Open Experimental Platform and Challenge Problems Breakout

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Attendees

- Tamer Nadeem, Old Dominion University
- Casey Alford, Embedded Systems Technology Inc.
- David Kuehn, USDOT Federal Highway Administration
- Steven Shladover, UCB – PATH Program
- David Du, University of Minnesota
- Xenofon Koutsoukos, Vanderbilt University
- Rahul Mangharam, U Penn
- Adel Sadek, SUNY Buffalo
- Byungkyu “Brian” Park, Univ. of Virginia
- Chris van Buskirk, Vanderbilt University
- Ken Butts, Toyota Technical Center
- Jonathan Sprinkle, Arizona
- Tony Tsakiris, Ford
- Yilu Zhang, GM
- Tony Larsson, Halmstad Univ.
- Jeff Cook, Univ. of Michigan
- Shige Wang, GM

What’s “Open”?

- Data (subj to human subjects approval)
- Inputs
- Experiments
  - Methodology
  - Results
  - Algorithms, tools, analysis
  - Design/development processes
  - Observations
- Code/Models
- Interfaces (incl. what to buy for integration)
- Time or Access to system and sources

State of the Art

- Existing OEPS:
  - Groovenet – open source, downloadable
  - Transims – open source
  - NS2 – network simulator, supports V2I, V2V simulation, open source
  - NCTUNS – short-range communication simulator, open source
  - Michigan test bed
  - C-VET UCLA vehicular test bed
    - Instrumented test bed on campus (vehicles, intersection) – for human factors, collision avoidance, etc.; open to researchers; future plans to make available remotely using local university support; what components are needed and how should they be used?
  - C2 Wind Tunnel – HLA-based
    - Matlab/Simulink/Stateflow integrated with NS2
    - Heterogenous simulations
  - Sites too (not just vehicles), and not always "easy open"
- Non-open platforms
  - TORC Tech (uses JAUS interfaces, no access to proprietary Ford/TORC data)

State of the Practice

- Localized development of open platforms (can be used by others, but results not broadcast well).
- Lots of repeated work.
- Lots of work to keep components working in integrated environment as other components change.
- Lots of OEM subsystem models but difficult to integrate efficiently into complete vehicle model.

OEP Limitations, Needs

- Who pays?
- Hard to go from experimental facilities to open information.
- Models
  - have critical assumptions, conditions, behaviors that don't work for all usages.
  - restricted based on experiment
    - simulation platforms of just vehicles (no traffic environment) or
    - subsystems of vehicles (e.g., powertrain, engine).
- Need
  - spectrum of platforms (subsystems to vehicle fleets).
  - to transfer information from experiment to simulation. Should information be shared. Do we need a central clearinghouse for data and models?
  - safe places to do experiments. OEM tracks usually "closed."
  - to agree on representative application/platform that all can use.
    - Flows down to design, test, implementation, etc.
    - Funnel idea – what's included (Jonathan to add picture)
  - complete control for experimentation; representative systems to convince OEMs that tech is "ready"
  - maintenance of platforms that are developed so they stay useful going forward. Need organization?
- Burden of documentation. Who?

Challenges for OEP Impl

- Business case for OEMs to open up resources (e.g., tracks)
  - Who pays?
  - Who's responsible or liable?
- Extending participation/expansion
  - How dynamic are business agreements?
  - Can groups join late? How?
  - Keep it as open as possible to avoid these problems.
- Automated driving in dedicated lane with V2V and V2I communications.
- What's the reward for the developing institution?
  - Deep knowledge of subsystems
- Work force for institutionalization
- OEP useful to community

Challenge Problems

- Goals
  - "Goal"-oriented – safety, energy
  - Energy/fuel conservation
  - No traffic death vehicle
  - Vehicle recall identification/management to reduce costs
  - Low(er) cost sensors for autonomy
  - Learning from other experiments/design process/verification & validation
- Enablers
  - Cross-cutting
  - Security and privacy (don't duplicate existing DOT work but address what is missing)
  - Scalability of communications (and modeling refinements)
  - Validating abstractions/models
  - Suites of standard models
  - Build/spec your simulation
  - Black/white/grey box for certain components
- Solutions (i.e., demos that emerge from goals/enablers)
  - Cooperative automated driving
  - Collision avoidance
  - Real-time traffic congestion management
  - Shown extensions to non-passenger cars (trucks/buses)

OEP: Suggestions

- Work in the OEP *must* be precompetitive
- Approaches, and results, *must* be shared
- Work done on new feature functions
- Work is done a layer above proprietary info.
- Good results may result in auto manufacturer entering into more 1-to-1 agreements
- Sites, not just vehicle(s), must be part of OEP

Issues with OEP Tools and Methods

- Virtual vehicle platform
  - Content and fidelity driven by research questions
  - Subsystem replacement to change fidelity (need proper interfaces)
  - Validating abstractions/models
  - "May" come from validating experiments
- Learning from other experiments/design process/verification & validation
  - Suites of standard models
  - Build/spec your simulation
  - Black/white/grey box for certain components
- Methods
  - Checking non-functional requirements
  - Multi-level, traceability and interfaces at multiple levels
- Problems/Questions
  - Non-synchronous model refinement/evolution
  - Commercial or free models (e.g., CarSim)?
  - How many physical vehicles to start with?
  - Addressing interoperability (different manufacturers)

Research Roadmap and Milestones

- 2-3 years
  - Catalog of existing OEPs and components
  - Determination of Institutional model
  - Process to mature existing testbeds to institutional(s), or build new
- 3-5 years
  - First results validating approaches to challenge problems
- 10 years
  - Validated models for virtualization, “choose your system”
- 20 years
  - Extensions to other vehicle types
  - Robust models