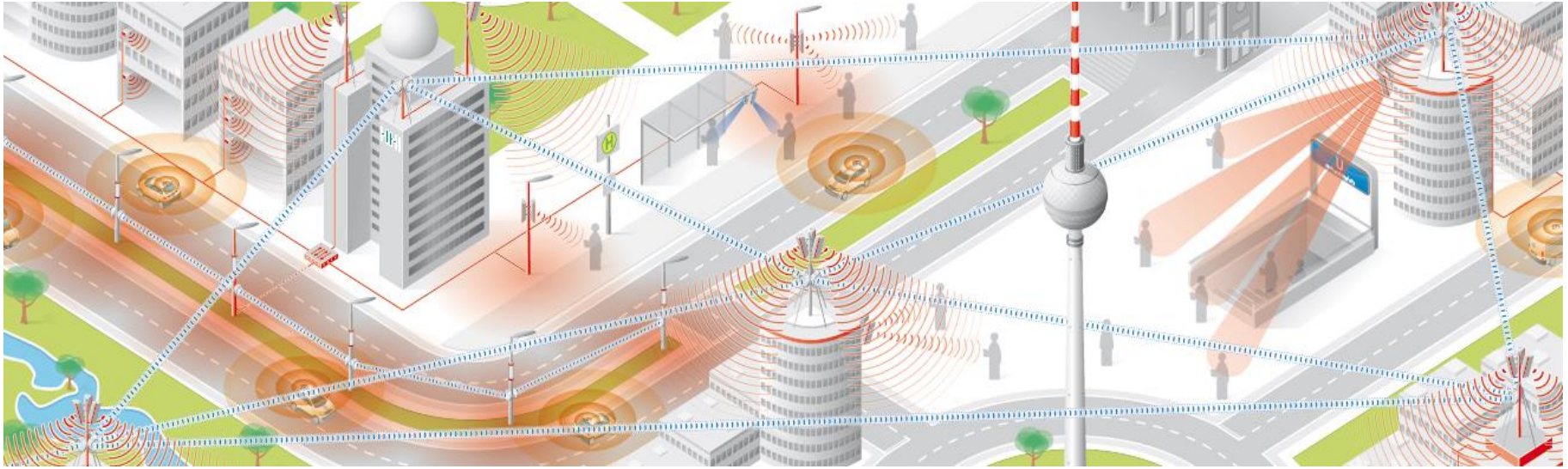


Power savings and optimization in Open RAN networks

MARTIN KASPARICK | FhG HHI

WIRELESS COMMUNICATIONS AND NETWORKS

Power Savings and Optimization in Open RAN Networks

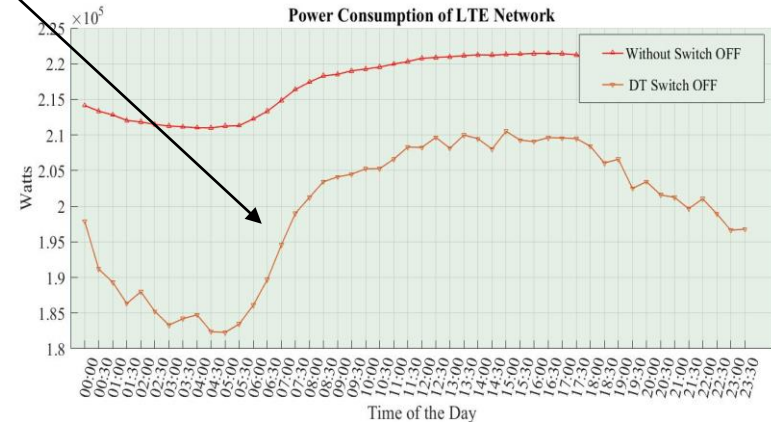
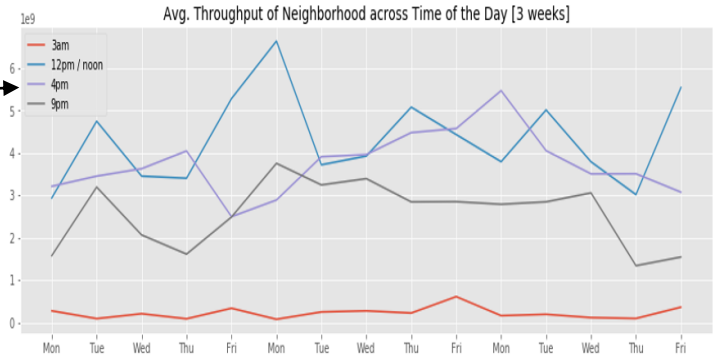


Energy consumption in cellular networks

- Increasing energy consumption in networks leads to a severe increase in OPEX and significant impact on CO2 emissions
- In 5G and beyond, this trend will continue (densification of hardware and radios, higher frequencies / bandwidths, advanced signal processing)
- Energy efficient solutions required on base station level, site level, network level
- In this talk, we:
 - Discuss impact of Open RAN architectures
 - Describe framework for ai-based and load-adaptive energy optimization
 - Discuss testing and evaluation of optimization solutions

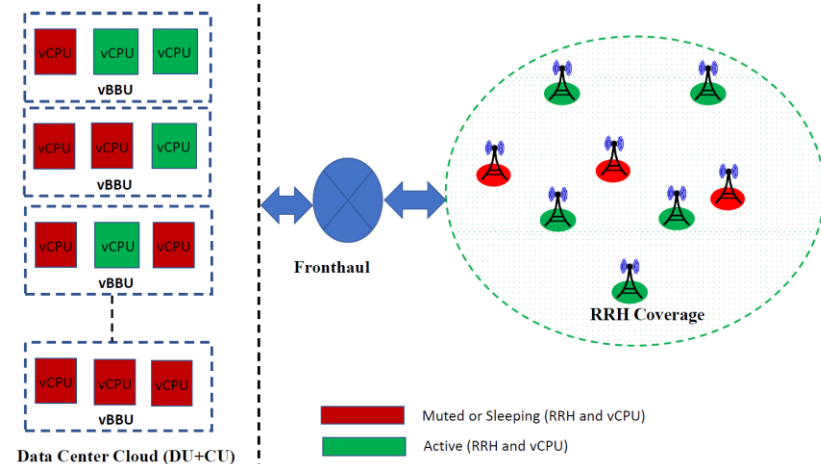
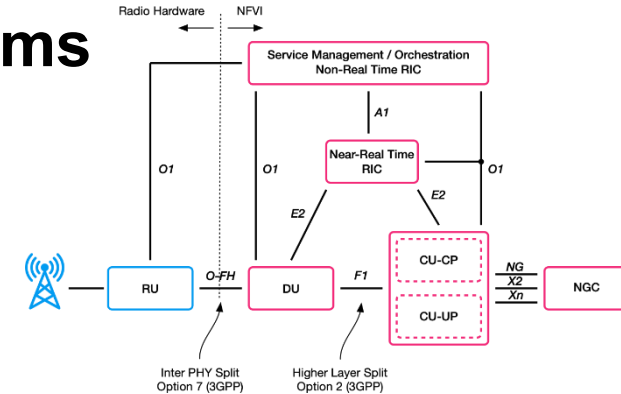
Motivation: Load-Adaptive Energy Savings

- Mobile networks are designed to support peak traffic, although user traffic (load) shows clear patterns if we look at the aggregate traffic in a given sector
- Current approach: Local switch-off (some cells can be switched off during periods of low load in this sector)
- More savings can be achieved by using state of the art global optimization
- **Challenge:** Energy consumption of a network depends on the topology (e.g., RUs, DUs, CUs), QoS demand (e.g., throughput), and structure of the network itself
- Models are inaccurate because networks are complex and nodes are coupled (i.e., optimization should be non-local / global)
- We overcome this by combining leveraging *state of the art AI* in globally optimizing energy consumption



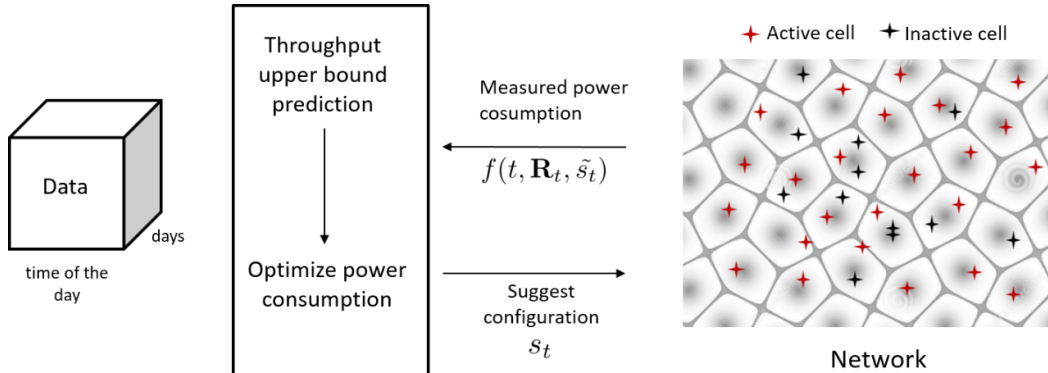
Energy Optimization in Open RAN Systems

- Open RAN networks are disaggregated, which increases complexity, but gives more degrees of freedom (we can switch off RUs, DUs, CUs etc.)
- Virtualization technology and centralized computing
 - New potentials for energy savings (pooling gains)
 - On the other hand: running signal processing on COTS hardware is less efficient than on specialized hardware
 - More constraints, e.g., latency of links between CUs, DUs and RUs
 - Higher dimensional AI problems compared to previous systems (take into account RF hardware, 5G/6G base band signal processing, and data center / computing hardware energy consumption, ...)



CU's and DUs may not be co-located and may be virtualized

Energy Control Framework with Feedback



Constraints $s_t \approx \tilde{s}_t$

That is, what is suggested by optimization is 'close' to what is also feasible, i.e., a strategy that is not rejected by the network

Bayesian Optimization

$$\underset{s \in \mathcal{S}_t}{\text{maximize}} \quad \text{EI}(t, \mathbf{R}_t, s) \times \Pr\{c(s) \leq 0\}$$

Set of 'good' topology/configurations

Expected improvement in power consumption given QoS and topology

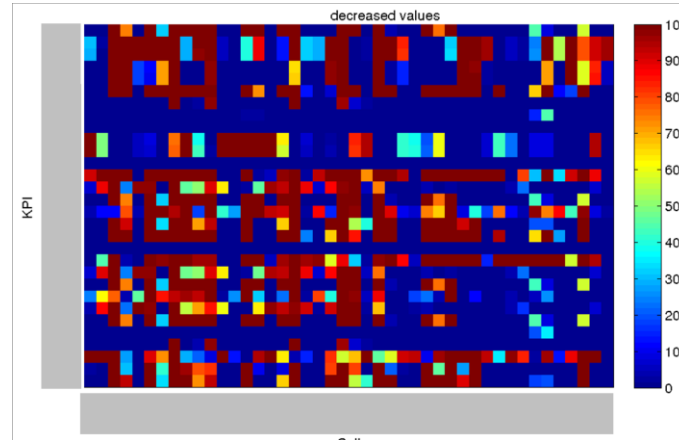
Probability that the suggested configuration is 'feasible' in the network

Approach: Use online AI to learn a model of energy consumption, with the following components

- Predict QoS demand of the network (using robust statistics and state of art AI)
- 'Suggest' new topologies/configurations to the network that minimize energy consumption while preserving QoS and satisfy various (even unknown) constraints
- Use network KPI feedback to update/improve AI model and monitor performance
- Exploit network structure, such as location, direction of cells, their importance, and expert knowledge about energy consumption (metric needed)

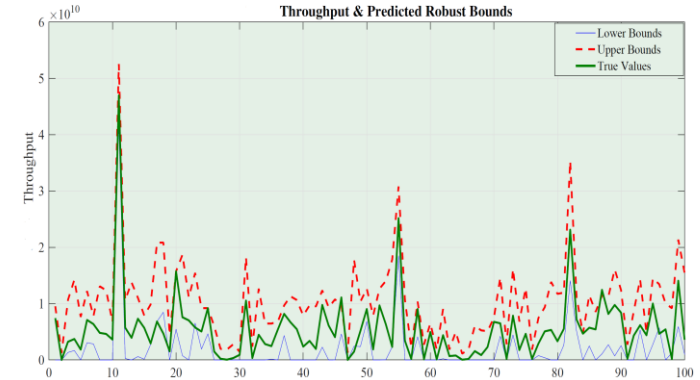
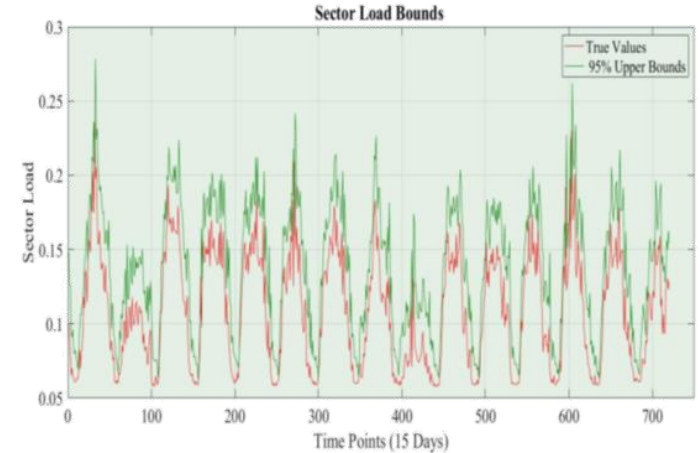
Feature Selection and KPI Analysis

- Accurate models for energy consumption are difficult to obtain due to increasing complexity
- We have devised algorithms that can learn which KPIs are sufficient for a learning task (dimensionality reduction)
 - **E.g., which KPIs do not need to be collected to estimate the energy consumption**
- Detection of statistically significant changes in KPIs after changes are introduced in the network

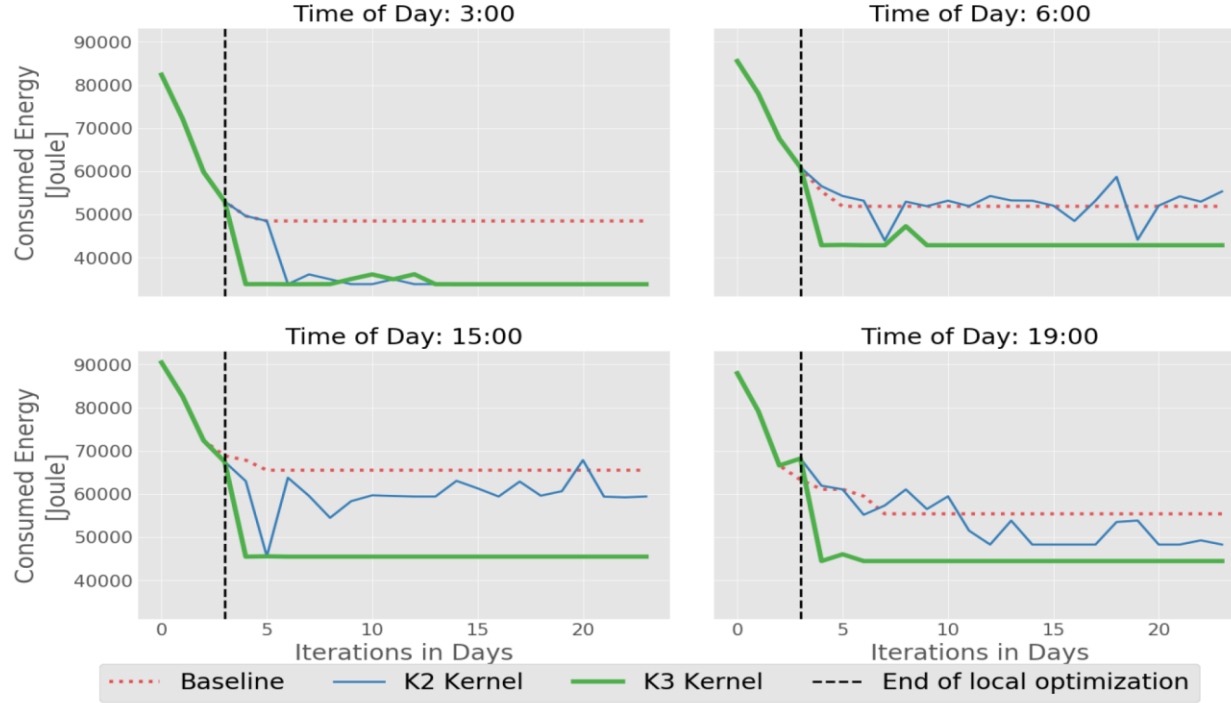


Load and Demand Prediction

- We need a *robust* way to find network configurations that minimize network-wide energy consumption and satisfy QoS requirements
- Main ingredient: predict load and traffic demand
 - *Upper bound* prediction for future time-points given past data / throughput values
 - A combination of *robust statistics* and time-series analysis, can achieve a high accuracy
- Energy consumption can be minimized by selecting the smallest set of active nodes (configuration) that can support this upper bound



Performance of ,global‘ energy optimization



- Red Baseline: local load-based optimization
- Blue: Bayesian Optimization using standard kernel machines
- Green: Bayesian Optimization using kernels and metrics that take into account side-information/prior knowledge about topology and energy function

Network Simulator (NS3) with energy and cell-load modelling

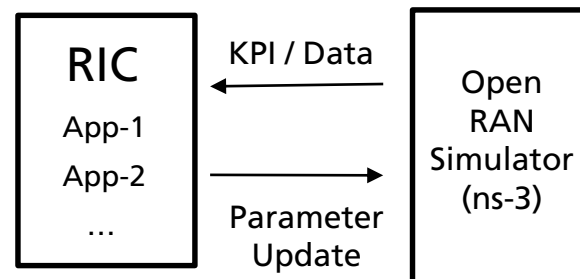
ORAN System-Scale Simulator Development

■ Extension of Open Lab with an ns3-based ORAN simulator

- Investigate Scaling Effects
- Development of new models and suitable abstractions for Open RAN (Energy models, cell-load models, fronthaul models, computation-load models, KPI generation models etc.)

■ Development of RIC & SON functionality

- Interface RIC implementations with the ORAN simulator
- Algorithm testing, conflict detection, causality detection, network stability analysis

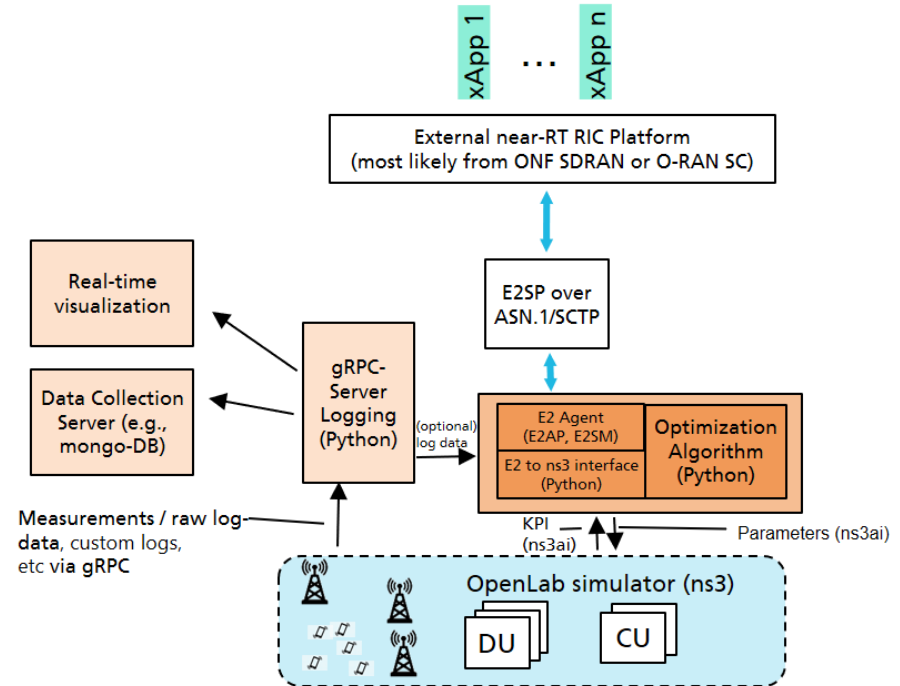


Energy saving
use case and
others

Simulator / RIC Coupling Architecture

Three main elements

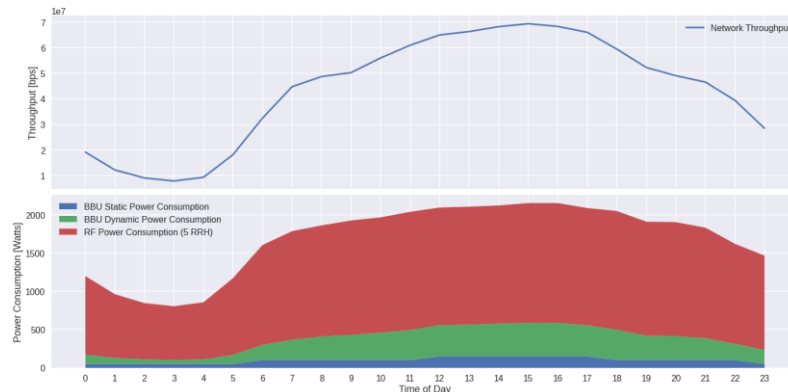
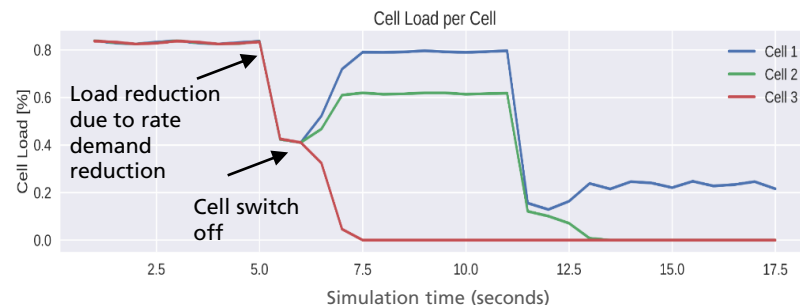
- ns-3 simulator including models for 5G, Open-RAN, energy consumption etc.
- Python based RIC-bridge with capabilities for E2 coupling with external near-RT RIC, and also direct (not E2-based) optimization
- gRPC-based logging, visualization and advanced KPI calculation



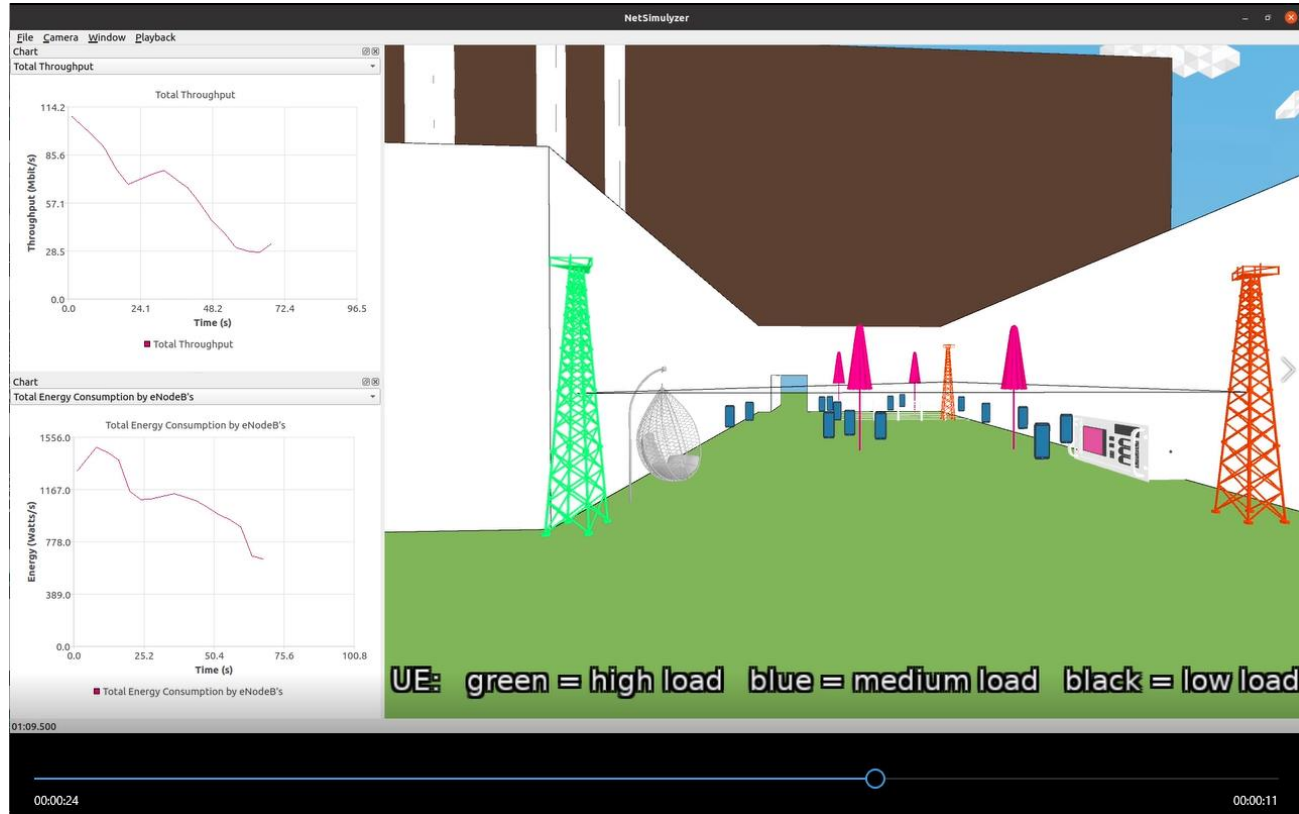
Example: Load-Adaptive Energy Saving APP Design

■ Combining machine learning & optimization

- **Demand prediction:** Learning robust bounds on cell-load using real-time network data
- **Energy Prediction:** Learning network energy consumption as a function of cell throughput and network topology
- **Global Optimization:** Minimizing the network energy by switching OFF RUs and DUs, and handing off users to active cells
- **Energy Savings:** Show the achieved energy savings vs network cost



Evaluation and Realization – Energy Saving App



Outlook & Ongoing Work

■ Energy optimization

- Decreasing dimensionality / problem size by further integrating network structure into optimization
- Extend energy consumption consideration to RIC / AI
- Integration of energy consumption monitoring and metrics into testbeds in order to test energy saving algorithms and solution, development of control interfaces
- Test of AI-based load-adaptive control protocols as x/r-APPs

■ Simulation / Digital Twin

- Digital twin / simulator integration with RIC for App testing and conflict detection
- Align with similar projects
- Study conflicts and interdependencies of energy saving use case with other apps / optimization functions

5 reasons why European operators signed the MoU on Open RAN

HOLGER ERKENS | Deutsche Telekom
Senior Partner Manager

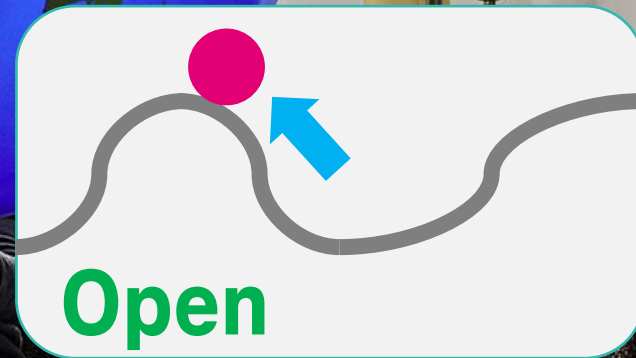
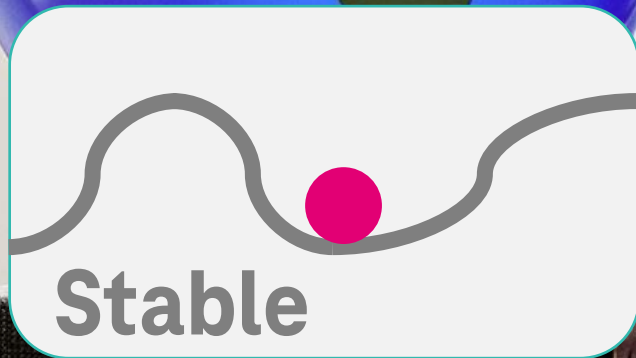
5 reasons why European operators signed the MoU on Open RAN

i14y LAB #Summit22 | Holger Erkens



LIFE IS FOR SHARING.

How should your preferred RAN ecosystem look like?





“

**No one can whistle a symphony.
It takes a whole orchestra to play it.**

– H.E. Luccock

The Open RAN MoU

- Open RAN MoU created end of 2020, publication January 2021
- Origin: The GSM MoU dating back to 1987
- Signatories: CTOs of the large European Telcos



MEMORANDUM OF UNDERSTANDING BETWEEN THE SIGNATORIES COMMITTING THEMSELVES TO IMPLEMENTING OPEN RAN BASED NETWORKS IN EUROPE

The purpose of the Memorandum of Understanding is to provide a framework for a specific commitment to support the development of a non-fragmented global OPEN RAN (as defined in Annex II) ecosystem for deployment across the European network footprint of each of the signatories, and to start operation as soon as solutions become mature enough for a given targeted use case.

Deutsche Telekom AG, Orange S.A., Telefónica S.A., Vodafone Group Plc (the "Founding Members"), and any other signatories,

recognising:

- that OPEN RAN will be a key technology for modern mobile networks and its success requires strong timely collaboration and support from both industry and policy makers in order to achieve early economies of scale.
- that usage of OPEN RAN technology will lead to a more competitive 5G environment enabling supplier diversification in Europe as per EU 5G Security Toolbox guidelines and more flexibility for industry to innovate and differentiate.
- that promoting the development and recognition of OPEN RAN specifications and standards is necessary to accelerate the emergence and maturity of a single and consistent OPEN RAN ecosystem under common OPEN RAN architecture and requirements in order to enable a true multi-vendor environment in Europe.
- that the development and implementation of OPEN RAN will have a positive impact on the European Telecommunication market with the transformation of existing vendors and the creation of new companies and start-ups towards a future-proof model.

Why Open RAN MoU?

Reason #5: Platform for collaboration

- Collaboration on all levels (CTO, SVP, working level) on technical and policy/ecosystem topics
- Always under antitrust guidance
- No fixed agenda – open to new topics to support the ecosystem, adapting to advance of Open RAN

Reason #4: Established MNOs' interests

- Current open ran deployments mainly greenfield, 5G SA and/or enterprise networks
- Open RAN MoU to articulate the needs of established operators in front of established and new vendors

Reason #3: Support ecosystem alignment

- Need for alignment identified and communicated where required
- Open RAN ecosystem is in considerable need of alignment to stay diverse and open

Reason #2: The European voice of Open RAN

Communication to European regulatory bodies via publications and discussions to stimulate discussion and raise awareness

- European climate different from US and Asia – we have something to lose
- MoU signatories published **ecosystem report** to recommend rapid action as
 - new vendors have a lot to gain
 - traditional vendors risk to fall behind
- **Whitepaper on Open RAN security** published to address current concerns



Reason #1: Foster the diverse and open ecosystem

- Publication of **Open RAN Technical Priorities**
- Support new RAN vendors (not in RfQs) in tailoring products to operators' needs
- All relevant technical areas covered
- Second release with considerable addition of RIC, SMO requirements + energy efficiency
- Wide ranging collaboration with TIP on requirements definition
- More releases to come



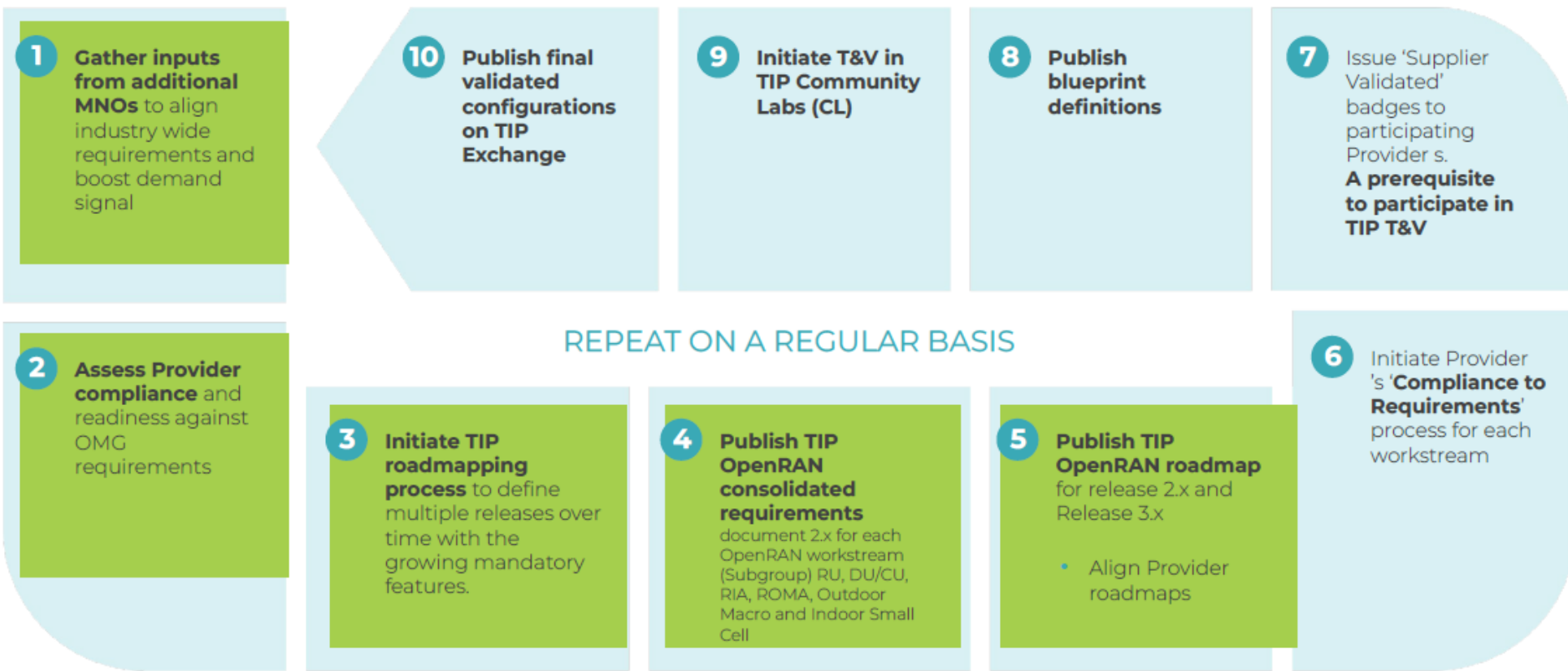
TIP adopts MoU technical priorities

Translating Operator Requirements to Blueprints



Microsoft Excel
Worksheet

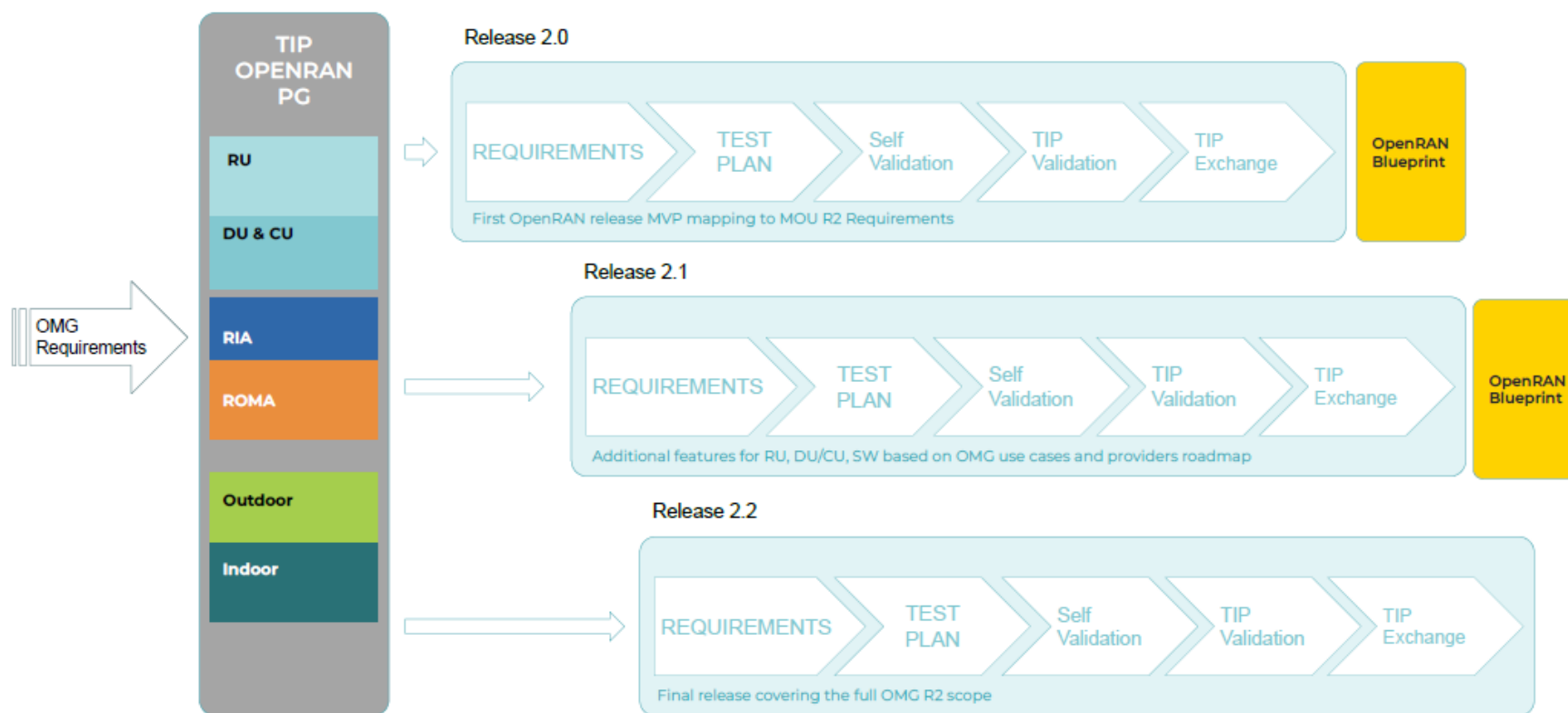
MoU Tech Priorities
rel-2



TIP adopts MoU technical priorities

OpenRAN MOU Requirements in TIP

TIP OpenRAN Release 2 is a forward-looking TIP OpenRAN Roadmap based on OMG and other operator inputs





Call for action

Drive the ecosystem together with us!

holger.erkens@telekom.de

A vertical purple line is positioned to the left of the text. Several purple squares of varying sizes are scattered around the text, including one to the left of the name, one to the right of the title, and a cluster of many small squares at the bottom of the slide.

TIP Academy

JOHN PUDNEY | Telecom Infra Project
Global Sales Manager



TIP
ACADEMY



TELECOM INFRA PROJECT

in collaboration with **accenture**

An Introduction to TIP Academy and Open Network Upskilling

Why TIP Academy?

Telecom Infra Project (TIP) exists to accelerate and facilitate the growth of Open Networks, bringing better connectivity to the world. Open RAN cannot scale without vendor-neutral standardized skills and training in place

What TIP Academy means for your teams



Upskilling – team members will have proven key competencies and skills to work efficiently on Open RAN projects



Attraction – Showing partners that your project teams are independently verified to be competent, and that your company has invested in their skills, ultimately attracting attention during tender process, RFIs and RFPs

94%

Retention – 94% of team members say being given relevant training encourages them to stay with a company and increase employee engagement



Certification and Promotion – Individuals and teams will be promoted through TIP channels including PR and TIP Exchange to raise profile across the global Open RAN community

“I need to stretch my team’s capabilities so we can take on more complex projects”

About TIP Academy curriculum



By industry leaders, for future industry leaders

Courses available for **all levels**



FREE 'What is Open RAN?' course available for teams to sample



Independent standards from trade organization committed to accelerating and facilitating the growth of Open Networks



All courses are **based on real-world deployment**

“I want to attract new talent to my company that I can onboard with key skills in place”

The benefits of TIP Academy for Network Operators

Enable – Market knowledge / process comprehension

Identify – Current / future market opportunities

Proof – Independent validation of 'speaking the same language'

Attract – Skilled workers with passion for Open RAN projects

Save – Time and money by teams being focused on what matters

Achieve – Goals and KPIs efficiently

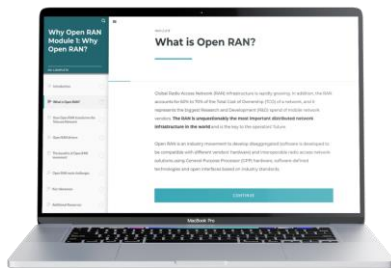
Community – Not just educating teams but adding them to a global community

“I would like to know my team had the skills, competencies and knowledge to successfully deploy Open RAN projects”

Participating Companies Feedback

Unique

A Unique Programme
96% of test students felt
this training was not
available elsewhere



Valued



Focused

A Focused Programme
93% of test students felt
the course met their
expectations



Recommended

A Recommended Programme
84% of test students felt they would recommend undertaking the course to colleagues or associates

TIP Academy programme delivery



Stage 1

E-learning modules created by industry experts for learners to complete online



Stage 2

Instructor-led practical training held with Subject Matter experts (Q4 2022)



Stage 3

Accredited Certification Programme (including 'fast-track' Architect Certification) (Q2 2023)

“I would like to know my team had the skills, competencies and knowledge to successfully deploy Open RAN projects”

Learning Courses within Open RAN Curriculum

Apprentice Level

- Why Open RAN
- Open RAN Fundamentals
- Open RAN System Integration
- Open RAN System Dimensions
- Ecosystem of Open RAN Solutions
- Introduction to AI&ML Applied to Open RAN
- Security in Open RAN

Professional Level

- Distributed Unit and Centralized Unit Analysis
- Open RAN TCO and Business Evolution
- Radio Intelligence Controller (RIC)
- Service Management and Organisation
- Continuous Integration/Continuous Deployment (CI/CD in Open RAN
- Radio Unit in Depth
- Open RAN System Integration II

2.3. Open RAN System Integration

2.3.1 Learning Program Description

This Learning Program provides a complete description of all the tasks required to complete the integration of each of the components of the Open RAN architecture and successfully achieve the activation of the Open RAN site.

Upon completion of this Learning Program, you will be able to:

- Develop an E2E view of the testing, integration, and commissioning procedures that lead to efficient Open RAN site activation.
- Identify the primary challenges in migrating to a new operating paradigm with new technologies and processes.

Topics covered:

1. Open RAN Integration and Testing for RU, DU, and CU
2. Telco Cloud Infrastructure Integration
3. Orchestration Platform Integration
4. Open RAN Integration and Site Activation
5. Open RAN Migration Issues and Considerations

TIP Academy FAQs

Do I need to be a TIP Participant to access TIP Academy?

No, TIP Academy is open to anyone looking to develop their skills. However, TIP Participants do receive a discounted price amongst other benefits.

Where does the training take place?

Currently the training modules are all available online so your teams can complete training wherever they choose. In 2023 we will be introducing more interactive courses for those who benefit from 1-2-1 learning and support.

Can I contribute to TIP Academy?

TIP is about sharing best practice and skills across the global Open RAN community and would be delighted to hear from individuals or companies who feel they can add value to the TIP Academy.

What languages are the modules available in?

Currently modules are only available in English but we welcome feedback on languages that you feel we should include in the future.

I'm already a professional working in Open RAN, why should I do this?

Qualifications remain the fastest way to prove your competency and skill in any area. Shortly, 'fast-pass' courses will be available with certification to prove your credentials to any partner / potential collaborators in the future.



in collaboration with **accenture**

For more information please contact:

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+44 7801 490 899

www.tip.academy



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Thank You!