The slides in this module are in this order:

- Instructor
- Learning Objectives
- Content-related slides
- Summary (what we have learned)
- References
- Questions?

This module is sponsored by the U.S. Department of Transportation’s ITS Professional Capacity Building (PCB) Program. The ITS PCB Program is part of the Research and Innovative Technology Administration’s ITS Joint Program Office.

Thank you for participating and we hope you find this module helpful.
Instructor

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Learning Objectives

1. How ITS is used by agencies to operate the system
2. Why form/maintain partnerships and how this is supported by ITS
3. Why prioritize the options for applying ITS
4. Recognize the role of management and operations (M&O) and how ITS can contribute to an overall Transportation Systems Management and Operations (TSM&O) mindset
5. How to develop performance management goals

Key Message:

1. Understand how ITS technologies and applications are used by agencies to effectively operate the transportation system.
2. Be energized to form and maintain relationships with other disciplines and jurisdictions within your region to ensure integrated traffic management across modes and stakeholder groups, and learn how ITS supports and facilitates the relationships between agencies, operators, and other partners to further operations objectives.
3. Understand the importance of converting raw data into useful information to provide situational awareness to decision makers.
4. Recognize that management and operation (M&O) of traffic is a primary goal of an organization, not simply building, operating, and maintaining infrastructure, and how ITS can contribute to an overall TSM&O mindset. This includes discussion of key elements:
   • Traffic incident management
   • Emergency management
   • ITS maintenance
   • Work zones
5. Be able to develop performance goals that lead to improved traffic operations.
Key Message: For many years these were the primary concerns of State Highway Departments and rural counties.

Most agency performance measures (if they had them at all) related to yards of asphalt and/or concrete laid, miles of roads repaired, etc.

Audience Interaction: Ask the class for others examples. Some possibilities:

- Safety improvements
- Repairing crash damage
- Some were toll roads, so collection of fees
Key Message: Traffic operations had an earlier start in urban areas because of the need to separate opposing traffic in time, since they usually couldn’t do so in space.

We begin to see the institutional differences now: state/county versus city.

It should be noted that some states operate all traffic signals, but most operate none, or few. In the latter cases, the states usually install the signals, but a local agency operates them under an operate and maintain agreement.

Audience Interaction: Again, ask for some other examples:
• Cleaning the streets
• Parking control
Key Message: As urban freeways became more prevalent in the latter half of the 1900s, agencies began to be more involved in traffic management, thus traffic operations.

The slide has several of the early treatments listed:

- Early use of closed-circuit television (CCTV)
- Xs and arrows (lane controls)
- Police or dedicated safety service patrols (SSPs)
- Ramp metering began in the 1960s

Eventually agencies needed a coordinated center to be the hub of traffic control.

TMCs are also called Traffic Operations Centers, or TOCs. The acronym TMCs will be used for consistency in this module.
Key Message: As urban arterial systems became more advanced, agencies began to be more involved in arterial traffic management, and traffic operations in general.

Surveillance early on was primarily detector data from intersections with some mid-block “system” sensors, so it was basically flow data, although some systems were more sophisticated. Now, closed-circuit television (CCTV) is becoming common.

Signal timing has been primarily accomplished by off-line optimization programs to develop time-of-day and other types of timing plans.

In coordinated corridors, they attempt to progress platoons of traffic.

In grid systems, like a downtown, they try to minimize some combination of delay and stops throughout the network.

Real-time traffic-adaptive control (RT-TRAC) is self optimizing and is just now becoming more common.

Eventually these agencies also needed a coordinated center to be the hub of traffic control.

TCCs are increasingly becoming as functional as TMCs with the addition of more ITS.
**Key Message:** On all roadways, albeit to different extents, the leading cause of non-recurring congestion is traffic incidents, as stated in the graphic.

Most of the other sources can be mitigated by ITS as well.

We will see that ITS technologies and processes are essential to effective traffic operations.

This begins with a discussion of the need for regional partnerships to follow.
Key Message: Transportation facilities are not isolated, either functionally or geographically. Users don’t care who operates which facilities and systems; they just want them all to operate efficiently.

Today we need RTSMOs to effectively manage the system.

Ideally, formal organizations would be created to make this happen.

Audience Interaction: Ask if anyone is aware of such an organization in their area and, if so, to describe it.
Key Message: In the past, the formal process for transportation planning was always focused on infrastructure.

The primary organizations are shown on the slide. The process is largely dictated by Federal rules, and states have adopted the same process for state planning.

At the purely local level, the process is similar, but may be less involved.

The context for planning is shown on the next slide.
**Key Message:** The typical life cycle of transportation projects has six common stages, as follows:

1. Programming is the process of taking goals and objectives from an over-arching plan, such as an agency’s Strategic Plan to developing concepts for achieving those goals and objectives. It usually includes identifying funding sources and approximate costs.
2. Planning is the formal process of moving the project(s) from the programming stage into an approved status with a budget and target schedule for implementation. This process is prescribed for all projects funded with Federal dollars, and most states use it for state-funded projects as well. Often the MPO in the region plays a major role, even for Federal/state-funded projects.
3. Design is the detailed process of determining the specific plans and specifications that can be used for construction and includes final cost details.
4. Construction is the process of building the project.
5. Operation is the set of daily and seasonable tasks that keep the facility working as planned.
6. Maintenance is the process of ensuring the good health of the facility so that it remains functional.

As shown, it is a circular process that feeds back into itself for improvements, enhancements, and adopting new technologies and materials.

For ITS projects, the overall process is similar, but another overarching requirement is the ITS System Architecture. There is a National ITS Systems Architecture, a Statewide Architecture, and (if Federal funds are used), a Regional Architecture. These define which ITS devices may be used in a project, to ensure compatibility among similar deployments.

The programming and planning stages are pretty much the same as any other project, but the remaining stages, shown in yellow, have a more detailed set of steps, referred to as the Systems Engineering Process (SEP).

This is because ITS projects involve a more complex set of elements than typical infrastructure projects, namely electronics and software.
Key Message: According to FHWA (source: http://ops.fhwa.dot.gov/travel/plan2op.htm), “Planning for Operations” includes three important aspects:

1. Regional transportation operations collaboration and coordination activity that facilitates Regional Transportation Systems Management and Operations.
2. Management and operations considerations within the context of the ongoing regional transportation planning and investment process.
3. The opportunities for linkage between regional operations collaboration and regional planning.”

It should be noted that designing for operations is also an outgrowth of this change in culture.
**Planning for Operations (cont’d)**

**Transportation Systems Management and Operations (TSM&O)***

FHWA: "an integrated program to optimize the performance of existing multimodal infrastructure through implementation of systems, services, and projects to preserve capacity and improve the security, safety, and reliability of our transportation system."

Source: http://ops.fhwa.dot.gov/publications/rctoprimer/prim0701.htm

**Key Message:** TSM&O is the new culture that the traffic operations community is promoting. It is rapidly gathering steam as evidenced by the active existence of the AASHTO Subcommittee on Systems Operations and Management (SSOM) and the TRB Committee on Regional Transportation Systems Management and Operations (AHB10).

It is important to have a plan or set of plans to guide the entire TSM&O effort. Components of this should include at least the following:

- An ITS Strategic Plan
- A TSM&O Plan
- A Traffic Incident Management Plan
- An Emergency Operations Plan
- A Traffic Signal Management Plan
Key Message: The examples here are not unique to TSM&O, but the rationale for TSM&O is to draw multiple jurisdictions and disciplines together to coordinate these and other programs.

TSM&O is being actively used in Florida, Maryland, Washington State, and likely others.

Audience Interaction: Ask if anyone can suggest others. The most obvious is Integrated Corridor Management (ICM).
Key Message: ICMM is a recent addition to TSM&O. It was adapted from Carnegie Mellon University’s Capability Maturity Model Integration (CMMI).

The goal is to develop (in this case) a traffic operations program that is not only effective, but predictable as well.

The full text of the objectives is to enhance:

- “Culture/leadership related to the level of understanding and potential leverage of SO&M, as reflected in values, mission, leadership, and related legal arrangements and strategy applications, and as demonstrated by leadership.
- Organization and staffing related to how structure aligns responsibilities and accountabilities vertically and horizontally, consistent with capabilities and incentives at the staff level.
- Resource allocation for operations and capital, and the degree of transparency and sustainability in relationship to program improvement.
- Partnerships in terms of degree of alignment and stability in objectives, procedures, roles, and relationships.”
While relatively new, the existence of Strategic Highway Research Program (SHRP) 2 tools, should promote ICMM. It has begun being implemented in Florida.
**Key Message:** Now let's get to the meat of the topic.

Module 3 covered the various ITS field devices like sensors, CCTV, dynamic message signs (DMSs), ramp meters, highway advisory radio (HAR), and road weather information subsystems (RWIS). This module covers how these subsystems and software are used to manage traffic and respond to incidents and emergencies.

While there is much overlap between TMC/TOCs (Traffic/Transportation Management/Operations) Centers and TCCs (Traffic Control Centers), they are covered separately because today, they are generally distinctly different.

We note that TCCs are quickly beginning to use ITS more fully, but the institutional differences remain for the most part.

**Audience Interaction:** Does anyone know of cases where the State DOT's TMC also has local traffic engineers controlling signals?
**Key Message:** These are the “what they do” functions of a typical TMC.

**Audience Interaction:** Name other functions.
Some possibilities:
- Coordinate with co-located agencies.
- Monitor Environmental Sensor Stations (ESSs).

### TMC Functions
- Operate TMC software system
- Monitor CCTV cameras and sensors
- Provide condition status
- Dispatch safety service patrols
- Notify public safety dispatchers
- Collect system performance data
- Collect operational performance data
Key Message: These are the “why they do it” functions of a typical TMC.

Module 4 of the ITS ePrimer has a lengthy table of specific functions and expected outcomes under various conditions.

Audience Interaction: What are some others?
Key Message: Ideally, the TMC would be an integral part of a regional operations organization and/or traffic incident management (TIM) Team.

The 4-Cs:
• Communication – being in close voice and data contact with the other agencies for data/info sharing.
• Cooperation – working together, not separately, in solving problems.
• Coordination – ensuring that all parties are fully informed of activities, resource needs, and allocations.
• Consensus – applying unified command in considering options and decision making.

Audience Interaction: What communications media should be used?
• Telephone and cell phone.
• Common radio frequencies and protocols.
• Internet (emails and Web sites).
• Shared data and video feeds, including computer-aided dispatch from public safety.
• Remote TMC workstations in other agencies.
• Ideally face-to-face via co-location.
**Key Message:** TCCs are similar, but have some differences from TMCs.

Note: ADMS = arterial dynamic message sign.

**Audience Interaction:** Name other functions.

Some possibilities:
- Coordinate with co-located agencies.
- Parking management.
**Key Message:** These are the “why they do it” functions of a typical TCC.

The ePrimer has another lengthy table of specific functions and expected outcomes under various conditions.
Key Message: Documentation covers ITS Architecture, Concepts of Operations, TMC/TCC Operations manuals, incident management plans, emergency plans, standard operating procedures (SOPs), job guides, etc.

Staffing should be based on a needs assessment that addresses what you are trying to accomplish and what skills are needed to meet those needs, obviously considering the equipment and software you have deployed.

Training includes self-study, classroom, online course and simulations, table-top exercises, field exercises, on-the-job training, etc.

Note that neither the module nor ePrimer module covers such issues as funding, staging, and the like.

Audience Interaction: Ask if there are others. Funding would be an obvious one.
Key Message: System monitoring has two aspects: 1) monitoring the system for the purposes of traffic management, and 2) monitoring to assess the health of the system itself. This section deals with the later. The first is covered later in the performance management section.

Good traffic operations requires an effective and well-operating system.

System and even individual component failures can be detrimental to operations.

The details of the bullets are as follows:

• System reliability – helps to ensure system robustness and overall reliability.
• Efficiency – the TMC and field equipment are operating at or above specifications and performing their expected functions properly.
• Effectiveness – that the ITS is achieving its program goals and objectives from an operational perspective.
• Accountability – enables managers to be confident that the investment in the ITS is being nurtured and protected through proper operation the vast majority of the time, or contrarily, that problems exist that need to be addressed.

Audience Interaction: Ask if anyone can suggest others. Meeting the agency’s mission could be one.
**Key Message:** A simple law of (traffic) physics is that when traffic demand approaches the roadway capacity, the quality of service rapidly diminishes, and then when demand exceeds capacity, traffic flow breaks down completely.

Strategically, there are only two ways to avoid this congestion: 1) reduce the demand, or 2) increase or enhance—that is make better use of—the capacity of the roadway.
Key Message: There are a number of programmatic strategies for reducing traffic demand by encouraging changes in traveler behavior. Some examples are as follows:

- Programs that promote alternative travel modes, such as using transit, ride sharing, and associated travel demand management (TDM) services, as well as encouraging non-motorized travel.
- Encouraging flexible work times, telecommuting, and the use of satellite work places.
- Real-time ATIS that encourages drivers to use alternate routes, change trip times, or effect other behavioral changes.
Key Message: The following strategies—most of which are called active traffic management (ATM)—can be applied to enhance or increase capacity and/or stabilize flow (which has a similar affect) on limited-access highways, as indicated:

- Metering traffic onto freeways – by spacing out the merging traffic, there is less queuing in the acceleration lane, and smoother merges, which permits more stable flow past the ramp and increases throughput. Often freeway mainline speeds are increased dramatically.
- Reversible lanes – having reversible or contraflow lanes permits otherwise unused capacity in the off-peak direction to be used in the peak direction of flow. This is a good use of existing roadway, and ITS facilitates its operation through lane control signals, remote-controlled gates, CCTV, and sensors.
- Movable median barriers to add capacity during peak periods – functionally, this is similar to contraflow, but instead of shifting traffic to the other side of a median, the median itself is moved, effectively adding a lane to the peak direction.
- Automated toll collection improvements – electronic toll collection (ETC) is the standard for toll systems. “Open road tolling (ORT)” (or “free-flow tolling”) have no cash collection at all.
- Managed lanes – are either new lanes or existing high-occupancy vehicle (HOV) lanes converted to high-occupancy toll (HOT) lanes that operate as toll lanes using ETC (or even ORT) for single-occupant vehicles (SOVs) or even low-occupant vehicles. Carpools of two- or three-plus occupants may generally use the HOT lanes freely (thus encouraging demand shift to HOVs), while SOVs are charged a variable toll that is dependent on the time of day, level of congestion in the general-use lanes, and occupancy of the HOT lanes.
- Hard-running shoulder – some locales allow buses and, in some cases, general (mixed) traffic to use the shoulder lane during peak periods. The name comes from the fact that the shoulders have to be upgraded to normal travel lane strength for “hard-running” traffic.
- Work zone management – work zones are clearly areas of reduced capacity. Efficient management of these areas is essential for efficient traffic operations, as discussed in greater detail later in this module.
- Variable speed limits – an element of ATM, using variable speed limits that better reflect the realistic speeds indicated by the onset of congestion can have calming effect and reduce erratic lane changing; thus the
smoother traffic flow permits more throughput.
Key Message: More strategies, these are focused on surface streets:

- Optimizing the timing of traffic signals – this strategy has been used nationally for many years; however, many cities and counties are somewhat lax in updating the timing to accommodate changing demand patterns.
- Real-time traffic-adaptive control (RT-TRAC) strategies eliminate the retiming issue altogether and can be even more effective, since they adjust cycle by cycle in near real time.
- Restricting turns at key intersections – this strategy eliminates signal phases (usually left turns) that take time away from the primary through movements.
- Reversible lanes – just as on freeways, some cities use reversible lanes on arteries for the same reason.
- Transit signal priority – this uses sensors and/or transponders to detect buses approaching an intersection and special control software to either extend the green time on the bus’s phase if already green, or to shift the green to the bus phase from opposing phases.
- Signal timing for crossings – too often when trains, drawbridges, or other modes preempt signals and block traffic, signal timing continues as if the blockage had not occurred. Signal timings should be adjusted to accommodate re-routing that some drivers decide to do. Again, RT-TRAC strategies can react to this situation automatically.
**Key Message:** TMCs (and TCCs) are directly or indirectly involved in most of the foregoing strategies to some extent. What can TMC managers and operators do to explicitly help mitigate non-recurring congestion? Here are some examples:

- Use Advanced Traveler Information Systems (ATIS) to the fullest extent. TMC managers and operators can use their ATIS tools to maximize the dissemination of useful traveler information by all channels, particularly the DMSs, 511, HAR (if used), and media.

- Continuously scan the CCTV images looking for signs of breakdown, such as a smoking vehicle that might break down, debris on the roadway, dangerous or excessive vehicular maneuvers, or anything that might lead to an incident.

- Agencies might consider having the operations needs, not the order of occurrence, dictate the priority of both preventive and, even more importantly, reactive maintenance.

- Integrated Corridor Management (ICM) is designed to operate the freeways and arterial network, at least for a corridor with similar travel routes, to optimize the use of both types of facility.

- Finally, data being generated by ITS field devices and vehicle probes are valuable resources that may provide a foundation for the increasing use of models that can predict congestion and/or travel times to enable system managers and operators to take action to avoid the onset of congestion—either by diversion or trip changes. In the future, dynamic traffic assignment should become a reality.
Key Message: The purpose of ICM is to manage individual transportation corridor components, such as modes and facilities, which can be much more effective if accomplished in a coordinated and integrated manner. Following is a summary of the identified high-level needs:

- Information sharing and coordination across different transportation systems
- Optimization of the supply (available capacity of various modes and facilities) and demands for transportation services within the corridor
- Need for informative decision making process to assist in ICM implementation
- Need to disseminate traveler information that affects traveler’s route, mode, and travel time decisions
- Analysis and prediction of system performance for planning and real-time operations
- Estimation of the behavior of travelers in response to advanced management strategies
Key Message: Advanced Traveler Information Systems (ATIS) are used to inform travelers in the best possible manner to enable them to make informed—and hopefully safe—decisions about mode use, route taken, departure time, or even trip deferral. A side effect of these better decisions can often be supportive of efficient and safe traffic operations. For example, in the highway sector:

- Provide pre-trip information [such as via radio and TV traffic reports, Web sites, navigation maps, and information service provider (ISP) feeds] that might enable travelers to change their travel mode, change the trip departure time, or change the route of the trip, all to avoid an incident or just normal congestion, thus reducing traffic demand in the affected area.

- Provide en route information [such as via DMSs, radio traffic reports, GPS (global-positioning system) navigation maps, and ISP feeds to a smartphone] that might enable travelers to change their trip plans en route, such as changing their route or even abandon the trip, again, to avoid an incident or just normal congestion. Even if the traveler does not change any trip plans, just knowing the nature of congestion, perhaps with some indication of travel time or incident location, can reduce drivers’ frustration and anxiety, thus making them safer drivers that are less prone to take unnecessary chances, such as excessive lane changing.

- On managed lanes, the current HOT pricing is conveyed by DMSs, allowing SOV
drivers to make a decision to use the HOT lanes, thus relieving demand in the general-use lanes.

- Provide en route information during longer (e.g., intercity or interstate) trips, using techniques like those mentioned previously (as applicable) or kiosks at rest areas, to help these longer range travelers adjust their trip plans.

- ATIS can also provide information that does not directly affect current travel, but serves other purposes, such as safety messages, smog alerts, and for AMBER and Silver Alerts. Silver Alerts are modeled after AMBER (America's Missing: Broadcast Emergency Response Alerts), but are for senior citizens suffering from irreversible deterioration of intellectual faculties and are believed to be missing. These alerts are used in many states, but are often called by different names.
Key Message: To review from module 3, a Road Weather Information System (RWIS) consists of a set of sensors, or Environmental Sensor Stations (ESSs), that can detect and report a number of environmental measures that affect roadway operations. Depending on the particular ones desired, these can include the following:

- Ambient air temperature.
- Road surface temperature.
- Wind direction and speed.
- Presence of falling or suspended particulates, such as dust, rain, snow, sleet, smoke, and fog.
- Fossil fuel emissions (technically not road weather information, but in the family).
### RWIS (cont'd)

**Advantages**

- Snow and ice mitigation
- Detect hazardous environmental conditions
- Detect visibility hazards
- Assist in bridge closing
- Policy for signal timing
- Commercial weather services

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**Key Message:** RWIS is an effective tool for traffic (and agency operational) management. Some uses are as follows:

- Optimize maintenance operations in cold climates and/or mountainous regions where snow and ice are commonplace by enabling managers to dispatch the right equipment and materials at the right times.
- Detect conditions that may be hazards (such as high winds or flooding) that impact roadway operations.
- Detect other conditions that cause reduced visibility, such as fog, smoke, blowing dust or sand, and blizzard (white-out) conditions on roadways. Note that smoke and fog together make a particularly hazardous combination, as experienced on I-4 and I-75 in Florida in 2008 and 2012, respectively.
- Wind-speed sensors on some roadways and on bridges alert TMCs when they should consider issuing travel advisories for trucks and other large vehicles. When winds are particularly high, they may indicate the need to close bridges to all traffic.
- Environmental sensors can be used as a policy for RT-TRAC signal control.

Several of these measures have the primary purpose to assist the agency in being more efficient, but better traffic operations is a welcome spin-off.

A number of DOTs (as well as other industries) subscribe to commercial weather forecasting companies that provide timely, location-specific forecasts that are reputedly even better than the National Weather Service. This is possible because they draw their data from multiple sources, including the National Weather Service, and fuse the results.
Key Message: As shown earlier, traffic incidents are the leading cause of non-recurring congestion. To fully understand how incidents are managed, one must understand the timeline, or stages, of an incident, which can be summarized as follows:

- Detection that an incident has occurred.
- Verification that the incident has indeed occurred, determining its location, and having sufficient information to enable an appropriate response.
- Response by dispatching appropriate assets to resolve the incident.
- Clearance, or the removal of the vehicles, damaged property, and victims, first from the roadway itself and complete reopening of any blocked lanes, and then from the entire incident scene.
- Recovery to normal traffic flow.

This graphic illustrates the timeline. Notice that recovery is relatively longer than the earlier stages. Incident managers estimate that recovery normally takes four to five times longer than the combined earlier stages (starting with verification).

Thus every minute saved in these earlier steps, particularly clearance, which is generally the longest of these, saves 4–5 minutes in recovery.

That is critical to efficient traffic operations, and reduces the chances of secondary incidents, which just restart the cycle all over again.

Secondary incidents are often more severe than the original incident.

Audience Interaction: Notice that we refer to secondary incidents, not crashes. Can you name some other typical secondary incidents?

Some possibilities:
- Vehicles run out of gas idling in the queue
- The overheat and stall
- Drivers turn off their engines and can’t restart
- Road rage results in confrontations
- Drivers make erratic maneuvers to try to exit the roadway or bypass the incident and crash and hit guardrails
Key Message: Many regions have found it useful to form an interagency, multijurisdictional TIM team.

The team can operate as a unit to create TIM Plans and Concepts of Operations (ConOps) that identify stakeholders and their respective roles and responsibilities in incident management, and then continue to function as a mechanism for sharing new techniques, cross-training, and conducting post-incident assessments through regular meetings.

Members of the TIM team can, and generally should to the extent practical, come from all of the stakeholder groups listed on the slide.

Some, such as Federal agencies, may serve more of an advisory role than an active role in TIM.

TIM teams, while not an absolute requirement, can greatly enhance the effectiveness of incident response and recovery, thus improving traffic operations.

One of the important things TIM teams can do is to promote an “Open Roads Philosophy,” under which agencies agree on a formal “Open Roads Policy (ORP)” to
clear the roadway as quickly as safely possible. Some even set a numerical goal, usually 90 minutes following the arrival of the first responder.

**Audience Interaction:** Name some of the others. Possibilities are:

- Towing and recovery
- HAZMAT services
- MPOs
- Coroners
- Media
Key Message: Now we turn more explicitly to the roles that ITS plays in TIM.

Module 4 of the ITS ePrimer contains a table that details the various functions of ITS for each stage of an incident. Here, we briefly summarize the functions from the perspective of ITS devices and the TMC:

- Some TMC software systems have automated incident detection algorithms that track traffic characteristics (e.g., volume, speed, etc.) over time and location to detect significant changes in traffic flow patterns to insinuate an incident. An alert is issued so an operator can follow up and confirm an incident.
- TMC operators use CCTV cameras to detect incidents themselves, verify incidents reported by others, and monitor the response, clearance, and recovery, reporting changing conditions and status as needed.
- DMSs, and HAR, if available, are used to inform users that are actually traveling on the highway, or approaching the highway, of the incident.
- 511 and the media are used to inform the general public, so they can possibly change their trip plans.
- Archived data and recorded CCTV images (if the agency allows this) can be used for post-incident analysis and training.
- The TMC itself is a (note “a”, not “the”) hub for managing the incident. The official
hub is the on-scene incident commander and his/her unified command, but the TMC is a valuable resource for assisting in the incident management.

All of these tools dramatically impact traffic operations for the better—reducing incident durations and lessening the chance of secondary incidents.
**Key Message:** Now we move from “typical” traffic incidents to more serious incidents, which we refer to as emergencies, since they are more severe in nature.

Emergency transportation operations (ETO) brings in a somewhat different cast of players to respond to and manage these events. This section addresses the characteristics and responses to emergency events where little or no advance notice is provided, as well as for events with more advanced notice but with largely unpredictable impacts (such as a hurricane).

This graphic illustrates the declining frequency of incidents of various types and the types of agencies involved as the severity increases.

Following 9/11/2001, a number of national initiatives were implemented to improve our emergency preparedness and response. One of the most important to transportation agencies was the National Incident Management System (NIMS). (It should be noted that all incidents, even minor traffic crashes, are subject to NIMS albeit, usually on an informal basis.)
Key Message: Maintenance of ITS devices and traffic signal systems can clearly impact traffic operations. There are two aspects related to operations.

The first relates to physical device maintenance, namely, monitoring device operational status, scheduling preventive maintenance, and monitoring operational performance. Included are discussions of maintenance management systems, and such specialized support systems as fiber management systems.

The second aspect relates to maintenance activities on the roadway and its impact on traffic. Because freeway management systems (FMS) and arterial management systems (AMS) are somewhat different, they are covered separately, while recognizing some commonality.

A well-designed maintenance management system is important because:

• The size and inventory is growing due to technological advances.
• ITS maintenance is different than roadway maintenance; it is mostly involving electronics and communications.
• The number of stakeholders involved is greater (e.g., manufacturers, vendors and suppliers, maintenance staff, sometimes from different agencies, etc).
• There are integration issues associated with many different device types and brands.
• There is a need for consistent procedures and practices.
• There is a need for accurate and complete ITS inventory (devices and materials, such as fiber).
• There is a need for an efficient work-order-based maintenance system.
• There is a need for the ability to track expenses (e.g., labor, materials, parts, entire devices, and MOT) to the specific device or subsystem.
• There is a need for timely, accurate, and comprehensive reporting.
• There is limited funding – need to be efficient and effective with available resources, while at the same time justifying the maintenance program.
Key Message: By their very nature, work zones have a negative impact on traffic operations.

The purpose of using ITS (and other techniques) is to minimize the negative impacts and keep traffic moving through the zone as efficiently, and safely (for both the travelers and workers), as possible, especially for nighttime work.

ITS technology can be applied in work zones for the uses shown on the slide.
**Key Message:** The need for performance measures (PMs) is widely recognized. Performance measures have been a topic of discussion for many years; however, it is only recently that ITS devices provided the data that are essential to supporting PMs and their importance in operations.

The current transportation authorization act, Moving Ahead for Progress in the 21st Century (MAP-21) created a new standard for performance- and outcome-based programs.

Performance management from the ITS industry’s perspective is important to:

- Ensure that the agency achieves its goals and objectives.
- Ensure adequate resource allocation.
- Ensure that the systems deployed are cost-effective.
- Ensure that the return on investment is positive in terms of road-user benefits.
- Ensure that the performance measurements are consistent across the country.
- Ensure that the performance measurements are increasingly outcome-based, rather than simply output-based.
**Key Message:** This graphic illustrates the framework for using the indicated measures as part of performance measurement and management.

According to FHWA, the following four performance measures are being given emphasis (http://www.dot.state.fl.us/trafficoperations/ITS/Projects_Deploy/PerfMeas/presLindley052305.pdf):

- **Travel-time reliability** (Buffer Index) – the buffer index is the additional time that must be added to a trip, to ensure that travelers making the trip will arrive at their destination at, or before, the intended time, 95% of the time.
- **Extent of congestion** – spatial (also measurable by time) - miles of roadway within a predefined area and time period, for which average travel times are 30% longer than unconstrained travel times.
- **Incident duration** – the time elapsed from the notification of an incident until all evidence of the incident has been removed from the incident scene.
- **Customer satisfaction** – a qualitative measure of customers’ opinions related to the roadway management and operations services provided in a specified region.

All of this is aimed at ensuring the best possible level of operational service to the traveling public.

**Audience Interaction:** Can anyone identify other PMs that would be useful that ITS can expressly help with (bearing in mind these are national PMs)?

Some possibilities:
- Total vehicular throughput
- Total person throughput
- Percentage on-time arrivals of transit vehicles
• Percentage on-time arrivals of commercial vehicles
Key Message: Hopefully this module has instilled a strong sense of passion for the importance of traffic operations. Highways and other modes are merely conveyances for vehicles, people, and cargo. How effectively these users of the transportation system maneuver through the system is—or should be—the primary business of transportation agencies and their partners. The priorities in this regard are the following:

- Safety – of both the traveling public and those who service the system in any way.
- Efficiency – for people and goods to complete their trips in a timely and cost-effective manner.
- Environmentally sound – minimize the use of fuel and other resources, while minimizing pollutants.
- Security – ensuring the welfare of transportation users and those affected by the traffic.

Key tenets of this effort are inter-agency/multijurisdictional exercising of the 4-Cs—communication, cooperation, coordination, and consensus—focusing on operations and not equipment per se; and viewing transportation users as customers, placing their satisfaction first.
Key Message:

1. We covered how ITS technologies and applications are used by agencies to effectively operate the transportation system.
2. You should now understand the importance of relationships with other disciplines and jurisdictions within your region to ensure integrated traffic management across modes and stakeholder groups, and understand how ITS supports and facilitates the relationships between agencies, operators, and other partners to further operations objectives.
3. You should appreciate that operations should be a priority in assessing the options for applying ITS technologies and applications.
4. You should understand why management and operation (M&O) of traffic is a primary goal of an organization, not simply building, operating, and maintaining infrastructure and understand how ITS can contribute to an overall TSM&O mindset.
5. You should be able to develop performance management goals that lead to improved traffic operations and understand why they are important.
Major references listed. The FHWA Office of Operations Web site has a treasure chest of information about traffic operations, planning for operations, TSM&O, various ITS subsystems, etc.

References

- **Toolkit for Deploying TIM/QC Best Practices**: [http://www.i95coalition.net/i95/Training/QuickClearanceWorkshop/tabid/188/Default.aspx](http://www.i95coalition.net/i95/Training/QuickClearanceWorkshop/tabid/188/Default.aspx)
Questions?

1. Maintaining roads and bridges is the most important job of transportation agencies: True or False?
2. Are O&M and M&O just the same thing?
3. What is the primary cause of recurring congestion?
4. What is the primary cause of non-recurring congestion?
5. Transportation planning has nothing to do with traffic operations: True or False?
6. The primary job of a TMC is to focus on system status: True or False?

Answers:

1. False; while maintenance is very important, operations is (or should be) the top priority.
2. No, operation and maintenance is the old way of looking at this, management and operations (the latter including maintenance) is the right terminology.
3. Bottlenecks that reduce capacity, such as major interchanges, heavy merging or weaving, grade changes, sharp curves, etc.
4. Traffic incidents, the worst of which are crashes, but debris, stalls, and even roadside activities can cause them.
5. This was somewhat true in the past, but planning for operations is now considered a priority.
6. False; just like question 1, system up-time is important, but managing the traffic is the TMC’s job one.