# SIMULATION, TEST AND REFERENCE ENVIRONMENT FOR MOBILE IP BASED HETEROGENEOUS COMMUNICATION NETWORKS

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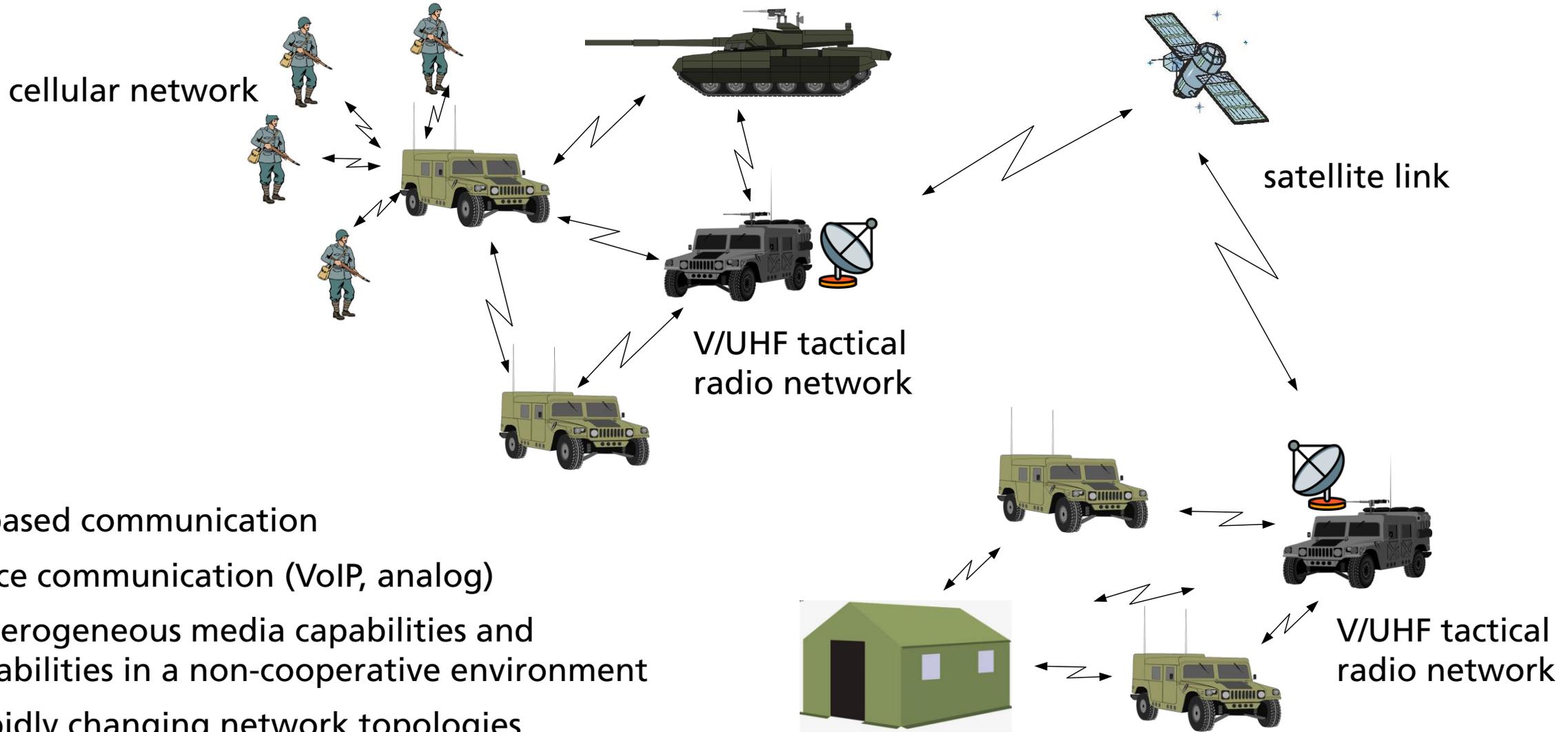## Fraunhofer

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# SIMULATION, TEST AND REFERENCE ENVIRONMENT FOR MOBILE IP BASED HETEROGENEOUS COMMUNICATION NETWORKS

**Outline**

- Motivation
  - Future tactical communication requirements
  - Challenges of heterogeneous communication networks
  - Digitalization of German Bundeswehr Land-based Operations (D-LBO)
- Architecture of simulation, test and reference environment
- Test software: From test case to test results
- Benefits of the simulation, test and reference environment
- Conclusions and outlook

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# Examples of Future Tactical Communication Requirements



cellular network

V/UHF tactical
radio network

satellite link

V/UHF tactical
radio network

- IP based communication

- Voice communication (VoIP, analog)

- Heterogeneous media capabilities and
  reliabilities in a non-cooperative environment

- Rapidly changing network topologies

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# Motivation: Simulation-, Test and Reference Environment

Challenges of integrated networks: **Complexity**

- System of systems

- Heterogeneous networks with various transmission technologies

- Mobile and dynamically changing non-cooperative environment (low bitrates, occasional high latencies, disruptions)

Risks:

- No or limited interoperability in between systems and components

- Limited end-to-end performance of the interconnected heterogeneous communication technologies

- Limited performance of the different communication technologies themselves

- High financial risk/ effort in case of a system's replacement within the system-of-systems

➔ Requirement for comprehensive and extensive system testing BEFORE, DURING and AFTER fielding
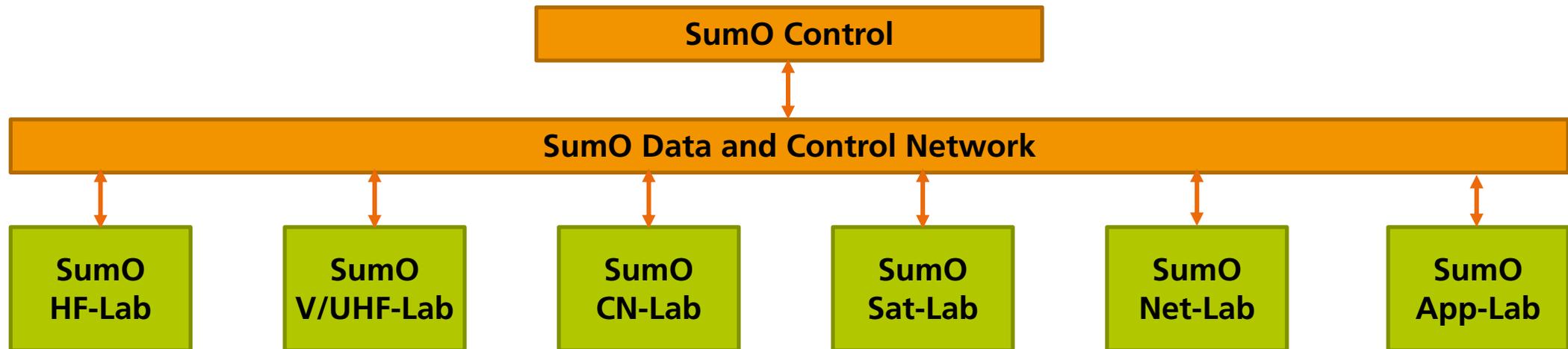
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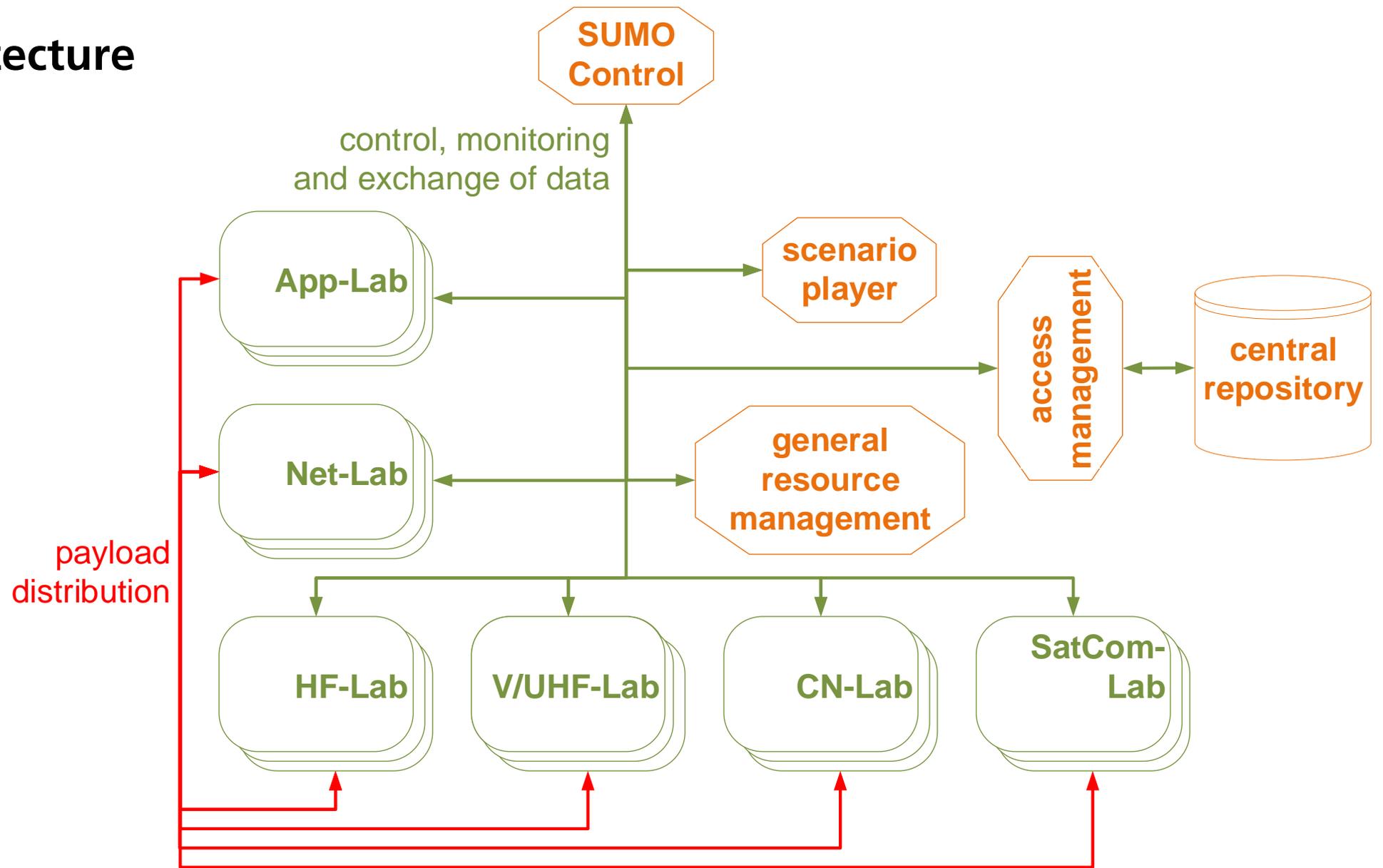# D-LBO: Digitalization of German Bundeswehr Land-based Operations



T. Sierksma, M. Rother: D-LBO: Digitalisation of German's Ground Forces' Operations and why it Matters for the Netherlands, intercom 47/2, 2018

# SumO – Simulation, Test and Reference Environment for Heterogeneous Networks
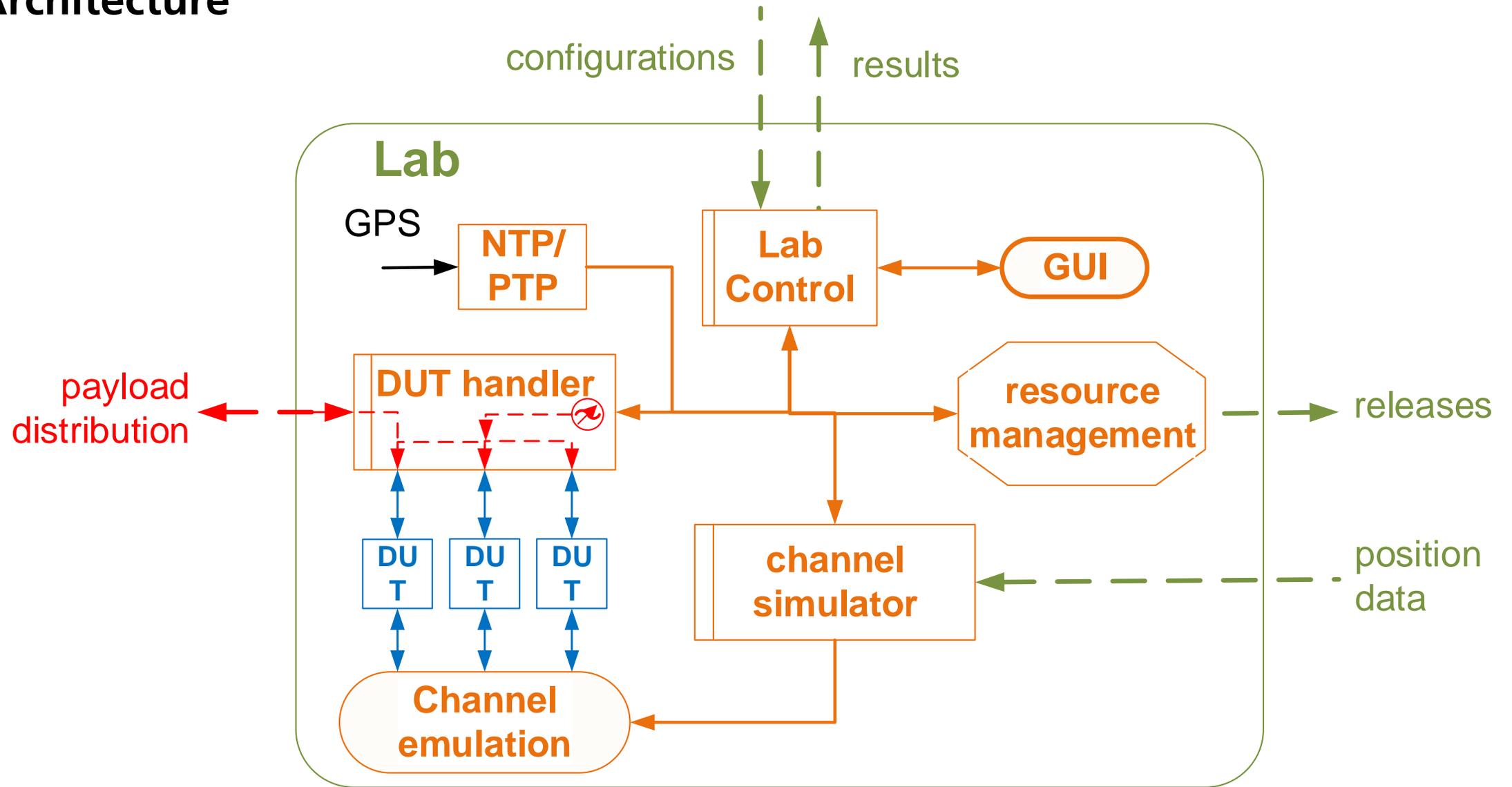
- Tests of
  - Individual devices in a system's context
  - Systems of a single type of devices in a system-of-systems context
  - the overall system summing up to hundreds of radio, networking, and application devices of different types
- Integration of multiple technology-specific labs via one over-all framework providing modularity and extensibility
- Utilizing virtualization of devices jointly with hardware-in-the-loop
- Synchronized, rule-based triggering of DUTs and state recording throughout the labs integrated in the framework

**SumO Control**

**SumO Data and Control Network**

| SumO HF-Lab | SumO V/UHF-Lab | SumO CN-Lab | SumO Sat-Lab | SumO Net-Lab | SumO App-Lab |

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# Overall Architecture

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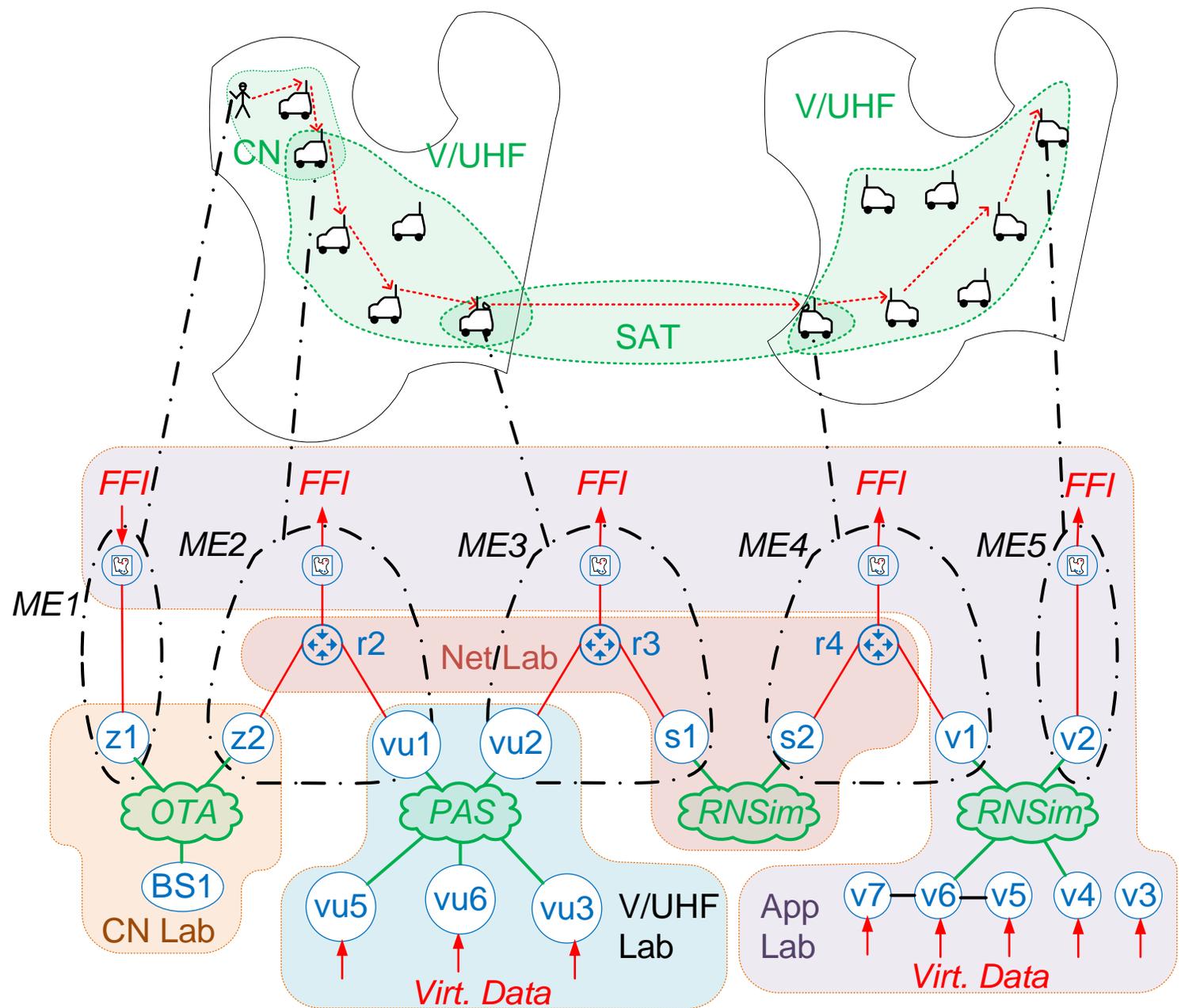# Lab Architecture

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# Exemplary Test Case

CN – Cellular Network

ME – Mobile Entity

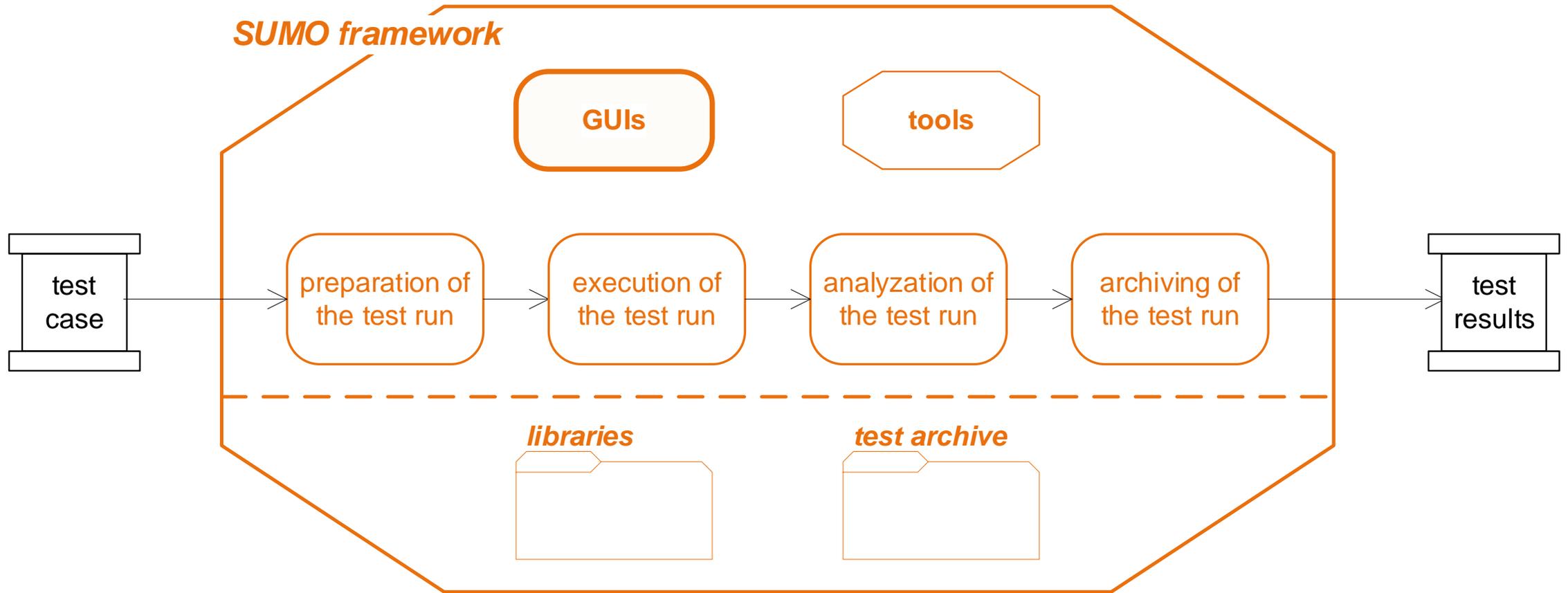FFI – Friendly Force Information

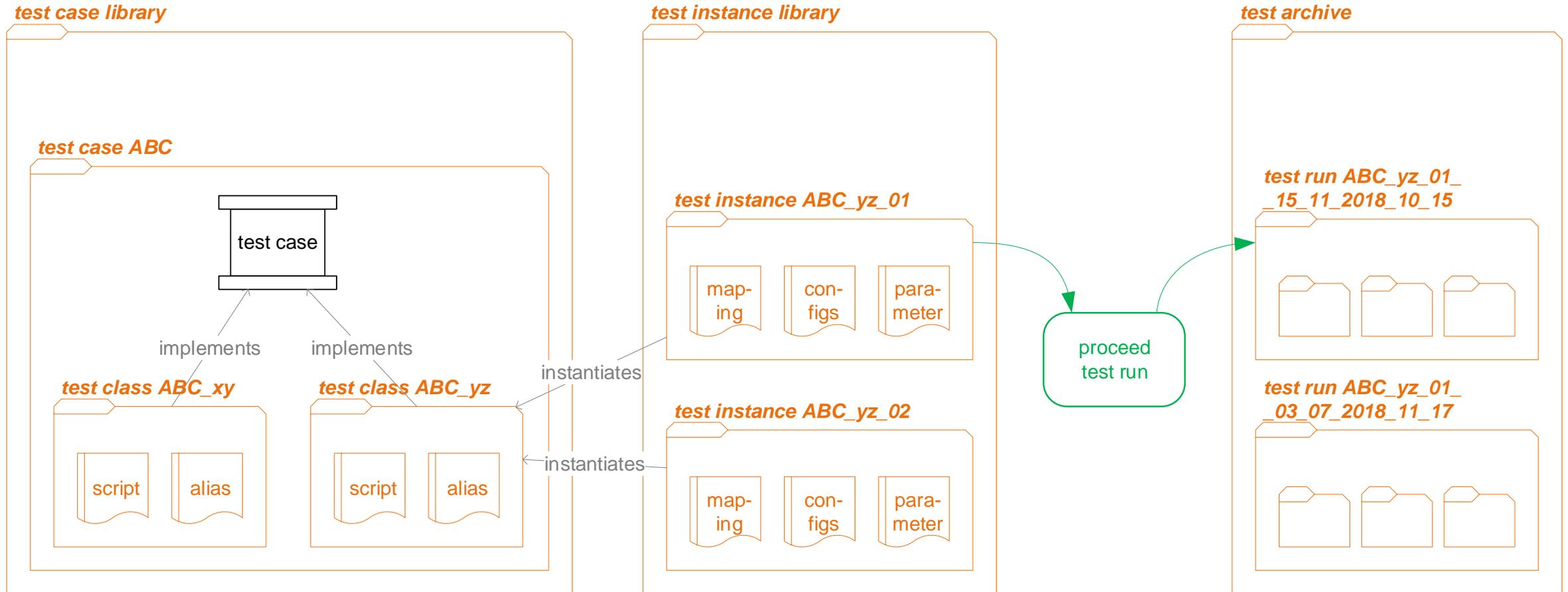PAS – Path Attenuation Simulation

RNsim – Radio Network SIMulation

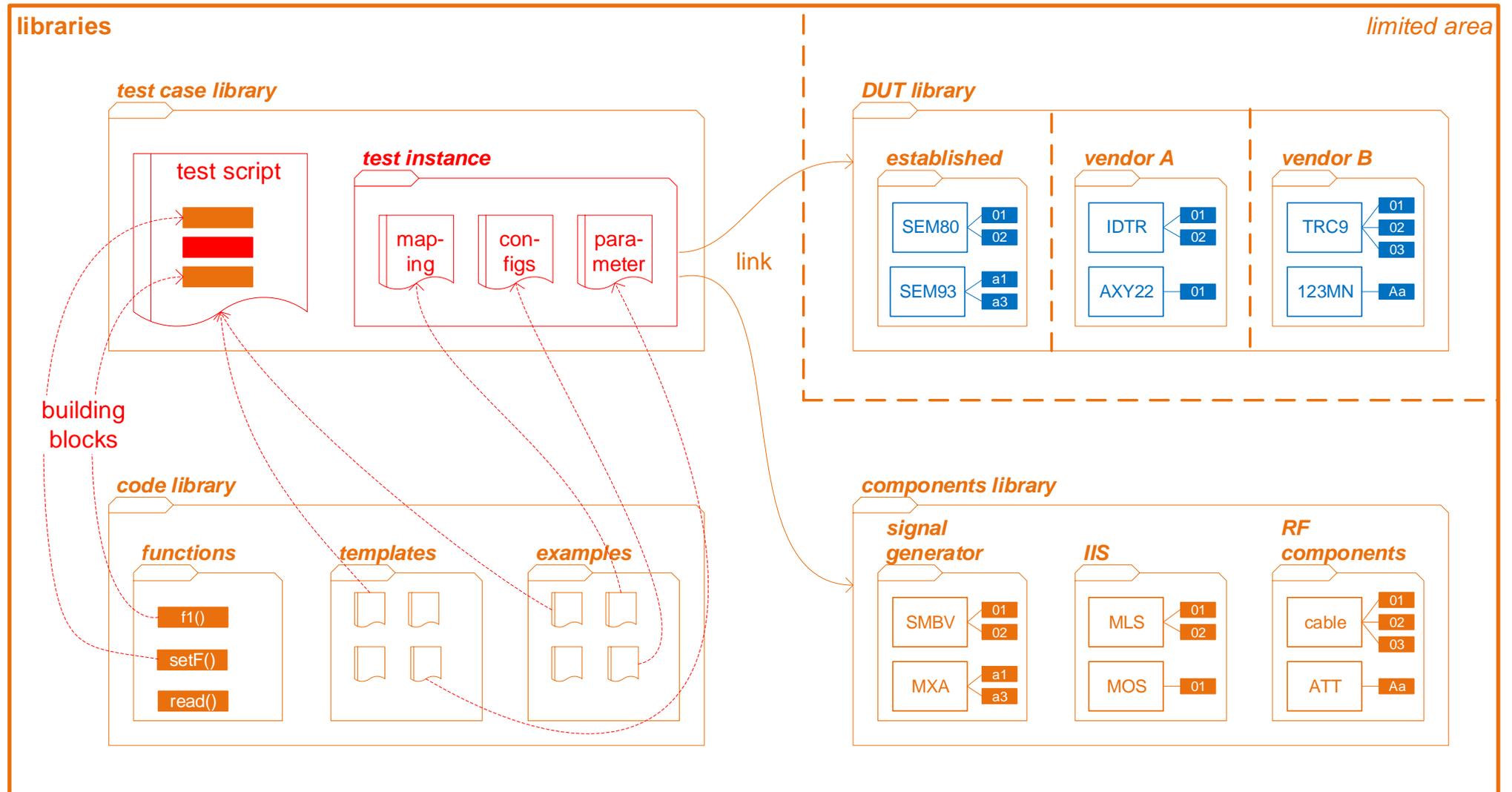Fraunhofer

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# From Test Case to Test Results
## Overview

# From Test Case to Test Results
## Test Instance

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# From Test Case to Test Results
## Libraries



**libraries**

*limited area*

**test case library**

test script

**test instance**

map-ing    con-figs    para-meter

link

**DUT library**

**established**

SEM80   01 02

SEM93   a1 a3

**vendor A**

IDTR   01 02

AXY22   01

**vendor B**

TRC9   01 02 03

123MN   Aa

building blocks

**code library**

**functions**

f1()

setF()

read()

**templates**

**examples**

**components library**

**signal generator**

SMBV   01 02

MXA   a1 a3

**IIS**

MLS   01 02

MOS   01

**RF components**

cable   01 02 03

ATT   Aa

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# Benefits of the Simulation-, Test and Reference Environment

- Support during analysis, design and configuration of the network of technically heterogeneous networks

- Acceptance tests of components, profiles and applications

- Integration and interoperability tests prior to the roll-out of updates, upgrades, and replacing/new systems to the field as part of projects' Change and Release Management Processes

- Support of a Configuration Management Database

- Non-proprietary component and system tests for benchmarking within the specifications or requirements

- Unbiased, objectively comparable and reproducible test results

- Validation of new configurations within the system-of-systems

- Fault analysis under realistic emulations/ simulations and reproducible environmental conditions

- Script-based test automation and evaluation

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# Conclusions and Outlook

- Before SumO, there was no means of reproducible testing of multiple interacting devices in large, heterogeneous dimensions.

- Introducing virtualization of communication devices for scalability reasons is both technically and economically as well as time efficient.

- The SumO framework will provide a repository

  - of all relevant parameters and

  - technical interdependent capabilities and configurations

  - of all tested devices

  that can be utilized as blueprints for initial mission configurations.

- Current status: feasibility study to provide full proof-of-concept within the next 12 months.

- SumO applies to D-LBO and TEN for enabling the technical validation and verification throughout the programs' systems' life cycles.

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# SumO
## Current implementation of the V/UHF-Lab
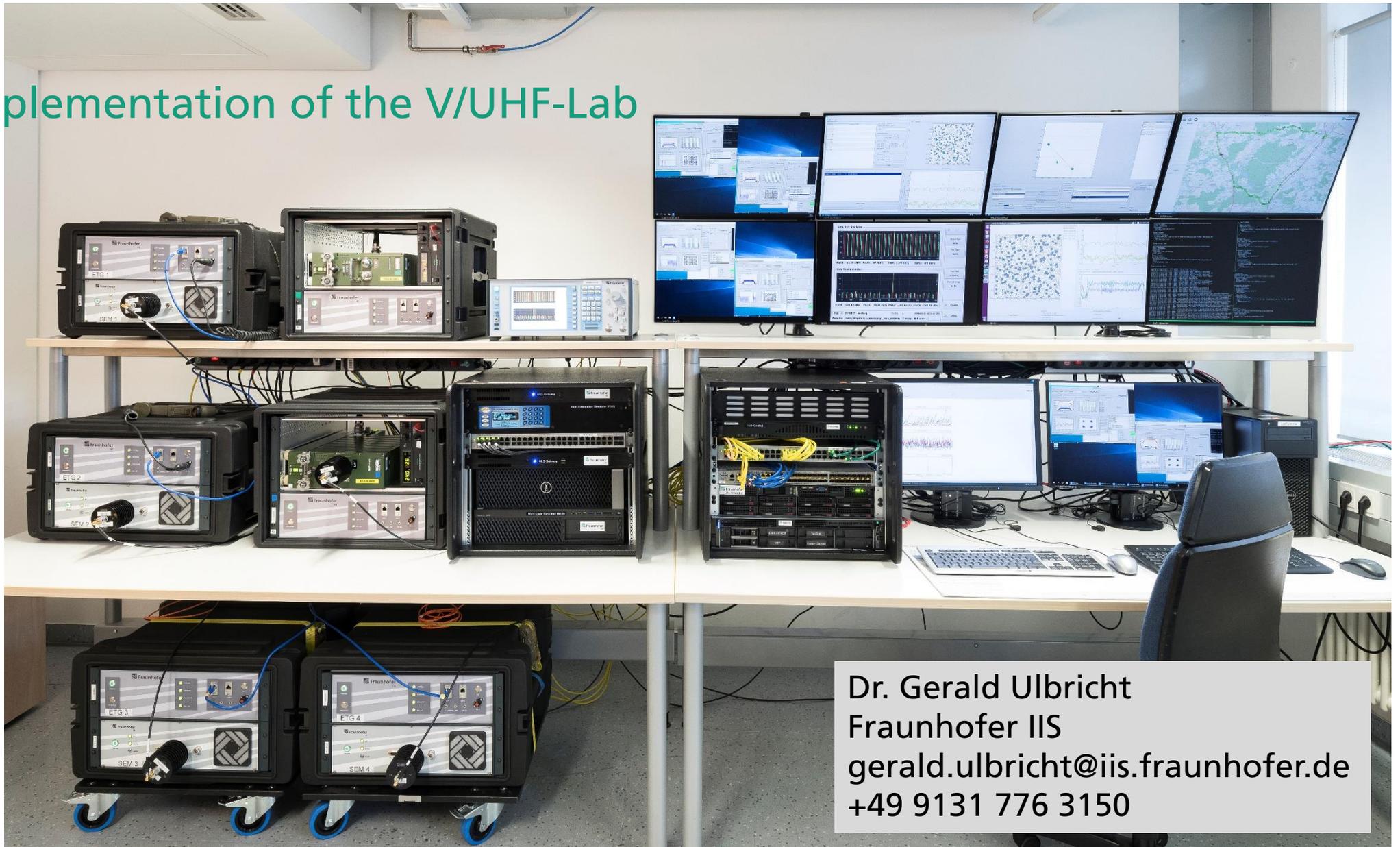
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