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 an 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

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

GENI-enabled Vehicular Sensing and Control (VSC) Networking Platform

System Architecture
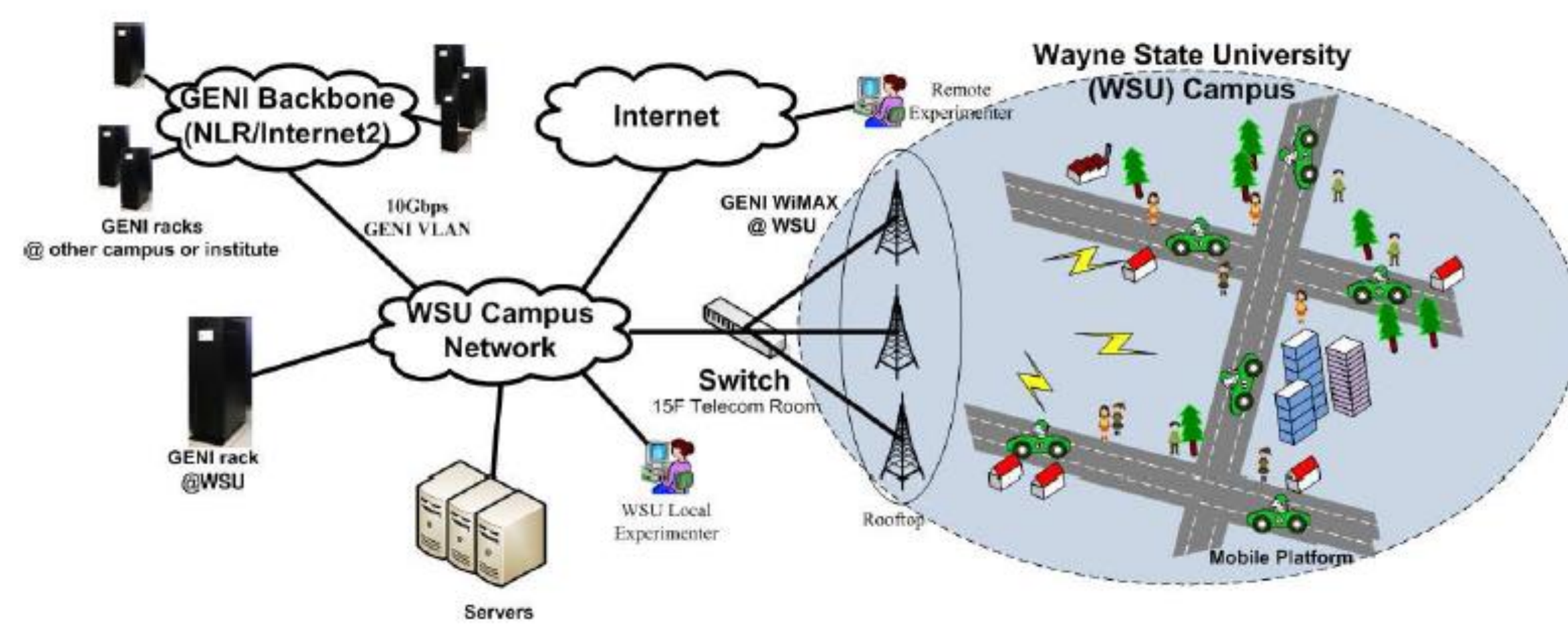
- A research infrastructure developed on vehicular networks with the integration of GENI resources
  - Resource virtualization
  - In-field vehicle internal state sensing and surrounding condition sensing
  - Simultaneous operation of real-world applications and experiments
  - Parallel, distributed emulations on GENI racks with realistic sensing data

Resource Virtualization
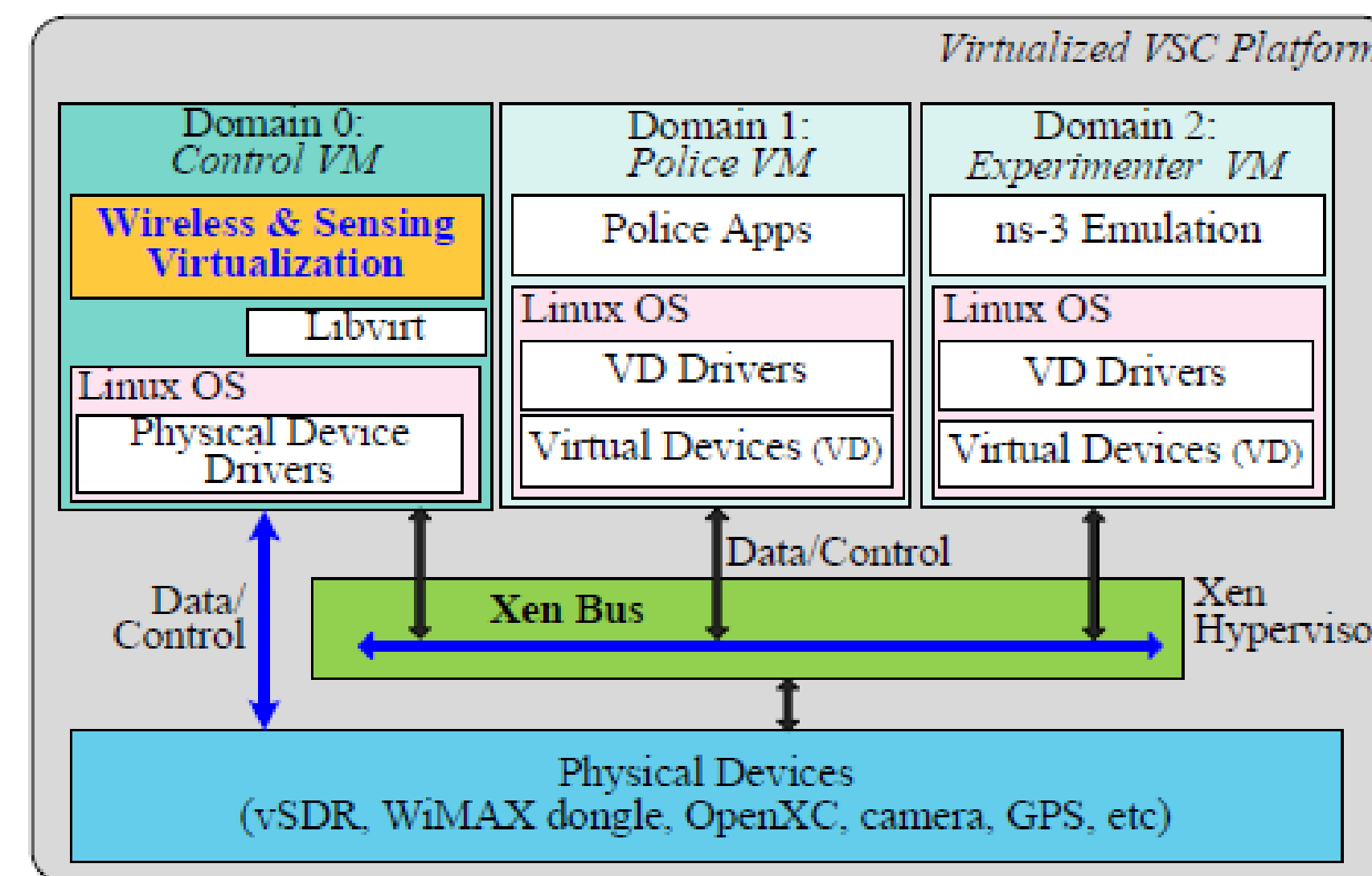
- Simultaneously support multiple types of virtual machines
  - Police, Experiment, Application Virtual Machine
- vSDR-based IEEE 802.11p and WiMAX wireless resource virtualization
- Sensing data virtualization to serve different VMs and GENI Racks

### Emulation with GENI racks
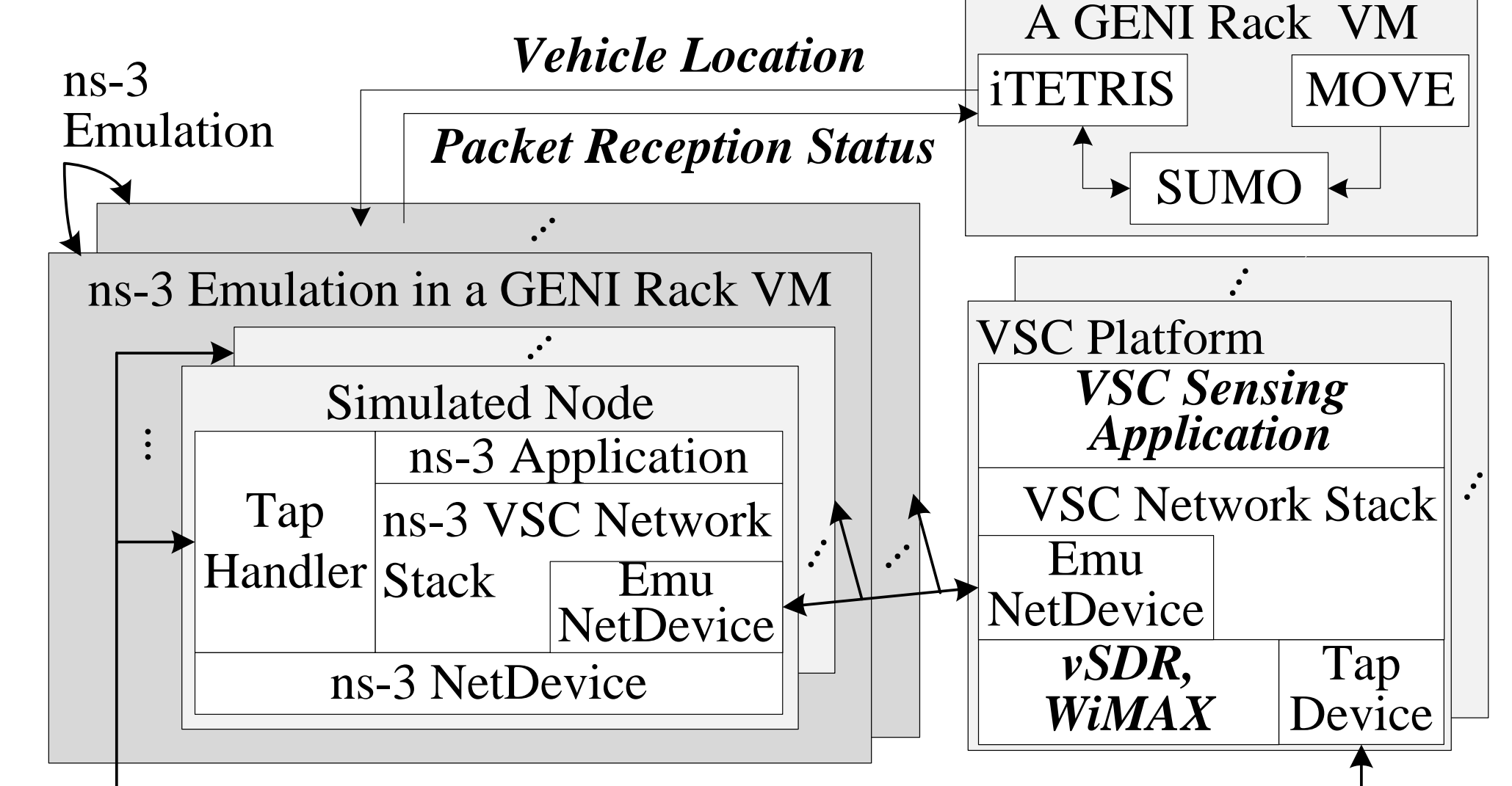
- Physical-layer emulation of VSC networks
- Physical-layer models instantiated by realistic application traffic and measurements
- VSC networking protocol evaluation
- Scalable experiments with the deployment of additional GENI resources

VSC Platform-based Applications and Experiments

Scenarios

- Vehicular internal state sensing
- Fuel Economy with different road types
- Camera-based object detection and localization
- Link property investigation
- Vehicular network related protocol emulation

(a) Instant behavior
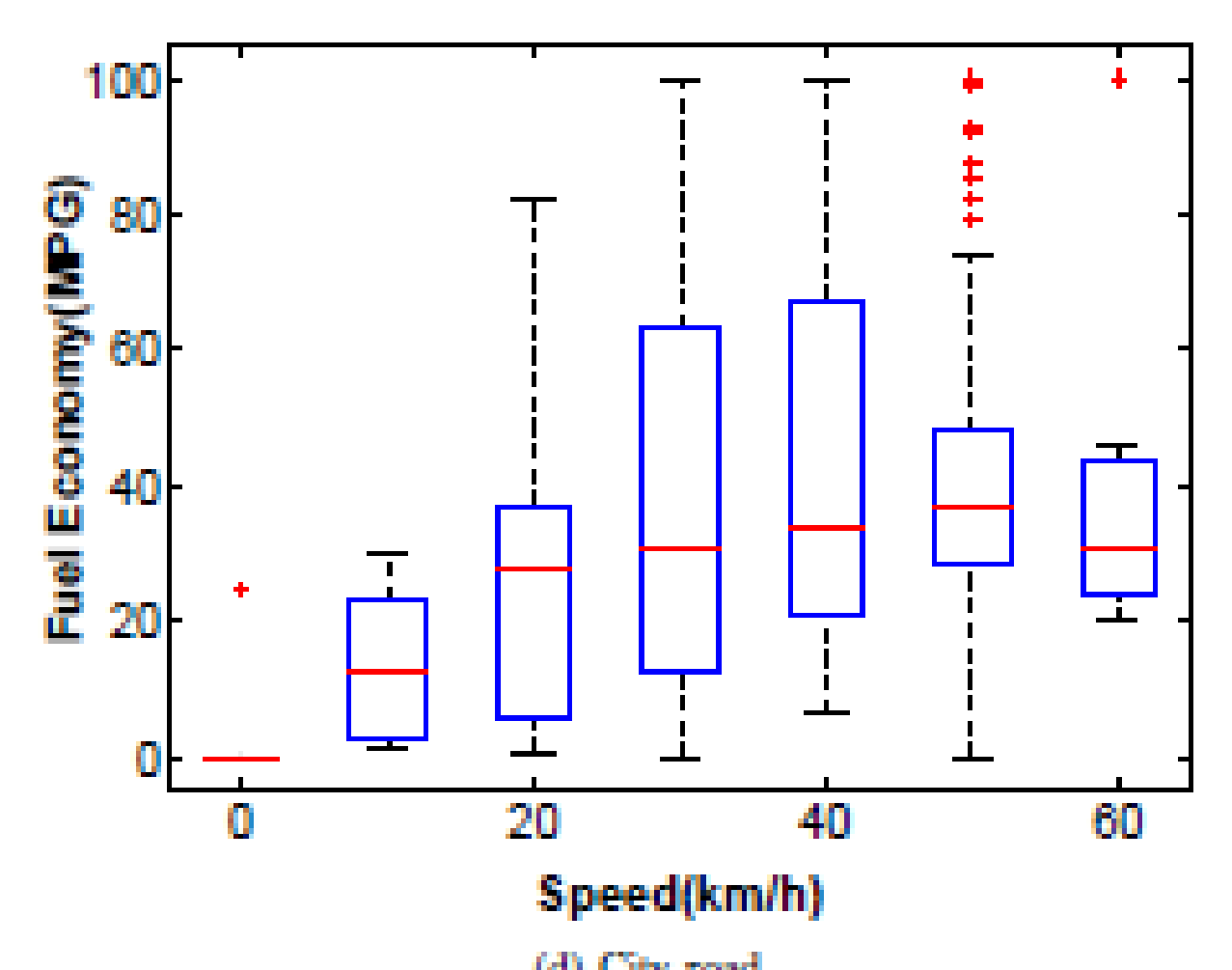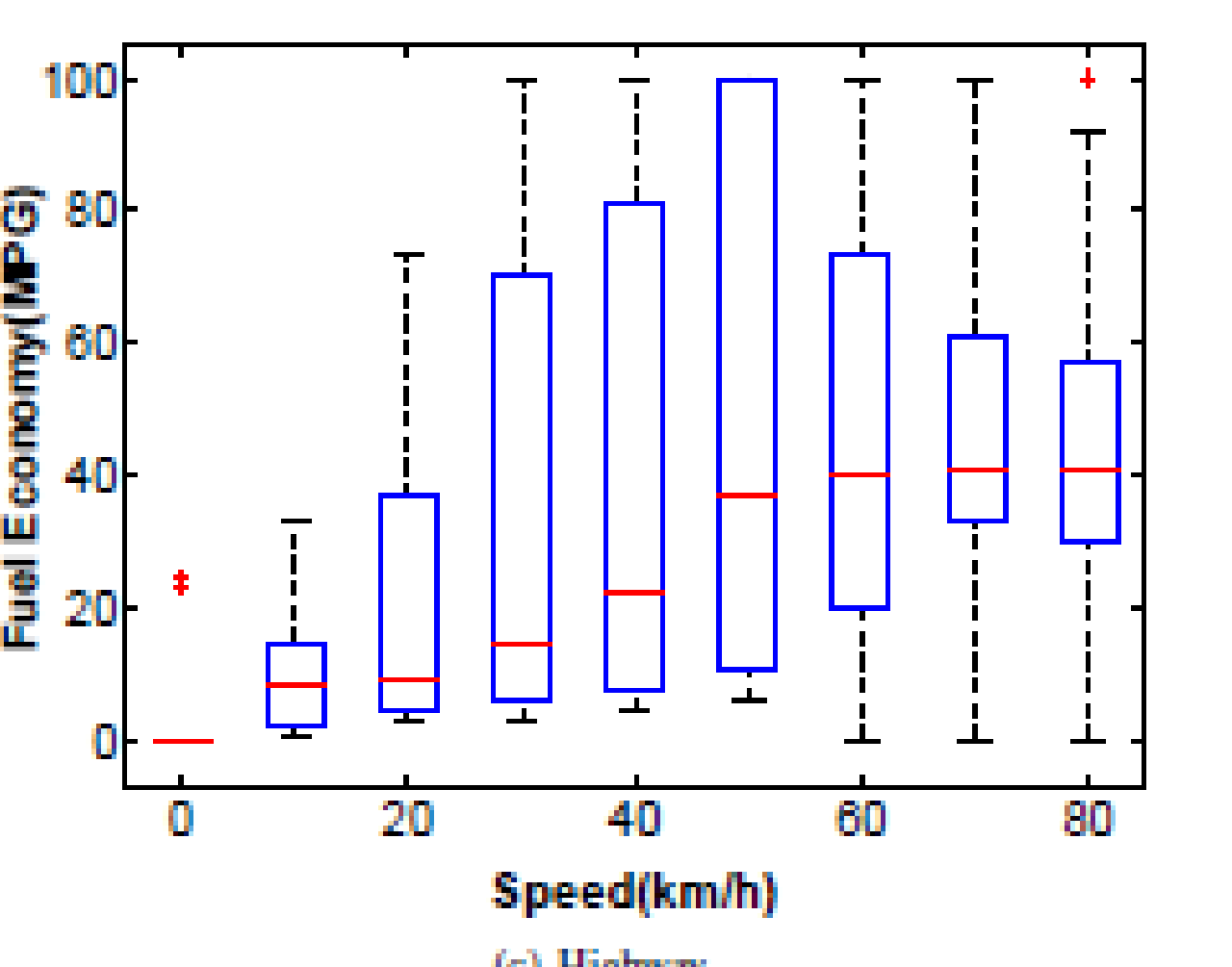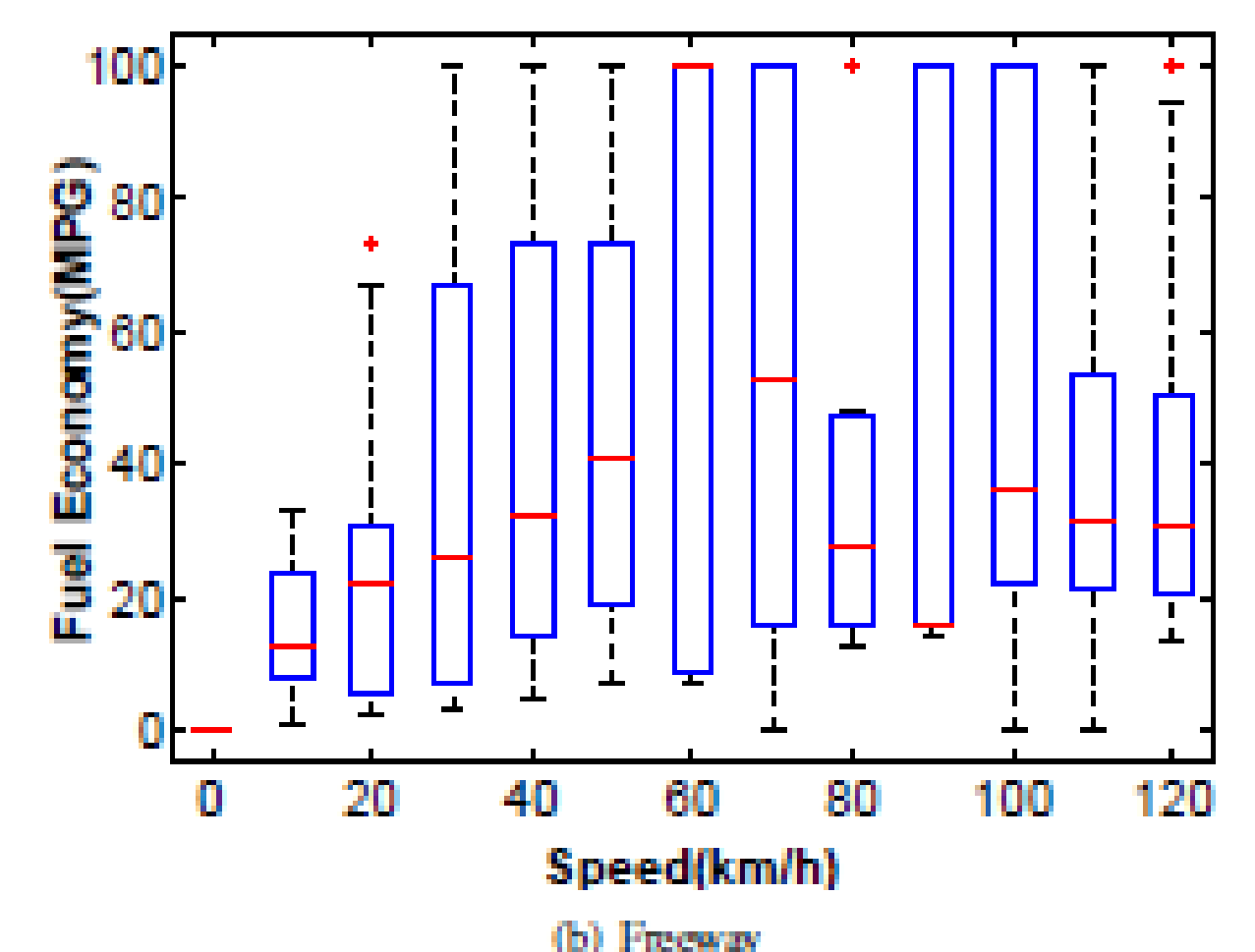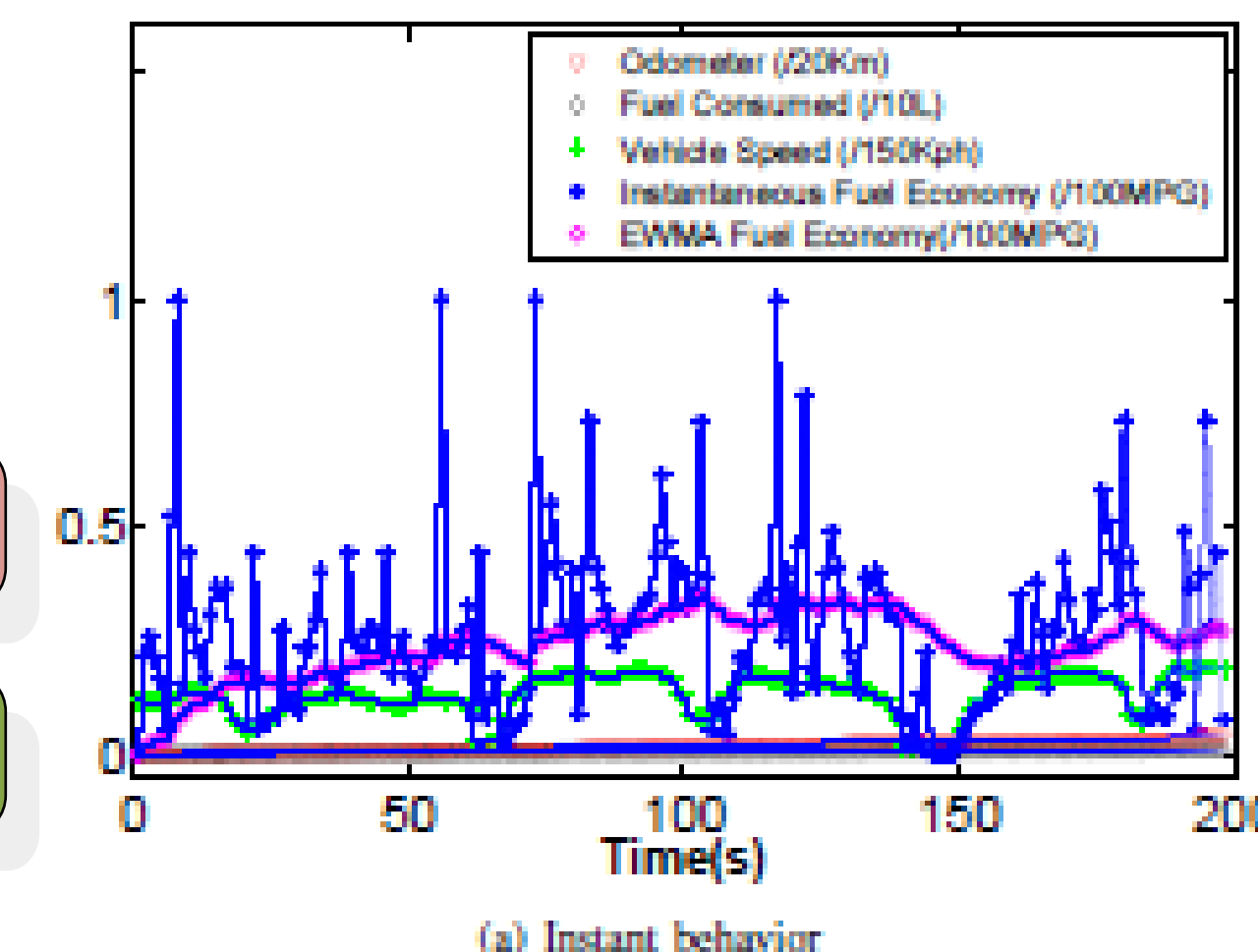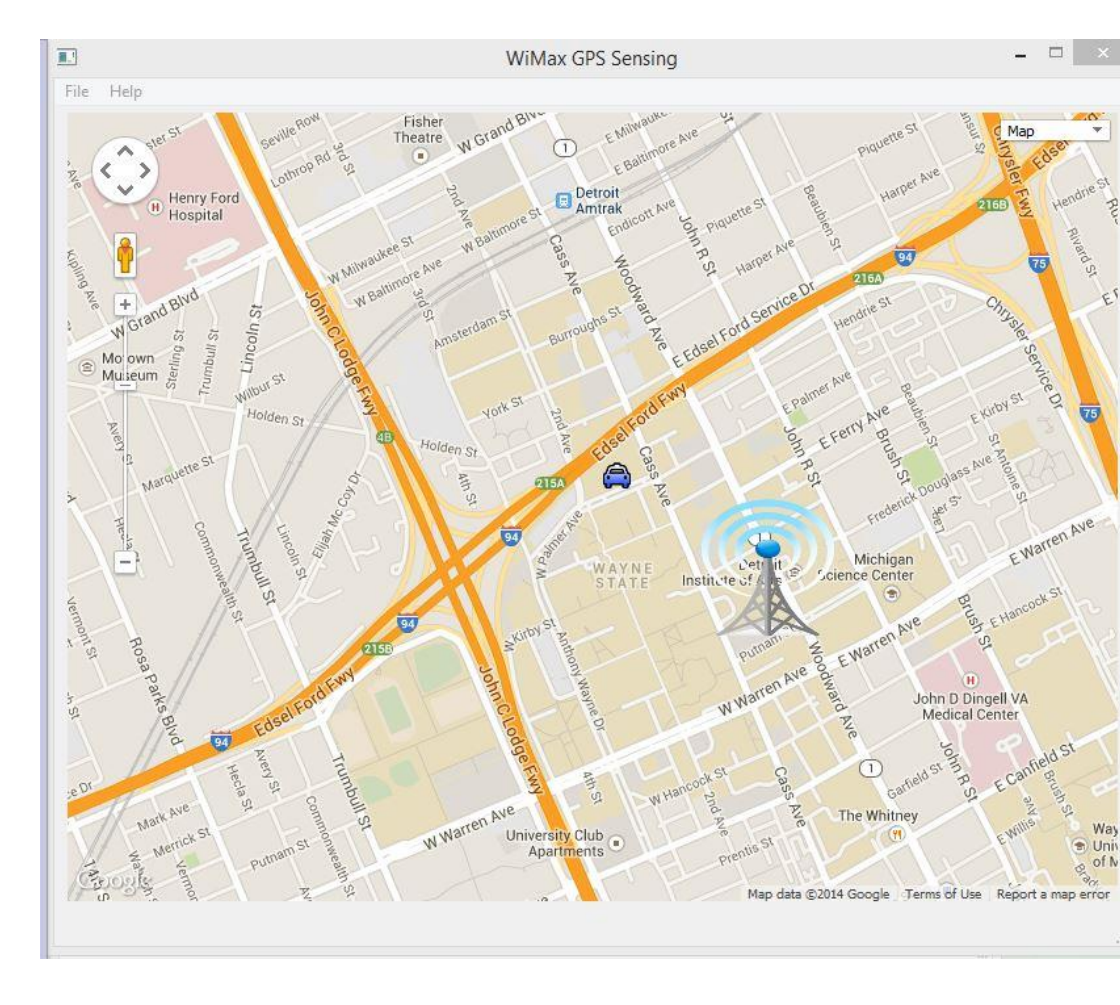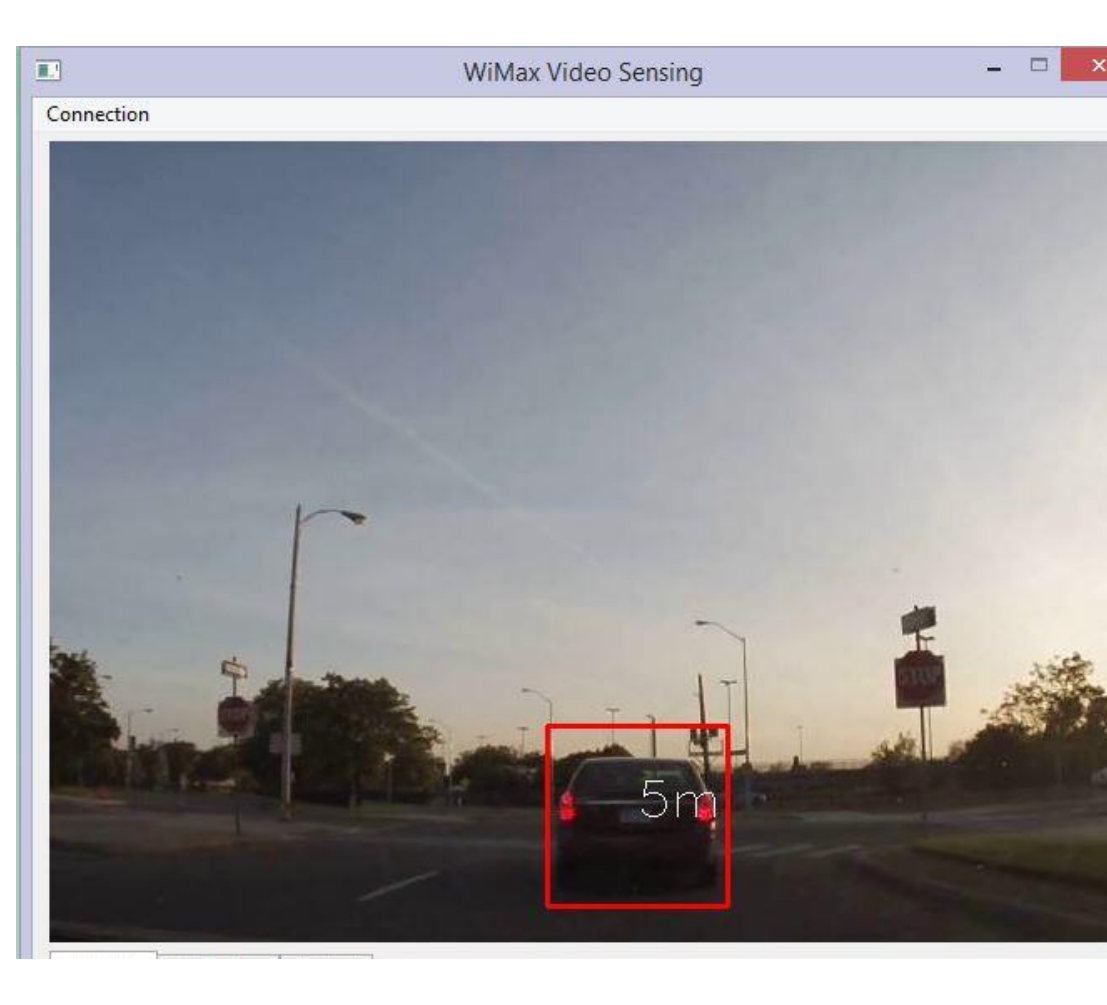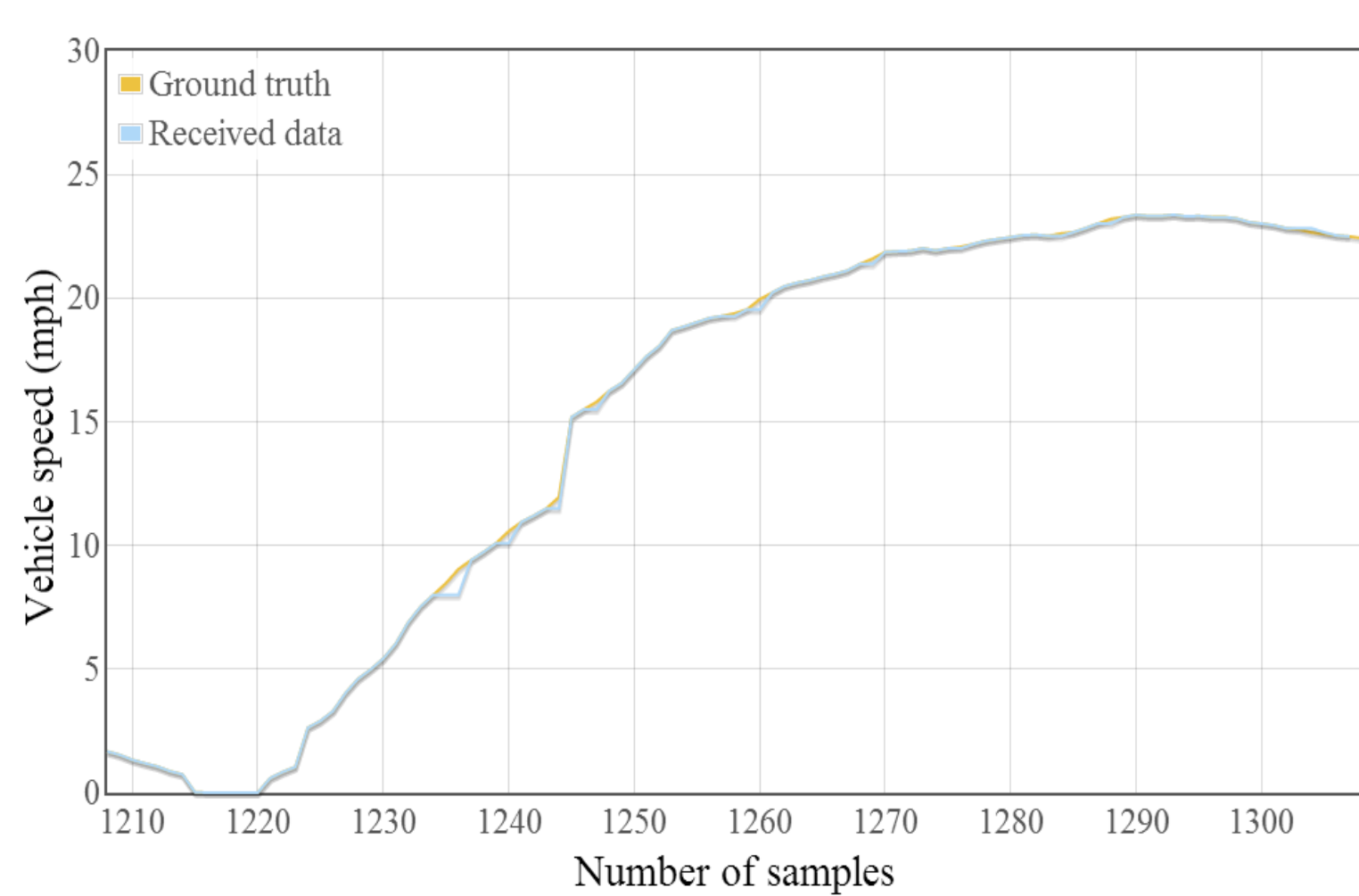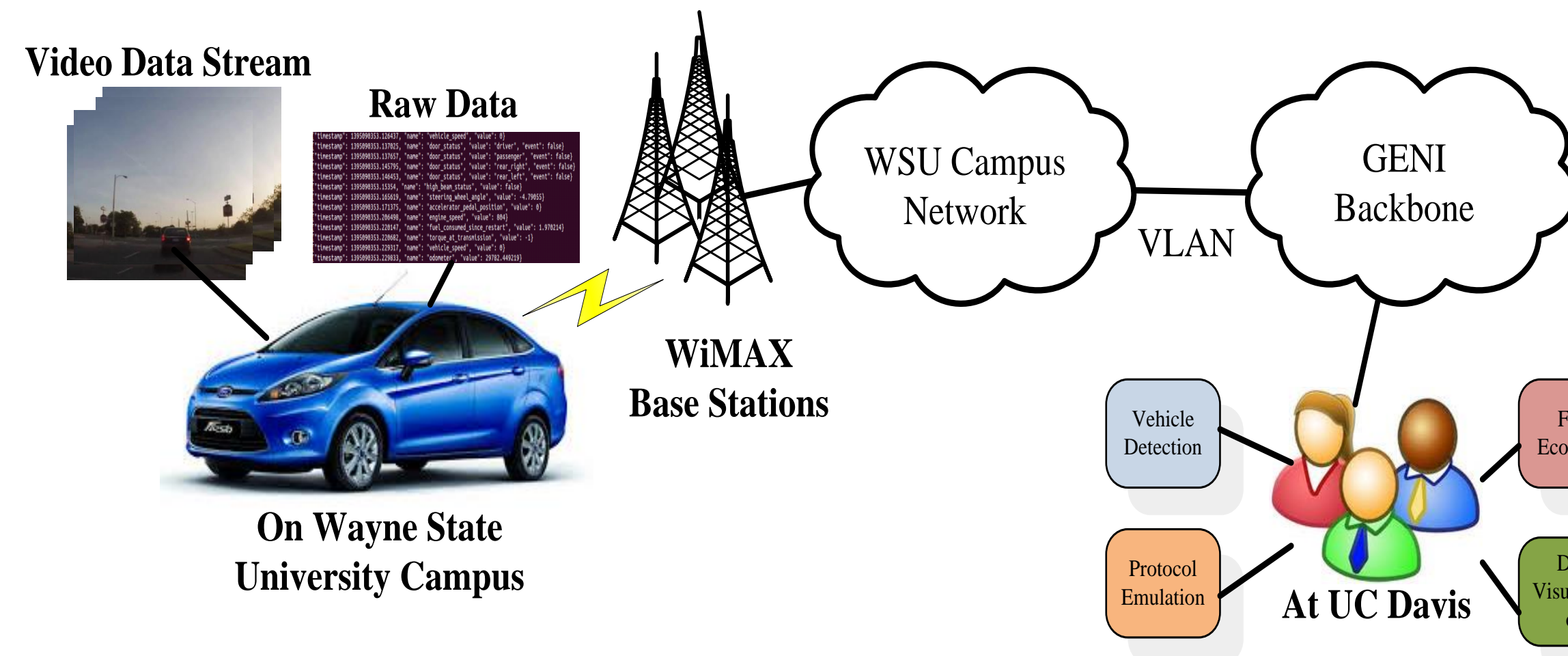
(b) Freeway

Protocol Emulation

Vehicle Detection

(c) Highway

(d) City road

Fuel Economy