THE ECLIPSE OPEN-SOURCE IOT TEST ECOSYSTEM

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CHALLENGES IN IOT

- Wide portfolio of competences required
  - Devices (sensors, HW, embedded SW)
  - Platforms (Cloud, platform domain knowledge)
  - Applications (SW, dashboard, business logic)
- IoT platforms
  - 360+ worldwide
- IoT protocols
  - Rich selection
  - IP-based
  - non-IP based
- Connectivity options
  - Throughput
  - Latency
  - Power efficiency
  - Packet size

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![IoT application logic diagram]

- **IoT services layer**
  - OPC UA
  - HTTP
  - Web Socket
  - AMQP
  - XMPP
  - MQTT
  - MQTT-SN
  - CoAP

- **Transport**
  - TLS/SSL
  - TCP
  - UDP
  - IPv4/IPv6 (6loWPAN)

- **Cellular**
  - 4G, NB-IoT, Cat-M1, EC-GSM… [5G]

- **Non-cellular**
  - Wifi, LoRa, Sigfox, Zigbee, BLE, …

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**application**

**services**

**transport**

**connectivity**
TRENDS IN IOT

Top IoT Concerns / Trends 2015-2017

Connectivity Protocols

What connectivity protocol(s) do you use for your IoT solution?

Messaging Standards

What messaging protocol(s) do you use for your IoT solution?
## TEST COVERAGE BY SDO-S

<table>
<thead>
<tr>
<th>Cellular: 4G, NB-IoT, Cat-M1, EC-GSM...[5G]</th>
<th>Non-cellular: Wifi, LoRa, Sigfox, Zigbee, BLE, ...</th>
</tr>
</thead>
</table>
QUO VADIS IOT?

Cathedral OR Bazaar?
**TEST OBJECTS**

- **IoT devices**,  
  - Mikrocontroller (**MCU**),  
  - **Gateways** (Bosch XDK, IoT starterkits)

- **IoT platforms**  
  - RIOT, relayr, Thread, mbed…  
  - service layer (oneM2M, FiWare)

- **IoT protocols**  
  - Constrained Application Protocol (**CoAP**)  
  - MQ Telemetry Transport (**MQTT**)  

**IoT challenges**: complexity, asynchronism, long operation phase, resource constraints
INTEGRATION OF SEVERAL TESTING APPROACHES

IoT Testing

- Software Testing
- System Testing
- Protocol Testing
- Security Testing
- Test Automation
TEST AUTOMATION

- Less resources needed (time and money)
- Avoid human mistakes due to manually testing
- During test development and execution
- Speed-up of regression tests and product time-to-market
• **One test technology for different tests**
  – Distributed, platform-independent testing
  – Integrated graphical test development, documentation and analysis
  – Adaptable, open test environment

**DESIGN PRINCIPLES OF TTCN-3**

**Areas of Testing**
  – *Conformance* and *functional* testing
  – *Interoperability* and *integration* testing
  – *Real-time, performance, load* and *stress* testing
  – *Security* testing
  – *Regression* testing

Did you know that **YOUR PHONE**...
THE ECLIPSE PROJECT

• Supplement to **running** Eclipse projects
  – Paho, OM2M, Titan

• **New project** at Eclipse Foundation:
  [https://projects.eclipse.org/projects/technology.iottestware](https://projects.eclipse.org/projects/technology.iottestware)
  – TTCN-3 test suites for **CoAP, MQTT, OPC-UA**, LoRa?

• Assured **licenses** for users

• **Currently a cooperation of**
  relayr GmbH, Ericsson, LAAS/CNRS, itemis AG, Spirent Communications, Easy Global Market, Iskratel/Sintesio, Fraunhofer FOKUS, …
SAMPLE TESTSUITE STRUCTURE: MQTT

- **Broker as SUT**
  - All mandatory message data fields
    - Regular and illegal data
      (Fixed/variable header, payload)
  - Protocol features
    - General
    - Connect/disconnect (session)
    - Subscribe/unsubscribe
    - Immediate publish
    - Last will and Testament (LWT)
    - Heartbeats keepAlive values
    - Topic
    - Error handling

- **Client as SUT**
  - …
TEST DEVELOPMENT SAMPLE: MQTT

✓ Test configurations

✓ Test Suite Structure

✓ Test purpose (catalogue)

✓ Test implementation (TTCN-3)
STATUS: ECLIPSE IOT-TESTWARE REPOSITORY

Contribution Activity:
Commits on this project (last 12 months).

https://github.com/eclipse/iottestware.git
# MQTT BROKER EVALUATION (JULY 2017)

<table>
<thead>
<tr>
<th>Broker</th>
<th>Version</th>
<th>PASS</th>
<th>FAIL</th>
<th>INCONCLUSIVE</th>
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</table>

PASS: # = Number of tests passed, % = Percentage of tests passed. FAIL: # = Number of tests failed, % = Percentage of tests failed. INCONCLUSIVE: # = Number of tests inconclusive, % = Percentage of tests inconclusive.
ECLIPSE TITAN - THE TEST EXECUTION TOOL

**THE standard test language**
- Functional testing: conformance, function, interoperability, end-to-end, regression
- Performance and stress tests
- Security testing
- Programming language designed for testing: multi-process, timers, alternative responses, matching to wildcards
- Directly supports ASN.1, IDL
- Continuous maintenance and extensions

**Test types and domains**
- Functional
- Performance
- Model-based
- Security
- Abstract: reusable code, independent of environment

**Ecosystem**
- Protocol support: 50+ protocols
- Automotive: CAN-bus
- C-ITS: all protocols
- IoT: HTMLs, MQTT, CoAPs, WebSocket
- Auto codec generation: text, binary, ASN.1BER, XML, JSON

**Users**
- Code development: Designer, Executor
- Test execution: LogViewer
- Test result & log analysis: Compiler, XSD2TTCN, MC, Utilities

**Protocol support**
- Telco
- Automotive
- IoT
- Web services
- Smart metering
- and more…

**Users before 2014**
- 4000+ users
- 15 years development
✓ Advanced testing technology:

✓ (Open source) IoT-Testware (code):

✓ Standardized IoT test purposes:
FUTURE: PERFORMANCE TESTS, VULNERABILITY TESTING

- RIoT: IoT performance/load tester
  - Open sourcing is ongoing
  - Has been used with different platforms
New Working Group (TST) will develop IoT test catalogues and specifications (not covered elsewhere).

The types of testing include conformance, interoperability, security and performance testing.

The initial technical focus will be:
- IoT network layer (communication protocols, node connectivity, edge computing etc.),
- IoT layer (data accumulation and aggregation),
- Application layer (interfaces, business processes etc.).
Thank you for your attention!

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