Building CitySim

Digital twin for AI validation in Network management

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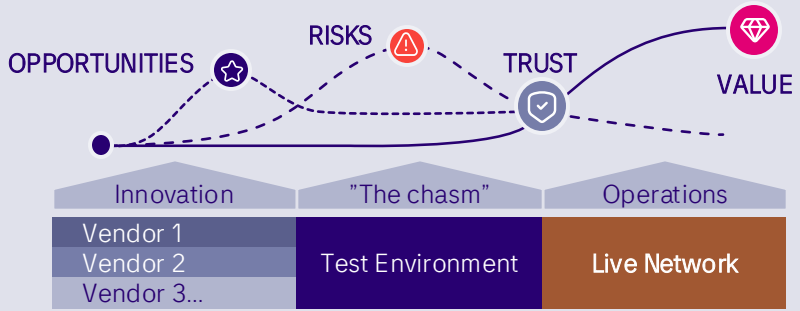
Summary: A unique validation method for intelligent and autonomous networks

Today

An integrated digital twin based on existing and proven assets



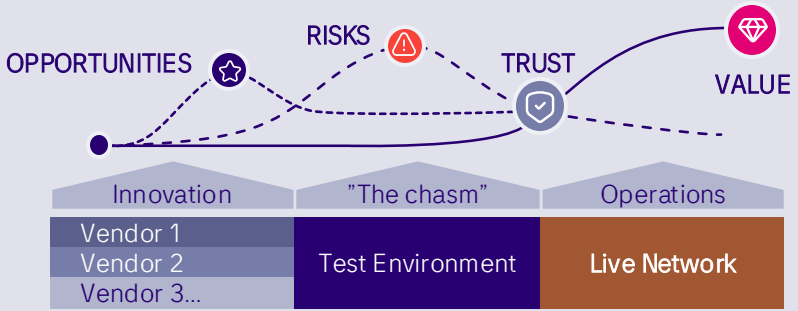
(Static) Traffic modelling	AI based User & Service centric modelling to synthesize realistic traffic
Lack of data	Digital twin: Training on synthetic data
Cumbersome validation analysis	AI based behavioural analysis. Quality assurance of models

Summary: A unique validation method for intelligent and autonomous networks

Today

An integrated digital twin based on existing and proven assets

Impact on Operator



(Static) Traffic modelling

AI based User & Service centric modelling to synthesize realistic traffic

Lack of data

Digital twin: Training on synthetic data

Cumbersome validation analysis

AI based behavioural analysis. Quality assurance of models

Lower cost of operating networks through more rapid deployment of autonomous networks

- → Value effect understood
- → Ability to validate what-if scenarios
- → Generate synthetic data for training of AI functionality

Increase revenues by earlier evolution towards intelligent autonomous networks

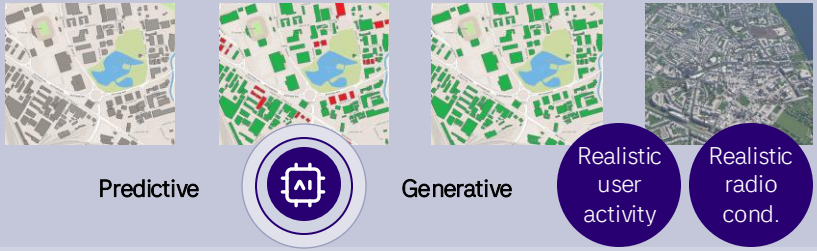
- → Enables new services
- → Ability to elaborate on QoS vs resource efficiency

Promising Results

Leverage on Digital Twins and AI to realize the solution

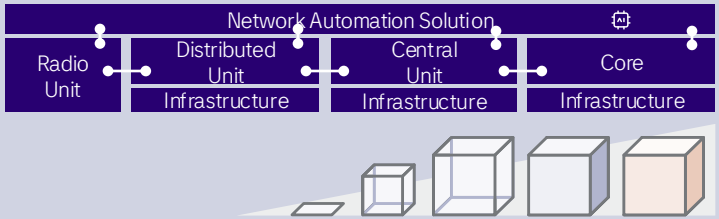
A trinity of models in celestial harmony with AI/ML

World model evolution



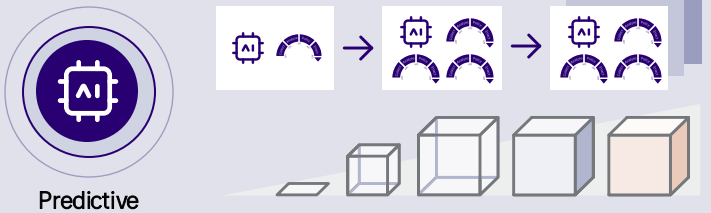
TRUST

Network model evolution

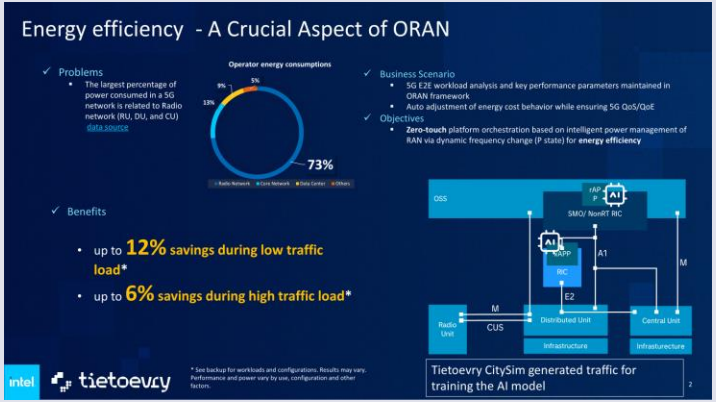


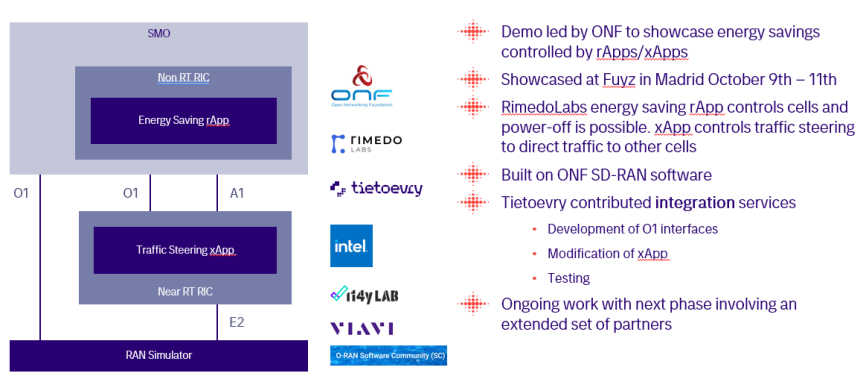
System Events

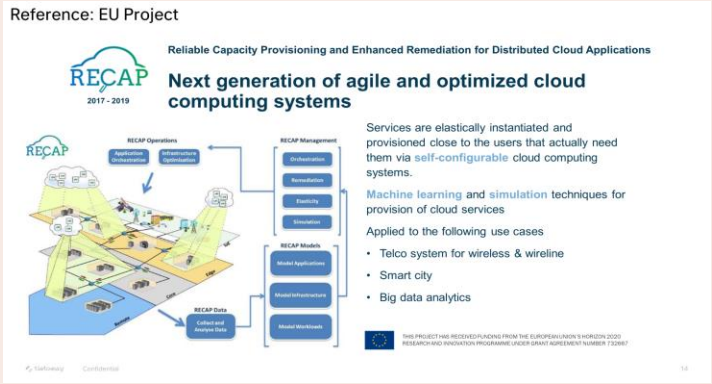
System behavior model evolution



We are good at custom digital twins' development and integration







Demo Introduction – Stadium Scenarios

- Users entering and leaving Serving Area (cells) according to model
- rApp monitors Serving Area load (PRB usage)

Normal Scenario

Low load in Serving Area:

- Load is below threshold
  → rApp selects cell according to priority
  → rApp enables cell barring
- Traffic steering moves users to other cells
- Barred cell is empty → rApp turns off cell

High load in Serving Area:

- Load is above threshold
  → rApp selects inactive cell
  → rApp disables cell barring
  → rApp turns on cell

Validator continuously checks rApp behavior and detects no anomaly

Abnormal Scenario 1

Low load in Serving Area:
Barred cell still have users → rApp turns off cell too early

Validator detects anomaly

Abnormal Scenario 2

Low load in Serving Area:
Load below threshold → rApp does not turn off cells

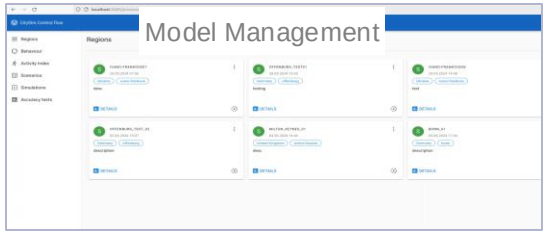
Validator detects anomaly

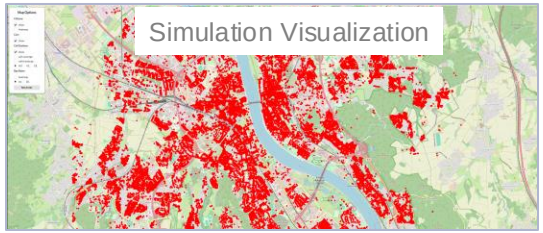
Abnormal Scenario 3

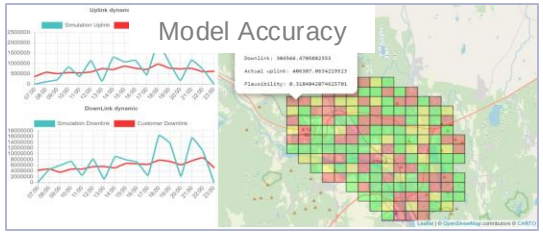
High load in Serving Area:
Load above threshold → rApp does not turn on cell

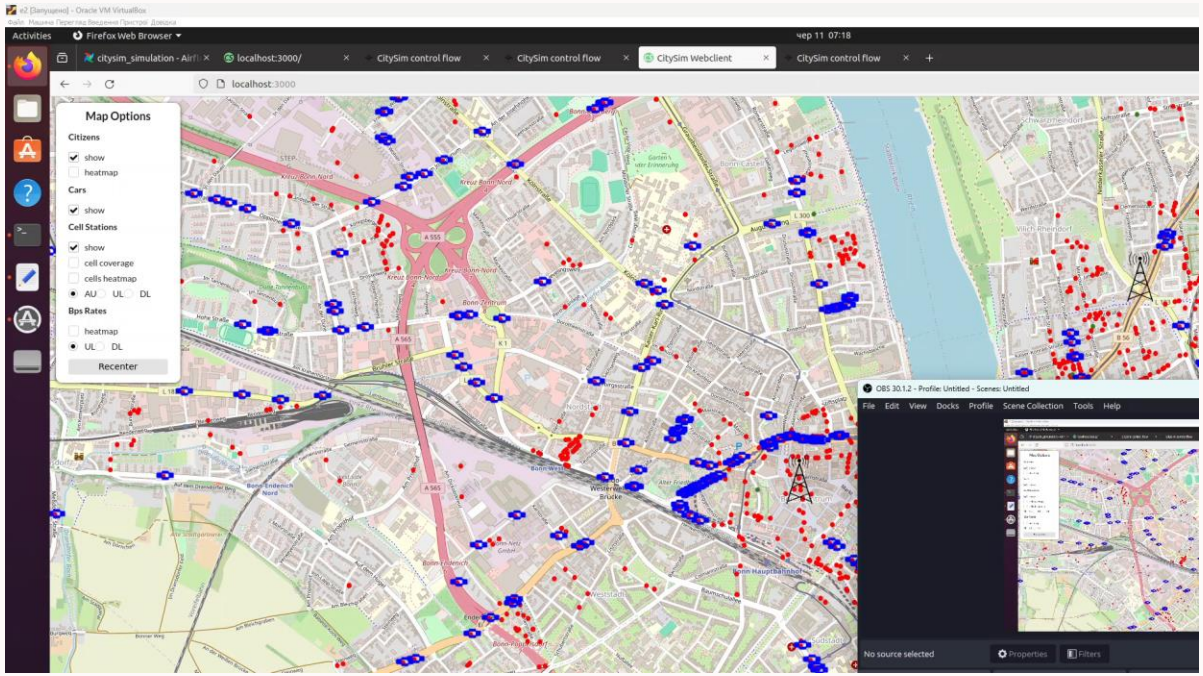
Validator detects anomaly

Demo: CitySim

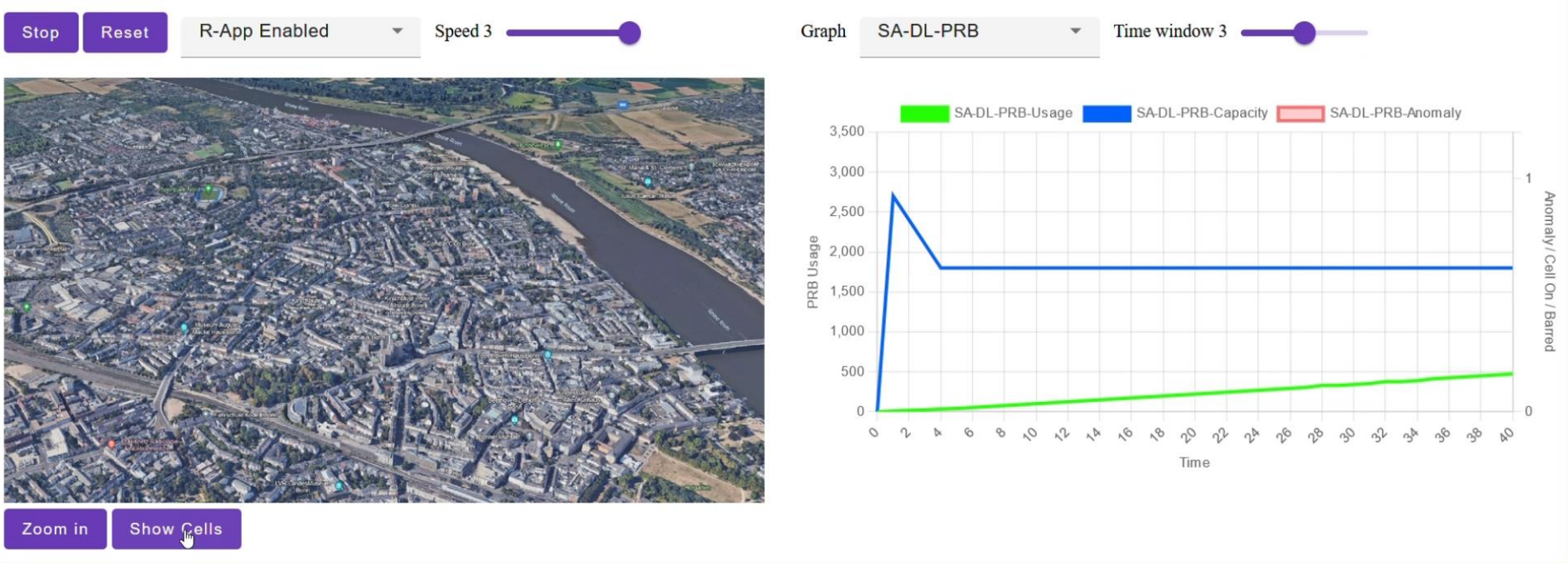




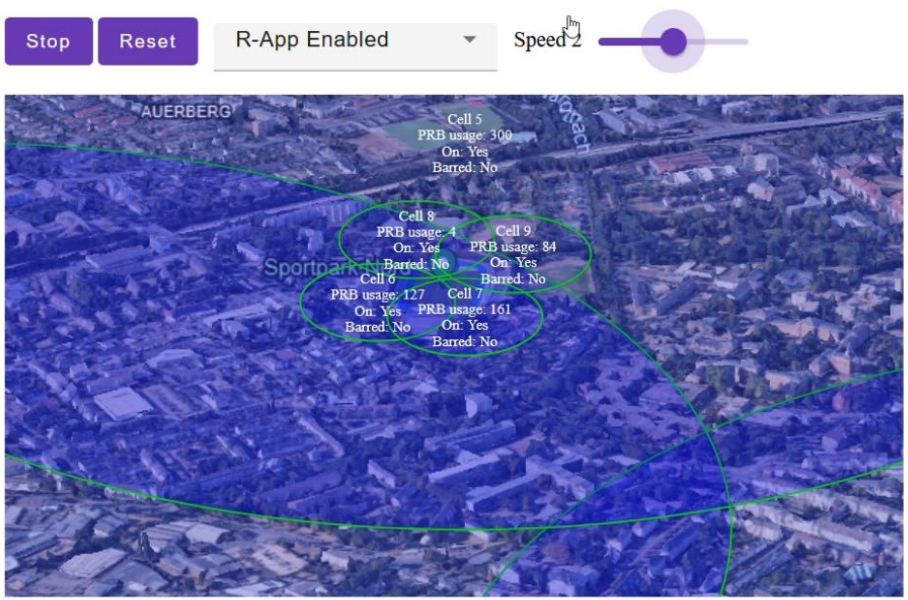


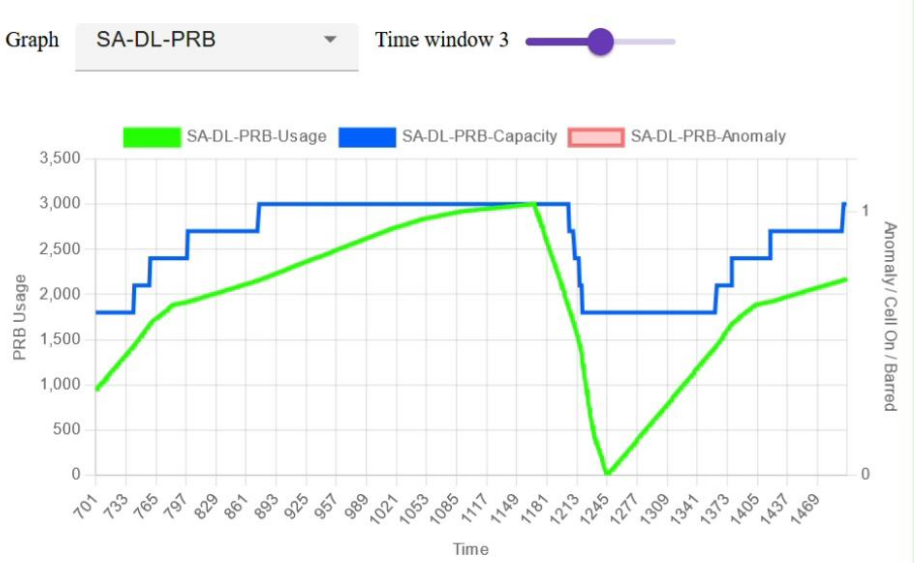


Demo: Normal Scenario



Demo: Abnormal Scenario 1





Demo Summary – Scenarios

Normal Scenario

Abnormal Scenario 1

Abnormal Scenario 2

Abnormal Scenario 3

Digital Twin

- Serving area with 10 cells
- 10 000 users

Validator detected all anomalies in run-time

- 100% of synthetic anomalies detected
- Detection within 0.5 second

Validator approved the “normal” scenario with no false negatives.

- Effort for adaption: 24 hours (based on existing solution)
- Time for training: 15 seconds on laptop (34 parameters per serving area)

Q&A time

Thank you for your attention

Let's build TRUST in AI together

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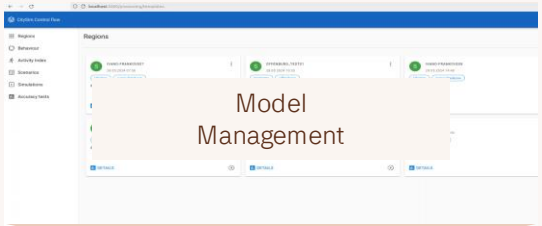
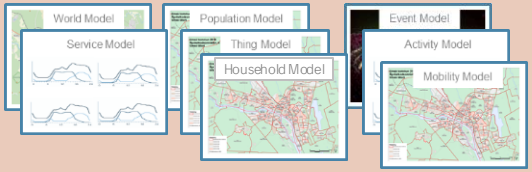
Backup slides

CitySim (as a digital twin)

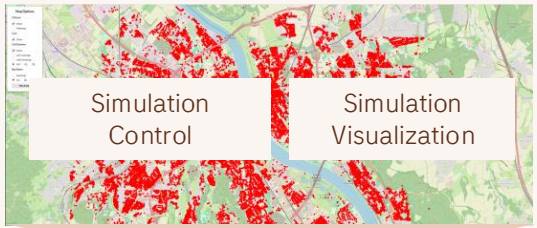
Modelling



Data Collection & Analytics

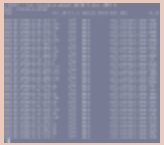


Simulation

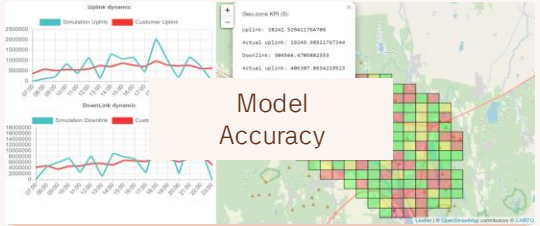


Simulation Core

Population
Household distribution
Service Usage
User Mobility
Traffic Model



Model Validation



Model Validator

Trust in Models

Models' KPIs (Space & Time)

Real-life datasets

What-If-Scenarios

Positive Events

Negative Events

Concert, Game

The Automation Solution

The Stack

Users

Traffic / OTT Services

Radio Network

Application

Physical Platform

Cloud Platform

Cloud Infrastructure

Site

Transport

Energy

Workloads

Constraints

Terrorism

Data center attack

Attack on Energy Infrastructure

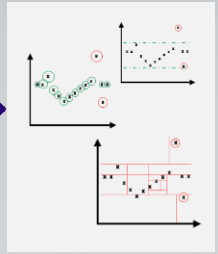
Vandalism

Ongoing projects – System behavior analysis

KPI analysis

Live network

SBA



Functional behavior analysis

System under test

SBA

Automatic fault classification

Continuous Integration

SBA

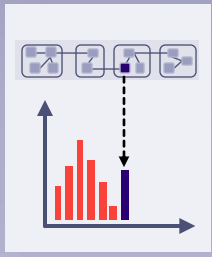
Old faults

New fault

Delay/bottleneck analysis

Continuous Integration

SBA



RAN Simulator realized with TietoEVRY 5G Testbed

Component Overview

Features

User behaviour modelling
- Static, Semi-static, Dynamic traffic models
- Explore what-if scenarios

User experience measurements

Radio condition modelling

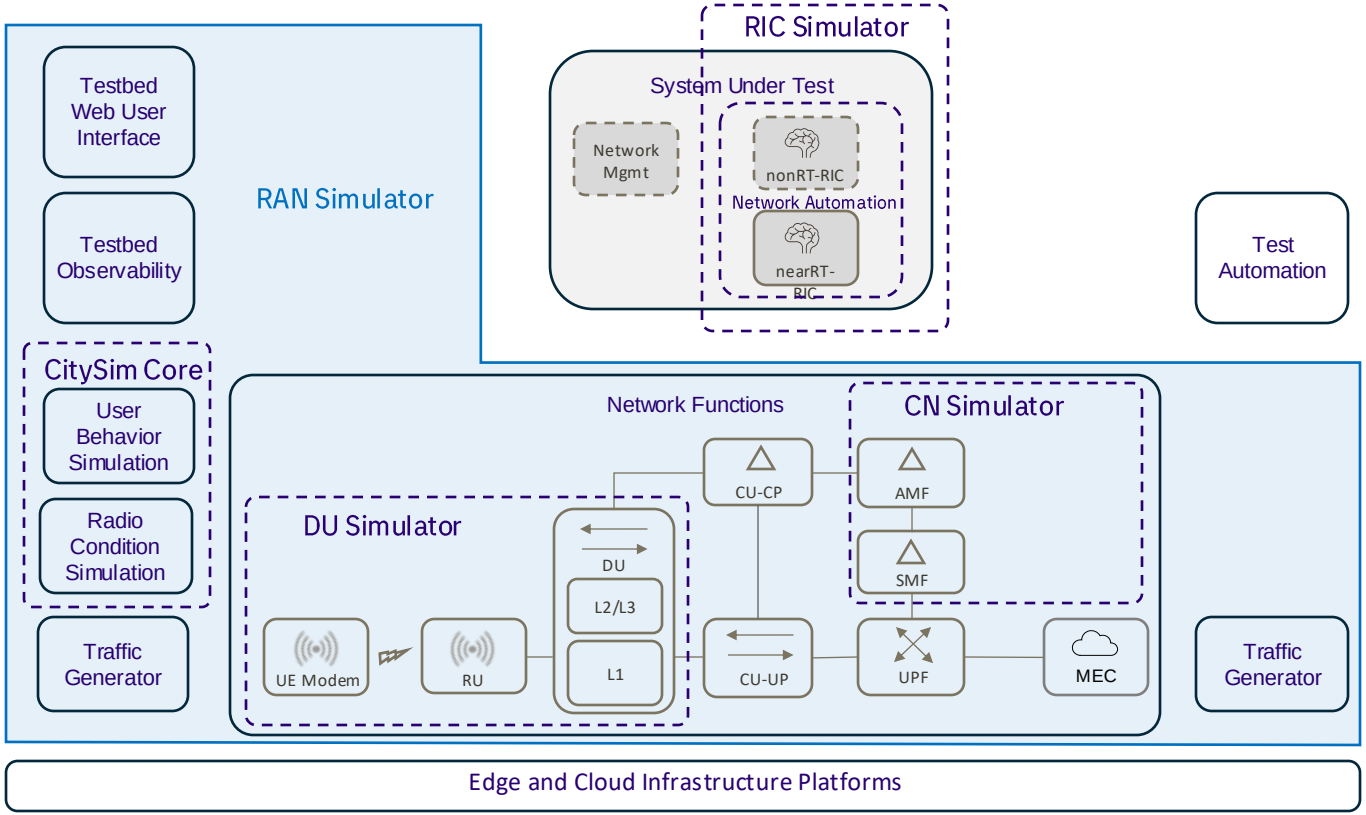
RAN network modelling
- Cell plans
- Network function models

RAN dynamics & resilience
- NF placement & scaling
- Load balancing
- Redundancy

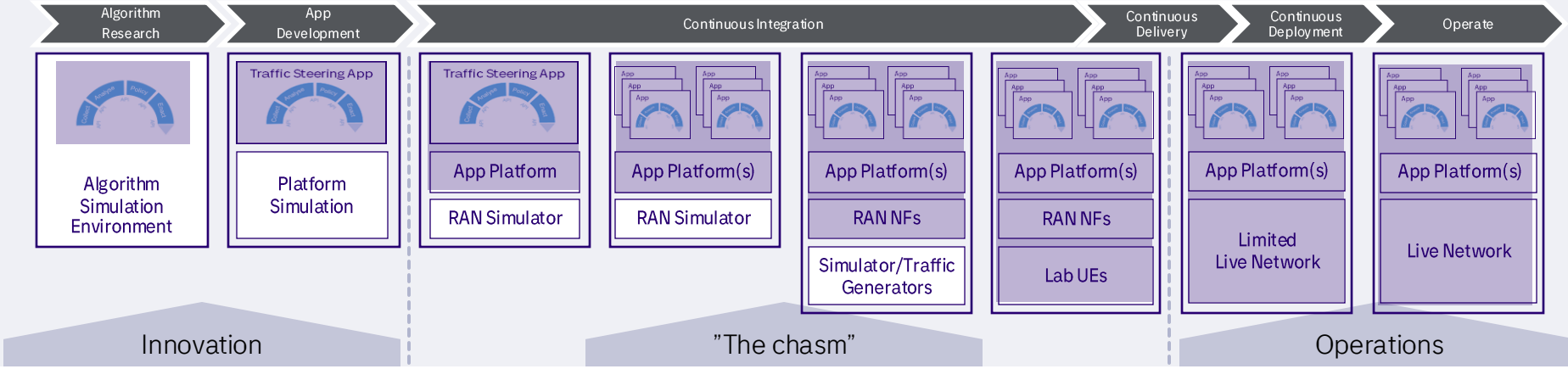
Infrastructure modelling
- Data centres
- Transport networks

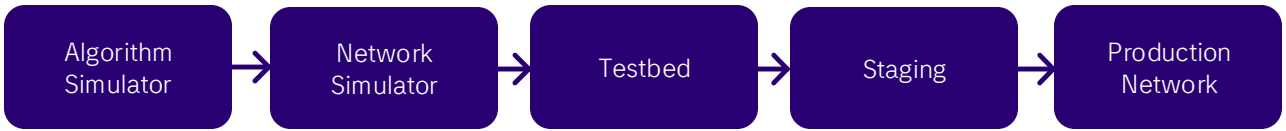
Capacity
- Cells
- Users
- Network Functions

Performance
- High performance packet processing



Building trust require realistic dynamics, and what-if scenarios to be captured



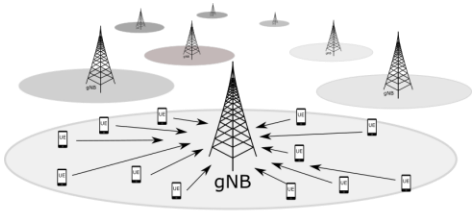


System behavior analysis (SBA)

2018 → 2023

Research

- Anomaly detection
- Root cause analysis
- Observability
- Failure prevention



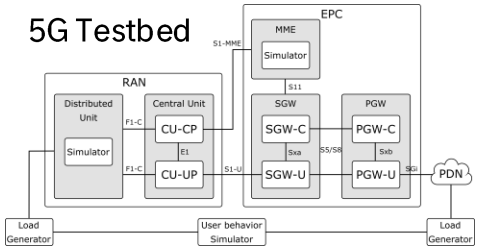
Radio Access Network

2021

Applied to Cloud RAN

- Analysis in Continuous Integration tests
- Analysis of Production network

5G Testbed

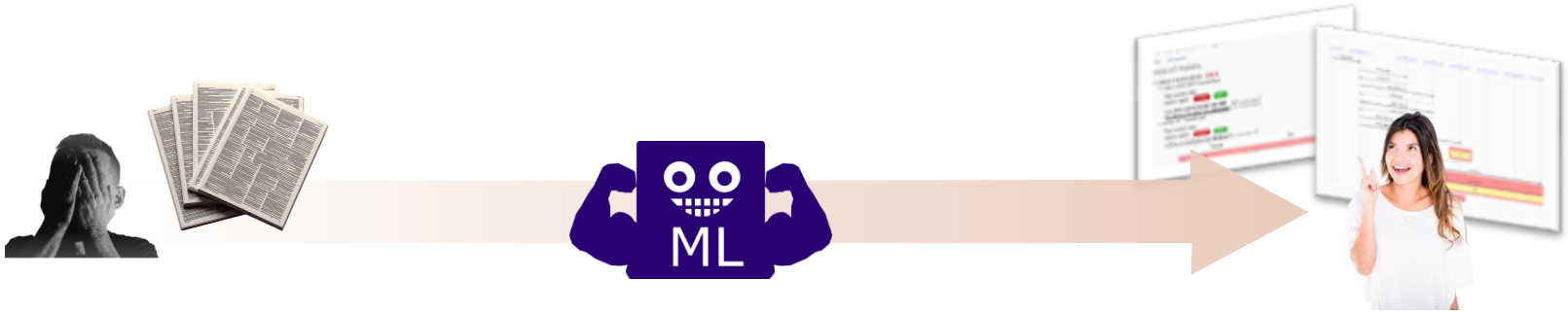


Traditional log analysis

- Manually analysis of large logs.
- Trouble shooters have knowledge of a small part of the system.
- Little or no visibility of the system behavior.
- Experts are needed to analyze and take accurate routing decisions.

System Behavior Analysis (SBA)

ML assisted troubleshooting



SBA learns the behavior from logs and
assists end-users in their troubleshooting

Ongoing projects – KPI analysis

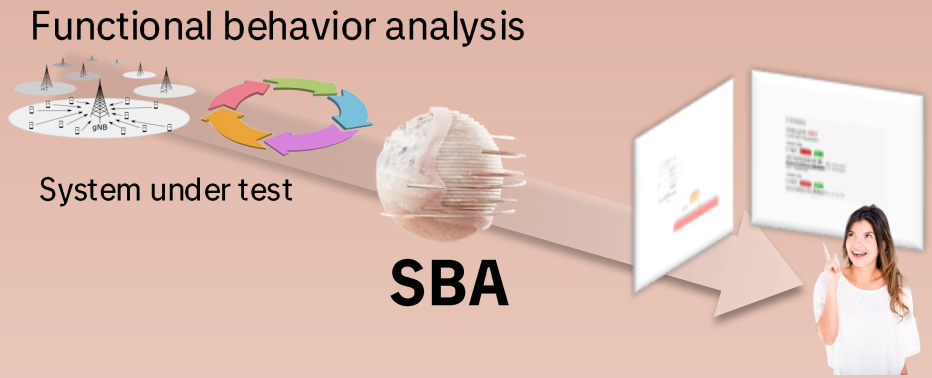
Problem

- KPI's are validated manually or by rule based systems.
- Difficult to understand the complex dependencies between KPIs

- **Unsupervised –** Help end-users to find KPI that are deviating. The non-deviating KPI periods can be used to learn the successful functional behavior.

- **Supervised –** Learn characteristics from KPI/metrics when functional behavior is normal. Predict behavior on new test data to help end-users to identify the type of deviations.

Ongoing projects – Functional behavior analysis

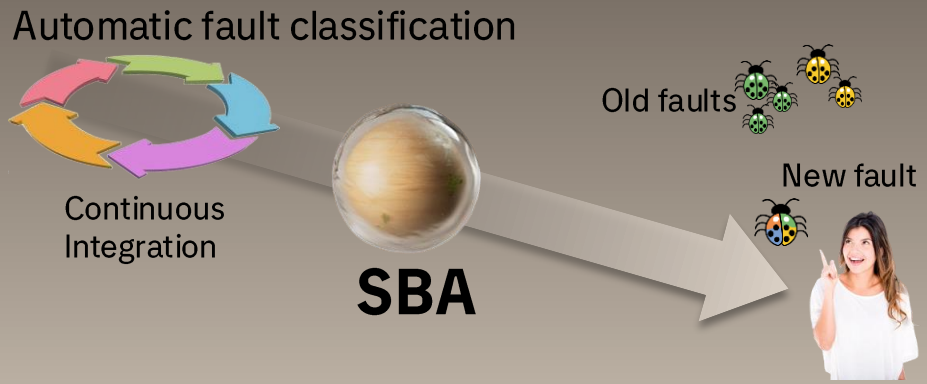


Problem

- Large systems require long time in manually analyzing the system logs.
- Most end users only know a part of the system.

- ML algorithms learn the functional behavior of the system.
- Identifies what parts of the system that has deviations in both successful and unsuccessful scenarios.
- Augments the troubleshooters to take more accurate routing decisions and faster find the root cause of faults.

Ongoing projects – Automatic fault classification



Problem

- Some faults occur several times and end-users spend time in analyzing the fault several time.

- ML algorithms compare the deviations found in the functional behavior analysis.
- Faults can automatically be grouped together.
- End-users can focus on new faults and reduce wasted troubleshooting time.
- Faster to find test runs that has the same fault.

Ongoing projects – Delay/bottleneck analysis

Delay/bottleneck analysis

Problem

- Difficult to find where small delays and bottlenecks occur in a large system.
- Delays can be occasional.

- ML algorithms learn the delays in the system by analyzing the functional behavior.
- Automatically identifies where abnormal delays occur between test runs.
- Improves the quality of the product by findings delays that rule-based tests cannot find.
- Decreases the lead time in troubleshooting.

Build TRUST in AI with us

Let's continue with in-booth presentation

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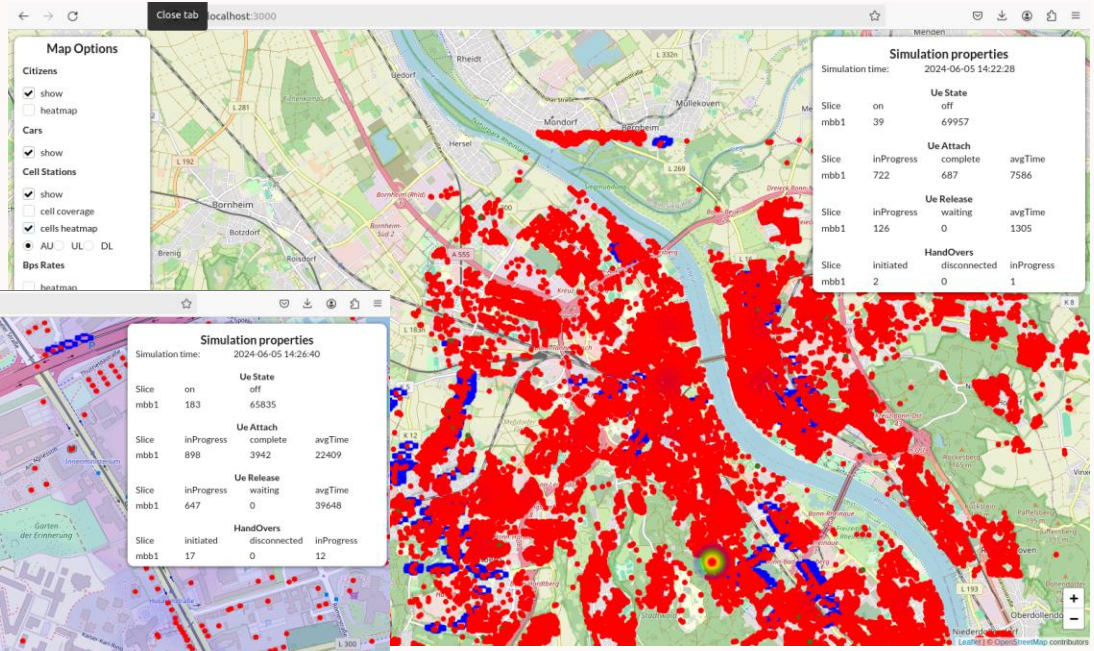
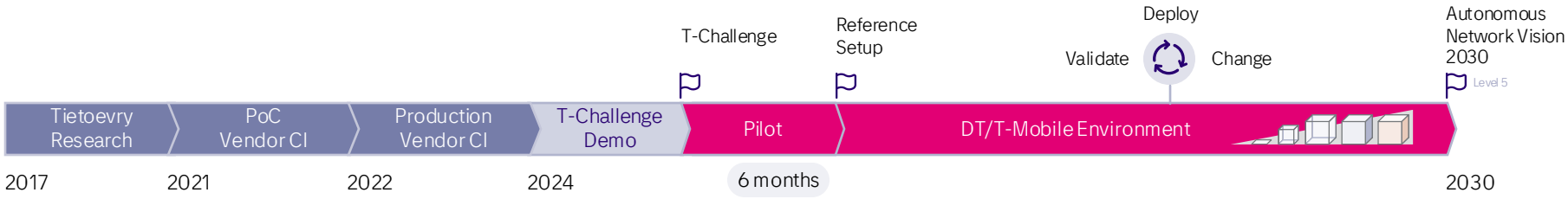
CitySim Screenshots



T-Challenge clean-up slides

Support your journey towards the Autonomous Networks



Evolve TRUST solution

CitySim world model evolution

- Evolve & validate regional models
- Evolve events for what-if scenarios
- Enhance model with generative AI

System behavior model evolution

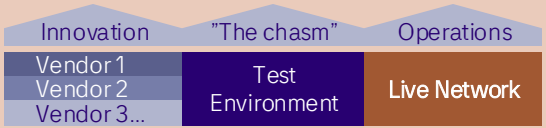
- Vendor specific vs generic models
- Platform instrumentation

Network model evolution

- Testbed provisioning
- Evolve events for what-if scenarios

Digital Twin Evolution

Apply TRUST in selected context



Understand needs in DT/T-Mobile validation process

Apply to selected Apps, Network Functions & Use cases

Call to action: Let's take on a new challenge together

In-booth demo

TRUST in energy optimization

Let's build TRUST together in...

5G Slicing & beyond

Industrial IoT

Open RAN Apps

CitySim for Fibre to Home

SPECIAL AWARD
€25,000

3RD PLACE
€35,000

2ND PLACE
€75,000

1ST PLACE
€150,000