Artificial Intelligence for Campus Communication

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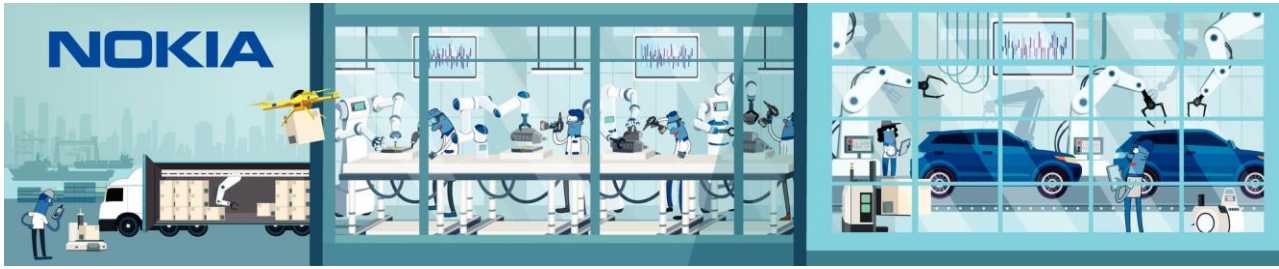
Motivation
Challenges and Enablers

Challenges
- Specific requirements and applications of campus network management (e.g. TSN and cMTC)
- High automation level required for operation without specific network operating experience
- Frequent reconfigurations of the entire infrastructure

Enablers
- ML-based methods that can dynamically adapt to changes in the environment
- Correlation of data from production and network management systems
- Environment models, e.g., a “digital twin”
- The context is more constraint than in wide area networks

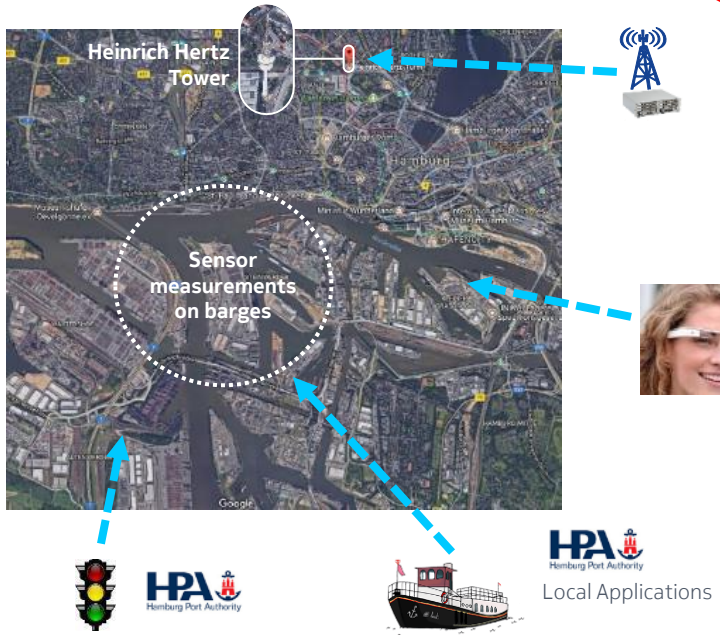


Case Study: Predictive Location-Aware Network Automation for Radio
The 5G network slicing testbed at Hamburg Harbor

PLANAR case study

A live testbed created in the 5G MoNArch project demonstrating 5G slicing at the Hamburg Harbor:

- Three slices
  - **eMBB**: Local applications in the harbor
  - **IoT**: Emission sensor readings from barges
  - **URLLC**: Traffic light control
- Data collection
  - **Slice-specific BTS KPIs**: PRB usage, throughput, latency etc.
  - **UE measurements** from up to three ships including position (by GPS), RSRP, RSRQ, ping etc.
  - Collected for 6 months every 5 seconds **~3M records**



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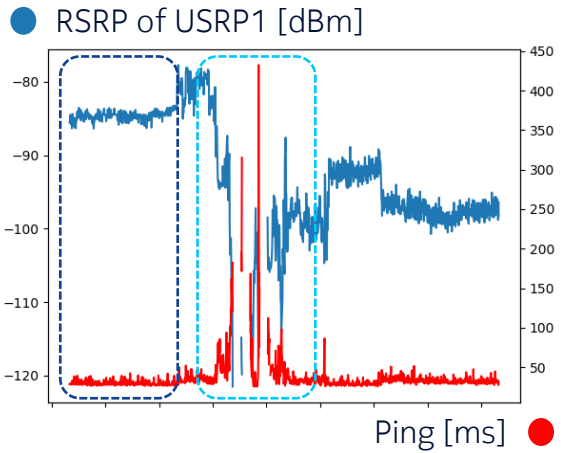
Predictive Location-Aware Network Automation for Radio
Problem statement

- IoT requires high reliability
- In certain areas of the testbed, coverage and mobility issues are observed in the IoT slice
  - Shadowing effects and/or
  - Long distances from the base station
- Reliable service must be guaranteed, but without overprovisioning of resources or compromising the performance of the other slices



Predictive Location-Aware Network Automation for Radio
Prediction of Mobility and QoS/RSRP

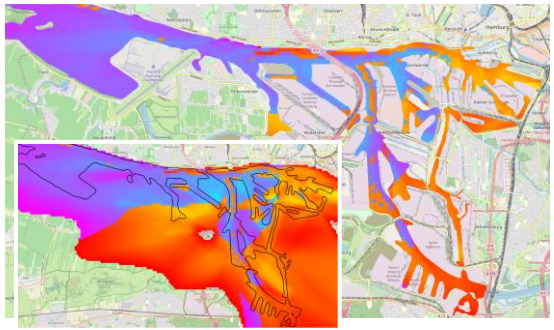
Radio Propagation Map:

- Based on UE measurements
- GPS position, RSRP

Mobility Pattern Prediction (MPP):

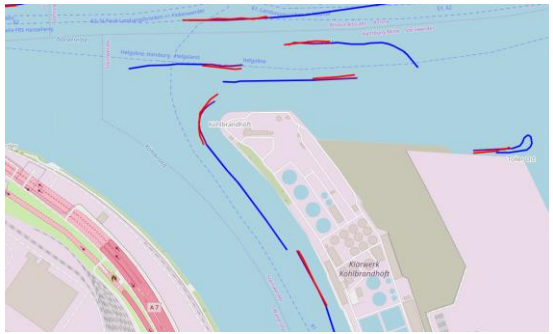
Prediction of barge movement using a convolutional neural network

Combining the mobility prediction with the coverage model, we were able to predict up to **90%** of the RLFs **40 seconds** ahead



RSRP, serving cell: $Cell_1$

RSRP, serving cell: $Cell_2$



Input sequence

Ground truth

Prediction

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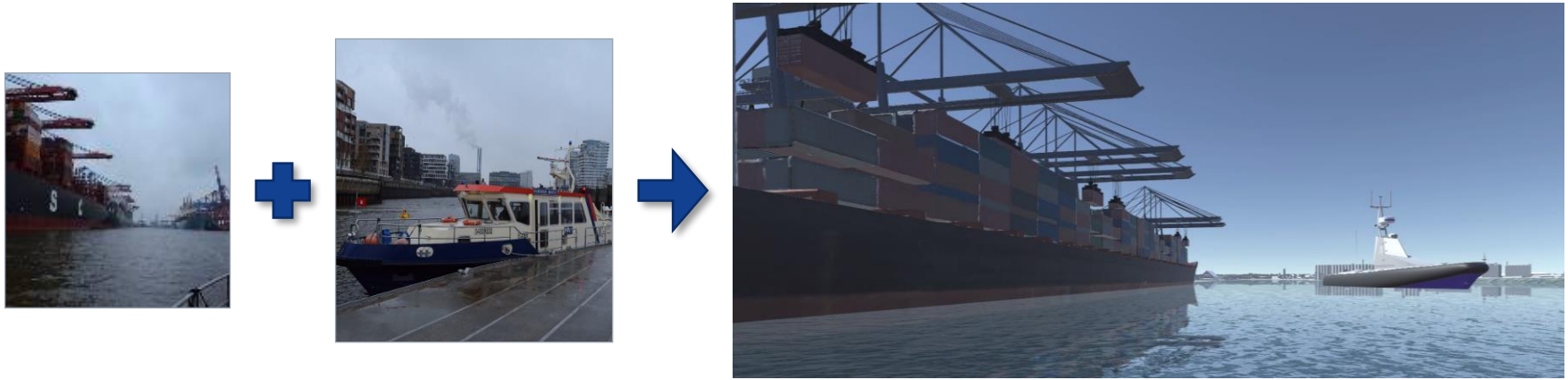
Predictive Location-Aware Network Automation for Radio
Closed-Loop Automation Evaluation with Simulation

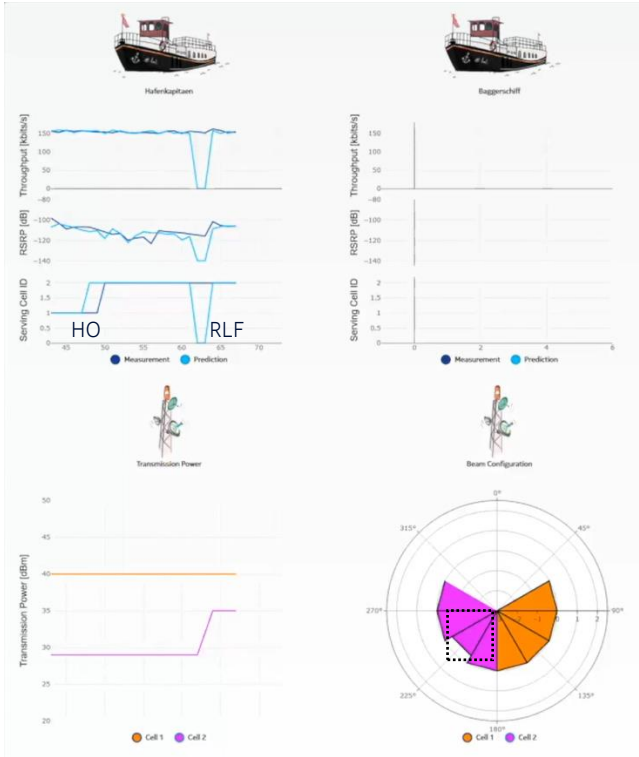
A **digital twin** of the testbed setup is **mirrored** in a simulator

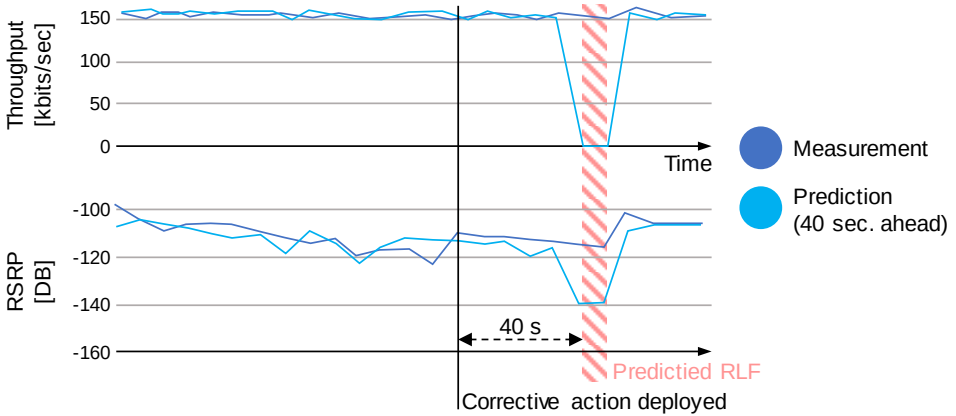
- Full 3D model of the city of Hamburg and especially the harbor area
- Network topology and configuration as in the real testbed
- Traces of the movement of the real barges are collected from the testbed and imported into the simulation scenario
- The coverage issues of the real testbed can be **reproduced**



Predictive Location-Aware Network Automation for Radio (PLANAR)

Demo





Demo @ IEEE NOMS 2020,
https://www.youtube.com/watch?v=nMdBbLv2G98

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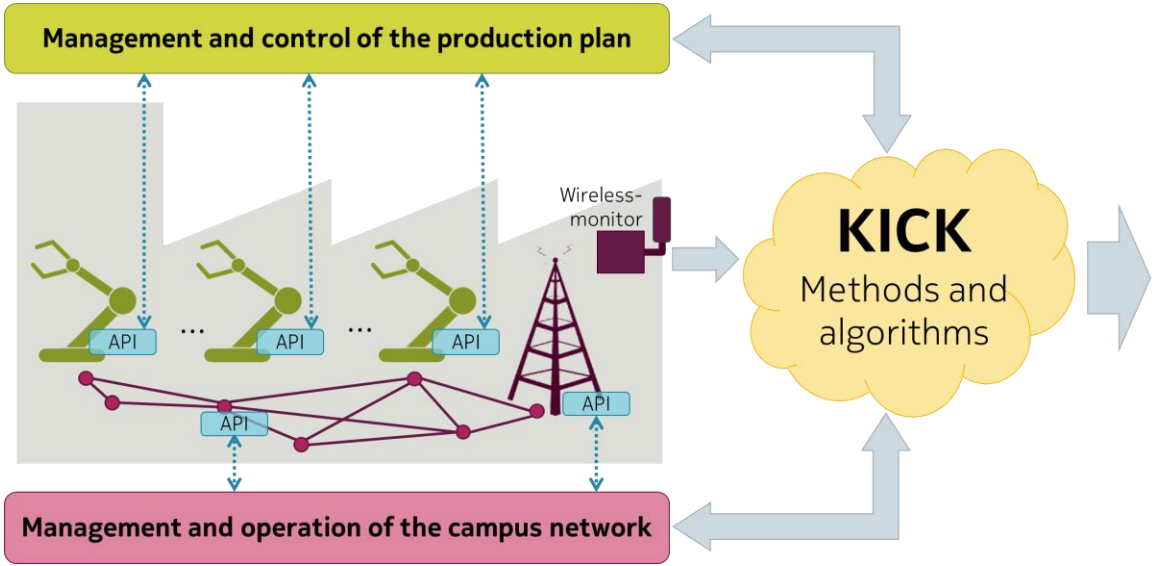
KICK Project
Artificial Intelligence for Campus Communication



https://kick-project.de/en/

1. **Optimization** across communication and production
2. **Simplification** of the campus network operation
3. **Economical viability** of private networks in factories
4. **Validation** of AI/ML methods in the joint production and communication worlds

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