THE GOLDEN AGE OF TRANSPORTATION

2013 ITS Maryland Annual Meeting

October 9, 2013

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Opening of Ohio and Mississippi Rivers by Corps of Engineers in Early 19th Century

- Infrastructure construction = 100 percent federal from \textit{general revenue}
- Infrastructure maintenance = 100 percent federal from \textit{general revenue}
- Vehicles = 100 percent private
- Led to rapid development of the Mississippi Valley and land west of the Appalachians
Brief History of Past Transportation Networks

Transcontinental RR

- Last half of 19th century
- Infrastructure construction = 100 percent private
  - Partially funded by land grants = at least 8 percent of US continental land mass given by federal and state government
  - Federal government received rebates into the 20th century
- Infrastructure maintenance = 100 percent private
- Vehicles = 100 percent private
Brief History of Past Transportation Networks

**Interstate Highway System**

- **Mid 20th century**
- **Infrastructure construction = state DOTs**
  - 90 percent funded by federal benefit taxes
  - Infrastructure maintenance = state DOTs
- **Vehicle = 100 percent private**
- **Changed US economic and social structure**
Lessons Learned

- National scale investments have profound impact on economic growth and productivity
  - Interstate generated 50-60% annual rate of return over two decades
  - Accounted for 1/4 of total US growth in economic productivity – all from just 4 cents per gallon!
- Similar scale of impacts from internet and wireless telecommunications
- Each has a different combination of public (federal and state) and private roles
- The next big breakthrough will not look like the past
Current Situation

- Urban congestion is major economic problem
  - More than cost of time and fuel
    - Harms access to jobs / labor / markets
- More than 32,000 highway deaths and 6 million crashes each year
  - 93 percent due to human error
- Traditional funding sources are weak
  - Slow economic growth
How Do We Solve This Problem?

- New model: Autonomous vehicles
  - 100 percent private vehicle
  - Zero percent infrastructure investment
  - Connected vehicles a positive variation
- Reduce accidents – approach zero deaths??
  - Important side benefit = fewer non-recurrent delays
- Reduce headways – more vehicles per lane per hour
  - 30-80 percent decrease in headways
  - Double capacity – or better.
- How soon will the magic happen?
Vehicle Technology

- Google car most famous example, but almost all auto firms and suppliers are active
- Related technology already being deployed
- When will autonomous cars be sold?
  - Google = 2017
  - Tesla = 2017
  - Nissan, GM say 2020
- But not all autonomous cars are equal
NHTSA’s Four Levels of Automation

**Level 0**
No Automation
No steering or braking/throttle control. e.g., crash warning systems, including V2V applications.

**Level 1**
Function Specific Automation
Braking/throttle and/or steering control, but not designed to work in combination to enable hands free/foot off pedal operation. e.g., automatic braking systems, lane keeping systems.

**Level 2**
Combined Function Automation
Integration of braking, throttle, and steering control designed to enable “hands free/foot off pedal operation”. • Driver available at all times to retake control.

**Level 3**
Limited Self Driving Automation
Integration of braking, throttle, and steering control. • Driver expected for occasional control. • Driver can cede full monitoring and control authority.

**Level 4**
Full Self Driving Automation
Integration of braking, throttle and steering control. • Driver NOT expected for control. • Responsibility for safe operation is solely rests with the vehicle.
Bosch’s View of the Four Levels
A Network View of Vehicle Technology

- Safety improved
- Delays due to congestion down
- Reliability up
- Needs down
  - All with no new public spending
- Spending gap still remains, but should be in reach
- Reduced congestion
  - Improve access to jobs/labor/markets
  - Productivity grows by 2 percent for every 10 percent increase in speed
- Economic benefit of self driving vehicles could be much larger than the Interstate!!
Implications for Maryland

- Medium and long-range plans need to recognize new vehicles
  - How soon will new vehicles deploy and what level of autonomous vehicles?
  - Fewer capacity problems
  - Funding gap shrinks
- Can Maryland become a self driving vehicle technology center?
  - Car companies need real-world test beds – not just a test track or an old air force base or parts of the Interstate
  - Can Maryland find a willing location with:
    - Arterials and access to Interstate
    - Nearby universities