Testing and Verification Session

Define T&V

- Simulation, traditional testing?

- Verify correctness properties?

- What is the scope?

    ○ Are you evaluating system, subsystem or component?

- A lot of work is either theoretical or very practical

Current Practice?

- Unit testing of subsystems

- Traceability of tests through the requirements

- Each feature comes with test cases: test parameterization based on family of product

- Testing is currently centralized : Top down ?

- NAS analyze data for loss of control in aerospace and build test scenarios for all manufacturers

    ○ In research themes extend this to CPS

Categories of T&V?

- Adaptive systems : runtime testing & verification

Big questions:

- When is testing enough testing?

- What is coverage? Relative to requirements?

- Di the designer interpret correctly the requirements?

- How to generate test requirements and connect them to requirements?

- Integrate MBD testing with legacy system testing

- Technology to trace multiple test cases through product families and product variances

- HIL/PIL must be part of the testing process

- What happens to environmental impact and other non predictable conditions?

- Heterogeneous approaches

- Systematic approach to avoid centralized testing?

- How do we ensure consistency along the whole process?

- Basic design workflows that are more amenable to verification?

- Create systems that are verifiable?

    ○ Design space for systems that are easier to verify?

    ○ Cannot do exhaustive testing: approach correct-by-design methods for CPS?

- What about human in the loop in the V&T process?

    ○ Especially in large scale systems?

    ○ Consider the T&V of the whole transportation system

    ○ Can we define human models for standardized tests for autonomous systems in particular?

- Coverage of interactions between the physical and the cyber

    ○ Verify the emerging CPS behavior

- What is coverage in the context of CPS?

- How do you verify and test machine learning algorithm?

    ○ What is a reasonable coverage criterion of ML algorithms?

- How do you establish confidence in the T & V results?

    ○ Quantify the level of coverage?

- What would be the standardized tests for transportation systems?

    ○ Crashing one car is not enough any more

    ○ Standardized tests for autonomous systems?

- Currently manufactures design for the tests

- Risk-based approaches in testing and quantify where the risks are?

  - What is the current status?

  - Hazard and risk analysis

- Certify autonomous systems the same way we certify the human drivers?

- Separate technology for an automated car vs an autonomous car

Concrete goals for the next 5 years?

- Focus on either interesting theoretical problems or practical?

- Testbeds??

  - Using cloud infrastructure to scale up big tests

- Technical advice to form the legal framework for autonomous systems?

- Making a verification roadmap

  - What would be the expected scale and complexity?

  - Parallel with the semiconductor industry: set the roadmap and follow the roadmap

- What is the bar for autonomous system testing, certification?

  - What are the problems with fundamental research solutions?

  - What is the societal expectation for autonomous systems?

    - Will guide the specs

- There are demo autonomous vehicles

  - What testing and verification beyond road testing?

10-15 year research themes?

- **Compositional testing:** test smaller systems and derive properties of the composed system

  - Also for maintenance and legacy integration

- How to apply ISO 26262 to

  - autonomous systems

  - Connected systems

- Testing for hybrid and highly non-linear systems

- Automate the data collection process for automatically analyzing accidents to improve test coverage and system design

  - Replicate the human process that takes place in aerospace in the field

  - Improve black boxes & surveillance process

  - What info do we need and what we do with the info?

  - Runtime data collection so that anomalies can be detected, analyzed etc

  - Analyzing the existing database for detecting anomalies and defining test scenarios?

  - Gap in the existing public data for advanced systems

  - SHARP2, aviation, rail etc data so that we can analyze CPS data on potential issues

  - Requirements in a formal / machine readable form so that data can be analyzed

- Incremental understanding of system requirements

  - Given a problem scenario how to perform traceability back in the requirements?

- Design process: Separate what from how

  - Abstraction of the implementation? This could be an abstraction on how

  - What: requirements. How can this be done effectively? An issue currently in industry.

- Testing cybersecurity of CPS

- Use existing database on accidents to create standardize tests for autonomous system?