Using Cyber Digital Twins for Automated Automotive Cybersecurity Testing
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The Need for Industrialized Automotive Cybersecurity Testing

- **UNECE**
  - Regulation R.155
  - Mandates cybersecurity and cybersecurity management
  - Requires testing of measures
  - Adopted in EU, Japan and Korea
  - Effective in EU for new types 2022 and for all new vehicles 2024

- **ISO/SAE 21434**
  - Cyber security management system for automotive systems
  - Risk-based approach
  - Also demands testing, however, does not specify details
  - To be supplemented for testing by ISO PWI 8477 (V&V) and ISO/SAE PWI 8475 (CAL &TAF)

=> Need for automated testing
Why Black Box Testing?

• Providing an attacker’s view
• Long supply chain – source might not be available
• Unwillingness (or inability) to disclose internals
Static Approach (Previous Work)

- Generalize Existing Attacks
- Formulate Attack Scenarios in DSL (ALIA[14])
- => SUT-Agnostic attack description
- Test Case Generation => augmenting attacks with SUT info

Problem: approach static - lots of a priori information needed!
Cyber Digital Twin (Previous Work[11])
Cyber Digital Twin – Pattern Matching

- Translate binary into own machine code format
- Compare patterns of known software with parts of the binary => software BOM
- Compare patterns of known vulnerabilities (CVEs) and general flaws with parts of the binary => security analysis results
Test Case Generation
State Machine-Based Testing

- Fault injection
  - Inject Faults into the State Machine
  - Use the ones producing interesting results as test cases
- Model Checking
  - Transform model into provable form
  - Use violations as test case inputs
Binary Analysis -> Attack DSL Scripts

• Generate DSL scripts out of findings
• Use pre-prepared building blocks
  • CVEs
• Code pieces for buffer overflows, etc.
Test Execution

- Test case generation produces a JSON output that can be interpreted by an execution engine
- Principally an environment description + shell commands
Conclusion

• Concept for model-based cybersecurity testing of automotive systems
• Uses existing building blocks
• Combines
  • Dynamic model generation
  • Dynamic security analysis
  • Automated test case generation
  • Automated test execution
Thank you for your attention!

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