Smart Roads

Vanderbilt University - Institute for Software-Integrated Systems

UC Berkeley – **NSF FORCES** and **Connected Corridors** Projects

Challenges

Complex and interconnected **road networks**

Emergency vehicles delayed due to traffic

Building our way out of congestion is no longer an option; we must coordinate our way to improved performance.

**World's largest traffic jam: 100+ Km/10+ days**

Connected Corridors

- The "next generation" of Integrated Corridor Management is being developed and ultimately piloted on a congested, urban freeway and arterial network in Southern California by **UC Berkeley** and a team of transportation agency and jurisdictional partners. Called Connected Corridors, it takes ICM to a new level by integrating freeway and arterial operations.

- **How**? The freeway ramps and arterial traffic signals will talk to each other, and decisions will be made via playbook scenarios, about what to do during incidents and events in near "real time."

Coordination and Control … need networks….

Vulnerable Communication & Control:

Highway IT Connections ←| |→Global web of critical IT infrastructure

Cyber Attacks

Command and Control Wind Tunnel

▸ **Vanderbilt's** Command and Control (C2) Wind Tunnel is a virtual laboratory for experimentation with simulated worlds that include both *physical* and *cyber* elements that are tightly coupled and interact. It has been used to evaluate C2 systems for the military, and to experiment with cyber defenses in industrial control (SCADA) systems. The tool is open source and is used in various research projects and in the industry.
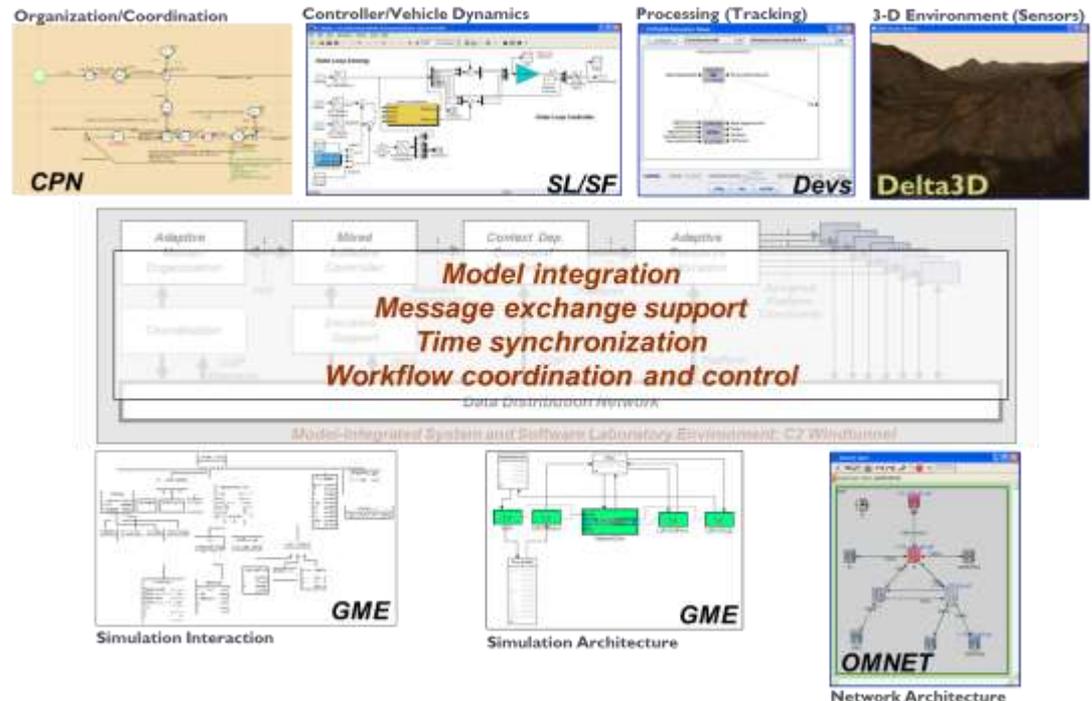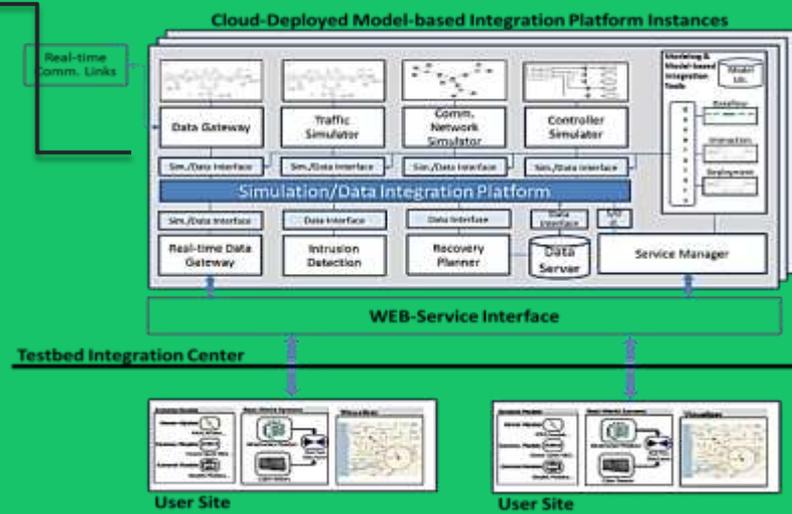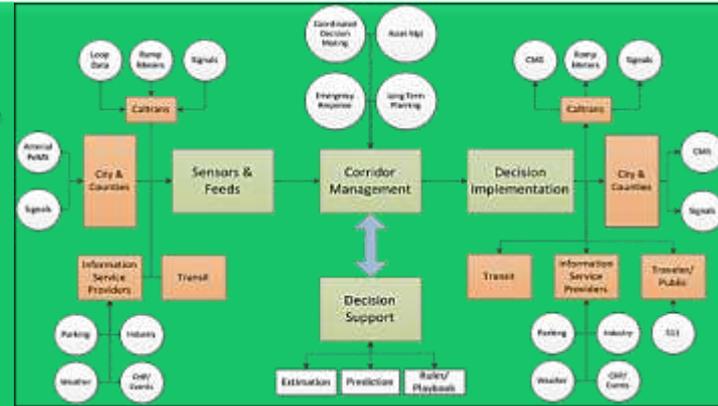
Integrated CPS Testbed

Our Solution:

Connected Corridors (CC)

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High-fidelity simulation software (C2WT)

Well-managed and resilient traffic flows

CPS Testbed

▸ The CPS testbed / system integrates **advanced control algorithms** and high-fidelity **simulation software** with real-time data to *predict* and *manage* traffic flows, to support resilience to cyber attacks.

▸ Use cases

Off-line

- ▸ High-fidelity simulation of road traffic, based on real data
- ▸ Development and evaluation of novel control algorithms – before they are applied
- ▸ Study of cyber effects on the networks and on the system
- ▸ Training of system operators in preparation for emergencies

On-line

- ▸ Real-time monitoring of traffic and predictive simulation
- ▸ Real-time control of traffic by ramp metering
- ▸ Real-time situational awareness about the status of the network

Smart Roads - Demo

Working prototype of a <u>Smart Transportation System</u>, working on real data collected from a segment of an interstate highway near a major city that shows

1) how the CPS improves the experience on the road,

2) how a cyber-attack could degrade that experience, and

3) how trained operators and clever algorithms can recognize and mitigate the effects of the attack, leading to recovery.
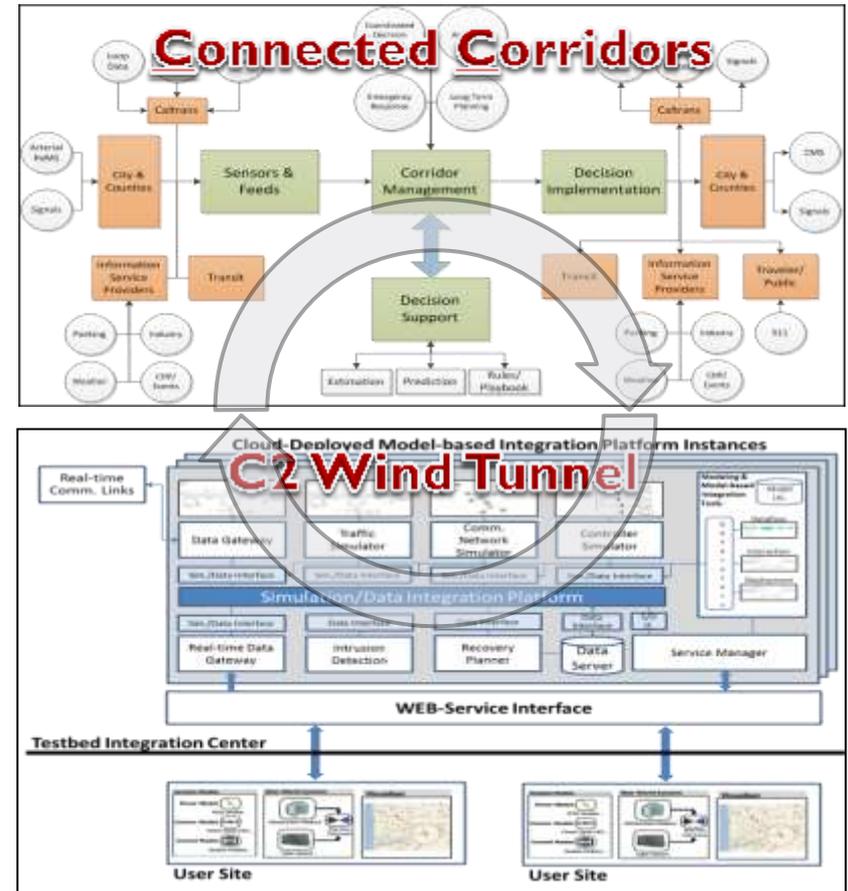
Smart Roads Benefits

▸ Projects such as Coordinated Corridors will

  ▸ improve quality of life for residents and commuters in urban corridors by decreasing greenhouse gas emissions;

  ▸ encourage use of public transportation; and

  ▸ move all types of traffic more efficiently (including autos, buses, trucks, and delivery vehicles) thus keeping workers and the economy moving.

▸ But with cyber-security … communities reap additional benefits: preventing cyber-attacks before they happen, informing decision-makers if by some chance a cyber-attack does get through the system, and even potentially enabling the system to take required actions to counter the attack, allowing system recovery to occur much more quickly.