, and to verify that the test cases, test scenarios, test scripts, environment, and test data have been prepared for the next test phase. Each of the subsystems contributing to the overall ICMS will hold Test Readiness Reviews for their subsystem.
- **Test Execution** – The VENDOR shall execute the test in accordance with the test plan

- **Hot Wash-up Meeting** – The VENDOR shall attend a hot wash-up meeting in person at the conclusion of the test execution. Unverified requirements will be discussed to facilitate the development of the Corrective Action Plan.

3.5.4.8 Corrective Action Plan

- The VENDOR shall address all unverified requirements with a Corrective Action Plan. This plan will become part of the Test Report. The Corrective Action Plan will include a list of each unverified requirement, and each item in the list will contain the following information:
    a. Requirement identification number, requirement text, and other attributes of the requirement
    b. Test Procedure identification number
    c. Symptoms or observations of the behavior or evidence that the requirement was not verified
    d. Proposed resolution of one of the following options:
        i. **Correction –** The VENDOR describes a solution to resolve the unmet requirement and retest the system at no additional cost to the DEPARTMENT. The VENDOR shall record the planned corrections in the issue tracking tool described in the Operations, Maintenance, and Support task.
        ii. **Deviation –** The VENDOR may request a deviation from a stated requirement if the system can be shown to provide an equivalent functionality. The DEPARTMENT has the discretion to accept or reject a deviation request. The VENDOR shall revise the requirement(s) and documentation to reflect the accepted deviation.
        iii. **Waiver –** The VENDOR may request a waiver for a requirement that is not verified. The DEPARTMENT may grant the waiver to accept the system as-is with regards to the unverified requirement if the requirement was unable to be tested or whose results are unable to be interpreted. If the requirement was unverified due to an error in the design or implementation, the DEPARTMENT may grant the requested waiver with the proviso that the problem will be fixed in accordance with the VENDOR-furnished, DEPARTMENT-approved correction within the approved schedule. If a fix for the problem proves impractical for the VENDOR, the DEPARTMENT may grant the waiver to accept the system as-is if the VENDOR provides commensurate consideration for the lack of specified functionality and there is an acceptable work-around procedure for the DEPARTMENT and an acceptable payment adjustment. The DEPARTMENT may also reject the waiver request and require that the VENDOR meet its obligations under the contract scope and system requirements.
        iv. **Temporary Waiver** – The VENDOR may request a temporary waiver for a requirement that is not verified. The DEPARTMENT may grant the

waiver to accept the system as-is at that time if the unmet requirement is included in the work plan and project schedule to be implemented and go through system testing and acceptance at a later time, and if the cost schedule is adjusted to move commiserate payment of the work involved in the unmet requirement to when the system having the requirement implemented has gone through system testing and acceptance.

3.5.4.9 Test Report Document

- The VENDOR shall develop a test report document using the Test Report Template as a starting point in accordance with section 3.5.1.3.1 - Developed Document Deliverables to record the results of the testing. This shall include the pass/fail results of each requirement to be verified, any deviations or waivers approved by the DEPARTMENT, and planned corrections.
- **System Acceptance** – After the test report is finalized and accepted, and after all unverified requirements are resolved, the subsystem or system under test shall be accepted by the DEPARTMENT formalizing the completion of a major milestone of the PROJECT.

3.5.5 Task 5 – Deployment

The VENDOR shall assist the DEPARTMENT with deployment of the ICMS into the production environment, once systems are accepted. The VENDOR shall develop a Deployment Plan using the Installation and Deployment Guide Template found online at http://cflsmartroads.com/projects/future_projects.html) as a starting point and in accordance with section 3.5.1.3.1 - Developed Document Deliverables to list the activities involved in deploying the software into operations. The Deployment Plan shall include at a minimum information:

- Deployment Diagram - Provide and describe a figure that depicts where all system products will reside within the operational site.
- Site Preparation - Describe the preparation required for the site on which the system product will operate. Define any changes that must occur to the operational site and specify features and items that should be modified to adapt to the new product.
- Checklist of Implementation Tasks - Checklist will include the task, person responsible, and schedule of events.
- Server Configuration - For all required servers (database, web server, etc.) provide configuration, including operating system version and any required software packages that must be installed.
- Installation Steps - Includes any prerequisites, installation steps, scripts, and all required configured values.
- Software Configuration - Include a list of prerequisites, roles, features, and packages that are required for deployment.
- Verification of Installation - Complete unit testing showing installation was successful.

The VENDOR shall attend a two-hour deployment readiness meeting prior to deployment of the software.

Upon DEPARTMENT approval of the plan and schedule, the VENDOR shall deploy the ICMS into the operational environment for operational use.

3.5.6 Task 6 – System Training

The VENDOR shall develop training plans, perform training, and provide training materials for operations and maintenance of the ICMS. Project files shall be set up and overall coordination of staff and all agencies involved will be maintained. The VENDOR shall provide training as early as it can be scheduled after the implementation milestone is reached. Training materials will be provided to trainees to include an updated description of system functions, application procedures, and error troubleshooting guides including contingencies and/or alternative modes of operations (backup plan). This will include providing Updated End User Training Materials, and Updated Technical User Manuals. Each major subsystem shall include training. The training tasks include:

3.5.6.1 Training Plan

- VENDOR shall develop a Draft Training Plan in accordance with section 3.5.1.3.1 - Developed Document Deliverables, which will describe how the system operators and users will be trained prior to operation of the system. The draft plan will be provided to the DEPARTMENT for review and comment. Once comments are addressed, a Final Training Plan will be developed.

3.5.6.2 Training Schedule

- As part of the project schedule, a high-level training schedule shall be included.

3.5.6.3 Training Manuals

- VENDOR shall develop the System Training Manuals in accordance with section 3.5.1.3.1 - Developed Document Deliverables.

- The VENDOR shall provide the Training Plan, Training Schedule, and Training Manuals corresponding to the subsystems being built, prior to System Testing and Acceptance.

3.5.6.4 Training Workshop

- The VENDOR shall provide an onsite training workshop for each subsystem being built.

3.5.7 Task 7 – Operations and Maintenance, and Support

Technical support shall be provided via phone and/or email. The VENDOR shall provide the appropriate staff to respond and support the ICMS with the following operations, maintenance, and support:

- Hardware activity shall be monitored by the VENDOR. If a hardware failure occurs, the VENDOR shall notify the DEPARTMENT of the issue and provide a plan of resolution. All hardware upgrades and maintenance shall be completed afterhours and sufficient notice will be given to the DEPARTMENT.
- Software support will include, but will not be limited to, resolving software issues, database issues as they relate to the application, and providing regular maintenance to systems to ensure continuity of the system. Routine maintenance to the system shall be communicated to the DEPARTMENT one week prior to the scheduled maintenance. If emergency maintenance is required, this shall be communicated to the DEPARTMENT as soon as it is deemed necessary. All work to the production system shall be done afterhours to reduce any impact on the system and to the client.
- An on-call support phone number shall be made available to the DEPARTMENT for all support calls. Support staff will be available, as needed, 24-hours per day, seven-days per week, year-round. Support calls will have a 30-minute response time. Calls made to the support number shall be routed to the appropriate staff as described below.
- Issues reported to the on-call support phone number will be entered as new issues into the tracking system by the support staff so that the issue and its resolution can be tracked. The support staff will provide the caller with insight as to how long it will take to resolve the issue. The VENDOR will estimate the time required to address the issue in its response.
- The following tiered support staff shall be available and respond to issues:
    a. Tier 1 Support Staff – System administrator:
        i. Available eight-hours per day, 8:00 AM to 5:00 PM Eastern Time with a one-hour break between 11:00 AM and 2:00 PM.
        ii. Available Monday through Friday, except holidays recognized by the DEPARTMENT, including New Year's Day, MLKJ Day, Memorial Day, Independence Day, Labor Day, Veterans' Day, Thanksgiving Day, Friday after Thanksgiving, and Christmas Day.
        iii. Will perform tasks in the following general priority:
            1. Respond to issues reported by users or detected by the system
                a. Record all support requests in an issue tracking system.
                b. Respond to and acknowledge issues within 60 minutes of being reported and recorded in the issue tracker.
                c. If cause and resolution is not identified, escalate issues to the appropriate staff within 120 minutes of being acknowledged.

d. Notify appropriate DEPARTMENT staff of issues that will require emergency system downtime.

2. Perform routine maintenance tasks as required
3. Other tasks as assigned by the DEPARTMENT

b. Tier 2 Support Staff – Product developer:
   i. Acknowledge support requests entered in the issue tracking tool.
   ii. Respond to issues escalated by the system administrator within four hours of escalation in order to support identifying the cause and provide a resolution of the issue. If a tier 1 support staff is able to resolve the issue after discussion with the computer programmer, it can be reassigned to them for resolution.
   iii. Respond to enhancement requests made by the DEPARTMENT project manager and provide the appropriate cost estimate for the enhancement.
   iv. Review issues closed by other support staff within one business day to confirm the issue was properly resolved. This may include soliciting confirmation from the user reporting the issue.
   v. Escalate issues that require expertise beyond the product developer to the tier 3 product specialist
c. Tier 3 Support Staff – Product specialists
   i. Respond to deeper issues escalated from tier 2 that require larger effort for resolution and require specialized knowledge dealing with the modelling and traffic simulation systems, DFE, or any other highly specialized components of the ICMS.

- Provide a schedule of staff covering tier 1 support for a minimum of two weeks out into the future, including the support staff names, phone numbers, and email addresses.
- Provide a web-based issue tracking tool for users to collaborate with support staff with the following functions and constraints:
  a. Users will be able to report defects, issues, and enhancement requests
  b. This system shall be available 24-hours a day / 7-days a week
  c. Administrators and support staff will be able to respond to users, update issues with additional information, and log maintenance activities
  d. Issue tracking tool will track issue status, the staff that worked/is working on the issue, any comments recorded by the support staff, how the issue was resolved, and other issue information agreed upon between the DEPARTMENT and VENDOR
  e. Issue tracking tool shall be an open-source tool, such as Mantis
  f. Information collected by the issue tracking tool shall be the property of the DEPARTMENT

g. Issue tracking tool shall be delivered to the DEPARTMENT upon request and at the end of the contract term such that the DEPARTMENT can take over operation of the tool in its current state.

- The VENDOR shall suggest and request any needed software related licensing renewals and support for COTS packages used by the PROJECT over the same period.
- The VENDOR shall attend weekly operational review meetings for the first two months after deployment, followed by monthly operational review meetings for the remainder of the CONTRACT.
- The VENDOR shall update all manually updated data sets within one week of when new data becomes available.
- The VENDOR shall perform preventative maintenance activities that include, but are not limited do:

  a. Enter logs of maintenance performed to an issue tracking tool
  b. Perform daily, weekly, and monthly server maintenance and sub-system monitoring activities
  c. Perform monthly database and data store maintenance activities including optimization and backup

- The VENDOR shall maintain and update the predictive models over a five-year period. Each model maintenance cycle should correspond to following triggers:

  - Errors within the log files during simulations
  - Changes to the infrastructure of the network
  - Reduction of the quality of the predictions below acceptable levels
  - Updates to any of the ITS within the network
  - Updates to the underlying software platform

3.5.7.1 Service Level Agreements with Non-performance Liquidated Damages

The VENDOR shall use all reasonable commercial efforts, being no less than accepted industrial standards in this regard, to ensure that the ICMS is available 99.9% of the time in any calendar month. If it is not, the DEPARTMENT will be eligible to receive the Service Credits described.

Definitions. The following definitions shall apply to the Uptime Service Level Agreement (SLA).

- **"Downtime"** means, for a server, if there is more than a five percent user error rate. User error is calculated using server monitoring software, based on results from ping tests, web server tests, TCP port tests, and website tests. Downtime is measured based on server side error rate.

- **"Emergency Downtime"** means those times where the VENDOR becomes aware of a vulnerability that, based on a risk assessment of the vulnerability, the VENDOR deems to require immediate remediation and, as a result, the ICMS is made temporarily unavailable in order for the VENDOR to address the vulnerability. Emergency Downtime is not considered Downtime for purposes of this ICMS Uptime SLA, and will not be counted towards any Downtime Periods
- **"Monthly Uptime Percentage"** means the total number of minutes in the calendar month minus the number of minutes of Downtime suffered from all Downtime Periods in the calendar month, divided by the total number of minutes in the calendar month.
- **"Scheduled Downtime"** means those times where the VENDOR notifies the DEPARTMENT of periods of Downtime five days prior to the commencement of such Downtime. There will be no more than 12 hours of Scheduled Downtime per calendar year. Scheduled Downtime is not considered Downtime for purposes of this Uptime SLA, and will not be counted towards any Downtime Periods.
- **"Services"** means the services provided to the DEPARTMENT by the ICMS Service including source control, project management, ticketing collaboration, and other services in accordance with the Contract or, alternatively, on terms as expressly agreed between the DEPARTMENT and VENDOR.
- **"Service Credit"** may be provided according to the following schedule:

- Payment Adjustments
  - **Maximum Service Credit.** The aggregate maximum number of Service Credits you can claim for any and all Downtime Periods that occur in a single calendar month shall not exceed 30 days of services added to the end of your billing cycle. Service Credits may not be exchanged for, or converted to, monetary compensation.
  - **Uptime SLA Exclusions.** The Uptime SLA does not apply to any performance issues: (i) caused by factors outside of the VENDOR's reasonable control; (ii) that resulted from any actions or inactions of the DEPARTMENT or any third parties; or (iii) that resulted from the DEPARTMENT's equipment and/or third-party equipment (not within the primary control of the VENDOR).

Table 3: Response and Repair Time Service Level Agreement Parameters and Liquidated Damages

Definition	KPI	System Acceptance Test Measurement Requirement	Operations Measurement Period/Sample	Liquidated Damages*
Priority 1 issue is defined as any failure that will result in: loss of ability to create response plans; inability to accurately create response plans; inability to send response plans to requested agencies; inability to collect data that would result in missing data in the archived data. Maintenance response time shall be measured from the time when the VENDOR receives notification of the maintenance event or failure, and ending when the VENDOR staff acknowledge the notification of the problem or acknowledge the associated alarm or alert in the network monitoring system (NMS) application.	Maximum response time of 15 minutes during normal operating hours of 6 AM – 7PM on weekdays. Maximum response time of 1 hour outside of normal operating hours.	NMS application will be utilized to report all events for this category during the test time period.	All events submitted monthly. Liquidate damage (LD) applies to individual events.	For every hour over the KPI, the VENDOR shall be subject to liquidated damages of 1%, with a maximum of 6% per day of the monthly support payment.
Repair time shall be measured from the time when the VENDOR receives notification of the maintenance event or failure and ending when the failure condition is corrected and the system is returned to normal operation.	Maximum repair time of 1 hour during normal operating hours of 6 AM – 7PM on weekdays. Maximum repair time of 4 hours outside of normal operating hours.	NMS application will be utilized to report all events for this category during the test time period.	All events submitted Monthly. LD applies to individual events.	For every hour over the KPI, the VENDOR shall be subject to liquidated damages of 1%, with a maximum of 6% per day of the monthly support payment.

Measurement Method:

- System acceptance testing can be used to verify successful resolution
- System report to be provided by the VENDOR to indicate performance

Notes:

1. Provide a report and detail log of all Priority 1 events including:
    a. Loss of response plan generations is related to the loss of any system and/or hardware
    b. Exclusions include DEPARTMENT-directed postponements
    c. Report indicates Maintenance event, failure detection, notification time, and repair times for each event, and make clear those events that exceed the SLA
    d. Repair time is measured for each event
    e. Time duration between the event notification and repair for each ticket.
    f. Events will be tracked on an individual basis, and summarized by the VENDOR for monthly reporting
2. The report will indicate all repair times and those that exceed the SLA increments, examples below:
    a. Event notification occurs and at 3 hr. to 3hr 20 min later repair complete and returned to normal operations; SLA LD is $300
    b. Event notification occurs and at 3 hr. 21 min to 3 hr. 40 min later repair complete and returned to normal operations; SLA LD is $600

3.6 Special Services

Upon mutual agreement between the DEPARTMENT and the VENDOR, the VENDOR may be required to perform work outside the milestone-based negotiated scope of the ICMS "Works for Hire" detailed in the above sections. This work will be related to the support, engineering, maintenance (including emergency maintenance), modifications, growth, and enhancement of ICMS-owned and operated by the DEPARTMENT or other authorized agencies. This work shall be considered Special Services and may include, but not be limited to, design, software development, infrastructure engineering, engineering analysis, recommendations and testing, fabrication, prototype programs, data collection activities, training, installation, reporting and documentation. Examples of future work items are, but not limited to:

1. DIs created for new agency partners not identified in original build of the ICMS
2. Database administration and maintenance
3. Software applications enhancements using SunGuide and/or interfacing with SunGuide
4. Web-based software applications
5. Customized queries and reports
6. System migration to future changes in hardware and operating systems
7. Configuration management
8. Documentation, user manuals, and training
9. Development of Incident Response Scenario Building
10. Other tasks and/or Special Services as assigned or requested by the DEPARTMENT's Contract Manager will be assigned by task work order

All task assignments not included in section 3.5 will be negotiated by hour classification units based on following job classification categories. All work products will fall under the same "Work for Hire" solely owned by the DEPARTMENT as outlined in Section 1.10. The below job classification hourly rate shall be negotiated during the Invitation to Negotiate selection process and the VENDOR will be required to fill our Exhibit C – Hourly Rate by Job Classification. If the VENDOR does not fill in Exhibit C, the VENDOR will be deemed non-compliant and be disqualified from the selection process.

Table 4: Labor Categories and Descriptions

Labor Category Name	Labor Category Description
Project Manager	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 5+ years of managing software development projects including projects greater than $2M in size.
Senior Computer Programmer	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 10+ years of programming experience and experience in software development

Labor Category Name	Labor Category Description
Computer Programmer	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 5+ years of programming experience and experience in software development
Junior Computer Programmer	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 1+ years of programming experience and experience in software development
Senior Database Administrator	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 10+ years of database administration experience and experience in software development
Database Administrator	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 5+ years of database administration experience and experience in software development
Junior Database Administrator	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 1+ years of database administration experience and experience in software development
Senior Network Architect	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 10+ years of network architecture experience and experience in software development
Network Architect	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 5+ years of network architecture experience and experience in software development
Junior Network Architect	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 1+ years of network architecture experience and experience in software development
Senior Web Developer	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 10+ years of web developer experience and experience in software development
Web Developer	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 5+ years of web developer experience and experience in software development
Junior Web Developer	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 1+ years of web developer experience and experience in software development
Quality Assurance / Quality Control Manager	Computer Engineering, Electrical Engineering, or Computer Science Bachelor's degree with 5+ years of experience.

4 Vendor Performance

In the event the VENDOR fails to achieve project milestones and schedule according to the method of compensation, the VENDOR shall make payment adjustments to the DEPARTMENT in the form of a reduction of the amount billed the DEPARTMENT in the next invoice. The reduction amount will be $2,000 per day. LDs for different tasks are not to be additive if multiple tasks are behind schedule simultaneously.

The VENDOR shall make payment adjustments for each missed support call response or repair deadline as defined in section 3.5.7.1 and below. This reduction is considered liquidated damages and may not be recovered as retainage.

In the event the VENDOR causes harm to the DEPARTMENT or other DEPARTMENT systems, the VENDOR shall provide liquidated damages to the DEPARTMENT commensurate with the impact to the DEPARTMENT for restitution of the damage.

Table 5: Service Level Key Performance Indicators and Liquidated Damages

Service Level KPIs	Definition	KPI	Liquidated Damages*
Availability of Applications, including; DSS, IEN, DFE	An application will be considered unavailable if it is not functioning to a reasonable level of usability and ability to accomplish the ICMS operations described in section 1.6.	Maximum of 7 hours of downtime each month after deployment	For every hour over the KPI, the VENDOR shall be subject to liquidated damages of 1%, with a maximum of 6% per day of the monthly support payment.
	Measurement method: (Host Hardware and Applications) **Host Availability** (specific to each Host Hardware and Application) % = 1 – (total Host Hardware/Application downtime / (Expected time of operations – exclusions]) 1. SAT and Operations methods to be the same 2. System report to be provided by the VENDOR to indicate performance Notes: 1. Exclusions include all time when the system is not operating during preventative maintenance activities pre-approved by the DEPARTMENT, or due to damage beyond the VENDOR's control 2. DFE measurement is related to entire system excluding components/software included 3. This addresses software applications that fail and are not available 4. Interfaces are included based in VENDOR interface availability only 5. SLA applies to each application independently, and excludes hardware availability 6. Need to identify the processes and hardware that impact the Host Hardware and Application and make sure failure of each will create an alarm message via automated Solar Winds monitoring with supporting system-generated availability reports being provided to the VENDOR 7. Identify if there are failures that cannot be identified through software failures alone 8. Identify the problems (such as external interfaces) where the VENDOR is not responsible; such alarms should be identified with explanation 9. SLA damages example: for a month (24hr x 30 days' x (100%-99%) = 8.2 hours of allowable down time, so for downtime in excess of SLA, LD are being calculated as: a. From 8.2 hr. to 9.2 hr. is 2% of monthly maintenance/warranty fee; and b. From 9.2 hr. to 10.2 hr. is 4% of monthly maintenance fee.		
AC2 System Accuracy	System accuracy is measured by calculating the GEH of the mesoscopic model.	Maximum GEH of 10.0 for any on hour	For every one hour over the KPI, the VENDOR shall be subject to liquidated damages of 1% of the monthly support payment.

Service Level KPIs	Definition	KPI	Liquidated Damages*
	Measurement Method: **The DEPARTMENT will pick ten intervals at the DEPARTMENT's sole discretion to calculate the GEH according to the formula below. If a majority of the samples fail to meet the KPI, the DEPARTMENT will select an additional ten intervals. If a majority of the samples fail to meet the KPI, the DEPARTMENT will select an additional ten intervals.** The volume accuracy will be defined by 95% of available count locations. $GEH = \sqrt{\frac{(E-V)^2}{(E+V)/2}}$ where: E = model estimated volume V = field count		
TC1 **System Response Plan Creation and Dissemination Performance**	For events that result with the need to select and evaluate response plans, and are selected for activation, the performance is measured as the timeframe from when the response plan criterion is met to when transmission is made by the system to all of the ICMS partnering agencies via the IEN. Note this timeframe is exclusive of any DEPARTMENT configurable dwell/holding period.	Minor: 7 minutes, Moderate: 15 minutes, and Major: 25 minutes	For every day that contains one or more occurrences of the ICMS exceeding the minor, moderate, or major KPIs, the VENDOR shall be subject to liquidated damages of 1%, 2%, or 3%, respectively, of the monthly support payment.

5 Contract Deliverable Requirements List

Provide a tabular list of all documents that are required. Provide a unique numerical identification code for each deliverable for tracking purposes. It is suggested that a draft and final be indicated by a decimal value, for example, a preliminary draft work plan might initially be version 0.1, a subsequent draft might be identified as version 0.2 and the final document accepted by the DEPARTMENT would then be identified as version 1.0.

Table 6: Contract Deliverable Requirements List

Task	Scope Reference	Deliverable Number	Title	Due Date
1	3.5.1.2.2	ICMS-PRR	Project Risk Register	30 days after NTP
1	3.5.1.2.4	ICMS-SCHED	Project Schedule	30 days after NTP
1	3.5.1.2	ICMS-PSEMP	Project Systems Engineering Management Plan	30 days after NTP
1	3.5.1.2.4.1	ICMS-Report-MMYY	Monthly Progress Reports	Monthly on 5th of each month for the previous month
1	3.5.1.2.4.2	ICMS-MTG-AGENDA-<topic>-<YYYY-MM-DD>	Meeting Agendas	5 business days prior to all meetings
1	3.5.1.2.4.2	ICMS-MTG-NOTES-<topic>-<YYYY-MM-DD>	Meeting Minutes	5 business days after all meetings
2	3.5.2.2	ICMS-PD	Preliminary Design	60 days after NTP
2	3.5.2.1	ICMS-REQ	System Requirements Specification	60 days after NTP
2	3.5.2.3	ICMS-CD	Critical Design	90 days after NTP
2	3.5.2.4	ICMS-CG	Software Coding Guidelines	90 days after NTP
2	3.5.2.5	ICMS-SD	System Design Document	90 days after NTP
3	3.5.3	ICMS-MDP	Model Development Plan	TBD by Work Plan
4	3.5.4	ICMS-SDP	Software Development Plan	TBD by Work Plan
4	3.5.4.1	ICMS-DFE	Data Fusion Environment	TBD by Work Plan

Task	Scope Reference	Deliverable Number	Title	Due Date
4	3.5.4.2	ICMS-IEN	Information Exchange Network Software	TBD by Work Plan
4	3.5.4.3	ICMS-ERE	ERE Software	TBD by Work Plan
4	3.5.4.6	ICMS-STP	System Test Plan	TBD by Work Plan
4	3.5.4.7	ICMS-TP	Test Procedures	TBD by Work Plan
4	3.5.4.8	ICMS-CAP	Corrective Action Plan	TBD by Work Plan
4	3.5.4.9	ICMS-TR	Test Report Document	TBD by Work Plan
5	3.5.5	ICMS-DP	Deployment Plan	TBD by Work Plan
6	3.5.7	n/a	Plan of Resolution for hardware failure	TBD by Work Plan
6	3.5.7	n/a	Schedule of Staff	TBD by Work Plan
6	3.5.7	n/a	Web-based Issue Tracking Tool	TBD by Work Plan
6	3.5.6.1	ICMS-TRP	Training Plan	TBD by Work Plan
6	3.5.6.2	ICMS-TRS	Training Schedule	TBD by Work Plan
6	3.5.6.3	ICMS-TRM	Training Manuals	TBD by Work Plan
6	3.5.6.4	ICMS-TRW	Training Workshop	TBD by Work Plan