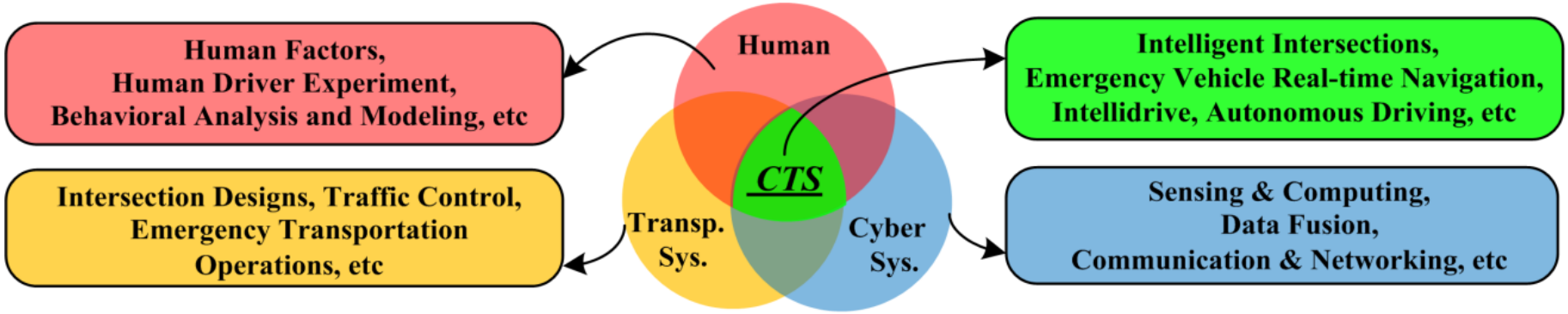
ITDNS Design and Applications (2010 – present)



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Graduate Student support (2010 – present)

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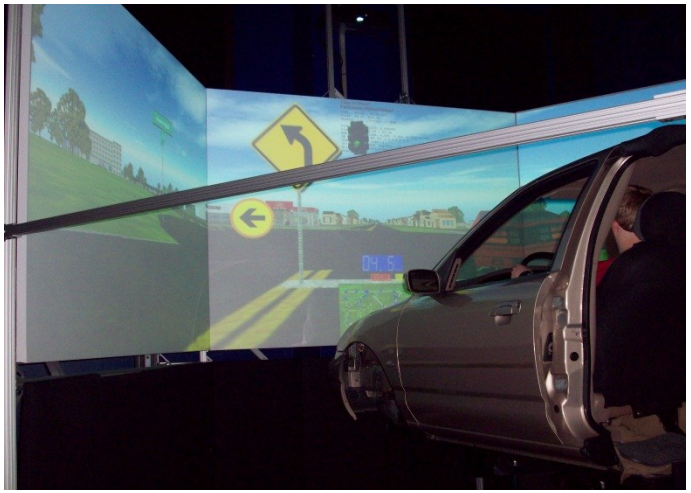
- **Civil Engineering**: Shan Huang, Yunjie Zhao
- **Industrial Engineering**: Jingyan Wan, Yiqi Zhang
- **NYSCEDII**: Ankur Bhargava, Yaqin Yang

Project Overview

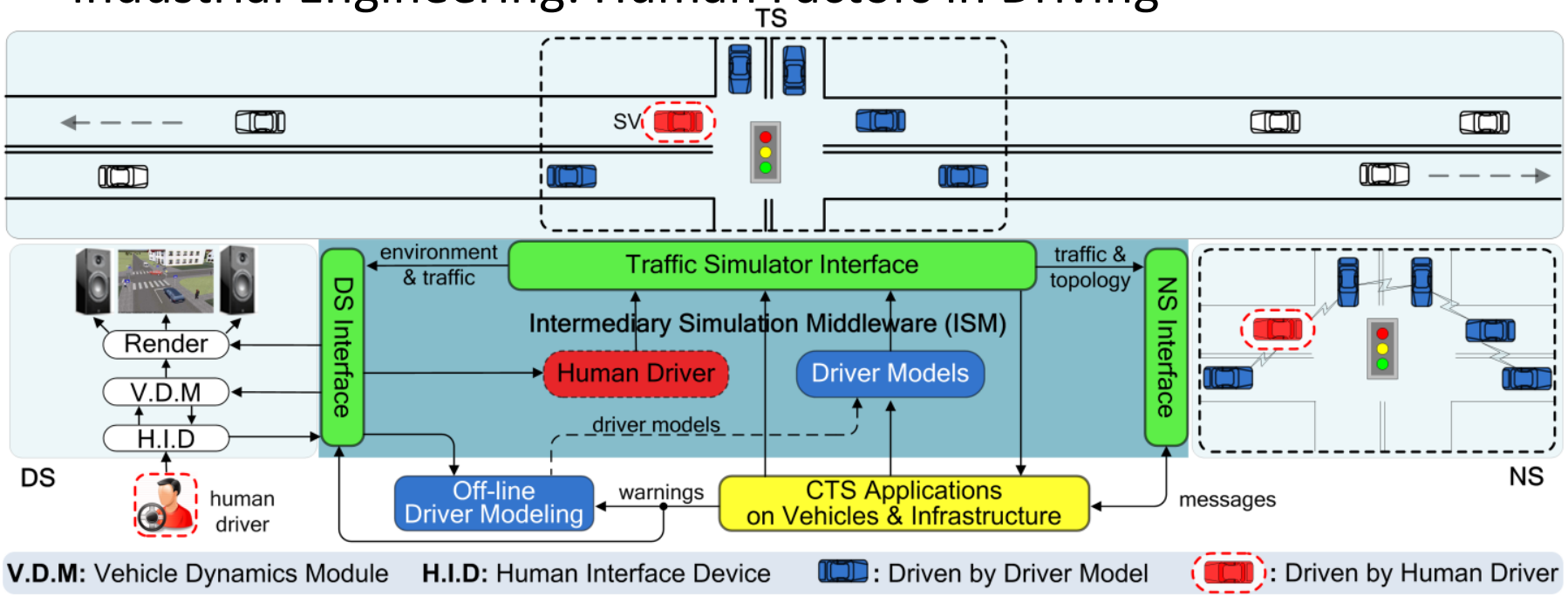
- CPS Project Context
  - ITDNS: DS, TS, NS Design
- Preliminary 3-in-1 Integration
- ITDNS Validation Study
- Future applications and development
  - 5-in-1 Integration (NSF MRI)
  - Human factors study (NSF CMII)
- Applications of Integrated Simulation
  - Teen driver training
  - Experiential learning
  - Senior driver evaluation



CPS Project Context

Vision: an Integrated Traffic-Driving-Networking Simulator (ITDNS)

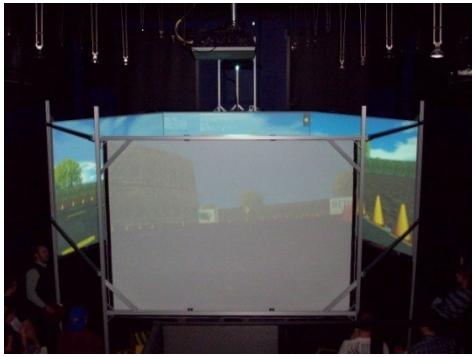
- NYSCEDII: Driving Simulator (DS)
- Computer Science: Network Simulation (NS)
- Civil Engineering: Traffic Simulation (TS)
- Industrial Engineering: Human Factors in Driving



UB DS Design

Hardware Infrastructure:

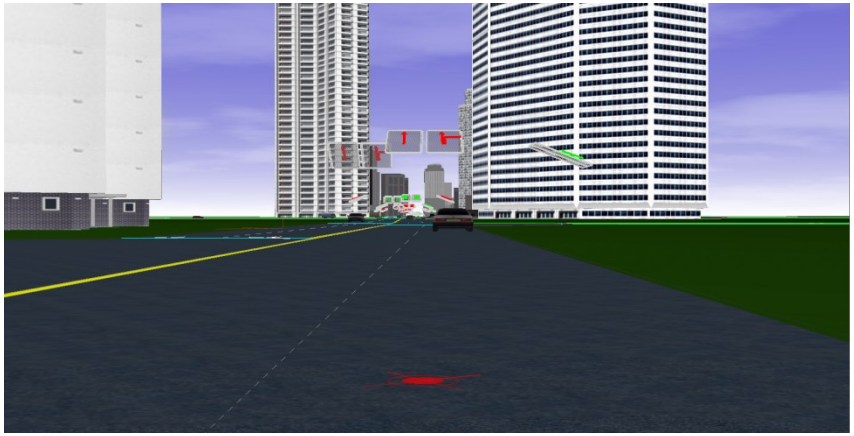
- Six D.O.F. motion platform
- 2-seater cabin
- On-board (reconfigurable) controls
- 4-screen VR environment
- 2.1 channel audio system

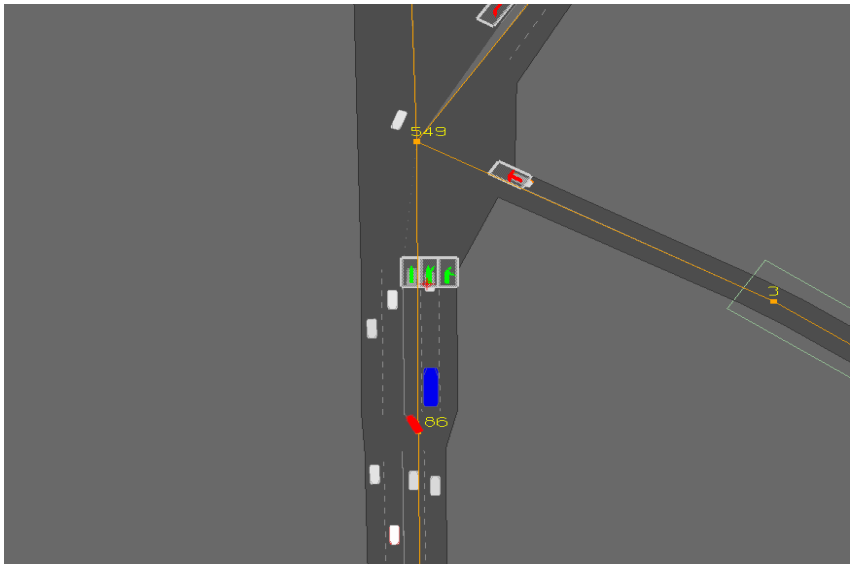


UB TS Design

Build on PARAMICS:

a microscopic traffic simulator





<u>TS features</u>:

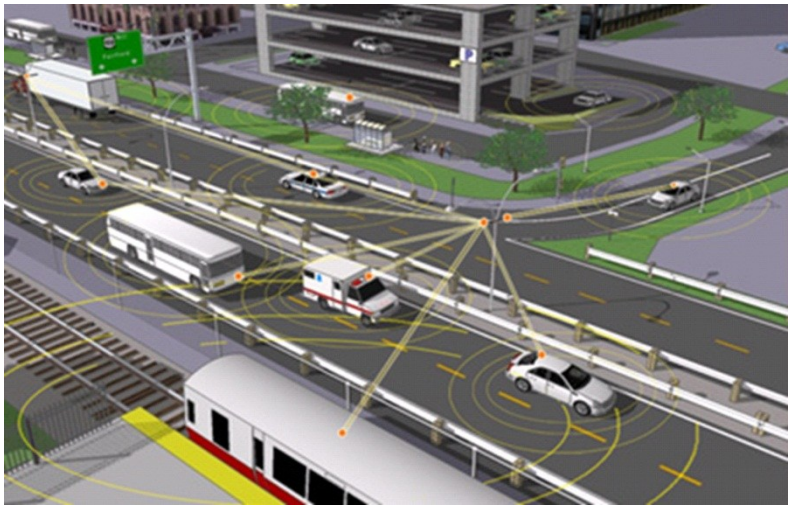
- Network Configurations
- Calibrated Traffic Demand
- Real-life Signal Timings
- Car-following Model
- Lane-changing Model
- Override PARAMICS Model:
  - e.g., break-down vehicle
  - e.g., running through red light

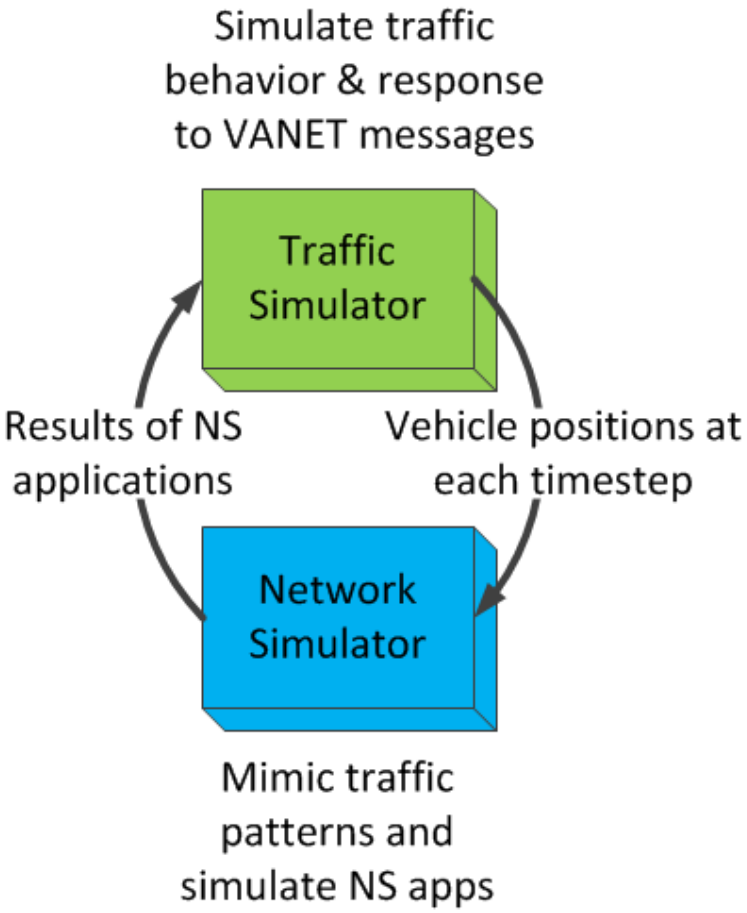
UB NS Design

Build on ns-2: a open source network simulator

NS Features

- ns-2 is highly customizable
- Both OBUs and RSUs can be simulat
- Realistic wireless simulation
- Safety and Infotainment apps





Preliminary 3-in-1 Integration

- Step 1: start TS simulation, and select subject vehicle. (*serve as input to both DS and NS*)
- Step 2: Driver Input (Steering, gas, and brake pedals), NS initialization. (*topology setup*)
- Step 3: DS analysis processing (e.g. vehicle dynamics), state outputs result (e.g. position, velocity)
- Step 4: Render motion and audio outputs, NS analysis (e.g. VANET applications)
- Step 5: serve as outputs to TS, and proceed to Step 2.

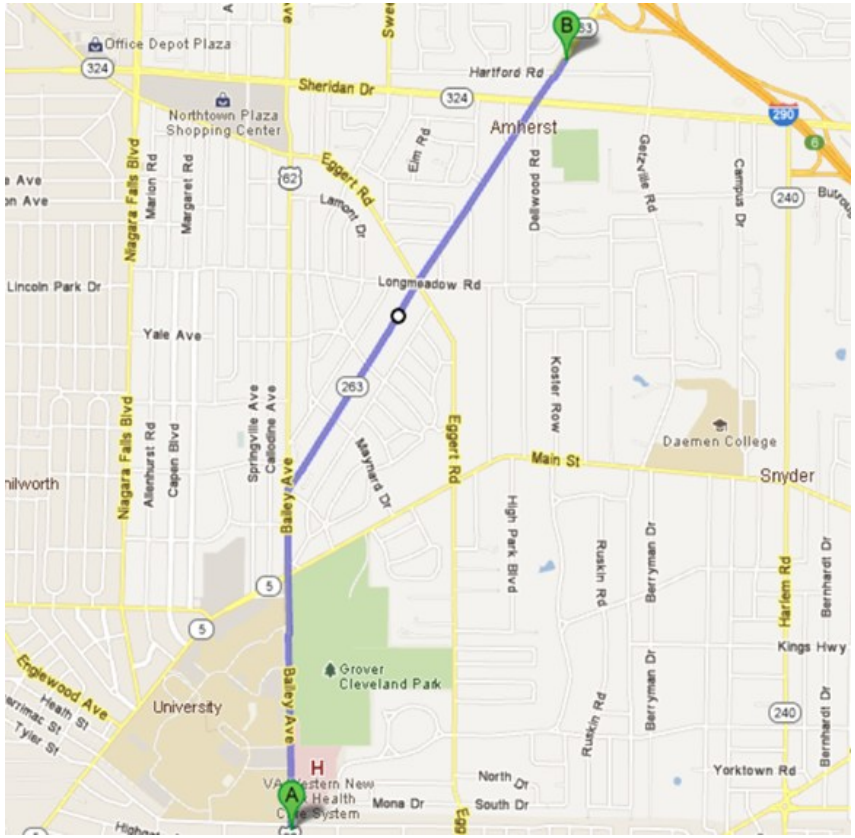
Preliminary 3-in-1 Integration

- "Subject Vehicle" (SV) speed, position, orientation are overridden by the actions of the live driver
- SV is surrounded by other traffic vehicles whose behaviors are dictated by the TS
- Background traffic now responds in real-time to the actions of the live driver, a feature often lacking in stand-alone driving simulator implementations
- NS can attain real-time traffic and topology information to build a realistic simulation scenario, a feature ideal for vehicular network and human factor studies.

ITDNS Validation Study (2012-2013)

- **Study Details**:
  - 2.3 mile corridor
  - Buffalo, NY
  - 11 traffic signals
- **Objectives:**

- Drivers drive BOTH physical roads and the ITDNS simulation of the same roads
- Compare performance, virtual to physical, to fine tune and "validate" simulation
- Determine impact of factors (years of driving experience, congestion levels) on metrics



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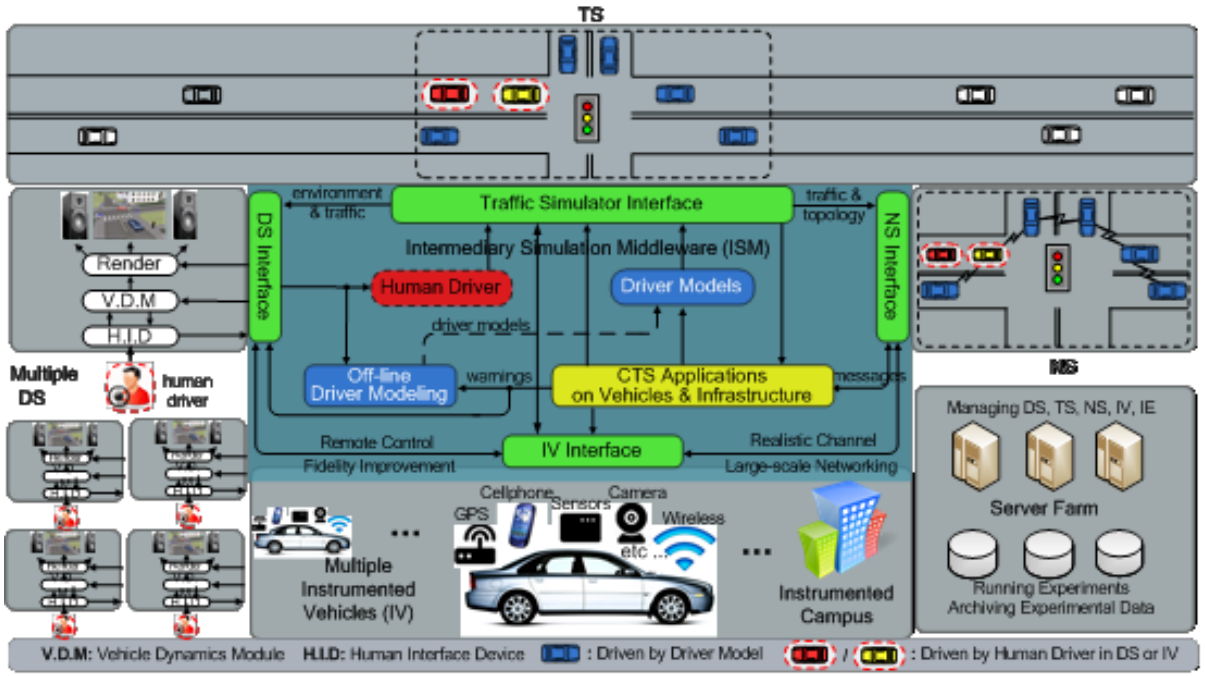
“5-in-1” Integration

NSF MRI: IMPRESIVE (Interdisciplinary, Multi-modal and Partial Reality Experimental System with Instrumented Vehicles and Environment)

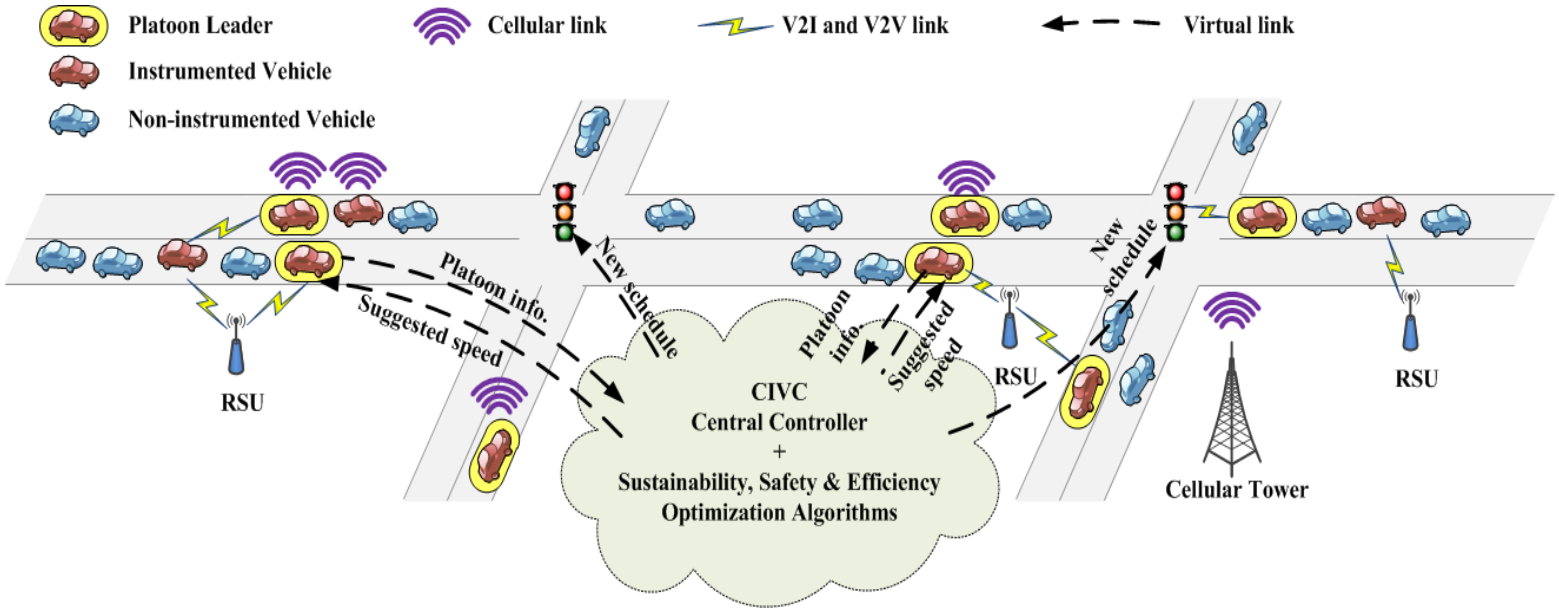
- Extend ITDNS with Instrumented Vehicles and Environment
- This becomes a “5-in-1” integrated simulation environment



Human Factors Analysis

NSF CMII: Make use of the ITDNS (and its evolving capabilities) to study "Eco-signals"

- Focus on the notion of co-operative vehicle-intersection control for sustainability (CVIC-S)



Teen driver training

- Traffic accidents: the leading cause of death (teens aged 16-20)
- Use integrated simulation capabilities to assist teen drivers with early supplementary driver training

Experiential Learning

- Use integrated simulation capacity to demonstrate (in situ) to young scientists and engineers about the dynamics of vehicles

Senior driver evaluation

- Driving capacity is known to decline with age (e.g., vision, cognition, reaction time)
- Integrated simulation can serve as a useful suite of tools for evaluating driver skill for those aged 65+

In-Vehicle

+

In-Simulator

=

Overall Assessment