Private 5G:
IS-Wireless and the CampusDynA project – Enabling mutual adaptation of network and application behaviour with Open RAN

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LIQUID RAN™

ALL YOU NEED TO DEPLOY A 5G NETWORK (TOGETHER WITH 4G AND SOON 6G)

Heterogeneous Network Hardware

Network Software
Liquid RAN™ (DU, CU, RIC) + Core/SMO

O-RAN ALLIANCE

5G

Lte

PATENTED

11 patents
(4 granted, 1 pending, 6 in preparation)

Private network users

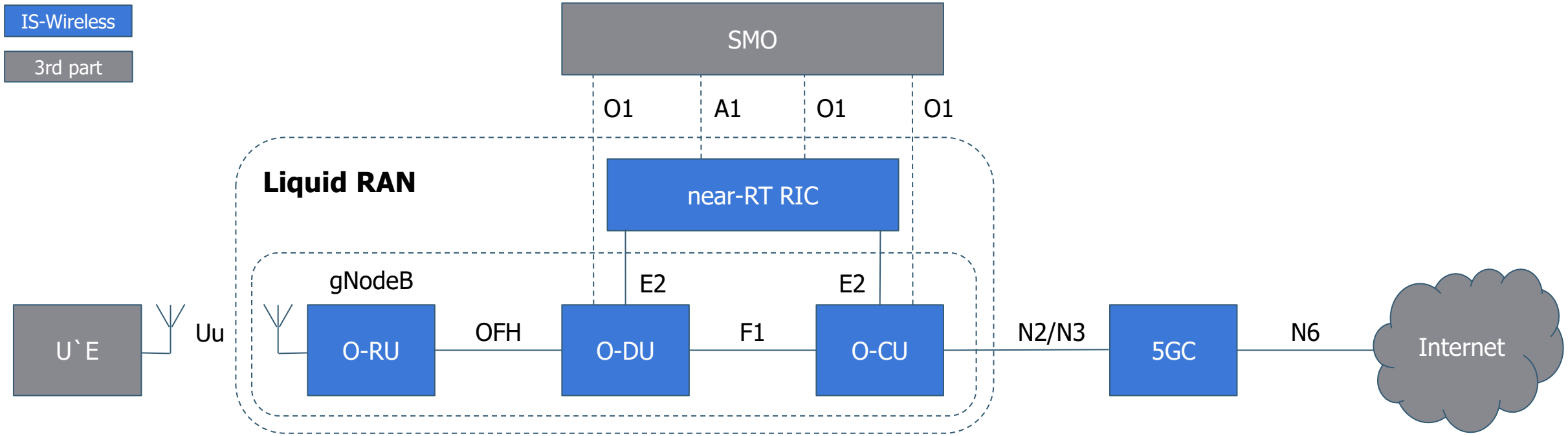
Outdoor/indoor Radio Units

Customer premise COTS servers…

… or shared EDGE/Cloud

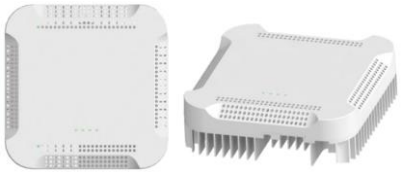
Internet

LIQUID RAN™ BASED NETWORK ARCHITECTURE



HETEROGENEOUS NETWORK HARDWARE

Radio units, broad spectrum (450MHz- 48GHz) , different output power (250mW-160W)



Indoor, low power (up to 1W)
Coverage: hundreds of meters

Outdoor low power (up to 5W)
Coverage: a few kilometres

Outdoor high power (up to 160W)
Coverage: tens kilometres

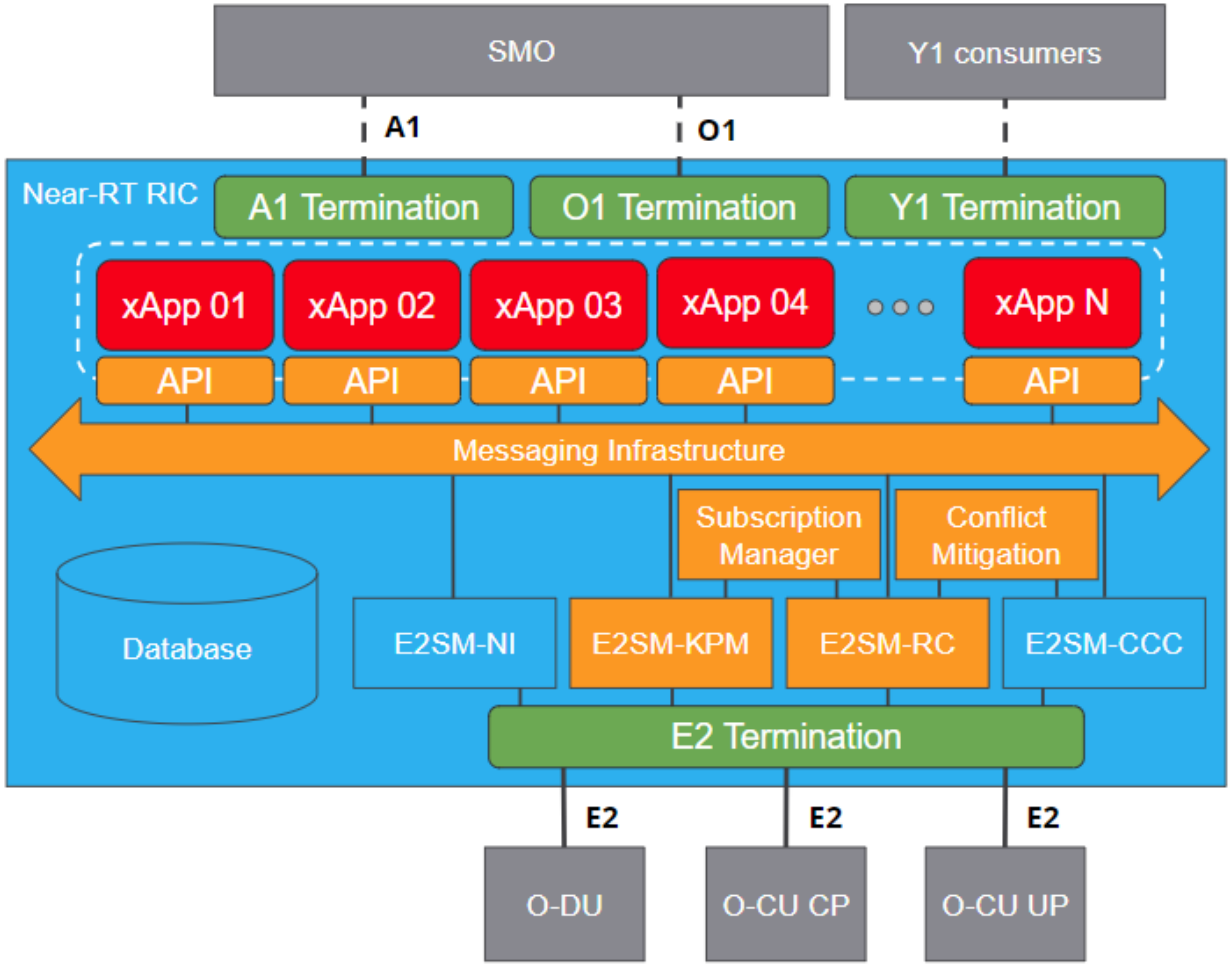
General purpose compute hardware

Single server

Pole mounted

Data centers/could

NETWORK INTELLIGENCE



- O-RAN compliant
- Open API:
  - Readiness for 3rd Party xApps
  - MNO can modify existing and/or prepare own algorithms
- xApps (examples):
  - PRB Quota Modification (Slicing)
  - QoS Aware Handover (Robots control)
  - Energy Efficiency (Servers switch off)

PRIVATE 5G - WHY TO BOTHER?

- Security - Ability to protect network against cyber-attacks and ensure devices are properly authenticated. Keeps enterprise infrastructure separate.
- Control - Isolates network as a customer controlled, standalone 5G network/ private network slice. Guarantees service quality by full network control.
- Reliability - Guarantee network performance is maintained at a predetermined level throughout its operation
- Coverage - Provision of high endpoint density and reliable connectivity both inside and outside buildings. Provides coverage across large sites.
- Mobility - Enable seamless handover between different cells without connection loss. Provides ability to monitor and control moving assets assuring flexibility.
- Intelligence - Ability to adapt network behaviour in near real time regime to match dynamically changing requirements. Using 5G unique Radio Intelligent Controller offers you unlimited options to accommodate network functionality

EXAMPLES OF IS-WIRELESS DEPLOYMENTS

PŁOCK ORLEN SA: **5G SA 800 MHZ AND 3.4 GHZ RAN+CORE**

KRAKÓW ASTOR COMPANY: **5G SA 3.6 GHZ RAN (CORE FROM T-MOBILE), CONTROL OF ROBOTS**

BERLIN CAMPUSDYNA CONSORTIUM (OSRAM, T-SYSTEMS, GESTALT ROBOTICS, FRAUNHOFER): **5G SA 3.6 GHZ RAN+CORE+XAPPS, CONTROL OF ROBOTS**

THE CAMPUSDYNA PROJECT

Profile

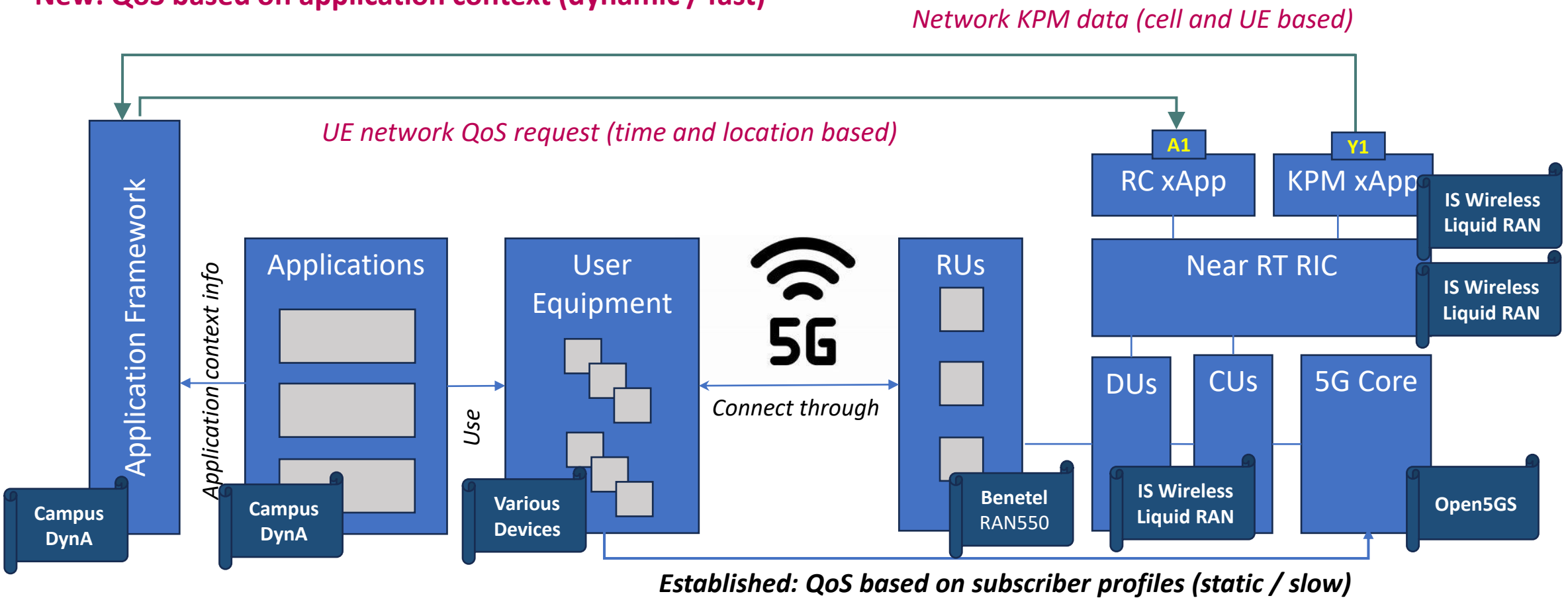
- German R&D project
- Funded by Federal Ministry for Economy and Climate Protection
- 6 partners, 36 months duration
- Three industrial use cases
- Test bed with 5G network at WvSC
- https://www.campusdyna.de
- info@gestalt-robotics.com

Mission

- Dynamic adaptation of campus networks and applications in industrial use cases
- Applications in the fields of autonomous mobile robotics, resource efficiency of production facilities and civil security of production sites:
- Supporting edge-controlled AGV's with low latency and large bandwidth requirements by temporal and spatial allocation of network resources
- Enabling synchronized measurement campaigns aiming to monitor and predict the energy consumption of large consumers in real time and optimize their energy use
- Extending network availability to prioritized use by third parties, in particular emergency forces in the event of major incidents

FOCUS ON DYNAMIC RAN MONITORING AND CONTROL

New: QoS based on application context (dynamic / fast)



Established: QoS based on subscriber profiles (static / slow)

CAMPUSDYNA RAN ANALYTICS

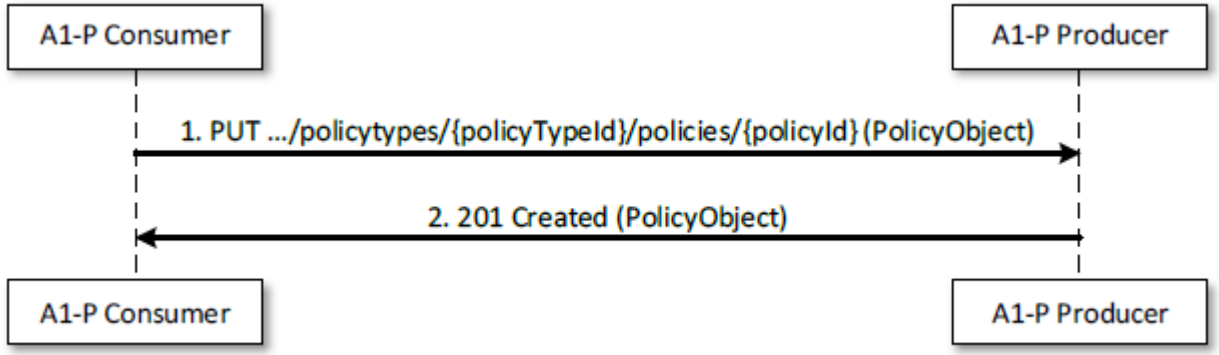
- Report Service 1: Collect from RAN the **KPMs per** E2 node (**cell**) including the percentage of PRBs used and the throughput with use of the E2SM-KPM Report Service Style 1.
- Collect from RAN the **KPMs per UE** including the UE throughput with use of the E2SM-KPM Report Service Style 2.
- Collect from the RAN the **UE identities** with use of E2SM-RC REPORT Service Style 4: UE Information.
- Collect from RAN the **QoS profile of UEs**.

- Reports are made available to the Application Framework through the **Y1 interface**.
- On the Y1 interface the Key Performance Measurements (KPMs) will be sent from the xApp to the Application Framework **every 1 s**.
- The communication on the Y1 interface is done over **TCP socket** where the Near-RT RIC is the server and the Application Framework plays the role of the client.

CAMPUSDYNA RAN CONTROL

- Control Service 1: **Modify** at the RAN the **QoS profile of the UEs** in order to change the UE priority used by the MAC scheduler with use of the E2SM-RC CONTROL Service Style 1: Radio Bearer Control, Control Action ID 1: DRB QoS Configuration (E2SM-RC 8.4.2.1).
- Control Service 2: **Enforce** in the RAN **handovers** to other cells of some UEs in order to improve the OoS offered to the UEs.

- Policy requests are transmitted by Application Framework (A1-P Consumer) through the **A1 interface**, using the standardized A1 Application Protocol (A1AP).



Quelle: O-RAN.WG2.A1AP-R003-v04.00

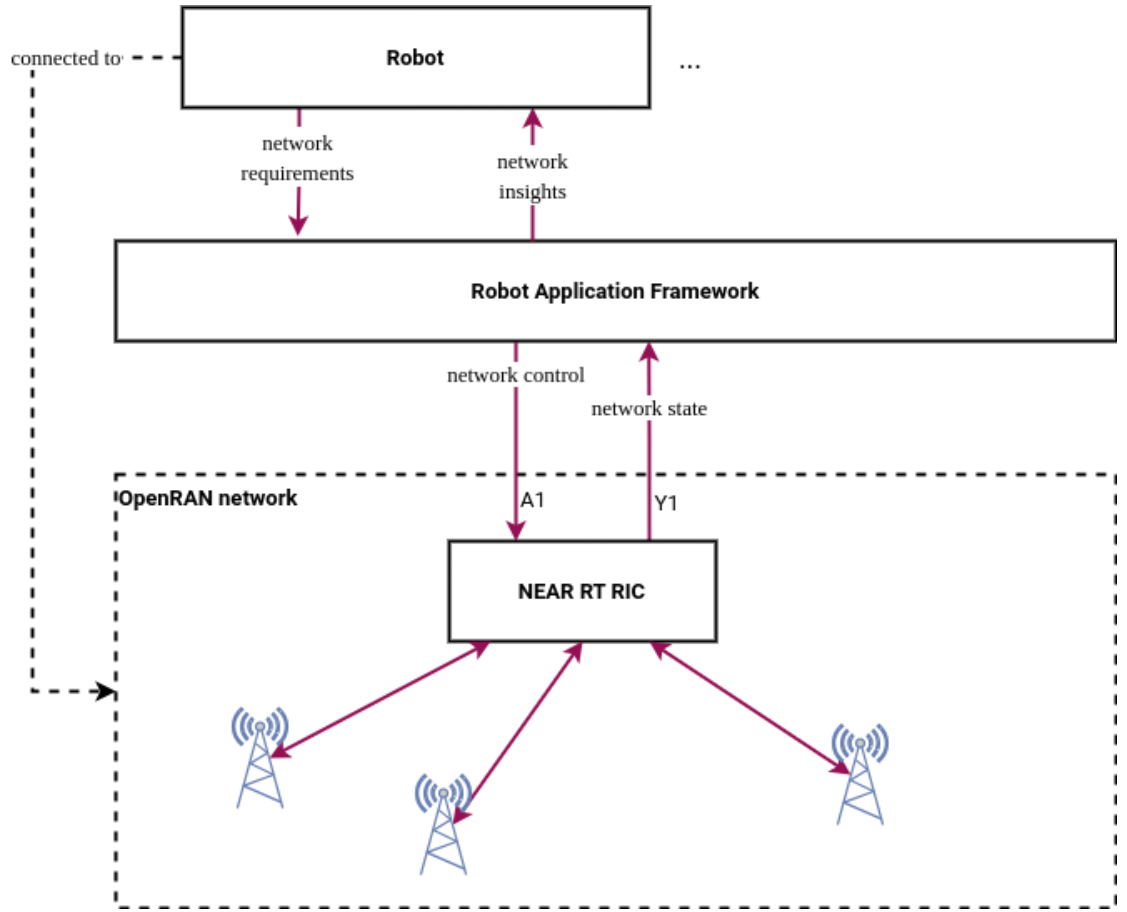
CAMPUSDYNA ROBOT APPLICATION FRAMEWORK

Function 1:

- Modelling the spatio-temporal status of network and industrial applications by means of a digital twin:
  - Holistic view of network and industrial applications
  - Forecasting the network status

Function 2:

- Centralised QoS scheduling enables priorisation of mission critical data transmission, under consideration of requirements derived from the application context



CAMPUSDYNA INSIGHTS

- Dynamic QoS management based on application context successfully implemented and tested at Werner von Siemens Centre for Industry and Science
- A1 and Y1 interfaces easy to implement for application developers
- Edge controlled autonomous robot operation benefits from route and fleet management optimization
- Static UE IDs needed by robot application framework
- Robot applications will probably benefit from less downlaod centric TDD channel structure (tbd.)