

# Concept of Operations for the Houston Intelligent Transportation System (HITS) Project

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Prepared for the City of Houston Traffic Operations Division

Prepared by the Texas A&M Transportation Institute and City of Houston

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## 1 Purpose of Document

The Concept of Operations (ConOps) document defines the operational mission of the Houston Intelligent Transportation System (HITS) project and sets forth the operational requirements necessary to achieve that mission. The ConOps defines: 1) the goals, objectives, and capabilities of each system included in the project; and 2) the roles and responsibilities of the City of Houston, other agencies, and associated project stakeholders.

The purpose of this ConOps document is to:

- To ensure that City of Houston and other stakeholder needs and expectations have been documented early in the project development process;
- To ensure that the project deployment is linked to the agency mission, goals, and objectives;
- To identify and document existing operations, and where gaps may exist;
- To identify where the HITS system could supplement existing operations;
- To define the envisioned operational environment with the HITS system in place;
- To establish a list of operational requirements; and
- To begin the traceability of the systems engineering process.

## 2 Scope of Project

Houston is the nation's 4th largest city and is home to some of the most congested roads in the country. Houston is home to approximately 2.1 million residents, with the metropolitan region consisting of approximately 6 million residents. The City of Houston has over 6,000 center lane miles of arterial, collector and local roadway system spanning over 640 square miles. The Texas State Data Center predicts the metropolitan region will add another 2-3 million residents and 1 million jobs by 2030. With a booming population and limited space for urban transportation system capacity expansion, the existing roadway network needs to become 'smarter' to meet the needs of a growing city.

The City of Houston Public Works and Engineering (PWE) is in responsible charge of city infrastructure. The Traffic Operations Division (TOD), housed within PWE, oversees the transportation infrastructure of the city. TOD's stated mission is to "facilitate safe and efficient mobility on the City's streets". TOD's vision is "Integrating people, plans, and projects to deliver premier transportation management services to the City of Houston by:

- Reducing Traffic Congestion on City Streets;
- Improving Traffic Safety Measures Throughout the City;
- Linking System Improvements to Regional Goals;
- Developing New, Sustainable Resources; and
- Increasing Organizational Readiness."

The HITS project directly addresses each of these elements of the vision statement. Through real-time monitoring and control, the city can reduce congestion by using the system optimally and enabling citizens to make more informed decisions and it ties into other regional projects that use travel time

monitoring and messaging to the public for enhanced mobility. In addition, through savings in delay and emissions, it makes the city's transportation system more sustainable. The collection of travel time and volume data will increase the organizations operational knowledge and allow for better planning capabilities to guide future investment.

The goals of the HITS project are to reduce travel delay, improve accessibility, and improve travel time reliability for motorists and transit vehicles on the project corridors. Through these improvements the HITS project would improve functional capacity and reduce vehicular emissions.

Many components of the overall HITS project have been completed or are in progress. They include a fiber cable and wireless (WiMAX) traffic communications network, an initial deployment of cameras and count stations (25 and 16 locations respectively), Bluetooth AVI (50 locations completed, with 602 additional reader locations deployed in 2015) and a more advanced centralized traffic signal software system scheduled for 2016-2017.

The HITS project aligns with the high-level Houston Regional ITS Architecture as shown in Figure 1. The white boxes are subsystems impacted by the HITS project. The project is in general alignment with the regional ITS architecture.

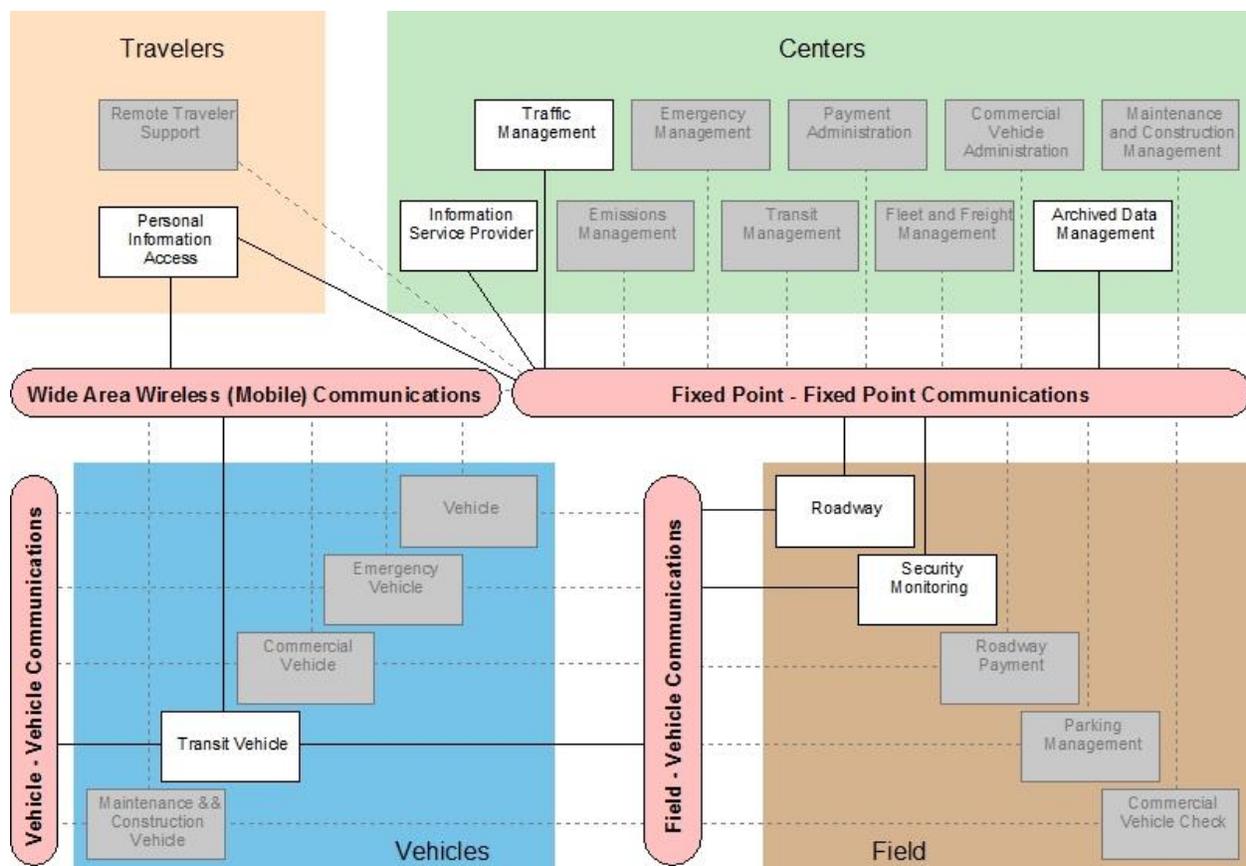


Figure 1 . High-Level ITS Project Architecture Diagram.

## 3 Referenced Documents

U.S. Department of Transportation, California Division. Systems Engineering Guidebook for ITS. [Online] [Cited: December 2015.] <http://www.fhwa.dot.gov/cadiv/segb/>

Additional Local References:

- Houston-Galveston Area Regional ITS Architecture
- National ITS Architecture
- ICM foundational documents (USDOT)
- West Houston ICM Concept of Operations
- Houston TranStar IS Requirements
- Houston TranStar Policy and Procedures Manual

Houstontranstar.org:

- CCTV views: <http://traffic.houstontranstar.org/cctv/transtar/>
- DMS sign messages: [http://traffic.houstontranstar.org/dms/dms\\_by\\_roadway.html](http://traffic.houstontranstar.org/dms/dms_by_roadway.html)
- Route Builder: <http://traffic.houstontranstar.org/routebuilder/>
- Speed Charts: <http://traffic.houstontranstar.org/speedcharts/>
- Speed Map Archive: [http://traffic.houstontranstar.org/map\\_archive/](http://traffic.houstontranstar.org/map_archive/)
- Annual Speed Averages: <http://traffic.houstontranstar.org/hist/histmain.html>
- Historical Travel Times: [http://traffic.houstontranstar.org/hist/hist\\_traveltimes\\_menu.html](http://traffic.houstontranstar.org/hist/hist_traveltimes_menu.html)

## 4 Background

### 4.1 Current Conditions

The City of Houston currently operates and maintains 2,450 traffic signals on a street system of nearly 6,000 center lane miles. At the present time, most real-time operations are reactive in nature (responding to outages reported in 311 or responding to major arterial incidents with Mobility Response Team (MRT) staff). On a relative scale, there is very little real-time signal control and little to no real-time modification of signal timing to current operational conditions. There is very minimal arterial traveler information because the methods to collect real-time data and disseminate them in a meaningful manner are limited at this time. However, the city has identified enhanced arterial operations as a priority initiative in its mission.

In 2011, the city began deploying WiMAX technology to enable multiple public works applications, one of which was to extend real-time communications to a majority of traffic signal cabinets. In 2015, the city selected a new central management software solution to upgrade capabilities to control traffic signals in real-time. With the WiMAX communications as a foundation for widespread real-time

capability, and the new central software (Trafficware was awarded a contract to provide ATMS.now for the city's central software solution) to provide the ability for real-time control of signal operations, complementary and proactive ITS elements are needed to extend the capability for enhanced signal operations, arterial traveler information, arterial monitoring and data collection on key city street corridors.

## 4.2 Rationale for the HITS Project

The HITS project is intended to strengthen all aspects of the delivery of transportation services in the City of Houston, including in the areas of operations & maintenance, incident management, and planning. There is a need for TOD to generate multi-faceted data, from traffic volumes from mid-block detection and traffic signal detectors; to performance measures of arterial streets (including travel times and throughput); to origin-destination information to be used in future planning efforts.

There is also a need to provide real-time information to other operating agencies and the traveling public to optimize use of the arterial system during normal and incident conditions.

## 4.3 What the HITS Project Will Do

The HITS project is an expansion of existing ITS infrastructure to monitor and manage arterial traffic in real-time. The scope of the project is deployment on approximately 150 arterial corridors, in 16 zones, throughout the City of Houston. The geographic scope of the project is shown in the Exhibits located in Appendix A. The functional scope of the HITS project will:

- Enable traffic management staff to detect abnormal network conditions so that they may use central control to optimize operations by changing signal timing plans under various conditions;
- Provide operational visibility to enable traffic management staff to detect and respond to congestion and incidents in near-real time;
- Provide real-time traveler information to the public, partner agencies, and media outlets for use and dissemination;
- Provide data for post-event analysis, TSM&O improvements, and long-term planning efforts; and
- Allow maintenance staff to identify, assess, and respond faster to equipment failures.

The portion of the HITS project covered by this ConOps (and partially funded by the 2014 TIGER Grant) will deploy 91 Dynamic Message Signs (DMS), 113 Closed-Circuit Television (CCTV) cameras, 144 traffic count stations, 489 enhanced traffic signal detection locations. This system will leverage existing and programmed infrastructure deployments, including fiber cable/ wireless (WiMAX) communication system, 650 Bluetooth Automatic Vehicle Identification (AVI) sites, and deployment of a centralized arterial traffic management software system (ATMS). A brief discussion on each of the elements of HITS and why each is important to the overall project goals is summarized below.

**WiMAX Communications.** The City of Houston has deployed Worldwide Interoperability for Microwave Access (WiMAX) at more than 1,650 traffic signals. WiMAX enables the City to wirelessly communicate

with each signal for coordination and central control. Also, WiMAX will be used to communicate with each DMS, CCTV camera, and count station proposed on the HITS project.

**Central Software.** A central software system provides remote access and control for the City's traffic signal network, as well as selected ITS devices (including CCTV and detection systems). This system can monitor intersection controllers in real-time, enabling operators to invoke signal timing changes remotely, and implement action plans (preset timing changes) for events and incidents. Centralized control will help coordinate signal operations within Houston and across neighboring jurisdictions, and enable TOD staff to receive alerts when malfunctions occur. Currently in procurement, this software system has been approved and funded through the regional CMAQ program (recently ATMS.now by Trafficware was selected as the central software solution).

**CCTV Cameras.** Closed Circuit Television (CCTV) cameras provide the ability to monitor traffic flow, verify incidents, and visually verify timing plan implementation.

- The HITS project will install 113 pan-tilt-zoom (PTZ) cameras. These cameras will typically have the ability to view all four approaches of an intersection, with key video feeds made available to the media and public in a manner consistent with current freeway CCTV. This capability does not exist for traffic operations on city arterials.

CCTV deployed on fiber routes will have full motion video and snapshot capability. CCTV deployed on WiMAX can be configured for full motion (30 frames per second (FPS)), but most will likely be 5-10 FPS to preserve bandwidth. Public viewing of CCTV on WiMAX will be via snapshots or motion images (5-8 snapshots in a short movie) only via the Houston TranStar website.

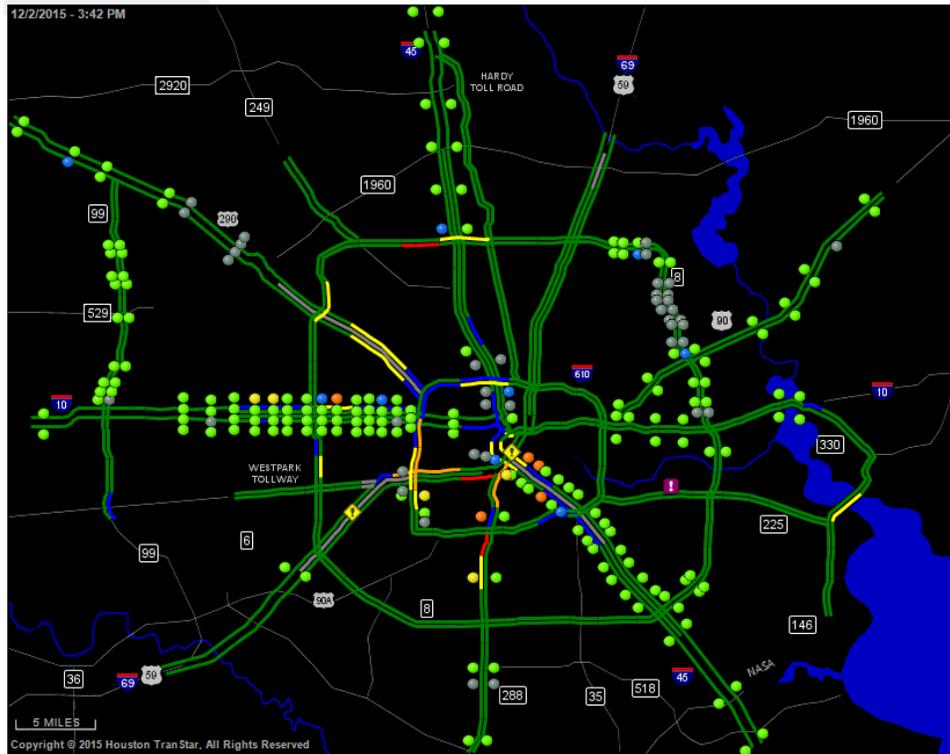
**Dynamic Message Signs (DMS).** DMS are a key component to relaying travel time and incident information to drivers via roadside display. They can influence driver route selection, reduce travel time, mitigate the severity & duration of congestion due to incidents, and contributes to improvement of the network's overall performance.

- HITS calls for the deployment of 91 DMS at key locations along Houston's arterial roadway network. These DMS will be used to post travel times, incident information, and other messages to arterial travelers. This capability does not exist today on COH arterials.

**Midblock Speed and Count Stations.** Deployment of 144 midblock traffic count and speed stations allow transportation managers to monitor fluctuations in traffic volumes throughout the day, and allow the capture of seasonal and long-term changes in traffic patterns that influence planning. The initial deployment of midblock count stations is complete, with 16 stations in Houston's west side.

- 16 count stations currently exist. An additional 144 count will be installed as part of the HITS project to bring wider-area monitoring to the city.
- Algorithms will be deployed to monitor sudden, unexpected drops in speed or abnormal volume levels and generate alarms to notify City of Houston operators at TranStar.

Several existing types of point detection provide partner TranStar agencies with traffic volume, speed and lane occupancy. These point detectors use a variety of technologies including inductive loop, radar and video detectors. TxDOT detectors, for example, feed other operations such as inputs for the ramp metering systems on some corridors in the area. Partner agencies have experience with the technology to assist the City in their deployment and operations.



**Figure 2. Speed/Volume Radar Detection Sites in the Houston Area (as of December 2015).**

These radar sites give traffic operations staff an ability to view average speed, average lane occupancy (in percent), total volume, and volume by class (small, medium, and large size vehicles) in 30 second bins by lane. An example of the 30-second data is shown in Figure 3.

IH-45 North Southbound at Richey		View Charts				
Lane Description	Average Speed (mph)	Average Occupancy %	Total Volume	Total Small	Total Medium	Total Large
SB Outside	52	15	16	13	0	3
SB Middle 1	65	11	14	12	1	1
SB Middle 2	64	12	12	6	4	2
SB Inside	71	12	17	12	4	1
<b>Summary</b>	<b>63</b>	<b>12</b>	<b>59</b>	<b>43</b>	<b>9</b>	<b>7</b>

Data Time: 3:44:00 PM 12/02/2015 - 30 second data

< Close Window > Close this window before opening another one.

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**Figure 3. Radar Detector 30-Second Data Summary.**

A program runs at Houston TranStar to process 30-second radar data into charts to compare current volume, speed and communications reliability against a rolling average of the previous three months of similar days (e.g., previous 12 Mondays). Examples of these charts are shown in Figure 4 below.

Houston TranStar Radar Charts

IH-45 North Southbound at Richey

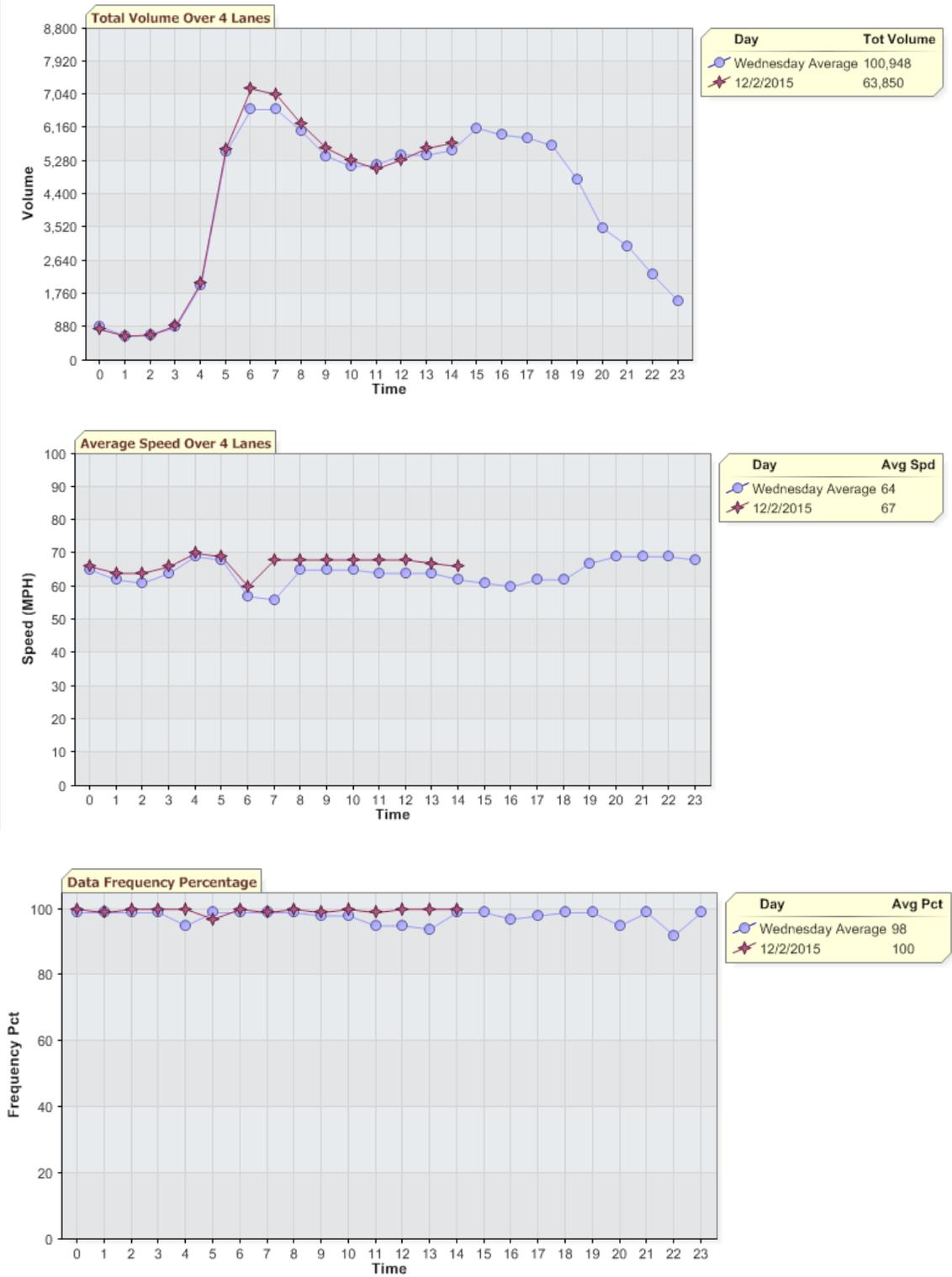
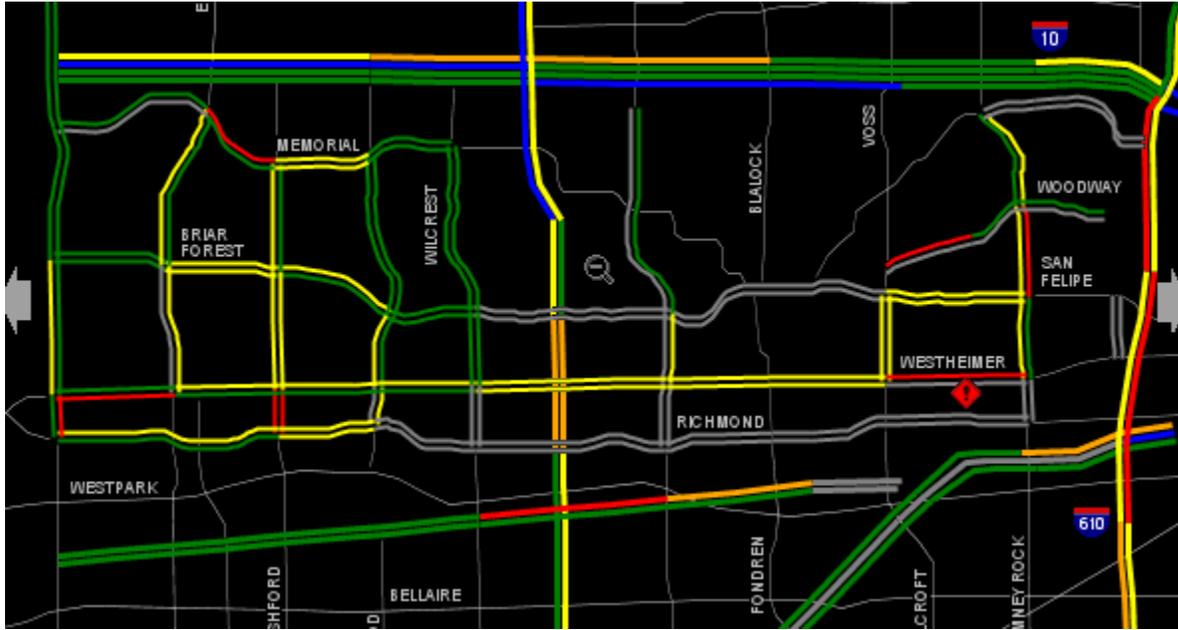


Figure 4. Example of Volume, Speed and Communications Reliability Charts for Radar Detector Sites

**Travel Time Monitoring System.** The City of Houston is currently operating 48 Bluetooth-based Anonymous Wireless Address Matching (AWAM) readers in west Houston. Data is disseminated in real-time on Houston TranStar’s website. By tracking arterial corridor speeds and travel times, TOD can provide real-time operational data to travelers and study demand patterns and trends with archived data. A total of 650 AWAM reader locations will have been deployed to support the HITS project.



**Figure 5. West Houston Arterial Travel Time Coverage.**

As part of HITS, an alarm mechanism will be developed and installed to warn operators when speeds drop below a certain threshold so that they can be monitored and/or actions taken to mitigate the congestion.

## 5 Proposed System Concept

The HITS project is intended add several layers of operational awareness and traveler information to the City of Houston arterial network. Early in the process, city staff were queried to provide input on what functionality would be needed to enable the city to use this operational information to invoke changes in traffic signal operations and generate real-time performance measures on arterial operations.

Early concept exploration for the HITS project built on the deployment of a widespread wireless communication system based on the WiMAX protocol. Once this communication system was in place, it would allow real-time monitoring of signal operations and allow faster response to intersections if a non-normal state. However, city staff also envisioned deployment of other ITS infrastructure – from more basic monitoring of travel times and traffic volumes, to more aggressive implementation of DMS signs, CCTV, changeable lane assignment, dynamic lane assignment and other active traffic management techniques.

After discussions among various levels of city staff, the desire was to accomplish a few main objectives with a HITS project, with constraints which included widespread deployment across city council boundaries to crosscut all segments and areas of the city.

One area that was critical to address in the HITS project was to provide enhanced traffic signal detection at selected intersections. This would increase reliability for normal operations and enable additional functionality, including automated traffic counts and calculation of enhanced performance measures. In a city with over 2,400 traffic signals, there are numerous traffic signal approach configurations and many ways to use various technologies to detect them. Through the HITS project, city staff wanted to provide the most appropriate and efficient detection at critical intersections throughout the city. The second objective was to be able to generate traffic data from the enhanced detection deployment, which is an emerging industry capability. This would help city staff optimize traffic signal timings based on automatically collected turning movement counts.

City staff also desired to be able to collect traffic volumes on approach to intersections and at mid-block locations on a daily, long term basis to track growth in various areas of the city. Primarily for data collection and planning efforts, a continuous traffic data collection gives a historic context to proposing improvement projects to alleviate congestion and preempt it in emerging areas of town. Secondly, but just as important, collection of traffic volumes, classification, and spot speeds is one way to detect, in real-time, abnormal conditions that can be addressed through changes in signal timing or deployment of the City of Houston's Mobility Response Team to critical intersections.

Another technology that could be used to detect abnormal conditions is through the existing AWAM travel time monitoring system deployed in the West Houston area. This system uses Bluetooth-based probe data to generate travel times and speeds over arterial street segments. This system was deployed in 2010 on a test basis and is being expanded from the current 50 readers to more than 650 readers in 2015. This system makes it possible to collect current travel times on the arterial network at a price point that is feasible on a widespread deployment. Both the travel time monitoring and traffic volume monitoring systems are desired to be used to provide alarms or alerts for unusual arterial roadway operational conditions. When these abnormal conditions are sensed, city staff would train their attention to those areas or segments to determine if an operational response is needed. To provide visual observation capability at critical points in the arterial roadway, deployment of CCTV was desired.

City staff also expressed a desire to provide a level of traveler information on the arterial system in key corridors. With the evolution of dynamic message technology to include graphical and multi-color screens at a reasonable cost, this technology was desired to provide text-based messages as well as graphical images where appropriate. The Houston population is used to receiving traffic information via DMS on the freeways and tollways, and it was a logical extension to provide DMS capability on the arterial system. By policy, there was a desire to automatically provide travel time information to travelers on the arterial network via roadside message signs (from the travel time monitoring system) and as well through the [houstontranstar.org](http://houstontranstar.org) website.

The HITS project will interface with existing systems at Houston TranStar and within the City of Houston. The high level relationships among various existing and planned subsystems are depicted in Figure 6 below. This diagram represents how the HITS project will interface with existing subsystems at Houston TranStar and existing and planned HITS project elements.

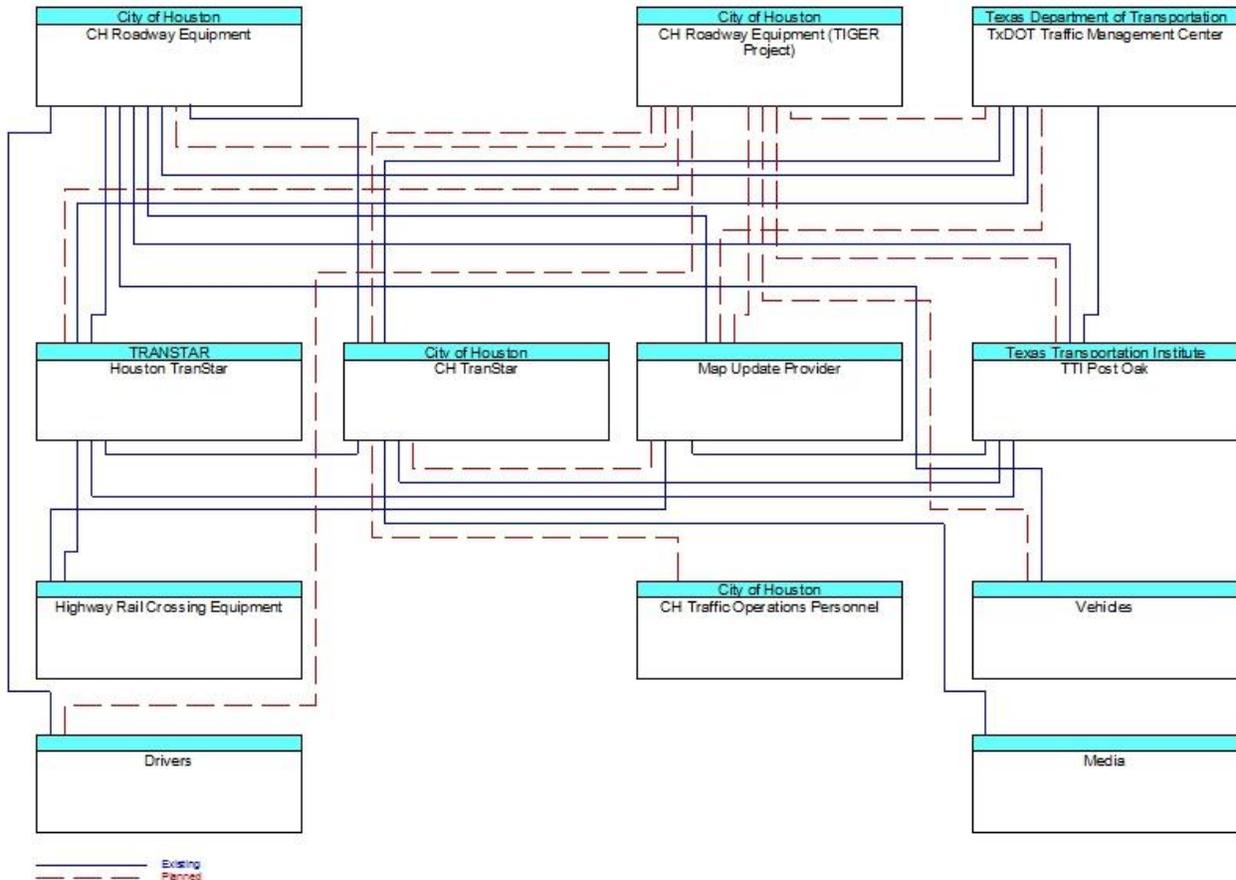


Figure 6 . High-Level Data Flow Diagram for the HITS Project.

## 6 User-Oriented Operational Description

In approaching the issue of developing the HITS concept, a customer-specific view of operations is one tool to enable system designers to gain insight into the day-to-day needs of a system's users and the ways that users vision the system will be used. The classes of system users have been defined to include COH operators, motorists/travelers, partner transportation agencies and the media. Each user class's interaction with the HITS is defined as follows:

### 6.1 COH Operators and Traffic Staff

COH operators conduct daily operations defined as: 1) operations related to a significant incident that invokes response or management strategies to be deployed; and 2) normal, recurring congestion conditions.

### 6.1.1 COH Operators

Their activities will include:

- Coverage
  - Major thoroughfares in the City of Houston covered by the HITS system
  - Partial monitoring coverage along freeway and tollway frontage roads within the City of Houston through shared data with TxDOT and Harris County (at TranStar console)
- Monitoring
  - COH CCTV video
  - Regional (TxDOT & Harris County) CCTV video
  - 911 COH EOC HPD/HFD incidents
  - Arterial and freeway travel time system
  - Arterial traffic volume system from:
    - volume count stations and
    - select traffic signal controllers providing enhanced information
  - DMS messaging system
  - Traffic signal system health status and alerts
  - ITS equipment health status and alerts
  - Weather events
  - Other emergency events
- Coordination
  - Coordinate construction and/or lane closure activity with TranStar partners
  - Coordinate regional events (Houston Livestock Show & Rodeo, Super Bowl, etc.)
  - Coordinate signal timing changes with TranStar partners
- System Data Dissemination
  - Enable distribution of arterial travel times via internet and data feed
  - Enable distribution of traveler information via internet and roadside DMS
- Maintenance
  - Perform routine maintenance
  - Monitor Wi-MAX, fiber, cellular, and other communications systems for issues
  - Repair/replace malfunctioning system devices
- Action
  - Monitoring automatically generated messages sent to DMS
  - Posting manually generated messages to DMS
  - Changing signal timings remotely (not a HITS function, but central-software related)
  - Reviewing speed maps, travel speed and volume data to investigate abnormal conditions – report to 311/911/HPD/MRT for response.

These functions will be carried out from the workstations with integrated computer and communications support during normal operational hours and also during special events. In addition to the expected traffic operators, system users may include COH 911 staff, MRT dispatchers, and other city-staff users. COH management and support staff will also occupy the HITS consoles (on the floor or

remotely) and will have remote access to the same traffic information as the traffic operators through their own workstations.

### **6.1.2 COH ITS Administrator**

The HITS Administrator is responsible for the quality of work of the COH operators as well as daily administrative functions and operations. The administrator will set responsibilities for operators and define or limit the range of their monitoring and control of the HITS resources by setting policies and procedures.

### **6.1.3 COH/TranStar - HITS Support Personnel**

HITS will be an integration of various technologies that include computers, communications, video, radio, phone, and vehicle detection sensors. HITS and TranStar support personnel will coordinate the maintenance of field equipment and inventories of spares. COH or TranStar IS support personnel at TranStar includes hardware and software specialists to maintain computer system performance and to troubleshoot issues as they may arise. Communications specialists (COH staff) should provide system performance monitoring and troubleshooting of the Wi-Max and fiber communications systems, CCTV, traffic volume monitoring and travel time systems.

## **6.2 Motorists/Travelers**

Motorists will receive regulatory and advisory information from the HITS via Dynamic Message Signs, the internet, and rebroadcast information via media and 3<sup>rd</sup> party providers. Their vehicles passing sensors generate the data for volume and travel time data processing. With the widespread use of cellular technologies and mobile devices, travelers provide additional anonymized input for the HITS system. Motorists and travelers may make travel decisions based on information distributed by HITS through the houstontranstar.org website. This information may be repackaged and distributed through commercial media or via the Internet.

## **6.3 Partner Agencies**

Partner agencies, including those at Houston TranStar (TxDOT, METRO, and Harris County) will rely on the HITS for arterial information as well as indirect access to DMS to communicate to motorists. Partner agencies shall be able to access HITS information through direct interaction with COH operators or through webpages and remote workstations for input and output of transportation related data.

Partner Agencies include:

- Houston TranStar
- Texas Department of Transportation (TxDOT)
- Texas Department of Public Safety (TxDPS)
- Harris County Public Infrastructure Department (HCPID)
- Harris County Toll Road Authority (HCTRA)
- Harris County Office of Homeland Security
- Harris County Sheriff's Office (HCSO)
- Houston-Galveston Area Council (H-GAC)
- Metropolitan Transit Authority of Harris County (METRO)
- METRO Police (METRO PD)
- City of Houston Police Department (HPD)
- City of Houston Fire Department (HFD)

## 6.4 Information Service Provider

Information Service Providers (ISP) or 3<sup>rd</sup> party data entities operating from the TMC or with data sharing agreements with TranStar repackage HITS generated data and provide timely traffic information to radio stations, television stations, internet websites and other outlets. Data feed specifications should comply with existing TranStar data feed protocols, and new protocols and data feeds should comply with national standards and/or agreed upon protocols among TranStar partner agencies.

## 7 Operational Needs

Given that TOD’s stated mission is to “facilitate safe and efficient mobility on the City’s streets”, and that TOD’s vision is “Integrating people, plans, and projects to deliver premier transportation management services to the City of Houston by: Reducing Traffic Congestion on City Streets; Improving Traffic Safety Measures Throughout the City; Linking System Improvements to Regional Goals; Developing New, Sustainable Resources; and Increasing Organizational Readiness.”, one area in which the city believes that they are lacking, but that can significantly help in reaching their stated vision, is through the use of additional intelligent transportation system elements.

The city currently uses ITS to monitor and manage most traffic signals and measure travel times on selected segments of the arterials system, but the HITS system is intended to address gaps in functionality that are desired. These gaps and the resulting needs are shown in Table 1.

**Table 1. Gaps in Existing City of Houston Arterial ITS Deployments and Proposed Mitigation.**

Gap/Deficiency:	Mitigation:
1. Stakeholders agree that existing traffic signal detection capabilities have degraded over time and are in need of replacement and/or enhancement	Deploy traffic signal detection with enhanced functionality and generate performance measures from central software
2. Stakeholders noted that traffic volumes are measured on a manual, ad hoc basis with a continuous, systematic method desired for performance measurement, traffic operations, and planning purposes	Deploy sensors to measure traffic volumes on key sections of arterial roadways
3. Stakeholders agreed that arterial incident management is limited and that a monitoring and alert function is desired	Deploy a system to monitor and provide alerts when unusual traffic volume or travel time conditions are determined on monitored roadways using a ruleset
4. Stakeholders agreed there is limited operational knowledge of real-time operations and travel times on key arterial facilities for normal, recurring conditions	Deploy CCTV and traffic volume data collection and reporting systems to supplement existing travel time monitoring equipment and reporting systems on arterial roadways

Gap/Deficiency:	Mitigation:
5. Stakeholders agreed there is limited operational knowledge of real-time operations and travel times on key arterial facilities for incident conditions	Deploy a system to automatically send travel time information to roadside message signs and provide traveler information via internet.
6. Stakeholders agreed there is limited arterial traveler information traffic speeds and travel times to the public for normal, recurring conditions	Deploy a system to display travel speeds and travel times to the public via the Houston TranStar website and third-party providers via data feeds
7. Stakeholders agreed there is limited capability to archive and retrieve travel time, speed and volume information for planning purposes	Deploy a system to provide segment travel time, segment travel speed, and traffic volume data for real-time and historic display with ability to export for archived use.

From the gaps and identified mitigation activities, the seven stated needs for HITS include:

1. To provide enhanced traffic signal detection at selected intersections for normal operations and to enable additional functionality, including automated traffic counts and enhanced performance measures;
2. To provide arterial operational monitoring capability through monitoring travel times or traffic volumes;
3. To provide alarms or alerts for unusual arterial roadway operational conditions through monitoring travel times or traffic volumes;
4. To provide visual observation capability at critical points in the arterial roadway network through deployment of CCTV;
5. To automatically provide travel time information to travelers on the arterial network via roadside message signs and houstontranstar.org website;
6. To systematically collect traffic volumes at key points in the arterial roadway network; and
7. To provide an interface for the visualization and export of segment travel times and speeds, and traffic volumes from an archive.

## 8 System Overview

The HITS system will provide a more efficient and reliable travel experience throughout the City of Houston arterial system. Transportation operations within the network will be enhanced through a more enabled and flexible capability to respond to real-time (current) network conditions. Through monitoring system operation and disseminating travel information to the public, the city staff can better influence the optimal use of the capacity of the system in response to changing corridor conditions.

The daily management and operation of the HITS covered arterials will be a primary effort by city staff, but as part of the TranStar consortium, TxDOT, Harris County and Houston METRO staff will have access to the arterial information and can assess that information as to how it will impact their system.

The daily operation of the HITS network will be similar to the existing TMC model used on a regional basis for freeways and tollways, but will focus on a more detailed monitoring and control scheme using the ATMS.now system for arterial management with dedicated city staff. Each City of Houston operator will monitor and control a portion of the HITS arterial network, with major changes in signal timing, or posting of DMS messages to arterial signs coordinated by city Traffic Operations Division supervisory staff. The City of Houston will be responsible for determining which response plans for various scenarios are needed and develop response plans accordingly.

Performance measurement and monitoring will be the responsibility of a combination of the ATMS.now system, existing ITS subsystems (e.g., the AWAM travel time monitoring system), and systems to be designed and delivered as part of this project. The communications, systems, and system networks will be integrated to support the HITS network command center/console. HITS operators and designated staff will monitor arterial network travel conditions up to 24 hours, 7 days per week, and use the response plans, current information, and defined network strategies to address situations as they present themselves. Traveler information provided roadside (via DMS), via Internet, and through the media will be arterial network-based, and will enable travelers to determine travel alternatives using current conditions.

## **8.1 System Users**

There are three primary classes of HITS system users: 1) city transportation management staff, 2) the traveling public, and 3) transportation system planners. How each class of user uses HITS may vary significantly, with very different priorities for each user.

### **8.1.1 The Transportation System Manager**

The transportation management user consists of the team of city staff dealing with traffic and transportation that will use the HITS system to more efficiently move people and goods throughout the major arterials in the city. Through HITS, these users will have a robust set of system performance measures that will be used to make more informed decisions during daily operations and during various incidents within the arterial network. Through the proposed links to the Houston Emergency Center (City of Houston 911) the transportation management user would also have access to the dispatch status during response to incidents via a consolidated view of HPD and HFD/EMS incidents.

### **8.1.2 The Traveler**

The traveler may be considered the ultimate customer and consumer in the eventual deployment of the full HITS concept. While some segment of the traveling public will want the types of information available to the transportation management user, the overall traveling public in the Houston region wants traveler information boiled down to some basic forms: travel time (preferably in real-time) and travel cost (in real-time if some type of congestion pricing is in effect). Any other information is incidental to time and cost, and is essentially provided so that the user can make the best judgment on whether to start a trip, by what mode, by what path, or whether or not to make the trip at all.

Currently, users can get information on the freeway, HOV lane, and tollway systems via the Houston TranStar website's real-time traffic map. Users can get transit route, fare, and schedule information in

static form through a link from the TranStar website to the METRO website. Arterial information available through this project will provide alternative routing information on city streets, enabling travelers with a way to judge different arterial routes like they currently are able to do with freeway and tollway routes.

### **8.1.3 Transportation Planners**

HITS will generate numerous data streams, from traffic volumes, travel times, travel speeds, and signal timing performance. This data will be useful to planners generating the needs for transportation system improvements for the City of Houston and greater Houston region.

## **8.2 System Modes and States**

Normal operations will consist of typical system use with 95% or more of field devices reporting to the HITS system. Since the HITS system will consist of several different subsystems (CCTV, travel time monitoring (TTM), etc.), failure in one subsystem should not render the HITS system inoperable. When accessing HITS-generated data, the traveler should be presented with information even though the all ITS data may not be available.

At a minimum, the HITS system should indicate whether a portion of the network is available for travel (open or closed), and additional traveler information provided if available. The HITS system should be setup to recognize an information gap, and process a request to investigate the problem with a maintenance call.

There may be times when the system is shut-down for maintenance or modified for operations during emergency conditions (during hurricane evacuations to preserve bandwidth, for example). Simple text messages should replace the normal web-based pages to inform the user that the service is unavailable during system maintenance.

## **8.3 System Capabilities**

The major system capabilities include the input, processing and output of traffic and incident information to satisfy systems to provide information to operate and traverse the City of Houston arterial network in a more efficient and informed manner. The identified needs as outlined in Section 7 of the Concept of Operations. In summary the capabilities provided by the HITS system shall include:

- Enhanced traffic signal detection at selected intersections to supplement normal operations and generate automated traffic counts;
- Collect traffic volumes at key points on the arterial roadway network at mid-block stations to provide spot speed, volume and classification data for operations and planning;
- Interface to the recently installed 650 reader AWAM system, giving operators and the public travel time information similar to what is currently provided on the freeway/tollway network;
- Create the functionality to provide operators with alarms for unusual or abnormal arterial roadway operational conditions through monitoring travel times and/or traffic volumes;
- Provide an interface for the visualization of segment travel times and speeds;

- Deploy CCTV to provide visual observation capability at critical points in the arterial roadway network
- Provide traveler information on the arterial network by providing snapshots to the public via the Houston TranStar website and by deploying dynamic message signs to the roadside to provide automated travel time information to travelers on the arterial network (and other messages as appropriate).

The HITS system shall be deployed for operator use at Houston TranStar (on the main control room floor and a satellite office on the 2<sup>nd</sup> floor) and at the 2200 Patterson facility. Each of these locations should provide full functionality over the HITS system.

## 9 Operational Environment

The HITS system will consist of bringing together a system of sub-systems, and will be housed at Houston TranStar. Since TranStar is a mature TMC with established policies and protocols to which the city is a party, many of the operational and policy issues associated with the HITS system would be covered by existing TranStar policies and procedures.

The computer hardware and software should comply with TranStar IS requirements and any furniture or space requirements should be specified by TranStar IS. The HITS system graphical user interfaces should be designed to be viewed on existing operating systems and platforms as specified by TranStar IS and compliant with the City's central software system, ATMS.now. The HITS system, consisting of computer equipment and databases, should be specified to the requirements of TranStar IS, including their durability characteristics.

The HITS system should be designed such that it could be expanded regionally, using applicable standards and regionally approved ITS Architecture. It should be fully scaleable and expandable, including in regard to bandwidth, rack space and to new workstations. The environmental conditions that the HITS system must operate should be specified by TranStar IS at the time of detailed design.

The City of Houston will need to provide trained staff as both administrators and operators of the HITS system. It is envisioned that seven to eight operators and one to two administrators will need to be dedicated to the HITS system to provide adequate operations and manpower. The staff numbers can vary as the city generates roles and responsibilities for the operators and as the ITS elements are deployed to various portions of the city.

At ultimate buildout, it would be envisioned that two supervisor/administrators and eight operators would be needed for peak period (five days per week during AM and PM peak periods (three hours each)). Staffing would be provided for special planned events on weekends as necessary. Operators should have, at minimum, high school diplomas with preferably 2- or 4-year college degrees (entry level engineers). Supervisors should be professional engineers and have at least three years' experience with traffic operations, signal system, and/or ITS.

## 10 Support Environment

The HITS system will primarily be housed at Houston TranStar. Since TranStar is a mature TMC with established policies and protocols to which the city is a party, many of the operational and policy issues associated with the HITS system would be covered by existing TranStar policies and procedures.

TranStar IS personnel will advise on computer and server specifications. The computer hardware and software will be expected to comply with TranStar IS requirements and any furniture or space requirements should be specified by TranStar IS. The HITS system, consisting of computer equipment and databases, should be specified to the requirements of TranStar IS, including their durability characteristics.

HITS will be administered and operated by city staff and as such that staff will be held to policies and be expected to comply with existing city procedures. New policies and procedures are likely required to govern the use of HITS ITS elements, including CCTV and DMS. To the extent possible, the city should rely on the experience and knowledge of partner agencies at Houston TranStar in setting agency policies and procedures, and in the technical aspects of operating and maintaining an ITS system.

## 11 Operational Scenarios

Depending on the location within the city, responses may vary depending on both location and time-of-day. In order to capture the various operational and response strategies, a typical location and scenario was chosen for most of the use cases below.

For the ConOps, typical types of incidents were identified, areas of recurring congestion specified, and high frequency locations for arterial incidents examined. The scenarios were developed based on situations different from the baseline of normal daily system operations, which may include minor routine incidents.

### 11.1 Normal Daily System Monitoring and Operations

Daily operation is defined as: 1) operations related to a significant incident that invokes response or management strategies to be deployed; and 2) recurring congestion conditions.

- Coverage/staffing
  - Two staff members during weekday peak hours (6-10 am and 3-7 pm)
  - At least one staff member for 12-14 hours daily, 7-days per week, 365 days per year
  - Major thoroughfares in the City of Houston covered by the HITS system
  - Partial monitoring coverage along freeway and tollway frontage roads within the City of Houston through shared data with TxDOT and Harris County (at TranStar console)
- Monitoring
  - COH CCTV video
  - Regional (TxDOT & Harris County) CCTV video
  - 911 COH EOC HPD/HFD incidents
  - Arterial and freeway travel time system

- Arterial traffic volume system from
  - volume count stations and
  - select traffic signal controllers
- DMS messaging system
- Traffic signal system health status and alerts
- ITS equipment health status and alerts
- Weather events
- Other emergency events
- Coordination
  - Coordinate construction and/or lane closure activity with TranStar partners
  - Coordinate regional events (Houston Livestock Show & Rodeo, Super Bowl, etc.)
  - Coordinate signal timing changes with TranStar partners
- Data Dissemination
  - Distribute arterial travel times via internet and data feed
  - Distribute traveler information via internet and roadside DMS
- Maintenance
  - Perform routine maintenance
  - Monitor Wi-MAX, fiber, cellular, and other communications systems for issues
  - Repair/replace malfunctioning system devices

## 11.2 Traveler Information

The traveler information capabilities for the HITS System shall involve multiple media. This includes dissemination through interface with existing systems provided via Houston TranStar for both pre-trip planning and in-route traveler information. Information will be provided regarding travel times, congestion, incidents, and road conditions. When there are incidents, information will be provided to enable the public to make decisions on options using alternate routes, or for adjusting trip time or modes.

The HITS System travel information dissemination should consist of:

- Dynamic message signs (DMS) placed at strategic locations;
- Interactive traveler information via internet website (at [houstontranstar.org](http://houstontranstar.org)) that commuters can quickly check for pre-trip information, to include travel time/speed information and incidents;
- Data feeds which enable 3<sup>rd</sup>-party providers to consume and repackage HITS data for their customers; and
- Data feeds to media partners of video and other data.

The responsibilities of the City of Houston to provide traveler information include:

- Camera images

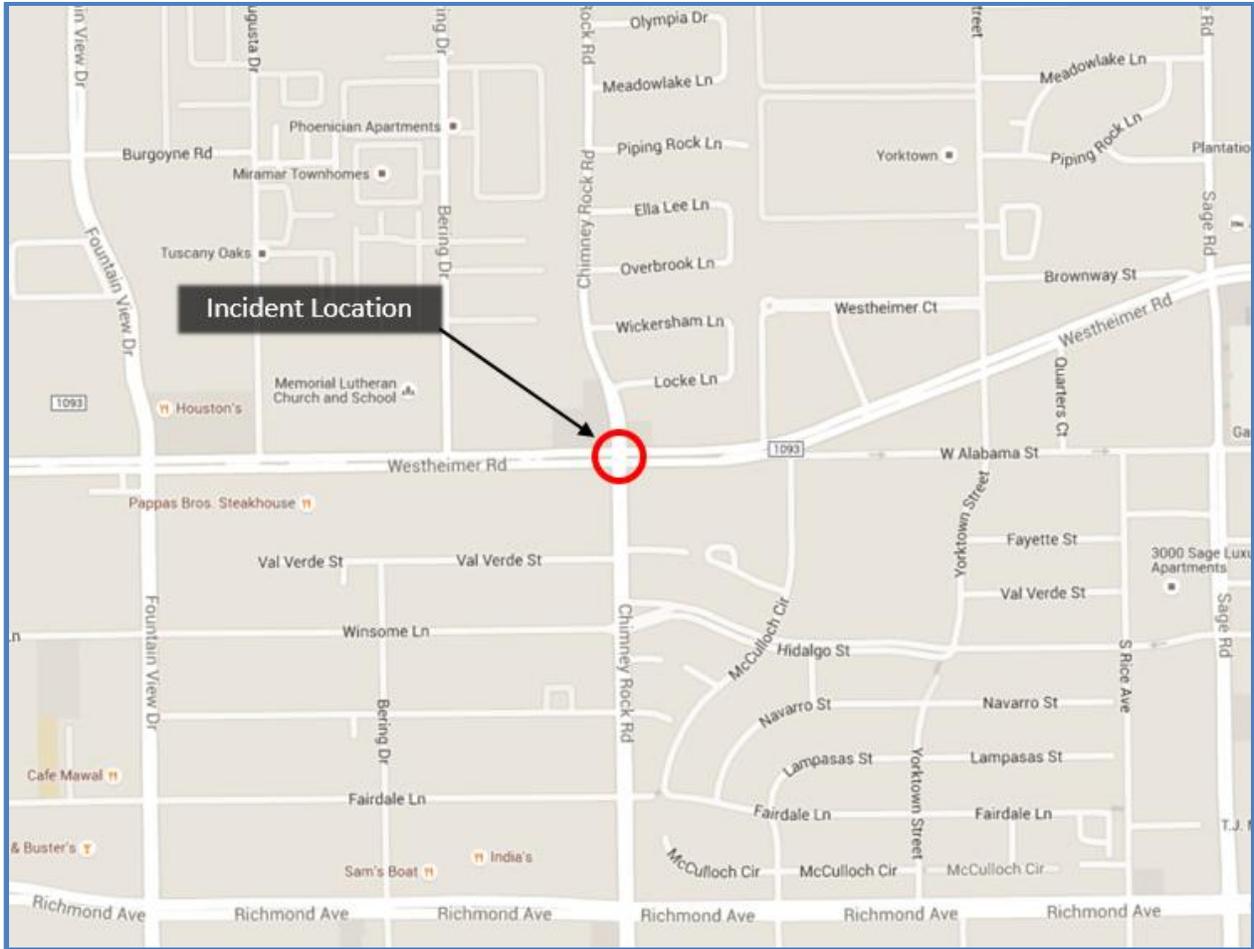
- Provide snapshots of camera images to the public via the Houston TranStar website, in similar form and fashion as TxDOT and Harris County camera images (snapshots on Wi-MAX cameras and potentially moving snapshots on fiber cameras).
- Travel time information
  - Comply with existing Houston TranStar reporting and mapping capabilities and requirements to post information to traffic.houstontranstar.org
  - Comply with existing Houston TranStar reporting policy to send travel time information to 3<sup>rd</sup> party data feeds
  - Make available via the Houston TranStar web interface charts, graphs, tables and historical archives of speed data
- Traffic volume information
  - Make traffic volume data available to the public via the Houston TranStar web interface through charts, graphs, tables and historical archives traffic volumes
- Incident information
  - Use HFD and HPD combined incident data feed to push incidents in a list to the public via the website (this currently exists, but lags by 10-15 minutes)
  - Show incidents as clear when they drop off the data feed or when operators are notified that incidents are no longer impacting traffic flow
- Dynamic Message Signs
  - During normal operations, post travel times to DMS for predetermined destinations on arterial routes
- Traffic signal status
  - Provide data on current traffic signal status (normal, flashing, out, or non-communicating) in map and tabular format of signals processed through the central software system

### 11.3 Arterial Incident Management

A sample major incident was chosen at a particular intersection where vehicle collisions often occur that can have a major impact on arterial mobility in the city.

Incident Description:

During the evening peak period, a major incident occurs at the intersection of Westheimer Road at Chimney Rock Road that closes the intersection for the afternoon peak rush hours. The incident begins at 4:15 PM and is expected to last until 8:00 PM.



**Figure 7. Incident Location at Westheimer Road and Chimney Rock Road (map source: Google)**

**Incident Timeline:**

4:15 PM	Collision occurs between a light truck and gasoline tanker truck with a jack-knifed cab and overturned tanker trailer the result. Several citizens call to E911 to report the crash. A small fire starts from a rupture of the truck fuel tank caused by the light truck. A live data feed (via webpage) from the HEC presents an alert message at the COH TranStar HPD and Traffic consoles.
4:20 PM	HPD and HFD w/EMS arrive on scene. HFD takes charge of the scene management and advises HPD to close the intersection and to begin moving traffic away from the area. HPD TranStar (console officer) advises COH TranStar (console staff) of the order. COH Traffic begins monitoring area CCTV and posts incident messages “intersection closed” on surrounding DMS. Data feeds are automatically updated and a media release is prepared regarding the closure.
4:25 PM	COH Traffic invokes central signal software system to make timing changes along Westheimer Road and the alternate routes of Sage Road, Richmond Avenue, Fountain View Drive, and San Felipe Street. HPD and Mobility Response Team begin to deploy at critical intersections in case manual control is required. Other traffic control points setup by Mobility Response and HPD on the edges of the Westheimer at Chimney Rock

	intersection.
4:27 PM	COH Traffic TranStar notifies METRO of intersection closure so that transit routes can divert.
4:30 PM	Media new release sent to news broadcast news outlets via social media and traditional press release. HPD calls for flatbed wrecker and heavy wrecker. EMS departs from the scene with both drivers.
4:35 PM	COH Traffic TranStar requests TxDOT post on-freeway DMS messages to avoid the area of the Westheimer at Chimney Rock intersection. TxDOT posts messages on IH 610 West Loop and on IH 69 Southwest Freeway.
4:38 PM	HFD notifies HPD, HPD TranStar, COH Traffic TranStar that fire threat is extinguished.
4:45 PM	HFD contacts owner of the fuel truck to bring another tanker to offload the gasoline.
5:15 PM	Light truck is loaded on to flatbed wrecker and departs scene.
5:25 PM	HPD and Mobility Response take manual control of several signals on alternate routes.
5:45 PM	2 <sup>nd</sup> tanker arrives, begins offloading gas from overturned trailer
6:20 PM	2 <sup>nd</sup> tanker departs scene, heavy duty wrecker/rotator uprights overturned trailer, moves trailer to West Alabama Street, east of Westheimer for additional recovery.
6:45 PM	HFD clears remaining debris and informs HPD to reopen intersection. HPD and Mobility Response clear residual queues on alternative routes, notifying HPD TranStar and COH Traffic at TranStar when leaving posts.
7:00 PM	COH Traffic cancels DMS messages and changes status of incident in the incident reporting system. COH Traffic returns signal timings to normal plans via central software. COH Traffic continues to monitor travel time monitoring system outputs (speed charts), traffic volume system outputs (volume charts) until return to normal. COH Traffic and HPD advise press release that the incident response is complete and that METRO can begin running normal routes and stops.
8:00 PM	COH Traffic operators confirm travel time and volume conditions are typical. Operations return to normal.

Additional Roles and Responsibilities for Arterial Incident Management Scenario over the normal operations scenario:

- City of Houston
  - Provide incident-related messages on area DMS
  - Decision (management involved) to change signal timings on alternate routes
  - Ongoing monitoring of the incident through contact with HPD console, HEC incident data feed, and voice/data communications with affected departments
  - Ongoing monitoring of flow on arterial network and common alternate routes
  - Decision (HPD and Mobility Response) to setup traffic control and invoke intersection control as needed
  - Enter incident information into incident reporting system
  - Share incident status with TxDOT and METRO via personal on-floor communications and through web-based travel time and incident reporting interfaces
  - Distribute information to public and media through Houston TranStar website.

## 11.4 Planned Event Management

The City of Houston annually hosts several large events, including the Houston Livestock Show & Rodeo, Houston Texans NFL Football games, holiday festivals and concerts. Other events, including Super Bowls, MLB and NBA All-Star Games, and NCAA Final Fours have been and are planned for the city. During these large events, traffic management and control become important tools in managing the overall event.

In this scenario, the HITS system is employed for traffic management around the Houston Livestock Show & Rodeo – and event that lasts more than two weeks, typically in March each year. Parking is a major concern during the event, as much of the on-site parking at the NRG Stadium and Center site is being used for the show.

### Incident Description:

During the weekday evening peak period, NRG Stadium & Center are the site of a Rodeo Performance and Concert. The show begins at 7:00 PM and ends at 11 PM. Figure 8 shows the NRG area and several of the key intersections for traffic control.

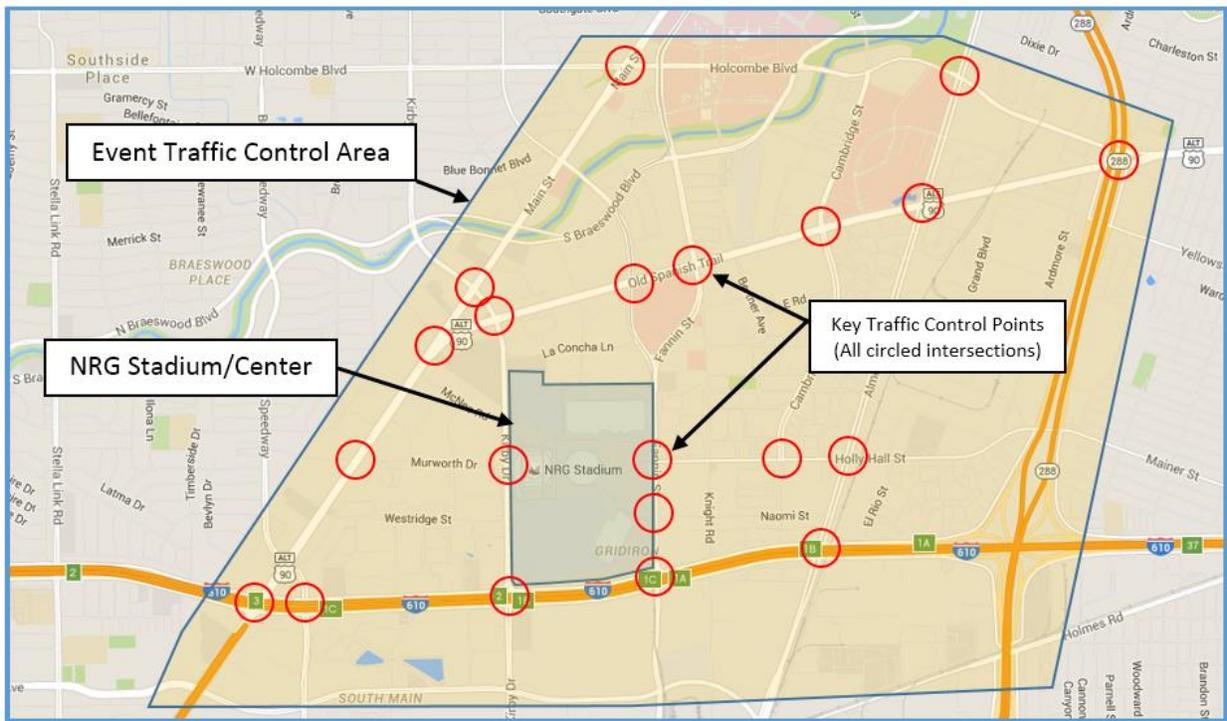


Figure 8. NRG Stadium Area, Traffic Control for HLS&R Event (map source: Google)

### Planned Incident Timeline:

4:00 PM	HLS&R assets (portable CMS, off-duty LEO) are in place and working to direct traffic to appropriate parking areas.
4:30 PM	Traffic begins to build on IH 610, Kirby Drive, Fannin Drive, South Main Street and

	O.S.T. as regular rush hour is overlaid by early arrivals (volunteers and attendees) to NRG Park. Traffic volume sensors alert operators at TranStar to several locations where volumes are abnormally high. Travel time monitoring shows that travel speeds are abnormally low on several routes to and from NRG Park. COH Operators begin CCTV monitoring in response and change a few signal timing plans to alternative “Rodeo” timings.
5:30 PM	Traffic volume sensors are reporting significantly heavy volumes on routes approaching NRG Park. Travel time monitoring is showing “red” on most routes around the stadium and NRG grounds. COH Operators invoke additional “Rodeo” timings remotely from TranStar.
5:45 PM	COH Operators and HPD at TranStar begin coordination with off-duty LEO contracted by HLS&R to respond to hot-spots where congestion leading to parking areas is hindering through traffic on arterials. Conditions are confirmed with CCTV. COH Operators coordinate with TxDOT partners on DMS messages on IH 610 and SH 288 directly on the floor of TranStar.
6:15 PM	COH Operators field call from METRO Rail Dispatch about congestion at Fannin and Holly Hall intersection – congestion at that intersection is causing the LRT to be unable to route efficiently. COH Operators speak with HPD console and HPD is dispatched to assist in traffic control.
7:15 PM	Crowds are largely on NRG Park site, COH operators return to “normal” operations.
10:30 PM	Crowds begin leaving NRG Park after concert is finished. HLS&R assets are working, COH operators at TranStar begin preparations for signal timing changes if needed.
11:15 PM	COH Operators at TranStar monitoring CCTV invoke “outgoing flush” timing patterns at key intersections around the stadium. These scenarios are pre-planned and run for about one hour.
11:40 PM	COH Operators determine that traffic volumes and travel times are recovering from looking at dashboard indicators on consoles at TranStar. Operators cease “flush timings” early.
12:00 AM	COH Traffic operators confirm travel time and volume conditions are typical. Operations return to normal.

Additional Roles and Responsibilities for Planned Incident Management Scenario over the normal operations scenario:

- City of Houston
  - Provide incident-related messages and parking area messages on area DMS to supplement HSL&R assets
  - Decision (management involved) to change signal timings on key routes
  - Ongoing monitoring of the event through contact with HPD console and voice/data communications with affected departments
  - Ongoing monitoring of flow on arterial network and key routes
  - Coordination with TxDOT and METRO on operational status
  - Decision (HPD and Mobility Response) to setup and/or change traffic control as needed
  - Share event status with TxDOT and METRO via personal on-floor communications and through web-based travel time and incident reporting interfaces

## 11.5 Generate and Report Traffic Data for Planning

The HITS System generates several traffic and transportation data elements that are important for planners and other agencies to manipulate. Traffic volume data, travel time and speed data are two key measures that transportation planners are interested in harnessing for their model use and calibration, particularly as their models reach into meso- and micro-modeling capabilities.

The portions of the HITS System used to provide traffic data for planning and performance reporting consist of:

- Interfaces via internet website (at [houstontranstar.org](http://houstontranstar.org)) that engineers and planners can access to view graphs (selectable by, at a minimum, 15-minute, hourly, day, week, month, or annual aggregate values) including travel time/speed information and traffic volume information;
- Travel time information
  - Comply with existing Houston TranStar reporting and mapping capabilities and requirements to post information to [traffic.houstontranstar.org](http://traffic.houstontranstar.org)
  - Make available via the Houston TranStar web interface charts, graphs, tables and historical archives of speed data
- Traffic volume information
  - Make traffic volume data available to the public via the Houston TranStar web interface through charts, graphs, tables and historical archives traffic volumes
- Other performance measures, to include incident information and after-action reports, reliability, incident management and event planning and response
- Output formats should include PDF, XLS or CSV, or XML.

## 12 Summary of Impacts

The HITS project will impact the system users as follows:

City staff (administrators, supervisors, operators) – the city will have to commit new resources to administer, supervise and operate the HITS system. Two additional supervisors and up to eight operators will be required to staff and operate the system. The city will have to commit to maintaining in good order communications networks, field devices and front end systems so that operations are optimal and ITS elements are in good working order. This would be expected to cost the city upwards of \$400,000 per year for additional staff, and potentially \$500,000 per year if maintenance for ITS is outsourced.

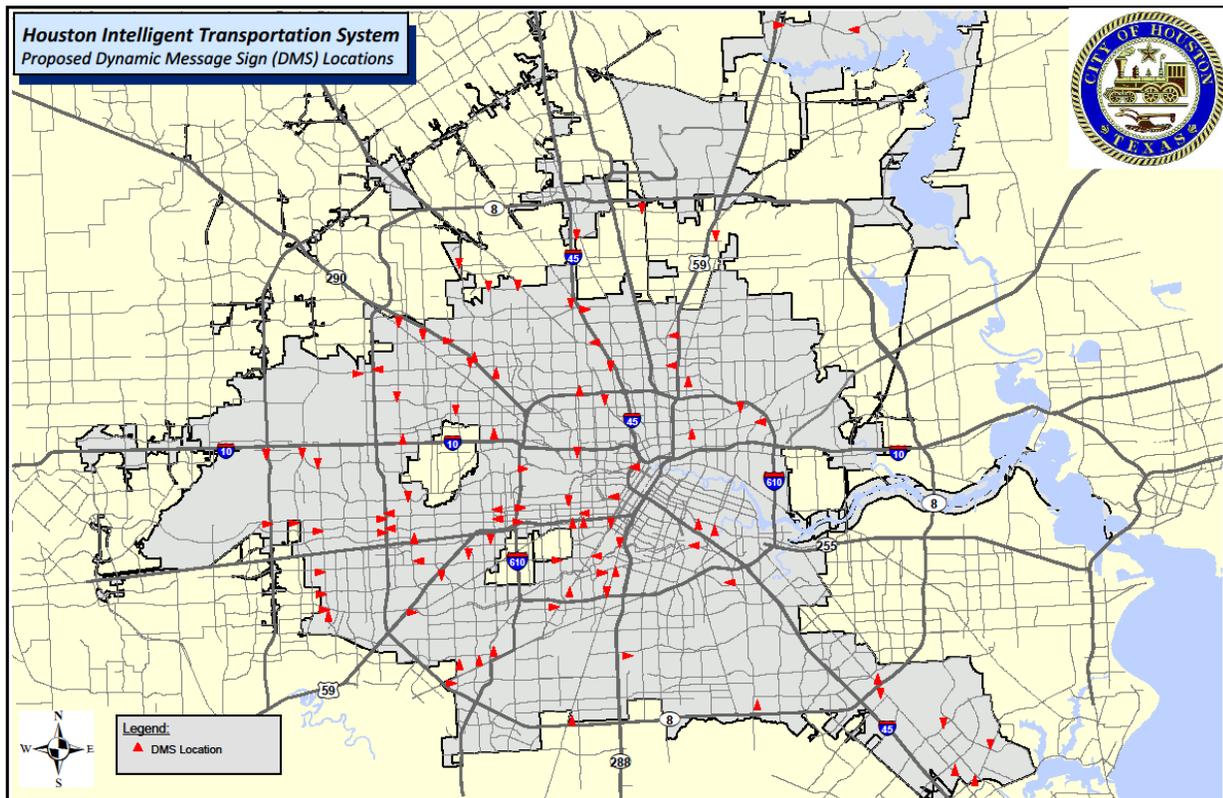
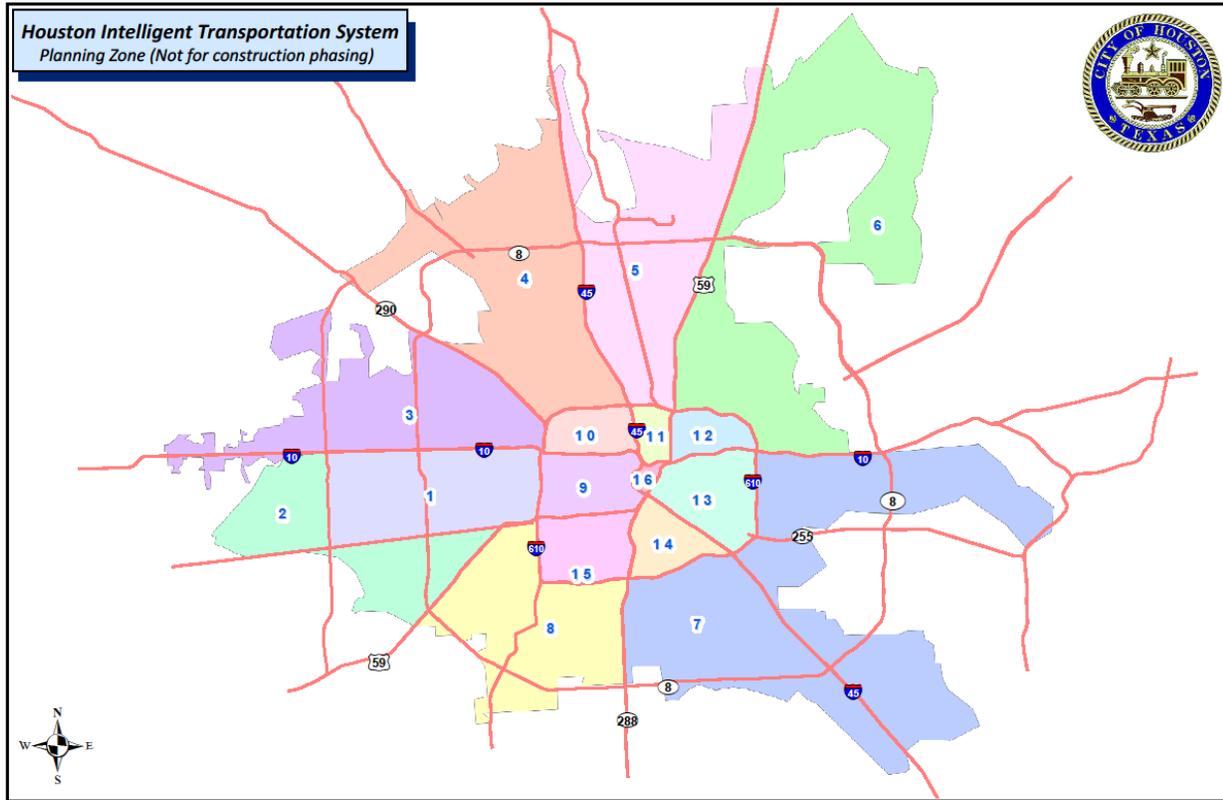
Houston TranStar – Houston TranStar will be impacted by the HITS system by additional workload on the IS staff to operate and maintain computer systems on behalf of the partners in the consortium. This anticipated additional workload could be upwards of 20-40 hours per month at Houston TranStar.

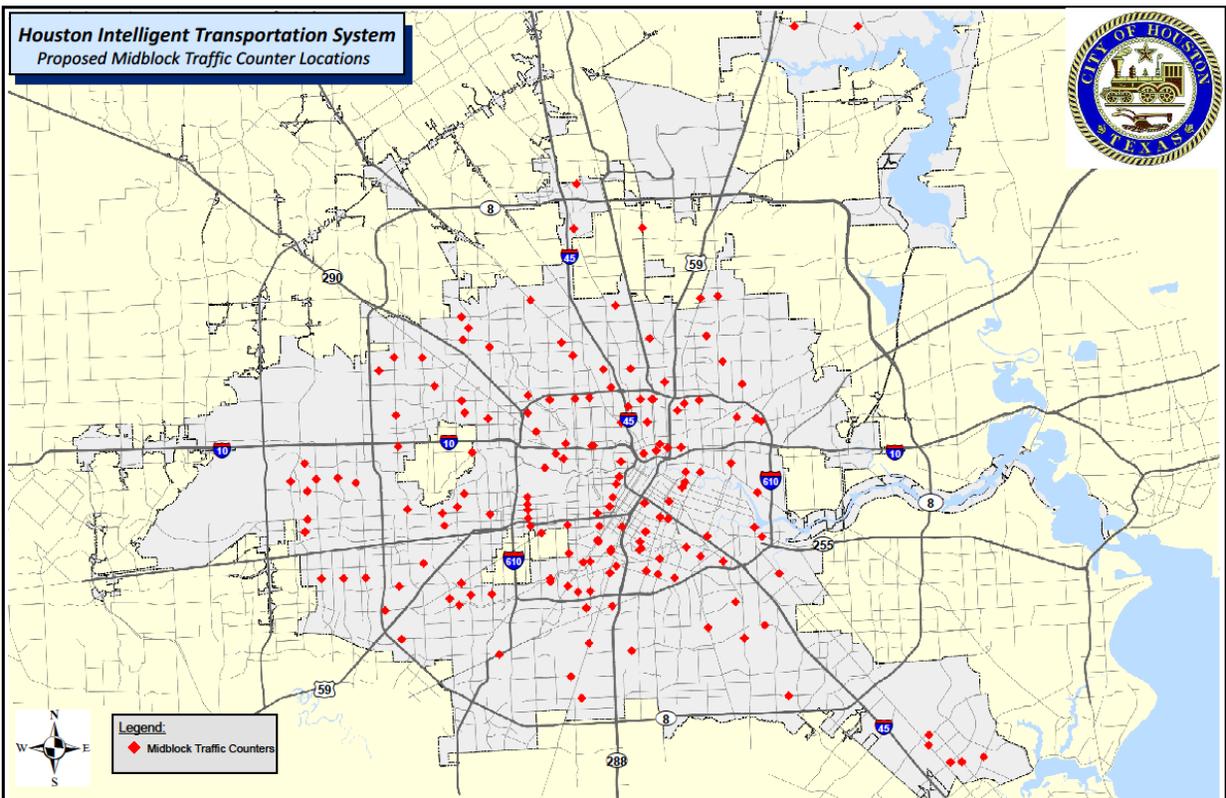
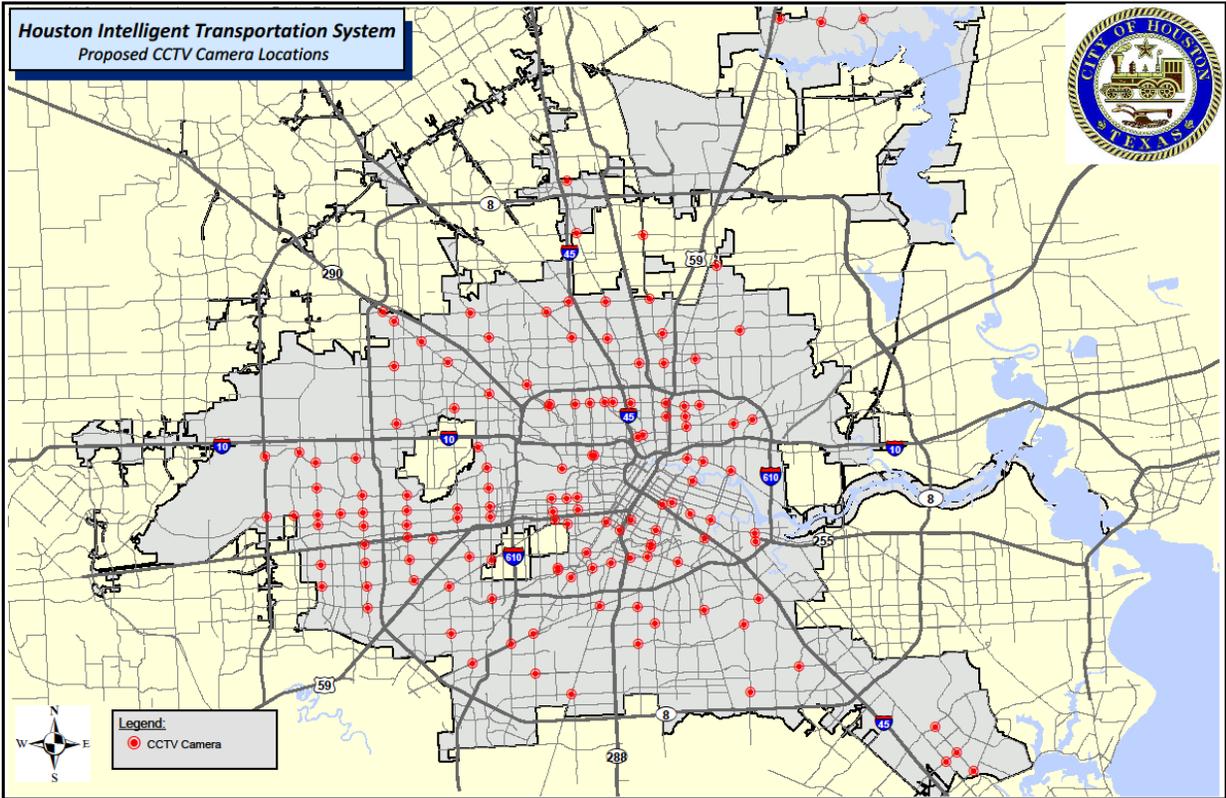
Travelers - The traveler may be considered the ultimate customer and consumer in the eventual deployment of the full HITS concept. The overall traveling public in the Houston region desires traveler

information boiled down to the basic form of travel time and incident information. Currently, users can get information on the freeway, HOV lane, and tollway systems via the Houston TranStar website's real-time traffic map. The estimated benefits for traveler information, incident management, and TranStar center operation on the freeway and tollway system is estimated at over \$500M per year. While difficult to definitively determine, the addition of the HITS system and operation on the City of Houston may have societal benefits of similar impact in the millions of dollars of delay savings.

Transportation Planners - HITS will generate numerous data streams, from traffic volumes, travel times, travel speeds, and signal timing performance. This data will be useful to planners generating the needs for transportation system improvements for the City of Houston and greater Houston region and their ability to quantitatively assess those proposed improvements.

# 13 Appendix A - Exhibits





**Proposed Intersection with Advanced Detection**

	<i>First Street</i>	<i>Second Street</i>
1	Market	Kress
2	Market	Lathrop
3	Market	Lockwood
4	Market	McCarty
5	Market	Miles
6	Market	Normandy
7	Market	Pleasantville
8	Market	Sheffield
9	Market	Wayside
10	Bingle	US-290
11	Bingle	Pinemont
12	Bingle	Tidwell
13	Bingle (Houston Rosslyn)	Little York
14	Houston Rosslyn	W Gulf Bank
15	Houston Rosslyn	Alabonson
16	Houston Rosslyn	Woodsman Trail
17	Houston Rosslyn	W Mt Houston
18	Houston Rosslyn	Breen
19	Houston Rosslyn	Chippewa
20	Telephone	Sam Houston
21	Telephone	King Row Mobile Home Park
22	Telephone	Fuqua
23	Telephone	Almeda Genoa Si
24	Telephone	Almeda Genoa Ni
25	Telephone	Brisbane
26	Telephone	Airport
27	Telephone	Dillon
28	Telephone	Brace (Drouet)
29	Telephone	Bellfort
30	Telephone	Reveille
31	Telephone	Westover
32	Telephone	Dixie
33	Telephone	Long (Park Place)
34	Telephone	Fairway
35	Telephone	Woodridge
36	Telephone	I-610 (S Loop)
37	Homestead	E Mt Houston
38	Homestead	Hartwick
39	Homestead	Little York
40	Homestead	Langley
41	Homestead	Parker
42	Homestead	Bretshire
43	Homestead	Tidwell
44	Homestead	Laura Koppe
45	Homestead	Ley (Weaver)
46	Homestead	I-610 (N Loop)
47	Main	Blodgett
48	Main	Wenworth
49	Main	Southmore
50	Main	Bissonnet (Binz)

	<i>First Street</i>	<i>Second Street</i>
51	Main	Sunset
52	Main	Cambridge
53	Main	Memorial Herman Medical Plaza
54	Main	John Freeman
55	Main	University
56	Main	Dryden
57	Main	Southgate
58	Main	Holcombe
59	Main	Pressler
60	Main	Greenbriar
61	Main	N Braeswood
62	Main	S Braeswood
63	Main	Kirby
64	Main	Old Spanish Trail
65	Main	McNee
66	Main	Murworth
67	Main	Westridge
68	Main	Buffalo Speedway
69	Main	I-610 (S Loop)
70	Westheimer	Richmond
71	Westheimer	Westheimer Parkway
72	Westheimer	SH-6
73	Westheimer	Briargreen
74	Westheimer	Westhollow
75	Westheimer	Windchase
76	Westheimer	Synott
77	Westheimer	Ashford Oak (Briarwest)
78	Westheimer	Shadowbriar
79	Westheimer	West Houston Center (Gray Falls)
80	Westheimer	Kirkwood
81	Westheimer	Crescent Park
82	Westheimer	Woodland Park
83	Westheimer	Hayes
84	Westheimer	Wilcrest
85	Westheimer	Walnut Bend
86	Westheimer	Blue Willow
87	Westheimer	Rogerdale
88	Westheimer	Sam Houston
89	Westheimer	Seagler
90	Westheimer	Briarpark
91	Westheimer	Elmside
92	Westheimer	Tanglewilde
93	Westheimer	Westerland
94	Westheimer	Jeanetta
95	Westheimer	Fondren
96	Westheimer	Lazy Hollow
97	Westheimer	Dunvale
98	Westheimer	Old Farm
99	Westheimer	Stoney Brook
100	Westheimer	Hillcroft (Voss)

**Proposed Intersection with Advanced Detection**

	<i>First Street</i>	<i>Second Street</i>
101	Westheimer	Winrock
102	Westheimer	Briarhurst
103	Westheimer	Greenridge
104	Westheimer	Fountain View
105	Westheimer	Bering
106	Westheimer	Chimney Rock
107	Westheimer	Yorktown
108	Westheimer	Sage
109	Westheimer	Mc Cue
110	Westheimer	I-610
111	Antoine	W Gulf Bank
112	Antoine	Long Creek
113	Antoine	Victory
114	Antoine	Little York
115	Antoine	Desoto
116	Antoine	Tidwell
117	Antoine	Pinemont
118	Antoine	Acorn
119	Antoine	43rd
120	Antoine	US-290
121	Antoine	34th
122	Antoine	Hammerly
123	Antoine	Long Point
124	Antoine	Westview
125	Antoine	Ikea
126	Antoine	I-10 (Katy Freeway)
127	Mykawa	Almeda Genoa
128	Mykawa	Orem
129	Mykawa	Airport
130	Mykawa	Bellfort
131	Mykawa	Dixie (Donoho)
132	Mykawa	I-610
133	Almeda	Almeda Genoa (Fuqua)
134	Almeda	Orem
135	Almeda	Almeda Plaza
136	Almeda	Airport
137	Almeda	Reed
138	Almeda	Holmes Ei
139	Almeda	Holmes Wi
140	Almeda	I-610
141	Almeda	Holly Hall
142	Almeda	Old Spanish Trail
143	Almeda	Holcombe
144	Almeda	S MacGregor
145	Almeda	N MacGregor
146	Almeda	Hermann
147	Almeda	Binz
148	Almeda	Southmore
149	Almeda	Blodgett
150	Almeda	Wheeler

	<i>First Street</i>	<i>Second Street</i>
151	Almeda	Cleburne
152	Wayside	Little York
153	Wayside	Tidwell
154	Wayside	Ley
155	Wayside	I-610 (N Loop)
156	Wayside	Wallisville
157	Wayside	I-10 (East Freeway)
158	Wayside	Avenue R
159	Wayside	Navigation
160	Wayside	Canal
161	Wayside	Capitol
162	Wayside	Polk (69th)
163	Wayside	Carrillo Elementary
164	Wayside	Lawndale
165	Wayside	Esckridge (Sylvan)
166	Wayside	I-45
167	Wayside	Telephone
168	Wayside	Wheeler
169	Wayside	Griggs
170	Wayside	I-610 (S Loop)
171	Wayside	Long
172	69th	Avenue R
173	69th	Navigation
174	69th	Canal
175	69th	Capitol
176	Lockwood	Tidwell
177	Lockwood	Laura Koppe
178	Lockwood	Weaver
179	Lockwood	Crosstimbers
180	Lockwood	Bennington
181	Lockwood	Shreveport
182	Lockwood	Kelley
183	Lockwood	I-610
184	Richmond	Synott
185	Richmond	Ashford Park
186	Richmond	Dairy Ahsford
187	Richmond	Shadowbriar
188	Richmond	West Houston Center
189	Richmond	Kirkwood
190	Richmond	Woodland Park
191	Richmond	Wilcrest
192	Richmond	Walnut Bend
193	Richmond	Rogerdale
194	Richmond	Sam Houston
195	Richmond	Briarpark
196	Richmond	Gessner
197	Richmond	Tanglewilde
198	Richmond	Jeanetta
199	Richmond	Fondren
200	Richmond	Dunvale

**Proposed Intersection with Advanced Detection**

	<i>First Street</i>	<i>Second Street</i>
201	Richmond	Stoney Brook
202	Richmond	Hillcroft
203	Richmond	Unity
204	Richmond	Greenridge
205	Richmond	Fountain View
206	Richmond	Chimney Rock
207	Richmond	Barrington
208	Richmond	S Rice
209	Richmond	Sage
210	Richmond	Mc Cue
211	Richmond	Post Oak (I-610)
212	SH-6	Westhollow (Shell Research)
213	SH-6	Richmond
214	SH-6	Parkhollow
215	SH-6	Piping Rock
216	SH-6	Halliburton
217	SH-6	Briar Forest
218	SH-6	Eagle Vista (ECR Way)
219	SH-6	Briarhills Parkway
220	SH-6	Memorial
221	SH-3	Buoy
222	SH-3	El Dorado
223	SH-3	Barringer
224	SH-3	Pineloch
225	SH-3	FM 1959
226	SH-3	Clear Lake City
227	SH-3	Brantley
228	SH-3	Scarsdale
229	SH-3	Sam Houston SSR (Conklin)
230	SH-3	Sam Houston NSR
231	SH-3	Fuqua (Gemao Red Bluff)
232	SH-3	Shaver
233	SH-3	Edgebrook
234	SH-3	Allendale
235	SH-3	Howard
236	SH-3	Simscrest (Chavez HS)
237	SH-3	Park Place
238	SH-3	Central (Park Terrace)
239	SH-3	Broadway
240	Shepherd	Veterans Memorial
241	Shepherd	Victory
242	Shepherd	Little York
243	Shepherd	Dillard
244	Shepherd	Parker
245	Shepherd	Northew
246	Shepherd	Montgomery
247	Shepherd	Tidwell
248	Shepherd	Donovan
249	Shepherd	Pinemont
250	Shepherd	43rd (Crosstimbers)

	<i>First Street</i>	<i>Second Street</i>
251	Shepherd	Garden Oaks
252	Shepherd	38th
253	Shepherd	34th
254	Shepherd	I-610
255	Shepherd	24th
256	Shepherd	20th
257	Shepherd	19th
258	Shepherd	14th
259	Shepherd	11th
260	Shepherd	I-10 (Katy Freeway)
261	Shepherd	Center
262	Shepherd	Washington
263	Shepherd	Feagan
264	Shepherd	Memorial
265	Durham	I-610
266	Durham	24th
267	Durham	20th
268	Durham	19th
269	Durham	14th
270	Durham	11th
271	Durham	I-10 (Katy Freeway)
272	Durham	Center
273	Durham	Washington
274	Durham	Feagan
275	Will Clayton	Colonel Fisher
276	Will Clayton	Lee
277	Will Clayton	Humble
278	Will Clayton	McKay
279	Will Clayton	US-59
280	Airport	Broadway
281	Airport	Ruthby
282	Airport	Monroe
283	Airport	Hansen
284	Airport	Mosley
285	Airport	I-45
286	S Post Oak	Bellfort Ei
287	S Post Oak	Bellfort Wi
288	S Post Oak	Willowbend
289	S Post Oak	Willowbend
290	S Post Oak	Gasmer
291	S Post Oak	US-90 (Main)
292	S Post Oak	Allum
293	S Post Oak	Tidewater
294	S Post Oak	Orem
295	S Post Oak	Heatherbrook
296	S Post Oak	Fuqua Gardens View
297	S Post Oak	Fuqua
298	S Post Oak	Anderson
299	S Post Oak	Sam Houston
300	Bellaire	Synott

**Proposed Intersection with Advanced Detection**

	<i>First Street</i>	<i>Second Street</i>
301	Bellaire	Dairy Ashford
302	Bellaire	Cook
303	Bellaire	Kirkwood
304	Bellaire	Belle Park
305	Bellaire	Boone
306	Bellaire	Wilcrest
307	Bellaire	Turtlewood
308	Bellaire	Rogerdale
309	Bellaire	Sam Houston
310	Bellaire	Sharpstown Entrance 3
311	Bellaire	Sharpstown Entrance 4
312	Bellaire	US-59
313	Beechnut	Dairy Ashford
314	Beechnut	Cook
315	Beechnut	Kirkwood
316	Beechnut	Boone
317	Beechnut	Wilcrest
318	Beechnut	South Course
319	Beechnut	Sam Houston
320	Beechnut	Club Creek
321	Beechnut	Corporate
322	Beechnut	Jorine
323	Beechnut	Gessner
324	Beechnut	Mary Bates
325	Beechnut	US-59
326	Beechnut	Brae Acres
327	Beechnut	Fondren
328	Beechnut	Bissonnet
329	Beechnut	Hillcroft
330	Beechnut	Renwick
331	Beechnut	Chimney Rock
332	Beechnut	S Rice Wi
333	Beechnut	S Rice Ei
334	Beechnut	Endicott
335	Beechnut	Meyerland Plaza
336	Beechnut	I-610 (W Loop)
337	Beechnut	Newcastle
338	N Braeswood	Kirby
339	N Braeswood	Seuss
340	N Braeswood	Buffalo Speedway
341	N Braeswood	Stella Link
342	N Braeswood	I-610 (W Loop)
343	N Braeswood	S Rice Ei
344	N Braeswood	S Rice Wi
345	N Braeswood	Chimney Rock Ei
346	N Braeswood	Chimney Rock Wi
347	N Braeswood	Hillcroft
348	N Braeswood	S Braeswood
349	S Braeswood	Bissonnet
350	S Braeswood	Sapling

	<i>First Street</i>	<i>Second Street</i>
351	S Braeswood	Gessner
352	S Braeswood	Braesridge
353	S Braeswood	Fondren
354	S Braeswood	Hillcroft
355	S Braeswood	Chimney Rock Wi
356	S Braeswood	Chimney Rock Ei
357	S Braeswood	S Rice Wi
358	S Braeswood	S Rice Ei
359	S Braeswood	I-610 (W Loop) Nwi
360	S Braeswood	I-610 (W Loop ) Nei
361	S Braeswood	I-610 (W Loop ) Swi
362	S Braeswood	I-610 (W Loop) Sei
363	S Braeswood	Stella Link
364	S Braeswood	Buffalo Speedway
365	S Braeswood	Kirby
366	S Braeswood	David Underwood (H)
367	S Braeswood	Bertner
368	S Braeswood	William C Harvin
369	S Braeswood	Pressler
370	S Braeswood	Holcombe
371	Bay Area	Seawolf
372	Bay Area	Feather Craft
373	Bay Area	El Camino Real
374	Bay Area	Diana
375	Bay Area	Saturn
376	Bay Area	Reseda
377	Bay Area	Space Center
378	Bay Area	University (Krueger)
379	Bay Area	Middlebrook
380	Hardy	I-610 (N Loop)
381	Hardy	Cavalcade
382	Hardy	Collingsworth
383	Hardy	Quitman
384	Hardy	Lorraine
385	Elysian	I-610 (N Loop)
386	Elysian	Cavalcade
387	Elysian	Collingsworth
388	Elysian	Quitman
389	Elysian	Lorraine
390	Clay	Britmoore
391	Clay	Sam Houston
392	Clay	Westway Park
393	Clay	Shadowbriar
394	Clay	Gessner
395	Clay	Windfern
396	Clay	Cambell Wi
397	Clay	Campbell Ei
398	Clay	Blalock
399	Clay	Pinemont
400	Clay	Hollister

**Proposed Intersection with Advanced Detection**

	<i>First Street</i>	<i>Second Street</i>
401	43rd	Bingle
402	43rd	US-290
403	43rd	Lang
404	43rd	Watonga
405	43rd	W TC Jester
406	43rd	Rossllyn
407	43rd	Oak Forest
408	43rd	Ella
409	43rd	Alba
410	Crosstimbers	Yale
411	Crosstimbers	N Main
412	Crosstimbers	Airline
413	Crosstimbers	I-45 (North Freeway)
414	Crosstimbers	Bauman
415	Crosstimbers	Helmers
416	Crosstimbers	Irvington
417	Crosstimbers	Hardy WSR
418	Crosstimbers	Hardy ESR
419	Crosstimbers	Jensen
420	Crosstimbers	US-59
421	Crosstimbers	Hirsch
422	Ley	E Houston
423	Ley	Mesa
424	Gessner	Barryknoll
425	Gessner	Kingsride
426	Gessner	Memorial City Medical Center
427	Gessner	Mervyn's
428	Gessner	I-10
429	Gessner	Westview
430	Gessner	Long Point
431	Gessner	Neuens
432	Gessner	Tiger Trail
433	Gessner	Hammerly
434	Gessner	Emmora
435	Gessner	Westray
436	Gessner	Kempwood
437	Gessner	Kemp Forest
438	Gessner	Tanner
439	Gessner	US-290
440	Blalock	I-10
441	Blalock	Westview
442	Blalock	Long Point
443	Blalock	Neuens
444	Blalock	Campbell
445	Blalock	Hammerly
446	Blalock	Emmora
447	Blalock	Kempwood
448	Blalock	Colleen
449	Fairbanks N Houston	Tidwell
450	John F Kennedy (JFK)	Greens

	<i>First Street</i>	<i>Second Street</i>
451	John F Kennedy (JFK)	Aldine Bender (Drummet)
452	Ella	34th
453	Ella	Wakefield
454	Ella	Thorton
455	Ella	Pinemont
456	Wheatley	Tidwell
457	Wheatley	Little York
458	Wheatley	Montgomery
459	Wheatley	Victory
460	Cavalcade	Lockwood
461	Cavalcade	Hirsch
462	Cavalcade	US-59 (Eastex Freeway)
463	Cavalcade	Jensen
464	Cavalcade	Irvington
465	Cavalcade	I-45 (North Freeway)
466	Cavalcade	Airline
467	Cavalcade (20th)	Studewood (Main)
468	20th	Heights
469	20th	Yale
470	20th	Rutland
471	20th	Ashland
472	18th	W TC Jester
473	18th	Ella
474	18th	Seamist
475	Cullen	Almeda Genoa
476	Cullen	Orem
477	Cullen	Kennedy Heights
478	Cullen	Selinsky
479	Cullen	S Acres
480	Cullen	Airport
481	Cullen	Wilmington
482	Cullen	Reed
483	Cullen	Brinkley
484	Cullen	Bellfort
485	Cullen	I-610 (S Loop)
486	Cullen	Holmes
487	Cullen	Yellowstone
488	Cullen	Griggs
489	Cullen	Old Spanish Trail

ITS Standards which may apply to the HITS Project

(Use to be in compliance with the regional ITS architecture)

## Relevant Standards Activities

2/4/2016 10:08:53AM



Standards for HITS Architecture

status: Planned



**NOTE:** The ITS standards list has been customized or a standards group has been modified. The ITS standards presented in this report may represent a superset of options, and in some cases, provide redundant capabilities. In addition, these ITS standards are at different maturity levels. Care should be taken to select the standards that best meet the needs of the region or project.

Lead SDO	Standard Name	Document ID
<b>Flow: archive requests</b>		
<i>Source:</i> CH TranStar AASHTO/ITE/NEMA	<i>Destination:</i> Houston TranStar NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> CH TranStar AASHTO/ITE	<i>Destination:</i> TxDOT Traffic Management Center Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> TxDOT Traffic Management Center AASHTO/ITE	<i>Destination:</i> CH TranStar Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> TxDOT Traffic Management Center AASHTO/ITE/NEMA	<i>Destination:</i> Houston TranStar NTCIP Center-to-Center Standards Group	(See Footnote)
<b>Flow: archive status</b>		
<i>Source:</i> CH TranStar AASHTO/ITE/NEMA	<i>Destination:</i> Houston TranStar NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> CH TranStar AASHTO/ITE/NEMA	<i>Destination:</i> TxDOT Traffic Management Center NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> TxDOT Traffic Management Center AASHTO/ITE/NEMA	<i>Destination:</i> CH TranStar NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> TxDOT Traffic Management Center AASHTO/ITE/NEMA	<i>Destination:</i> Houston TranStar NTCIP Center-to-Center Standards Group	(See Footnote)
<b>Flow: archived data product requests</b>		
<i>Source:</i> CH TranStar AASHTO/ITE	<i>Destination:</i> TxDOT Traffic Management Center Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> TxDOT Traffic Management Center AASHTO/ITE	<i>Destination:</i> CH TranStar Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)

Lead SDO	Standard Name	Document ID
<b>Flow: archived data products</b>		
<i>Source: CH TranStar</i> <span style="float:right"><i>Destination: TxDOT Traffic Management Center</i></span>		
AASHTO/ITE	Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
ASTM	Standard Practice for Metadata to Support Archived Data Management Systems	ASTM E2468-05
ASTM	Standard Specifications for Archiving ITS-Generated Traffic Monitoring Data	ASTM E2665-08
<i>Source: TxDOT Traffic Management Center</i> <span style="float:right"><i>Destination: CH TranStar</i></span>		
AASHTO/ITE	Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
ASTM	Standard Practice for Metadata to Support Archived Data Management Systems	ASTM E2468-05
ASTM	Standard Specifications for Archiving ITS-Generated Traffic Monitoring Data	ASTM E2665-08
<b>Flow: data collection and monitoring control</b>		
<i>Source: CH TranStar</i> <span style="float:right"><i>Destination: CH Roadway Equipment</i></span>		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Data Collection and Monitoring (DCM) Devices	NTCIP 1206
AASHTO/ITE/NEMA	Data Element Definitions for Transportation Sensor Systems (TSS)	NTCIP 1209
<i>Source: CH TranStar</i> <span style="float:right"><i>Destination: CH Roadway Equipment (TIGER Project)</i></span>		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Data Collection and Monitoring (DCM) Devices	NTCIP 1206
AASHTO/ITE/NEMA	Data Element Definitions for Transportation Sensor Systems (TSS)	NTCIP 1209
<i>Source: TxDOT Traffic Management Center</i> <span style="float:right"><i>Destination: CH Roadway Equipment</i></span>		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Data Collection and Monitoring (DCM) Devices	NTCIP 1206
AASHTO/ITE/NEMA	Data Element Definitions for Transportation Sensor Systems (TSS)	NTCIP 1209
<i>Source: TxDOT Traffic Management Center</i> <span style="float:right"><i>Destination: CH Roadway Equipment (TIGER Project)</i></span>		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Data Collection and Monitoring (DCM) Devices	NTCIP 1206
AASHTO/ITE/NEMA	Data Element Definitions for Transportation Sensor Systems (TSS)	NTCIP 1209
<b>Flow: device control request</b>		
<i>Source: CH TranStar</i> <span style="float:right"><i>Destination: TxDOT Traffic Management Center</i></span>		
AASHTO/ITE	Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD

Lead SDO	Standard Name	Document ID
<i>Source:</i> CH TranStar AASHTO/ITE/NEMA	<i>Destination:</i> TxDOT Traffic Management Center NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> TxDOT Traffic Management Center AASHTO/ITE	<i>Destination:</i> CH TranStar Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
<b>Flow: device data</b>		
<i>Source:</i> CH TranStar AASHTO/ITE	<i>Destination:</i> TxDOT Traffic Management Center Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> TxDOT Traffic Management Center AASHTO/ITE	<i>Destination:</i> CH TranStar Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
<b>Flow: device status</b>		
<i>Source:</i> CH TranStar AASHTO/ITE	<i>Destination:</i> TxDOT Traffic Management Center Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> TxDOT Traffic Management Center AASHTO/ITE	<i>Destination:</i> CH TranStar Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
<b>Flow: fare and price information</b>		
<i>Source:</i> Houston TranStar AASHTO/ITE/NEMA SAE	<i>Destination:</i> CH TranStar NTCIP Center-to-Center Standards Group Advanced Traveler Information Systems (ATIS) General Use Standards Group	(See Footnote) (See Footnote)
<i>Source:</i> Houston TranStar AASHTO/ITE/NEMA SAE	<i>Destination:</i> TxDOT Traffic Management Center NTCIP Center-to-Center Standards Group Advanced Traveler Information Systems (ATIS) General Use Standards Group	(See Footnote) (See Footnote)
<b>Flow: incident information</b>		
<i>Source:</i> CH TranStar AASHTO/ITE	<i>Destination:</i> TxDOT Traffic Management Center Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> TxDOT Traffic Management Center AASHTO/ITE	<i>Destination:</i> CH TranStar Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)

Lead SDO	Standard Name	Document ID
<b>Flow: logged vehicle routes</b>		
<i>Source:</i> Houston TranStar	<i>Destination:</i> CH TranStar	
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
SAE	Advanced Traveler Information Systems (ATIS) General Use Standards Group	(See Footnote)
<i>Source:</i> Houston TranStar	<i>Destination:</i> TxDOT Traffic Management Center	
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
SAE	Advanced Traveler Information Systems (ATIS) General Use Standards Group	(See Footnote)
<b>Flow: probe archive data</b>		
<i>Source:</i> CH Roadway Equipment	<i>Destination:</i> CH TranStar	
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
<i>Source:</i> CH Roadway Equipment	<i>Destination:</i> TxDOT Traffic Management Center	
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
<i>Source:</i> CH Roadway Equipment (TIGER Project)	<i>Destination:</i> CH TranStar	
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
<i>Source:</i> CH Roadway Equipment (TIGER Project)	<i>Destination:</i> TxDOT Traffic Management Center	
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
<b>Flow: right-of-way request notification</b>		
<i>Source:</i> CH Roadway Equipment	<i>Destination:</i> CH TranStar	
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<i>Source:</i> CH Roadway Equipment (TIGER Project)	<i>Destination:</i> CH TranStar	
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<b>Flow: road network conditions</b>		
<i>Source:</i> CH TranStar	<i>Destination:</i> Houston TranStar	
AASHTO/ITE	Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
SAE	Advanced Traveler Information Systems (ATIS) General Use Standards Group	(See Footnote)
<i>Source:</i> CH TranStar	<i>Destination:</i> TxDOT Traffic Management Center	
AASHTO/ITE	Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> TxDOT Traffic Management Center	<i>Destination:</i> CH TranStar	
AASHTO/ITE	Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)
<i>Source:</i> TxDOT Traffic Management Center	<i>Destination:</i> Houston TranStar	
AASHTO/ITE	Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	ITE TMDD
AASHTO/ITE/NEMA	NTCIP Center-to-Center Standards Group	(See Footnote)

Lead SDO	Standard Name	Document ID
<b>Flow: road network traffic probe data</b>		
Source: Houston TranStar AASHTO/ITE/NEMA	Destination: CH TranStar NTCIP Center-to-Center Standards Group	(See Footnote)
Source: Houston TranStar AASHTO/ITE/NEMA	Destination: TxDOT Traffic Management Center NTCIP Center-to-Center Standards Group	(See Footnote)
<b>Flow: roadside archive data</b>		
Source: CH Roadway Equipment AASHTO/ITE/NEMA	Destination: CH TranStar NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Data Collection and Monitoring (DCM) Devices	NTCIP 1206
AASHTO/ITE/NEMA	Data Element Definitions for Transportation Sensor Systems (TSS)	NTCIP 1209
Source: CH Roadway Equipment AASHTO/ITE/NEMA	Destination: TxDOT Traffic Management Center NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Data Collection and Monitoring (DCM) Devices	NTCIP 1206
AASHTO/ITE/NEMA	Data Element Definitions for Transportation Sensor Systems (TSS)	NTCIP 1209
Source: CH Roadway Equipment (TIGER Project) AASHTO/ITE/NEMA	Destination: CH TranStar NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Data Collection and Monitoring (DCM) Devices	NTCIP 1206
AASHTO/ITE/NEMA	Data Element Definitions for Transportation Sensor Systems (TSS)	NTCIP 1209
Source: CH Roadway Equipment (TIGER Project) AASHTO/ITE/NEMA	Destination: TxDOT Traffic Management Center NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Data Collection and Monitoring (DCM) Devices	NTCIP 1206
AASHTO/ITE/NEMA	Data Element Definitions for Transportation Sensor Systems (TSS)	NTCIP 1209
<b>Flow: roadway equipment coordination</b>		
Source: CH Roadway Equipment AASHTO/ITE/NEMA	Destination: CH Roadway Equipment (TIGER Project) NTCIP Center-to-Center Standards Group	(See Footnote)
Source: CH Roadway Equipment (TIGER Project) AASHTO/ITE/NEMA	Destination: CH Roadway Equipment NTCIP Center-to-Center Standards Group	(See Footnote)
<b>Flow: roadway information system data</b>		
Source: CH TranStar AASHTO/ITE/NEMA	Destination: CH Roadway Equipment NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Dynamic Message Signs (DMS)	NTCIP 1203
Source: CH TranStar AASHTO/ITE/NEMA	Destination: CH Roadway Equipment (TIGER Project) NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Dynamic Message Signs (DMS)	NTCIP 1203

Lead SDO	Standard Name	Document ID
<b>Flow: roadway information system status</b>		
<i>Source:</i> CH Roadway Equipment <i>Destination:</i> CH TranStar		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Dynamic Message Signs (DMS)	NTCIP 1203
<i>Source:</i> CH Roadway Equipment (TIGER Project) <i>Destination:</i> CH TranStar		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Dynamic Message Signs (DMS)	NTCIP 1203
<b>Flow: signal control commands</b>		
<i>Source:</i> CH TranStar <i>Destination:</i> CH Roadway Equipment		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<i>Source:</i> CH TranStar <i>Destination:</i> CH Roadway Equipment (TIGER Project)		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<b>Flow: signal control data</b>		
<i>Source:</i> CH Roadway Equipment <i>Destination:</i> CH Roadway Equipment (TIGER Project)		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<i>Source:</i> CH Roadway Equipment (TIGER Project) <i>Destination:</i> CH Roadway Equipment		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<b>Flow: signal control device configuration</b>		
<i>Source:</i> CH TranStar <i>Destination:</i> CH Roadway Equipment		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<i>Source:</i> CH TranStar <i>Destination:</i> CH Roadway Equipment (TIGER Project)		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<b>Flow: signal control plans</b>		
<i>Source:</i> CH TranStar <i>Destination:</i> CH Roadway Equipment		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<i>Source:</i> CH TranStar <i>Destination:</i> CH Roadway Equipment (TIGER Project)		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<b>Flow: signal control status</b>		
<i>Source:</i> CH Roadway Equipment <i>Destination:</i> CH TranStar		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<i>Source:</i> CH Roadway Equipment (TIGER Project) <i>Destination:</i> CH TranStar		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)

Lead SDO	Standard Name	Document ID
<i>Source:</i> CH Roadway Equipment (TIGER Project) AASHTO/ITE/NEMA	<i>Destination:</i> CH TranStar Global Object Definitions	NTCIP 1201
<b>Flow: signal fault data</b>		
<i>Source:</i> CH Roadway Equipment AASHTO/ITE/NEMA AASHTO/ITE/NEMA	<i>Destination:</i> CH TranStar NTCIP Center-to-Field Standards Group Global Object Definitions	(See Footnote) NTCIP 1201
<i>Source:</i> CH Roadway Equipment (TIGER Project) AASHTO/ITE/NEMA AASHTO/ITE/NEMA	<i>Destination:</i> CH TranStar NTCIP Center-to-Field Standards Group Global Object Definitions	(See Footnote) NTCIP 1201
<b>Flow: signal system configuration</b>		
<i>Source:</i> CH TranStar AASHTO/ITE/NEMA AASHTO/ITE/NEMA	<i>Destination:</i> CH Roadway Equipment NTCIP Center-to-Field Standards Group Global Object Definitions	(See Footnote) NTCIP 1201
<i>Source:</i> CH TranStar AASHTO/ITE/NEMA AASHTO/ITE/NEMA	<i>Destination:</i> CH Roadway Equipment (TIGER Project) NTCIP Center-to-Field Standards Group Global Object Definitions	(See Footnote) NTCIP 1201
<b>Flow: traffic archive data</b>		
<i>Source:</i> CH TranStar AASHTO/ITE  AASHTO/ITE/NEMA ASTM ASTM	<i>Destination:</i> TxDOT Traffic Management Center Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC) NTCIP Center-to-Center Standards Group Standard Practice for Metadata to Support Archived Data Management Systems Standard Specifications for Archiving ITS-Generated Traffic Monitoring Data	ITE TMDD  (See Footnote) ASTM E2468-05 ASTM E2665-08
<i>Source:</i> TxDOT Traffic Management Center AASHTO/ITE  AASHTO/ITE/NEMA ASTM ASTM	<i>Destination:</i> CH TranStar Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC) NTCIP Center-to-Center Standards Group Standard Practice for Metadata to Support Archived Data Management Systems Standard Specifications for Archiving ITS-Generated Traffic Monitoring Data	ITE TMDD  (See Footnote) ASTM E2468-05 ASTM E2665-08
<b>Flow: traffic flow</b>		
<i>Source:</i> CH Roadway Equipment AASHTO/ITE/NEMA AASHTO/ITE/NEMA AASHTO/ITE/NEMA	<i>Destination:</i> CH TranStar NTCIP Center-to-Field Standards Group Global Object Definitions Data Element Definitions for Transportation Sensor Systems (TSS)	(See Footnote) NTCIP 1201 NTCIP 1209
<i>Source:</i> CH Roadway Equipment (TIGER Project) AASHTO/ITE/NEMA AASHTO/ITE/NEMA AASHTO/ITE/NEMA	<i>Destination:</i> CH TranStar NTCIP Center-to-Field Standards Group Global Object Definitions Data Element Definitions for Transportation Sensor Systems (TSS)	(See Footnote) NTCIP 1201 NTCIP 1209
<b>Flow: traffic images</b>		
<i>Source:</i> CH Roadway Equipment	<i>Destination:</i> CH TranStar	

Lead SDO	Standard Name	Document ID
<i>Source:</i> CH Roadway Equipment <i>Destination:</i> CH TranStar		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Closed Circuit Television (CCTV) Camera Control	NTCIP 1205
AASHTO/ITE/NEMA	Object Definitions for Closed Circuit Television (CCTV) Switching	NTCIP 1208
<i>Source:</i> CH Roadway Equipment (TIGER Project) <i>Destination:</i> CH TranStar		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Closed Circuit Television (CCTV) Camera Control	NTCIP 1205
AASHTO/ITE/NEMA	Object Definitions for Closed Circuit Television (CCTV) Switching	NTCIP 1208
<b>Flow: traffic metering control</b>		
<i>Source:</i> CH TranStar <i>Destination:</i> CH Roadway Equipment		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<i>Source:</i> CH TranStar <i>Destination:</i> CH Roadway Equipment (TIGER Project)		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<b>Flow: traffic metering status</b>		
<i>Source:</i> CH Roadway Equipment <i>Destination:</i> CH TranStar		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<i>Source:</i> CH Roadway Equipment (TIGER Project) <i>Destination:</i> CH TranStar		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
<b>Flow: traffic probe data</b>		
<i>Source:</i> CH Roadway Equipment <i>Destination:</i> CH TranStar		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Data Collection and Monitoring (DCM) Devices	NTCIP 1206
<i>Source:</i> CH Roadway Equipment (TIGER Project) <i>Destination:</i> CH TranStar		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Object Definitions for Data Collection and Monitoring (DCM) Devices	NTCIP 1206
<b>Flow: traffic sensor control</b>		
<i>Source:</i> CH TranStar <i>Destination:</i> CH Roadway Equipment		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201
AASHTO/ITE/NEMA	Data Element Definitions for Transportation Sensor Systems (TSS)	NTCIP 1209
<i>Source:</i> CH TranStar <i>Destination:</i> CH Roadway Equipment (TIGER Project)		
AASHTO/ITE/NEMA	NTCIP Center-to-Field Standards Group	(See Footnote)
AASHTO/ITE/NEMA	Global Object Definitions	NTCIP 1201

Lead SDO	Standard Name	Document ID
<i>Source:</i> CH TranStar AASHTO/ITE/NEMA	<i>Destination:</i> CH Roadway Equipment (TIGER Project) Data Element Definitions for Transportation Sensor Systems (TSS)	NTCIP 1209
<b>Flow: traveler archive data</b>		
<i>Source:</i> Houston TranStar AASHTO/ITE/NEMA ASTM SAE	<i>Destination:</i> CH TranStar NTCIP Center-to-Center Standards Group Standard Practice for Metadata to Support Archived Data Management Systems Advanced Traveler Information Systems (ATIS) General Use Standards Group	(See Footnote) ASTM E2468-05 (See Footnote)
<i>Source:</i> Houston TranStar AASHTO/ITE/NEMA ASTM SAE	<i>Destination:</i> TxDOT Traffic Management Center NTCIP Center-to-Center Standards Group Standard Practice for Metadata to Support Archived Data Management Systems Advanced Traveler Information Systems (ATIS) General Use Standards Group	(See Footnote) ASTM E2468-05 (See Footnote)
<b>Flow: video surveillance control</b>		
<i>Source:</i> CH TranStar AASHTO/ITE/NEMA AASHTO/ITE/NEMA AASHTO/ITE/NEMA AASHTO/ITE/NEMA	<i>Destination:</i> CH Roadway Equipment NTCIP Center-to-Field Standards Group Global Object Definitions Object Definitions for Closed Circuit Television (CCTV) Camera Control Object Definitions for Closed Circuit Television (CCTV) Switching	(See Footnote) NTCIP 1201 NTCIP 1205 NTCIP 1208
<i>Source:</i> CH TranStar AASHTO/ITE/NEMA AASHTO/ITE/NEMA AASHTO/ITE/NEMA AASHTO/ITE/NEMA	<i>Destination:</i> CH Roadway Equipment (TIGER Project) NTCIP Center-to-Field Standards Group Global Object Definitions Object Definitions for Closed Circuit Television (CCTV) Camera Control Object Definitions for Closed Circuit Television (CCTV) Switching	(See Footnote) NTCIP 1201 NTCIP 1205 NTCIP 1208

Lead SDO	Standard Name	Document ID
<b>Footnotes:</b>		
<b>Advanced Traveler Information Systems (ATIS) General Use Standards Group</b>		
SDO	Standard Name	Document ID
SAE	Location Referencing Message Specification (LRMS)	SAE J2266
SAE	Message Set for Advanced Traveler Information System (ATIS)	SAE J2354
SAE	Messages for Handling Strings and Look-Up Tables in ATIS Standards	SAE J2540
SAE	RDS (Radio Data System) Phrase Lists	SAE J2540/1
SAE	ITIS (International Traveler Information Systems) Phrase Lists	SAE J2540/2
SAE	National Names Phrase List	SAE J2540/3
<b>NTCIP Center-to-Center Standards Group</b>		
SDO	Standard Name	Document ID
AASHTO/ITE/NEMA	Octet Encoding Rules (OER) Base Protocol	NTCIP 1102
AASHTO/ITE/NEMA	Center-to-Center Naming Convention Specification	NTCIP 1104
AASHTO/ITE/NEMA	Ethernet Subnetwork Profile	NTCIP 2104
AASHTO/ITE/NEMA	Internet (TCP/IP and UDP/IP) Transport Profile	NTCIP 2202
AASHTO/ITE/NEMA	File Transfer Protocol (FTP) Application Profile	NTCIP 2303
AASHTO/ITE/NEMA	Application Profile for DATEX-ASN (AP-DATEX)	NTCIP 2304
AASHTO/ITE/NEMA	Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications (C2C XML)	NTCIP 2306
<b>NTCIP Center-to-Field Standards Group</b>		
SDO	Standard Name	Document ID
AASHTO/ITE/NEMA	Octet Encoding Rules (OER) Base Protocol	NTCIP 1102
AASHTO/ITE/NEMA	Transportation Management Protocols (TMP)	NTCIP 1103
AASHTO/ITE/NEMA	Point to Multi-Point Protocol Using RS-232 Subnetwork Profile	NTCIP 2101
AASHTO/ITE/NEMA	Point to Multi-Point Protocol Using FSK Modem Subnetwork Profile	NTCIP 2102
AASHTO/ITE/NEMA	Point-to-Point Protocol Over RS-232 Subnetwork Profile	NTCIP 2103
AASHTO/ITE/NEMA	Ethernet Subnetwork Profile	NTCIP 2104
AASHTO/ITE/NEMA	Transportation Transport Profile	NTCIP 2201
AASHTO/ITE/NEMA	Internet (TCP/IP and UDP/IP) Transport Profile	NTCIP 2202
AASHTO/ITE/NEMA	Simple Transportation Management Framework (STMF) Application Profile	NTCIP 2301
AASHTO/ITE/NEMA	Trivial File Transfer Protocol (TFTP) Application Profile	NTCIP 2302
AASHTO/ITE/NEMA	File Transfer Protocol (FTP) Application Profile	NTCIP 2303

Lead SDO		Standard Name		Document ID		
<i>Filters</i>						
Entity Class	Entity Type	Interconnects	Flow Type	Flow Status	Flow Futuristic	Market Package
Show Class	Show Type	Show Interconnect	Show Type	Show Status	Show Futuristic	Show Market Package
Yes Center	Yes System	Yes Center to Center	Yes Request	Yes Existing	Yes Futuristic	Yes All
Yes Field	Yes Human	Yes Center to Field	Yes Information	Yes Planned		
Yes Traveler	Yes Environment	Yes Center to Traveler				
Yes Vehicle		Yes Center to Vehicle				
		Yes Field to Field				
		Yes Field to Vehicle				
		Yes Traveler to Field				
		Yes Traveler to Traveler				
		Yes Traveler to Vehicle				
		Yes Vehicle to Vehicle				