A Model-Driven Methodology for Automotive Cybersecurity Test Case Generation

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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
Cyber Testing Manually

Tedious and Costly
Holistic Testing

- System level
- Including architecture
- Conducted on the communications networks inside an actual system
System Reconnaissance

- Use a variety of interfaces
  - Wireless UIs (WiFi, BlueTooth,..)
  - Wired UIs (USB,)
  - Diagnostic (OBD)
  - Wiretapping (CAN, LIN)
- Active (sending messages)
- Passive (listening only)

- More complete picture of the SUT
- Ability to segment attacks
Fingerprinting

- **Passively:**
  - Deviation
  - Kurtosis
  - Clock skew
  - ...

- **Actively:**
  - Sending (CAN) messages
    - Well formatted
    - Malformed

- Attribute a component according to the detecting interface
Model Generation

- Use (abstract) automata learning to learn a *behavioral* model
- Use model checking for test case generation
Variant Management

- Without a priori knowledge, a plethora of candidate models is available
- This set is narrowed down with every piece of information
- Each test case touches a number of assumed components, allowing for gathering data for fingerprinting
- Test cases will not only be chosen according to a potential attack vector, but also considering pivot elements to exclude or verify an optimal number of candidate models
Attack Model

- Augmenting the system model with attack information
  - Using CVE information
  - Using other public sources (Auto-ISAC, research, darknet)
  - Analysis - see previous presentation of this workshop ;)
- Should occur both component and function-wise
Attack Tree

- Assign cost to attacks on a specific component
- Shortest path (per cost) => most feasible attack
- Shortest path will be tested first, in conjunction with variant management considerations
- Test pass if the cost of the shortest path is above a certain threshold => *sufficiently secure*
Conclusion

- Concept for holistic zero-knowledge testing of automotive systems
- Combining fingerprinting and attack trees for test case generation
- Coping with variants that result from fuzziness
Thank you for your attention!

Thanks!

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