

SHOWCASE 1-4

MULTI-RAT INTERWORKING USING A 5G HIGH THROUGHPUT MMWAVE BACKHAUL

CHALLENGES

For this showcase, as SDR hardware platform the new NI USRP-2974 is used:

- It integrates an Intel CPU such on which the real-time host implementation of the NI LTE and WiFi Application Frameworks as well as the ns-3 instances for the different entities can run directly on the same device, minimizing the hardware effort.
- The connection between PHY (on FPGA) and MAC (on CPU) has RAT-dependent throughput and latency requirements. The NI L1-L2 API addresses these requirements for both LTE and WIFI.

RAT interworking experiments require higher layer functionality:

- Network simulator ns-3 contains models for LTE and WIFI protocol stacks that are used jointly in the real-time experimentation.

60 GHz mmWave backhaul link:

- At this frequency range, i.e, 60 GHz, RF impairments and path loss should be addressed carefully. In the base-band processing, we use the powerful NI PXI Chassis, while mmWave Sbeam antennas are used for transmitting the signals.
- The mmWave transmission allows high throughput, since the bandwidth is higher than normal sub 6Ghz systems.
- For addressing the mobility problem, we implemented a robust and reconfigurable beam steering algorithm.
- Beam steering algorithm and MCS can be optimized according to channel conditions.

GOALS

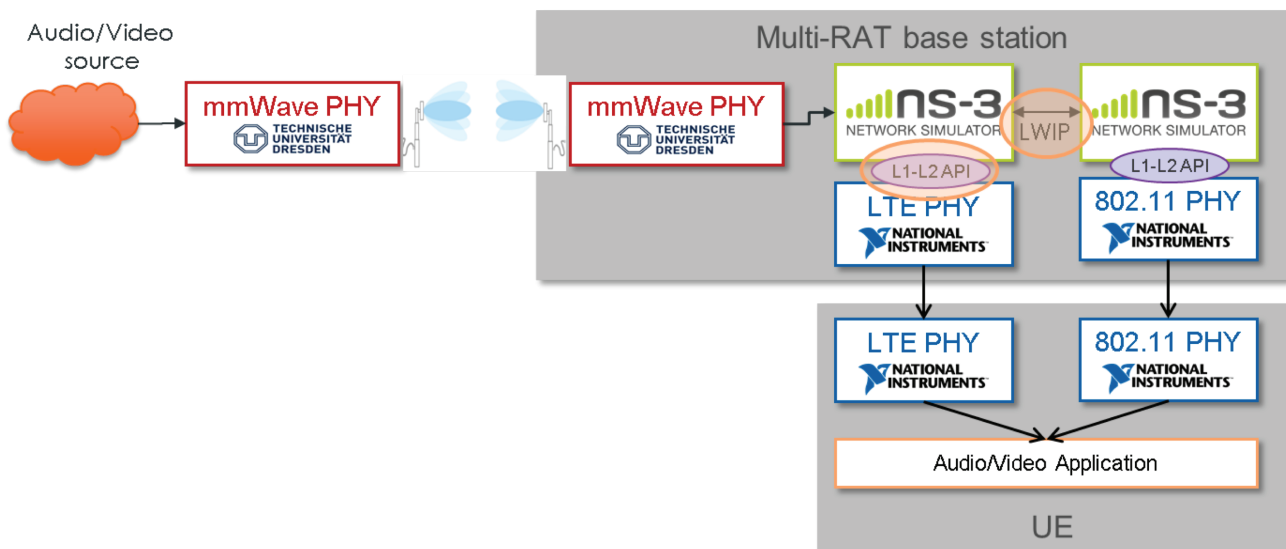
- Multi-RAT base station and terminal station with real-time capable LTE and WiFi implementations incorporating the new generalized NI L1-L2 API.
- LTE-WiFi Interworking technologies developed by open call partner.
- Run-time re-configuration of control parameters.
- High throughput mmWave backhaul link with beamsteering algorithm under mobility scenario.

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CONCEPT

- Backhaul base station with high throughput mmWave link to serve large quantity of users
- One Multi-RAT base station including:
 - mmWave link connected to high throughput backhaul.
 - LTE eNB and WiFi Access Point including interworking technologies running on the same NI USRP-2974.
 - One Multi-RAT terminal station including an LTE UE and WiFi Station running on the same NI USRP-2974.
- Remote control terminal for run-time re-configuration using testman protocol.



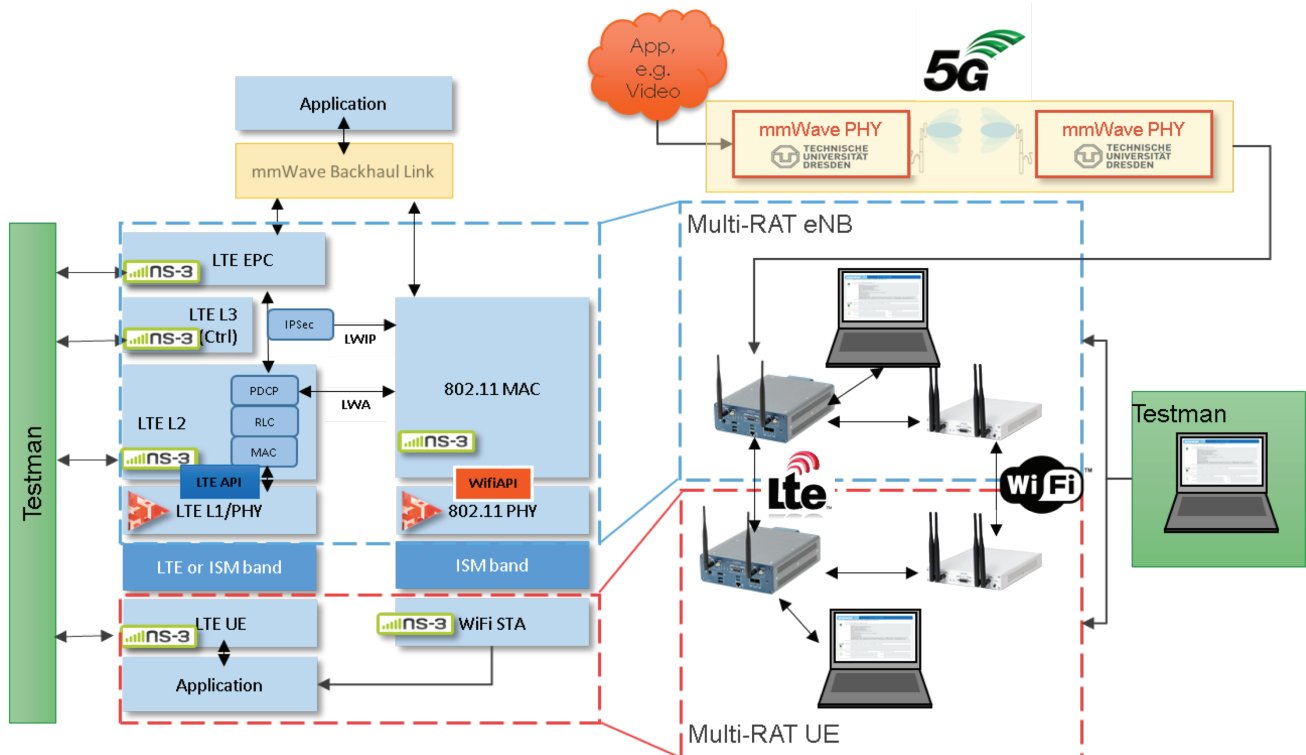
INNOVATION

- First prototyping and experimentation platform that involves interworking between LTE and WiFi, with additional E2E inclusion of a 5G mmWave link.
- Presented Multi-RAT platform is relevant in scenarios like factory floor automation and communication. In such environments, each machine might come from a different vendor and each vendor might utilize a different RAT.
- Aggregating, managing and interworking of RATs is an important topic of ongoing research for the operators of such factories.
- This experiment demonstrates that the 60 GHz as a backhaul solution is feasible for practical applications. In addition, it has also been shown possible technical solutions for optimizing the mmWave link, e.g., with reconfigurable beam steering algorithm.

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DEMO SET UP



1. mmWave backhaul link:

- Video stream is sent from backhaul to the multi-rat base station, that further routes it to final destination.

2. Real mobility scenario is emulated with robot, e.g., bus transporting people.

3. Multi-RAT part:

- A user (passenger in the bus) is connected via LTE and gets the video stream on the Multi-RAT terminal station.
- The resources for the user will be virtually limited (e.g. more users in the LTE cell). As a result, the video will become unstable.
- LTE/WIFI interworking will be switched on via SDR control plane (testman).
- The video stream recovers using the WIFI link through LTE/WIFI interworking



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RESULTS

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IMPACT

- Outside of ORCA, researchers might not have multiple, open and fully modifiable RATs at their disposal running on the same SDR platform.
- The platform developed saves time for researchers by providing a head start for RAT interworking experiments across all layers, without the need to invest significant effort in setting up and then integrating the individual PHY links.
- The proof-of-concept of mmWave link as a backhaul solution was successfully implemented for line-of-sight conditions. In the future, the inclusion of a second antenna to increase coverage can be explored in order to allow more advanced experimentation.