Orchestration and Reconfiguration Control Architecture

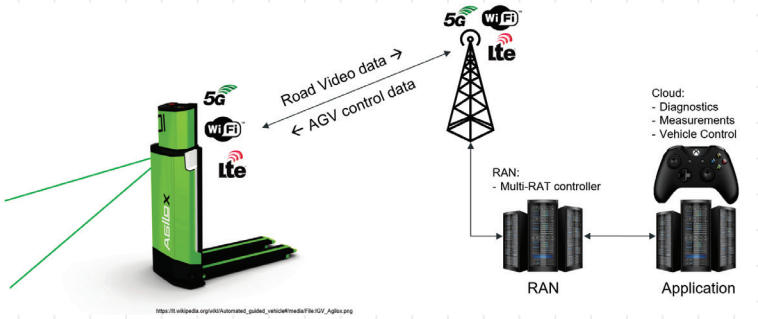
SHOWCASE 4

AGV NAVIGATION BASED ON MULTIPLE RADIO ACCESS TECHNOLOGIES

GOALS

- Demonstrate the concepts for interworking and aggregation of multiple radio access technologies (RAT) by leveraging the real-time Multi-RAT platform developed within ORCA project by NI, see D3.5 and D4.5 [1,2].

- Demonstrate a typical scenario of an industry 4.0 application on top of this platform for wirelessly connected automated guided vehicles (AGV) integrated into the ORCA factory of the future.



CHALLENGES

- Determinism and real-time behaviour are the keys for a reliable wireless system and the main development challenge.

- NI PXI or USRP 2974 real-time controller hardware with NI Linux RT operating system allows optimized process scheduling for real-time requirements of the higher layers which are represented by ns-3 modules for LTE and WIFI.

- 5G higher layer stacks were not fully available by the end of this project, see D3.5 [2]. That's why NI integrated an adapted LTE protocol stack towards the 5G flexible numerology physical layer (PHY).

- Implementation of PHY processing for all RATs on FPGA-based NI USRP-RIO SDR. The connection between PHY (on FPGA) and MAC (on CPU) with NI L1-L2 API has RAT-dependent throughput and latency requirements taken into account.

CONCEPT

- Multi-RAT base station and terminal station Software-Defined Radios (SDR) supporting LTE, WIFI and 5G radio access technologies

- RAT interworking technologies such as LTE-WLAN aggregation (LWA) for LTE-WIFI interworking and dual connectivity (DC) for LTE-5G interworking including runtime reconfiguration driven by a centralized Multi-RAT controller unit

- All RATs are implemented as full stack solutions supporting end-to-end data transfer

- Variable traffic routing during run-time allows seamless operation on application level

- Robot control application shows capabilities of wireless links in an industry 4.0 environment

[1] https://www.orca-project.eu/wp-content/uploads/sites/4/2020/05/ORCA_D3.5_Final_v1.0-compresso.pdf

[2] https://www.orca-project.eu/wp-content/uploads/sites/4/2020/05/ORCA_D4.5_Final_v1.0_compressed.pdf

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DEMO SET-UP

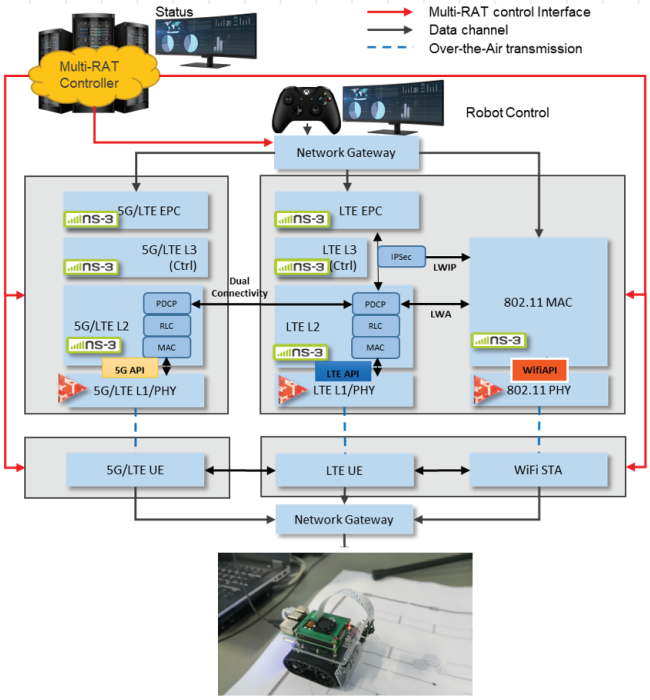
The demo setup depicted in the figure consists of a Multi-RAT base station and terminal station supporting LTE, WIFI and 5G RATs and their interworking technologies such as LWA/LWIP or DC. Controllable network gateway applications are used for flexible traffic routing during run-time to and from the robot control application based on decisions which are taken by the Multi-RAT controller.

- The demo setup focuses on wireless transmission in downlink direction. All three wireless links run in parallel, and LTE can be seen as the master path.

- The robot control application sends data packets to the network gateway, which forwards the packets to an available wireless link at the base station, e.g. LTE. where data is sent over-the-air and received by the respective terminal station.

- Another network gateway forwards the data from the terminal station to the steerable robot which is the final destination.

- Additionally, the robot provides a video stream from drivers perspective for control purposes.



- The Multi-RAT controller evaluates link and traffic conditions, and achieves RAT run-time reconfiguration by enabling/disabling LWA/LWIP/DC interworking functionality or reconfiguring the network gateways for RAT transparent communication.

- During RAT reconfiguration the robot is seamlessly steerable which is the key goal of this showcase and a proof for an industrial application with high reliability constraints.

RESULTS

With the end of the ORCA project a full stack Multi-RAT solution running on real-time SDR platform is made available to experimenters through the OWL/TUD testbed [3]. With the robot control application on top, capabilities for an industrial use case were validated. A Multi-RAT controller evaluates link and traffic conditions and allows run-time RAT reconfiguration.

IMPACT

- Provide the research community with open and fully modifiable RATs.

- Provide the research community with a head start for RAT interworking experiments across all layers, without the need to invest a significant amount of effort in setting up and then integrating the individual PHY links.

[3] http://owl.ifn.et.tu-dresden.de/orca/