GENI-Enabled Vehicular Sensing and Control Networking: From Experiments to Applications

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Overview

Context

- Road vehicle transportation has become a major source of societal concerns
- Next-generation vehicles will cooperate with each other and with transportation infrastructures to improve transportation safety and efficiency
- Large-scale, permanent deployment of research-only vehicles infeasible in general
- High-fidelity and at-scale emulation as a via enabler for innovation in vehicular sensing and control networking

Project Objectives

- To enable evaluating Vehicular Sensing and Control (VSC) networking solutions in a wide range of scenarios and at scale
- To bridge the GENI and VSC research as well as application communities for self-sustaining GENI development
- To evaluate the design and implementation of GENI

GENI-Enabled Vehicular Sensing and Control Network Emulation
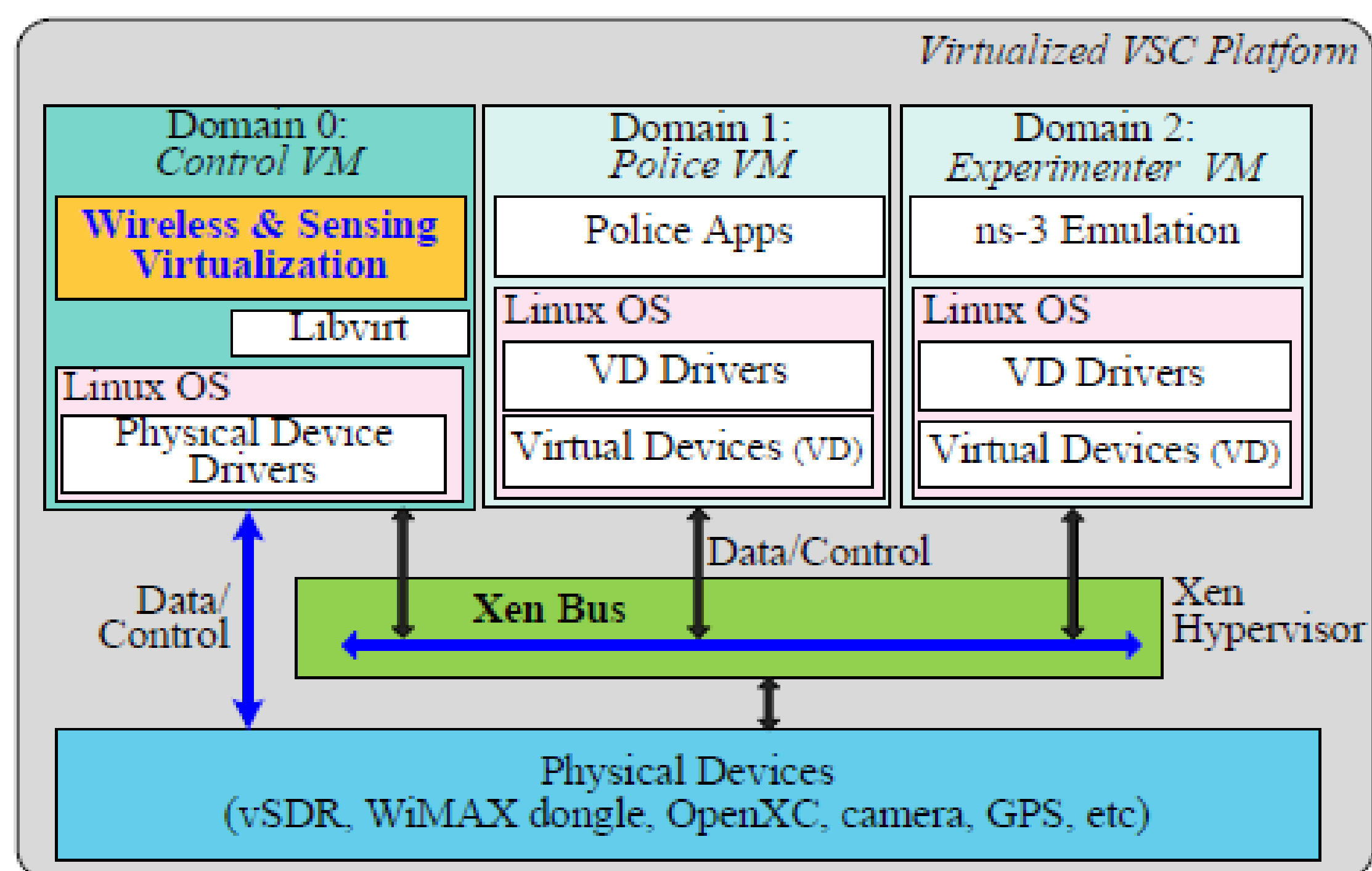
Expected Contributions to GENI

- New GENI capabilities: virtualized VSC platform, real-world vehicular sensing
- Stress-test GENI capabilities: WiMAX, rack, VLAN, VSC platform, ORCA, OMF, etc
- Create the technology foundation and community structure for self-sustaining development of GENI
- Stimulate community efforts for using GENI in VSC networking research
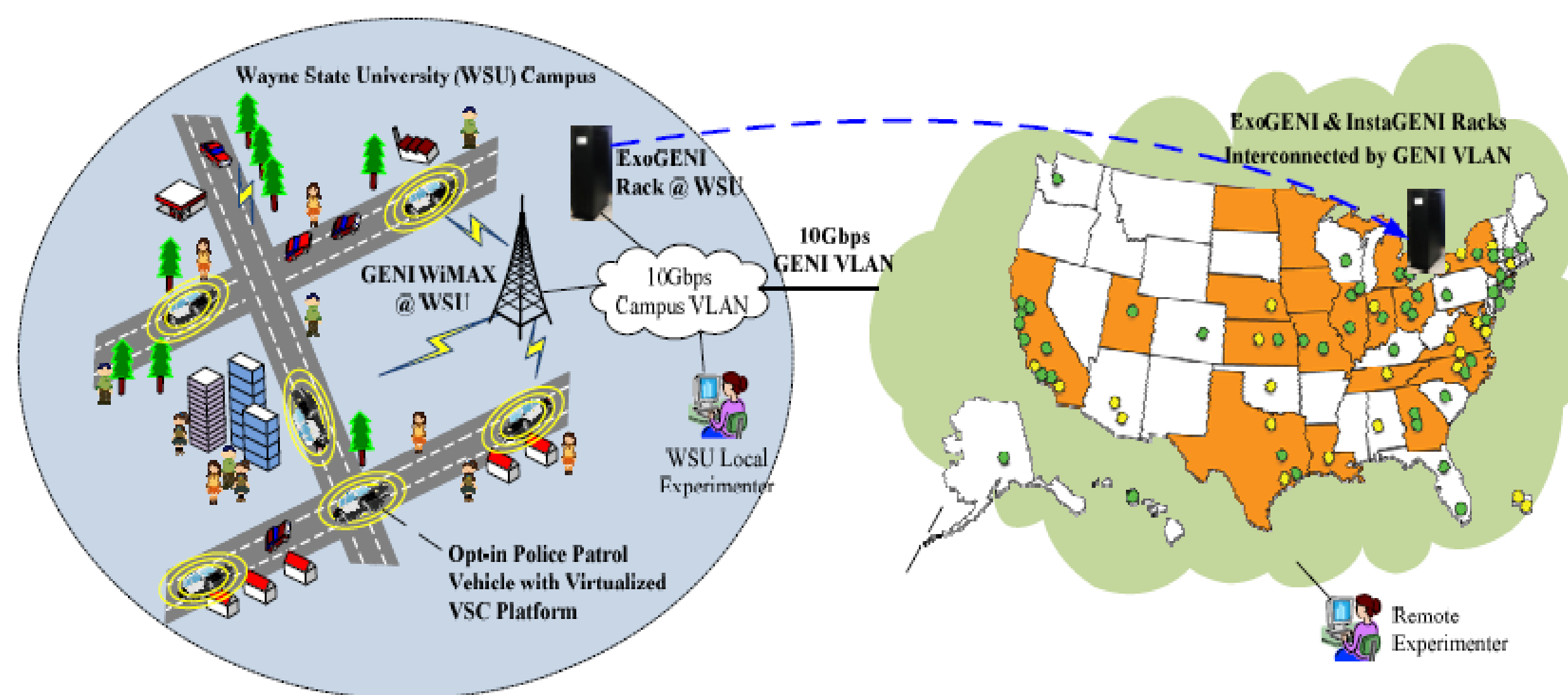
Virtualized Vehicular Sensing and Control Networking Platform

Virtualized VSC Platform

- Simultaneous operation of real-world applications (e.g., Police patrol) and experiments (e.g., DSRC evaluation)
  - Resource Virtualization
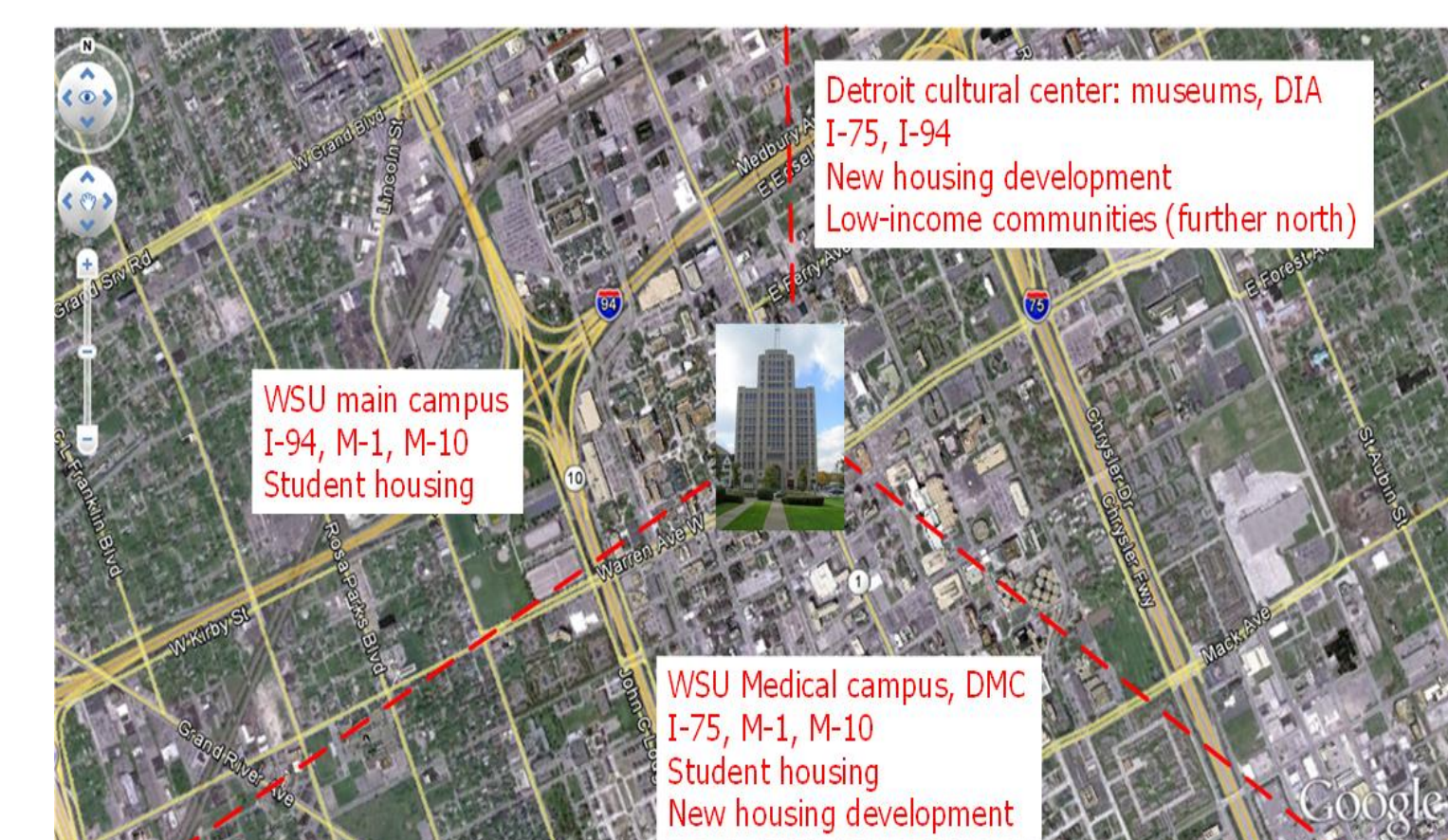- Vehicle internal and external sensing: OpenXC, camera
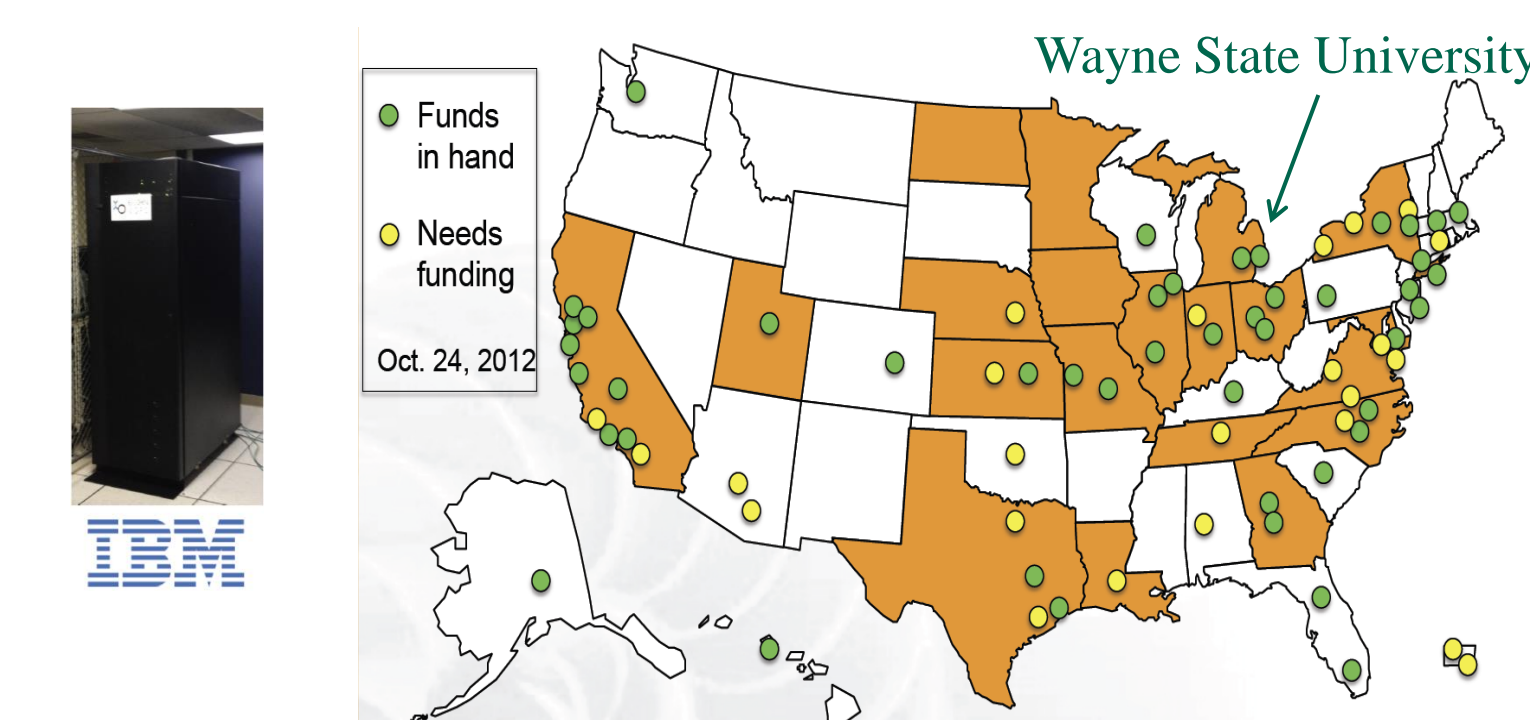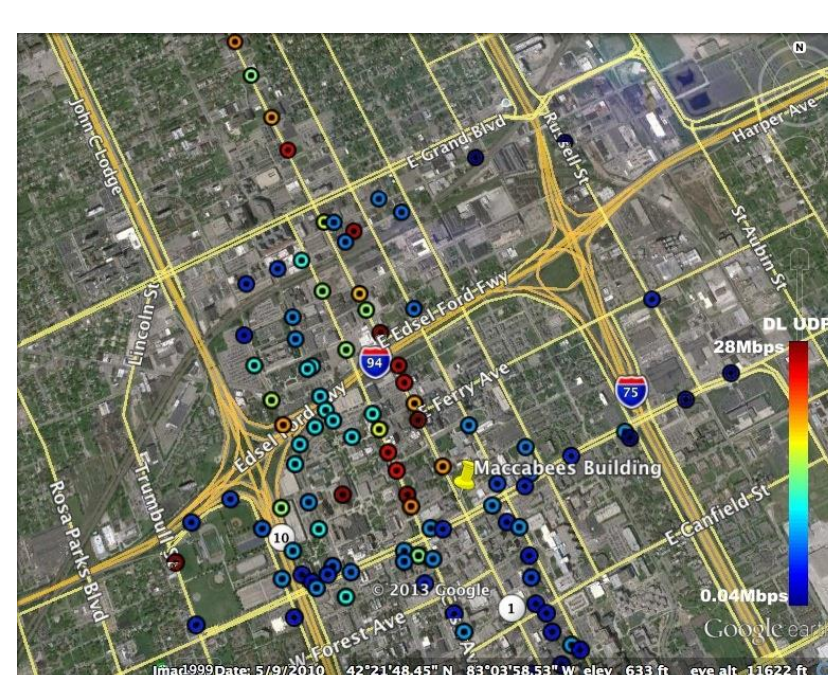- At-Scale emulation with GENI racks

Virtualization Mechanism

- ❖ Simultaneously support multiple virtual machines
  - Police Virtual Machine
  - Experimenter Virtual Machine
- ❖ vSDR-based IEEE 802.11p and WiMAX wireless resource virtualization
  - Capacity Virtualization
  - Physical Virtualization
- ❖ Sensing data virtualization module to dispatch data to different VMs and GENI Racks

Camera-based object detection and localization

GENI Infrastructures on WSU campus

GENI WiMAX research network

GENI cloud computing: ExoGENI rack

GENI-enabled Vehicular Sensing and Control Network Emulation

Experiment Scenario

WiMAX Coverage

Downlink throughput
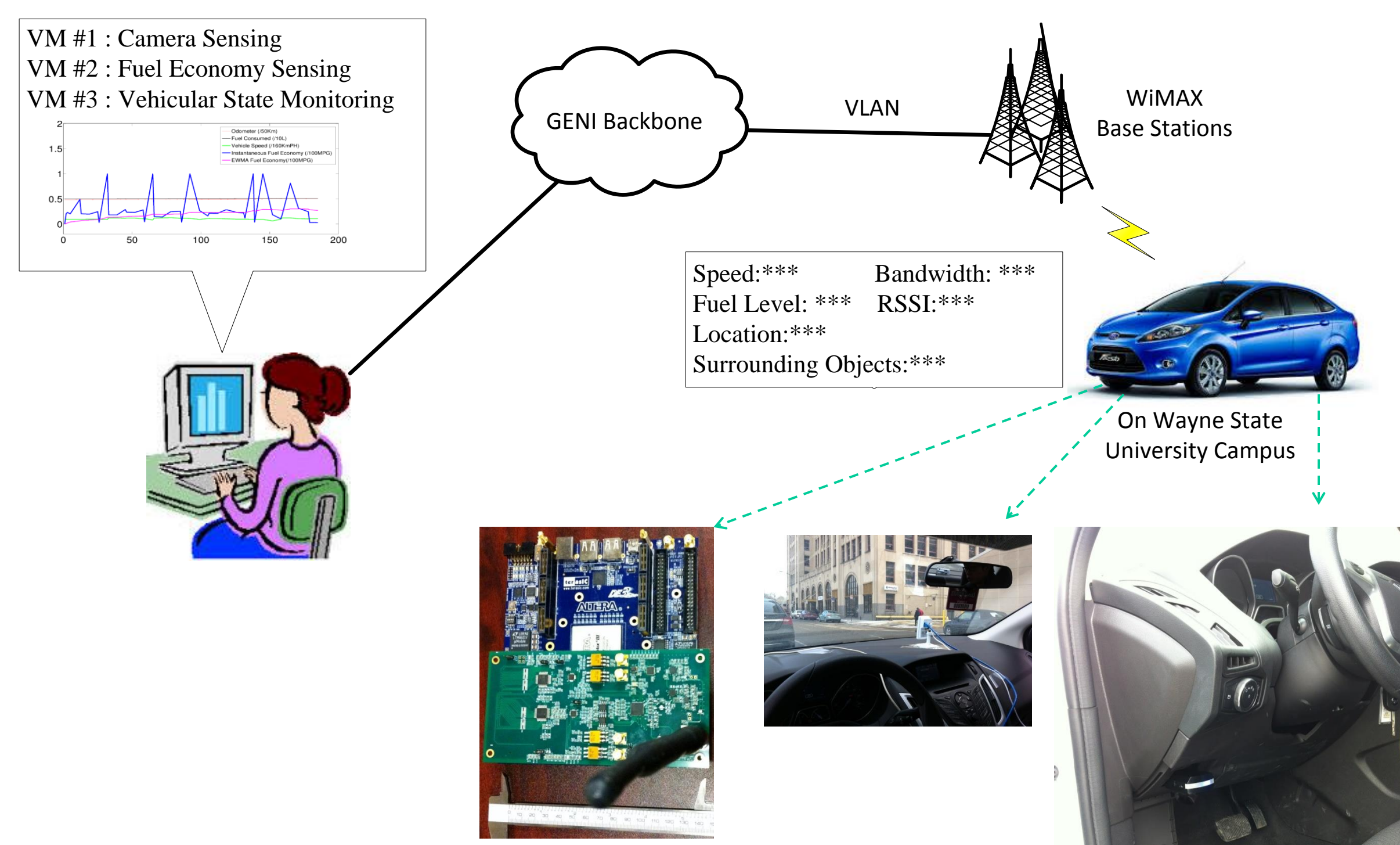
- Vehicular internal state sensing
  - Fuel consumed since restart
  - Odometer since restart
  - Vehicle speed
  - Engine speed, accelerate pedal position, steering wheel angle, etc
- Camera-based object detection and localization

Multi-dimensioanl VSC network emulation