7th UCAAT User Conference on Advanced Automated Testing

ETSI

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

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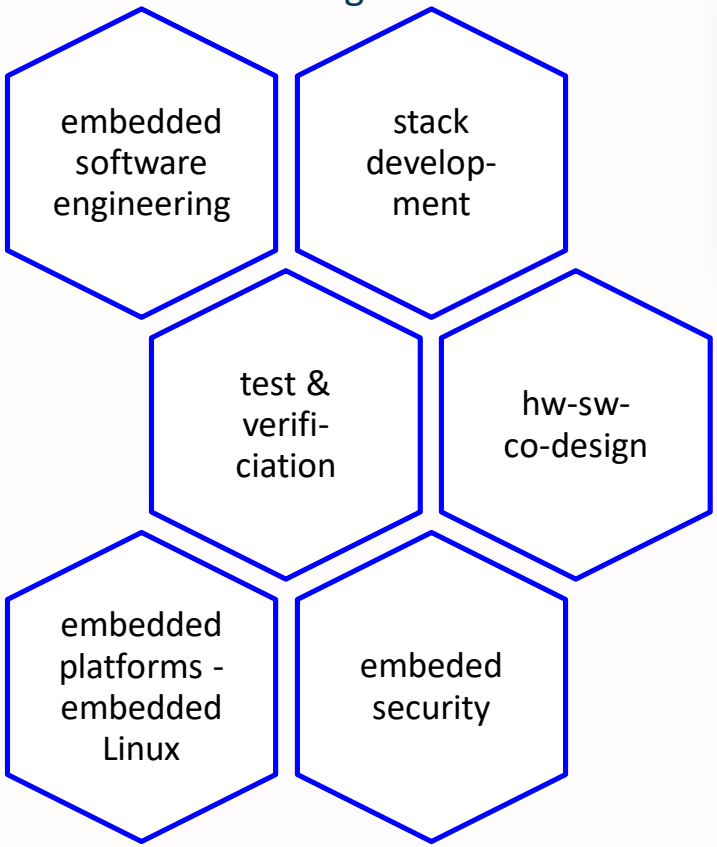
Who we are ?

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



Team: 12 full time engineers / PhD candidates
~10 graduate /under graduate students

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 use 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 usecase?

- 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 life 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

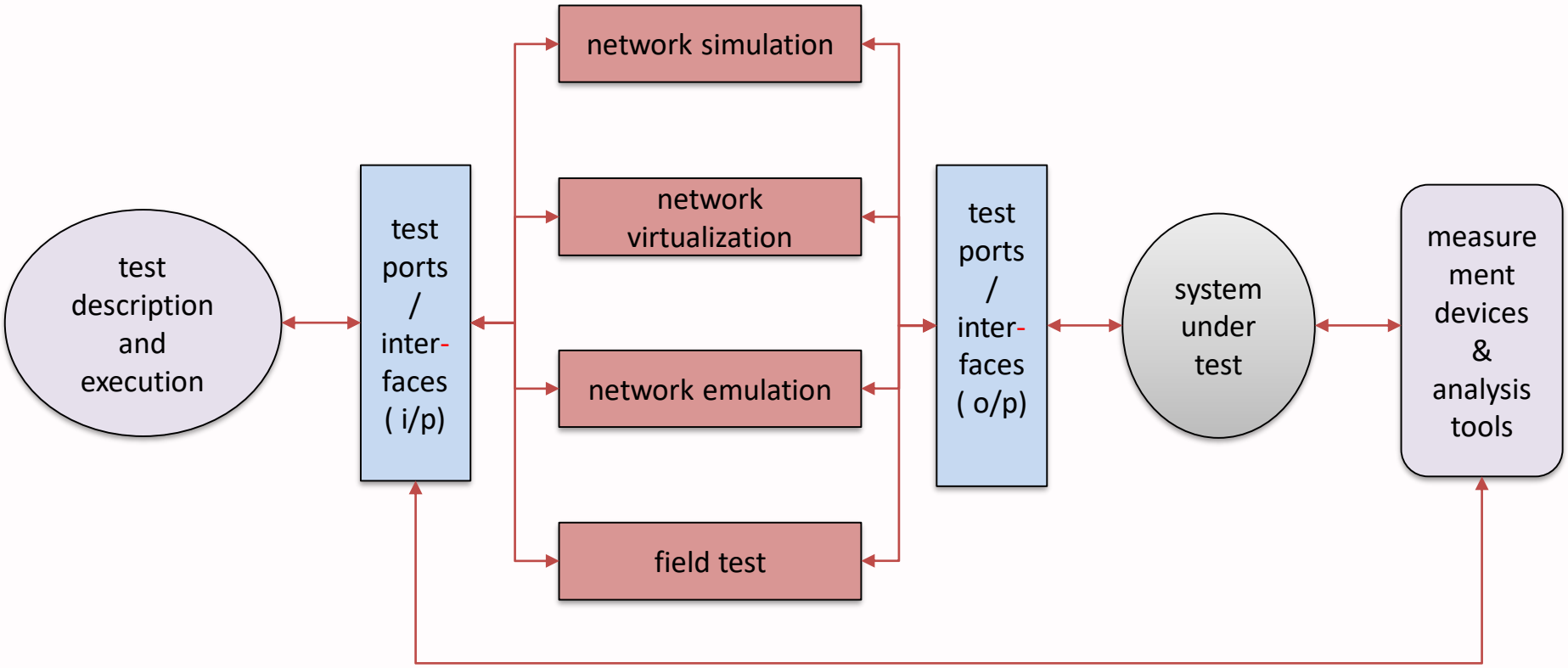
- Existing functional test solutions
  - technology specific
  - start testing at system level
- Generic test platforms with different levels of abstraction
- Testcases are described differently

System Aspects		Network Simulation	Network Virtualization	Network Emulation	Field Tests
Microcontroller	Protocol implementation	abstracted	real	real	real
	Hardware Abstraction Layer	abstracted	abstracted	real	real
Transceiver IC		abstracted	abstracted	real	real
Radio Channel		abstracted	abstracted	abstracted	real

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



Seamless and unified test environment - implementation

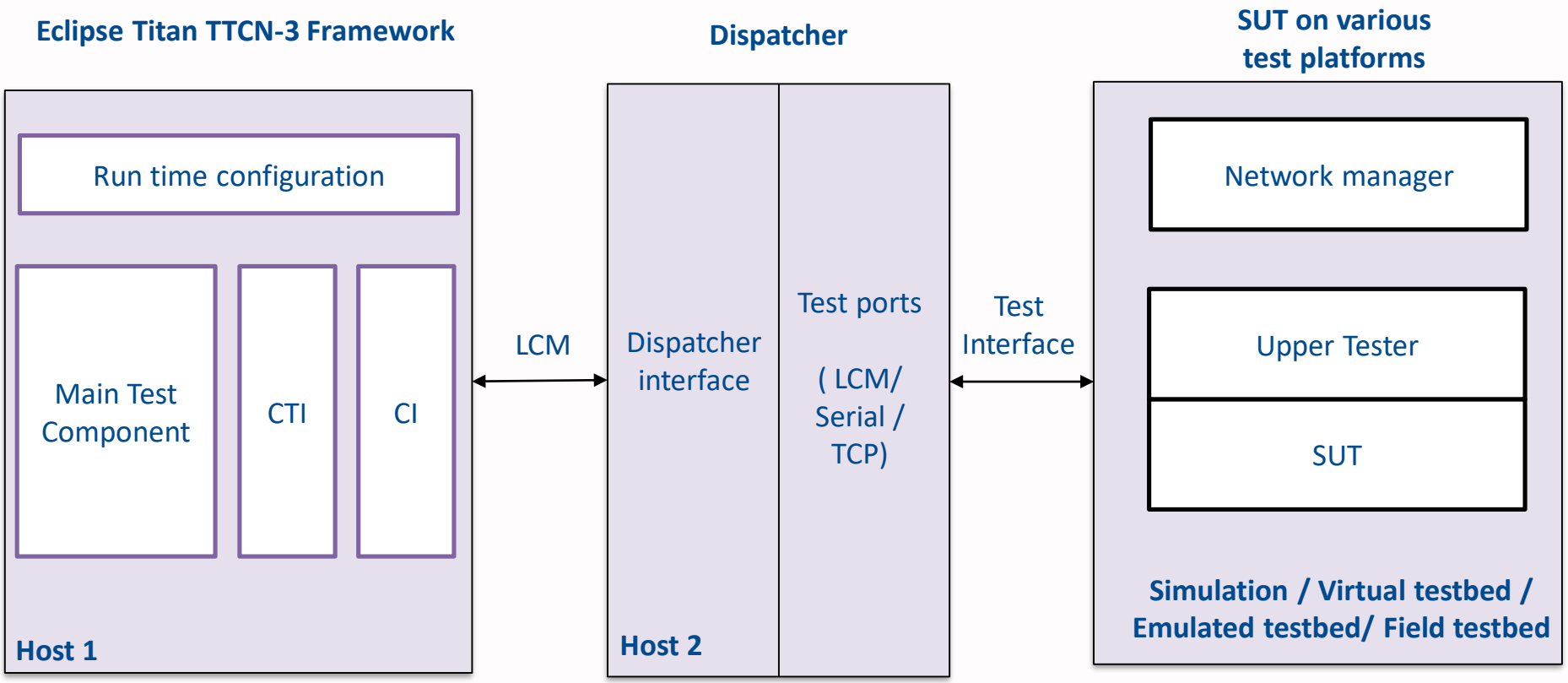
In house developments

Virtual Testbed for Embedded Networking Nodes (VTENN)

Automated Physical Testbed (APTB)

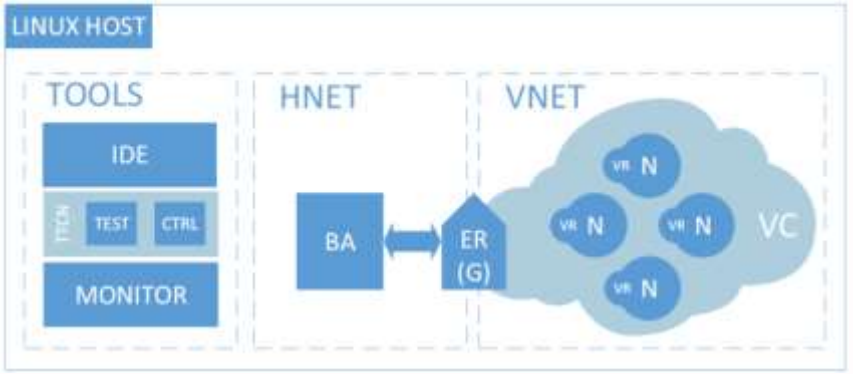
Logo Source https://www.nsnam.org
https://projects.eclipse.org/projects/tools.titan

Seamless and unified test environment – TTCN-3 Integration

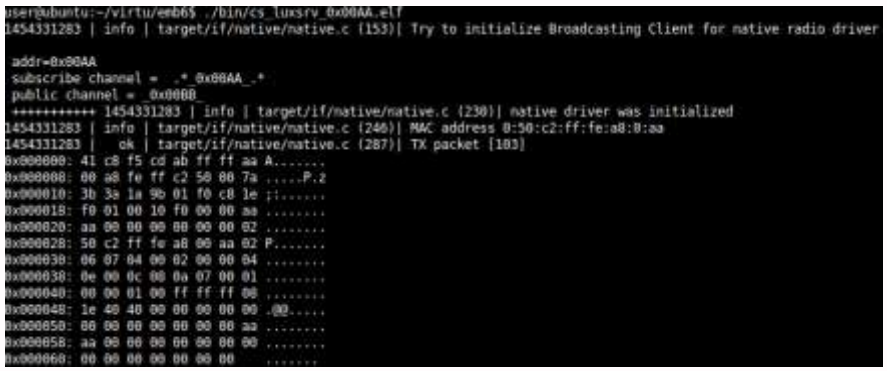


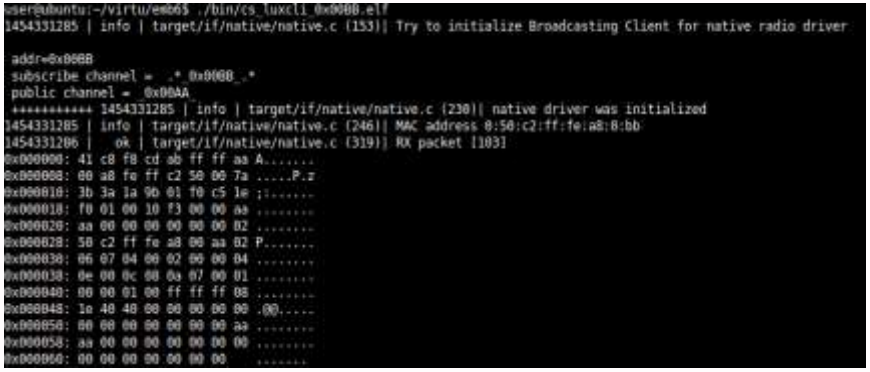
Virtual Testbeds

- 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



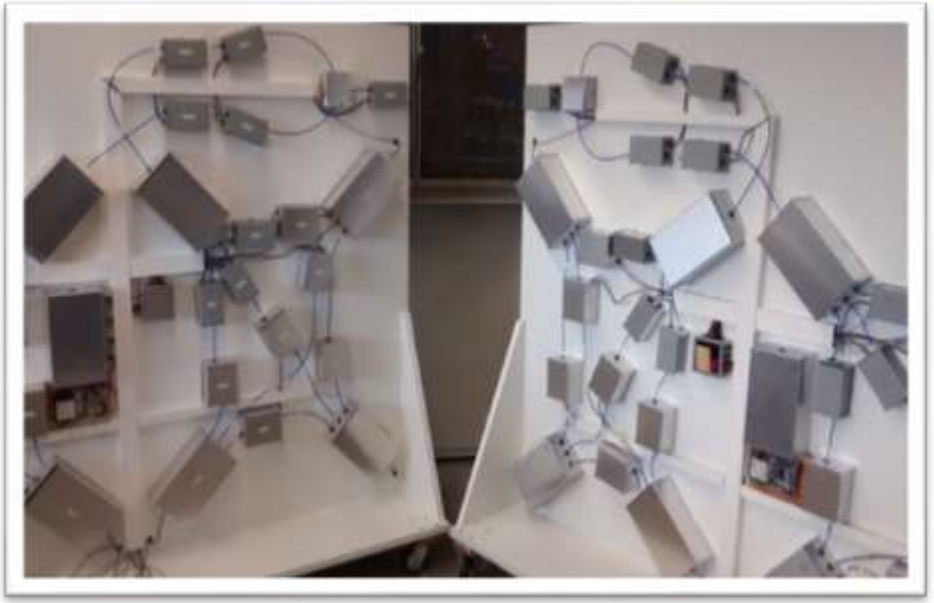
VTENN Architecture





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



Rear side of APTB

Front side of APTB

Automated Test Flow

Test Case Scenario Description

RF characteristics	Network topology	Application	Models (multipath/timing)

Configuration of SUT

Test Interface	Protocol statck	Measurement devices

Test Execution

Simulation	Virtual Testbed	Emulated Testbed	Field Testbed

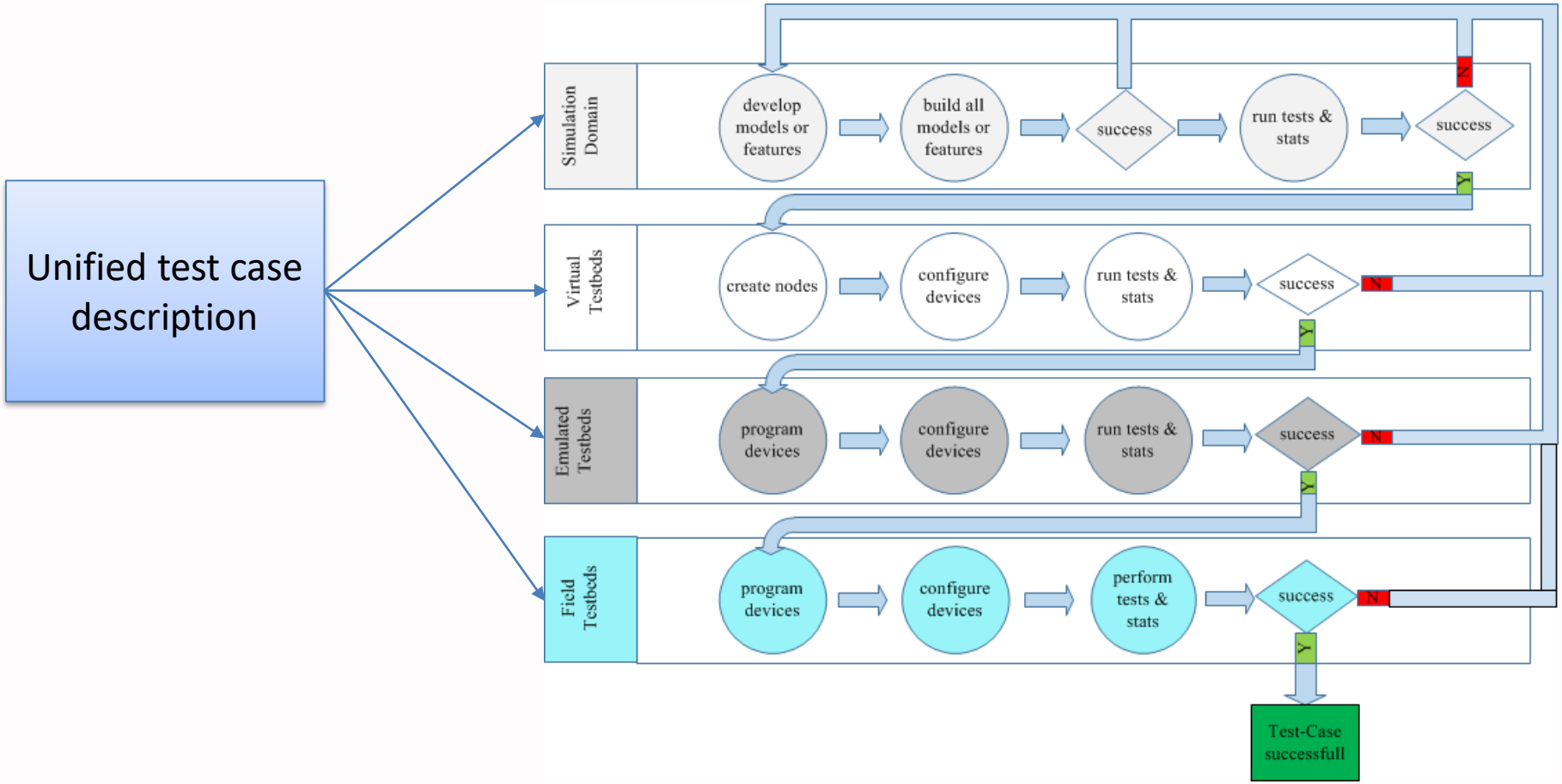
Monitoring and Measurements

Logs and Statistics	Signal /Spectrum/Power Analyzer	Wireshark / Priporitary analysis tools

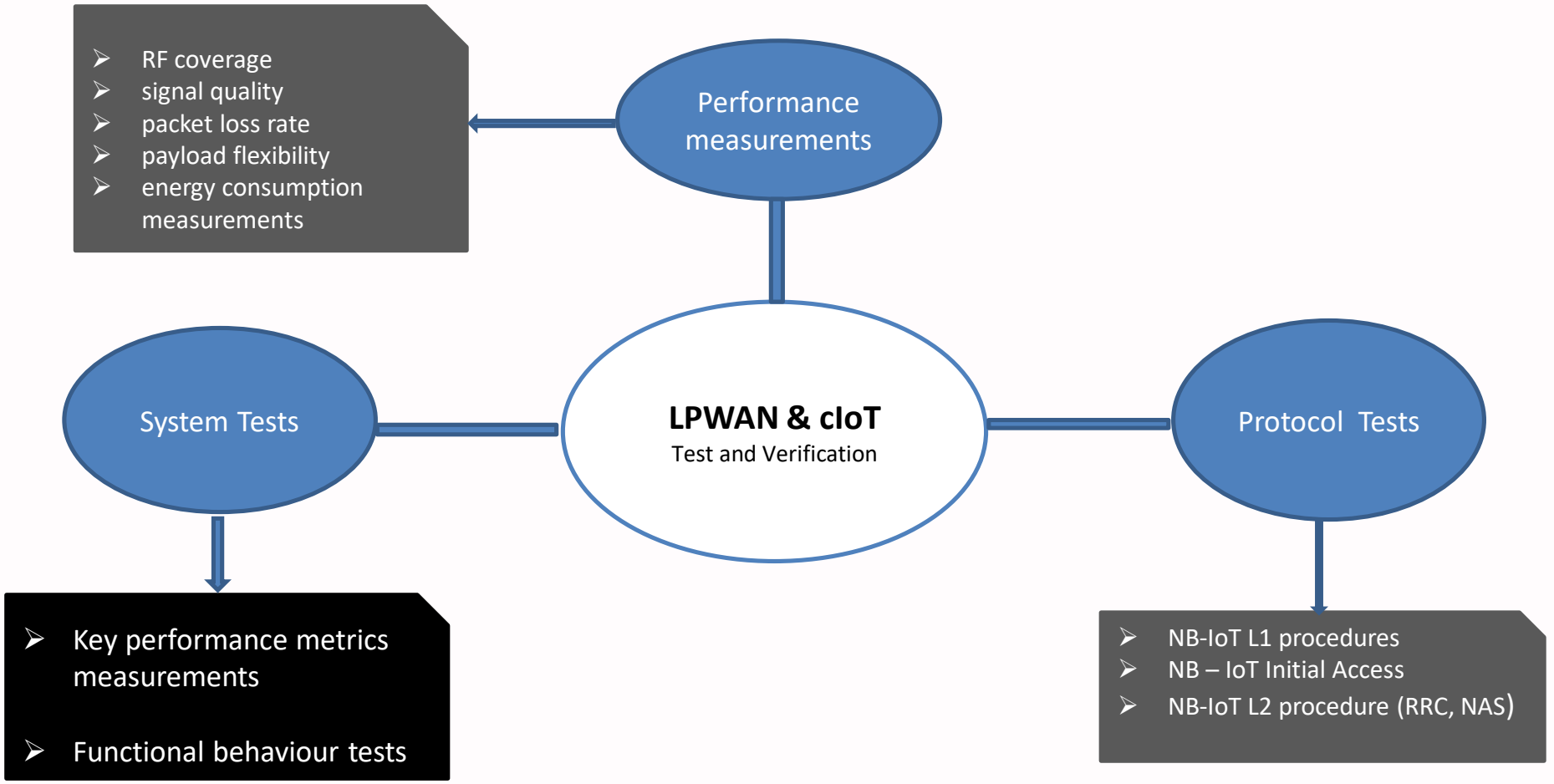
Test Result Analysis

System / Functional Tests	Performance Measurements	Protocol Verification

Continuous Integration



Example testcase – LPWAN & cIoT



Conclusion

- Significantly contribute to fulfil the lack of seamless and unified test environment for spatially 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

Thanks!
Q&A

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