A Vision for Automotive CPS

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Automobiles and Societal Impact

• About 40,000 people are killed and 3 million people are injured every year in the US alone in automobile accidents.

• Globally,
  – Road traffic injuries is **the leading killer** of people aged 10 to 24.
  – About **400,000 automobile fatalities** every year.
  – **Annual cost** of road injuries in medical care, disability and property damage is **$518 billion**.

• Traffic congestion:
  – The average US driver spends **a week stuck in traffic per year**.
  – In the **EU, 80 billion euros wasted per year** due to traffic congestion.

• Independence?
  – For women, **10 years of transportation dependency** (95 - 85)
CMU’s Tartan Racing Wins Autonomous Driving Urban Challenge
Intermediate Milestones

• Pedestrian, child, bicyclist or animal **warnings**
• Part-time chauffeuring
  – Virtual Valet
  – Highway Chauffeur
  – Traffic jam Chauffeur
• Dependable, safe and real-time embedded **computing** and communications
• **Cables** (tend to) **go away**
What’s Ahead?

• **External**: Complexity and *uncertainty in the environment*
  – Weather, lighting, and road conditions; construction; accidents; and obsolete information.

• **Internal**: *Online and safe recovery* from failures of sensors, actuators, computing or communications.
  – Sensors
    • Calibration, wear and tear, failures.
    • Occasional loss of GPS

• **Vehicular Networks**
  – communicate securely and coordinate carefully

• **Societal acceptance**
  – Reliability, cost and maintenance

• **Legal** implications

• **Incremental** deployment
Research Challenges

- **Robust perception** of a continually changing world
  - Deal with exceptions
- **Know how to behave** safely under all conditions
- Detect, isolate and **recover from failures** of sensors, actuators, computing and communications
- Diagnostics and **prognostics**
- **Verification & validation** not just of the software but of the entire system
- **Cost-effective** transducers
Broader Implications

- If a car can drive itself in relatively unstructured and uncontrolled environments and be safe,
  - **Rail**: “cars” on well-defined rails (“railroads”) with different physical dynamics
  - **Aviation**: A2A and A2I (A2X ~ V2X)
  - **Autonomous Mobile Entities**
    - Assisted living for seniors, young, the busy, the bored at home
    - Healthcare: mobile and infrastructural entities that understand, alert, alleviate and aid