

**SDR '10 Wireless Innovation Conference and Product Exposition  
Analysts Workshop**

# Opportunities for Innovative Wireless Technologies that Enable Future Intelligent Transportation System Applications

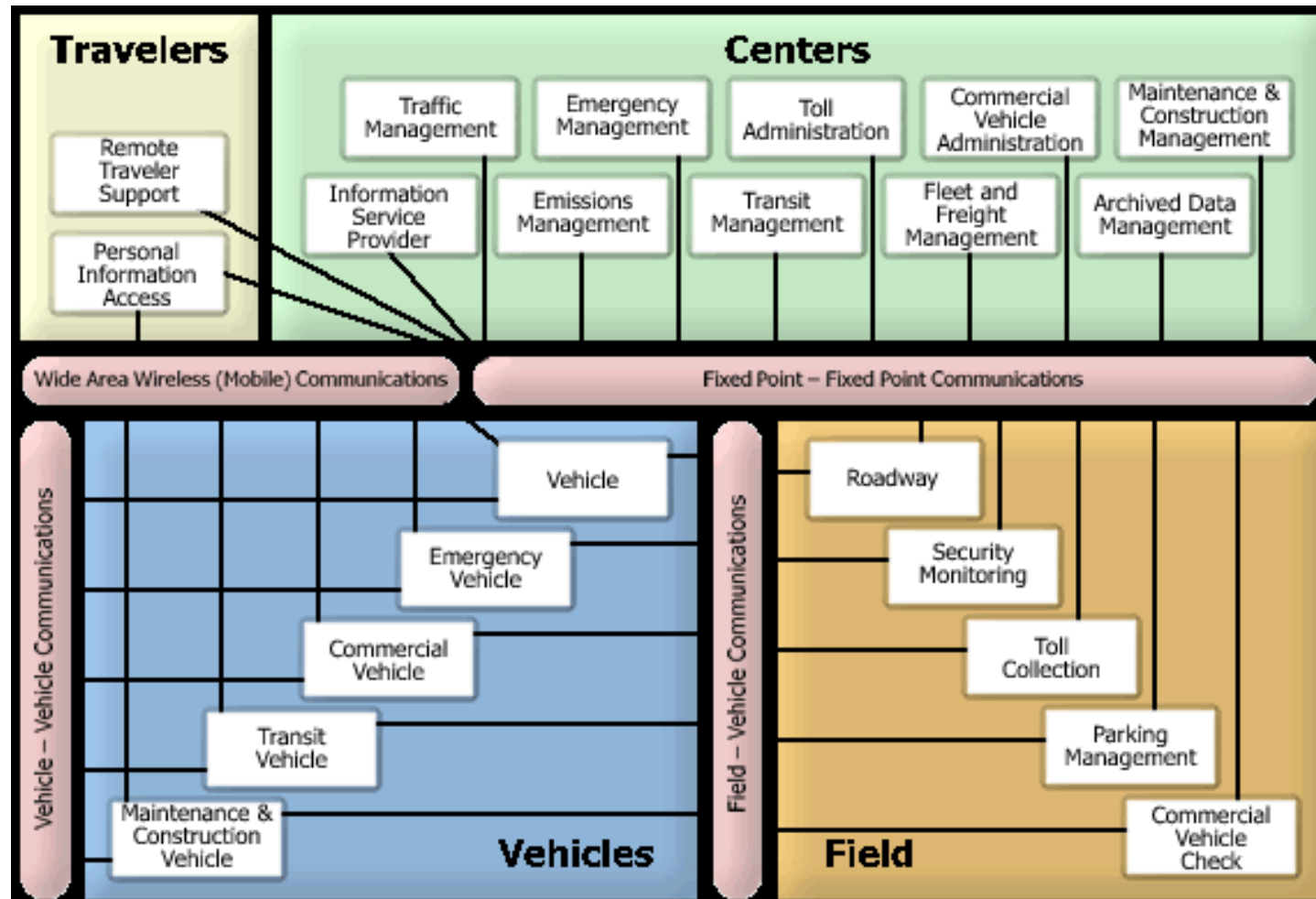
Craig Pickering  
Booz Allen Hamilton  
Washington, DC  
12/02/10

## Overview

- ▶ Intelligent Transportation Systems and IntelliDrive<sup>SM</sup>
- ▶ State and Local ITS Trends
- ▶ Commercial Market
- ▶ Applications

*Note: The IntelliDrive<sup>SM</sup> Logo is a Service Mark of the U.S. Department of Transportation*

# The National ITS Architecture is enabled by wireless technology

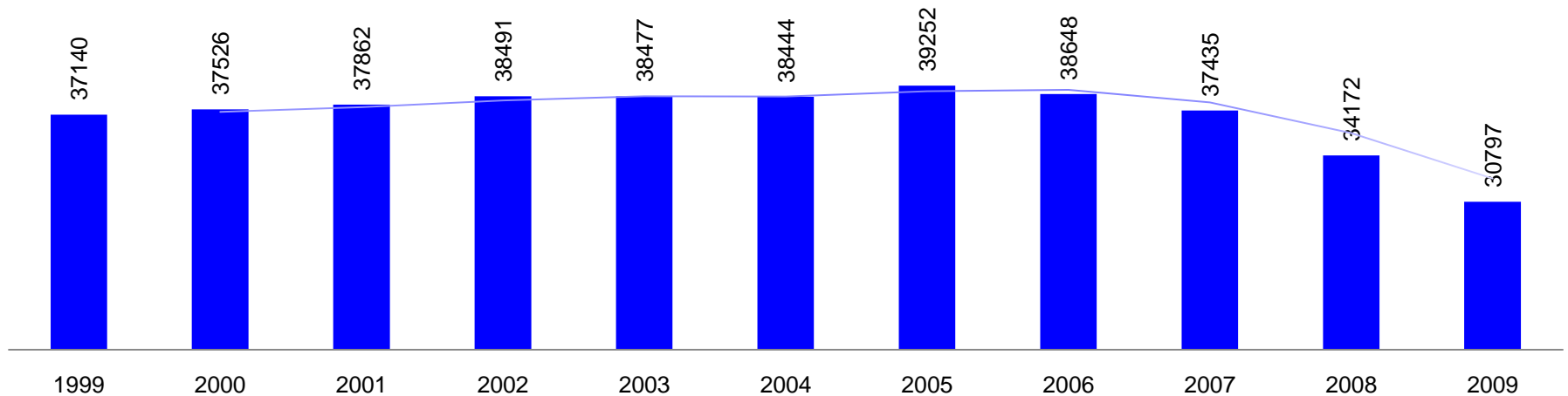


# The US DOT IntelliDrive<sup>SM</sup> program is leading a revolution in ITS technology using wireless communication



**Fatalities on the road have dipped over the past couple years ...**

### **United States Traffic Fatalities 1999 – 2009**

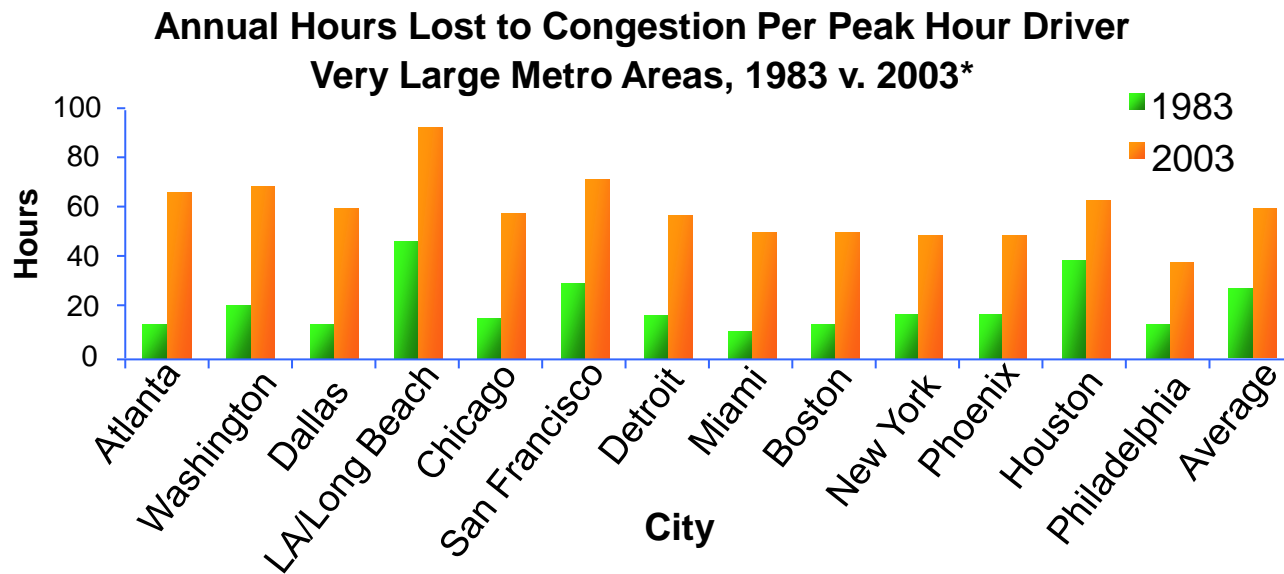


*Source: National Highway Traffic Safety Administration; <http://www.fars.nhtsa.dot.gov/Main/index.aspx>*

**... but ITS safety applications can drive rates even lower**

# Another key concern of the US DOT is traffic congestion

- ▶ Commuting costs
- ▶ Quality of life
- ▶ Productivity



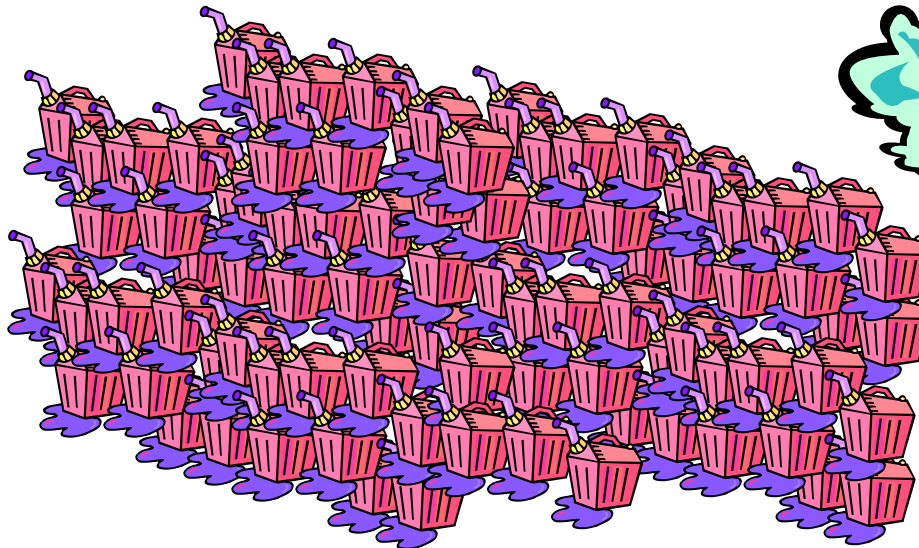
Source: ITS World Congress 2006 – assumes gasoline cost of \$2.67/gal



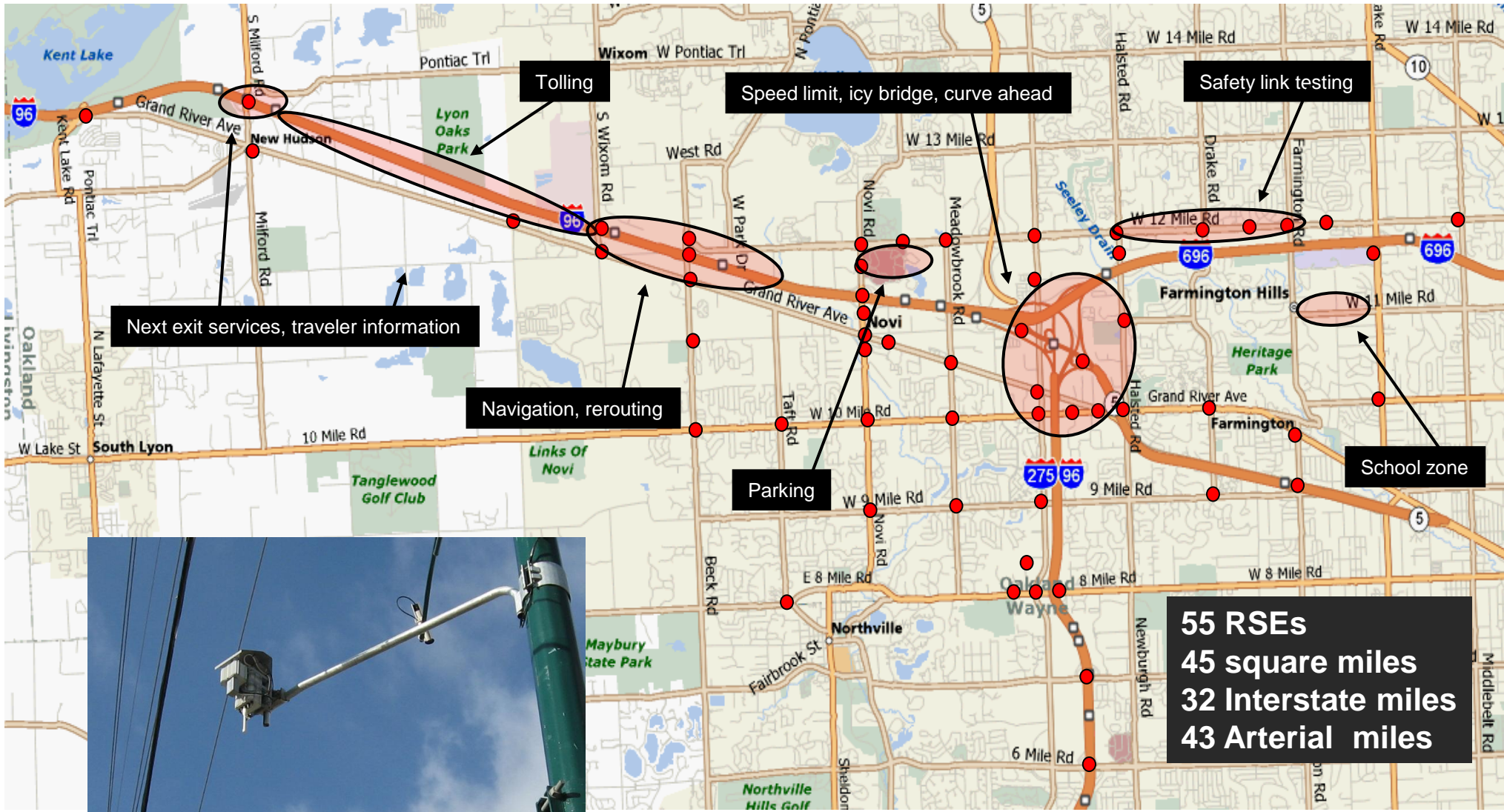
Congestion on I-95 in Northern Virginia

# Inefficiencies on the road are impacting the environment

- ▶ An estimated 3 Billion gallons of fuel wasted annually
- ▶ A fifth of CO<sub>2</sub> emissions are from vehicles
- ▶ Fuel economy and cleaner cars only part of answer
- ▶ Technology can help improve vehicle efficiency

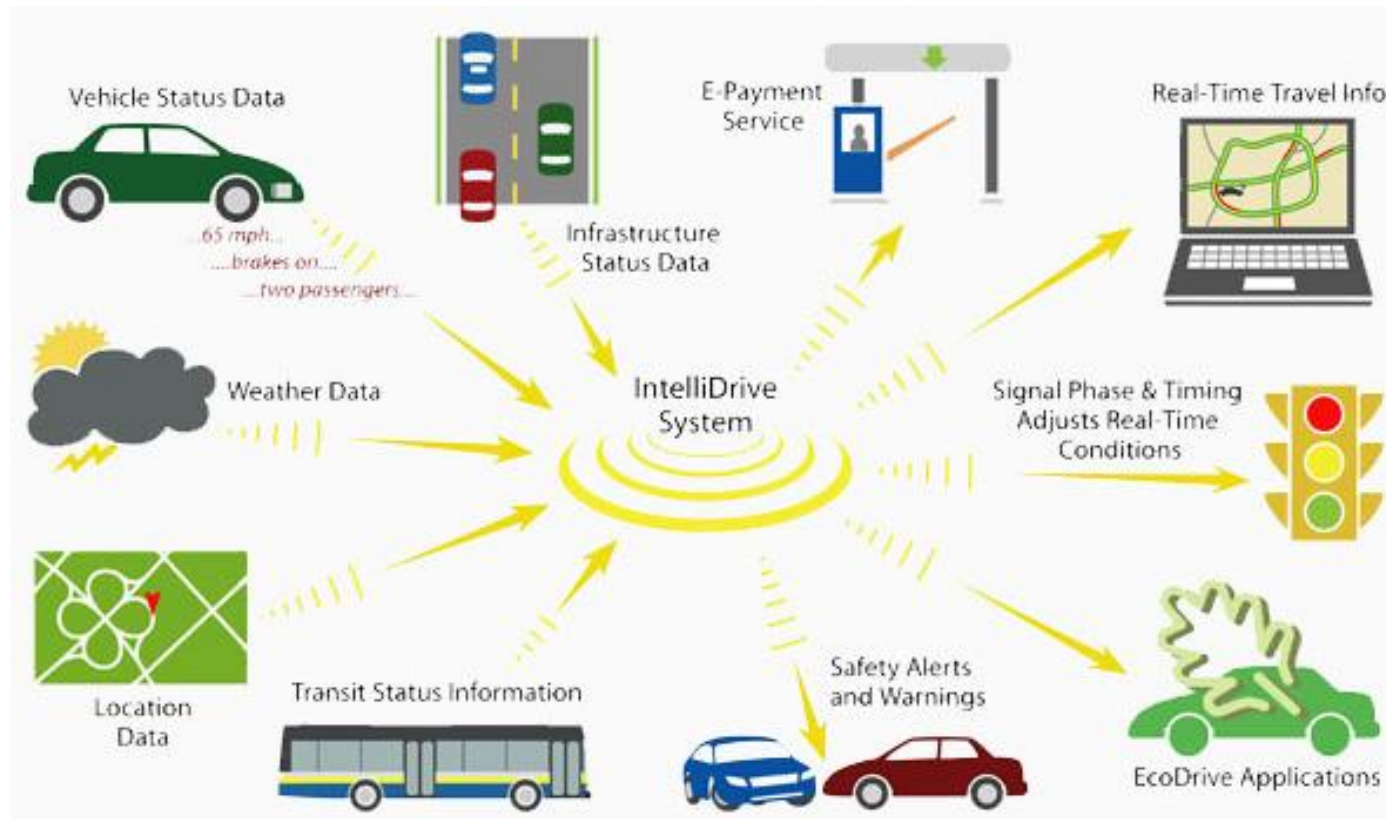


# US DOT IntelliDrive<sup>SM</sup> Test Bed



Booz | Allen | Hamilton

# State and Local DOTs envision the future of wireless Communications associated with IntelliDrive ...



Source: US DOT

... and will most likely be responsible for deployment














# Vehicle Manufacturers are increasingly using wireless communications to create new services

- ▶ In- vehicle telematics applications are expanding.



- ▶ There are two approaches currently being offered:
  - Utilize embedded wireless devices
    - OnStar, ATX, and Hughes Telematics
    - Call center advisor provided for many services
  - Integrate personal communication devices (cell phones) into vehicle systems
    - Ford Sync

# ITS applications are enabled by wireless communication technology

<b>Arterial Management</b>  <ul style="list-style-type: none"> <li>▸ Surveillance</li> <li>▸ Traffic Control</li> <li>▸ Lane Management</li> <li>▸ Parking Management</li> <li>▸ Information</li> <li>▸ Enforcement</li> </ul>	<b>Freeway Management</b>  <ul style="list-style-type: none"> <li>▸ Surveillance</li> <li>▸ Ramp Control</li> <li>▸ Lane Management</li> <li>▸ Special Events Trans. Mgmt.</li> <li>▸ Information</li> <li>▸ Enforcement</li> </ul>	<b>Crash Prevention &amp; Safety</b>  <ul style="list-style-type: none"> <li>▸ Road Geometry Warning</li> <li>▸ Highway-Rail Crossing Warning Systems</li> <li>▸ Intersection Collision Warning</li> <li>▸ Pedestrian Safety</li> <li>▸ Bicycle Warning</li> </ul>	<b>Road Weather Management</b>  <ul style="list-style-type: none"> <li>▸ Surveillance, Monitoring, &amp; Prediction</li> <li>▸ Information Dissemination Advisory Strategies</li> <li>▸ Traffic Control Strategies</li> <li>▸ Response &amp; Treatment</li> </ul>	<b>Intermodal Freight</b>  <ul style="list-style-type: none"> <li>▸ Freight Tracking</li> <li>▸ Asset Tracking</li> <li>▸ Terminal Processes</li> <li>▸ Drayage Operations</li> <li>▸ Freight-Highway Connector System</li> <li>▸ International Border Crossing Process</li> </ul>
<b>Transit Management</b>  <ul style="list-style-type: none"> <li>▸ Operations &amp; Fleet Management</li> <li>▸ Information</li> <li>▸ Transportation Demand Mgmt</li> <li>▸ Safety &amp; Security</li> </ul>	<b>Traffic Incident Management</b>  <ul style="list-style-type: none"> <li>▸ Surveillance &amp; Detection</li> <li>▸ Mobilization &amp; Response</li> <li>▸ Information</li> <li>▸ Clearance &amp; Recovery</li> </ul>	<b>Emergency Management</b>  <ul style="list-style-type: none"> <li>▸ Hazardous Materials Management</li> <li>▸ Emergency Medical</li> <li>▸ Response &amp; Recovery</li> </ul>	<b>Electronic Payment &amp; Pricing</b>  <ul style="list-style-type: none"> <li>▸ Toll Collection</li> <li>▸ Transit Fare Payment</li> <li>▸ Parking Fee Payment</li> <li>▸ Multi-use Payment</li> <li>▸ Pricing</li> </ul>	<b>Commercial Vehicle Operations</b>  <ul style="list-style-type: none"> <li>▸ Credentials Administration</li> <li>▸ Safety Assurance</li> <li>▸ Electronic Screening</li> <li>▸ Carrier Operations</li> <li>▸ Security Operations</li> </ul>
	<b>Traveler Information</b>  <ul style="list-style-type: none"> <li>▸ Pre-Trip Information</li> <li>▸ En-route Information</li> <li>▸ Toursim &amp; Events</li> </ul>	<b>Information Management</b>  <ul style="list-style-type: none"> <li>▸ Data Archiving</li> </ul>	<b>Roadway Operations &amp; Maintenance</b>  <ul style="list-style-type: none"> <li>▸ Information Dissemination</li> <li>▸ Asset Management</li> <li>▸ Work Zone Management</li> </ul>	

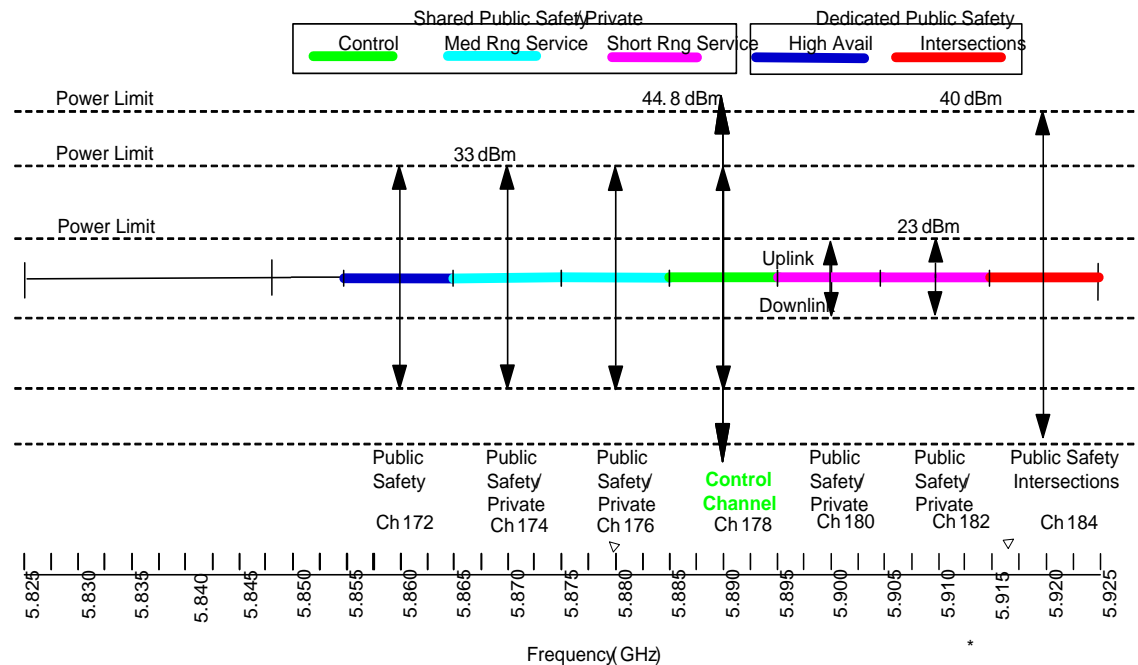
# Application performance requirements - ballpark

	Intersection Safety Apps	V2V Safety	Advisory Messages	Probe Data	Electronic Toll Collection	Mileage Based User Fees	Consumer Transactions
<b>Message Size (Estimated Bytes)</b>	<b>0.5K</b>	<b>0.5K</b>	<b>2K</b>	<b>10K</b>	<b>1K</b>	<b>5K</b>	<b>100K</b>
<b>Message Rate</b>	<b>10 Hz</b>	<b>10 Hz</b>	<b>10 Hz</b>	<b>One per Vehicle per RSE</b>	<b>10 Hz</b>	<b>One per Vehicle per Trip</b>	<b>One per Vehicle per every 10 RSE (est)</b>
<b>Instantaneous Bandwidth</b>	<b>5 Kbps</b>	<b>1.25 Mbps</b>	<b>20 Kbps</b>	<b>2.5 Mbps</b>	<b>10 Kbps</b>	<b>~5 Kbps</b>	<b>2.5 Mbps</b>
<b>Bi-Directional Data Flow</b>	<b>Yes</b>	<b>Yes</b>	<b>No</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
<b>Latency</b>	<b>&lt;100 msec</b>	<b>&lt;100 msec</b>	<b>&lt;1 sec</b>	<b>&lt;1 sec</b>	<b>&lt;100 msec</b>	<b>&lt;1 sec</b>	<b>&lt;1 sec</b>
<b>Multiplicity (Broadcast)</b>	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>	<b>No</b>	<b>Yes</b>	<b>No</b>	<b>No</b>
<b>Availability</b>	<b>Very High</b>	<b>Very High</b>	<b>High</b>	<b>Moderate</b>	<b>High</b>	<b>Moderate</b>	<b>Moderate</b>
<b>Localization</b>	<b>High</b>	<b>Very High</b>	<b>Moderate</b>	<b>Low</b>	<b>High</b>	<b>Low</b>	<b>Very Low</b>

Source: Cogenia

## 5.9 GHz Dedicated Short Range Communication

- ▶ US DOT working with FCC secured spectrum for transportation safety in 1999 – notice issued in 2003
- ▶ Operating Band is 5.86-5.92 GHz
- ▶ Standards Developed include IEEE 802.11p and IEEE 1609
- ▶ US DOT Activity
  - Here I Am device
  - Roadside Equipment
  - After-Market Safety Device



# Some limitations of Wireless Technologies

	<b>5.9 GHz DSRC</b>	<b>WiMax</b>	<b>WiFi</b>	<b>3G Cellular</b>	<b>Satellite</b>
<b>Max Bandwidth-One User (mbps)</b>	10	15	10	3	2
<b>Foot Print Area (sq-km)</b>	0.06	1	0.03	9	15M
<b>Max Users In Footprint</b>	400	4,500	100	25,000	200M
<b>Min Bandwidth Per User (kbps)</b>	25.0	3.3	100.0	0.1	0.00001
<b>Bi-Directional Data</b>	Yes	Yes	Yes	Yes	No
<b>Latency</b>	100 ms	10-20 sec	10-20 sec	20-30 sec	60-600 sec
<b>Multiplicity (Broadcast)</b>	Yes	Multicast	Multicast	No	Yes
<b>Availability</b>	High	Moderate	Low	Low	High
<b>Localization</b>	High	Moderate	High	Poor	Very Poor

Source: Cogenia

1. Application of 5.9 GHz DSRC limited by coverage area
2. 3G Cellular and Satellite lack bandwidth in some large scale applications
3. 3G Cellular, WiMax and Satellite can be inefficient for local applications – but 4G may solve
4. WiFi and DSRC are similar, but DSRC is optimized for transportation applications

# Wireless Technology is a hot topic for ITS deployment ...

