



UNITED STATES
DEPARTMENT OF TRANSPORTATION

ITS ePrimer
Module 5: Personal Transportation

September 2013
Updated March 2016

**ITS Professional Capacity Building
Program
ITS Joint Program Office
U.S. Department of Transportation**

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Learning Objectives

1. Learn of capabilities, features, and limitations of ITS technologies for personal transportation
2. Understand deployment opportunities and constraints
3. Understand how ITS personal transportation applications impact the user and the transportation system in terms of mobility and accessibility
4. Understand emerging and future trends in ITS technologies for personal transportation



Real-Time Travel Information

Information types and impacts

Pre-Trip

- Trip departure time
- Mode of travel
- Route choice

En Route

- Change route
- Change mode (if alternate mode with parking available)
- Expected arrival times



Real-Time Travel Information

Dissemination

▪ **Web**

- Every State DOT offers traveler information Web site
- Pre-trip information
- Wide geographic area coverage
- Images from CCTV cameras on real-time conditions

▪ **511 Phone System**

- More than 40 511 systems
- Highest usage under major events
 - Extreme weather
 - Major road closures



Real-Time Travel Information

Dissemination

Changeable Message Signs (CMS)

- Expected travel times to destinations
- Alerts on incidents, inclement weather, other events
- Location important (prior to decision point)
- Emergency Messages
 - AMBER Alert
 - LEO Alert
 - SILVER Alert



Real-Time Travel Information

Dissemination

Changeable Message Signs (CMS)

CMS Implementation in Michigan DOT

<https://www.youtube.com/watch?v=tUNgPSx0rxk>



Real-Time Travel Information

Dissemination

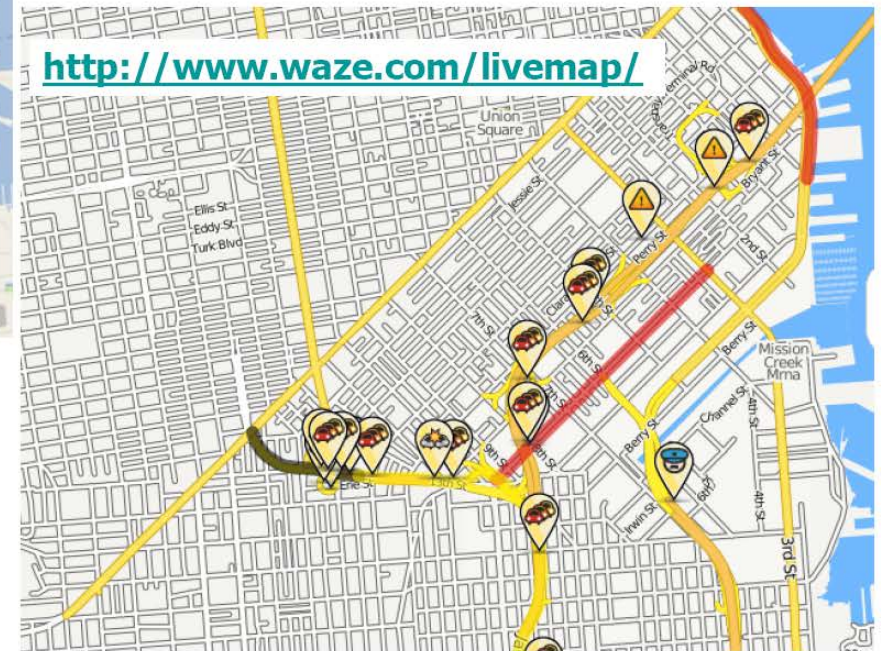
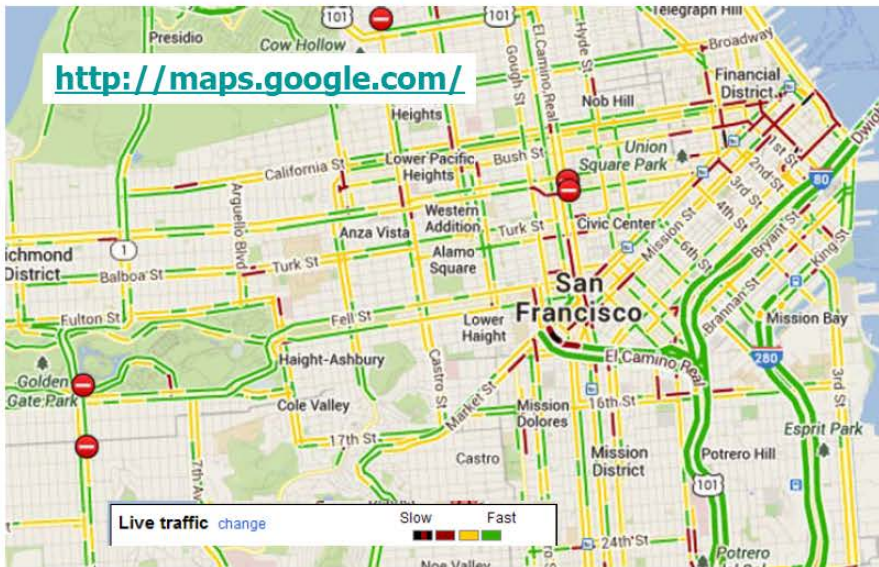
- Highway Advisory Radio (HAR)
- E-mail
- TV/Radio
- Kiosks
- Private Information Providers
 - In-vehicle navigation
 - Handheld devices
- Social Networking Media



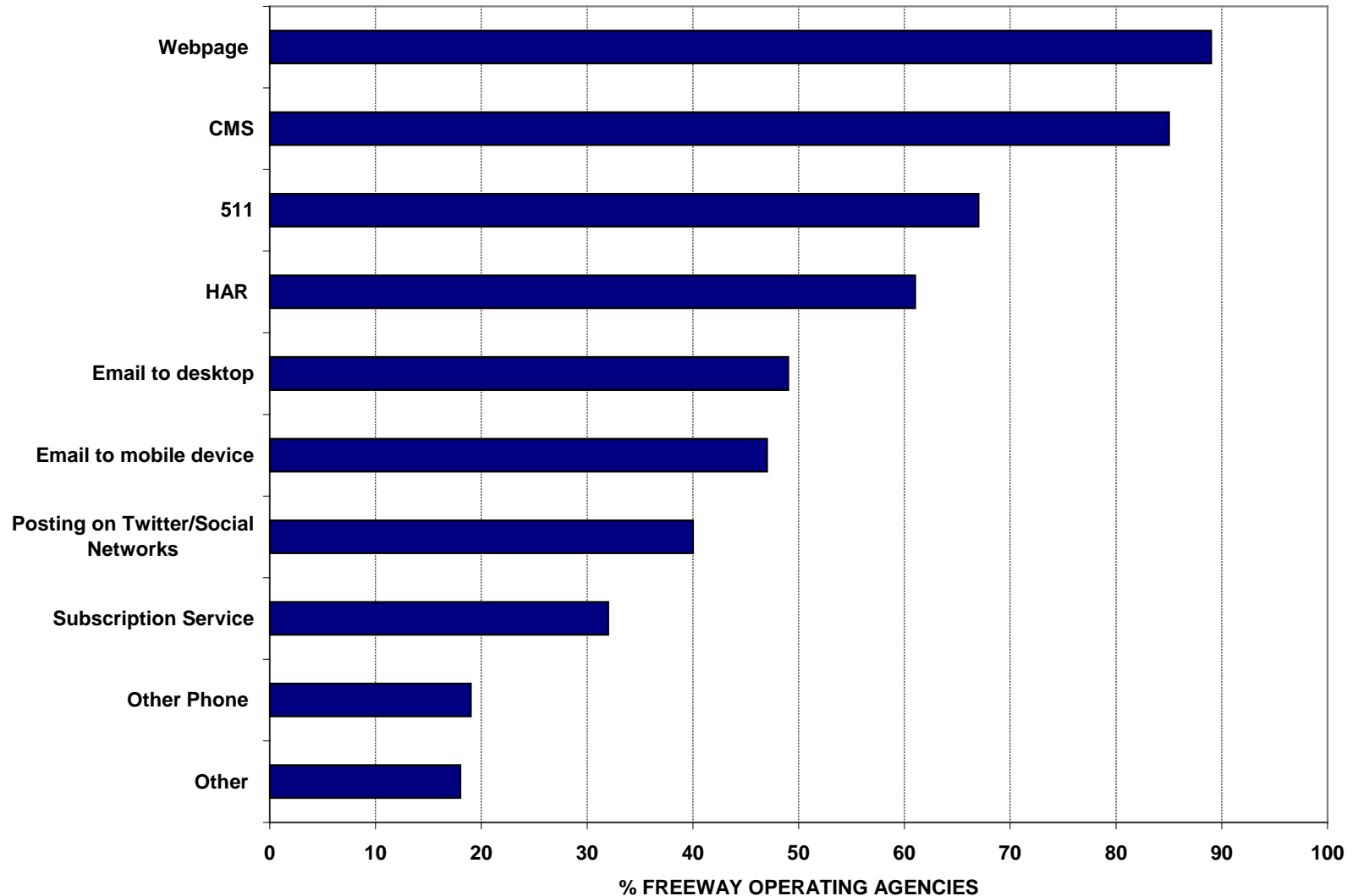
Real-Time Travel Information

Dissemination

Increasing use of mobile applications and social networking



Real-Time Travel Information



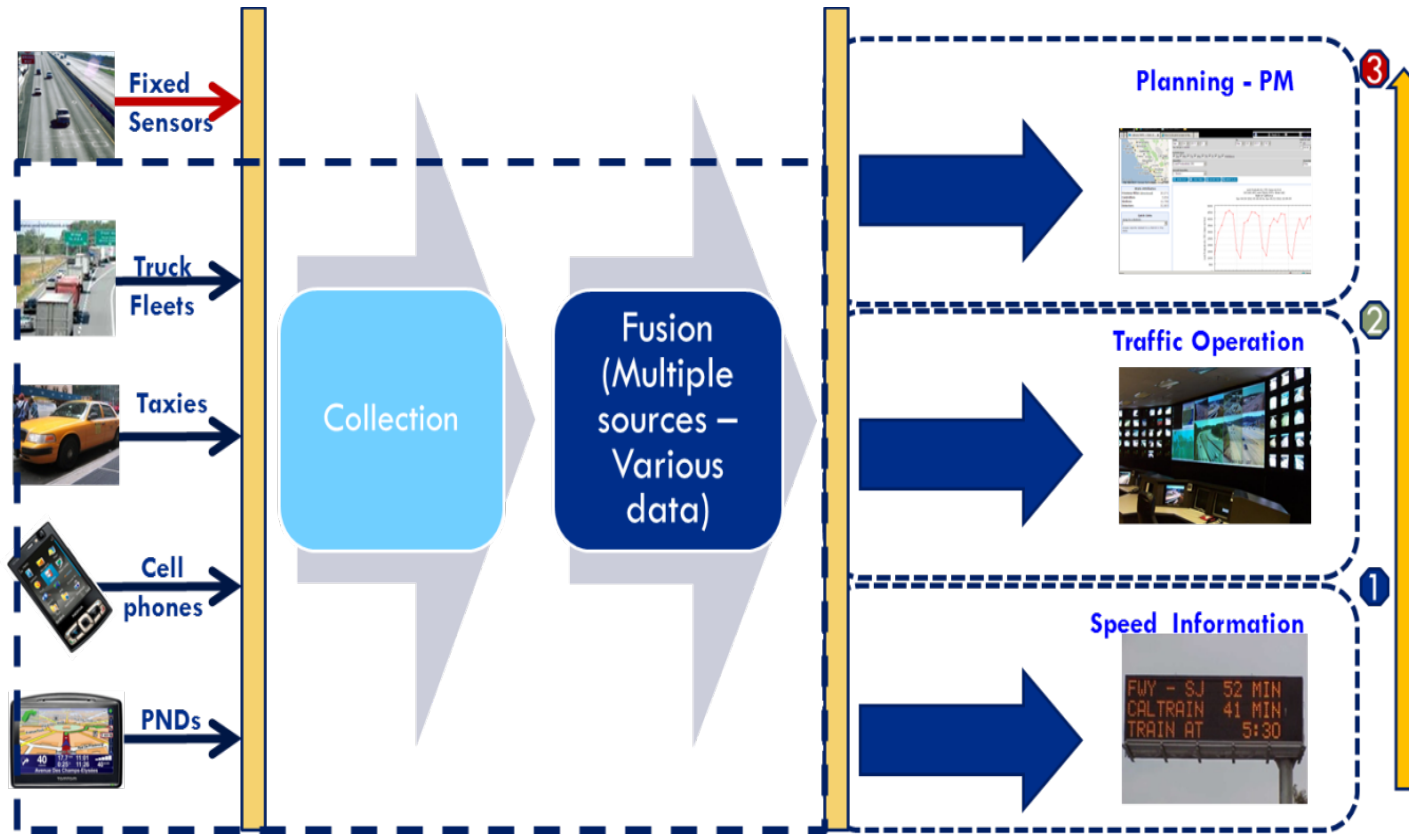
Real-Time Travel Information

Data Sources

- Fixed sensors approximately 0.5 mile apart in each travel lane (e.g., loops, radar, video)
- Event information from incident management teams, police patrols
- CCTV
- Probe vehicles
 - ETC transponders
 - Cell phones
 - Bluetooth readers

Real-Time Travel Information

Data Collection-Fusion-Utilization



Real-Time Travel Information

Benefits

Improve Traveler Decision Making

- Make accurate and timely decisions
 - Routing
 - Time of departure
 - Mode
 - Not make the trip
- Sense of “self control” to traveler

Reduce Frustration and Irrational Behavior

- Improve perceived level of service



Real-Time Travel Information

Benefits

Spread or Reduce Peak Traffic Demand

- Over space: alternative routes
- Over time
- Alternative modes
- Eliminating discretionary trips

Field Evaluation Results

- Traveler information users perceived time savings
- In-vehicle travel time savings are small



Real-Time Travel Information

Transit

Dissemination

- Web
- Mobile Applications
- Station/Transit Stop Displays
- In-vehicle Displays

Content

- Maps/schedules
- Expected arrivals real-time
 - Transit vehicle tracking (AVL)
- Online Trip Planner



Parking Information

Public Agencies/Operators

- Maps with Parking Facilities
- Information on the Web: location/characteristics

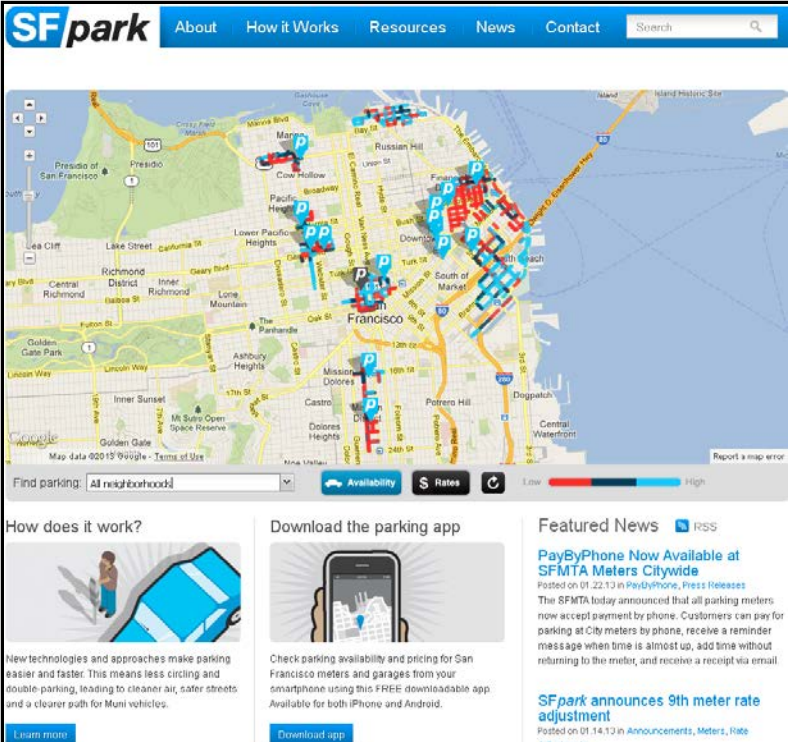
Parking Lots

Space Availability

Private Service Providers

Web/Mobile Applications

- Real-time Parking Availability
- Online Reservation/Payment



The screenshot displays the SFpark website interface. At the top, there is a blue navigation bar with the SFpark logo and links for 'About', 'How it Works', 'Resources', 'News', and 'Contact'. A search bar is located on the right. The main content area features a map of San Francisco with various parking facilities marked by colored 'P' icons. Below the map, there are three columns of content: 'How does it work?' with an illustration of a person at a parking meter, 'Download the parking app' with a smartphone icon, and 'Featured News' with a headline 'PayByPhone Now Available at SFMTA Meters Citywide'. The 'Featured News' section includes a sub-headline 'SFpark announces 9th meter rate adjustment'.

City of San Francisco: Parking Information Web site

<http://sfpark.org/>



Parking Information

Multimodal Information

- Driving Times
- Parking Availability at Transit Stations
- Transit Information
 - Departure/Arrival Times

- Influences Mode Choice
 - Travel Time Savings
 - Perceived Congestion



Driver Assistance Systems

- Night Vision
- Adaptive Cruise Control
- Collision Warning
- Collision Avoidance
 - Front collision
 - Lane keeping
- Precision Docking
 - Precise stopping at transit stops
 - Reduces passenger boarding and alighting times
- Driver Impairment Monitoring
- On-Board Monitoring for Commercial Vehicles



Driver Assistance Systems

Advanced Driver Assistance System

https://www.youtube.com/watch?v=5vuKvW_5QVM

Precision Docking – Real World Demonstration

<http://www.youtube.com/watch?v=JvXLdifNfmg>



Driver Assistance Systems

Adaptive Cruise Control (ACC)

Conventional cruise control + radar sensors

Adjust speed to maintain a preset headway (min. 1 sec)

Cooperative ACC (CACC)

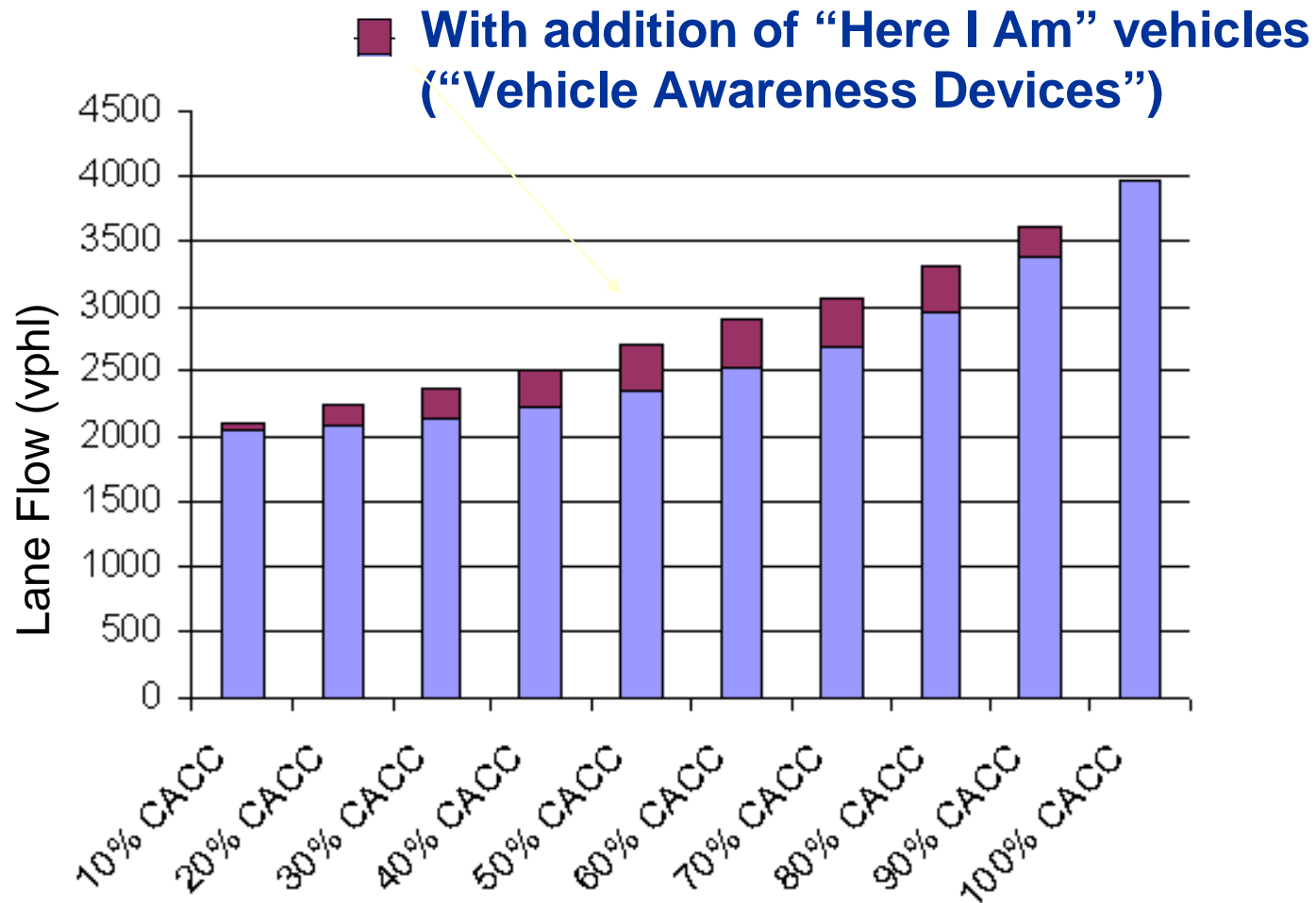
ACC systems + wireless data communications among vehicles

- Allows adoption of shorter gaps
- Potential to increase lane capacity



Driver Assistance Systems

Lane Capacity vs. CACC Market Penetration



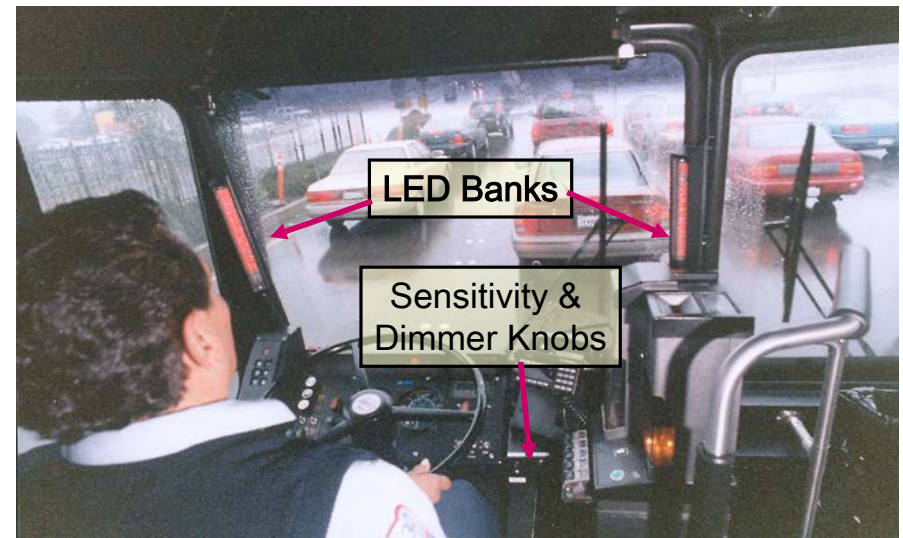
Driver Assistance Systems

Collision Warning (CW)

Available/Planned in Private Automobiles

Operational on Transit Systems

- Forward CW
 - Samtrans (San Mateo Bay Area)
- Rear Impact CW
 - Ann Arbor Transit
- Lane Change/Merge CW
 - Pittsburgh Transit



Driver Assistance Systems

Impairment Monitoring

Technology to monitor driving performance and physiological factors

Approaches:

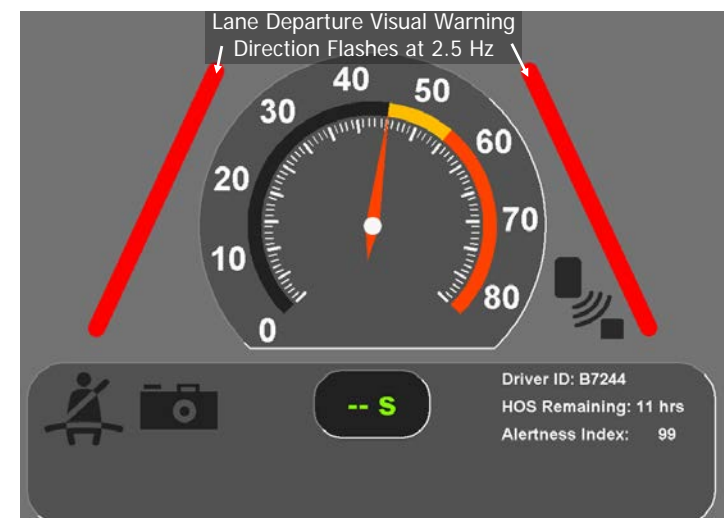
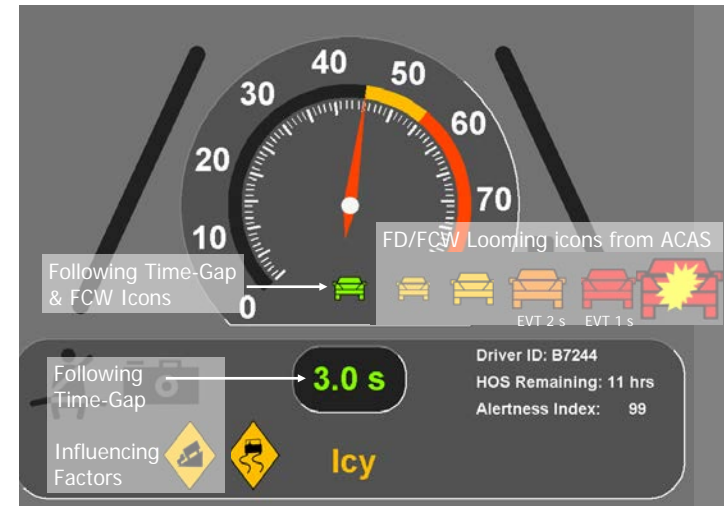
- Ocular measures—image processing, eye-tracking
- Doppler radar illumination of face/body
- Head movement monitoring using capacitor plates
- Stereo image processing of eyes/face/head
- Lane-keeping and steering input patterns



Driver Assistance Systems

On-Board Monitoring for Commercial Vehicles developed for FMCSA

- Speed Selection
- Following Distance
- Attention (Inattention)
- Fatigue



Traveler Comfort and Convenience

In-Vehicle Navigation and Route Guidance Systems

- GPS-based
- Turn-by-turn directions
- May include real-time traffic information
- Additional Information (Parking, Yellow Pages)
- Autonomous or through subscription

Transit Fare Payment Systems

- Magnetic cards
- Smart cards for multiple transit lines/agencies
- Mobile phones



Traveler Comfort and Convenience

Electronic Toll Collection (ETC)

- Toll paid through transponders without stopping
- ETC increases toll lane capacity 4 times
- ETC transponders may operate across states/facilities
- ETC mandatory for congestion pricing implementation

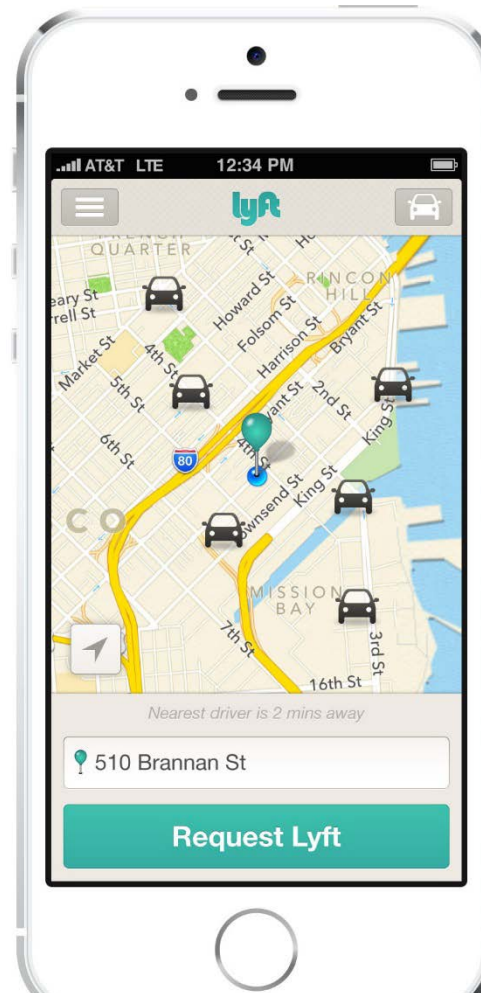
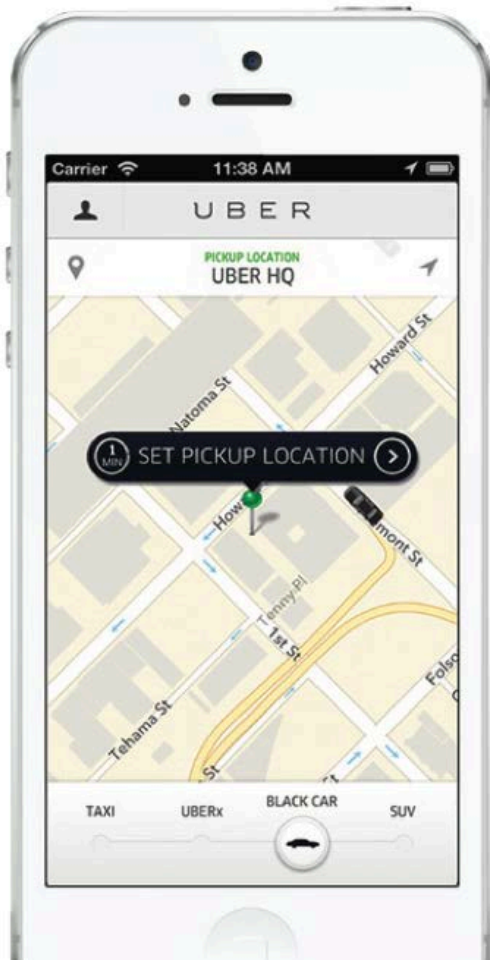
Open Road Tolling (ORT): toll collection at highway speeds

- Higher capacity
- Improved safety
- Reduced fuel and emissions



Traveler Comfort and Convenience

Mobile applications for ride-share services



Traveler Comfort and Convenience

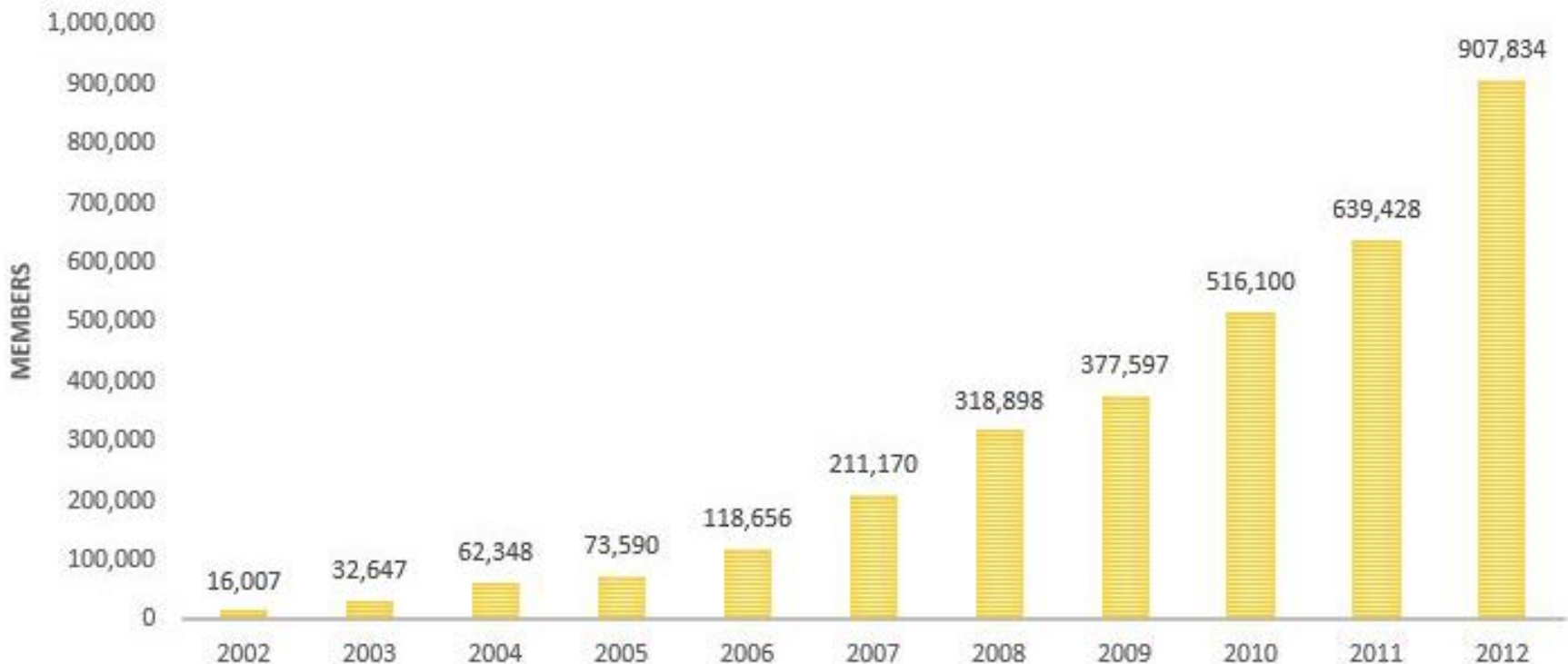
Carsharing

- Car availability without car ownership
- Designed for occasional car users
- Offered by private companies and car manufacturers through membership
- Extensive tech use (mobile applications) for operations
- Benefits
 - Reduction in auto ownership
 - Increase in transit ridership
 - Reduction in fuel consumption/emissions



Traveler Comfort and Convenience

Carsharing: North American Member Growth



Electrified Vehicles

Increasing interest in Electric Vehicles = 3.5% U.S. car sales

- Rising fuel costs
- Environmental concerns
- Improved Technology/Options for Electric Vehicles

Types/Options:

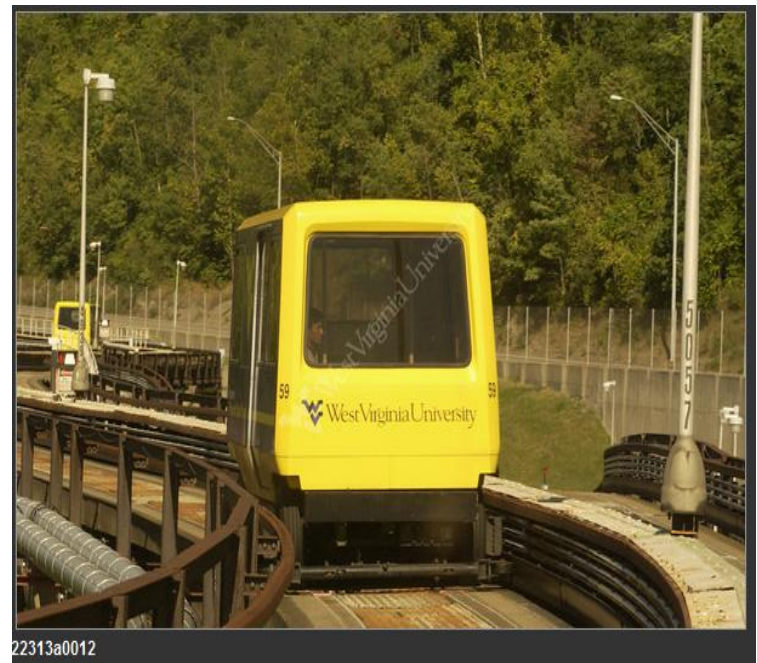
- Electric Vehicles (EVs)
 - Batteries
 - Zero emissions
 - Limited range
- Hybrid Electric Vehicles (HEVs)
- Plug-In Hybrids (PHEVs)



Personal Rapid Transit (PRT)

Concept: Alternative to Conventional Transit in Low Density Areas

- Small driverless vehicles (up to 15 passengers)
- Dedicated tracks/Off-line Stations
- High Capacity (2 seconds Headways)
- Point-to-Point Service/Passenger Comfort
- Limited Implementations



Morgantown PRT system, West Virginia. Courtesy of West Virginia University.

Personal Rapid Transit (PRT)

Recent Implementations

- ULTRA Heathrow airport
(2.4 miles, 21 vehicles)

ULTRA PRT system

<http://www.ultraglobalprt.com/>



Source: Ultra Global PRT 2013

2getthere Abu Dhabi

(1.1 mile, 13 vehicles)

2getthere PRT system

<http://www.2getthere.eu>

Personal Rapid Transit (PRT)

Recent/Planned Implementations

- Suncheon, South Korea
- Heathrow airport expansion

Feasibility Studies

- “Last Mile” solution for transit systems
- Major employment centers/business parks
- San Jose International Airport-ground access



Vehicles, Internet, Phone, and the Future

Cooperative Vehicle-Infrastructure Systems

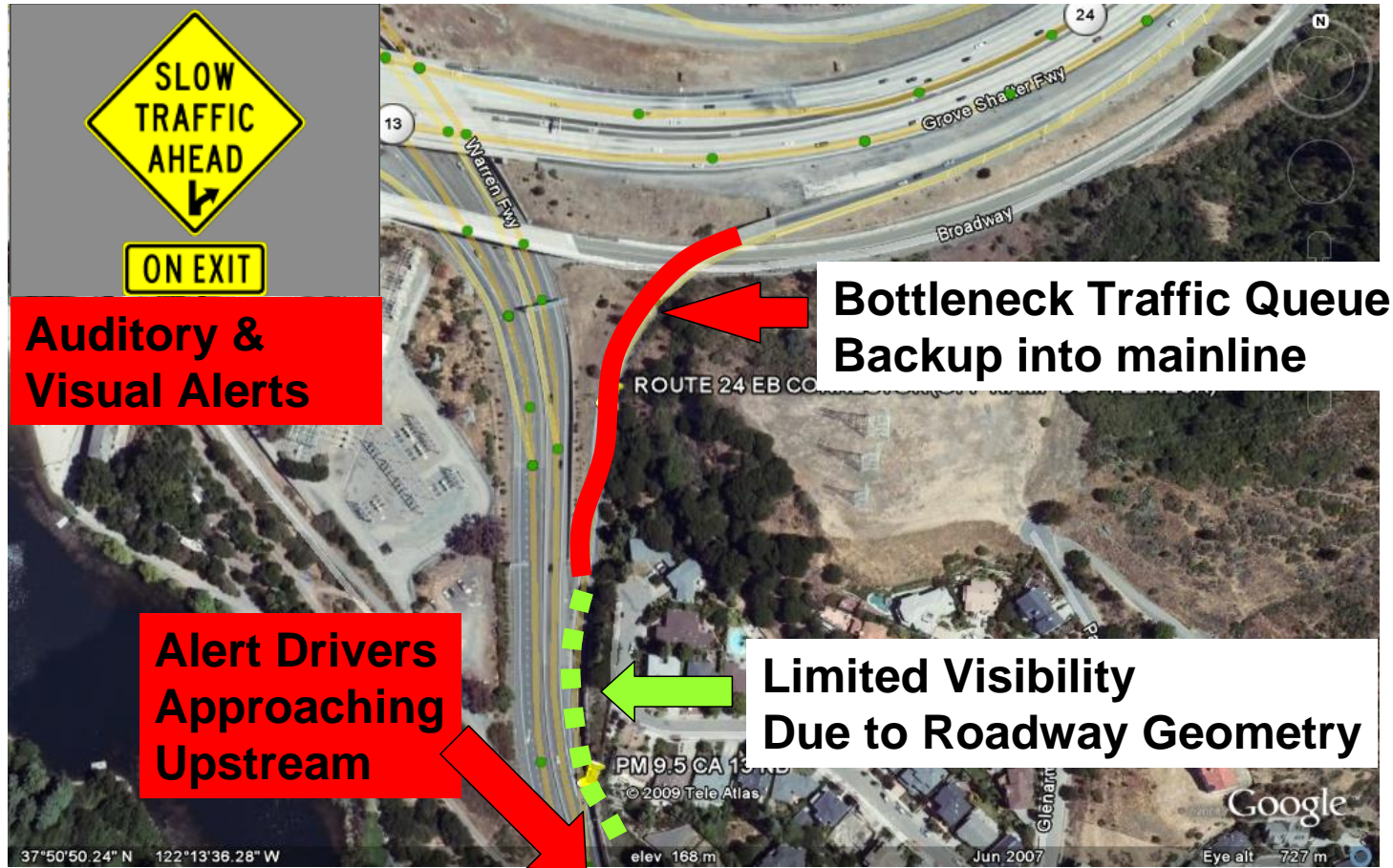
Vehicle-to-vehicle (V2V)

- Communications
 - DSRC
 - Mobile Devices
- Applications
 - Active Safety Systems
 - Reduce crashes by 80%
 - Driver Alerts (Queue Warning)



Vehicles, Internet, Phone, and the Future

Connected Vehicles—Queue Warning



Vehicles, Internet, Phone, and the Future

Cooperative Vehicle-Infrastructure Systems

Vehicle-to-Infrastructure (V2I)

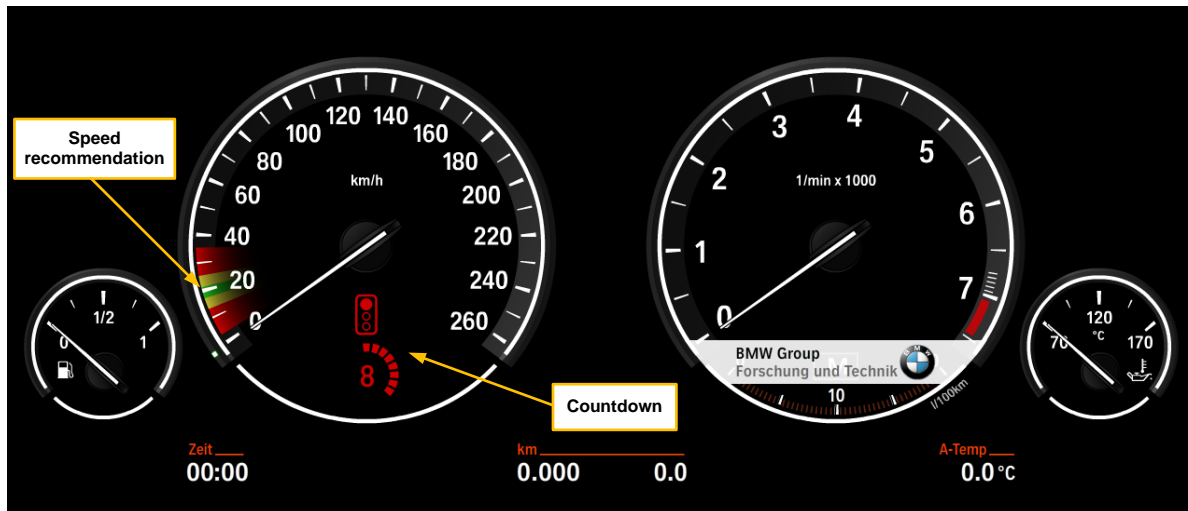
- SPaT (Signal Phasing and Timing) Message
- Applications
 - Safety
 - Mobility
 - Improved traffic signal control
 - Dynamic route advisory
 - Environment
 - Speed advisory for minimum fuel/emissions



Vehicles, Internet, Phone, and the Future

Dynamic Speed Advisory
(source: BMW)

V2I Example:
SPaT message



Summary

Traveler Information

- Increased usage of mobile devices as data sources and information dissemination
- Multimodal applications

Driver Assistance Systems

- Several in-vehicle systems to improve safety

Emerging Applications

- Connected Vehicle (CV) technologies (V2V, V2I, I2V)
 - ❑ Prevent most accidents
 - ❑ Improved control, incident management, travel information
 - ❑ Effectiveness depends on penetration rates of CV vehicles



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www.its.dot.gov/connected_vehicle/connected_vehicle.htm
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- International Energy Agency, “Technology Roadmap: Electric and plug-in hybrid electric vehicles.” Organization for Economic Cooperation and Development, 2009.



Questions?

- What are the critical characteristics of traveler information systems?
- What are the impacts of multimodal information on mode choice?
- What are the benefits of carsharing?
- What are the key characteristics of PRT systems?
- What are the benefits of CV technology?

