Seamless And Unified TTCN-3 Test Environment For Spatially Distributed IoT, 5G and Radio Technologies

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Supervised by [Prof. Dr.-Ing. Axel Sikora]
Who we are?

- Institute of Reliable Embedded Systems & Communication Electronics (ivESK)
  - Prof. Dr.-Ing. Axel Sikora

- stack development
- test & verification
- hw-sw-co-design
- embedded platforms - embedded Linux
- embedded software engineering
- security

Team: 12 full time engineers / PhD candidates
~10 student jobs

Industrial Partners
Agenda

- Introduction
- Problem Analysis
- Seamless and Unified Test Environment
- Virtual Testbed for Embedded Networking Nodes (VTENN)
- Automated Physical Testbed (APTB)
- Example test case
- Conclusion
Introduction

- Spatially Distributed Wireless Networks (SDWN) technologies for IoT and Industry 4.0 case cases
  - Devices are usually,
    - spatially distributed
    - battery driven
    - resource constrained
    - less expensive
  - They require wireless connectivity with,
    - low data rate
    - narrow bandwidth
    - wide coverage
    - long battery life
    - low cost

Which is the suitable wireless connectivity for this use case?

- Short Range Wireless Networks (SRWN)
- Low Power Wide Area Networks (LPWAN)
- Cellular IoT (cIoT) Networks (also specified as 5G technologies)
Motivation

• Role of functional testing in SDWN
  • during system development cycle
  • for systematic comparison

• Challenges of functional testing in SDWN
  • communication devices are resource constrained
  • connectivity is via wireless channel
  • operate in complex topologies
  • complex mechanisms such as MAC, routing, network management

Need of **Seamless and unified** test environment for SDWN
Problem Analysis

- Existing functional test solutions
  - technology specific
  - start testing at system level

- Multiple test platforms with different levels of abstraction

- Testcases are described differently

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<th>System Aspects</th>
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Seamless and unified test environment - Requirements

• Flexible and shall provide a **uniform environment**

• It should use an identical test description language and should **support identical test case description** in various abstraction levels

• The environment should have an **option to control System Under Test (SUT) remotely**

• The environment needs a **centralized control**

• The environment should have an **identical performance measurement and analysis** options
Seamless and unified test environment - Novel architecture

- Test description and execution
  - Test ports / interfaces (i/p)
    - Network simulation
    - Network virtualization
    - Network emulation
    - Field test
  - Test ports / interfaces (o/p)
  - System under test
    - Measurement devices & analysis tools
Seamless and unified test environment - implementation

Eclipse Titan
TTCN-3 based test framework

network simulation

virtual testbed

emulated testbed

field testbed

In house developments

Virtual Testbed for Embedded Networking Nodes (VTENN)

Automated Physical Testbed (APTB)
Seamless and unified test environment – TTCN-3 Integration

Eclipse Titan TTCN-3 Framework

- Run time configuration
- Main Test Component
- CTI
- CI
- LCM
- Dispatcher interface
- Test ports (LCM/Serial/TCP)
- Test Interface

Host 1: Eclipse Titan TTCN-3 Framework

Host 2: Dispatcher

SUT on various test platforms

- Network manager
- Upper Tester
- SUT
- Simulation / Lab tests / Emulated testbed / field testbed
Virtual Testbeds

- Virtualized Testbed for Embedded Networking Nodes (VTENN)

- Virtual nodes in PC environment, where each node execute the original embedded code

- Different nodes are running in parallel and are connected via so called virtual interfaces
Emulated Testbed

- Automated Physical TestBeds (APTB)
- Automated testing environment with physical networking nodes
- Wired connection of RF elements
- Antenna outputs to RF waveguide
- Static and dynamic path characteristics
Automated Test Flow

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Continuous Integration

Unified test case description

User Conference on Advanced Automated Testing
Example testcase – LPWAN & cIoT

- **System Tests**
  - Key performance metrics measurements
  - Functional behaviour tests

- **Protocol Tests**
  - NB-IoT L1 procedures
  - NB – IoT Initial Access
  - NB-IoT L2 procedure (RRC, NAS)

- **Performance measurements**
  - RF coverage
  - Signal quality
  - Packet loss rate
  - Payload flexibility
  - Energy consumption measurements

- **LPWAN & cIoT Test and Verification**
Conclusion

• Significantly contribute to fulfil the lack of seamless and unified test environment for distributed wireless networks

  • Novel unified function test environment architecture

  • unified test case description and test method

  • support to use same code branch on various test platforms