TRANSCOM Systems Concept of Operations

TRANSCOM℠
TRANSPORTATION OPERATIONS COORDINATING COMMITTEE

Prepared for:
TRANSCOM

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				real time transit info
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TRANSCOM Systems ConOps v.5.0	5.0	09/18/2015	S. Altman	Finalize Version 4.3. Minor grammatical corrections.
TRANSCOM Systems ConOps v 5.1	5.1	10/15/2015	S. Altman	Insert Summary of Major Document Revisions

Summary of Major Document Revisions

This section provides a summary of the major changes to the finalized versions of each major revision. The last major revision was version 5.0.

Version 5.0

Section	Change
2.1	• Add description of transit initiatives
2.2	• Modify definitions for DFE and Data Exchange • Update Figure 2-2 (TRANSCOM System Overview) to reflect current projects. Derivations of this figure throughout the document are also updated.
2.4	• Update language to describe current enhancements to DFE.
2.5	• Update language to describe current enhancements to SPATEL. • Add table defining SPATEL tools
2.6	• Discuss transit enhancements to Middleware
2.7	• Discuss transit enhancements to Data Exchange
3.2	• Add user needs 3.2.2.5 and 3.2.2.6
3.3	• Update user need 3.3.3
3.8	• Update section to provide user needs for transit project • Add user need 3.8.2.4
3.11	• Update language for intro to user need 3.11.2 • Add needs to user need 3.11.2.8 • Add user need 3.11.2.10 to 3.11.2.12
4.2	• Add/modify system features 4.2.1 to 4.2.4 and 4.2.9
4.3	• Add system features 4.3.13 to 4.3.29
4.4	• Update intro to section to describe current state of Middleware development
4.5	• Update language to system feature 4.5.3 • Add system features 4.5.4 and 4.5.5
Appx A	• Update definitions
Appx B	• Update table

Contents

Table of Figures

List of Tables

1. INTRODUCTION

1.1. Purpose of this Document

The purpose of the TRANSCOM Systems Concept of Operations (ConOps) is to: (1) document existing and future user needs and system features, and (2) present in non-technical terms, and from a user's perspective, what TRANSCOM Systems do and are planned to do, and what data and how data are processed to allow member agencies to provide coordinated regional and multi-state ITS information exchange.

1.2. TRANSCOM Background and Mission

TRANSCOM is a coalition of 16 transportation and public safety agencies in the New York/New Jersey/Connecticut Tri-State region. It was created in 1986 to provide a cooperative, coordinated approach to regional transportation management.

TRANSCOM collects current transportation data from member agency systems and the private sector – a network that encompasses approximately 100 centers throughout the Tri-state region and beyond.

TRANSCOM creates value for the region and its member agencies through processing of regional transportation information collected: TRANSCOM verifies the collected data, and aggregates and fuses the data to create a regional view of near real-time transportation status. TRANSCOM then provides this validated, verified, and processed regional transportation data back to its member agencies.

TRANSCOM's mission is to improve the mobility and safety of the traveling public within the New Jersey/New York/Connecticut region. Improvement in mobility and safety is achieved by TRANSCOM aiding in the regional coordination, development, deployment and implementation of various types of Intelligent Transportation Systems (ITS) with and among its member agencies. These systems include advanced Information and Communication Systems (ICS) that allow for the timely dissemination of critical information, collected by ITS systems, to TRANSCOM's member agencies and to public or private organizations or individuals for a range of applications. Its main areas include:

- The TRANSCOM Operations Information Center (OIC) collects and disseminates real-time incident and construction information, 24- hours-a-day, to over 100 facilities of its member agencies and affiliated agencies. The OIC coordinates and helps to marshal member agencies' traveler information resources (such as, variable message signs (VMS), 511 systems, and highway advisory radio (HAR) for regional incident response.
- The Regional Construction Coordination Program (RCC) helps member agencies to avoid unknowingly restricting capacity on parallel or adjacent facilities and routes. This includes maintaining a long-term database of all construction planned or underway for the region. Additionally, this program involves knowing where construction is taking place on a real-time basis, so that member agencies can cancel or modify a project if it is on a key diversion route around a major incident.

- The Regional Special Events Coordination Program (RSE) involves minimizing the impact of major special events on regional mobility. These include: sporting events, festivals, concerts and religious ceremonies. This activity includes maintaining a data base of the locations, dates, times, sponsoring organizations and key agencies affected for each event, including on a real-time basis. This effort also involves integration with construction coordination, since some planned projects may need to be cancelled or modified to minimize congestion on impacted routes before, during and after an event.
- TRANSCOM implements and operates Intelligent Transportation Systems (ITS) to improve the quality, timeliness, and dissemination of transportation information. These systems include: TRANSMIT, a system that uses electronic toll- collection technology to determine travel times and speeds and to detect incidents; the TRANSCOM OpenReach (OR) system which ensures coordination and integration of advanced transportation management and information systems that are being implemented by the 16 member agencies; and the XML feeds from these systems which allows for the sharing of this information, not only with TRANSCOM's members and their 511 traveler information systems, but also to any other public or private organization or individual who wants access to this valuable real-time highway and transit information.

1.3. Systems Engineering Process (SEP)

1.3.1. Application of the SEP

TRANSCOM projects follow the Systems Engineering Process (SEP). The SEP is described in the popular "Vee" diagram showing the life cycle of an ITS system.

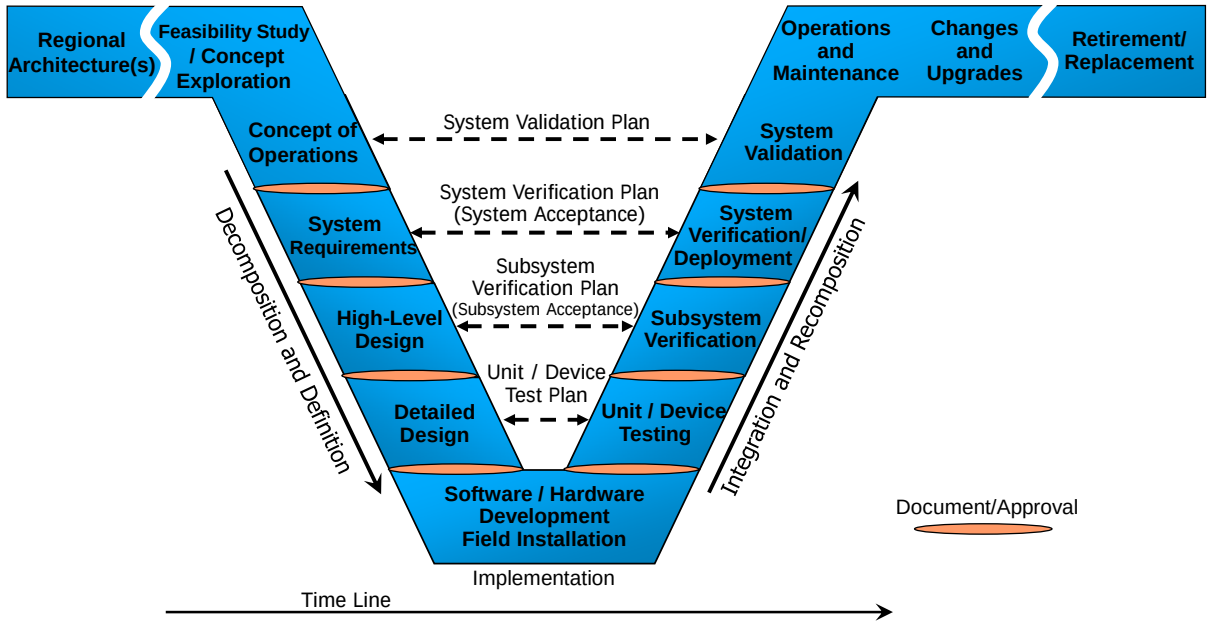

Figure 1-1 – System Engineering Process

1.3.2. System Engineering Documents

The set of system engineering documents will be developed including:

TRANSCOM-wide System Engineering Documents

- TRANSCOM ITS System Architecture
- TRANSCOM Systems Concept of Operations (ConOps)

Project specific System Engineering Documents

- System Requirements Specification (SRS)
- System Design Description (SDD)
- Test Documentation

1.3.2.1. TRANSCOM ITS System Architecture

The TRANSCOM ITS System Architecture is one of two system engineering documents maintained at the TRANSCOM-wide level. The other document is this TRANSCOM Systems ConOps. The ITS Architecture is not intended to be a regional architecture for the Tri-State region, but rather reflects TRANSCOM's role and systems as defined in regional ITS architectures developed by one or more member agencies (e.g., New York State, NJTPA, ConnDOT, CRCOG – Hartford Region, and New York City Sub-region). The TRANSCOM ITS System Architecture is cross cutting of member agencies. It was developed by integrating ITS services from architectures that include TRANSCOM. The result is a single *Turbo Architecture* database, a standardized ITS Inventory and descriptions, a set of service packages using the standardized ITS Inventory, and a standardized list of applicable ITS standards. The TRANSCOM ITS Systems Architecture was developed with the intent that member agencies updating their regional ITS architectures may have the latest information available about TRANSCOM's ITS systems.

In addition, TRANSCOM was motivated to develop a TRANSCOM ITS System Architecture for the reasons summarized below:

- TRANSCOM is included in several regional ITS architectures, with information varying with time the regional architecture was developed, and with lack of consistency in terms of naming and description of the ITS inventory underlying the regional ITS architecture.
- Member agencies rely on TRANSCOM to support them with regard to Rule 940 conformance.
- Member agencies rely on TRANSCOM to support them with regard to ITS Standards conformance.
- Member agencies rely on TRANSCOM to support them with regard to Section 1201 Real Time System management Information Program conformance.
- TRANSCOM is required to develop SEA reports for projects where it receives Federal funds. In addition, project approval, based on the SEA report, is required by FHWA representatives from NY, NJ, and CT.

Contents of TRANSCOM ITS System Architecture includes:

- Standardized ITS Inventory and descriptions
- Service Packages illustrating TRANSCOM Systems
- List of Candidate ITS Standards
- Materials to assist with FHWA Rule 940/FTA Policy and RTSMIP Conformance Support

1.3.2.2. TRANSCOM Systems ConOps

The TRANSCOM Systems ConOps is one of two system engineering documents maintained at the TRANSCOM-wide level. The other document is the TRANSCOM ITS System Architecture, which was described above. The ConOps is intended to be cross cutting of the core set of systems and developed and maintained by TRANSCOM, including OpenReach, Data Fusion Engine, SPATEL, Middleware, and Data Exchange. The rationale for maintained a single ConOps for the TRANSCOM Systems is that a change in one system, for example SPATEL, may require a change in one or more of the other systems.

This ConOps also includes a base set of User Needs to be used by specific projects.

1.3.2.3. Guidelines for Project-specific System Requirements Specifications

It is envisioned that future projects will develop a System Requirements Specification (SRS). This ConOps includes a base set of System Features (Section 4) that can be used to elicit system requirements for specific projects, and traced to the base set of User Needs. It is expected that future project-specific system requirements will provide a trace of requirements to user needs, and that new user needs and system features identified and used to update this ConOps.

1.3.2.4. Guidelines for Project-specific Design Description Documents

Each future project will develop a Design Description Document (DDD). The DDD will define or identify the following.

Module Descriptions

- Name and Identifier of New System Modules
- Name and Identifier of System modules being changed, along with a description of the changes
- Brief overview of the module and processing
- Traceability of the module to system features
- Description of Module Inputs and Outputs

ITS Standards-based Interface Specifications

ITS Standards are specifications that allow agencies to exchange information using common data formats and definitions.

The application and use of standards in projects will streamline both TRANSCOM's data collection efforts as well as TRANSCOM Member Agencies' data streams. In addition, when new sources of data are available, they can be added with relative ease, rather than relying on proprietary formats and entirely new software efforts to integrate the new data stream.

TRANSCOM is currently working to upgrade OpenReach to a standards-based approach via the TRANSCOM Middleware Project, as well as providing the TRANSCOM Data Exchange Feeds based on ITS standards.

Each future project will as part of the design effort, document how it incorporates ITS standards.

Application Programming Interface (API)

As part of the design effort, project will develop an application programming interface to document how to integrate and use the design module in the context of a software system.

1.3.2.5. Guidelines for Project-specific Test Documentation

Future projects based on this ConOps will develop test documentation, including:

- Test Plan. Outlines the general approach to testing and verification of system requirements.
- Test Cases. Define the inputs, expected outcomes/outputs, and execution conditions for a test.
- Test Procedures. Define the step-by-step processes required to conduct a test.
- Test Reports . Document the results of testing including test incidents, anomalies, and summary of testing.

It is recommended that Test Documentation be based on IEEE 829 Standard for Software and System Test Documentation.

1.4. TRANSCOM Systems ConOps Organization

The TRANSCOM Systems ConOps consists of four sections and 2 appendices:

- **Section 1 – Introduction.** Contains introductory information, and an overview of the organization of this report.
- **Section 2 – Current Situation and Statement of Problem**. Provides an overview of how TRANSCOM Systems gather, process, and deliver data. This section provides an overview of existing TRANSCOM Systems, and vision for future applications.
- **Section 3 – User Needs.** Outlines the user needs for TRANSCOM Systems gathered from stakeholders and end-users (e.g., member agencies, 3rd party information consumers).
- **Section 4 – Justification for and Nature of Enhancements**. Provides a list of desired system features required to satisfy the user needs identified in Section 3.
- **Appendix A – Glossary.** The glossary includes short definitions of acronyms and terms.
- **Appendix B – Traceability Matrix of System Features to User Needs.** This table lists the system features identified in this ConOps (for future development) and corresponding user needs that are satisfied.

2. CURRENT SITUATION AND STATEMENT OF PROBLEM

2.1. Problem Statement - Key Drivers of TRANSCOM Systems Enhancements

A number of transportation initiatives are driving member agencies to request TRANSCOM System updates to allow the exchange and fusion of new kinds of information within the TRANSCOM Tri-state region. These include:

- **Regional Multi-State ATDM/ICM:** Currently, regional transportation agencies, including TRANSCOM Member Agencies, are preparing an Integrated Corridor Management proposal for the I-495 corridor (a multi-state corridor). In addition to this specific initiative, a number of regional ATDM (Advance Transportation and Demand Management) initiatives have been proposed and discussed. These important transportation operations initiatives are clearly a part of the near-term future of regional ITS. ATDM and ICM rely on a standardized, center-to-center (C2C) process for exchanging transportation data in order to calculate and assess response plans. The TRANSCOM new Middleware, together with updates in OpenReach and the Data Fusion Engine project prepares for these initiatives by ensuring that a standardized C2C platform already will exist in the region before these initiatives are deployed.
- **Performance Measures and Data Analysis:** The Moving Ahead for Progress in the 21st Century Act (MAP-21) establishes a performance based highway funding program. The specific USDOT rulemakings have yet to be entirely released. However, this project will help prepare the New York/New Jersey/Connecticut region for setting and meeting MAP-21 based performance requirements by creating a common, standards-based platform that gathers transportation data in a unified way, which will feed into the TRANSCOM SPATEL Archive. Data Fusion Engine updates will integrate historical information, both private and public sector-based, similar to the function of the Data Fusion Engine for real-time information.
- **Freight Information**: Freight information includes freight traveler information (travel time and delays), definition of freight routes, and freight parking.
- **Roadway Weather Information**: Member agencies collect road weather information via RWIS and ESS. Member agencies wish to share their RWIS and ESS data, as well as snow removal operations status (e.g., number of lanes cleared).
- **Parking Information**: Agencies collect and desire to share parking information such as parking availability, type of lot (freight, or passenger car), number of spots for the disabled, etc. This includes parking information at Airports, Transit Facilities, Park-n-Ride, Freight Parking, and from 3rd party parking information providers.
- **Transit Information**: Member transit agencies provide real-time information about the status of transit, including planned, real time, and historical transit trip status, vehicle location data, and alerts for planned and unplanned transit related events.
- **ITS Standards-based Center-to-Center (Middleware) and Data Exchange Process**: This initiative will provide a standards based approach to allow agencies to exchange data using a common, standards-based platform. Currently, TRANSCOM's OpenReach uses a mixture of outdated standards and non-standards-based specifications. This will streamline both TRANSCOM's data collection efforts as well as TRANSCOM Member Agencies' data streams. In addition, when

additional sources of data are available, they can be added via the TRANSCOM Middleware with relative ease, rather than relying on integrating a brand new, separate data stream.

2.2. Current Situation - TRANSCOM Systems Overview

2.2.1. TRANSCOM Systems Users

TRANSCOM System Users, as defined in this ConOps, is comprised of the following. Section 3 of this report documents relevant user needs driving new system features.

- **TRANSCOM Member Agencies and Transportation Operations Centers** –TRANSCOM member agencies provide incident, construction, and special event information through manual entry by transportation center operators via a network of terminals.
- **TRANSCOM Member Agency Systems (Data Interfaces)** –TRANSCOM member agencies provide transportation information (e.g., link speed, message sign text and appearance information) directly from agency ITS systems via a data interface.
- **3rd Party Information Providers** –TRANSCOM supplements member agency data with that of 3rd Party information providers (e.g., Inrix, Navteq-Here, Bluetoad). TRANSCOM Systems collect and normalize the information into a standard set of links and nodes representing the regional transportation network.
- **3rd Party Information Consumers** –TRANSCOM provides a subset of information to 3rd Party Consumers and Developers.

2.2.2. TRANSCOM Systems

This subsection outlines the current state of TRANSCOM's system processes, including how data is received by TRANSCOM, how data is processed by TRANSCOM, and how TRANSCOM provides data back out to its member agencies.

The TRANSCOM System, as defined in this ConOps, is comprised of five core sub-systems:

- **TRANSCOM OpenReach** – a network of terminals and servers installed in member agency operations centers.
- **TRANSCOM Data Fusion Engine** – the data fusion engine collects real-time and historical information (e.g., speed and travel time) referenced to a local transportation network (links, nodes) and maps the information to a regional reference system (links, nodes) to produce a normalized aggregated regional view of the information. An effort is underway to integrate real time transit information as part of the larger transportation network in the DFE.
- **TRANSCOM SPATEL (Selected Priorities Applied to Evaluated Links)** – an archive of historical speed and incident data used as a planning tool, and as a source for federal reporting performance measures in New York and New Jersey
- **TRANSCOM Middleware** – provides an ITS standards-based interface for center-to-center communications. This interface will replace the existing OpenReach-based non-standards based interface currently in place.

- **TRANSCOM Data Exchange –** a secure API that allows agencies, including centers and devices, to access real-time transportation information gathered by TRANSCOM. The existing interface will be replaced or supplanted with an ITS Standards-based interface, the same as used for the Middleware. An effort is underway to include real-time transit information as an output of the TRANSCOM Data Exchange in the GTFS-RT and SIRI formats.

The primary goal of the TRANSCOM Systems is to develop a common platform where agency center systems can exchange (publish and receive) transportation information -- incidents, construction, special events, roadway and transit network status, parking occupancy, and message sign data -- with TRANSCOM OpenReach and Data Fusion Systems, using open standards.

Figure 2-1 below provides an overview of current, planned, and future TRANSCOM system processes.

In the figure below:

- Black = Existing Processes
- Blue = Under Development
- Red = Future Applications

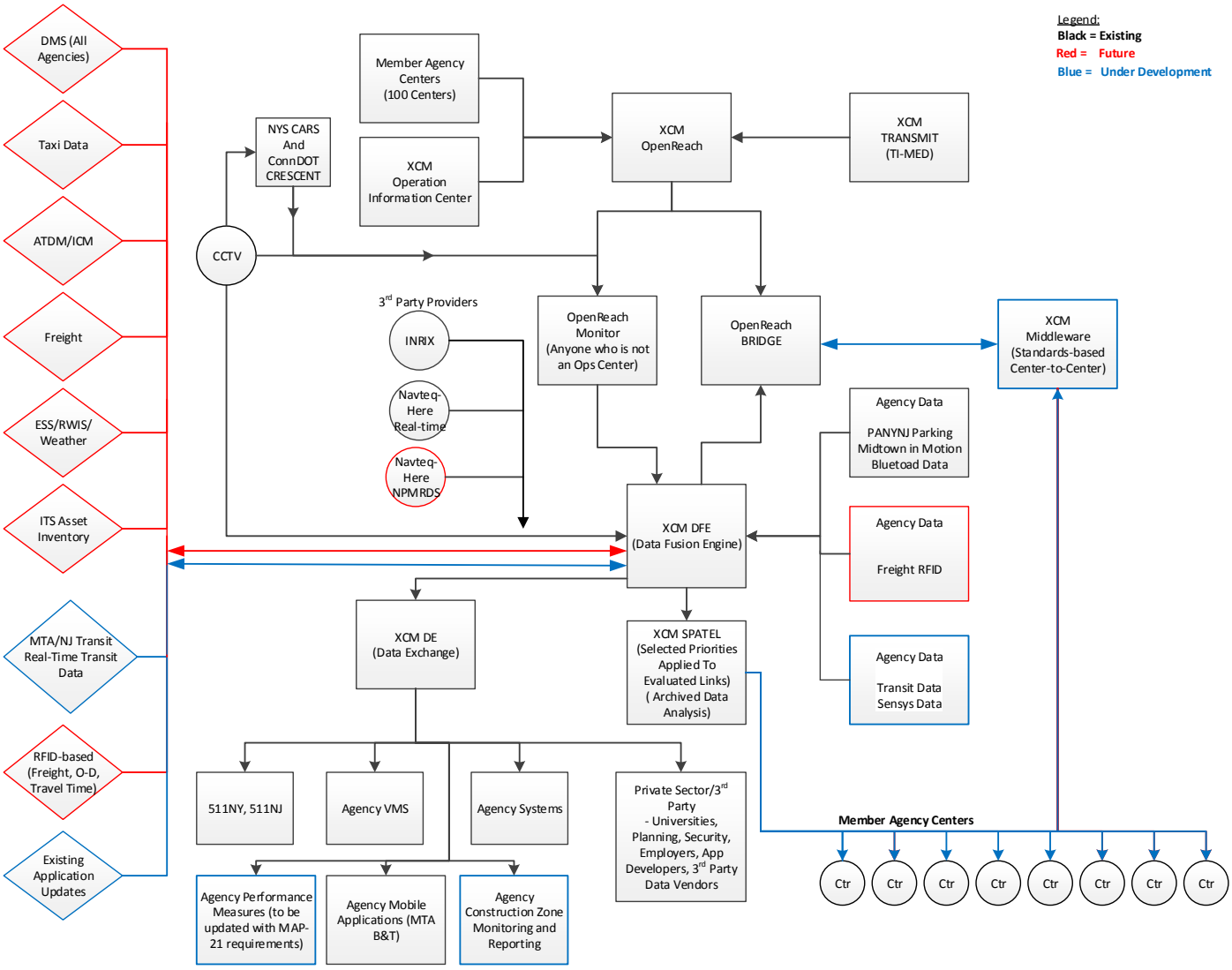

Figure 2-1 - TRANSCOM System Overview

2.3. TRANSCOM OpenReach

2.3.1. TRANSCOM OpenReach Inputs

In general, TRANSCOM receives data from these primary sources:

- Directly from a TRANSCOM member agencies and centers via OpenReach - incidents, construction and special events
- Via Data Interfaces to member agency systems - for roadway network and facility status (e.g., Midtown in Motion, Parking Information Systems)
- TRANSMIT - provides travel time and incident detection information on roadway facilities, and
- Private transportation data providers – roadway network conditions.

2.3.1.1. TRANSCOM Member Agency Centers

TRANSCOM member agency's primary mode of incident, construction, and special event information is through manual entry into the TRANSCOM OpenReach Servers, although the data entry content varies by agency. The input is represented in Figure 2-2, below.

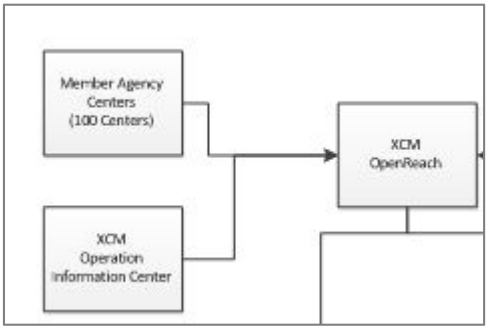

Figure 2-2 - TRANSCOM Open Reach (Member Agency Input)

Several agencies input incident data via the TRANSCOM OpenReach application installed on member agency workstations located in their operations centers. Table 2-1 outlines the agencies that directly input data to OpenReach, as well as the types of incident data that are entered into the OpenReach system.

Table 2-1- TRANSCOM Member Agency Inputs to OpenReach

Highway Incident Data	Planned Highway Roadwork	Planned Highway Special Events
Conn DOT NJ DOT NJ Turnpike Authority NYSDOT Region 10 NYSDOT Region 11 NYSDOT Region 8 NY State Thruway Authority NYC DOT NYPD NYSP	NJ DOT NYSDOT Region 10 NYSDOT Region 11 NYSDOT Region 8 NYC DOT	NJ Turnpike Authority NYSDOT Region 8

Note that the TRANSCOM OIC provides validation and verification of all data before it reaches member agencies through the TRANSCOM OpenReach system.

The remaining data in TRANSCOM OpenReach is relayed to the TRANSCOM OIC, which then validates and verifies the data and inputs it directly into TRANSCOM OpenReach. This includes not only highway incident, roadwork and event data, but also transit incident, construction, and special event data.

2.3.1.2. TRANSMIT (TI-MED)

TRANSMIT (TRANSCOM's System for Managing Incidents and Traffic) is a traffic surveillance and incident detection system that uses E-ZPass electronic toll collection tags as traffic probes. One of the primary

uses of the TRANSMIT system is to provide en-route motorists with an estimated travel time to a destination. These travel times may be displayed to the public in a variety of ways, including Dynamic Message Sign (DMS) displays, websites and kiosks. TRANSMIT Readers are deployed at key locations in the transportation network by TRANSCOM member agencies. The data received from the readers are processed through TRANSMIT servers which are operated by TRANSCOM. The data is then processed and sent back to member agencies through a variety of sources, including the TRANSCOM data feed and TRANSCOM OpenReach.

Figure 2-3 represents the input of TRANSMIT and related systems to TRANSCOM OpenReach.

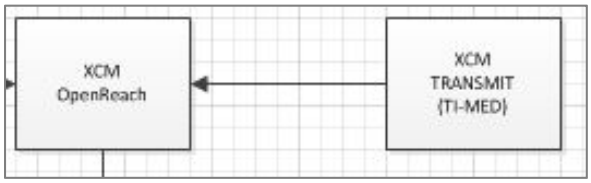

Figure 2-3 - TRANSMIT

The TRANSMIT system is currently undergoing a system upgrade, that will result in a modified series travel time assessment tools and functions, including a complete replacement of all system servers, networking as well as firmware upgrades to existing field hardware, known as TI-MED

2.3.1.3. TRANSCOM OpenReach Monitor

The TRANSCOM OpenReach Monitor is a subsystem in the overall TRANCOM system that gathers data from sources that are not TRANSCOM Member Agencies. This data is then incorporated in to the TRANSCOM Data Fusion Engine, and incorporated to TRANSCOM OpenReach through the OpenReach Bridge. TRANSCOM OpenReach Monitor is separate from OpenReach and the DFE inputs in order to provide a third person data entry source separate from TRANSCOM member agencies' operations centers. Currently, the inputs to the TRANSCOM OpenReach Monitor include NYS Cars, ConnDOT Crescent, and other CCTV inputs.

Figure 2-4 shows the TRANSCOM OpenReach Monitor with its corresponding inputs and outputs.

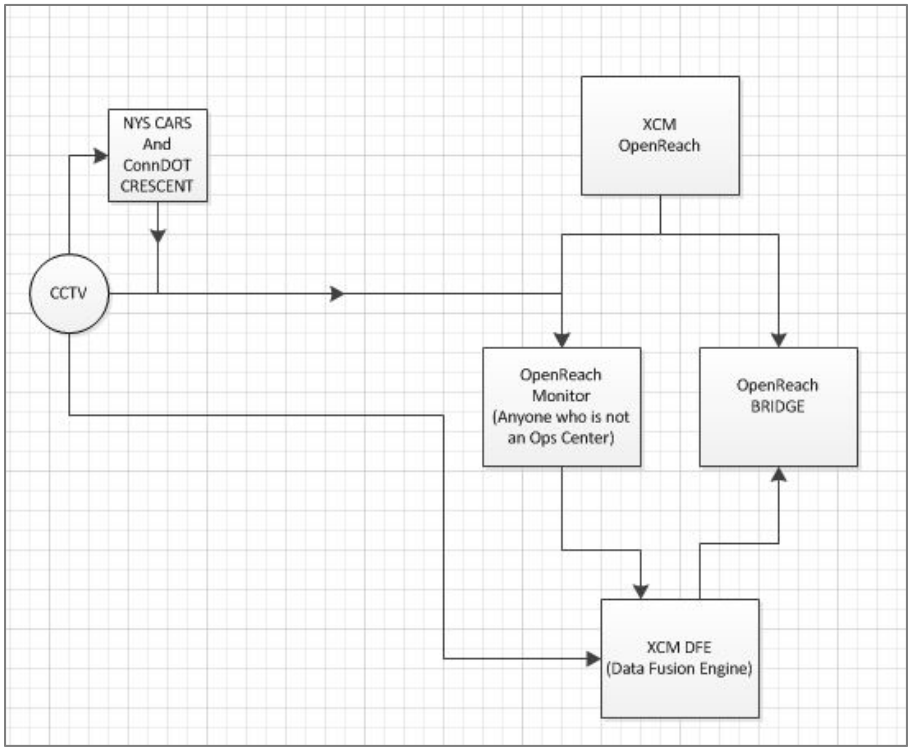

Figure 2-4 - TRANSCOM OpenReach Monitor

2.4. TRANSCOM Data Fusion Engine

2.4.1. TRANSCOM DFE Inputs

2.4.1.1. 3rd Party Transportation Data Providers

TRANSCOM additionally acquires data from private transportation providers. These providers are Inrix, and Navteq-Here. These data come from a variety of sources – for example, Inrix utilizes GPS data taken from commercial vehicles. These private sources of data are fused with TRANSCOM OpenReach data (which includes both TRANSMIT and TRANSCOM member agency data) into a single feed by TRANSCOM's DFE (Data Fusion Engine). Navteq-Here currently provides real-time traffic information to TRANSCOM. Navteq-Here also provides historical data via the FHWA National Performance Management Research Data Set, which is being integrated as part of a 2015 project into the Data Fusion Engine In addition, the TRANSCOM DFE collects CCTV images provided by private transportation data providers, in particular TrafficLand.

Figure 2-5 illustrates how these sources feed into the TRANSCOM DFE.

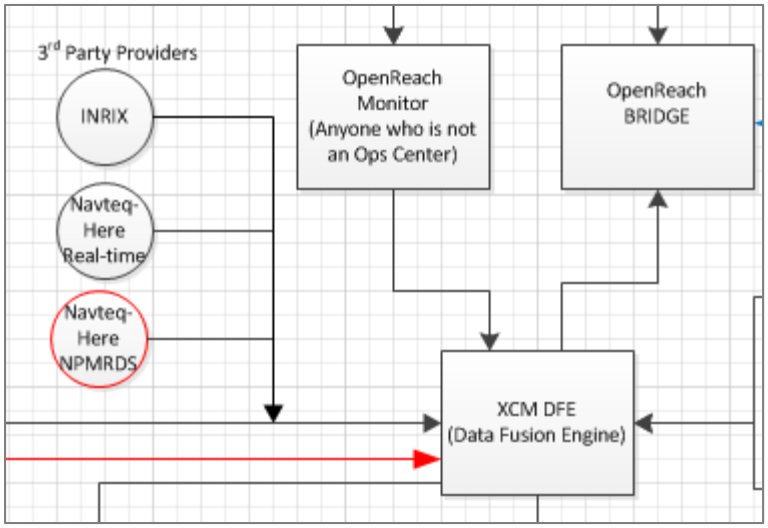

Figure 2-5 - Private Transportation Data Providers (NMPRDS should be updated from Red to Blue)

2.4.1.2. Agency Data

TRANSCOM collects additional data from member agencies, such as speed, travel time and parking data. For example, speed and travel time data is gathered from E-ZPass tags on vehicles in the midtown section of Manhattan as part of the Midtown in Motion, an Active Traffic Management (ATM) system. In addition, E-ZPass tags are used to estimate current parking capacity at PANYNJ airports. This data is used to calculate the percentage of parking spaces available in airport parking lots. In the future, TRANSCOM plans on collecting travel time and speed data from Sensys wireless vehicle detection systems installed by NJTA. In addition, TRANSCOM is planning on potentially integrating any additional private transportation data provider data, such as RFID-based data gathered from freight or transit vehicles. Efforts are currently underway to integrate transit data from transit agencies.

These inputs are gathered and directly inputted to the TRANSCOM DFE, as shown in Figure 2-6.

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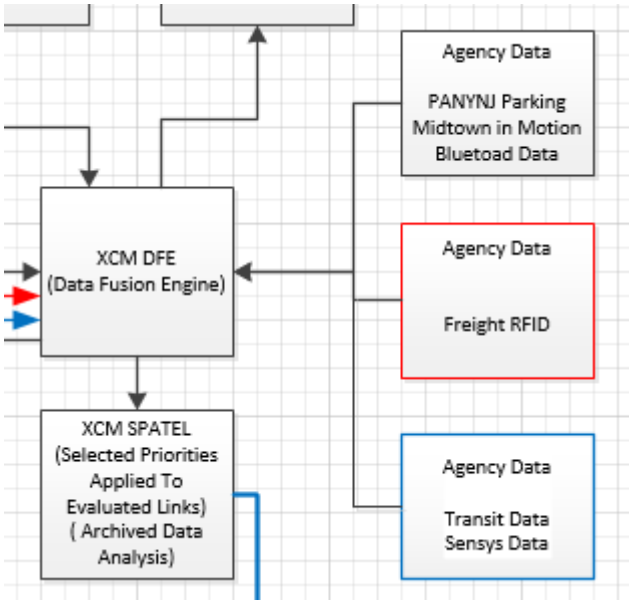

Figure 2-6 - Agency Data

2.4.2. TRANSCOM Data Processes

After collecting data from the above data sources, TRANSCOM then validates, verifies the processed data into a useable format for its member agencies. The majority of these processes occur in two systems. First, as mentioned in Section 2.3.1.1, the TRANSCOM OIC verifies and validates all inputs from member agencies before the data reaches the TRANSCOM OpenReach system.

Second, the TRANSCOM DFE collects data from the various sources mentioned above and fuses it into a single feed. The TRANSCOM DFE is represented in Figure 2-7 below.

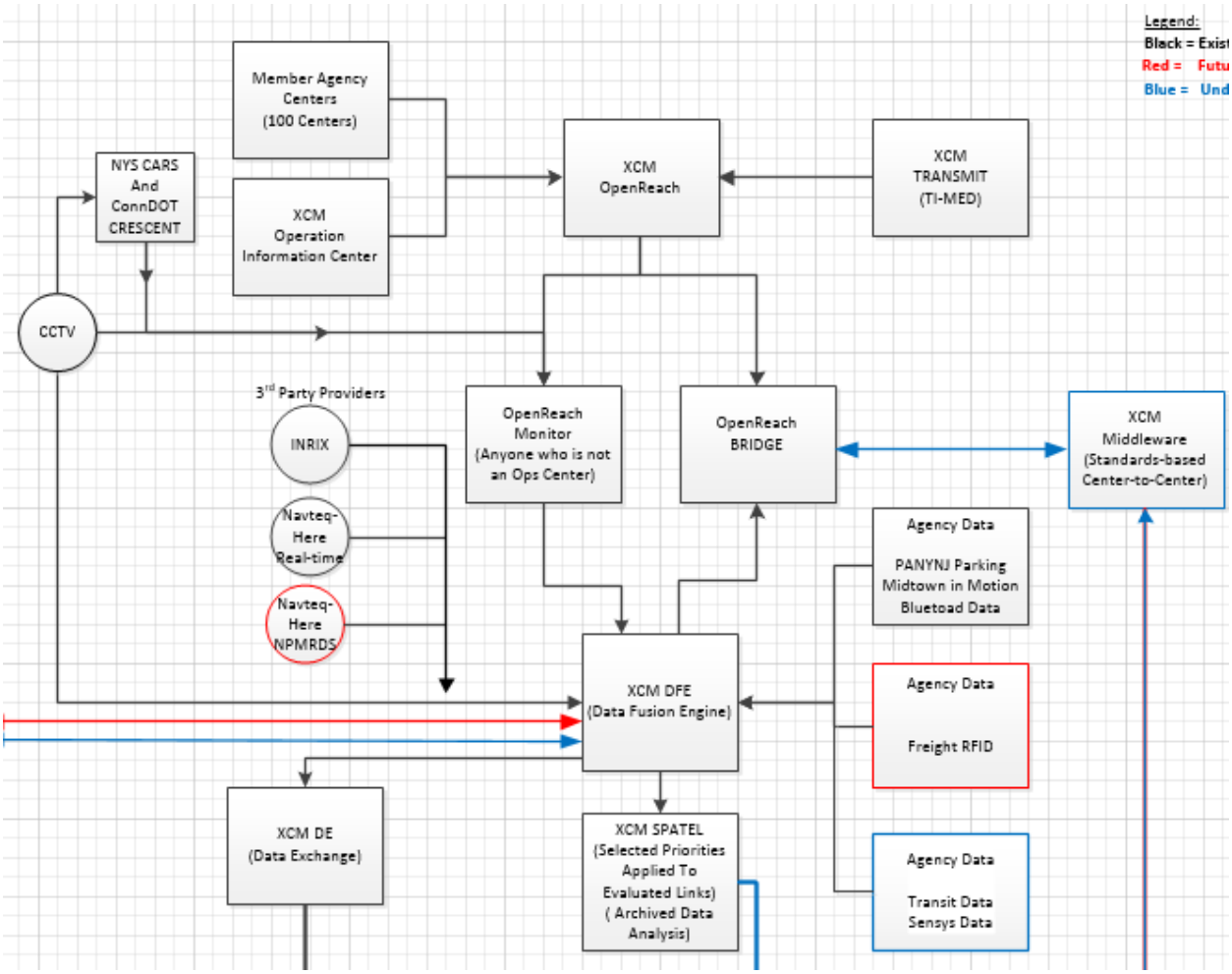

Figure 2-7 - TRANSCOM Data Fusion Engine

The TRANSCOM DFE allows agencies to view a single source that combines information from various inputs into an accurate representation of speed, travel time, and event information (incidents, construction, and special events) on highways and transit facilities within the TRANSCOM region. For example, an agency could view TRANSMIT data showing speed data on the George Washington Bridge, and then also view Navteq/HERE data showing a slightly different speed on the George Washington Bridge. Instead, TRANSCOM fuses this speed data into a single output that provides member agencies with a single, accurate representation of activity in the TRANSCOM region.

To accomplish this, TRANSCOM converts inputs to a geographically universal format, allowing for links, or segments of roadway, that may be different sizes in different user systems to match up into a universal TRANSCOM format. Finally, TRANSCOM pushes this data out to member agencies and the public through several formats.

2.4.3. TRANSCOM DFE Outputs

Currently, TRANSCOM has two systems that output data to member agencies and to the public. These outputs are represented in Figure 2-8 below.

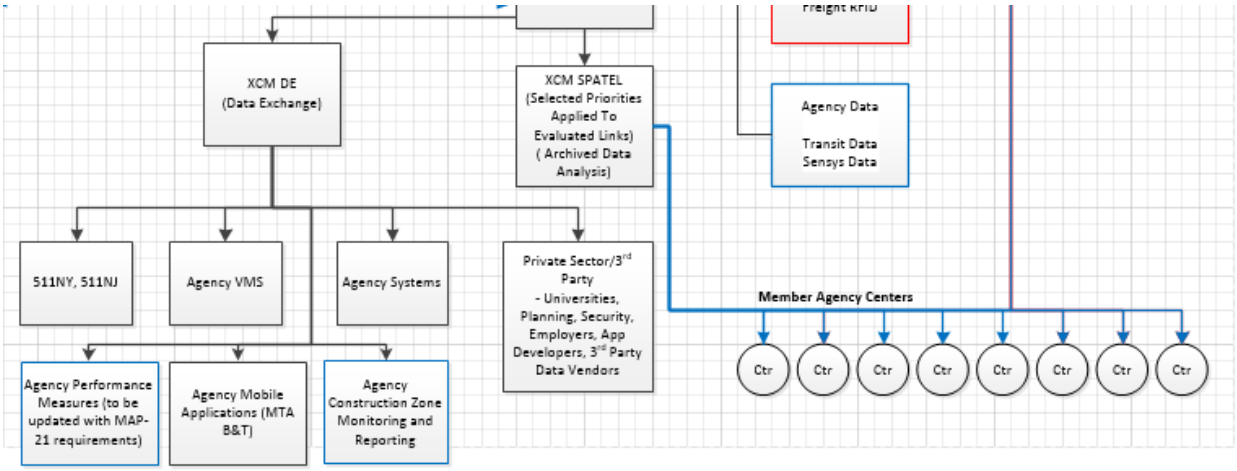

Figure 2-8 - TRANSCOM DFE Outputs

2.5. TRANSCOM SPATEL

The TRANSCOM DFE outputs data to member agencies through the TRANSCOM Archive, also known as TRANSCOM SPATEL. This tool is available to member agencies through a web portal available with a secure password. The TRANSCOM SPATEL Archive allows member agencies to search historical travel time, incident and speed data through an interactive archive format. In the future, transit data will be included as part of SPATEL, giving users the ability to view real-time bus and train locations and ETA information. Agencies may select geographic locations and search for traffic data within specific parameters. This provides a powerful operations and planning tool to TRANSCOM member agencies. In addition, this tool is the source of performance measures for New York, New Jersey and Connecticut as well as regional TRANSCOM Member Agencies, such as PANYNJ, MTA, and NJ TRANSIT. The SPATEL tool is made up of twelve tools, which are described in Table 2-2.

In addition to the TRANSCOM SPATEL Archive, TRANSCOM provides real-time speed, incident, and travel time data to agencies through the TRANSCOM DE (Data Exchange). The TRANSCOM DE is an API feed that delivers traffic and transit information in real time to member agencies. This information is primarily used by agency systems, such as ATMS software, as well as directly to DMS operated by TRANSCOM member agencies. This allows specific travel times for routes connected to DMS to be updated in real time.

Table 2-2- SPATEL Tools

Operations Dashboard	The Operations Dashboard provides users with real time performance data for a set of specific trips, showing current operational conditions along these trips.
Corridor Viewer	The Corridor View shows real time performance data and current conditions for specific corridors. The Corridor View Tool is used to compare travel times both within and between corridors. Trips within each corridor can be filtered by facility and direction.
Project View	The Project View provides a real time view of the current conditions of

	roadways that are affected by construction projects. The Project Monitoring Tool provides a map view highlighting the project area.
Zone View	The Zone View provides real time conditions in a defined area. The tool displays a map, which shows the location of events and incidents, and congestion levels on roadways. The Zone View can be configured to send an email alert to designated individuals when a planned construction project has transitioned to active status within a defined zone.
Event Playback	The Event Playback tool allows users to review historical conditions over a specific timeframe. For example, a user can review conditions in a given area that occurred in response to a specific event progressively through the morning peak period.
Operational Map	The Operational Map provides real time information on roadway conditions, highway, and transit events (incidents, construction, special events), and ITS devices for the region. The map has various layers, and the user can select the exact information that he or she wishes to view, such as incidents/events, speeds, or ITS device locations. Clicking on an element of the map, such as an incident or a roadway link brings up further information.
Regional Conditions Viewer	The Regional Conditions View extends the functionality of the Operational Map tool to include a list of active events/incidents occurring, and a set of filters to limit the events shown. If an event is selected, the map shows the surrounding area, providing the real time conditions in that area.
Historical Travel Time Analysis Tool	The Historical Travel Time Analysis tool is a comprehensive application that provides historical average performance data for selected trips, as seen below. The various views within the tool provide detail which is useful for the planning process, and show data for AM and PM Weekday Peak Periods.
Travel Time Comparison	The Travel Time Comparison tool allows a user to view the impact on travel time caused by an event, such as an incident, construction, or special event.
Data Source Comparison	The Data Source Comparison tool shows travel time for a trip for all possible data sources available for that trip at a user selected time. This includes agency sources (TRANSMIT, Midtown-in-Motion), third party sources (INRIX or Navteq/HERE), different device sources (Bluetooth, Wi-Fi), and historical data.
CCTV Viewer	The CCTV viewer allows users to view live video from CCTV cameras.
Video Wall Viewer	The Video Wall Viewer allows users to generate a “video wall” containing multiple CCTV feeds in one view.

2.6. TRANSCOM Middleware

The TRANSCOM Middleware Project, of which this document is part, aims to create a platform where TRANSCOM member agencies can exchange transportation information using open standards. This will allow TRANSCOM member agencies to connect through a secure, middleware platform to access and upload data in a common format. This system is represented in Figure 2-9 below:

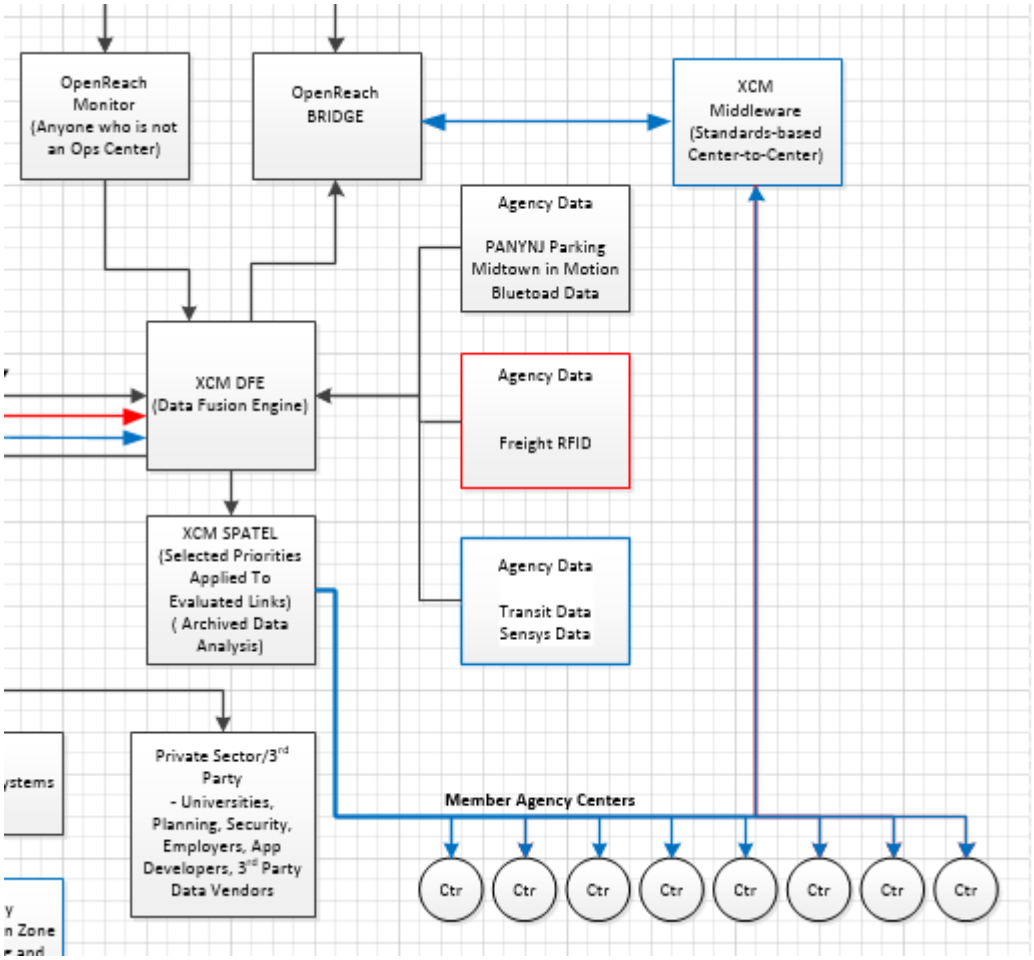

Figure 2-9 - TRANSCOM Middleware

Much of the data in the middleware project is already available to member agencies, either through the TRANSCOM Data Exchange or through TRANSCOM OpenReach. However, the TRANSCOM Middleware project will create a one-stop shop where member agencies can access all TRANSCOM data. In addition, the standards-based approach, utilizing the TMDD 3.03 and SAE J2354 standards, will allow for a single, simple data format for agencies to both access TRANSCOM data and to upload their data to TRANSCOM.

The TRANSCOM OpenReach Bridge, pictured above, gathers data from the TRANSCOM OpenReach system, as well as the TRANSCOM Data Fusion Engine. The OpenReach Bridge was originally intended to serve as a platform to push out this data to member agencies. However, the data format for this massive amount of data proved too complex for member agencies to easily plug into the OpenReach Bridge. TRANSCOM Middleware will utilize open standards (TMDD v3.03 and SAE J2354), that have been adopted by agencies and vendors alike. In addition, by creating a middleware platform, the project will ensure that agencies centers and systems will stay secure. Agencies will not directly connect to each other when downloading or uploading data, but rather negotiate through a secure platform provided by TRANSCOM.

The project has been divided into two phases. Phase 1 will involve the current set of data that TRANSCOM collects from member agencies. Phase 2 will add additional capabilities, such as device control, environmental and weather data, and real-time transit information.

In Phase 1, a standards-based specification will be created that adapts elements from the TRANSCOM Data Feed and OpenReach. This process will create a customized specification of the latest version of TMDD and SAE J2354 for TRANSCOM. Existing TRANSCOM Data Feed and OpenReach requirements will be compared to TMDD v3.03/SAE J2354 to identify TRANSCOM-specific needs and requirements that are contained within the current TMDD standard. Those needs and requirements not within the TMDD will be identified as extensions of TMDD. Where applicable, new TRANSCOM-specific needs and requirements will be developed and included in the appropriate sections of the specification.

Figure 2-10 represents the future applications to be added to the TRANSCOM Data Fusion Engine, and by extension to the TRANSCOM Middleware.

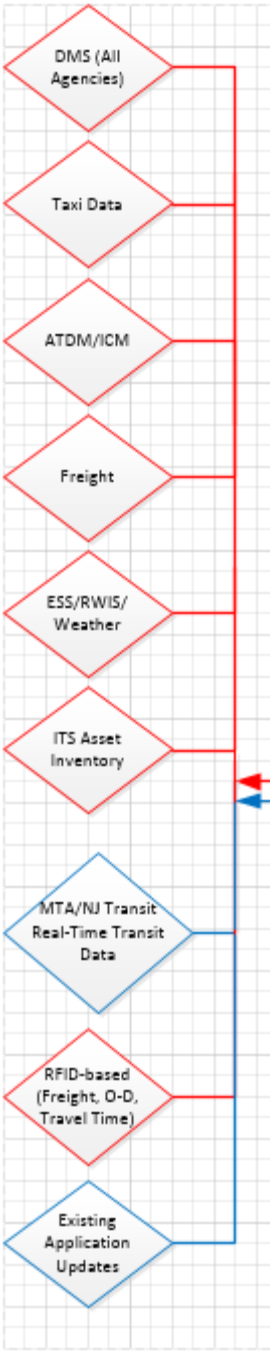

Figure 2-10 - TRANSCOM Future Applications

The future data feeds represent transportation data now or soon-to-be available in the TRANSCOM region. In the near future, these data sources will be adapted into the TRANSCOM Data Fusion Engine and by extension added to the TRANSCOM Middleware.

The implementation of Real Time Transit Data in Middleware is now underway. When complete, centers will be able to exchange real time data for Estimated Time of Arrival predictions, Transit Vehicle

Location Information, and Transit System Events/Incidents. Data will be available using open standards for transit (SIRI and GTFS-RT). Currently, NJ Transit Rail is being implemented to Middleware, with MTA NYCT Subway, MTA Long Island Rail Road, MTA Metro-North Railroad, and NJ Transit Bus being proposed for near term implementation.

2.7. TRANSCOM Data Exchange

Finally, TRANSCOM pushes this same data through the TRANSCOM DE to 511NY and 511NJ. These feeds allow the traveling public to access this same accurate, real time information through the Internet and telephone, as well through mobile devices. There is currently an effort underway to push real time transit information feeds in the SIRI and GTFS-Realtime formats. Figure 2-11 illustrates TRANSCOM DE outputs.

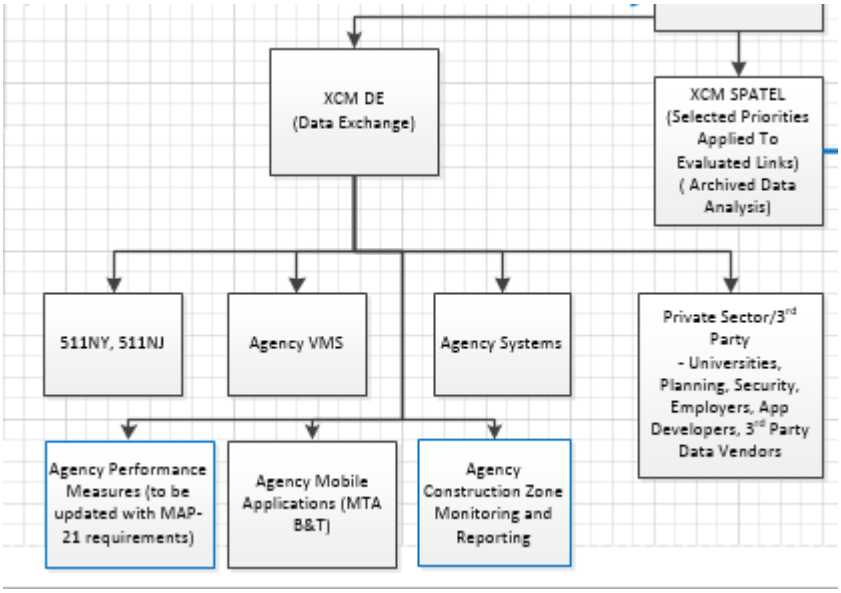

Figure 2-11 - TRANSCOM Data Exchange

3. USER NEEDS IDENTIFICATION

The TRANSCOM User Needs are derived from a number of sources. Key sources of needs include:

- Member agencies, that use TRANSCOM information for the purposes of operating the transportation system and providing traveler information to the public;
- Agency and center operations staff provide regular input through their daily activities, regional coordination activities with other member agencies, and with TRANSCOM OIC staff;
- MPOs, which use TRANSCOM information for purposes of transportation planning; and
- 3rd Party Private Information Providers and Consumers that provide value added information for commercial purposes.

In addition, TRANSCOM has a number of Committees that meet regularly and provide input to TRANSCOM Systems needs, usability, and improvements:

- Technical Committee (projects), meets quarterly;
- Finance and Policy Committee;
- Technology and Operations Committee (Steering Committee);
- TRANSCOM Board.

The TRANSCOM User Needs are organized into 12 groups, as follows.

1. Manage Event Information (incidents, construction, and special events – highway and transit)
2. Manage Travel Time Information
3. Manage Road Network Information
4. Manage Dynamic Message Sign Information
5. Manage CCTV Information
6. Manage Device Control Requests
7. Manage Parking Information
8. Manage Real-Time Transit Information
9. Manage Weather Information
10. Manage Freight Information
11. Manage Performance Measure and Data Analysis Information
12. Manage Regional Multi-state ATDM/ICM

3.1. Manage Event Information User Needs

3.1.1. Event Information Overview

Events information allows agencies to inform other agencies, or travelers, about something happening in the roadway or transit facilities. Event information is needed to inform agencies and travelers about something happening in the transportation network.

Scheduled event information is needed for agencies to inform each other about scheduled events that may impact other agencies roadway or transit network. In addition, sharing scheduled event information can help avoid adding stress to the transportation network – for example, scheduling

construction on a neighboring highway during a football game. In addition, sharing real-time event information can help other agencies anticipate heavy traffic conditions that may impact their roadways.

Event information as traveler information is needed to inform travelers about conditions on the transportation network, both roadway and transit. Both unscheduled and scheduled event information can help travelers anticipate an event that may impact traffic, and therefore change their traveling behavior.

Event information can be divided into two basic types:

- *Scheduled Events* are events that are known ahead of time. This can include maintenance or construction on the roadway, as well as a special event in the area, such as a football game or cultural event, that will have an impact on the transportation network
- *Unscheduled events*, or incidents, are events that are not known of ahead of time. These can range from heavy traffic to accidents

Event information can be updated in real time, depending on the current situation on the roadways. Updates apply both to scheduled and unscheduled events.

3.1.2. Events

Centers have a reason to share event information in order to impart situational awareness and to facilitate the coordination of activities and resources. Event information can include incidents, obstructions, traffic conditions, weather conditions, evacuations, homeland security events and natural and man-made disasters.

The need for event information varies depending on the type of information being shared, or type of center receiving information. For example, a traffic management center may be interested in receiving current even information in order to have situational awareness or to act operationally with internal response plans. A public safety center may request event information in order to coordinate for incident response. Based on the center's use of the data and the type of data, a center may desire constant updates on virtually all entities (for example, a traveler information system), or may only desire status information for selected entities upon request (for example, a geographically remote center may only be interested in major status changes or major events, or the center may only be able to handle a certain amount of data).

3.1.3. Incident Information

Transportation agencies need to exchange incident information to support management of the network. Incident information is also exchanged between centers so that events can be known to other centers, which may want to have situational awareness or need to react operationally with internal response plans. External centers need to obtain incident information from owner centers such as a description, location, severity, hazardous materials involved, and status of the event. Incidents can include lane or road closures, accidents, or heavy traffic on a roadway.

3.1.4. Scheduled Event Information

Transportation agencies need to exchange scheduled information so that events can be known to other centers. Other centers may need to react operationally with internal coordination plans. Scheduled events might include concerts, ballgames, state fairs, parades, or other large events that may affect the transportation network.

3.1.5. Scheduled Construction Information

Transportation agencies need to exchange construction information relating to current road or lane closures due to construction.

3.1.6. Construction Schedule Conflicts

TRANSCOM collects schedule information and status about construction and special events. Transportation agencies need to identify schedule conflicts in order to minimize the impact on traffic and transit service of multiple construction/special events activities occurring on the same facilities during the same times.

3.1.7. Operational Enhancements of Event Management Tool

Transportation agencies use OpenReach to manage the entry and update of Event information. OpenReach users have identified the following operational enhancements:

- **Create Author of Unassociated Actions**. Transportation agencies need to add the operator's (author) name who entered an Action that is not associated with a specific event (referred to as unassociated actions);
- **Automate Regional Conditions Report and Filters**. Regional Conditions Reports are currently created manually. The report is sent every one or two hours depending on agency. During emergency events (e.g., hurricanes, blizzards), TRANSCOM may deal with many additional agencies and need to provide updates more frequently. Transportation agencies have identified the need to generate the report automatically and organized by reporting agency (new filter).
- **Create an Event Starting from Map**. Transportation agencies have identified the need to initiate the creation of an event, starting from its map location, defined by the user clicking on a map.
- **Internet-based Thin-Client System**. Transportation agencies have identified the need to access the OpenReach tool from a browser. A secondary benefit with this need is the reduced system administration required for network access via a Thin-Client (e.g., number of IP ports that need to be defined) versus the effort to administer a personal computer-based workstation running software.

3.2. Manage Travel Time Information User Needs

3.2.1. Travel Time Information Overview

Travel time data is an estimate of how long it takes a vehicle to traverse a particular link in the roadway. When these links are combined, travel time to a particular location can be communicated to travelers as traveler information. Traveler information is necessary to reasonably manage the expectations of travelers. Real-time traveler information, in the form of travel times or speeds, can help travelers see

into the future, and either prepare themselves for difficult traveling situations, or help them make different traveling choices.

Travel time estimates are calculated based on a combination of historical travel time data and real-time roadway data. For example, a traveler may be driving north on the New Jersey turnpike towards the George Washington Bridge. A DMS may post an estimate of how long it will take to reach the George Washington Bridge along the roadway. This trip will involve roadways operated by three separate agencies: the New Jersey Turnpike Authority, New Jersey DOT, and the Port Authority of New York and New Jersey. TRANSCOM's data feed provides an estimate of this trip by combining estimates of travel times along a set of links leading from the DMS to the George Washington Bridge.

In addition to travel time estimates, the TRANSCOM Data Feed provides estimates of speed along a given roadway based on real-time samples. Speed estimates are based on real-time information only and have not been supplemented with historical data.

3.2.2. Travel Time Data

Centers have a reason to share travel time information for a specific section of road, or link, with other centers. Centers need travel time data for two reasons:

- Travel times can be processed and communicated to customers as traveler information. Travel times as traveler information can help users make informed decisions about their choices when using the transportation system. In addition, travel times as traveler information helps users manage their expectations about the transportation system.
- Travel times and speed data are also used for operational reasons by transportation management centers. This data provides estimates of the current conditions in the transportation system. Centers may use this information to react operationally to different conditions on the roadway.

Travel time information can include both speed data and travel time data.

3.2.2.1. Speed Data for Roads

Transportation agencies need to receive speed data on roads (both limited access and arterials) so the transportation agency can manage the road network in order to reduce recurring and non-recurring congestion. Speed data can provide other centers with information about the roadway. This information can be used to react operationally to different conditions on the roadway.

3.2.2.2. Travel Time Data for Roads

Transportation agencies need to receive travel time data on roads (limited access and arterials) in order to provide this information to travelers through roadway devices (e.g. DMS, HAR, and Connected Vehicle RSEs) and through traveler information outlets (e.g. 511, websites, social media). Travel times, when communicated to travelers as traveler information; help manage roadway user's expectation. In addition, travel times as traveler information can help roadway users make informed decisions about their traveling plans based on current road network conditions.

3.2.2.3. Probe Data for Roads

TRANSCOM currently integrates probe information from TI-MED, and 3rd Party Sources. Transportation agencies have identified the need, where available, to collect and provide probe data to TRANSCOM. E.g., NYCDOT collects Taxi Trip Data (historical), and is working to collect real-time taxi trip data.

3.2.2.4. Historical Data for Roads

TRANSCOM agencies have identified the need to collect historical data (speed, travel time) for roads. For example, the FHWA has acquired Navteq-Here information, referred to as the National Performance Management Research Data Set (NPMRDS).

3.2.2.5. Optimize Historical Data

There is a need to optimize Historical Travel Time Data by allowing users to remove specific days from historical travel time calculations. Events such as snow days, major events, and roadway closures may skew summary data in a way that is not reflective of average data. User need to be able to remove such outlier data points from calculations.

3.2.2.6. Level of Service Data

There is a need to provide Level of Service calculations for roadways, as defined by the Highway Capacity Manual (HCM).

3.3. Manage Roadway Network Information User Needs

3.3.1. Roadway Network Information Overview

Roadway network information is needed to define the roadway network in order to match data to specific locations in the transportation infrastructure. The TRANSCOM system manages upwards of 250,000 roadway links in real-time. Well-defined roadway network information is necessary not only to ensure that the traffic information is applied to the correct geographic location, but also to ensure that traffic information can be combined into meaningful traveler information.

Roadway network information is commonly made up of three types of data:

- **Nodes**. Nodes are points in space, and are defined by latitude and longitude. Nodes are the smallest data element that is unique within a network. Nodes are commonly known locations in the transportation network. Nodes can be the beginning and end points of a link, such as mile markers or highway exit, a location of a device, an intersection, or the location of an incident.
- **Links**. Links are sections of roadway, and are defined by nodes. Links can be any section of roadway between two defined nodes. Data, such as travel time or speed, are often assigned to links.
- **Routes**. A Route is a collection of links. For example, a collection of links that are assigned travel time data may be combined to form a route to show travel time along a facility.

TRANSCOM collects data from a large variety of sources, ranging from member agencies to private transportation data providers. Most of these sources have separate link definitions for the road network. The set of roadway links that comprise the full TRANSCOM data set now exceeds 250,000.

3.3.2. Roadway Network Data

To understand and interpret real time information relating to travel times, incidents, construction based road closures, and road weather information, the agencies or organizations receiving the information need to have a complete definition of the road network relevant to the information received. Other centers need this information in order to geographically place road network information being shared by a center. Other centers also need this information in order to be able to translate between different definitions of road networks. For example, some private road network information providers may have one definition of a road network, while information provided by a TRANSCOM member agency may have different definitions of the same space in the road network.

A traffic network represents a collection of roadway nodes, links and routes. A node is the smallest data element that is unique within a network. Nodes provide a geographic location that can represent the beginning and end points of a link, location of a device, intersection, or location of an incident. A route is a collection of links.

When a center elects to participate in a C2C environment, it may make available to other centers its traffic network information, which it uses to reference location of its center entities.

3.3.2.1. Roadway Network Inventory

The traffic network inventory sharing provides operation centers within the C2C network a list of nodes, links and routes that compose the roadway network. Centers need a roadway network inventory to provide an overarching list of all links, nodes and routes in another centers inventory in order to geographically place road network information and translate between roadway network systems.

3.3.2.2. Link Inventory

Centers need to share link inventory including a description, unique identification and spatial information for all links in the traffic network. Centers need a link inventory to provide a list of all links in another centers inventory in order to geographically place road network information and translate between roadway network systems.

3.3.2.3. Node Inventory

Centers need to share node inventory including a description, unique identification and spatial information for all nodes in the traffic network. Centers need a node inventory to provide a list of all nodes in another centers inventory in order to geographically place road network information and translate between roadway network systems.

3.3.2.4. Route Inventory

Centers need to share route inventory including a description, type, unique identification and spatial information for all routes in the traffic network. Example route types include: travel routes (typically used to create travel times), transit routes, alternate routes and detour routes. Centers need a route inventory to provide a list of all routes in another centers inventory in order to geographically place road network information and translate between roadway network systems.

3.3.2.5. Node, Link, and Route Status

Centers share current status information about the traffic network they operate, which may help other centers perform route planning or traffic management within their jurisdiction. Centers need node, link and route status in order to differentiate between active and inactive portions of the roadway network.

3.3.3. Operational Enhancements to Roadway Network Map

The TRANSCOM Roadway Network model is a key reference used by all TRANSCOM Systems. It is used by OpenReach users to view roadway network information and status, used by the Data Fusion Engine to map data sources to the TRANSCOM regional view, and used by Data Exchange users to interpret link information. The TRANSCOM Middleware will provide a TMDD-based description of the roadway network. TRANSCOM System users have identified the following operational enhancements, as follows:

- Provide separate indicators on map for Major vs. Minor events
- Provide Drawbridge Status (Opened/Closed)
- Provide Signal Location
- Provide Parking Lot Location
- Provide Freight Routes
- Provide Location for Adverse Roadway Weather Conditions
- Provide Roadway Status for Snow Removal/Clearance (e.g., number of lanes removed)
- Ability to view NJ Straight Line Diagram Data
- Ability to define a new trip (feature not available through DE)
- Ability to link NJ mile marker Data
- Ability to link to munocast (volume) data (NJ)

3.4. Manage Dynamic Message Sign (DMS) Information User Needs

3.4.1. Dynamic Message Signs Information Overview

The term Dynamic Message Sign (DMS) encompasses variable, changeable, drum, and blank-out electronic roadway signs. DMS data is needed to share information between agencies about messages that are posted on DMS in the region. This information can help agencies coordinate regional traveler information into a cohesive system. This allows for regional traveler information to be communicated to travelers in a seamless system.

The current TRANSCOM data feed includes 2200 trips. Trips are similar to routes, in that they are collections of links. However, trips include specific travel time data.

In addition to trips, DMS data will include DMS inventory, and DMS status. DMS inventory describes the location, type, and characteristics (number of lines, size, etc.) of DMS in a given agency's jurisdiction. DMS status describes a sign's operational status and the contents of the message displayed on the sign.

The future data feeds represent transportation data now or soon-to-be available in the TRANSCOM region. In the near future, these data sources will be adapted into the TRANSCOM Data Fusion Engine and by extension added to the TRANSCOM Middleware.

3.4.2. Dynamic Message Signs Information

Dynamic message signs (DMS) are used by centers to help manage the surface transportation system. They can be used to:

- Provide travelers information that help the travelers select routes;
- Inform travelers about traffic congestion;
- Inform travelers about travel times;
- Inform travelers about roadway or traffic conditions;
- Inform travelers about planned activities that may affect traffic conditions;
- Provide information about transportation alternatives; and
- Provide other public service announcements

3.4.2.1. DMS Inventory

Centers need to exchange DMS inventory information so that DMSs operated by a center can become known to other centers. Centers need to exchange DMS device attributes so that the capabilities of the DMS devices operated by the owner center can become known to external centers.

Inventory information includes static DMS device attributes such as:

- Location (including direction of traffic the DMS is facing);
- Size (physical dimensions, characters per line, number of lines); and
- Type (technology, permanent versus portable)

3.4.2.2. DMS Status

Centers need to exchange status information for each DMS. Status information includes:

- Communications status (connected, disconnected, failed);
- Operational status (available, not-available); and
- Current operational state information (content of the display on the sign, etc.)

3.4.2.3. DMS Message Appearance

Centers need to exchange information on how a message actually appears on the active face of a DMS operated by another center. Centers should properly confirm how a message will look on a DMS controlled by another center. How a message appears on a DMS may vary based on the physical attributes of the DMS (color, number of lines, number of characters per line, physical size, etc.) and its capabilities (fonts supported, MULTI-tags support, default values, etc.). Centers should send either freeform text messages, in MULTI-string format, or from a library associated with the DMS.

3.5. Manage CCTV Information User Needs

3.5.1. CCTV Information Overview

TRANSCOM collects CCTV status and image information from its member agencies and private transportation data providers, in particular TrafficLand. Closed circuit television (CCTV) cameras are used by centers to view the surface transportation system. In addition, agencies may provide a link to

this "regionalized" CCTV information provided by TRANSCOM as part of their traveler information systems.

CCTV devices can be used by centers to:

- Verify roadway status (e.g., congestion, incidents, construction, and special event activity);
- Determine what assistance may be needed by the incident;
- Monitor the progress of incidents, construction and special events;
- Determine when the residual congestion from an incident is cleared;
- Provide visual images to the public as to the state of the roadway; and
- Determine what type of emergency services need to be dispatched

3.5.2. CCTV Data

CCTV data are used by centers to visualize and monitor roadway conditions. CCTV data includes the following:

- CCTV Owner
- CCTV Location
- Image Rates (whether still image, slow scan, streaming video such as 30 fps – frames per second, etc.)
- Available Formats (e.g., JPEG/MPEG, Flash);
- Image Size in Pixels
- Distribution Constraints (e.g., not for public, on an as needed basis)
- Is CCTV available for Remote Control

3.5.2.1. CCTV Device Inventory

Centers need to exchange CCTV inventory information so that CCTV devices that are operated by a center can become known to other centers. Centers need to exchange CCTV device attributes so that the location of CCTV devices may be known to other centers in order to know what CCTV images may be available

3.5.2.2. CCTV Device Status

Centers need to exchange status information for each CCTV device in order to see if CCTV images for this location are available.

3.6. Manage Device Control User Needs

3.6.1. Device Control Overview

Transportation agencies need to share access to devices near operational borders. Until recently, TRANSCOM's role in the control of devices has been limited to the assistance, through the use of telephone and fax, to help coordinate, for example, the request of one agency to place a message on another agency's DMS. Member agencies have requested that TRANSCOM automate the process to allow sharing of control of DMS and CCTV. Transportation agencies will need to set limits (in real-time) for when TRANSCOM may barter remote control of a device.

TRANSCOM Systems needs to provide managed requests for device control. Note, that in the case of 3rd part provided CCTV image (e.g., TrafficLand), the CCTV may not be accessible from a TRANSCOM network, and the ability for TRANSCOM to help delegate remote control will not be possible. Therefore, TRANSCOM can only assist to delegate remote device control for those devices that are on a TRANSCOM managed/accessible network (the precise definition to be defined during requirements definition and design).

Centers need to control other centers' devices to provide a backup connection in case of emergency or closure. There is a need to be able to perform such control from agile devices using a web based interface, to provide for increased utility and usability. In addition, device control sharing may increase efficiency in interagency operations.

As part of Phase 2, TRANSCOM plans to supplement the current capability to share device inventory and status to include the ability to control other agencies' devices. This would apply specifically to CCTV cameras and DMS.

An external center may desire to control traffic through the use of traffic control devices connected to the owner center. There are two primary reasons an external center may wish to do this. First, many traffic control centers do not stay open 24 hours a day, 7 days a week. The second reason is that emergency conditions sometimes require the evacuation of an operations center.

Most transportation operations centers are scheduled to be open when the value of the operations are high compared to the cost of keeping them closed. For some centers, this means that they are closed during the night and/or during weekends. Nonetheless, conditions may arise during these periods that require active traffic management. In these cases, the center may wish to allow another external center to have limited control of its equipment.

One of the most important uses of ITS devices is to manage traffic during natural disasters and other emergency situations that require the evacuation of the civilian population. For example, during a hurricane evacuation where the operations center could be closed down, the traffic along the evacuation routes may be controlled via remote terminals from an external center.

Due to the various liability concerns involved with controlling traffic control devices, each organization will need to establish its own institutional policies defining under what conditions an external centers may exert control upon a device. These policies may include:

- An operator to manually process the request;
- A computer to automatically approve/deny the request; and
- Some combination of operator and computer to process the request.

In addition, not all agencies currently supply TRANSCOM with the current messages displayed on DMS in the region. TRANSCOM plans to incorporate all DMS messages into their system, when available.

3.6.2. Request Device Control

Centers need to grant device control to other centers via TRANSCOM. An external center may desire to monitor or control devices connected to a TRANSCOM managed network. Among the reasons an external center may wish to do this (and an owner center may wish to allow it):

- The first reason is that many transportation operations centers do not stay open 24 hours a day, 7 days a week.
- The second reason is that emergency conditions sometimes require the evacuation of an operations center

3.6.2.1. Request to Control a Remote DMS

Centers need to share traffic DMS information, such as the ability to control a remote DMS device. External centers may need to control a DMS in order to change the message to provide traveler with different information. For example, another center may wish to inform travelers of an event and provide alternate routes.

3.6.2.2. Request to Control a Remote CCTV Device

Centers need to be able to request a change to the parameters of a CCTV device, such as the camera position, operated by another center In order to view an event, see real-time traffic conditions, or verify an incident.

3.7. Manage Parking Information User Needs

3.7.1. Parking Information Overview

Parking Information is needed to inform travelers whether parking spaces are available in a particular lot. This information can help travelers make more informed choices, which in turn can lessen traffic and emissions impacts in a particular facility.

TRANSCOM receives parking information from PANYNJ airport facilities. Parking lots report the percentage of spaces that are taken based on the number of cars that enter or exit the lot. This parking information does not include information on individual spaces.

3.7.2. Parking Data

Centers need to exchange parking information with other centers. Parking information can provide specific information on the availability of parking in a given lot. This information can then be passed on to travelers in order to inform them which lots are full and which have room. This allows travelers to make better transportation choices and decrease traffic and emissions that result from travelers driving between lots looking for parking. TRANSCOM anticipates provide parking lot information and status for the following:

- Airport Parking;
- Commercial Vehicle Parking;
- Park-n-Ride Facilities;
- Commuter Transit Parking;

- Private Parking Lots;
- 3rd party parking lot information service providers

3.7.2.1. Parking Lot Information

Centers need to share parking lot information with other centers. Parking lot information can include whether or not a parking lot has available space, as well as the specific percentage of available parking spaces available in a given parking lot.

3.8. Manage Real-Time Transit Information User Needs

3.8.1. Real-Time Transit Information Overview

3.8.1.1. Transit Schedule and Route Information Overview

TRANSCOM does not intend to specify needs related to static transit schedules and routes. The rationale for this is two-fold: (1) a number of transit agencies in the region already publish their transit schedule information in a standardized format that is readily available (GTFS), and (2) NYSDOT (a member agency) has pioneered and worked to identify the static schedule information required for transit trip planning, and working with a large number of agencies (e.g., NYCT, Bee-line, NFTA, CDTA, etc.) to collect and process standardized regional transit schedule information. While NYSDOT's past work in managing state-wide transit information will be used as a starting point, other member agencies input will be solicited to fine-tune special requirements.

In the event that the NYSDOT approach is substantially different from the needs of New Jersey and Connecticut members, TRANSCOM will initiate an activity to identify user needs under a separate project and task. The results will be included into a future version of the TRANSCOM Systems ConOps.

TRANSCOM intends to follow NYSDOT's lead to identify suitable standards and formats for static schedule and route information. Transit service is largely defined by routes, patterns, stop points, and timepoints – the 'transit schedule'. TRANSCOM will support and coordinate with NYSDOT to ensure that real-time transit information available from TRANSCOM systems can be readily exchanged with NYSDOT systems, including the methods used to define the base transit service (network and schedule).

Published static transit schedules (transit service) change resulting from transit maintenance, construction, special events, etc. These transit service changes are currently managed through transit event management. TRANSCOM intends to coordinate with NYSDOT to identify standardized formats for publishing impacts on transit service that may impact real-time transit operations.

3.8.1.2. Real-Time Transit Information Overview

Centers need to share real-time transit information to provide real-time information about alternate routes during events and incidents. Currently, when an incident or event affects the transportation system, alternates to a particular route are generally alternate routes along highways or surface streets. When real-time transit information is shared between centers, transit options can be suggested as alternatives to travelers.

Currently, TRANSCOM has two member agencies that provide real-time transit information. The Metropolitan Transportation Authority provides real-time Bus and Train locations on many of their routes for New York City Transit, MTA Bus Company, Long Island Rail Road, and Metro-North Railroad. New Jersey Transit generates both real-time bus and rail information, PANYNJ PATH provides real-time train information in PANYNJ facilities, but currently does not broadcast these times to the public. Finally, CT Transit also produces a real-time feed.

3.8.2. Real-Time Transit Information

Centers need to share real-time transit information with other centers. Transit centers may share real-time transit information with other centers in order to inform travelers about transit alternatives in case of a major incident. Real-time transit information can allow travelers to make a seamless transition from traveling via roadways to traveling via transit. Further, transit centers may share transit related event or incident information with other centers, so that other transit agencies can accommodate event-driven changes in ridership and roadways can accommodate event- driven changes in traffic flow. Additionally, TRANSCOM shall look into integrate Bus AVL system data into DFE and SPATEL as an alternate data source for roadway travel time information.

3.8.2.1. Real-Time Bus and Train Locations

Transit agencies need to share real time bus locations with peer transportation/transit agencies, public traveler information providers, private third party providers, and travelers.

3.8.2.2. Real-Time Transit Passenger Loading

Transit agencies need to share real time transit vehicle passenger loading with peer transit agencies, public traveler information providers and private third parties.

3.8.2.3. Predicted Bus or Train Arrival/Departure Times

Transit agencies need to share real time predicted bus or train arrival or departure times with peer transit agencies, public traveler information providers, and private third party providers. Predicted arrival times may be viewed by trip or by stop.

3.8.2.4. Transit Alerts

Transit agencies need to share alerts about scheduled and unscheduled events affecting transit service with peer transit agencies, public traveler information providers, and private third party providers. Events affecting transit may include construction, incidents, weather, equipment problems, or special events affecting transit ridership.

3.9. Manage Weather Information User Needs

3.9.1. Weather Information Overview

Centers need to exchange weather information so that other centers may be aware of inclement conditions on other centers' roadways. Exchanging weather information may allow agencies to anticipate incoming poor weather conditions. In addition, weather information may be used in order to have situational awareness or to act operationally with internal response plans.

Weather information can be collected from environmental sensor stations (ESS) which may be deployed on TRANSCOM member agency roadways. In addition, agency vehicles may be equipped to sense poor roadway conditions.

3.9.2. Weather Information

Centers need to share weather information that may affect roads and facilities within a center's jurisdiction. Road weather information can include current weather information, such as icy conditions on a specific roadway, or weather forecast information, which may allow centers to anticipate inclement weather in the near future.

3.9.2.1. Road Weather Environmental Conditions Data

Transportation agencies need to collect road weather environmental conditions data in order to create weather related traveler information to provide to travelers or to perform weather related maintenance operations such as roadway treatment and snow removal.

3.9.2.2. Weather Forecasts

Transportation agencies need to send forecasts of upcoming adverse weather related conditions (e.g. ice, snow, fog, heavy rain) to peer transportation agencies, public traveler information providers, private third parties, and other agencies to support their traveler information services or other operations.

3.9.2.3. Roadway Snow Removal Operational Status

Transportation agencies need to share information about snow removal operations with other agencies. TRANSCOM's role is to augment information received from agencies to provide a regional view of snow removal operations. Roadway link status reported needs to include results from agencies reports snow removal operations status (e.g. 2 of 4 lanes snow remain covered, 1 lane clear).

3.10. Manage Freight Information User Needs

3.10.1. Freight Information Overview

Freight vehicles, and often freight containers themselves, area often tracked by private freight companies or freight facilities. This tracking often takes the form of RFID tags, similar to TRANSMIT/TI-MED. In the future, TRANSCOM could obtain this freight tracking information and integrate it into the TRANSCOM DFE, obtaining an additional source of road network data. Once into DFE, the data could be made available to freight organizations for planning/operational purposes as well.

In addition to speed and travel time data provided by freight vehicles, TRANSCOM also plans to incorporate an archive of overheight and overweight restrictions on links within the region. This valuable tool will help agencies predict when and where overheight and overweight vehicles may violate these restrictions.

3.10.2. Freight Data

Centers need to share freight information in order to be aware of freight vehicles that have the potential to affect the flow of traffic on the transportation system, or have the potential to damage facilities. These may include over height or overweight vehicles, as well as HAZMAT vehicles. Freight information

allows agencies to anticipate potential incidents involving freight vehicles and infrastructure, as well as faster and safer responses to potentially hazardous incidents involving freight vehicles.

3.10.2.1. Freight Routes

Transportation agencies need to define and share with other agencies and 3rd parties the definition of freight routes.

3.10.2.2. Freight Delays and Travel Time

Transportation agencies need to determine and share with other agencies and 3rd parties information about freight delays at terminals and ports (nodes), and travel time on freight routes.

3.10.2.3. Commercial Vehicle Parking Availability

Transportation agencies need to provide information about commercial vehicle parking information and availability in near real-time.

3.10.2.4. Bridge and Tunnel Height-Weight Restrictions

The number of commercial vehicle impact with bridges and tunnels in the TRANSCOM region ranges in the hundreds per year. Commercial vehicle-infrastructure impacts may be reduced if freight-route-specific, determinable by the freight transport user, could be joined with infrastructure height-weight-dimension restriction information and provided back to the freight transport user.

Transportation agencies need to provide freight transport users height-weight-dimension restriction information on a freight route basis.

3.10.2.5. Commercial Vehicle Inspection Stations

Transportation agencies need to provide freight transport users information about inspection station status (opened/closed) in near real-time.

3.10.2.6. HAZMAT Freight Information

Centers need to be aware of HAZMAT vehicles in their jurisdiction, as well as to be aware of the specific hazardous material passing through their jurisdiction. Certain facilities may carry restrictions about whether or what kinds of HAZMAT vehicles may utilize a facility. In addition, foreknowledge of the specific types of hazardous materials being transported by HAZMAT vehicles can allow a faster and safer response to incident involving HAZMAT vehicles.

3.10.2.7. Over Height and Overweight Freight Information

Centers need to be aware of vehicles that may be over height or overweight in their jurisdiction. Facilities may have restrictions as to the height and weight of vehicles that may utilize a facility. These restrictions are applied to avoid damage, both short term and long term, to a facility. Awareness of over height and overweight vehicles allow a freight vehicle not meeting these restrictions to be diverted before causing damage to a facility.

3.11. Manage Performance Measures and Data Analysis Information User Needs

3.11.1. Performance Measures and Data Analysis Overview

The Moving Ahead for Progress in the 21st Century Act (MAP-21) establishes a performance based highway funding program. The specific USDOT rulemakings have yet to be entirely released. However, TRANSCOM agencies have identified the need to prepare the New York/New Jersey/Connecticut region for setting and meeting performance requirements by creating a common, standards-based platform that gathers transportation data in a unified way, which will feed into the TRANSCOM SPATEL Archive. Data Fusion Engine updates will integrate historical information, both private and public sector-based, similar to the function of the Data Fusion Engine for real-time information.

3.11.2. Performance Measures Data

Performance measures are an ongoing data source being sought after by transportation agency operations and planning groups as well as MPO's. TRANSCOM is actively meeting with all of their Member Agencies as well as regional MPO's to avail them of the tools and data available from SPATEL as well as to review and refine additional metrics needed. The SPATEL Archive application is being developed in a configurable manner in order to support both agency requests as well as support USDOT specifications that are defined via MAP-21 when it is released. These reviews also include reviews of additional sources of data that are available to be mapped via the DFE into SPATEL for the purposes of expanding the quantitative and qualitative measures available for analysis and reporting to their constituents.

3.11.2.1. Provide Trip Travel Time vs. Historical

Transportation agencies need to compare current trip travel time vs. historical to identify whether current conditions are normal or of a recurring nature, or due some other factor. Knowing that trip travel time is possibly due to some factor impacting traffic or transit allow agency/operators to investigate possible causes and to begin to develop a strategy to alleviate the problem and improve travel times.

3.11.2.2. Provide Trip Travel Time Reliability

Transportation agencies need to know whether the trip travel time is reliable and within what tolerance ranges. In other words, transportation need to know whether the trip travel time is volatile and changes frequently (low reliability), or whether the trip travel time is stable (high reliability). Trip travel time reliability may be a factor to be included in determining the type of strategy to employ to alleviate adverse travel times.

3.11.2.3. Provide Average Travel Time over User Specified Time Period

Transportation agencies need to know average travel time across specified time periods. Specific time periods and whether the need is to specify a time period dynamically should be revisited during requirements elicitation.

3.11.2.4. Provide Comparison of Downstream vs. Upstream Segment Speed Data

Comparison of Downstream and Upstream segment (i.e., a link or a route) may be used to identify any restriction in capacity of a roadway, whether from recurring congestion, incident, construction, special event, or weather. Collection of historical information and data analysis of downstream and upstream may allow the possible determination of the probable cause of the roadway constraint and indicate whether a transportation agency action is required.

Transportation agencies need to configure (i.e., specify) and later compare the differences in traffic conditions (speed, volume) of downstream vs. upstream segments to determine possible causes in reduction in capacity on roadways (e.g., recurring congestion, event, weather, etc.)

3.11.2.5. Provide Weather Impact Indicators (vs. Historical)

Transportation agencies have identified the need to identify metrics, collect roadway weather information, and to correlate weather and impacts on transportation (e.g., travel time, speed, and frequency of incidents) by route and time-of-day.

3.11.2.6. Provide Freight Travel Impact Indicators (vs. Historical)

Transportation agencies have identified the need to identify specific metrics, collect attributes and information about events that impact freight travel (e.g., weather, time-of-day, port congestion, tunnel and bridge lane closings, etc.), and to correlate attributes to forecast impacts on freight transportation (e.g., travel time, and speed) by freight route and time-of-day.

3.11.2.7. Provide Performance Measures Dashboard and Reports

Transportation agencies need to configure which performance measures and report criteria are important to them. As such, agencies need to configure Performance Measures User Interface (dashboard), and reports, to show parameters used in determining strategies to employ to improve travel conditions for travelers.

3.11.2.8. Provide Operational Enhancements to Performance Measures Tool

The TRANSCOM SPATEL (Data Analysis Tool) is used by member agencies to identify current performance of routes against historical information. TRANSCOM SPATEL users have identified the following operational enhancements:

- Create a Freight Layer. The freight layer would include information specific to Freight (e.g., freight routes, parking availability, travel time, etc)
- Create a Weather Layer. The weather layer would include icons to show RWIS/ESS location, and highlight hazardous roadway weather conditions.
- Generate an ad-hoc Freight Trip via SPATEL. This includes the need to generate as-requested freight routes based on available freight condition information, such as bridge height, weight restrictions, etc.
- Create Tablet Version of SPATEL Analysis Tool. There is a need to provide access to the SPATEL tool for agency staff that work in the field, such as construction personnel.
- 3rd Party Software Company to Review and Maintain All Source Code. There is a need to ensure that TRANSCOM's software is open source, and readily available to any member agency that wishes to install TRANSCOM software. The intent of this is need is to ensure that the software

(code) is well-formed, adhering to coding standards, and readily reproducible if an agency wants to use it. A 3rd Party company will conduct periodic software process and code reviews.
- Provide historical event statistics in a graphical form. There is a need for users to view the number of historical events that have occurred broken down over a specified time range with user selectable filters.
- Ability to query trips on map by origin/destination pair, radius, polygon, or trip type.
- Ability to view incident summary in Historical Travel Time Analysis Tool to receive insight on impact of incidents on travel time
- Ability to view a histogram showing real time speed
- Ability to compare speed and travel time
- Display incident, weather, congestion, construction, and special event details within Histograms
- Display transit vehicle location on operational map

3.11.2.9. Provide Evaluation of Travel Time Data Sources

Members transportation agencies have identified the need to evaluate characteristics (e.g., reliability, accuracy, methodology, coverage) of travel time data sources, especially 3rd party providers.

Transportation agencies need to identify reliability, accuracy, and coverage gaps of travel time data by data source.

3.11.2.10. Provide Bottleneck Information

There is a need to be able to view information about bottlenecks on roadways, including location information, and time information.

3.11.2.11. Incident and Travel Time Alerts

There is a need for users to be able to receive alerts containing roadway condition information, including incidents and travel time, within a defined zone, corridor, or construction project area. Users need to be able to set alert configurations and filters for such alerts.

3.11.2.12. Provide Integration for GIS Systems

There is a need to provide performance measure data in a standardized format (JSON and Shape files) for integration into member agency GIS systems.

3.12. Manage Regional Multi-state ATDM/ICM User Needs

3.12.1. Regional Multi-state ATDM/ICM Overview

Currently, regional transportation agencies, including TRANSCOM Member Agencies, are preparing an Integrated Corridor Management proposal for the I-495 corridor. In addition to this specific initiative, a number of regional ATDM (Advance Transportation and Demand Management) initiatives have been proposed and discussed. These important transportation operations initiatives are clearly a part of the near-term future of regional ITS. ATDM and ICM rely on a standardized, center-to-center (C2C) process for exchanging transportation data in order to calculate and assess response plans. The TRANSCOM new Middleware, together with updates in OpenReach and the Data Fusion Engine project prepares for these initiatives by ensuring that a standardized C2C platform already will exist in the region before these initiatives are deployed.

3.12.2. ATDM/ICM Data

TRANSCOM anticipates the implementation of ICM or ATDM systems in the region in the near to mid-range future. Although still in the early planning stages, ICM or ATDM could include two sources of data that will be important additions to the TRANSCOM system. First, additional data collection devices may be implemented as part of these types of programs. TRANSCOM plans to integrate the data that could be collected as part of an ICM or ATDM program into the TRANSCOM DFE.

Second, both these systems rely on recommending response plans to traffic incidents. TRANSCOM could serve as a clearinghouse for these traffic plans, and once integrated into the TRANSCOM SPATEL archived data analysis tool. This could be a valuable resource for assessing the performance of response plans in these systems.

ATDM and ICM systems need to capability to organize information and their interrelationships into corridors. A specific corridor may need to define information elements from the wealth of regional/multi-state data that TRANSCOM manages, for example:

- Roadway Network Information (speed, and travel time)
- Event Information (place and location of events that impact the corridor)
- Transit Service (location and availability of transit service within the corridor)
- Park-and-Ride Availability
- Weather (forecast and current)
- ITS Devices (location and availability of CCTV, DMS, HAR, and Signals within the corridor).

Specific requirements will need to be elicited to identify how best to relate information necessary to manage a specific corridor.

3.12.3. ITS Asset Inventory

A potential future application for TRANSCOM would be creating an ITS Asset Inventory for the region. Agencies may need an ITS Asset Inventory to have knowledge of ITS assets throughout the region. This could allow agencies to avoid redundant deployments, compare the lifespans and performances of their deployments to that of sibling agencies in the region, and ensure that agencies may know what devices they can have access to in the case of a regional emergency. This application would utilize the TMDD standard to create a digital, easily accessible, and universal format for an ITS Asset Inventory.

4. JUSTIFICATION FOR AND NATURE OF ENHANCEMENTS

The enhancements described in this section of the ConOps relate to new or updated system features contained in one or more of the 5 core TRANSCOM Systems. The term system feature is used here to describe a user benefit to be provided by the system, not constrained by the formal language used to describe a system requirement (e.g., does not use the shall statement format), and traceable to one or more user needs.

Each system feature is traceable to the user needs described in Section 3 of this ConOps as a form of justification for the system feature. The user needs provides a rationale for the system features. As such the system features identified in this section simply state what the system is intended to provide. Appendix B contains the Trace Matrix of System Features to User Needs.

This section contains a listing of system features organized by core system, as follows:

- TRANSCOM OpenReach Enhancements
- TRANSCOM Data Fusion Engine Enhancements
- TRANSCOM SPATEL Enhancements
- TRANSCOM Middleware Enhancements
- TRANSCOM Data Exchange Enhancements

As stated in Section 1 Systems Engineering Process, each future project that references this document as the project's ConOps is expected to develop system requirements based on the system features and user needs traceability contained in this section and in Appendix B. The system feature may provide an adequate starting point, and based upon analysis of the requirements developer, be expanded upon, broken into one or more requirements, or removed altogether. Changes to user needs, systems features, or traceability should be documented and used to update the information in this ConOps document.

4.1. TRANSCOM OpenReach Enhancements

4.1.1. Create Non-incident Event Log

Currently, only incident events are associated with an event log.

This feature will provide users the ability to associate an event log with construction, and special event type events.

4.1.2. Create Author of Unassociated Actions

The feature will allow a user to assign the name of the operator/author to Actions not associated with an event.

4.1.3. Create Construction Conflicts Module

This feature will allow a user to determine schedule conflicts in construction and special events for a particular roadway segment or neighboring segments (for example, as defined by a route).

4.1.4. Create Regional Conditions Report Filter

This feature will provide automated report generation, distribution, and additional filters to be applied to the Regional Conditions Report.

4.1.5. OpenReach Map Enhancements

This feature provides the following enhancements to the roadway network map:

- Capability to Store Link Set from the Map
- Creation of Major or Severe Incident Icon
- Creation of Drawbridge location and Openings Icon
- Creation of Signal Location Icon
- Creation of Parking Icon
- Creation of Adverse Roadway Weather Conditions Icon
- Generate an Event by a User starting from Map Location

4.1.6. Import NJ Straight Line Diagram Data

This feature, requested by NJ DOT, provides that capability to incorporate NJ Straight Line Diagram Data into the roadway network map. NJ Straight Line diagram data will be imported in SPATEL to support this function.

4.1.7. Internet-based Thin-Client System

This feature provides an Internet-based Thin-Client user platform (e.g., web browser) for access to the OpenReach system.

4.2. TRANSCOM Data Fusion Engine Enhancements

The feature provides the ability to imports feeds from new sources. Each imported data feed will be processed and mapped to the regional roadway/transit facility network.

4.2.1. New Jersey Transit (NJT) Feeds

This feature provides for the import and processing of transit feeds provided by New Jersey Transit. New Jersey Transit feeds currently have the ability to provide real time location data for transit vehicles, and estimated time of arrival (ETA) information.

4.2.1.1. Process New Jersey Transit Rail (NJT) Feed

This feature provides the ability to process the real-time feed for New Jersey Transit Rail. Integration of the NJT Rail feed to the Data Fusion Engine is currently under development.

4.2.1.2. Process New Jersey Transit (NJT) Bus Feed

This feature provides the ability to process the real-time feed for New Jersey Bus Feeds. Integration of the NJT Bus feed to the Data Fusion Engine is scheduled for future development.

4.2.2. Metropolitan Transportation Authority (MTA) Transit Feeds

This feature provides for the import and processing of transit feeds from the MTA. Currently, MTA feeds have the ability to provide real-time location data for transit vehicles, estimated time of arrival information, and incident/event information.

4.2.2.1. Process New York City Transit (NYCT) Subway Feed

This feature provides for the ability to process the New York City Transit Subway Feed. This feed is currently available in GTFS-RT format. Integration of the NYCT Subway Feed to the Data Fusion Engine is scheduled for future development.

4.2.2.2. Process Long Island Rail Road (LIRR) Feed

This feature provides for the ability to process the Long Island Rail Road Feed. This feed is currently available in GTFS-RT format. Integration of the LIRR Feed to the Data Fusion Engine is scheduled for future development.

4.2.2.3. Process Metro-North Railroad (MNR) Feed

This feature provides for the ability to process the Metro-North Railroad Feed. This feed is currently available in GTFS-RT format. Integration of the MNR Feed to the Data Fusion Engine is scheduled for future development.

4.2.2.4. Process New York City Transit (NYCT) Bus Feed

This feature provides for the ability to process the New York City Transit Bus Feed. This feed is currently available in the SIRI format as part of MTA Bus Time®.

4.2.2.5. Process MTA Bus Company Feed

This feature provides for the ability to process the MTA Bus Company Feed. This feed is currently available in the SIRI format as part of MTA Bus Time ®.

4.2.3. Port Authority of NY/NJ (PANYNJ) Transit Feeds

This feature provides for the import and processing of the transit feed from PANYNJ. Currently, this includes incident based alerts.

4.2.3.1. Process Port Authority Trans Hudson (PATH) Feed

The feature provides the ability to process the PATH feed.

4.2.4. Connecticut Department of Transportation (ConnDOT) Transit Feeds:

This feature provides for the import and processing of transit feeds from ConnDOT.

4.2.4.1. Process CT Transit Feed

This feature provides the ability to process the CT Transit Feed.

4.2.4.2. Process Shore Line East Feed

This feature provides the ability to process the Shore Line East Feed. Such a feed does not currently exist.

4.2.5. Port Authority of NY/NJ RFID at Terminals Feed

This feature provides for the import and processing of RFID feeds from PANYNJ at Port Terminals including the ability to generate travel times between RFID readers in a similar manner to the TRANSMIT application.

4.2.6. Member Agency ITS Asset Inventory Feed

This feature provides for the import and processing of ITS asset inventory feeds from member agencies.

4.2.7. New York City DOT Taxi Feed

This feature provides for the import and processing of historical and real-time (when available) of taxi trip information from NYCDOT.

4.2.8. Navteq-HERE historical data (NPMRDS)

This feature provides for the import and processing/fusion of NPMRDS data for the period of 2011-2013.

4.2.9. Native Link Mapping with NJ Mile Marker Shape Files and JSON Historical Data Reporting Service

This feature provides the following enhancements to the Data Fusion Engine:

- Prepare a mapping database of all non-interstate roadways in New Jersey accounting for Roadway, SRI Number, mile markers, and native links based on mile marker shapefiles available from NJ.
- Develop Data Reporting API Service that will provide output based on a user-inputted request to provide historical travel time information along with master data including native link id or trip id, line string, and other metadata information.

4.3. TRANSCOM SPATEL Enhancements

4.3.1. Provide Real-time Travel Time greater than 95th Percentile of Historical Travel Time

This feature will provide a notification alert when trip travel time is greater that 95th percentile historical average travel time. This feature will implement 95th Percentile of Historical travel times as following:

- Calculate runtime delay (Current Trip Travel Time – 95th Percentile of Historical Trip Travel Time)
- Implement 95th percentile of Historical TT in SPATEL Trip Data Analysis Graph – Data Comparison Graph
- Implement 95th percentile of Historical TT in SPATEL Trip Data Analysis Graph – Trip Graph Report
- Include 95th Percentile of Historical TT in EXCEL export reports
- Include this calculated delay and flag it in Travel Time Feeds as per TRANSCOM suggestions and by following TRANSCOM Business Rules
- Develop configurable email alerts when this calculated delay (Current Trip Travel Time – 95th Percentile of Historical Trip Travel Time) reaches beyond certain threshold (configurable by user).
- Add user indicating functionality in SPATEL trip dashboard when this calculated delay reaches beyond certain threshold (configurable)

4.3.2. Provide Trip Travel Time Reliability

This feature will provide the user with trip travel time reliability for a specified route based on historical data.

4.3.3. Determine Average Travel Time for Trip by Specific Time Period

This feature will allow users to specify data aggregation formats for trip travel time data, for example Monthly average, Quarterly Average, Seasonal Average, Yearly Average (Mon, Tue, … Sun), etc.

This feature also provides the capability to determine Average Travel Time for a Trip by Specified Periods (e.g., Month, Mondays, etc.)

4.3.4. Compare Expected vs. Real-time Trip Travel Time

This feature provides users the ability to compare Expected vs. Real-time Travel Time for a Period of Time into the Future (e.g., 30 Minutes, configurable). This feature will integrate expected Trip Travel Time in the following:

- SPATEL Trip Data Analysis Graph – Data Comparison Graph
- SPATEL Trip Data Analysis Graph – Trip Graph Report
- Travel Time Feeds as per TRANSCOM suggestion and by following TRANSCOM business rules

4.3.5. Compare Downstream and Upstream Segment Speed Data

This feature will allow the user to specify segments and parameters to flag notifications for situations when Downstream Segment Speeds are significantly Higher or Lower than Upstream Segment.

4.3.6. Record Travel Time, Playback Video, and Distribution

This feature will allow the user to record travel time information, playback, and distribute results via e-mail.

4.3.7. Develop Report Enhancements of the SPATEL Tool

This feature will modify the EXCEL reporting function to include columns for Posted Speed for Trip, and color based on both speed and percentage

4.3.8. Map Navteq-HERE Historical Data (NPMRDS) into SPATEL

This feature provides for the integration of NPRDS information as a SPATEL data source.

4.3.9. Create Additional Layers for SPATEL

This feature provides the following enhancements to SPATEL:

- Create a Freight Layer (map icons for parking locations, parking availability, and freight routes)
- Create a Weather Layer (map icons for adverse roadway weather conditions, and those ESS/RWIS providing information reflecting adverse or normal roadway weather conditions.)
- Generate an ad-hoc Freight Trip via SPATEL including the ability to generate as-requested freight routes based on available freight condition information, such as bridge height, weight restrictions, etc.

4.3.10. Create Tablet Version of SPATEL Analysis Tool

This feature will provide users with a tablet version of the SPATEL analysis tools.

4.3.11. 3rd Party Review of SPATEL Source Code

This feature provides for a 3rd Party Software Company to review and maintain all source code.

4.3.12. Evaluate Best Approach and Execution of Travel Time amongst Vendors

This feature provides for the evaluation of Travel Time Vendors' data.

4.3.13. Provide Automatic Email Alerts

This feature provides the ability for email reports to be created and sent for specific corridors to disseminate conditions within a specified date and time range.

4.3.14. Incorporate TRANSMIT Historical data

This feature provides the following enhancements to SPATEL:

- Add TRANSMIT historical data for years 2011 through 2013 to augment the HERE NMPRDS historical TMC condition data.
- Convert TRANSMIT segment historical data into native link format for years 2011, 2012, and 2013 by using TRANSMIT segment to native link mapping, and prepare this data to be available for comparison with NPMRDS historical TMC data.
- Make this data available in various graphical formats so that it can be compared with other historical data sources in the same interface as the SPATEL Historical Data Analysis Tool.

4.3.15. Provide Ability to Analyze Historical Data for Any Three Year Period

This feature provides the ability to analyze historical travel time data for any trip for up to a three-year period.

4.3.16. Create Bottleneck List

This feature provides the following enhancements to SPATEL:

- Create a bottleneck list and map for a state, specific roadway, or region.
- Provide a user interface for users to view historical bottleneck data for an area selected by state, county, specific roadway(s), or region over a specified time range and period.
- Provide capability for user to export selected bottleneck data.

4.3.17. Display Trips by Map Based Query

This features provides a map based interface in the Historical Data Analysis Tool of SPATEL, where a user can view all available trips for by querying an origin/destination pair, a radius, a polygon, or a specific trip type.

4.3.18. Provide User Generated Trips

This feature provides member agency users the with the ability to create their own trips for a short time period (e.g. two weeks) and provide data typically available for trips, including developing a dynamic travel data feed and making trips available in the Operations Dashboard.

4.3.19. Compare Incident Related Trips to Historical Data

This feature enhances the existing Historical Event Search tool to permit users to compare performance data for incident related trips to historical data for the selected trips, which may be filtered by year, season, quarter, month, day of the week, weekdays, or weekends. The travel time graph is used to compare data.

4.3.20. Provide Graphical View of Historical Event Breakdown

This feature uses graphics including radial charts, heat maps, and 3D maps to show the number of events/incidents for a specific time of day or day of the week, with user selectable filters.

4.3.21. Exclude Specific Days from Historical Travel Time Analysis Tool

The feature allows specific days (e.g. snow days, major events, roadway closures) to be removed from the Historical Travel Time Analysis Tool from a monthly query.

4.3.22. Provide Level of Service Details

This feature incorporates Level of Service Details into trip travel time graphs.

4.3.23. Provide Incident Summary Details in Historical Travel Time Tool

This feature provides incident summary details in the heat maps in the Historical Travel Time Tool, to provide insight on travel time details shown in this tool.

4.3.24. Display Real Time Speed Histogram

This feature provides a histogram of speed data in real time as a function on the Operational Dashboard

4.3.25. Compare Speed and Travel Time

This feature allows travel time to be compared to speed on speed histograms.

4.3.26. Provide Event Details within Histograms

This feature displays event summaries on travel time and speed histograms for the following categories:

- Incident
- Weather related Event
- Congestion
- Active Highway Construction Events
- Active Highway Special Events

4.3.27. Provide Zone-Based Email Alerts

This feature enhances the Zone Monitoring Tool by providing email alerts for incidents and low travel times based on user configured preferences.

4.3.28. Provide Time Filters within Corridor and Project Monitoring Tools

This feature enhances the Corridor Monitoring Tool and the Project Monitoring Tool by providing alerts related to travel time and incidents, which can be configured by parameters such as time of day, day of the week, and email list.

4.3.29. Provide Transit Vehicle Location

This feature enhances the Operational Map by displaying the location of transit vehicles (rail and bus).

4.4. TRANSCOM Middleware Enhancements

The project has been divided into two phases. Phase 1 involves the current set of data that TRANSCOM collects from member agencies. Phase 2 will add additional capabilities, such as device control, environmental and weather data, and real-time transit information. Currently, Phase 1 of Middleware

has been completed, as a result of successful verification testing in February, 2015. Phase 2 is currently underway.

4.4.1. TRANSCOM Middleware Phase 1

This feature will allow centers to exchange information in a format based on ITS standards.

- Exchange Roadway Network Information
- Exchange Speed and Travel Time Information
- Exchange Event Information (Incidents, Construction, Special Events)
- Exchange Dynamic Message Sign Information
- Exchange CCTV Information
- Exchange Parking Information

4.4.1.1. Exchange Roadway Network Information

This feature provides for the exchange of roadway network information between authorized centers and TRANSCOM Middleware.

4.4.1.2. Exchange Speed and Travel Times

This feature provides for the exchange of speed and travel time information between authorized centers and TRANSCOM Middleware.

4.4.1.3. Exchange Event Information

This feature provides for the exchange of information about roadway and transit events (incidents, construction, and special events) between authorized centers and TRANSCOM Middleware.

4.4.1.4. Exchange Dynamic Message Sign Data

This feature provides for the exchange of dynamic message sign data between authorized centers and TRANSCOM Middleware.

4.4.1.5. Exchange CCTV Data

This feature provides for the exchange of CCTV data between authorized centers and TRANSCOM Middleware.

4.4.1.6. Exchange Parking Data

This feature provides for the exchange of parking data between authorized centers and TRANSCOM Middleware.

4.4.2. TRANSCOM Middleware Phase 2

This feature will allow centers to exchange information in a format based on ITS standards.

- Exchange Device Control Requests
- Exchange Real-Time Transit Information
- Exchange Roadway Weather Information
- Exchange Freight Information
- Exchange ITS Asset Inventory
- Exchange Probe Data Information
- Exchange Performance Measures Information

4.4.2.1. Exchange Device Control Requests

This feature provides for the exchange of device control requests for DMS and CCTV between authorized centers and TRANSCOM Middleware.

4.4.2.2. Exchange Real-Time Transit Information

This feature provides for the exchange of real-time transit information between authorized centers and TRANSCOM Middleware.

4.4.2.3. Exchange Roadway Weather Information

This feature provides for the exchange of roadway weather information between authorized centers and TRANSCOM Middleware.

4.4.2.4. Exchange Freight Information

This feature provides for the exchange of freight information between authorized centers and TRANSCOM Middleware.

4.4.2.5. Exchange ITS Asset Inventory Information

This feature provides for the exchange of ITS asset inventory information between authorized centers and TRANSCOM Middleware.

4.4.2.6. Exchange Probe Data

This feature provides for the exchange of probe data between authorized centers and TRANSCOM Middleware.

4.4.2.7. Exchange Performance Measures Information

This feature provides for the exchange of performance measures data between authorized centers and TRANSCOM Middleware.

4.5. TRANSCOM Data Exchange Enhancements

4.5.1. Create and Process Dynamic Trips

This feature allows Data Exchange system users to:

- Create Dynamic Trips (i.e., select the origin and destination of the trip from a map)
- Provide output suitable for storing and printing
- Selection by type of trip requested (i.e. freight vs. bus vs. passenger vehicle)
- Associate Multiple Routes with a Created Trip

4.5.2. Provide Trip Travel Time Data

This feature allows users the capability to:

- Select and flag downstream segment speeds significantly higher or lower than upstream segment
- Provide Travel Time Reliability for a Trip
- Compare TT by Data Types (e.g., data source) Available for Common Links (i.e., TRANSCOM regional network links)

4.5.3. Provide Performance Measures Data

This feature provides the capability to share a set of measures (TBD) to support agency-requested performance metrics. It will be updated to support Map-21 Performance Measures Application for

Corridors measures when released by USDOT, which are anticipated to include freight and highway system delays and reliability.

4.5.4. Provide Real-Time Transit Information

This feature provides the capability to disseminate real-time information about the current operation of regional transit services. The following information is provided:

- Transit Trip Estimated Time of Arrival (ETA) information. This can be viewed by trip (ETA for all stops on a trip) or by stop (ETA for all trips arriving departing from a stop).
- Transit vehicle location information.
- Event/incident information affecting transit service or transit facilities.

4.5.5. Provide Trip Based Performance Measure Data for Integration to Agency GIS Systems

This feature provide trip based performance measure data in JSON feed with shape files to allow integration into an agency's GIS system.

Appendix A – Acronyms

Acronym	Description
API	Application Programming Interface
ATDM	Advanced Transportation and Demand Management
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
C2C	Center to Center
CCTV	Closed Circuit Television
ConOps	Concept of Operations
ConnDOT	Connecticut Department of Transportation
DMS	Dynamic Message Sign (includes variable, changeable, drum, and blank-out signs)
ESS	Environmental Sensor Station
ETA	Estimated Time of Arrival
FHWA	Federal Highway Administration
GPS	Global Positioning System
GTFS	General Transit Feed Specification
HAR	Highway Advisory Radio
ICM	Integrated Corridor Management
ISG	Infosense Global Solutions
MAC	Media Access Control

MPO	Metropolitan Planning Organization
MTA	Metropolitan Transportation Authority
MULTI	Markup Language for Transportation Information (see NTCIP 1203 v02)
NJDOT	New Jersey Department of Transportation
NJT	New Jersey Transit
NJTA	New Jersey Turnpike Authority
NJTPA	New Jersey Transportation Planning Authority
NPMRDS	National Performance Management Research Data Set (FHWA)
NYC DOT	New York City Department of Transportation
NYCT	New York City Transit (division of MTA)
NYPD	New York City Police Department
NYSP	New York State Police
NYSDOT	New York State Department of Transportation
OIC	Operations Information Center
PANYNJ	Port Authority of New York and New Jersey
RFID	Radio Frequency Identification
RSE	Roadside Equipment
RWIS	Road Weather Information System
SAE	Society of Automotive Engineers
SEP	Systems Engineering Process
SIRI	Service Interface for Real Time Information
TMDD	Traffic Management Data Dictionary
TRANSCOM DE	TRANSCOM Data Exchange
TRANSCOM DFE	TRANSCOM Data Fusion Engine
TRANSCOM OIC	TRANSCOM Operations Information Center
TRANSCOM SPATEL	TRANSCOM Selected Priorities Applied to Evaluated Links
VMS	Variable Message Sign
XML	Extensible Markup Language

Appendix B – Traceability Matrix of System Features to User Needs

System Feature ID and Title	User Need ID and Title
4.1. TRANSCOM OpenReach Enhancement	
4.1.1. Create Non-incident Event Log	3.1.4 Scheduled Event Information, 3.1.5 Scheduled Construction Information
4.1.2. Create Author of Unassociated Actions	3.1.7 Operational Enhancement of Event Management Tool
4.1.3. Create Construction Conflicts Module	3.1.6 Construction Schedule Conflicts
4.1.4. Create Regional Conditions Report Filter	3.1.7 Operational Enhancement of Event Management Tool
4.1.5. OpenReach Map Enhancements,	3.3.3 Operational Enhancements to Roadway Network Map
4.1.6. Import NJ Straight Line Diagram Data	3.3.3 Operational Enhancements to Roadway Network Map
4.1.7. Internet-based Thin-Client System	3.1.7 Operational Enhancement of Event Management Tool
4.2. TRANSCOM Data Fusion Engine Enhancements	
4.2.1. New Jersey Transit (NJT) Feeds	
4.2.1.1. Process New Jersey Transit (NJT) Rail Feed	3.8.2 Real-time Transit Information
4.2.1.2. Process New Jersey Transit (NJT) Bus Feed	3.8.2 Real-time Transit Information
4.2.2. Metropolitan Transportation Authority (MTA) Transit Feeds	
4.2.2.1. Process New York City Transit (NYCT) Subway Feed	3.8.2 Real-time Transit Information
4.2.2.2. Process Long Island Rail Road (LIRR) Feed	3.8.2 Real-time Transit Information
4.2.2.3. Process Metro-North Railroad (MNR) Feed	3.8.2 Real-time Transit Information
4.2.2.4. Process New York City Transit (NYCT) Bus Feed	3.8.2 Real-time Transit Information
4.2.2.5. Process MTA Bus Company Feed	3.8.2 Real-time Transit Information
4.2.3. Port Authority of NY/NJ (PANYNJ) Transit Feeds	
4.2.3.1. Process Port Authority Trans Hudson (PATH) Feed	3.8.2 Real-time Transit Information
4.2.4. Connecticut Department of Transportation (ConnDOT) Transit Feeds	
4.2.4.1. Process CT Transit Feed	3.8.2 Real-time Transit Information
4.2.4.2. Process Shore Line East Feed	3.8.2 Real-time Transit Information
4.2.5. PANYNJ RFID at Terminals Feed	3.10.2.2 Freight Delays and Travel Time

System Feature ID and Title	User Need ID and Title
4.2.6. Member Agency ITS Asset Inventory Feed	3.12.3 ITS Asset Inventory
4.2.7. NYCDOT Taxi Feed	3.2.2.3 Probe Data for Roads
4.2.8. Navteq-Here Historical Data (NPMRDS)	3.3.2.4 Historical Data for Roads, 3.11.2 Performance Measures Data
4.2.9. Native Link Mapping with NJ Mile Marker Shape Files and JSON Historical Data Reporting Service	3.3.3 Operational Enhancements to Roadway Network Map
4.3. TRANSCOM SPATEL Enhancements	
4.3.1. Provide Real-time Travel Time greater than 95th Percentile of Historical Travel Time	3.11.2.1 Provide Trip Travel Time vs. Historical
4.3.2. Provide Trip Travel Time Reliability	3.11.2.2 Provide Trip Travel Time Reliability
4.3.3. Determine Average Travel Time for Trip by Specific Time Period	3.11.2.3 Provide Average Trip Travel Time over User Specified Time Period
4.3.4. Compare Expected vs. Real-time Trip Travel Time	3.11.2.2 Provide Trip Travel Time Reliability
4.3.5. Compare Downstream and Upstream Segment Speed Data	3.11.2.4 Provide Comparison of Downstream vs. Upstream Segment Speed Data
4.3.6. Record Travel Time, Playback Video, and Distribution	3.11.2.7 Provide Performance Measures Dashboard and Reports
4.3.7. Develop Report Enhancements of the SPATEL Tool	3.11.2.7 Provide Performance Measures Dashboard and Reports
4.3.8. Map Navteq-Here historical data (NPMRDS) into SPATEL	3.11.2.1 Provide Trip Travel Time vs. Historical
4.3.9. Create Additional Layers for SPATEL	3.11.2.5 Provide Weather Impact Indicators, 3.11.2.6 Provide Freight Travel Impact Indicators
4.3.10. Create Tablet Version of SPATEL Analysis Tool	3.11.2.8 Provide Operational Enhancements of Performance Measures Tool
4.3.11. 3rd Party Review of SPATEL Source Code	3.11.2.8 Provide Operational Enhancements of Performance Measures Tool
4.3.12. Evaluate Best Approach and Execution of Travel Time amongst Vendors	3.11.2.9 Provide Evaluation of Travel Time Data Sources
4.3.13. Provide Automatic Email Alerts	3.11.2.11 Incident and Travel Time Alerts
4.3.14. Incorporate TRANSMIT Historical Data	3.2.2.4 Historical Data for Roads
4.3.15. Provide Ability to Analyze Historical Data for Any Three Year Period	3.2.2.4 Historical Data for Roads
4.3.16. Create Bottleneck List	3.11.2.10 Provide Bottleneck Information
4.3.17. Display Trips by Map Based Query	3.11.2.8 Provide Operational Enhancements to Performance Measures Tool
4.3.18. Provide User Generated Trips	3.3.3 Operational Enhancements to Roadway Network Map
4.3.19. Compare Incident Related Trips to Historical Data	3.11.2.1 Provide Trip Travel Time vs. Historical
4.3.20. Provide Graphical View of Historical Event Breakdown	3.11.2.8 Provide Operational Enhancements to Performance Measures Tool
4.3.21. Exclude Specific Days from Historical	3.2.2.5 Optimize Historical Data

System Feature ID and Title	User Need ID and Title
Travel Time Analysis Tool	
4.3.22. Provide Level of Service Detals	3.2.2.6 Level of Service Data
4.3.23. Provide Incident Summary Details in Historical Travel Time Tool	3.11.2.8 Provide Operational Enhancements to Performance Measures Tool
4.3.24. Display Real Time Speed Histogram	3.11.2.8 Provide Operational Enhancements to Performance Measures Tool
4.3.25. Compare Speed and Travel Time	3.11.2.8 Provide Operational Enhancements to Performance Measures Tool
4.3.26. Provide Event Details within Histograms	3.11.2.8 Provide Operational Enhancements to Performance Measures Tool
4.3.27. Provide Zone-Based Email Alerts	3.11.2.11 Incident and Travel Time Alerts
4.3.28. Provid Time Filters within Corridor and Project Monitoring Tools	3.11.2.11 Incident and Travel Time Alerts
4.3.29. Provide Transit Vehicle Location	3.11.2.8 Provide Operational Enhancements to Performance Measures Tool
4.4. TRANSCOM Middleware Enhancements	
4.4.1. TRANSCOM Middleware Phase 1	
4.4.1.1. Exchange Roadway Network Information	3.3.2 Roadway Network Data
4.4.1.2. Exchange Speed and Travel Times	3.2.2 Travel Time Data
4.4.1.3. Exchange Events (Incidents, Construction, Special Events)	3.1.3 Incident Information, 3.1.4 Scheduled Event Informaiton, 3.1.5 Scheduled Construction Information
4.4.1.4. Exchange Dynamic Message Sign Data	3.4.2 DMS Data
4.4.1.5. Exchange CCTV Data	3.5.2.1 CCTV Device Inventory, 3.5.2.2 CCTV Device Status
4.4.1.6. Exchange Parking Information	3.7.2 Parking Data
4.4.2. TRANSCOM Middleware Phase 2	
4.4.2.1. Exchange Device Control Requests	3.6.2.1 Request to Control a Remote CCTV, 3.6.2.1 Request to Control a Remote DMS
4.4.2.2. Exchange Real-Time Transit Information	3.8.2 Real-Time Transit Information
4.4.2.3. Exchange Roadway Weather Information	3.9.2.1 Road Weather Environment Conditions Data, 3.9.2.2 Weather Forecasts
4.4.2.4. Exchange Freight Information	3.10.2 Freight Data
4.4.2.5. Exchange ITS Asset Inventory	3.12.3 ITS Asset Inventory
4.4.2.6. Exchange Probe Data	3.2.2.3 Probe Data for Roads
4.4.2.7. Exchange Performance Measures Information	3.11.2 Performance Measures Data
4.5. TRANSCOM Data Exchange Enhancements	
4.5.1. Create and Process Dynamic Trips	3.3.3 Operational Enhancements to Roadway Network Map
4.5.2. Provide Trip Travel Time Data	3.2.2 Travel Time Data
4.5.3. Provide Performance Measures Data	3.11.2 Performance Measures Data
4.5.4. Provide Real-Time Transit Information	3.8.2 Real-time Transit Information

System Feature ID and Title	User Need ID and Title
4.5.5. Provide Trip Based Performance Measure Data for Integration to Agency GIS Systems	3.11.2.12 Provide Integration for GIS Systems