

## Intelligent Transportation Systems Institute

Improving Roadway Safety Programs through U-Agency Partnerships, November 2-3, 2011



## CENTER FOR TRANSPORTATION STUDIES

*Founded in 1987, CTS serves as a catalyst for transportation innovation, advancing knowledge through research, education and outreach.*

### STRATEGIC GOALS

- Strengthening University expertise
  - Championing formal education
  - Fostering ideas and knowledge development
  - Initiating public and stakeholder participation
  - Promoting applied problem-solving
- Serves as single university point of entry and coordination nexus for transportation research and education at University of Minnesota
  - Manages master agreement with MnDOT

### FEDERAL INITIATIVES

- ITS Institute
- Center for Excellence in Rural Safety
- HUD Sustainable Communities Program Evaluation
- Evaluation of Non-Motorized Pilot Programs
- Local Technical Assistance Program
- Federal RFPs: NSF, DOD, DHS, SHRP2, NCHRP, etc.

## ITS INSTITUTE

*UTC established in 1991 under ISTEA and renewed in 1997 through TEA-21 and in 2005 through SAFETEA-LU.*

**Theme: Human-centered technology to enhance safety and mobility.**

### INTERDISCIPLINARY RESEARCH PROGRAM

- Civil Engineering
- Computer Science/Engineering
- Electrical Engineering
- Mechanical Engineering
- Industrial Engineering
- Design
- Psychology
- Law
- Policy and Public Affairs

### PRIMARY RESEARCH AREAS

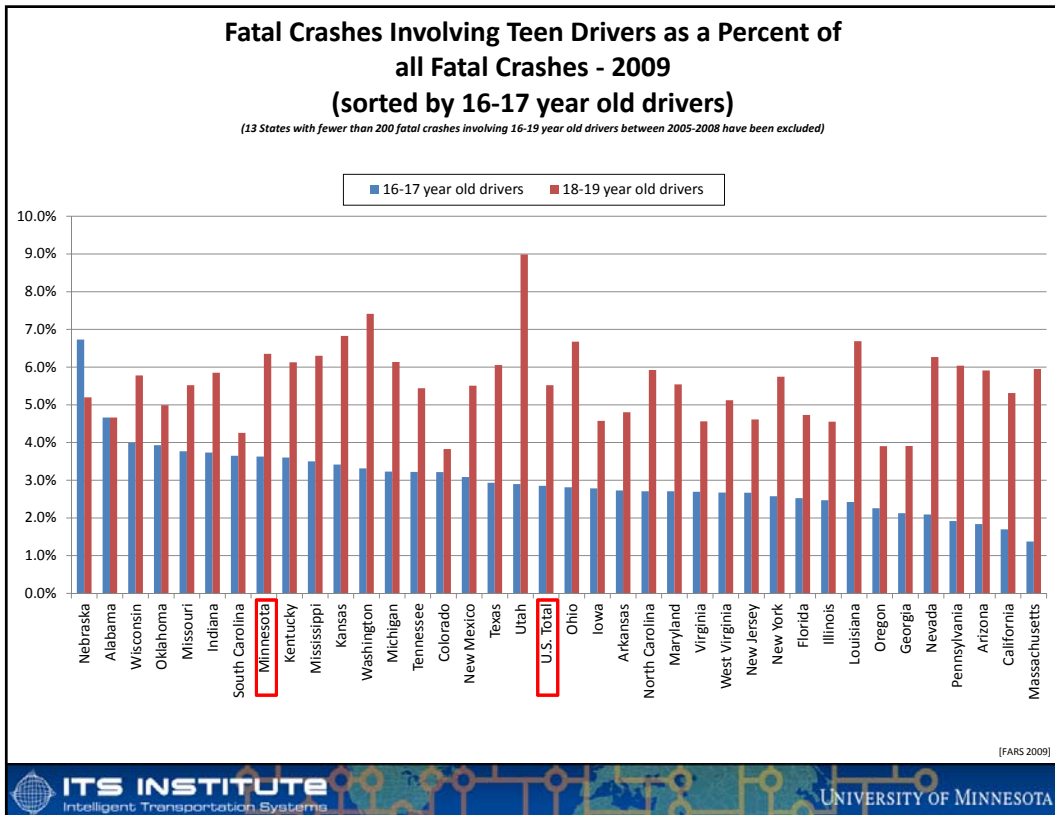
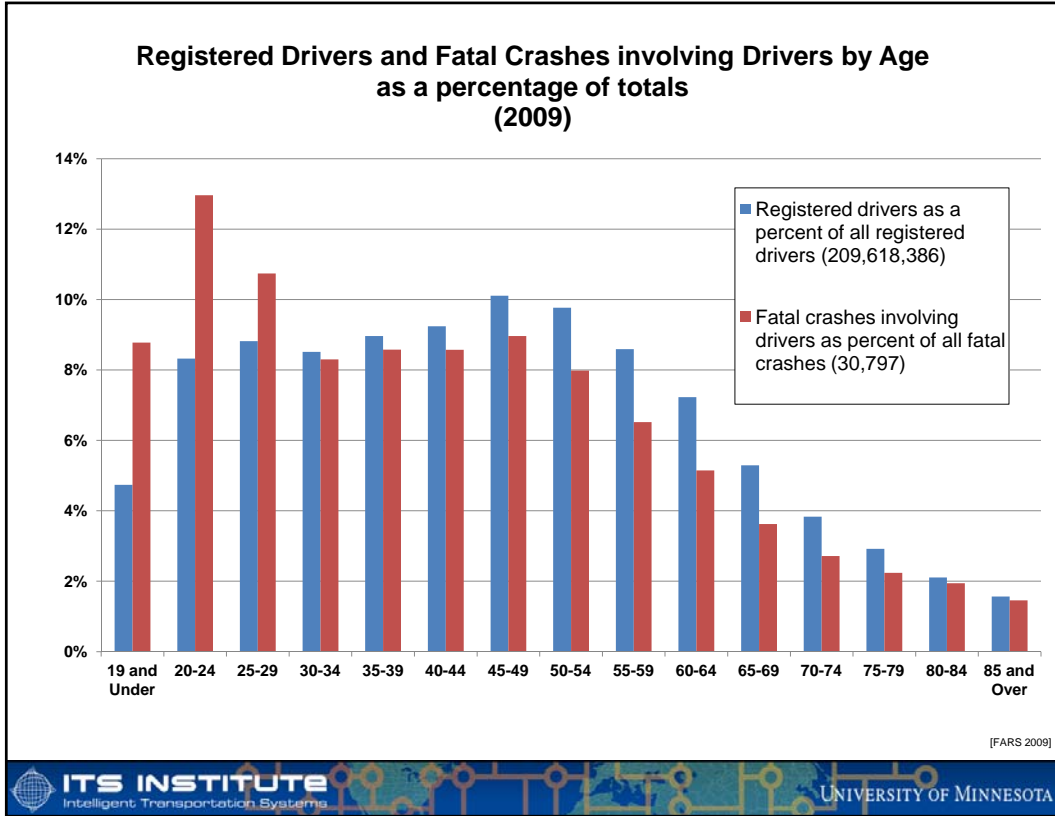
- Human Performance and Behavior
- Computing, Sensing, Communications, and Control Systems
- Technologies for Modeling, Managing, and Operating Transportation Systems
- Related Social and Economic Policies



## Overview

- ◆ Among the ITS Institute's long term goals:
  - ✦ Reduce road fatalities and crashes by concentrating on **high risk driver populations**
  - ✦ Motivate driving public to use transit; bypass congested lanes to improve travel times and maintain schedule adherence
  - ✦ Congestion mitigation
- ◆ Our focus:
  - ✦ Emerging technologies that are "human-centered"
  - ✦ Take advantage of **new DIGITAL infrastructure** based on: novel sensors, human-machine interface design & wireless communications
  - ✦ Research that leads to deployable solutions, taking ideas to the prototype stage, followed by testing in the real world
    - ... but this type of research is expensive
    - ... and cannot rely strictly on the faculty/student model of research.

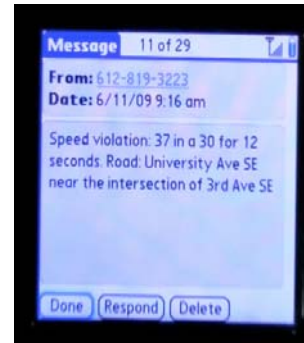




## “Smartphone”

### As Platform for Teen Driver Support System (TDSS)

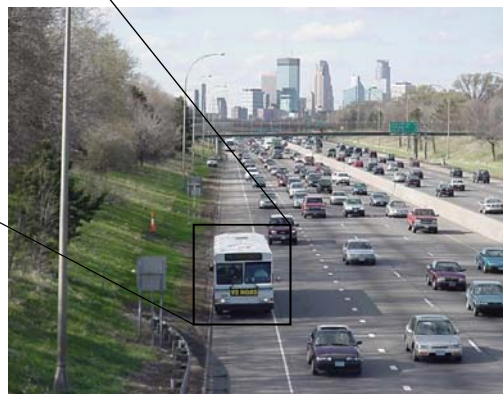
- ◆ Relies primarily on the capabilities of the teen’s **smartphone** (incorporating GPS receiver, accelerometer, etc.) for monitoring known teen driver risk factors and support of certain provisional licensure provisions
  - ◆ **All cellphone communication is subsumed**
  - ◆ Provides **real-time** feedback by ‘talking’ to driver to improve learning; reduce risky driving
  - ◆ Reports “critical” parameters back to parent via automated text messaging and web site
- Speed**
- ◆ Advance notification of speed limit changes
  - ◆ Graduated speeding warning
  - ◆ **If behavior doesn’t respond, parents are “texted”**



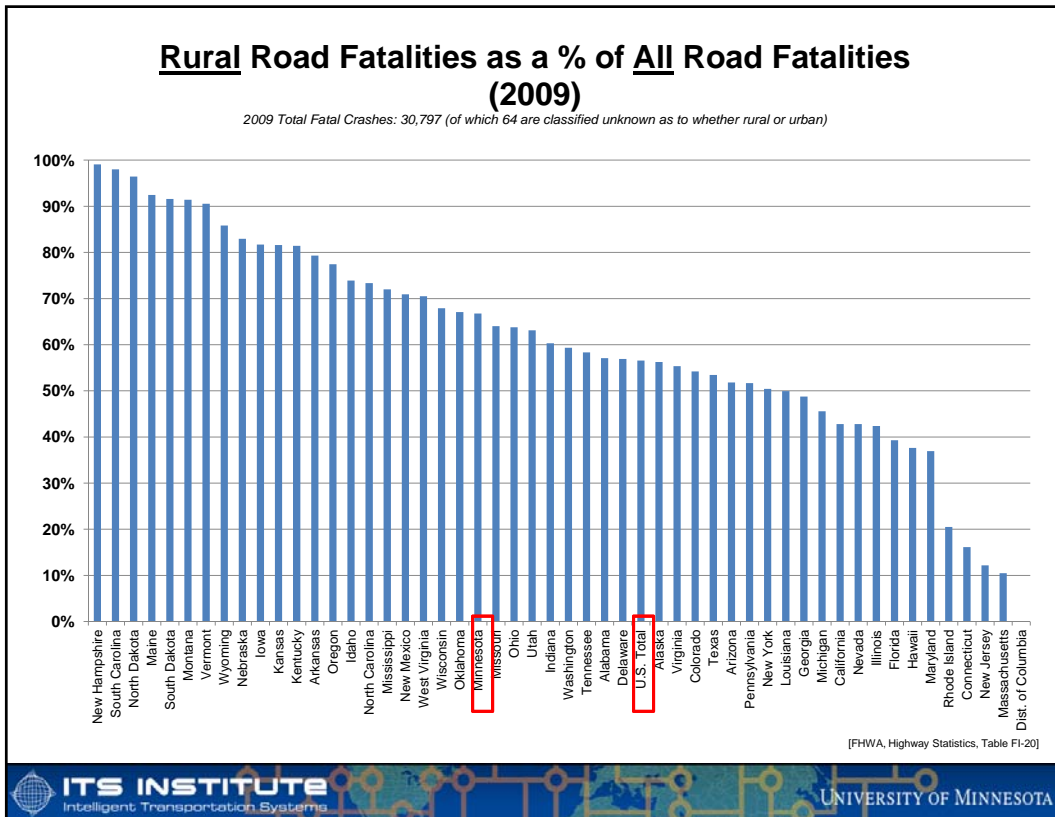
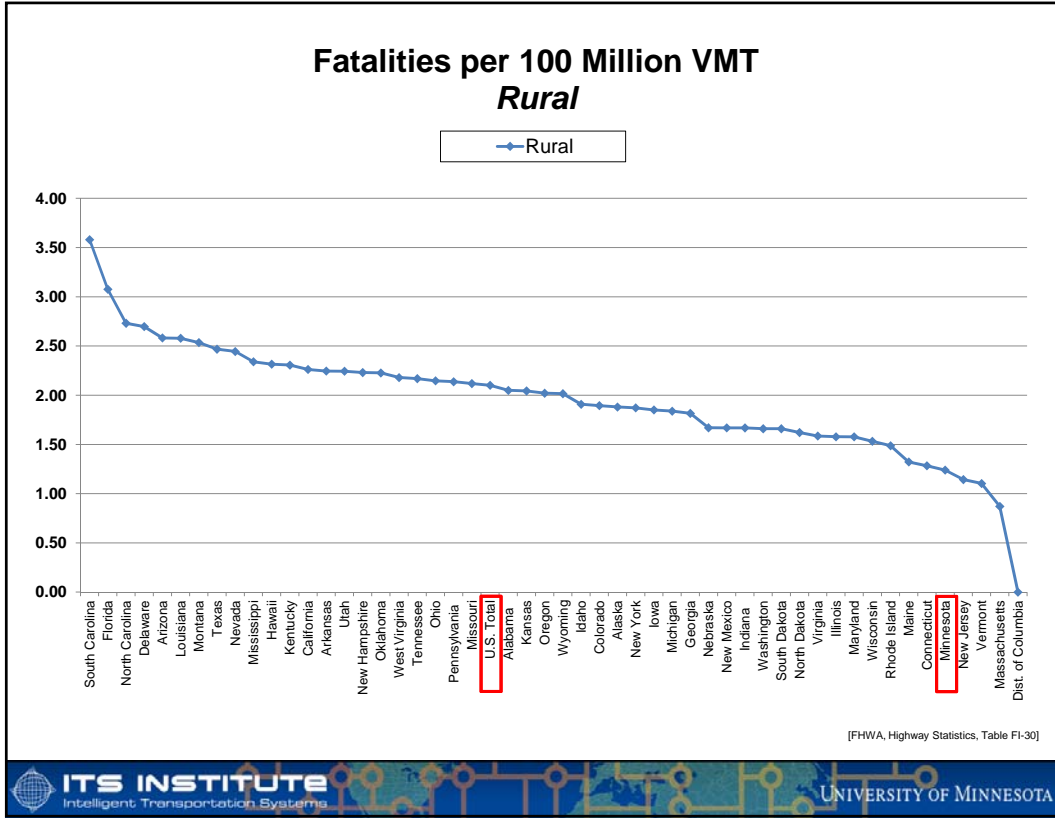
### Driver Assist Technology: Deploying Bus Rapid Transit along Narrow Road Shoulders to Bypass Congestion

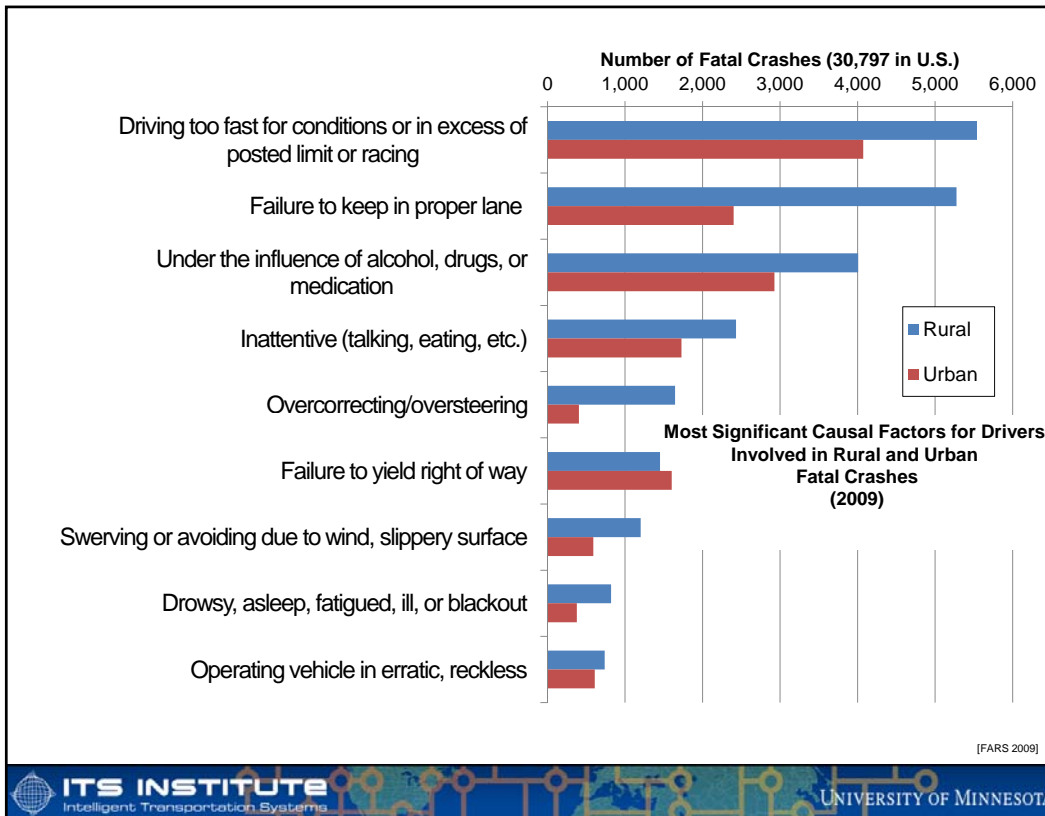


Deployed on 10 buses in passenger service since late 2010. Funded by US DOT. Partnered with MVTA, FTA, Met Council, Hennepin County, MnDOT



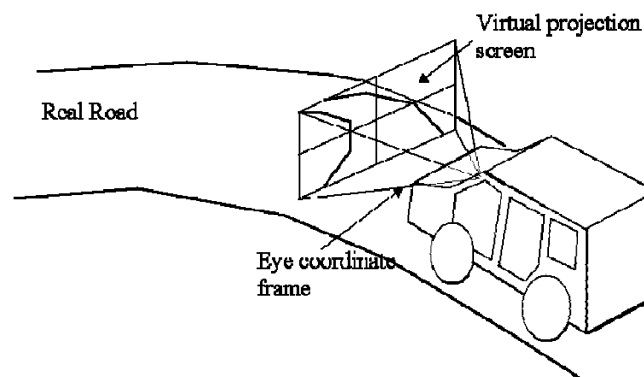
Driver assist system for lane keeping is same as needed for Lane Departure Warning System





## An Augmented Conformal Head Up Display

By referencing the vehicle AND the driver's eye position within an accurate digital map, one can accurately recreate the field of view from the driver's eye perspective.



System allows all lane boundaries and obstacles to be drawn and projected in real time on a virtual screen 10 meters in front of vehicle (to reduce eye fatigue)

## Bus – Driver Interface

### How do drivers best receive relevant information?

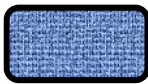


Head Up Display for vision enhancement & fwd collision avoidance

Graphical display for fwd & side collision avoidance

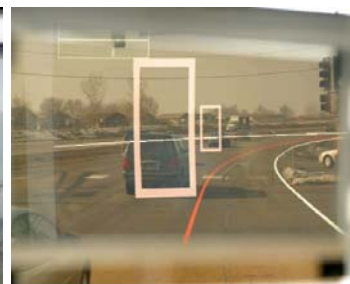
Torque feedback for lane departure prevention

Tactile seat for lane departure prevention (directional “buzzing” of seat cushion)



## Video through Head Up Display on MN Hwy 101

Day time view to show accuracy of projected lane markings



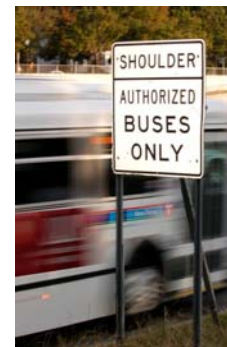
## MVTA Bus 2.0 is a driver assist system



**IBEO Lux LIDAR**  
25 Hz  
Tracks 64 targets  
4 laser planes

## Economic Benefits of Bus Only Shoulder BRT: Capital Cost Comparison

- LRT projects vary in cost from \$15 million to \$100 million per mile, with the average cost per mile approximately \$46 million
- Cheapest BRT option - \$2.5 million to \$2.9 million per mile, mixed flow with general traffic, excluding any cost associated with acquiring the right of way.
- **Bus Only Shoulder BRT in the Twin Cities range from as little as \$1,500 per mile to \$200,000 per mile (2007 dollars: avg \$150,000 per mile)**
- Potential benefits: Maximize road capacity of regular lanes



## DGPS-based Driver Assist Deployment; Testing Nationwide

- ◆ Snowplows & Airport Rescue and Firefighting (ARFF) Vehicles
  - ❖ 2 plows in Minnesota (Polk County)
  - ❖ In operation on snowplow & blower in Alaska since 2004
  - ❖ 2 ARFF in Deadhorse Airport; just deployed on 5 plows & blowers in Alaska (August 2011); 3 planned for 2012 in California (I-80 along Donner Pass)
- ◆ Buses
  - ❖ 10 buses operational since Nov, 2010
  - ❖ 2 more to be added shortly
- ◆ High Accuracy Digital Maps
  - ❖ Over 400 Miles



## States and Counties as Source of High Accuracy Lane Boundary Maps

Add Hi-accuracy DGPS to lane strippers.  
Result: A lane boundary digital map that can lead to more efficient lane striping and new Lane Departure Warning Systems.

- ◆ Minnesota has 134,000 miles of public roads (1/2 gravel)
- ◆ Mn/DOT stripes 12,300 center line road miles
- ◆ Equivalent to 36,900 line miles (actual painted line, not including gaps)
- ◆ Minnesota paints 24,000 line miles per year on average (5,600 line miles in the metro area alone)



## Coordination with Model Inventory of Roadway Elements (MIRE) FHWA Office of Safety

- ◆ Recommended listing of roadway inventory and traffic elements critical to safety management.
- ◆ Guideline to help transportation agencies improve their roadway and traffic data inventories.
- ◆ Provides a basis for a standard of what can be considered a good/robust data inventory and helps agencies move towards the use of performance measures.
- ◆ Need for improved and more robust safety data is increasing due to the development of a new generation of safety data analysis tools and methods.



## FHWA requires Accessible Pedestrian Signals (APS) from Maryland (2005)

“The ADA regulations at 28 Code of Federal Regulations Part 35.130(b)(1)(iii) requires that the aids, benefits, or **services provided to individuals with disabilities must be as effective** in affording equal opportunity to obtain the same result, to gain the same benefit, or to reach the same level of achievement **as those provided to others.**”

The FHWA finds that **“the lack of accessibility for blind pedestrians is a violation of the ADA.”**

<http://www.acb.org/pedestrian/fhwa-letter-concerning-aps11.html>



## Challenges when Crossing

- ◆ No a priori intersection geometry information
- ◆ Locating edge of street
- ◆ Locating crosswalk
- ◆ Interpreting signal & traffic patterns
- ◆ Aligning toward crosswalk
- ◆ Locating pushbutton, if it exists
- ◆ Determining when to cross
- ◆ Maintaining alignment while crossing



## Concerns about APS

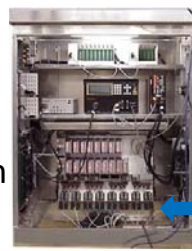
- ◆ Costs - \$6,000+ per intersection plus labor
- ◆ Noisy - adds 5 decibels of noise within 6 to 12 feet of pushbuttons
- ◆ Require additional stub, pushbutton station poles
- ◆ No standard pushbutton location
- ◆ Maintenance issues
- ◆ Braille verification



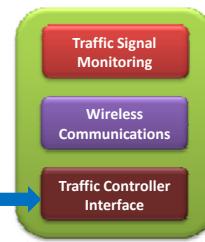


## Mobile Accessible Pedestrian Signal (MAPS) Prototype

- ◆ Integrate GPS, digital compass, accelerometer sensors and digital map on smartphone
- ◆ Wirelessly communicate with traffic signal controller
- ◆ Include Bluetooth geo-ID to correct GPS location at intersection
- ◆ User's interface:
  - Text to speech
- ◆ Only need single/double tap on smartphone screen



Traffic Controller Cabinet



Sniffer System



Text to Speech  
Digital  
Compass

## ITS and EMS: 'CrashHelp'

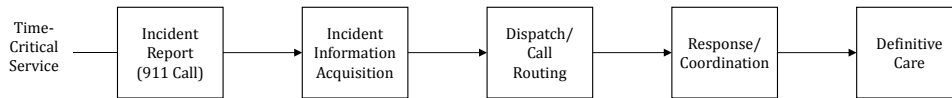
- The four "E's" of transportation safety (USDOT, 2006)
  - Education, Engineering, Enforcement, Emergency medical services (EMS)

**"EMS is the Safety-Net of Transportation, it needs to be there when the other three E's fail"**

- Idaho EMS Director

- ITS is needed to:
  - Support the end-to-end emergency response process
  - Provide information that can be used at the point of care, as well as to guide traffic safety analysis and improvements.

## Technology and EMS: 'CrashHelp'



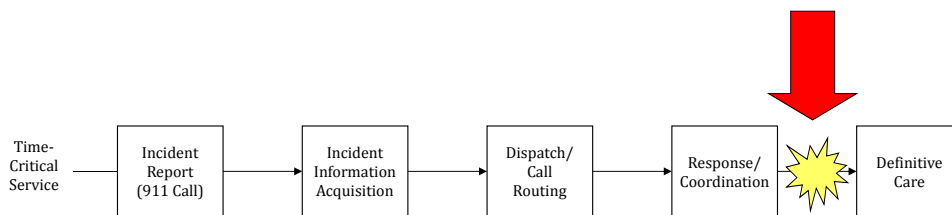
- NextGeneration 911
- IP telephony
- AACN
- Mobile phones

- Computer Aided Dispatch (CAD)
- GPS/AVL/GIS
- Navigation
- Pagers, cell phones
- Interoperable 2-way radios

- e-Patient care records (PCR)
- Hospital availability/diversion systems
- Patient tracking systems

- Many existing and emerging technologies

## Preliminary Research Findings



- Major Gaps - Information exchange from **pre-hospital** to **hospital**


CRASH  
HELP
A MOBILE & MULT-MEDIA EMS APPLICATION

## CrashHelp System Prototype


+



**For: EMT's / Paramedics in the field**  
Google Android Compatible Phone  
Android Application


**For: Emergency Department / Trauma Center**  
Web based interface



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## Mobile Phone App

- Allows for Secure Transmittal of Voice, Video, and Data From Crash site to ER
- Record/transmit audio messages, including for example:  
Vitals, Origin of incident, Mechanism of injury, Treatments given, Other: e.g., patient history
- Transmit pictures and video






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## Pilot Test & Evaluation Underway in Idaho

### Evaluation Metrics Being Assessed

- ◆ Improved information collection by on-scene EMS personnel
- ◆ Improved communication between pre-hospital transport and hospital organizations (ED / Trauma)
- ◆ Improved care decision making by hospital personnel (for some incidents)
- ◆ Improved resource utilization by hospital personnel



## Research – Prototypes – Commercialization - Jobs Technology Transfer

### Moving university research to deployment, will need:

- ◆ Funding for statewide and national prototype testing. Risk management.
- ◆ Venture capital for start-ups
- ◆ “Marketing” to technology deploying organizations – state DOTs, transit agencies, driver & vehicle licensing agencies, insurance companies, etc.
- ◆ “Marketing” to identify companies looking for new products
- ◆ Identification of prospective CEO’s who can build start-up
- ◆ Unique problems in transportation field. Compare to medical devices
- ◆ Firewall between research design and testing and the licensee to prevent conflict of interest
- ◆ Design of conflict of interest policies
- ◆ Don’t want researchers to leave and join startup/licensee



## The University's OTC recently signed licensing agreement with startup company (SMART Signal Technologies)

University news release on Nov 1:

[http://www1.umn.edu/news/news-releases/2011/UR\\_CONTENT\\_361757.html](http://www1.umn.edu/news/news-releases/2011/UR_CONTENT_361757.html)

Other news stories on the start-up:

- ◆ Pioneer Press, "U hopes tech will smarten traffic," November 2, 2011.
- ◆ Minneapolis/St. Paul Business Journal, "U of M startup thinks it can fix traffic jams," November 1, 2011.
- ◆ TECHdotMN, "U of M licenses traffic system IP to local startup," November 1, 2011.



## ITS Institute Educational Initiatives

### K-12 Outreach Activities

**Curriculum development to support transportation education**

### Summer Camps:

National Summer Transportation Institute  
U of M College of Science and Engineering Summer Camps

### Career video:

<http://www.its.umn.edu/Education/careers/video/>



## Gridlock Buster

- ◆ Traffic Control Game and Curriculum
  - Web-based; over 3 million hits online
  - <http://www.its.umn.edu/GridlockBuster/>
  - Teaches HS students about traffic engineering
  - Also available as download for classes and summer camps

