Intelligent Cars, Trucks, and Buses: Technology Status and Forecast

Fourth Joint Military/Civilian Seminar on Intelligent Vehicle Technology Transfer

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Executive Vice President

ITS AMERICA
The Intelligent Transportation Society of America

• **What is ITS America:**
  - Trade association representing over 400 public and private sector organizations involved in all aspects of ITS research, planning, development, and deployment
  - Headquartered in Washington, DC with 24 regional and state chapters representing 36 states

• **Our Vision:** Help save lives, time and money and help sustain the environment through broad deployment of interoperable ITS technologies

• **Our Mission:** Be proactive leaders for all ITS stakeholders promoting collaboration and networking in research, development and design of ITS technologies to accelerate deployment
Last Year’s Focus--Cars

The U.S. Experience

- Application of ITS systems/services in U.S. automotive industry lags behind Japan and Europe
- North Americans show interest in fuel efficiency
- European car buyers put more value in driving experience
- Japanese car buyers put high value on technology
- Universal “want” is safety
# The Automakers and Technology

## HOW THE AUTOMAKERS STACK UP

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XXX = All or many; XX = Some; X = Few; Blank = None
IntelliDrive<sup>sm</sup> -- The Future is Now

- IntelliDrive<sup>sm</sup> — formerly known as Vehicle Infrastructure Integration (VII) — combines leading edge technologies — advanced wireless communications, on-board computer processing, advanced vehicle-sensors, GPS navigation, smart infrastructure, and others — to provide the capability for vehicles to identify threats and hazards on the roadway and communicate this information over wireless networks to give drivers alerts and warnings.
IntelliDrive\textsuperscript{sm}

- At the core of IntelliDrive\textsuperscript{sm} is a networked environment supporting very high speed transactions among vehicles (V2V), and between vehicles and infrastructure components (V2I) or hand held devices (V2D) to enable numerous safety and \textit{mobility} applications.
IntelliDrive\textsuperscript{sm}

- This capability to identify, collect, process, exchange, and transmit real-time data provides drivers with a greater *situational awareness* of the events, potential, threats, and imminent hazards within the vehicle’s environment.

- When combined with technologies that intuitively and clearly present alerts, advice, and warnings—drivers can make better and safer decisions while driving.
IntelliDrive<sup>sm</sup>

- Additionally, when further combined with automated vehicle-safety applications, IntelliDrive<sup>sm</sup> provides the vehicle with the ability to respond and react when the driver can’t or doesn’t in time, significantly increasing the effectiveness of crash prevention and mitigation applications.
Trucks: Technology Status and Forecast
Scope of the Commercial Vehicle Industry

715,000 Interstate Motor Carriers

7 Million Commercial Drivers

8.8 Million Large Trucks and 32,000 Motor coaches

223 Billion Miles Traveled by Trucks
Freight Tonnage Forecast by Mode, 2004-2035

Net Freight Tons (in Billions)

- Truck
- Rail
- Water
- Other
- Air

Source: Global Insight, Inc., TRANSEARCH, 2004
Daily Truck Volumes—2002

Estimated Annual Average Daily Truck Flow - 2002
Daily Truck Volumes—2035

Estimated Annual Average Daily Truck Flow - 2035

faf2035_truck_volume_per_day_aadtt

FAF 2035 Truck Volume Per Day (AADTT)
- VAM Site
- FAF35

faf2035_truck_volume_per_day_aadtt

0 100 200 300

Miles

Freight Analysis Framework II. FHWA, U.S. DOT
Future Challenge

If unchecked, the growth in VMT could yield:

- Increased numbers of highway fatalities and injuries
- Increased time between commercial vehicle inspections by enforcement personnel
- Increased congestion
- Increased transportation costs for freight
- Reduced global competitiveness for U.S. economy
- More rapid deterioration of infrastructure
- Worsening air quality
A Vision for the Future

Commercial Vehicle Safety Component Concept

- Hours of Service
- Commercial Driver’s License Number
- Other Driver Monitoring Data
- Vehicle Identification Number
- USDOT Number (Carrier ID)

Other Fault Code Information
- Fuel System
- Transmission
- Air System
- Electrical/Electronic Systems

Lighting System Performance

Brake System Performance

Tire Condition Monitoring
That Vision in Action

- Identify vehicles and cargo reported as stolen and notify enforcement personnel
- Support existing e-screening and pre-clearance programs
- Off-Route Notice for Special Hauling Permits (OS/OW, HM, in-bond)
- Size/Weight Limit Warning
- Receive real-time information regarding truck parking availability
- Conduct direct enforcement (citations, fines, vehicle immobilization)
- Conduct direct enforcement (citations, fines, vehicle immobilization)
- Support existing e-screening and pre-clearance programs
- Conduct direct enforcement (citations, fines, vehicle immobilization)
- Geo-fence special events and notify enforcement resources
- Conduct direct enforcement (citations, fines, vehicle immobilization)
- Notify emergency responders and highway operators of a crash
- Update carrier safety fitness rating and other safety algorithms
- Provide data to support deployment of enforcement resources
- Provide enforcement coverage (e.g., wireless inspections) on bypass routes or where fixed sites do not exist
- Conduct direct enforcement (citations, fines, vehicle immobilization)
Current Projects

- Wireless Roadside Inspection Program (WRI)
- Onboard Safety Systems
  - Integrated Vehicle Based Safety Systems (IVBSS)
  - Onboard Monitoring System
- Smart Park
- Smart Roadside
Commercial Motor Vehicle Roadside Technology Corridor

A series of fixed and mobile state-of-the-art facilities for testing and evaluating CMV enforcement technologies in a real-world setting

"The goal of this long-term collaborative effort among FMCSA, TDOS, TDOT, ORNL and UT is to develop and promote advanced truck and bus safety inspection and enforcement technologies to save lives."

Benefits
- Provide Quantitative Assessments of Technology Benefits and Costs
- Support Technology Deployment Decisions
- Expedite Technology Testing Process
- Flexibility to Address Multiple Technology Types
- Test-bed for Truck and Bus Vehicle Infrastructure Integration (VII) safety applications

Field Operational Testing
- VII Test-bed for Truck and Bus Safety

Bench-top testing
- Hardware-in-the-loop testing
- Driving simulator testing
- Test course testing

Greene County Inspection Station

Knox County Inspection Stations

The University of Tennessee

TDOT Region 1 Headquarters

Active testing of infrastructure-based technologies at Inspection Stations

FMCSA

NTRC

UT

OAK RIDGE National Laboratory

Intelligent Transportation Society of America
Onboard Safety Systems

Safety Belts
Tire Pressing Monitoring
Brake Stroke Monitoring
Lane Change/Merge
Forward Collision Warning w/wo ACC
Lateral Drift Warning
Electronic Stability Control
Roll Stability Control

Collision Mitigation System
Rear Signaling System
Enhanced Camera Video Imaging System

Onboard Monitoring System
Integrated Vehicle-Based Safety System

Single Systems (Currently available)
Single Systems (Not on the Market Yet)
Integrated Systems (Currently Available)
Integrated Systems (Not on the Market Yet)
Integrated Vehicle-Based Safety System (IVBSS)

1. Lateral Drift Warning System
2. Lane Change/Merge Warning System
3. Forward Collision Warning System
Onboard Monitoring System for CMV Safety

To determine whether an onboard monitoring system can improve driver safety performance.
SmartPark

- Demonstrate technology for conveying real-time information on parking availability to truckers on the highway
Smart Roadside Vision

• Commercial vehicles, motor carriers, enforcement resources, highway facilities and key nodes on the freight system (ports and terminals, international border crossings, toll plazas, weigh stations, and other check points) share data in order to:
  – Manage the flow of commercial vehicle traffic
  – Help prevent and respond to crashes and other incidents
  – Focus enforcement resources on high-risk carriers, vehicles, and drivers
  – Reduce unnecessary delay for commercial vehicles, and thereby improve associated energy consumption and emissions
Roadside Programs/Projects Coordinated via Smart Roadside
1. E-Screening Site
2. E-Tolling
3. Over-Height Detector
4. Weather Monitoring Station
5. Transponder Reader (probes)
6. Weigh-in-Motion
7. Loop Detector
8. In-Vehicle Monitoring (In Motion)
9. E-Permitting Verification
10. Radiation Detection Systems
Anticipated Benefits of Smart Roadside

• If the Smart Roadside Vision is achieved, the following benefits will be realized:
  – Fewer commercial vehicle crashes and improved responses to crashes that do occur
  – More efficient and effective trips for motor carriers
  – More efficient operations for intermodal facilities and border crossings
  – Reduced infrastructure and enforcement costs
  – Enhanced preservation of infrastructure
  – Improved security and tracking for high-risk/regulated cargo
  – Improved air quality
Initial Deployments

- Seattle to Vancouver Corridor
- Virtual WIM State
- Virtual WIM State
- Virtual WIM State
- Virtual WIM State
- Virtual WIM State
- CVII Deployment
- I-95 Corridor Coalition Test
- FMCSA Roadside Technology Testbed
- Freight Data Integration Project
- Virtual WIM State
- Virtual WIM State
- Virtual WIM State

Virtual WIM State
Next Steps: Federal Role

• In support of the Smart Roadside Initiative, FMCSA and FHWA will:
  – Fund selected tests, demonstrations, and deployments
    • Coordinate with state and industry representatives to identify promising applications of Smart Roadside infrastructure
  – Coordinate the development of the necessary architecture and standards
  – Develop the appropriate Guiding Principles
  – Document the business case for the Smart Roadside
  – Develop/implement a deployment strategy
  – Maintain a Smart Roadside Roadmap to coordinate FMCSA, FHWA, and other related programs/projects
  – Facilitate stakeholder collaboration

• Collaboration with DHS and EPA also being sought
Next Steps: Stakeholders Role

• Envision an active role for public- and private-sector stakeholders in the Smart Roadside Initiative

• Public- and Private-Sector Stakeholders will:
  – Provide input to FMCSA and FHWA on the Smart Roadside Initiative via the Smart Roadside ad hoc team
  – Develop Guiding Principles
  – Identify potential solution sets that could be included in the Smart Roadside Initiative
  – Guide development of Smart Roadside deployment strategy
  – Comment on Smart Roadside business case
  – Provide inputs to Smart Roadside Roadmap
  – Fund and deploy Smart Roadside-related systems/technologies at roadside and in vehicles
  – Conduct Smart Roadside demonstrations/operational tests
Buses: Technology Status and Forecast
The Value of Transit Technology

• Wide range of mature, commercially available technologies
• Potential for technologies to generate significant efficiency and service quality benefits
• Benefits realized, but very limited amount of reliable and transferable quantitative data on benefits
• Despite promise and some successes, performance of technologies has fallen far short of its potential
  – Processes do not always address most important issues – institutional and organizational issues
  – Not taking full advantage of deployed technologies
  – Few agencies have integrated their technologies, so synergistic benefits not realized
The Value of Transit Technology, ctd

• Most progressive agencies focused on replacing, upgrading and integrating very mature technologies rather than identifying emerging technologies

• Private companies more focused on anticipating and adopting emerging technologies

• Continuum of approaches to technology deployment:
  – Stand-alone systems that reflect objectives of individual business units
  – Integrate technologies and base investments on broader, agency-wide business objectives
  – International agencies – investments more driven by agency-wide objectives, and increasingly on regional or national mobility considerations
Transit ITS Functionalities

• Communications / CAD
• Automatic vehicle location (AVL)
• Security
• Schedule Adherence
• Automatic passenger counter (APC)
• Transit Signal Priority
• Customer Information (En-route, Pre-trip)
• Analysis using Archived Data
• Advanced Fare Collection
ITS Functionalities: Onboard Systems
Transit ITS – Last 5 years

- Bus Rapid Transit (BRT) revolution
  - (often introduces/upgrades Transit ITS)
- Trip Planning & Interactive Voice Response (IVR) (not strictly ITS)
- Cellular communications
- Slow acceptance/growth of Transit Signal Priority (TSP)
- Development of Transit Comm. Interface Protocols
- Rapid deployment: onboard video recording systems
- Developmental phase for: Real-time traveler information systems On-board announcements & stop prediction. Smart card payment systems.
Transit ITS – Last 5 years

Vehicle Assist and Automation (VAA) – Assists or automates movement of buses to allow precise operations in extremely narrow lanes, at stations, and potentially bus maintenance facilities by using precision docking, vehicle guidance and automated operations.
VII for Transit

- Transit VII can support
  - effective operation management
  - better integration with traffic control system, e.g.
    - Signal priority with minimal impact to traffic
    - Vehicle probes
  - real-time traveler information, e.g.
    - On-vehicle, station, mobile based arrival and connection info

- Operations
  - Fleet Management (~ AVL but with real-time traffic information)
  - Demand-response / community transit
  - Incident management, communications bridge
  - Traffic signal priority
  - Automated platooning
  - Maintenance
  - Remote diagnostics (archived and live)
  - Tracking vehicles and spare parts
  - Mileage, passenger, and vehicle data transfer

- Data Analyses
  - Service planning (routes and schedules, run cutting)
  - Marketing
  - Emergency response planning
Transit Traveler Information

• Pre-trip traveler information:
  – Internet
  – Telephone
  – Mobile device
  – 511, 311 and 211

• En-route traveler information:
  – Wayside/in-station
  – On-board
  – Mobile device
  – 511
Transit Signal priority (TSP)

- Minimize delay experienced by buses and shorten round trip running times
- Demonstrate that signal priority traffic control software can work on different traffic controller equipment
Promising Emerging Technologies

• Various nanotechnologies:
  – Enable increased automation
  – Ubiquitous real-time exchange of information
  – Seamless integration of services

• Mechatronics:
  – Increase fuel economy
  – Improve vehicle performance and safety
  – Streamline maintenance

• Advances in speech recognition and language translation:
  – Improve customer service
  – Support more flexible and convenient services

• Hybrid-electric transit buses
  – reduce vehicle emissions
Transit ITS – Under Development

- AFC paradigm shift
  - Contactless credit card, Payment by cell phone
- Use of Wireless communications
  - Wi-Fi, Wimax, DSRC
- Other Areas of Transit ITS Developments
  - Transit Operations Decision Support Systems (TODSS)
  - Real-time digital video
  - Other demand-responsive systems (FlexBus)
  - Integrated Vehicle-Based Safety Systems (IVBSS), Vehicle Assist and Automation (VAA)
  - VIC / VII
- Multi-modal integration
  - (Advanced Traveler Information Systems (ATIS), TMCs, DOT Initiatives – Integrated Corridor Management, Urban Partnership Agreement)
New Perspectives on Benefits

- Image and customer convenience
- ADA Mandate
- Paratransit system productivity
  - Automating incident reporting
  - Responding to customer complaints
- Security (Terrorism)
Current / New Developments

- Effective use of Automatic Vehicle Locator (AVL) / Automatic Passenger Counter (APC) data and systems
- Traveler Information
  - Google Transit
  - Mobile delivery
  - Web 2.0
- More Effective Use of Transit Signal Priorities (TSP)
  - (Performance, Strategies)
- Real-time digital video
- New business models and architectures
  - Web-based applications
  - Building on stand-alone applications
    - (Stop enunciators, APCs)
Promising Emerging Technologies, ctd

- **Pervasive wireless communication:**
  - Wide-range of devices form ad-hoc communications networks
  - Cognitive radio uses smart devices to detect and utilize unused portions of local radio spectrum

- **Others:**
  - Artificial intelligence – facilitate data mining and customer pattern recognition
  - Quantum cryptography – improve data security
  - Terahertz radiation applications improve security and speed communications
Transit Forecast

• Much more information required about
  – capital, and operations and maintenance costs
  – communicating safety and security should be provided to agencies
  – communication project from concept-to-deployment should be made available to agencies
• Real-time information systems are dependent on data supplied by other ITS investments
• Transit operators derive many benefits (and costs) from implementing technologies required to support real–time traveler information systems, independent of whether they have implemented customer-facing technologies
• Many of the benefits derived from supporting systems are not the same as those derived from customer-facing real-time traveler information systems
Thank You

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