Resource Provisioning and Dynamic Resource Management in Intelligent Transportation Systems

Aniruddha Gokhale
Vanderbilt University EECS
Nashville, TN, USA

Contact: a.gokhale@vanderbilt.edu

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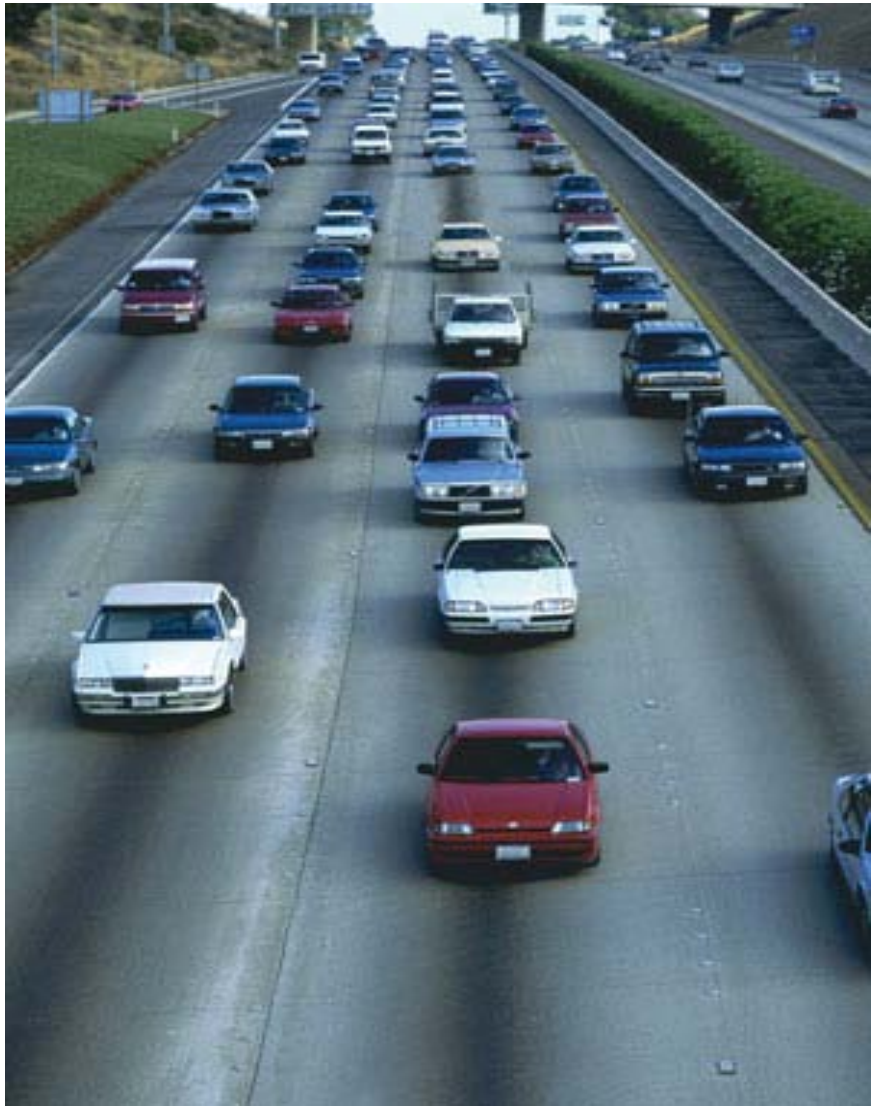
Scenario 1: Unanticipated Traffic Jams (1/2)



- Imagine heading out to work in the morning
- Traffic News on TV show no traffic problems
- You find the traffic moving smoothly at the beginning

Scenario 1: Unanticipated Traffic Jams (2/2)

- But soon you find yourself in a traffic jam
- And you just passed the exit ramp so you are stuck ☹

Scenario 2: A Dangerous Blind Curve

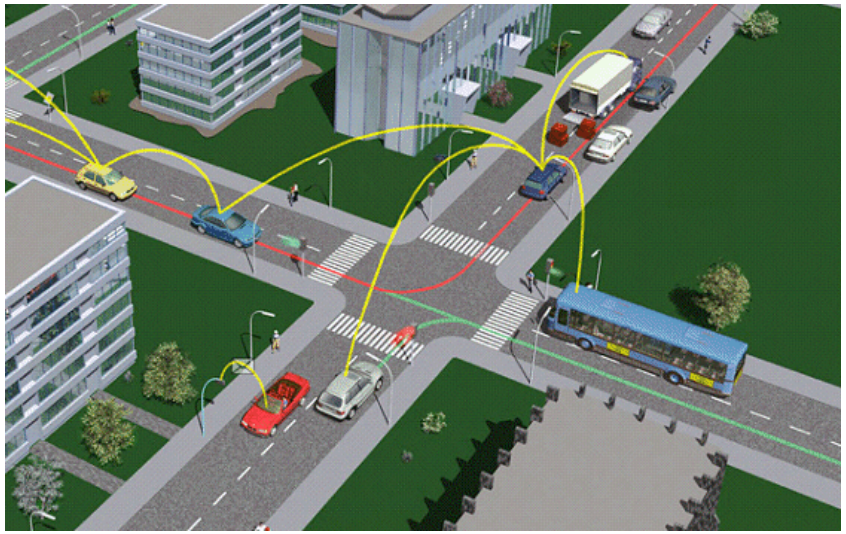
- One lane bridge
- Cannot see oncoming traffic behind the blind curve

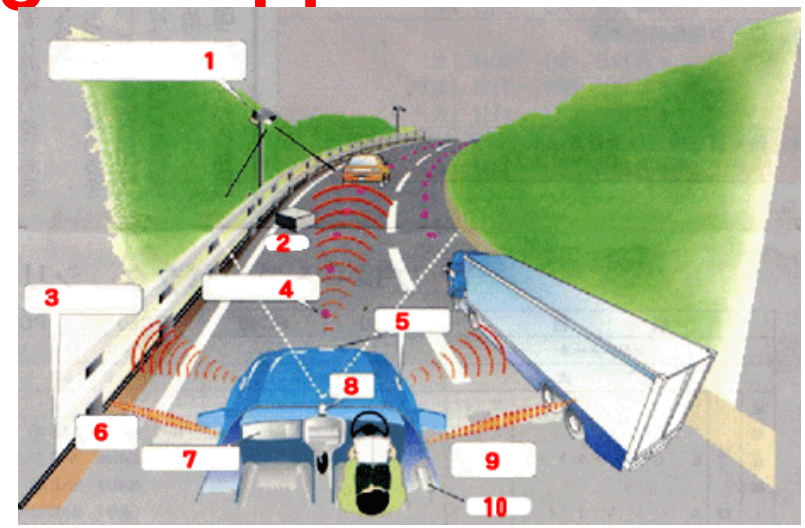
Many More Cases of Societal Impact

- ***Safety:***
  - An intersection where one road has a stop sign, and cross traffic does not stop
  - Lane changing and the “blind spot” problem
  - Collision avoidance by maintaining safe separation
  - Red light running: Traffic light shows up just behind a hill
  - Slippery and icy roads
- ***Entertainment:*** Kids in a vehicle want to watch a movie streamed over the network
- ***Maintenance:*** Monitoring vehicular health status periodically
- ***Law enforcement:*** Querying for registration and emission status

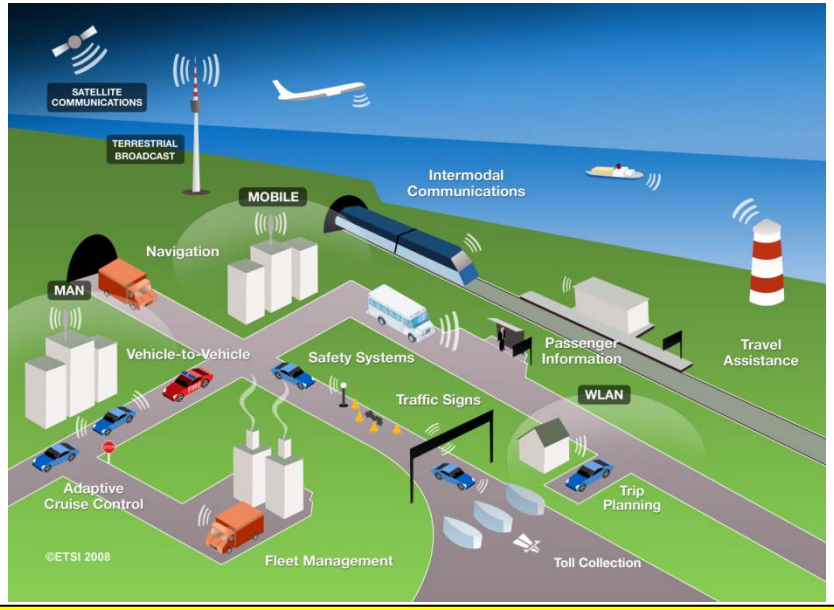
Intelligent Transportation Systems (ITS) is an emerging area of research tailored to address these requirements

Common Traits Among ITS Applications



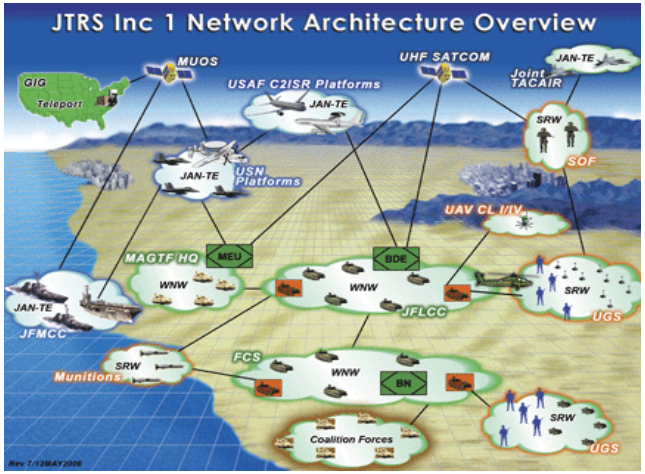


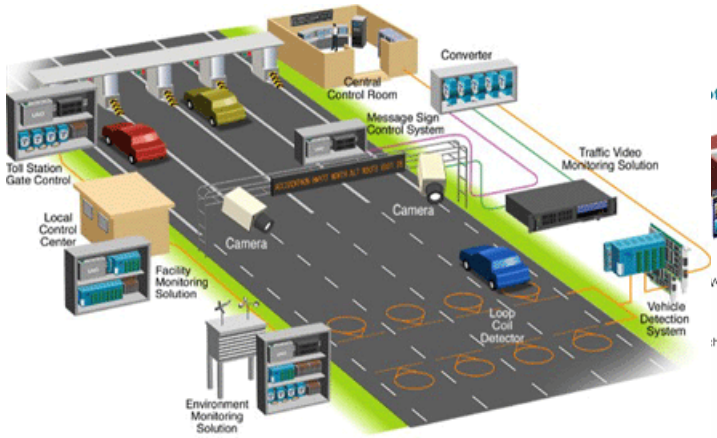
- Wireless medium, mobility => adhoc networks
- Substantial sensing and control of physical artifacts
- Real-time and reliable dissemination of information
- Unanticipated events and resource fluctuations
- Human factors

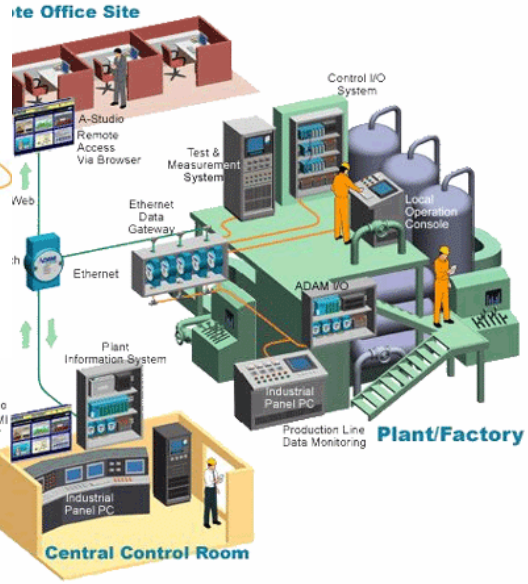


Resource provisioning & dynamic resource management is key

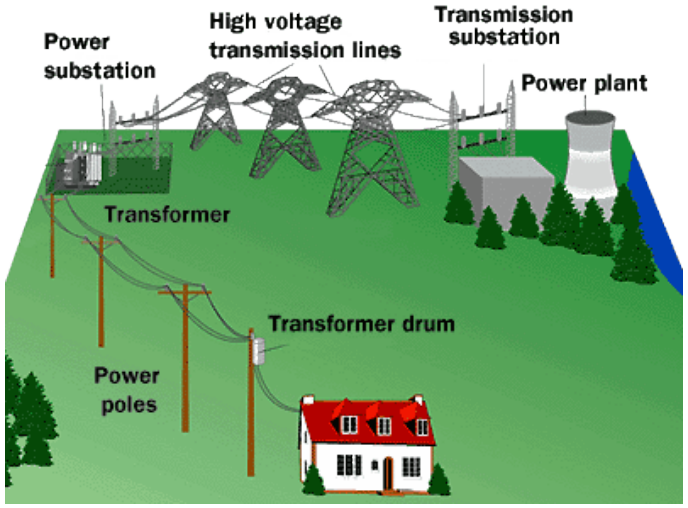
Cyber Physical Systems: A Promising Framework



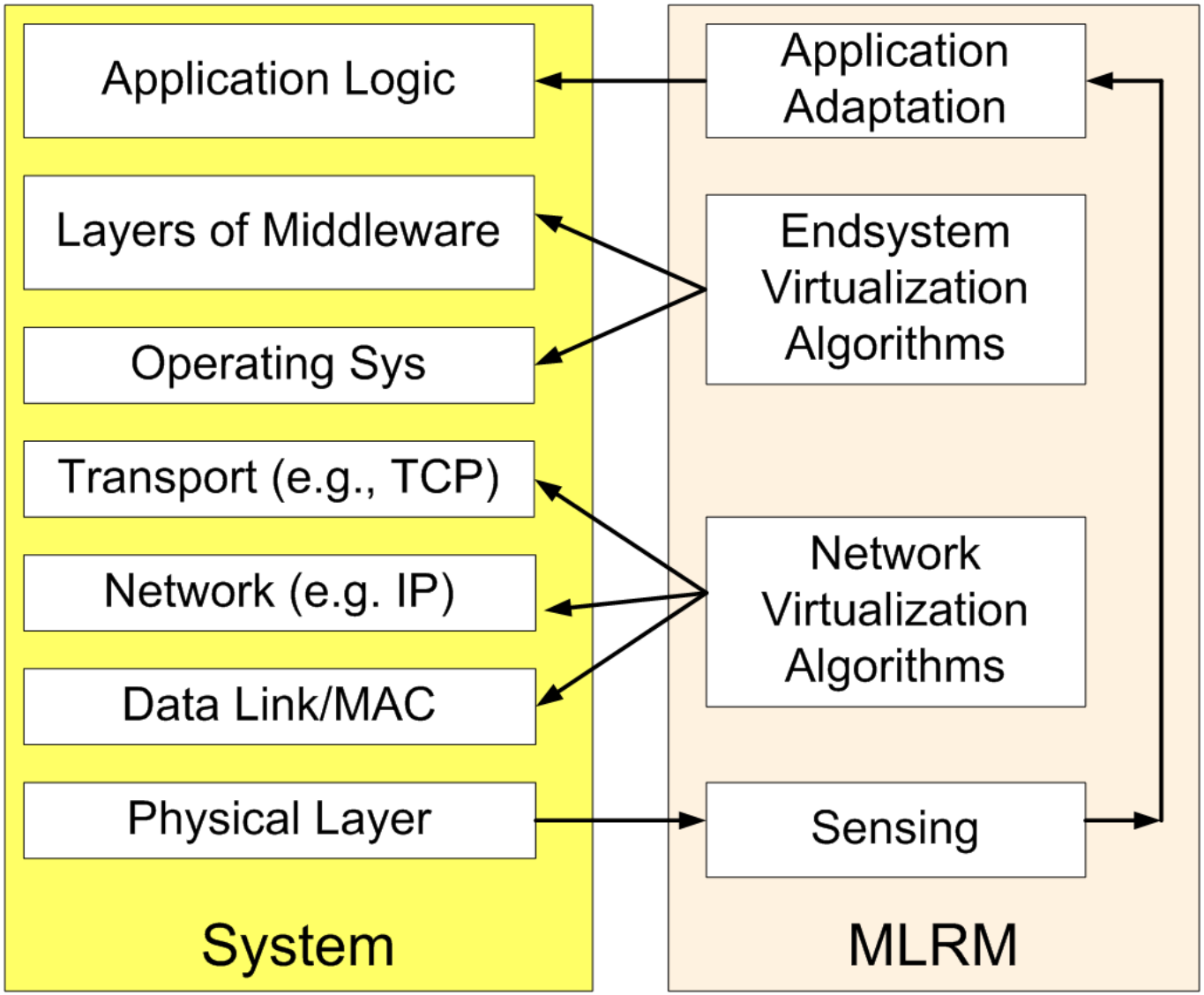




- Tight integration of cyber, networking & physics, *& even human factors*
- Software controls the physics; physics impacts software design and its operation
- Sensing & actuation
- Multiple QoS properties: real-time, fault-tolerance, security



Integrated Multi-layered Resource Management



Tight integration between multiple layers of resource management

CPS R&D is Hard

- Highly interdisciplinary – no single expertise suffices
  - Networking (wireless, mobile)
  - Sensing/control
  - Real-time, reliable computing
  - Design optimization
- Development and testing is hard – very hard to create a testbed to test the solutions
  - Need mobile devices that can be controlled
  - Networking technologies and software
- Simulations are a promising initial approach – but no single simulation tool suffices
  - Traffic modeling (e.g., SUMO does microscopic traffic modeling)
  - Network simulation (e.g., OMNeT++, NS2 for networks)
  - Embedded control (e.g., Matlab/Simulink, Ptolemy)