Lesson 1. Introduction Page 2

Intelligent Transportation Systems (ITS) is a joint public-private venture involving the use of integrated communication and electronic technologies in mitigating surface transportation problems.

This module will cover the following topics related to ITS:

- **Objectives**
- **Historical Background**
- **Overview of ITS User Services and Technologies**
- **Overview of Crosscutting & Emerging Issues in ITS**

ITS Primary Objectives Page 3

Typical surface transportation problems are interrelated and include:

- Traffic congestion, due to both recurring and non-recurring causes (see next page).
- Air pollution, particularly mobile emissions (e.g. carbon dioxide, hydrocarbon, nitrogen oxides, particulate materials, and ozone).
- Safety, including in-vehicle and out-of-vehicle (at transportation facilities).

ITS Primary Objectives (cont'd) Page 4

Congestion is a daily occurrence on many portions of freeway networks in urban areas. Recurrent congestion refers to the type of congestion routinely expected at predictable locations during specific periods of time in which demand exceeds capacity.

In contrast, non-recurrent congestion results from random or less predictable events such as:

- Traffic accidents and incidents
- Special situations (sporting events, weekend travel, maintenance and construction activities)
- Other factors of an environmental nature such as wet pavement, or sunrise and sunset aligned with driver's visibility.

ITS is not a panacea for all surface transportation problems. The primary objective of ITS is to mitigate those problems engendered by non-recurring incidents, which account for approximately 65% of peak period congestion. In other words, the primary motivation in using ITS technology is to optimize system performance by leveraging the effective capacity of the system.

ITS Primary Objectives (cont'd) Page 5

Experience has shown that each second of duration of traffic incident results in the equivalent of 4 second traffic recovery time. This underscores the urgency in minimizing the clearing time of traffic incidents through the use of such ITS technologies as traffic surveillance involving closed circuit television (CCTV), machine vision equipment, and sensors (including subsurface induction loop, acoustic, and radio frequency [RF] devices).

For instance, the use of electronic toll collection (ETC) can help increase throughput in excess of 200 percent by processing vehicles at a much faster rate than human attendants can. In this case, the use of ITS technology (ETC) optimizes system performance through a more efficient utilization of the effective capacity of the system.

ITS Primary Objectives (cont'd) Page 6

ITS Primary Objectives:

Through the application of state-of-the-art and emerging technologies, ITS programs aim to fulfill the following objectives:

- Provide solutions to current multimodal transportation problems
- Anticipate future transportation demands through an intermodal strategy
- Yield a more efficient use of the transportation infrastructure and energy resources
- Provide significant improvements in safety, productivity, accessibility, and mobility.

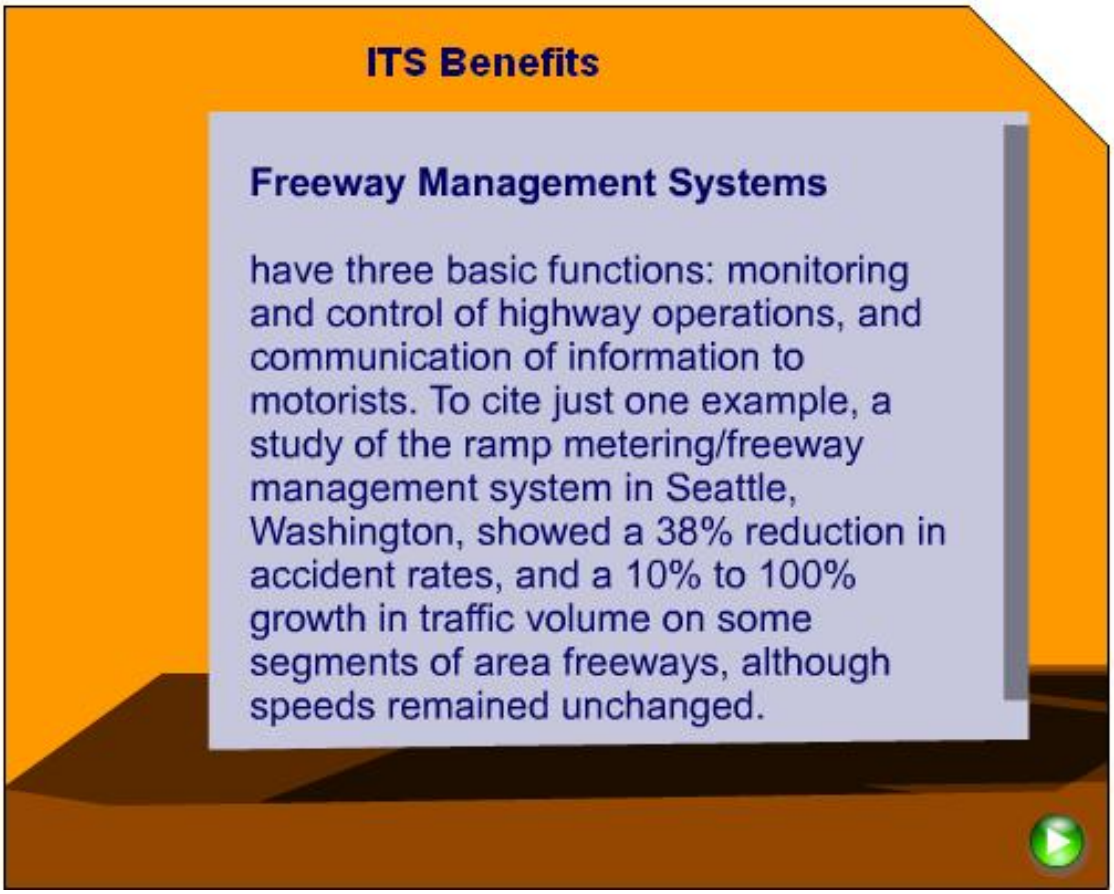
ITS Primary Objectives (cont'd) Page 6

ITS Primary Objectives:

ITS technology has proven effective in mitigating surface transportation problems engendered by non-recurring incidents. However, its use is by no means restricted to traffic incident management. Other areas benefitting from ITS technology include, among others:

- Transit management (adherence to bus scheduling, for instance)
- Freeway system management
- Surface street management (signal timing optimization)
- Commercial Vehicle Operations

ITS Benefits: Examples Page 7



ITS Benefits: Examples

ITS Benefits

Surface street management

includes surveillance and signal timing optimization. The Institute of Transportation Engineers (ITE) estimates that traffic signal improvements have led to 8%-25% reductions in travel time (M. Meyer). Derived benefits include lessened emissions and fuel consumptions.

For instance, the Automated Traffic Surveillance and Control Program in Los Angeles, CA, a computerized signal control system including about 1200 intersections and 4500 detectors for signal timing optimization, reported a 13% decrease in fuel consumption, a 14% decrease in emissions, a 41% reduction in vehicle stops, an 18% reduction in travel time, a 16% increase in average speed, and a 44% decrease in delay.

ITS Benefits: Examples

ITS Benefits

Transit management

A 1996 analysis report predicts that benefits deriving from the application of Advanced Public Transportation Systems (APTS) technologies will total between $3.8 billion and $7.4 billion in discounted 1996 dollars in the next few years (D. Goeddel). APTS also provides enhanced safety to passengers through remote monitoring of vehicle status and passenger activity. AVL and CAD technologies help operators adhere to the schedule, and improve schedule activities.

Lesson 2. ITS Programs in the World Page 8

ITS related research in the U.S. in the 1950's motivated similar interests in Europe and Japan.

The equivalent of the U.S. Electronic Route Guidance Systems (ERGS), which was perhaps the earliest ITS related research interest, was the European Autofarer Leitung and Information System (ALI) program and the Japanese Comprehensive Automobile Traffic Control System (CACS) program.

Since then, ITS movements have spread wide and far: the following sites will provide you with information on ITS programs in Korea (ITS Korea, Australia (ITS Australia, and Canada (ITS Canada).

ITS World Congress

The ITS World Congress was established in 1994. The founding organizations of ITS Congress are ITS America, ERTICO, and VERTIS, which are the ITS program coordination bodies for the U.S., Europe, and Japan, respectively. Other active members of the World Congress include ITS Korea, ITS Australia, and ITS Canada.

The Congress meets every year since 1994, as a forum for sharing worldwide ITS related initiatives and research efforts.

IVHS Categories Page 12

The original 6 IVHS categories are as follows:

- ATIS (Advanced Traveler Information Systems)
- ATMS (Advanced Traffic Management Systems)
- APTS (Advanced Public Transportation Systems)
- CVO (Commercial Vehicle Operations)
- AVCS (Advanced Vehicle Control Systems)
- ARTS (Advanced Rural Transportation Systems)

IVHS Categories: ATIS Page 13

Advanced Traveler Information Systems (ATIS), provide timely traffic, schedule, fare, reservation, and weather information that provides travelers the opportunities to make informed decisions on where to go, when to go, what transportation mode to use, which route to take, and how much to budget.

IVHS Categories: ATIS (cont'd) Page 14

ATIS comprises the following specific functional elements:

- Real-time roadway condition data provided by pavement surface sensors, closed circuit televisions (CCTV), and related technologies
- Real-time traffic condition data provided by surveillance cameras (e.g. CCTV, machine vision technology, etc), satellite imaging, probe vehicles, etc.
- Real-time roadway, traffic, and weather condition broadcast / dissemination from highway advisory radio (HAR), cable television (CATV), personal communication devices (e.g. pager and cellular phone), information kiosk, and variable message sign (VMS)
- In-vehicle navigation and route guidance provided by interfacing electronic map (e.g. digital maps from geographical information systems [GIS]), global positioning system (GPS) or related technology (e.g. dead-reckoning devices and land based radio signals), map matching technology, and routing algorithm
- Travel related service information (e.g. location of gas stations, hotels, parking, and transit stations) provided by electronic yellow pages

Early ATIS Projects

Some early Advanced Traveler Information Systems (ATIS) projects, most of which were initiated in 1992-3, are listed below (mouseover each project for a description, or click to link to its web site):

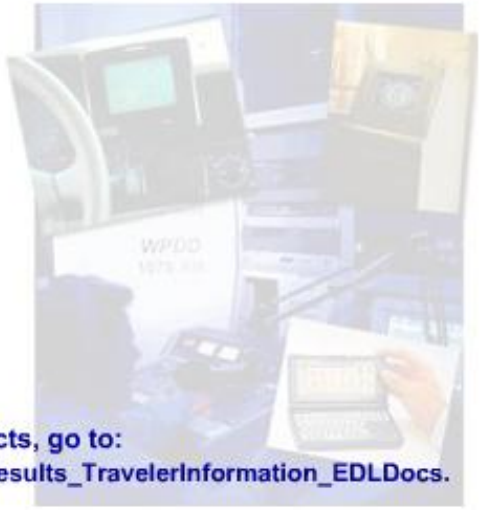
PATHFINDER
an in-vehicle navigation project conducted in Los Angeles, California

TravTek
a route guidance information with electronic yellow page project, conducted in Orlando, Florida

DIRECT

ADVANCE

Genesis



For documents related to these ATIS projects, go to:
http://www.its.dot.gov/eval/Metro/Metro_FOTResults_TravelerInformation_EDLDocs.htm

IVHS Categories: ATMS

Advanced Traffic Management Systems (ATMS) involve the use of surveillance technologies (e.g. machine vision devices, sensors, and CCTV) and advanced communications (e.g. VMS, HAR, and personal communication devices) to maximize throughput and safety.

IVHS Categories: ATMS (cont'd) Page 17

Surveillance technologies help further the goals of ATMS in the following ways:

- Facilitate timely (e.g. real-time) detection of roadway incidents and providing warnings to motorists or dynamically redirecting traffic through the use of VMS, HAR, or in-vehicle navigation technology to avoid congested areas of the road network
- Implement adaptive traffic signal timing that minimizes the number of stops and hence the delay on arterial roadways
- Provide signal preemption services to priority vehicles (e.g. emergency vehicles) to avoid possible conflict with other traffic at roadway intersections
- Implement effective ramp metering scheme in order to minimize interference on mainline traffic
- Implement electronic toll collection (ETC) scheme involving the use of transponders

Continued on the next page...

IVHS Categories: ATMS (cont'd) Page 18

- Implement multi-jurisdictional traffic control centers to address regional traffic operations issues
- Integrate and optimize multi-modal transportation system (e.g. passenger vehicles, trucks, train, and buses) operations
- Provide surveillance and detection systems that minimizes the misuse of high occupancy vehicle (HOV) designated facilities
- Use electronic sensors (e.g. machine vision cameras), involving less intrusive installation and maintenance than traditional in-pavement inductive loop detectors, as vehicular presence and incident detectors
- Use electronic sensors as defined above to identify empty spaces as a way of optimizing parking operations

Early ATMS Projects

Please mouse over each for a description, or click to follow the link.

I N F O R M

A project in Long Island, New York, involved in integrating the operation of several parallel freeways and arterial roadways through a centralized Traffic Management Center (TMC).

S M A R T C o r r i d o r

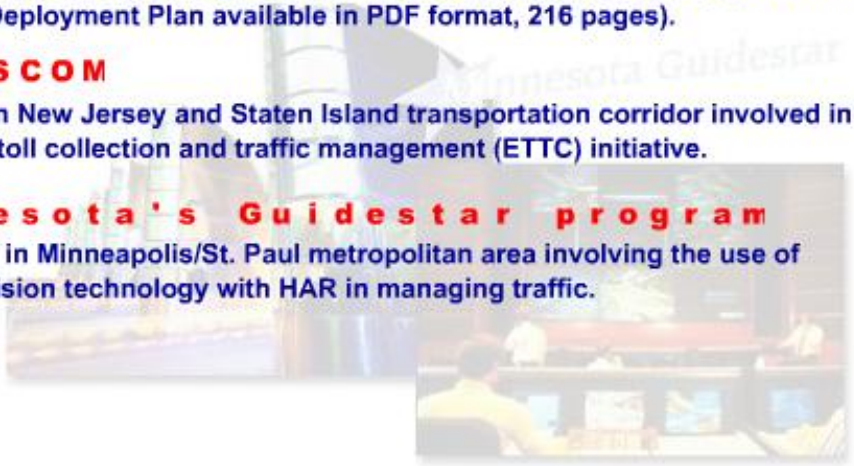
part of the Southern California ITS Priority Corridor, involved multi-jurisdictional freeway management and arterial control initiative (report on the Strategic Deployment Plan available in PDF format, 216 pages).

T R A N S C O M

A project in New Jersey and Staten Island transportation corridor involved in electronic toll collection and traffic management (ETTC) initiative.

M i n n e s o t a ' s G u i d e s t a r p r o g r a m

A program in Minneapolis/St. Paul metropolitan area involving the use of machine vision technology with HAR in managing traffic.



IVHS Categories: APTS

Advanced PublicTransportation Systems (APTS) address the transportation needs of non-drivers by leveraging services provided by ATIS and ATMS to streamline the operations of fixed-route transit, demand response paratransit, and other HOV modes (e.g. carpool and vanpool).

IVHS Categories: APTS (cont'd) Page 21

APTS comprises the following specific functional elements:

- **Real-time tracking of transit units (e.g. automated vehicle location [AVL] by interfacing GPS with Geographical Information Systems (GIS) related technologies.**
- **Real-time transit routing (which includes dynamic rideshare service) and scheduling**
- **Automated vehicle maintenance record tracking**
- **Remote access to transit schedules and fares through information kiosk, CATV, and personal communication devices, and VMS**
- **Surveillance of transit facilities (e.g. HOV lanes and transit stops) with infrared CCTV for safety, security, and illicit activities**
- **Signal preemption that gives right-of-way priority to transit vehicles at signalized traffic intersections in order to reduce travel time**

Sample APTS Projects

Sample APTS projects include the following (mouse over each for a description, or click to follow the link).

Maryland Transit Administration
Fleet management in Baltimore using AVL technology.

Real-time bus schedule
(including arrival times) displayed on VMS at transit stops in Denver, Colorado

Houston Smart Commuter
involving real-time transit information through personal digital assistants (PDA)

Summary of APTS Projects.

IVHS Categories: CVO Page 23

The primary object of Commercial Vehicle Operations (CVO) is to increase productivity and safety in the freight transportation industry by streamlining the licensing, registration, regulatory, taxation, and freight delivery processes.

Commercial Vehicle Operations integrate most of these processes into a single activity commonly known as "one-stop shopping."

IVHS Categories: CVO (cont'd) Page 24

Commercial Vehicle Operations (CVO) comprises the following specific functional elements:

- **Weigh-in-motion (WIM) and automatic vehicle classification (AVC), where commercial vehicles are weighed and classified without being stopped by using in-pavement sensors**
- **Automated permit and registration through a centralized system that can be accessed remotely by authorized personnel; i.e., law enforcement agents in all the states traversed from point of origin to point of destination resulting in minimal stopping of commercial vehicles as they cross state boundary lines (a phenomenon known as "transparent border")**
- **Automatic tracking of commercial vehicles/cargoes/passengers using AVL/barcode technologies**
- **Real-time vehicle routing and scheduling for just-in-time delivery of cargoes and passengers**
- **Automated vehicle maintenance record tracking**
- **Driver fatigue monitoring using in-vehicle sensor technology that monitors eye movement and vehicle trajectory**

Early CVO Projects

Early CVO projects, most of which were initiated in the early 1990s, include the following:

The Heavy Vehicle Electronic License Plate (HELP) / Crescent Project
involving integrated systems of Automatic Vehicle Identification (AVI), Automatic Vehicle Classification (AVC), and WIM technologies

The Advantage I-75
involving the use of AVI technology with transponder-equipped, properly documented trucks to travel along the I-75 corridor at mainline speed as a way of testing the aforementioned transparent border concept. For more information, read "Advantage I-75 Prepares to Cut Ribbon on Electronic Clearance" in the Fall 1995 issue of "Public Roads".

Commercial vehicle information systems & network (CVISN)
initiated in the mid-1990s to develop and test the aforementioned one stop shopping concept involving automated licensing, registration, tax reporting, and related activities (see also the CVISN Web site)

CVO Field Operational Tests

IVHS Categories: AVCS Page 26

Advanced Vehicle Control Systems (AVCS) comprises vehicle-based technological elements that provide safer, more efficient and more comfortable driving environment.

AVCS is an integral component of the Automated Highway Systems (AHS), which will be discussed later in this course.

IVHS Categories: AVCS (cont'd) Page 27

AVCS comprises the following specific functional elements:

- **Longitudinal and lateral collision warning devices that alert the driver when a collision is eminent or when there are vehicles within the driver's blind spots**
- **Infra-red night vision device that provides the driver a clear view of the roadway in the absence of adequate lighting (e.g. at nighttime and in inclement weather condition)**
- **Adaptive cruise control and automatic braking system (including automatic traction control, antilock braking, and in-vehicle navigation devices)**
- **Eye level display of navigation data**
- **Driver fatigue monitoring device (e.g. in-vehicle sensor technology that monitors eye movement and vehicle trajectory)**
- **Automatic propulsion technology that drives the vehicle with minimal human intervention**

IVHS Categories: ARTS Page 28

Advanced Rural Transportation Systems (ARTS), involve the application of the ITS technological elements (particularly ATIS and APTS elements) in the rural environment. The primary areas of application reflect the isolated nature of the rural environment and include:

- Mayday related services for incidents on desolate rural roads
- Dynamic ridesharing to cater to sparingly located rural residents
- Tourism and weather information For more information, read a short overview of rural transportation systems, and the "simple solutions" report on Mayday systems.

ITS Technological Elements

Click on each category to see the technological elements.

- **ATIS** (*Advanced Traveler Information Systems*): support technologies include PDA (Personal Digital Assistants), Kiosks, DMS (Dynamic Message Signs), Probe Vehicles, and Software Engineering.
- **ATMS** (*Advanced Traffic Management Systems*): support technologies include DMS, TMC (Transportation Management Center), CCTV (Closed-Circuit TV), PDA, Sensors, Transponders, RF Radios, Traffic Signal Devices, and Software Engineering.
- **APTS** (*Advanced Public Transportation Systems*): support technologies include DMS, CCTV, AVL (Automatic Vehicle Location), Kiosks, PDAs, and Transponders.
- **CVO** (*Commercial Vehicle Operations*): support technologies include AVL , RF Radios, Transponders, and Sensors.
- **AVCS** (*Advanced Vehicle Control Systems*): support technologies include AVL, Transponders, RF Radios, and Sensors
- **ARTS** (*Advanced Rural Transportation Systems*): support technologies include AVL, Kiosks, PDA, and RF Radios.