Developed for the
ITS Joint Program Office

ITS Grand Challenges: How Can You Help Meet Them?

ITE Student Chapter Series

The Ultimate ITS Vision?

- There is no consensus vision . . .

Image Source: ThinkStock/USDOT

- "Toward Zero Deaths" is a universal aspiration

TZD Toward Zero Deaths®
National Strategy on Highway Safety

- And most agree that the world of
  - Connected and
  - Autonomous Vehicles

is coming

Image Source: ThinkStock/USDOT

The Ultimate ITS Vision?

- But will this ultra-high tech, hyper-connected world be –
  - Livable?
  - Human scale?
- And will it be characterized by –
  - Social justice?
  - Environmental stewardship?

Image Source: ThinkStock/USDOT

Where We Stand

- Much of the foundational technology is in place
- Yet significant challenges remain

- There are still significant technological advances needed
- There are still significant institutional impediments

Image Source: ThinkStock/USDOT

Grand Challenges

- Refining the vision and making it reality will be challenging
- It is not a stretch to say Grand Challenges must be overcome
- Core ITS professionals must lead on challenges related to –
  - Technology
  - Human factors

- ITS professionals must play key supporting roles on challenges related to institutional issues such as –
  - Policy development
  - Risk assessment and management
  - Legal framework evolution
  - Liability and insurance system revolution

Image Source: ThinkStock/USDOT

Grand Challenges in Technology

- Big Data Management and Analytics
  - Wireless network capacity
  - Data fusion
  - Data mining
  - Accurate metrics for system benefits and costs
  - High fidelity, real-time, regional-scale modeling

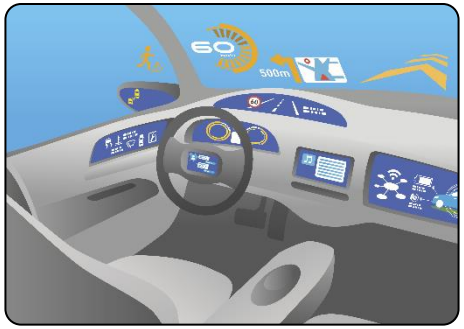
- Data and system security
  - Sensitive and personal data security
  - Protection against malicious system attacks

- Achieving the system reliability needed for wide spread autonomous vehicle use

Image Source: ThinkStock/USDOT

Grand Challenges in Human Factors

- In the pre-autonomous, connected vehicle era –
  - “Connecting” vehicles without overloading drivers
  - Providing information in ways that are quickly and accurately understood



- Entering the fully-autonomous vehicle era –
  - Managing the transition from the driver perspective
  - Training in system operation
  - Driver takeover in emergency situations

Image Source: ThinkStock/USDOT

Institutional Grand Challenges

- Adapting public policy and laws for connected and ultimately autonomous vehicles

- Assessing and managing system risks
- Establishing new tort liability and insurance systems
- Commercial vehicle operations in the autonomous vehicle era

Image Source: ThinkStock/USDOT

Research – The Key to Addressing the Grand Challenges

- Targeted research is essential
- Basic and applied research is underway in academia and industry
- Research gaps persist
- But exciting new thrusts are beginning

Image Source: ThinkStock/USDOT

Research Case Studies

- The scope of exciting and impactful research is broad
- Three examples . . . the tip of the iceberg
  - Probe data for system monitoring and management
  - Location-based social networking for travel demand modeling
  - Google Car

Image Source: ThinkStock/USDOT

Indiana Mobility

- Researchers at Purdue are using high definition probe data from INRIX to produce powerful visualization tools for Indiana

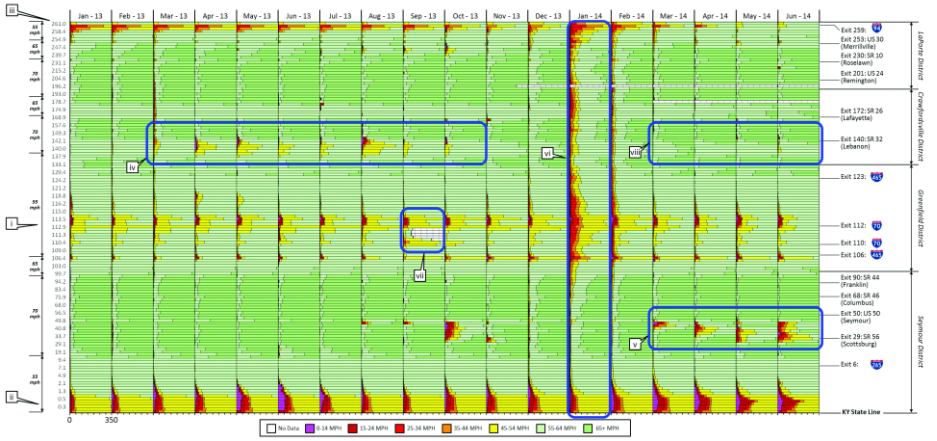
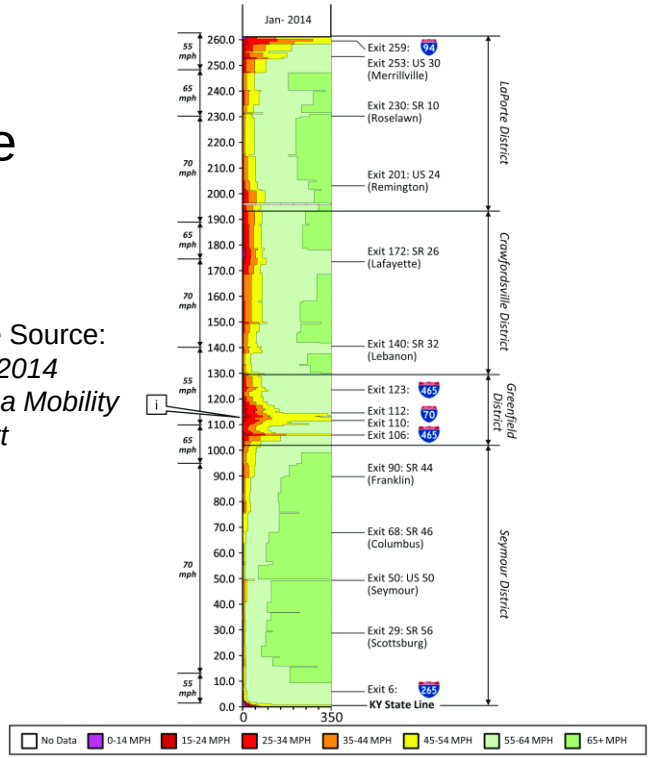


Figure 8. Speed profiles for southbound I-65, January 2013-June 2014.

Image Source:
2013-2014 Indiana Mobility Report



- The research also includes major work zone monitoring and operational support

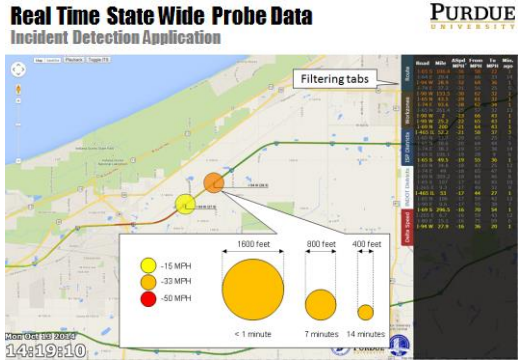


Image Source: Purdue University

Location-Based Social Networking (LBSN)

- Researchers at UT-Austin and Rutgers have been exploring the power in Foursquare™ data
- Results have been published on using the data to estimate urban origin-destination patterns
- Potential for fusing data across multiple LBSN providers is huge
- Privacy and safety issues must be addressed

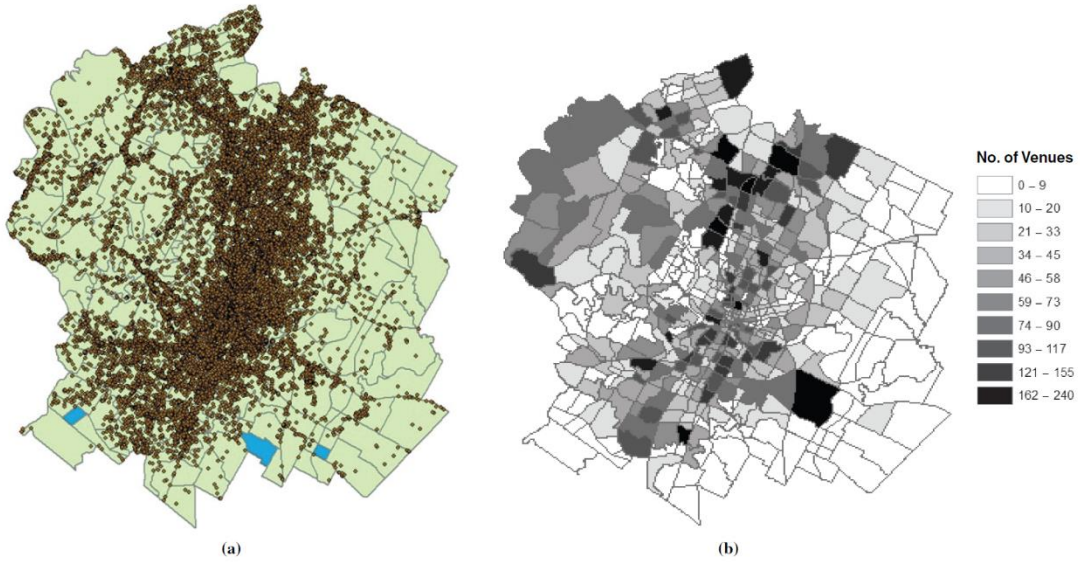


FIGURE 2 Venue locations within study area by (*a*) individual location and (*b*) density (no. = number).

Image Source:

Jin, P.J., et al., "Location-Based Social Networking Data Exploration into Use of Doubly Constrained Gravity Model for Origin–Destination Estimation," *Transportation Research Record: Journal of the Transportation Research Board, No. 2430*, Transportation Research Board of the National Academies, Washington, D.C., 2014, pp. 72–82.

Google Car

- The most visible of the autonomous vehicle research efforts
- Fully-autonomous

- Testing is –
  - Legal in four states
  - Underway in Mountain View, CA and Austin, TX
  - Google says the car will be market-ready in 2020

Image Source: ThinkStock/USDOT

Research Gaps and the Big Gap

- The research examples just cited are all early stage efforts
- Other emphasis areas include commercial vehicles, transit, etc.
- Gaps exist in all areas
- A persistent soft-side gap is the need to develop a clear vision of the “Smart City” of the future
  - This vision will guide all other efforts
  - Developing this vision should be a priority
  - Collaboration across many disciplines is needed

Image Source: ThinkStock/USDOT

Emerging Research Thrusts

- Three examples of cutting edge ITS research that are truly breaking new ground
  - Advanced Research Projects Agency-Energy (ARPA-E) TRANSNET research program
  - Simulator-based research on driver emergency takeover in autonomous vehicles
  - Electric autonomous taxi systems

Image Source: ThinkStock/USDOT

ARPA-E's TRANSNET Program

- **A**dvanced **R**esearch **P**rojects **A**gency-**E**nergy
- **T**raveler **R**esponse **A**rchitecture using **N**ovel **S**ignaling for **N**etwork **E**fficiency in **T**ransportation (TRANSNET)
  - Five awards totaling $14.5 million
  - Research teams will create control architectures to encourage energy saving travel behavior
  - University of Maryland National University Transportation Center Team
    - *Integrated, Personalized, Real-time Traveler Information and Incentive* (iPretii)

Image Source: University of Maryland National Transportation Center - http://ntc.umd.edu/

Emergency Takeover in Autonomous Vehicles

- What will happen when things go wrong in a self-driving car?
- Some visions include the need for travelers to take over driving
- This will be an entirely new travel situation

- Researchers in NC State's Department of Psychology are investigated emergency takeover using a driving simulator

Image Source: ThinkStock/USDOT

Autonomous Electric-Vehicle Taxis

- Imagine Uber with no drivers or exhaust

- Researchers at UT Austin and Lawrence Berkeley National Laboratory have found that the environmental and energy benefits could be huge

- The UT Austin researchers also investigated methods to model the impact of various vehicle staging schemes

Image Source: ThinkStock/USDOT

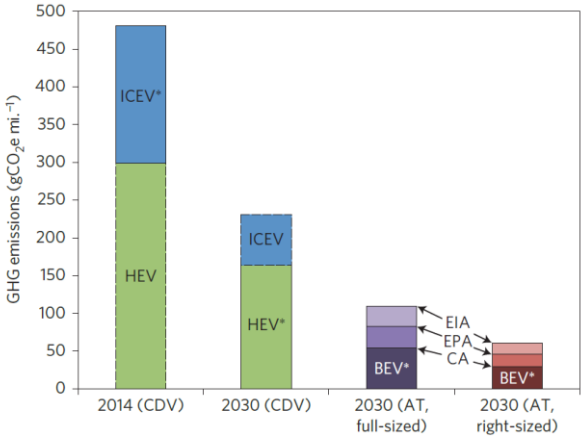


Figure 3 | GHG emissions intensities per mile for CDVs in 2014 and 2030, and ATs in 2030. Cost-optimal vehicle technologies indicated by asterisks. Both full-sized (purple) and right-sized (red) ATs are shown, each with three sets of electricity GHG intensity assumptions. Right-sized ATs have per-mile GHG emissions intensities 87–94% below 2014 ICEVs, and 63–82% below 2030 HEVs, depending on electricity GHG intensity.

Source:
Reprinted by permission from Macmillan Publishers LTD: Nature Climate Change, Greenblatt, J.B. and S. Saxena, "Autonomous taxis could greatly reduce greenhouse-gas emissions of US light-duty vehicles," *Nature Climate Change* 5 (2015): 860-63.

Joining the Grand Challenge Team

- The opportunities are vast and continuing to grow
- There are many ways to get in the game
  - See what the major research funding agencies are supporting
  - See what the major industry players are saying and doing
  - Search and read
  - Ask questions
  - Think big

Image Source: ThinkStock/USDOT

Joining the Grand Challenge Team

- Find an intersection between your skill set and a challenge that piques your interest
- Identify the academic and industry research programs that are seriously working to meet the challenge
- Create and execute an education plan to prepare you for the research
- Go for it!

Image Source: ThinkStock/USDOT