





3rd party identity card

Project acronym/name	6G-SANDBOX <i>Supporting Architectural and technological Network evolutions through an intelligent, secureD and twinning enaBled Open eXperimentation facility</i>		
Logo (if any)			
Organisation name(s)	Accelleran, 	Four Dot Infinity, 	Software Radio Systems 

Objective, goal, use case

The REACT-6G activity delivers the following additional functionalities in the 6G-SANDBOX infrastructure:

- A fully operational set of RAN components (DU, CU, Near-RT RIC, Non-RT RIC) which are O-RAN-compliant, Open5GS core components and their interfaces.
- The DU has been directly connected to existing Radio Units (Liteon and Benetel) in Malaga infrastructure via high-speed 10G interfaces, providing end-to-end RAN capabilities.
- Two ML-assisted xApps in the Near-RT RIC that perform power control of the RUs (energy-efficient and data-rate maximisation power control) trained in a Digital Twin simulated environment (also deployed in UMA).
- A Conflict Manager (CM) entity hosted in the RIC that detects and resolves the conflicts that occur between the two xApps, depending on several policies (e.g., system-level EE power control vs provided QoS).

The main objective of the activity is to deploy these additional RAN components in UMA and to develop and integrate xApps and CM functionalities, further enhancing the capabilities provided by 6GSANDBOX to maximise the project's uptake by interested 6G stakeholders and application developers.

Concept, approach

Two activities were carried out in parallel: the investigation of the deployment of the RAN components in UMA and the implementation of the xApps and CM functionalities:

- Regarding the first activity, a disaggregated architecture split across two servers was finally implemented to ensure modularity and scalability. The first Server hosts the RIC/CU and Open5GS core components (AMF and UPF functions) as VMs, while the second Server hosts the DU, which is directly connected to the RUs via high-speed 10G interfaces. The telemetry information from DU/RUs (Liteon and Benetel) towards the RIC/SMO are acknowledged in the RIC via the E2 interface, including interfaces for AI/ML repositories or functionalities.

- Regarding the design of xApps and CM, a simulated 3GPP-compliant wireless environment was considered and developed for implementing a Network Digital Twin (NDT). The key idea was to train the ML agents in a simulated environment with time-varying conditions, incorporating functionalities such as interference calculation, providing channel metrics such as SINR and data rate, performing dynamic association between UEs/RUs/ PRBs and also including UE mobility. The CM component was also evaluated using different resolution policies to illustrate their impact on network KPIs such as system-level data rate and energy efficiency.

Results (testing, validation) and Impact

REACT-6G outcomes:

- A disaggregated RAN architecture has been delivered and tested across two servers with RIC/CU/DU and Open5GS components to ensure modularity and scalability. The delivered RAN architecture leverages full 10G connectivity between CU and DU, with front-haul links carefully monitored for packet loss. The configuration supports flexible deployment, making it a robust foundation for performance benchmarking and future beyond 5G innovations in the framework of 6GSANDBOX project.
- Two xApps for power control of the RUs in a multi-cell environment have also been developed. The ML models have been tested in an NDT simulated environment and integrated in the RIC at UMA premises, along with the prototype reference CM. The CM functionality has been validated, showcasing its capability to detect direct conflicts across different power control actions and resolve them based on UE-centric or EE-centric policy.

Impact of the results:

- For the *6G-SANDBOX consortium*: the delivered architecture enables the collection of measurements and data from the radio (RU/DU) that can be exploited by diverse 6G scenarios, thereby facilitating experimenters to conduct testing on 6G services towards future innovations. Moreover, the implementation of the ML-assisted algorithms in the O-RAN environment is included, showcasing the adoption of automated radio control.
- For the *REACT-6G consortium partners*: the involved partners are planning to be commercially active in 6G technologies, developing and integrating additional RAN equipment and components, as well as ML algorithms residing in xApps in the framework of O-RAN architecture. In this context, FDI, ACC and SRS have already established relationships with members of 6G-SANDBOX's consortium, aiming to jointly develop O-RAN solutions for 6G networks with high commercial interest for the international markets.
- *Environmental Impact* is implicitly achieved through the objectives of the delivered ML algorithms for power control. In specific, the ML-assisted energy efficiency operation of the radio units was evaluated through the intelligent ML-assisted xApps in the simulated environment.