UNITED STATES
DEPARTMENT OF TRANSPORTATION

ITS ePrimer
Module 3: Application of ITS Technologies in Transportation Management

September 2013

Intelligent Transportation Systems Joint Program Office
Research and Innovative Technology Administration, USDOT

This is the first, title slide in all modules.

The following slides are in this order:

- Instructor
- Learning Objectives
- Content-related slide(s)
- 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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Module Purpose

- Review of the applications of ITS to the management of transportation facilities
- Identify the benefits of these applications
- Highlight associated challenges and lessons learned

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Explain that this module is highly related to Module 4 but differs in that Module 3 focuses on the tools utilized in transportation management while Module 4 focuses on the operation and management strategies utilized to improve the performance of transportation systems.

Learning Objectives

- Describe existing and emerging Transportation Management Systems (TMS) tools
- Explain associated issues
- Identify common challenges
- Identify lessons learned
- Discuss future actions

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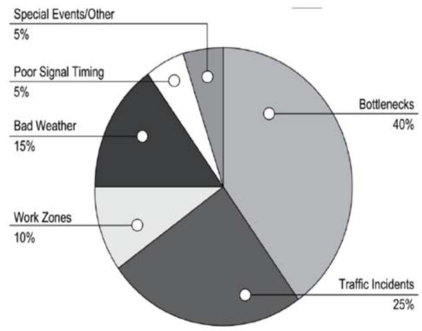
After completing the module, you should be able to:

- Describe the basic terminology and concepts of transportation management systems (TMS)
- Be familiar with the applications of ITS to the management of transportation facilities during recurrent and non-recurrent conditions on such facilities
- Explain highway system management data and the associated needs, data collection, data quality, data sharing, data archiving, and data analysis
- Identify challenges and lessons learned associated with TMS
- Discuss future actions with consideration of connected vehicle and highway systems

Need for Managing Transportation

- Increasing congestion impacts
- Increasing constraints on new capacity additions
- New capacity does not necessarily resolve congestion



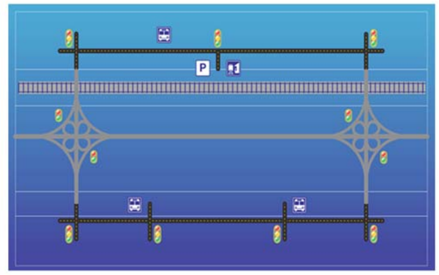
Source: "Traffic Congestion and Reliability: Trends and Advanced Strategies for Congestion Mitigation." Prepared for Federal Highway Administration (FHWA) by Cambridge Systematics, Inc., Cambridge, MA, September 2005.

Point out that TMS implementation is necessary to mitigate congestion impacts because of constraints on the addition of new capacity. In addition, adding capacity does not necessarily resolve non-recurrent congestion problems due to incidents, weather, work zones, special events, and poor signal operations. A large proportion of the congestion is due to these non-recurrent events and cannot be adequately addressed by adding capacity.

It is important to note that the congestion pie diagram applies to the National Highway System, which represents only 164,000 miles of roadway. There are 4 million miles of public roads in the U.S. and when considering that the vast majority of those roads are managed by local agencies, the distribution shown in the pie chart may be different.

Transportation System Management

- Application of advanced strategies and technologies to management
- Improve performance (mobility, reliability, safety, environmental impacts)



Source: USDOT Integrated Corridor Management Web site (http://www.its.dot.gov/icms/)

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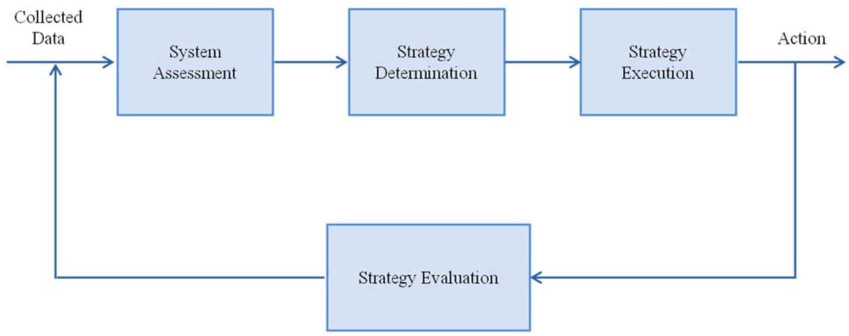
TMS has been proposed to address recurrent and non-recurrent congestion that impacts mobility, reliability, safety, and environmental impacts.

Point out that Transportation Management Systems (TMS) have been categorized based on the facility or the mode that they manage such as freeway, arterial, transit, freight, and parking facilities. However, integrated system management can be more effective.

A typical implementation of TMS involves one or more transportation management centers (TMC), field infrastructure, and mobile units communicating in real time to monitor and manage transportation systems.

Basic Functions of TMS



Source: Transportation Management Training Module. Consortium for ITS Training and Education (CITE), University of Maryland, CATT, College Park, MD. Accessed November 2012.

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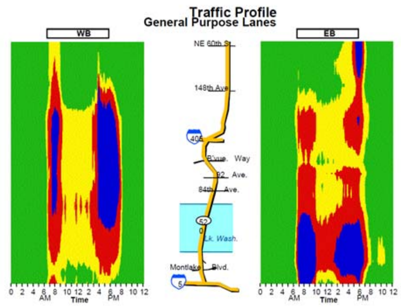
Point out that, although there are many types of TMS, in general, a TMS includes the four functions on this slide.

Need for Information Collection

- Performance monitoring
- Incident management
- System control
- Active traffic management
- Fleet management
- Priorities/preemptions
- Modeling/analysis support



Source: Neudorff, L.G., J. E. Randall, R. Reiss, R. Gordon, "Freeway Management and Operations Handbook," Prepared for FHWA, Washington, D.C., September 2003

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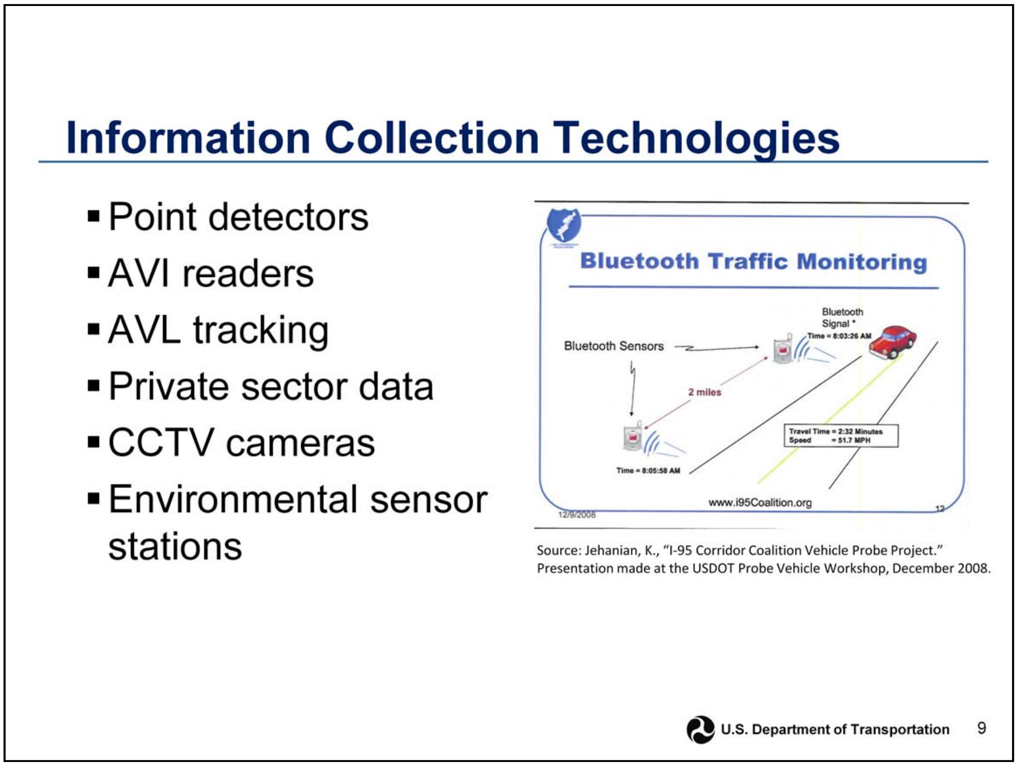
Note that information collection is related to the system state estimation and management strategy evaluation functions shown on the previous slide. The information is collected and in most cases uploaded to a central location at different aggregation levels; however, it can also be used locally at a roadside controller. The collected information can be used in real-time and/or archived for use for off-line applications.



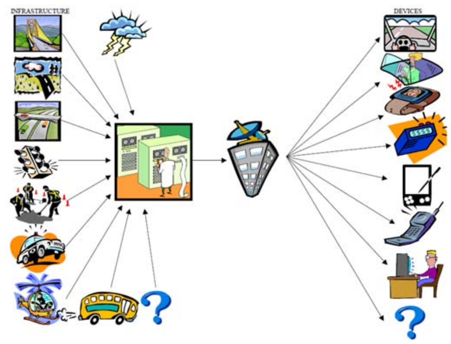
Explain that infrastructure point detectors provide traffic parameters measured at a point. Infrastructure-based point detectors include volume, speed, occupancy, presence, vehicle classification, and/or queue length. Segment measures have to be derived based on these point measures. On the other hand, AVI and AVL probe surveillance provide segment and/or trip measures such as travel time and occupancy but generally not counts or occupancy. Private sector data can be another cost-effective source of data.

Note that as currently implemented, many TMS applications, such as ramp metering and signal control, require volume and occupancy (or presence data) provided by point traffic detectors. Thus, the implementation of point traffic detectors is a major component of many applications of TMS, although advancements in Connected Vehicle technologies and the development of new TMS algorithms are expected to reduce the dependency on infrastructure detectors in the future.

Point out that one shortcoming of point detectors is that the travel time and speed estimation based on point detections is difficult, particularly for arterial streets. Thus, for applications that require travel time and possibly origin-destination estimation, probe surveillance technologies based on vehicle re-identification using Automatic Vehicle Identification (AVI) technologies (such as electronic toll readers, Bluetooth readers, or automatic license plate readers), tracking based on Automatic Vehicle Location (AVL) technologies, and private sector data can be good alternatives and have been increasingly used.

Information Dissemination

- Travel time
- Transit information
- Dynamic speed limit
- Lane control
- Dynamic pricing
- Route guidance
- Mode guidance
- AMBER/Silver Alerts



Source: Neudorff, L.G., J. E. Randall, R. Reiss, R. Gordon, *Freeway Management and Operations Handbook*. Prepared for FHWA, Washington, DC, September 2003.

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Information is used to encourage some type of response from travelers.

Information Dissemination Methods

- DMS
- HAR
- Trailblazers
- Graphical boards
- Kiosks
- 511 phone systems
- Web sites
- Phone apps
- In-vehicle systems

Source: Neudorff, L.G., J. E. Randall, R. Reiss, R. Gordon, *Freeway Management and Operations Handbook.* Prepared for FHWA, Washington, DC, September 2003.

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Note that these traveler information systems will be further discussed in Module 4. Dynamic Message Signs (DMS), Highway Advisory Radio (HAR), and trailblazers are classified as Advanced Traffic Management Systems (ATMS) not Advanced Traveler Information Systems (ATIS) in National Intelligent Transportation Systems Architecture (NITSA). The remaining technologies are classified as ATIS in NITSA.

Information Dissemination Issues

- Message content
- Message format
- Information credibility
- Dissemination activation
- Device location
- Device type

Source: Neudorff, L.G., J. E. Randall, R. Reiss, R. Gordon, *Freeway Management and Operations Handbook*. Prepared for FHWA, Washington, DC, September 2003.

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Explain that there is a need to develop operational policy to guide message development and posting. This policy should be based on identified needs and requirements that can be traced to the TMS concept of operations. The policy should cover who is allowed to post messages, the type of messages, the conditions that warrant message posting, the locations of these postings under different conditions, and so on.

Ramp Control

- Ramp metering
- Ramp closure
- Signal control at off-ramps
- Freeway-to-freeway connector metering

Source: Neudorff, L.G., J. E. Randall, R. Reiss, R. Gordon, *Freeway Management and Operations Handbook*. Prepared for FHWA, Washington, DC, September 2003.

Explain that these strategies should be considered based on identified needs. Ramp metering is the most widely used. Ramp closures can be beneficial during severe events such as incidents, adverse weather, planned and special events, and fire/smoke. Due to high speed and heavy volume on freeway-to-freeways connectors, longer queuing storage and advance warning devices are required.

Ramp Metering Strategies

- Isolated or coordinated
- Pre-timed, traffic responsive, or adaptive
- Preferential treatment of HOV, transit, emergency vehicles, or trucks

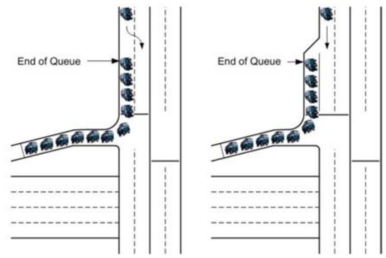
Source: Jacobson, L., J. Stribiak, L.Nelson, and D. Sallman, *Ramp Management and Control Handbook*. Report No. FHWA-HOP-06-001, Produced for FHWA by PB Farradyne, Washington, DC, January 2006.

Explain that the selection of strategy and control algorithm is an important consideration. Local control selects metering rates to address congestion and/or safety problems at a specific on-ramp merge area. This strategy is normally applied where the congestion problem is isolated. System-wide control selects metering rates on a number of on-ramp locations in a coordinated manner based on the conditions along a freeway segment, an entire corridor, or even a network of corridors.

Pre-timed also referred to as time-of-day or fixed time control utilizes metering rates calculated off-line based on historical conditions and are applied at a fixed schedule by time of day and day of the week. With traffic responsive and adaptive control, traffic parameters measured in real-time are used as inputs to a ramp metering algorithms to determine the metering rates and, in some cases, when and where to activate ramp metering.

Ramp Metering Issues

- Mainline vs. ramp performance
- Impacts on other facilities
- Public perception of adverse effects
- Public outreach efforts
- Coordination with other agencies



Source: Jacobson, L., J. Stribiak, L. Nelson, and D. Sallman, *Ramp Management and Control Handbook*. Report No. FHWA-HOP-06-001, Produced for FHWA by PB Farradyne, Washington, DC, January 2006.

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Point out that a number of issues are associated with ramp metering including:

- Achieving a balance between freeway mainline improvements and vehicle delays and queues at the on-ramps and parallel routes.
- Need to address perception that metering adversely affects on-ramp traffic, other facilities in the region, or other specific traveler groups (equity issues). Establish public information and outreach efforts.
- Coordination is needed with transportation agencies responsible for managing other effected transportation facilities.

Ramp Metering Benefits — MN Study

- 9% increase in throughput
- 14% decrease in travel time
- Travel time reliability improvement
- 26% decrease in crashes
- Benefit to cost ratio of 15 to 1

Courtesy: Florida Department of Transportation (FDOT)

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Note that the Minnesota study is one of the most important studies conducted to evaluate ramp metering. A large deployment of ramp metering is operated by the Minnesota DOT in the Twin Cities Metropolitan Region with more than 430 ramp meters. The Twin Cities ramp metering system was subject to an extensive evaluation during which the ramp meters were turned off for a six-week period for evaluation of the impacts of the ramp metering.

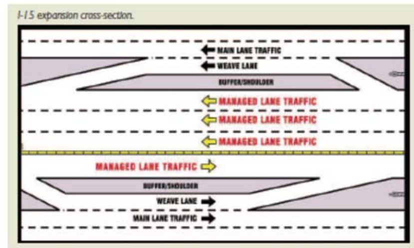
Multimedia Example

- Ramp Metering: Signal for Success - Federal Highway Administration Video can be found at http://www.youtube.com/watch?v=rsvaGXW6moA

Point out that Ramp Metering: Signal for Success is a Federal Highway Administration Video that provides a basic introduction to ramp metering and is intended for local decision-makers and the public, and features testimonials from officials of several cities.

Managed Lanes

- High occupancy vehicle (HOV) lanes
- High occupancy toll (HOT) lanes
- Express toll lanes (ETL)
- Truck-only toll (TOT) lanes
- Bus lanes
- Other special use lanes



Source: *Managed Lanes—A Primer*. Sponsored by FHWA, Washington, DC, August 2008.

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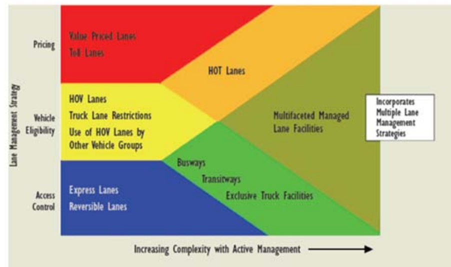
The type of managed lane should be selected based on goals and objectives, performance assessment, and modeling/analysis.

Managed Lane Strategies and Considerations

- Pricing strategies (fixed or dynamic)
- Vehicle eligibility
- Access control
- Enforcement
- Public outreach
- Modeling and analysis



Source: *Managed Lanes—A Primer*. Sponsored by FHWA, Washington, DC, August 2008.

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Note that increasingly, however, agencies are implementing dynamic pricing strategies that change the toll rate based on real-time measurements. Vehicle eligibility that involves selecting the type of vehicles allowed on the managed lanes, either for free or for a toll. Access control that determines the access points to the managed lane should be determined as part of the planning, traffic/simulation analyses, and design processes. It is also important for the transportation agency to communicate the benefits of the managed lane project through public outreach activities. Enforcement is another important element of a managed lane implementation and should be considered early in project development.

Multimedia Example

- FDOT 95 Express video:

http://www.youtube.com/watch?v=U1VzpFcfU78

Courtesy: Florida Department of Transportation

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Informational video about the Florida Department of Transportation's 95 Express. The video describes how the project combines the four transportation management techniques of transit, tolling, technology, and travel-demand management to improve the travel-time reliability and reduce congestion on Interstate 95 in Miami-Dade County.

Other Active Traffic Management

- Variable speed limit
- Queue warning
- Lane control
- Reversible lanes
- Hard shoulder running
- Bus-on-shoulder

Source: Fuh, C., *Synthesis of Active Traffic Management: Experiences in Europe and the United States.* Publication # FHWA-HOP-10-031, Prepared for FHWA by Parsons Brinckerhoff, Washington, DC, March 2010.

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Other use of strategies, tools, and resources to dynamically manage, control, and influence traffic flow and travel demand of transportation facilities

Arterial Systems

- Signal systems
- Bus priority
- Emergency vehicle preemption
- Rail-road crossing preemption
- Parking information
- System/equipment monitoring

Source: "Planning for Success: Applying Systems Engineering to ASCT Implementation." Presentation by Eddie Curtis, FHWA Office of Operations/Resource Center.

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Arterial systems are strategies or tactics to support specific operations objectives articulated at a local, regional, or state level. Arterial Management should be organized around a set of Goals, Objectives, Strategies, and Tactics, all validated through a set of meaningful performance measures.

Examples:

•Goal - Keep the cars moving and if they stop, not for very long.

•Objective - Provide smooth flow on arterial routes to commuter traffic on facilities that are parallel to or provide access to state highway and interstate routes.

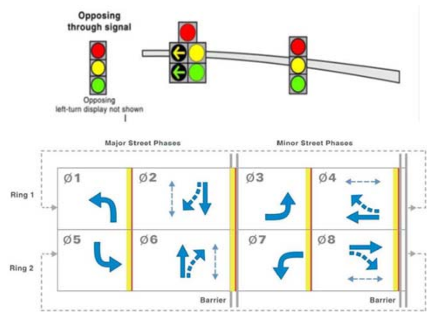
•Strategy - Implement a traffic signal control system to provide the capability to manage, operate, and maintain traffic signals.

•Tactic - Provide coordinated signal timing during peak hours to facilitate access to state highway and interstate routes.

Note that other active management strategies (dynamic speed recommendations, queue warning, lane control, managed lane, DMS, etc.) are also applicable to arterial management.

Signal Operations

- Updates based on:
  - Performance measurements
  - Operational objectives
- Signal timing
  - Manual
  - Optimization tools
  - Fine-tuning



Source: Koonce, P., L. Rodegerdts, K. Lee, S. Quayle, S. Beaird, C. Braud, J. Bonneson, P. Tarnoff, and T. Urbanik, "Traffic Signal Timing Manual." Produced for FHWA, Contract No. DTFH61-98-C-00075, Task Order No. B98C75-009, Washington, DC, June 2008.

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Note that poor traffic signal timing is one of the major reasons for traffic delays in urban arterials. Poor traffic signal timing is the outcome of ineffective traffic signal management programs and a lack of performance measurement to indicate that the timing has become inappropriate for the traffic conditions.

The traffic signal report card can be used as a reference.

Traffic signals should be timed to meet specified operational objectives. A set of meaningful performance measures should be used to determine if these objectives are achieved and signal updates should be based on evaluating resource constraints and meeting prioritized operations objectives. Existing signal optimization software possibly combined with microscopic simulation can help in this effort. However, field fine-tuning of the resulting timing is often necessary. A systematic program that evaluates operations objectives and resource constraints should help determine which tools an agency uses to optimize signal timing. In many cases manual methods can produce superior outcomes to simulation and optimization if these tools are not properly aligned with operations objectives and performance measures.

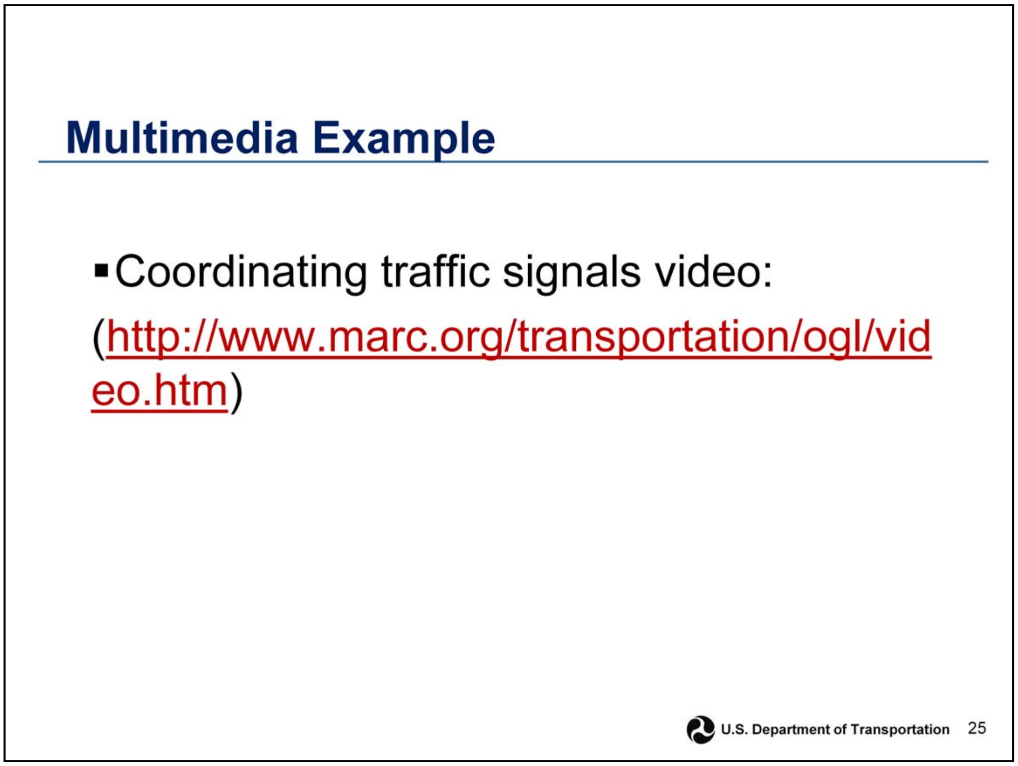
Point out that coordination of signals provides additional benefits compared to optimizing the operation of isolated signals.

One study showed that coordinated signal systems produced an average of 7.4% reduction in travel time, 16.5% reduction in delay, and 17% reduction in stops. However, the range of improvements has a huge range with typical B/C as high as 40:1.

Multimedia Example

- The Southwestern Pennsylvania Commission - before and after videos of signal retiming:
  - http://www.spcregion.org/trans_ops_traff_vids.shtml

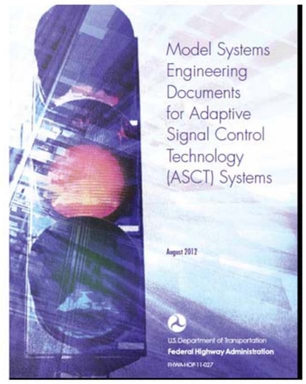
The Southwestern Pennsylvania Commission has developed a regional traffic signal program that includes technical assistance to municipalities as well as potential funding to assist in upgrading signal systems in the region. The regional traffic signal program has produced this before and after videos of signal retiming.



Coordinating traffic signals is one of the most cost-effective ways to help traffic move more efficiently. A four-minute video (http://www.marc.org/transportation/ogl/video.htm) explains how 20 cities, two states, and the Federal Highway Administration are working together with the Mid-America Regional Council to help improve traffic flow in Greater Kansas City.

Advanced Signal Control Strategies

- Traffic responsive control - initially proposed
- Adaptive signal control technology
- FHWA Model Systems Engineering Document for ASCT



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Describe briefly the difference between time-of-day, traffic responsive, and traffic adaptive control. Traffic responsive control was initially proposed but now the focus is on adaptive technologies.

Adaptive signal control strategies have been developed since the 1980s, with increasing interest in these strategies in the United States in recent years.

Point to FHWA *Model Systems Engineering Documents for Adaptive Signal Control Technology Systems - Guidance Document*. The *Model Systems Engineering Document for ASCT* is intended to help agencies apply a systematic process (systems engineering) to the implementation of adaptive control. The document can be used at the planning stage to determine if ASCT is an appropriate strategy to achieve stated operations objectives. The document is also intended for application during the implementation of ASCT projects facilitating the alignment of agency objectives and needs with a set of requirements to support the procurement of an ASCT system.

Multimedia Examples

- Santa Clara County adaptive signal timing video: http://www.youtube.com/watch?v=doXpCB3_nDA

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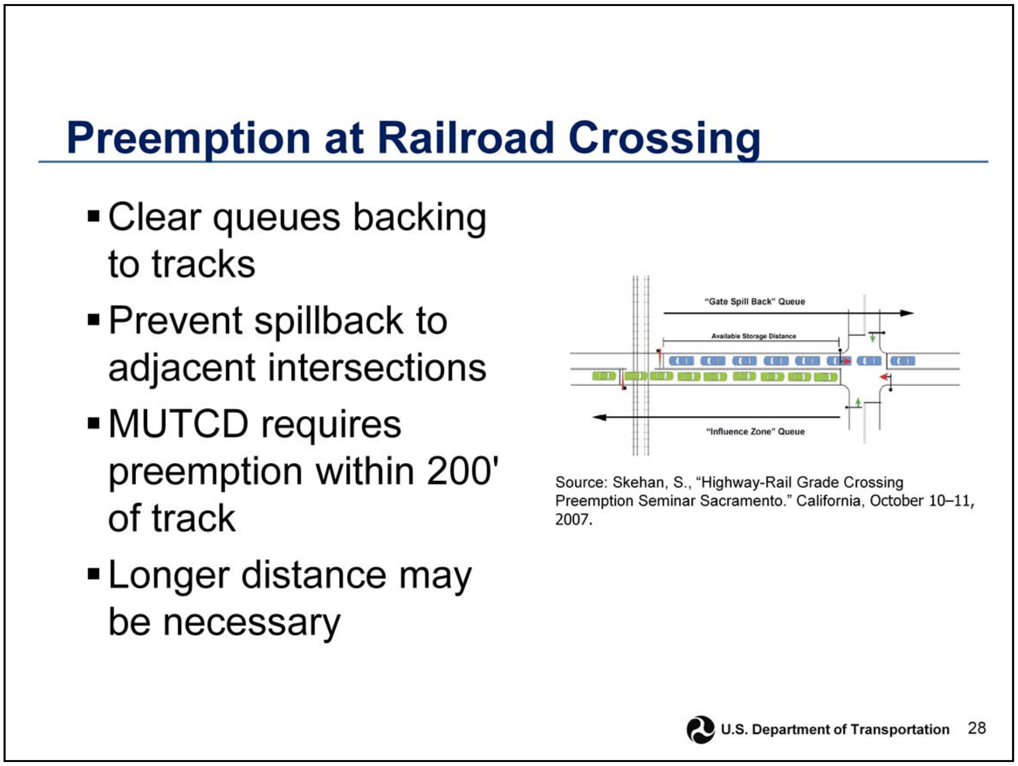
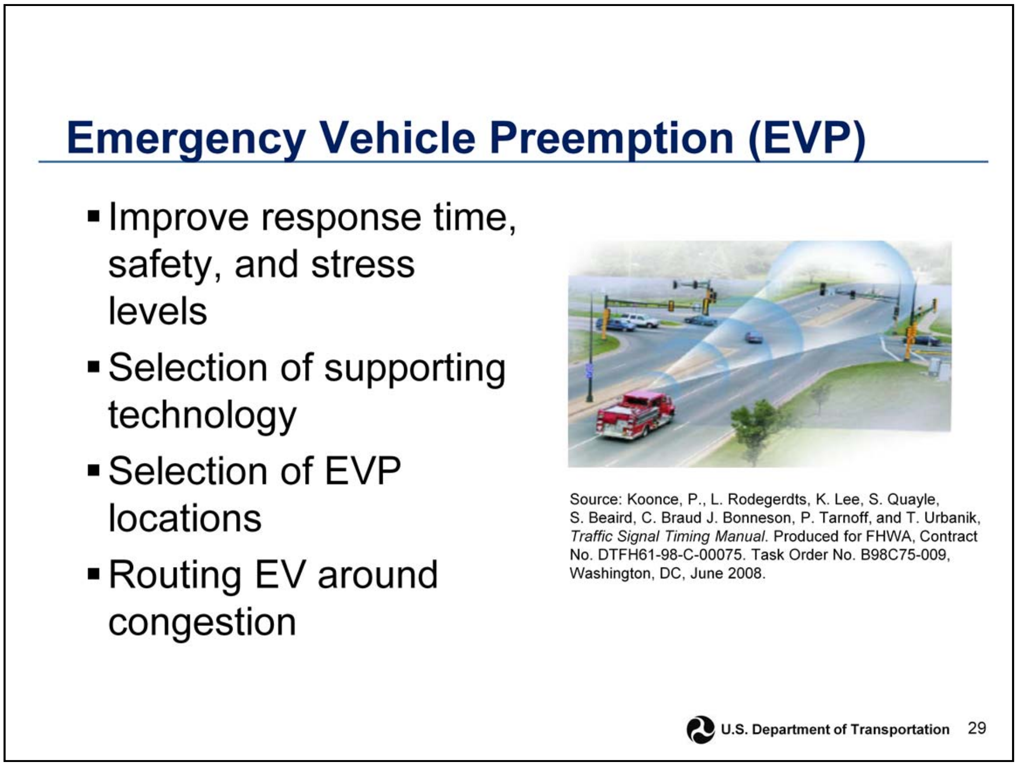
Santa Clara County adaptive signal timing for pedestrians in Santa Clara County that uses pedestrian sensors.



Point out that field measurements of queue lengths during critical traffic periods should be used to determine if preemption is needed. If field observation is not possible because the crossing is not yet in full operation, an acceptable modeling technique can be used to estimate the queue.

Preemption and priority as with signal control should follow the goal, objectives, strategy, and tactic framework discussed previously with consideration of what the agency or system is seeking to achieve through its implementation.



Results from a before and after comparison indicated that emergency vehicle response times decreased by 14 to 23 percent, saving approximately 70 seconds per response, on a typical response that spanned three to six signalized intersections. EVP evaluation indicated that the effective service radius of a fire and rescue station can be extended from less than 1.25 miles to more than 2 miles, potentially reducing the need for new stations and/or new equipment. Other studies showed significant reduction in emergency vehicle (EV) crashes.

A number of technologies have been used for EVP including radio-based, GPS-based, light-based, infrared-based, and sound-based. The preemption can be activated either by the local controllers or by the central system. When selecting technologies, consideration should be made of interoperability with other systems locally and in adjacent jurisdictions.

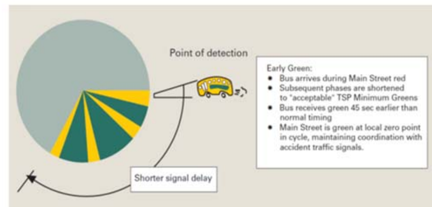
Some cities have installed EVP on all their signals. Others installed EVP only at frequently used paths of emergency vehicles, intersections with identified problems, or on newly installed signals.

EVP may not work well when lots of calls for preemption are made. Current systems can only service the first call, one at a time.

During oversaturated conditions with long queues, the EVP is not effective due to the long queues in front of the EV.

Transit Signal Priority (TSP)

- Active TSP approaches
  - Early green, green extension, phase insertion, phase rotation
- Passive TSP
- Queue jumpers
- Full bus lanes on arterials
- Bus-on-shoulders
- Transit on managed lanes



Source: Smith, H., B. Hemily, M. Ivanovic, *Transit Signal Priority (TSP): A Planning and Implementation Handbook.* Prepared for the United States Department of Transportation, Washington, DC, May 2005.

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Explain that, although preemption and priority may utilize similar equipment, these two strategies are different. Signal priority modifies the normal signal operation to accommodate transit vehicles, while preemption interrupts the operation. Note that preemption at railroad crossing has a priority over emergency vehicle preemption and the later has priority transit signal priority.

Previous evaluation of TSP indicates bus travel time saving of about 15% depending on the exiting signal delay with minor impacts on the overall intersection operations.

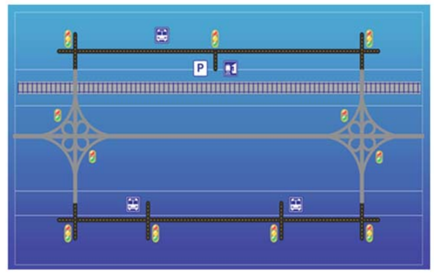
Careful attention should be given to minimizing the impact on general traffic operations.

Passive TSP does not require hardware and software modifications and is based on historical knowledge of transit route, schedule, dwell time, and ridership.

A queue jumper combines a short stretch of a special lane with a TSP to allow buses to bypass waiting queues of traffic.

Integrated Corridor Management (ICM)

- Information sharing and coordination between agencies
- Improvement of operational efficiency based on coordinated operation
- Promotion of cross-network shifts
- Planning for operations



Source: USDOT Integrated Corridor Management Web Site (http://www.its.dot.gov/icms/)

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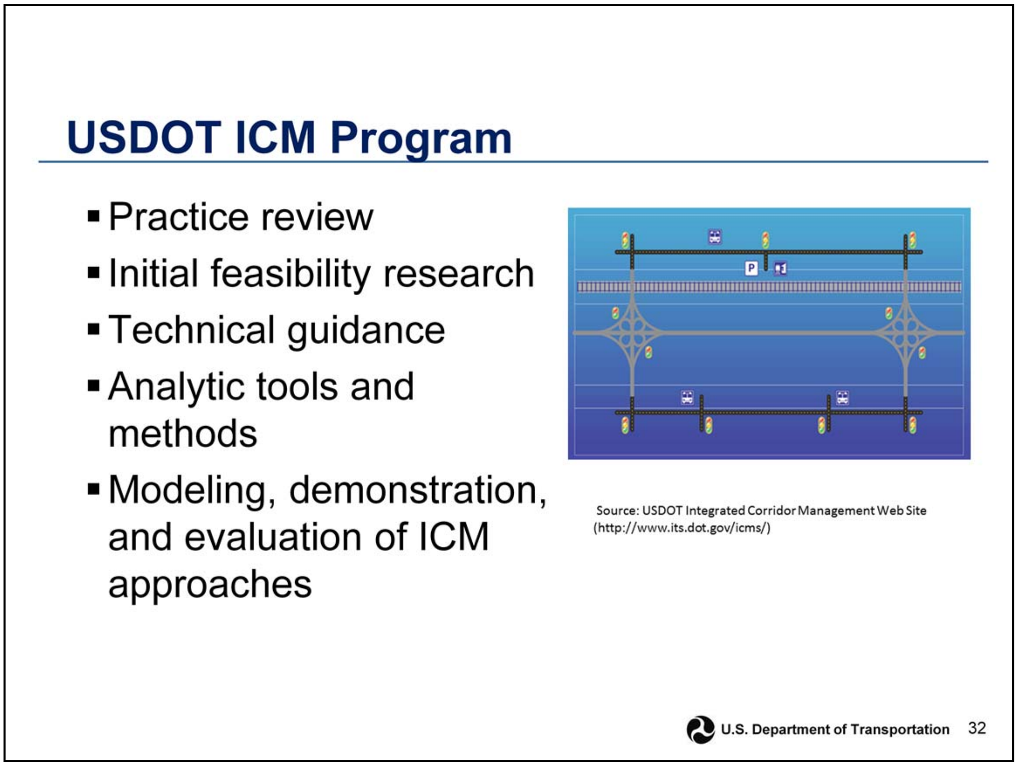
Integrated Corridor Management (ICM) can be defined as a collection of operational strategies and advanced technologies that allow transportation subsystems managed by one or more transportation agencies to operate in a coordinated and integrated manner, thereby increasing overall system throughput and enhancing the mobility, reliability, and safety of corridor users. An ICM initiative consists of the operational coordination of multiple transportation networks and cross-network connections comprising a corridor, and the coordination of institutions responsible for corridor mobility. The transportation subsystems could include freeways, arterials, parking, public transit, and freight facilities.



The USDOT's seven year ICM initiative aims at the development of new approaches for efficiently managing existing assets within a corridor.

Initially, all eight sites developed site-specific concept of operations (ConOps) and requirements documents. Three selected sites among the eight sites were selected for the application of Analysis, Modeling, and Simulation (AMS) methods. These three sites were Dallas, TX; Minneapolis, MN; and San Diego, CA. Phase 4 has involved outreach and knowledge and technology transfer to allow practitioners around the country to implement ICM strategies. The systems in Dallas and San Diego have entered the initial operations phase.

Transportation Management Centers (TMC)

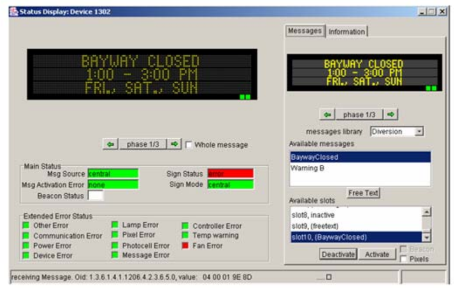
- Focal point of transportation management systems
- Focal point of coordinating with and communicating with other agencies

Courtesy of Florida Department of Transportation

Note that the TMC is where information about the transportation network is collected, processed, fused, and used to make decisions to effectively manage the system. TMC is also the focal point of coordinating with and communicating transportation related information to the media, information service providers, emergency and enforcement agencies, other transportation agencies, and the motoring public.

TMC Classifications

- Freeway Management Centers
- Traffic Signal System Centers
- Transit Management Centers
- Multijurisdictional/Multimodal TMCs



Source: Neudorff, L.G., J. E. Randall, R. Reiss, R. Gordon, *Freeway Management and Operations Handbook*. Prepared for FHWA, Washington, DC, September 2003.

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Freeway Management Centers (FMC): These centers are typically responsible for the monitoring and control of traffic on limited access facilities.

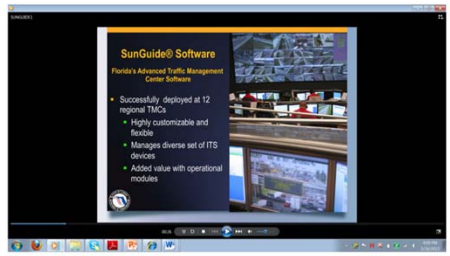
Traffic Signal System Centers (TSC): These centers focus monitoring and control functions of traffic signals on urban surface street networks.

Transit Management Centers (TRMC): These centers track and manages transit fleets. Depending on the center, the fleet could include buses, railcars, and/or paratransit vehicles.

In real-world implementations, the FMC functionalities are included in what is referred to as a regional traffic management center (RTMC) or a department of transportation or toll authority traffic management center, and the term FMC is not commonly used. Sometimes, these centers are also responsible for managing ITS deployment on arterial streets, in addition to freeways. Similarly, there are a variety of names used to reference traffic signal centers and TRMC in real-world implementations.

Multimedia Example

- Videos describing Florida Department of Transportation TMC Software Statewide deployment:
- http://www.itsa.wikispaces.net/file/view/SUNGUIDE1.mp4, ttp://www.itsa.wikispaces.net/file/view/SUNGUIDE2.mp4, and http://www.itsa.wikispaces.net/file/view/SUNGUIDE3.mp4

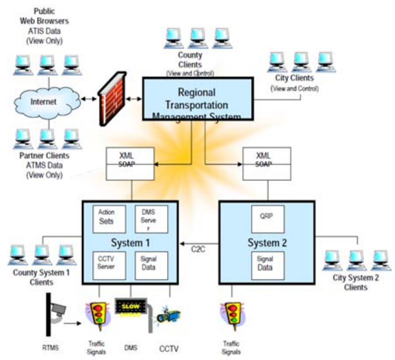


Courtesy of Florida Department of Transportation

Describe Florida Department of Transportation TMC Software Statewide deployment

Center-to-Center Coordination

- Sharing of information such as during events
- Coordinated strategy
- Coordinated control (e.g., signal control in adjacent jurisdictions)



Source: Neudorff, L.G., J. E. Randall, R. Reiss, and R. Gordon, *Freeway Management and Operations Handbook*. Prepared for FHWA, Washington, DC, September 2003.

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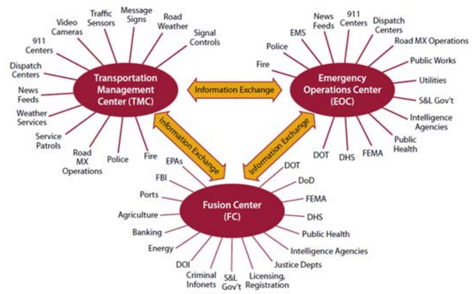
Center-to-center coordination is a key component in transportation systems management and operations (TSM&O) and ICM implementations, allowing agencies to work together to maximize the utilization of all capabilities to achieve agency and regional goals and objectives.

Information can be shared in real-time during events (such as incidents, work zones, and special events) or off-line as part of event planning or following the event as a “postmortem” evaluation.

Multijurisdictional/Multimodal TMCs

- Seamless travel information across jurisdictional boundaries
- More effective and integrated management
- Cost savings
- Improved working relationships
- Need formal agreement



Source: *Information Sharing Guidebook for Transportation Management Centers, Emergency Operation Centers, and Fusion Centers*. Prepared for FHWA, Washington, DC, June 2010.

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In some regions, regional multijurisdictional TMCs have been established that include various transportation management and enforcement agencies in the region. The benefits include providing seamless travel information across jurisdictional boundaries; allowing more effective and integrated management of the entire transportation system; and providing savings in implementation, operation, and maintenance costs.

Improved working relationships between agencies is expected. However, there is a need for formal agreement on operation processes and parameters.

TMS Device Maintenance

- Preventive maintenance
- Responsive maintenance
- Emergency maintenance
- Continuous funding is a main issue

Courtesy Schneider Electric (formerly Telvent)

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Preventive maintenance is scheduled operations performed to keep the systems operating

Responsive maintenance refers to operations that are initiated by a fault or trouble report

Emergency maintenance is similar to responsive maintenance, but the fault is more serious and requires immediate action.

Transportation Data

- Performance measurements
- Planning for operations
- Decision support tools
- Predictive modeling
- Impact assessment
- Modeling and operational analysis

Courtesy: Florida Department of Transportation

Data archiving is important to planning and operation. ITS data archiving, also referred to as ITS data warehousing, is defined as “the systematic retention and re-use of transportation data that is typically collected to fulfill real-time transportation operation and management needs.”

Transportation Data Issues

- Resources and funding
- Central warehouse vs. virtual warehouse
- Data quality
- Data fusion
- Adequate documentation
- Accessibility
- Maintainability
- Ease of use

Courtesy: Florida Department of Transportation

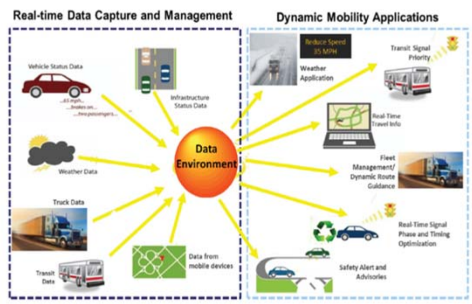
Explain that a good approach may be to start with the implementation of a small prototype, then expand to archiving more data sources and more complex systems with time.

Adequate documentation of the data archive and the associated data collection system is necessary.

Virtual data warehouse operates with several agencies operating their own individual data archives that are connected and integrated through computer interfaces.

USDOT Data Capture Program

- Support acquisition and provision of integrated, multisource data
- Enable the development of data environments



Source: USDOT RITA Web site (http://www.its.dot.gov/)

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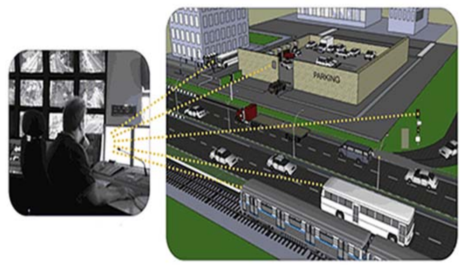
USDOT Real-Time Data Capture and Management program supports the active acquisition and systematic provision of integrated, multisource data that enhances current operational practices and transforms future surface transportation systems management.

Connected Vehicles (CV)

- Detailed probe data (type, quality, and quantity)
- Communication between TMC, drivers, and vehicles
- Better analysis of performance and responses



Source: USDOT RITA Web site (http://www.its.dot.gov/data_capture/data_capture.htm)

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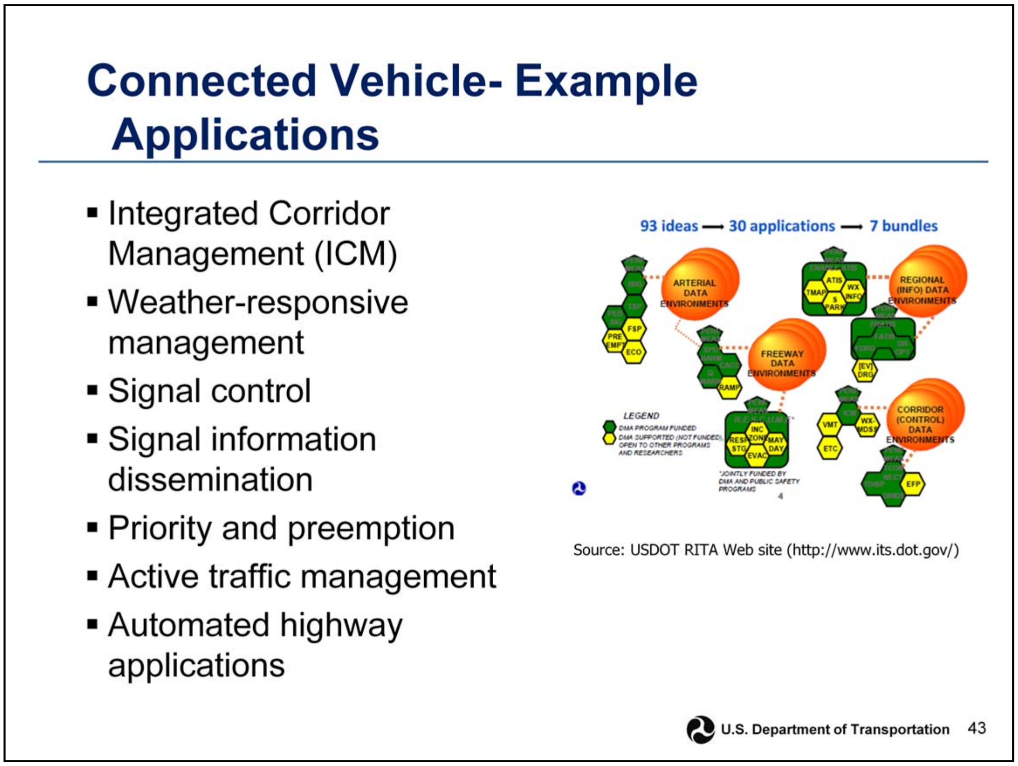
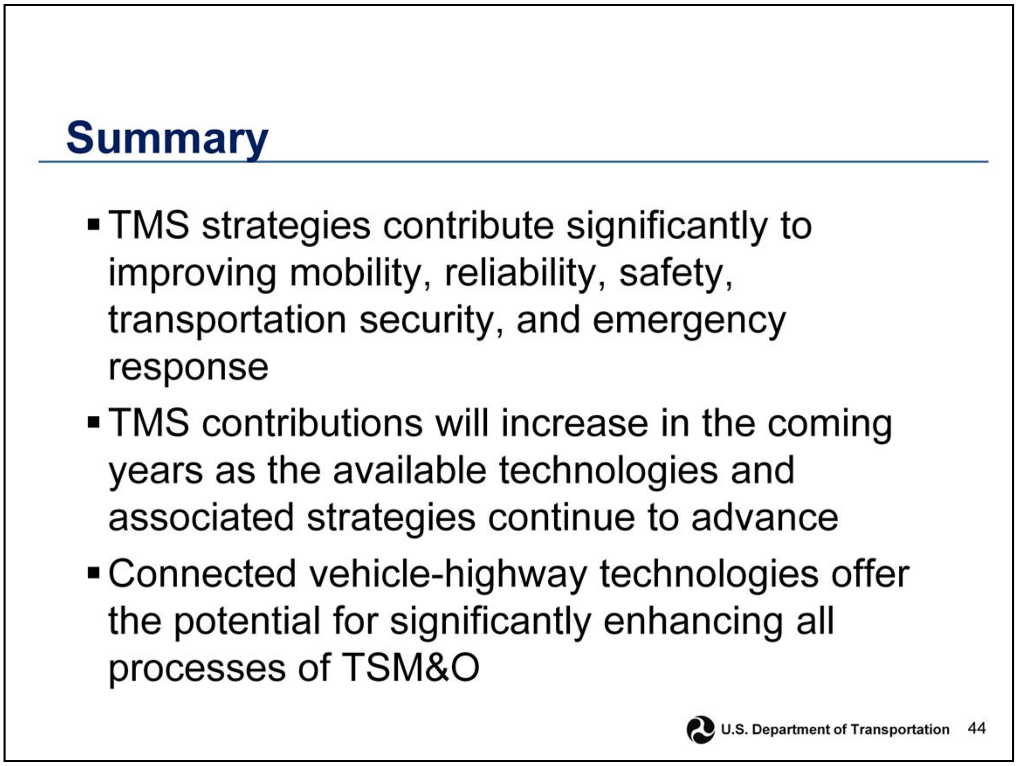
Note that Connected Vehicles (CV) will enable collecting detailed probe data from connected vehicles on-board units (OBU) and will allow much more detailed and accurate system state estimation. Also, note the ability to communicate information between transportation management centers, drivers, and vehicles will allow new methods of executing management strategies. In addition, information collected from the connected vehicle regarding performance and responses to management strategies will allow superior evaluation of these strategies both in real-time operations and off-line in planning for operations.



Examples include:

- Applications that integrate adaptive strategies across modes and facilities
- Weather-responsive management
- Adaptive signal controls
- Broadcasting real-time data about traffic Signal Phase and Timing to vehicles
- Traffic signal prioritization and emergency vehicles preemption
- Arterial network signal coordination
- Active traffic management applications such as speed management
- Automated highway applications such as cooperative adaptive cruise
- Corridor and regional management



There are a variety of TMS applications that are contributing significantly to reducing the congestion problems and the unreliability of the transportation systems around the country. TMS also play a major role in enhancing safety, transportation security, and emergency response. TMS contribution to improving system performance will only increase in the coming years as the available technologies and associated strategies continue to advance at a very high rate. Connected vehicle-highway technologies offer the potential for significantly enhancing all processes of transportation system management and have the potential for fundamental changes to how the transportation systems are managed and operated.

Questions

1. What are the four basic functions of transportation management?
2. Give examples of freeway management and arterial management applications.
3. What are the types of surveillance systems and which type is required for ramp metering?
4. List two issues associated with DMS applications and two issues associated with ramp metering.
5. Is it true that adaptive signal control is expected to provide benefits under all conditions?
6. List the benefits of emergency vehicle preemption.
7. Discuss issues associated with data archiving.
8. Give examples of potential connected vehicle applications in TMS.

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Answers:

1. System state estimation, management strategy determination, management strategy execution, and management strategy evaluation/feedback.
2. Freeway management: ramp metering, managed lane, variable speed limits, and information dissemination. Arterial management: signal control, rail-road preemption, emergency vehicle preemption, and transit signal priority.
3. Point detectors AVI readers, AVL tracking, private sector data, CCTV cameras, and environmental sensor stations. Ramp metering requires point detectors.
4. Ramp metering: mainline vs. ramp performance, impacts on other facilities, and public perception of adverse effects. DMS: message content, message format, and information credibility.
5. It may not be able to provide benefits under saturated conditions with capacity constraints.
6. Response time, safety, and stress level improvements.
7. Resources and funding, central warehouse vs. virtual warehouse, data quality, data fusion, adequate documentation, accessibility, maintainability, and ease of use.
8. ICM, weather-responsive management, signal control, signal information dissemination, priority and preemption, active traffic management, and automated highway applications.