



*UNITED STATES*  
**DEPARTMENT OF TRANSPORTATION**

*ITS ePrimer*  
**Module 5: ITS to Support Travelers**

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

# Instructor

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# Learning Objectives

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- Learn the capabilities, features, and limitations, of ITS technologies for multimodal transportation
- Understand deployment opportunities and constraints for ITS technologies for all travelers
- Understand emerging and future trends in ITS technologies for all travelers

# Outline

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- **Traveler Information**
- **Parking Information**
- **Mobility on Demand**
- **Mobility as a Service (MaaS)**
- **Driver Assistance Systems**
- **Traveler Comfort and Convenience**
- **Personal Rapid Transit**
- **Urban Aerial Mobility**
- **Connected and Automated Vehicles**

# Real Time Travel Information

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## 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

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## Dissemination (1)

### World Wide Web

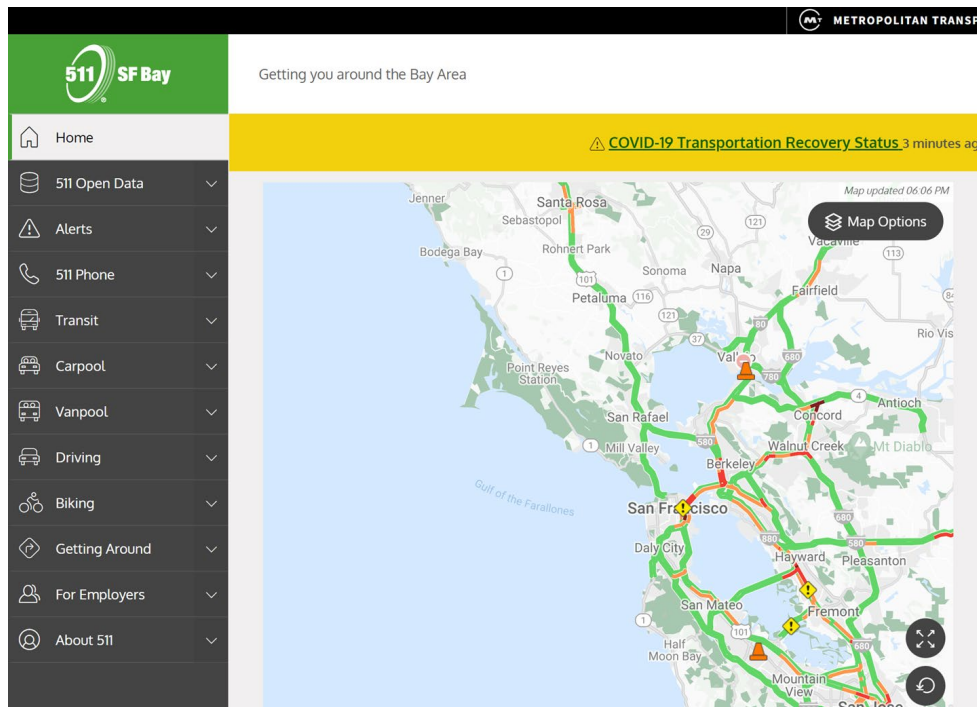
- Every state DOT offers traveler information website
- Pre-trip information
- Wide geographic area coverage
- Images from CCTV cameras on real-time conditions

### 511 Phone System

- Over 46 511 systems (include websites)
- Highest usage under major events
  - *Extreme weather*
  - *Major road closures*

# Real Time Travel Information

## Dissemination (2)



San Francisco Bay Area 511

<http://www.511.org>

# Real Time Travel Information

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## Dissemination (3)

### Variable Message Signs (VMS)

- 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*



VMS Implementation in Michigan DOT

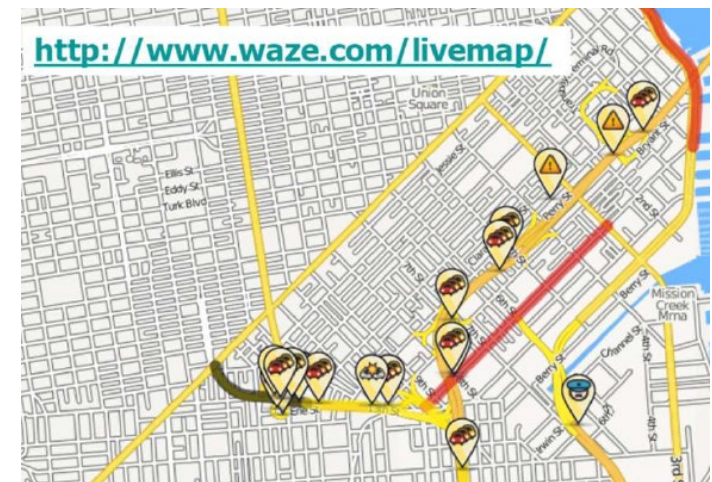
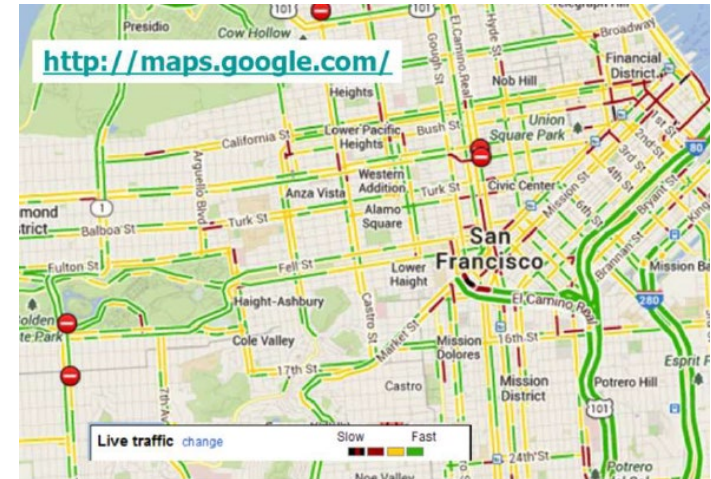
<https://www.youtube.com/watch?v=tUNgPSx0rxk>



# Real Time Travel Information

## Dissemination (4)

- Mobile applications and social networking
- Handheld devices
- In-vehicle navigation systems
- Email/text
- TV/Radio
- Highway Advisory Radio (HAR)



# Real Time Travel Information

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## 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

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## Benefits

### Spread or Reduce Peak Traffic Demand

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

### Field Evaluation Results

- Traveler information users **perceive** time savings
- In-vehicle travel time savings **are small**

# Real Time Travel Information

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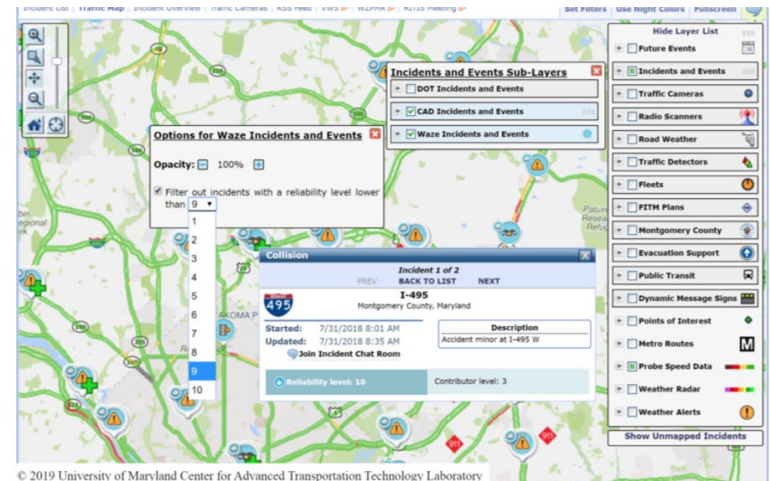
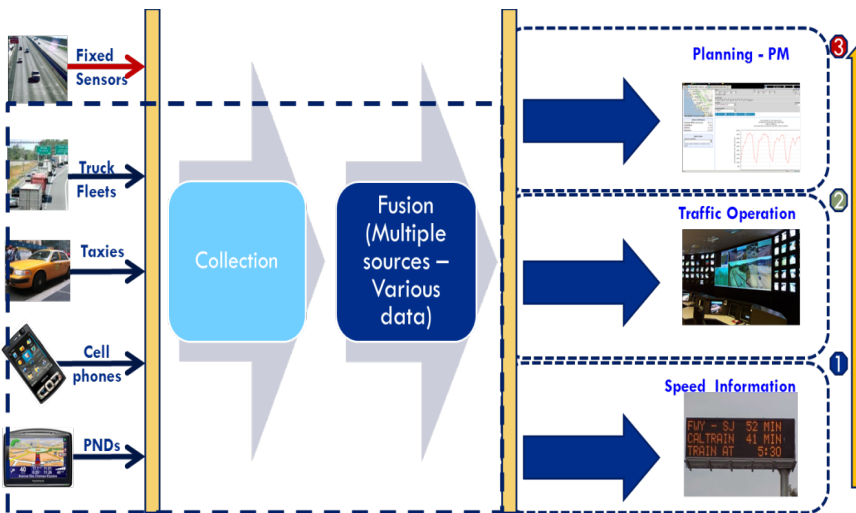
## Data Sources (1)

- 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 Sources (2)

Data Fusion from Multiple Sources improves coverage and accuracy  
Crowdsourced data integrated with TMC data



# 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)
- On-line Trip Planner





# Mobility on Demand (MOD)

- **MOD** vision for safe, reliable travel for all users
- **MOD** enables consumers to access mobility, goods, and services on demand by using shared mobility, delivery services, and public transportation solutions through an *integrated and connected multimodal network*



Source: USDOT, August 2017

# Mobility as a Service (MaaS)

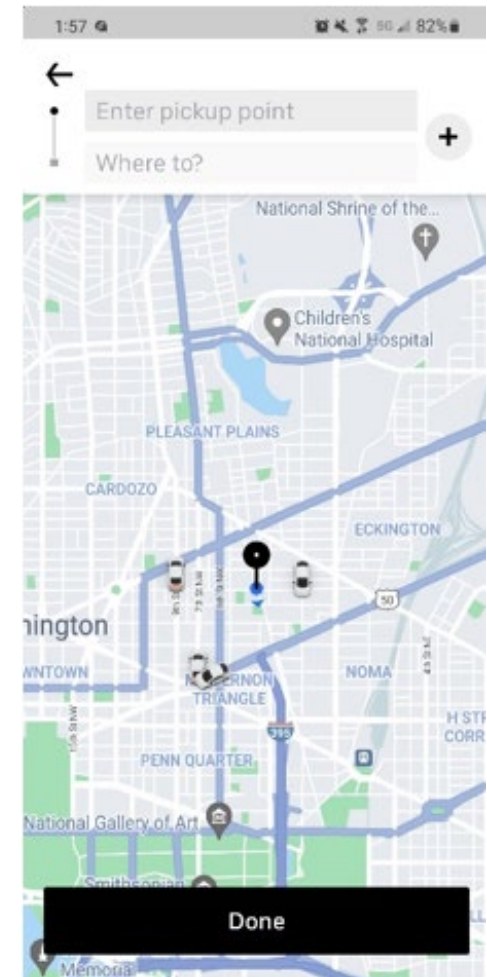
- **Mobility aggregation and submission services**
- **Access to several transportation modes**

## Transportation Network Companies (TNC)

- Offer on-demand rides by private vehicles
- Short trips in dense areas during off-peak periods

## Alternative Transit Services

- Paratransit, microtransit on demand transit
- Partnerships with TNC
- First & last mile, on call-and ride





# Mobility as a Service (MaaS)

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## Carsharing

- Car availability without car ownership
- Designed for occasional car users
- Provided by private companies through membership
- Benefits
  - Reduction in auto ownership, VMT
  - Reduction in fuel consumption/emissions

## Bikesharing

- Bikesharing systems integrated into existing transportation systems
- Bicycle stations often at transit hubs
- Complete street designs improve bicycle travel and safety

# Parking Information

## Public Agencies/Operators

- Maps with Parking Facilities
- Information on the Web: location, space availability

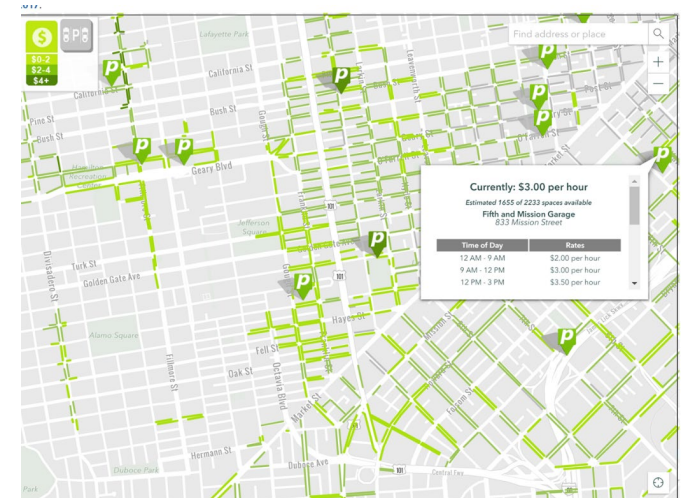
## Private Service Providers

### Web / Mobile Applications

- Real-time Parking Availability
- Online Reservation/Payment

## Advanced Systems (SF, DC)

- Real-time data on parking occupancy
- Parking pricing set to maximize utilization
- Information on Web and smartphones



San Francisco parking

# 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

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- Intersection Collision Warning Systems (CWS)
- Pedestrian Automatic Emergency Breaking Systems
- Lane Departure Warning System
- In Vehicle Vision Enhancements
- Blind-Spot Detection Information Systems (BLIS)
- Wrong Way Driving Warning
- Forward Collision Warning (FCM) Systems
- Rollover Warning Systems
- Driver Impairment Monitoring
- Adaptive Cruise Control (ACC)  
*Adjust speed to maintain preset headway (minimum 1 min)*

*Advanced Driver Assistance System*

[https://www.youtube.com/watch?v=5vuKvW\\_5QVM](https://www.youtube.com/watch?v=5vuKvW_5QVM)

# Traveler Comfort and Convenience

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## 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

- Smart Cards for multiple transit lines/agencies
- Mobile Phones
- Mobility Payment Integration (MPI): Shared payment media transit + mobility providers (TNCs, bikeshare, microtransit)

# Traveler Comfort and Convenience

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## Electronic Toll Collection (ETC)

- Toll paid through transponders without stopping
- ETC increases toll lane capacity four 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*

# Personal Rapid Transit (PRT)

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## Alternative to Conventional Transit in Low-Density Areas

- Small driverless vehicles (up to 15 passengers)
- Dedicated tracks/offline stations
- High capacity (2-second headways)
- Point-to-Point service/passenger comfort

## Feasibility Studies

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



# Personal Rapid Transit (PRT)

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## Recent Implementations

- ULTRA Heathrow Airport (2.4 miles, 21 vehicles)
- 2getthere Abu Dhabi (1.1 mile, 13 vehicles)



**ULTRA PRT system**

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



# Urban Aerial Mobility

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## Unmanned Aerial Vehicles (UAV)

### Commercial Applications

- Package Delivery
- Mapping and Surveying
- Infrastructure Inspections
- Surveillance

### Passenger Transport

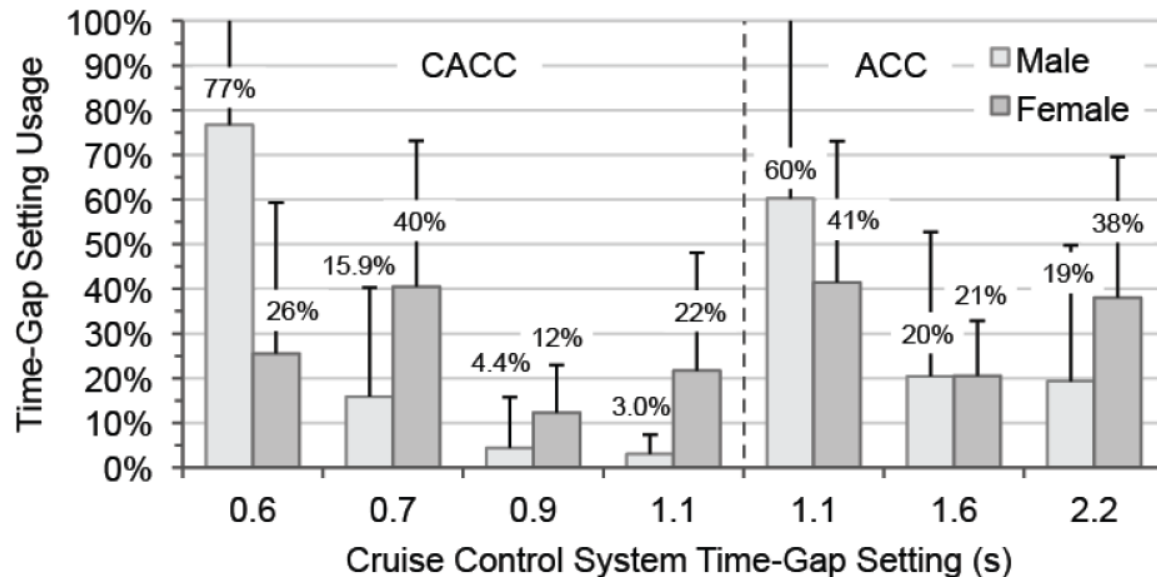
- VTOL airplanes
- “Flying Taxis”

# Vehicles, Internet, Phone and the Future

## Cooperative Vehicle-Infrastructure Systems

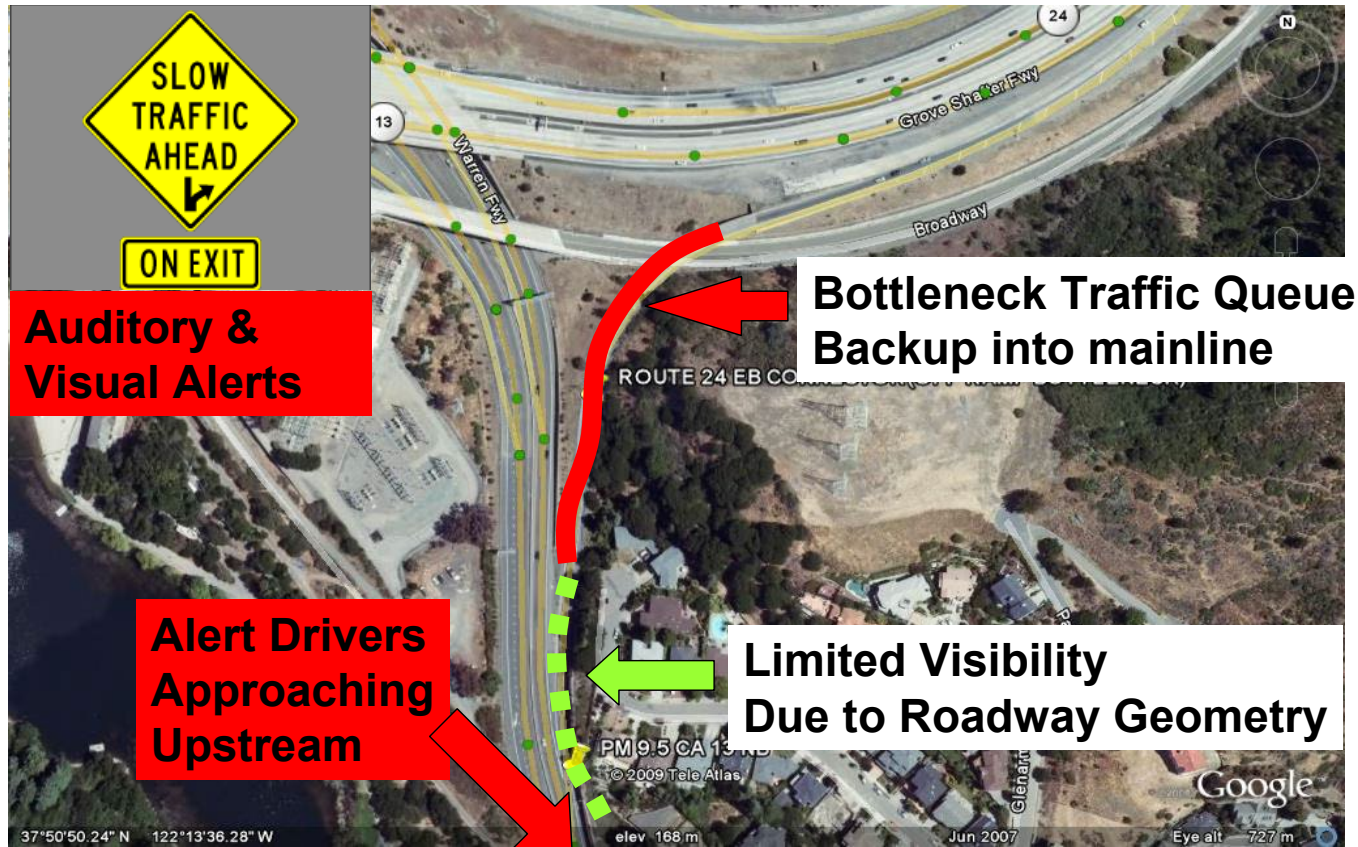
### Vehicle-to vehicle (V2V)

- Communications
  - *DSRC*
  - *Mobile devices*
- Cooperative Adaptive Cruise Control (**CACC**)
  - Shorter gaps
- *Active Safety Systems*
  - *Reduce crashes by 80 percent*
  - *Driver Alerts (Queue Warning)*



# Vehicles, Internet, Phone, and the Future

## Connected Vehicles (V2V)--Queue Warning



# Vehicles, Internet, Phone and the Future

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## Cooperative Vehicle-Infrastructure Systems

### Vehicle-to Infrastructure (V2I)

- SPaT Message
- Applications
  - *Safety*
  - *Mobility*
    - Improved traffic signal control
    - Dynamic route advisory
    - Environment
  - *Speed advisory for minimum fuel/emissions*

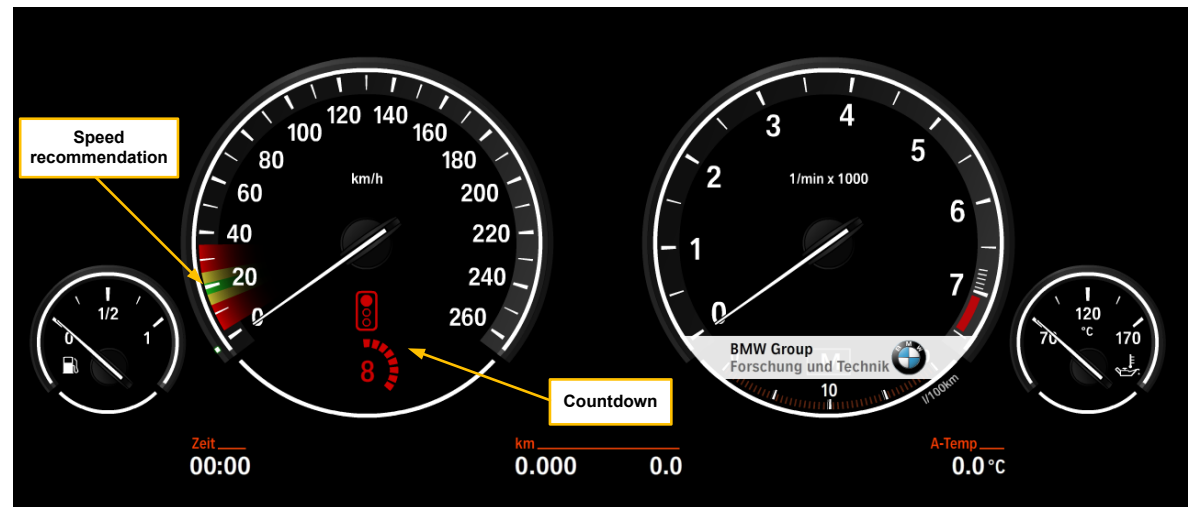
# Vehicles, Internet, Phone, and the Future

## Vehicle-to Infrastructure (V2I)

### Dynamic Speed Advisory (Source: BMW)

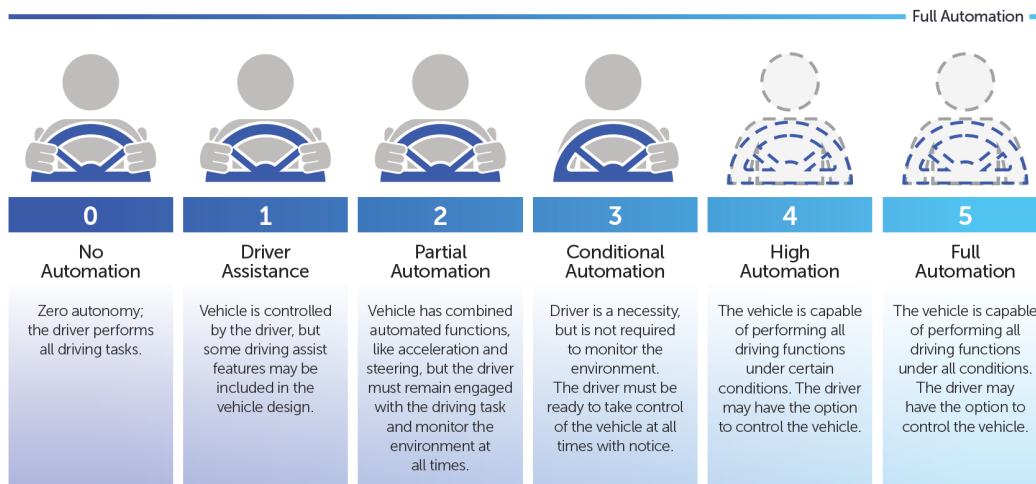
SPaT message transmitted to the vehicle

Signal status and recommended speed on driver speedometer



# Automated Vehicles (AV)

## Levels of Automation



- More than 30 private companies developing AV technology
- Emphasis on Level 4
- **Waymo** is the only automated private vehicle in operation
- **Nuro** is an AV mini car for package deliveries in neighborhoods

# Summary

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## Traveler Information

- Predominant use of mobile devices for data sources and information dissemination
- Multimodal applications

## Mobility on Demand (MOD)

- Safe, reliable travel for all users
- Connected multimodal network
- Mobility as a Service (MaaS)

## Emerging Applications

- Driver safety and convenience systems
- Connected Vehicles Technologies (V2V, V2I)
- Automated Vehicles