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## Interworking and JOINT Design of an Open Access and Backhaul Network Architecture for Small Cells based on Cloud Networks

### Challenges

5G networks will face an exponential increase in data traffic caused by an increasing number of mobile terminals, more powerful mobile devices, more diverse and bandwidth-intensive services, and the increasing gap between per-device capabilities and per-user requirements. Two key enablers will allow for the required data rates: ultra-dense deployments that are demand-adaptive, combined with flexible centralised processing, which allows for efficient management of ultra-dense mobile networks and optimized software solutions. In this context, iJOIN investigates two key concepts: RAN as a Service (RANaaS) and Joint RAN and Backhaul design.

### RAN as a Service (RANaaS)

RANaaS allows for partial centralisation of RAN functionality depending on the actual needs as well as network characteristics. It further allows for exploiting increasing storage and processing capabilities provided by a cloud-platform hosted in data centres. RANaaS allows for adaptability and flexibility with respect to network characteristics, use cases and traffic patterns, and software implementation of optimal algorithms. Implementing RANaaS poses serious challenges to the RAN resulting in real-time, bandwidth and latency constraints on RAN and backhaul. iJOIN addresses these challenges and provides a feasible solution that can be implemented in 5G networks.

### Joint RAN and Backhaul design

Small cells may need to be deployed where it is either difficult or too expensive to deploy fixed broadband access or line-of-sight-based microwave solutions for backhaul. Therefore, the backhaul network becomes an even more critical infrastructure part as it needs to connect small cells at different locations. This requires heterogeneous backhaul technologies suitable for different scenarios and use cases. In addition, limited backhaul resources must be considered when operating the RAN. This will drive the need for co-designing and co-optimizing the RAN and backhaul network through standardized interfaces.

### Exploitation opportunities

The introduction of the RANaaS concept has the potential to open the RAN/backhaul market for new players, like vendors and providers of cloud infrastructure platforms. RANaaS also provides the technological foundation for shorter and more efficient product development cycles due to the shift from dedicated equipment to software-based functions operated on cloud infrastructures. Finally, iJOIN technology will allow for a significant reduction of costs for operators, because part of the RAN computation complexity is moved to the cloud infrastructure.



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# iJOIN demonstrator at the MWC 2015



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### Demo description

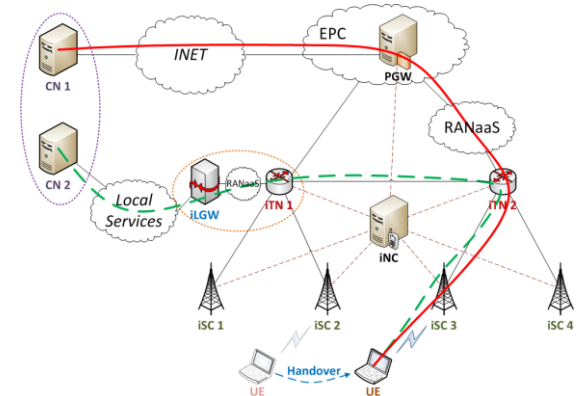
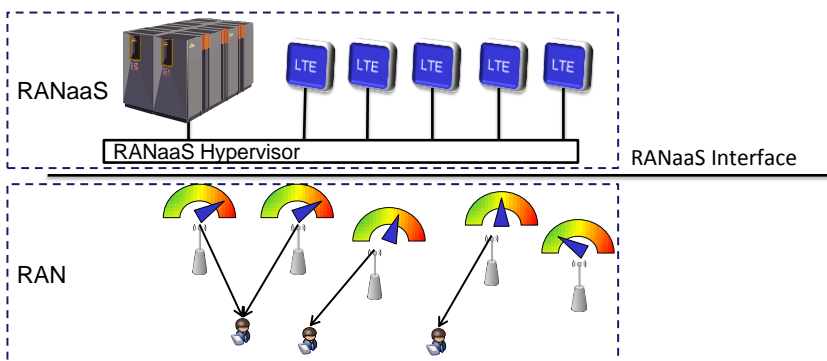
The iJOIN demo consists of the following two steps:

- In the first step, we focus on the data center demonstrator, which implements a network of a few hundred of base stations. The demo runs commodity HW and implements a standard compliant 3GPP LTE uplink decoding process. If the Cloud-RAN is congested an inter-Cloud-RAN load-balancing is initiated, which is done by means of mobility techniques. This step is addressed by the second demo based on a scenario with few base stations.
- In the second step, load-balancing across data servers is performed. This is done by handing over the mobile terminals to different data centers. This process may trigger a different functional split configuration. This step also involves additional use cases related to mobility, such as the creation of a new flow or a real handover to a new base station.

### Demo concepts

RANaaS implementation: The RANaaS platform implements an Infrastructure as a Service (IaaS) model where resources are provided on a “as a Service” paradigm. These resources may be limited which requires an active management of Cloud-RAN resources in order to avoid a computational outage rather than channel outage. This active management is performed without degradation of the system-throughput or degradation of network reliability.

Novel network management algorithms: The RANaaS concept provides an optimal split of the RAN functions between the mobile network and the cloud taking into account cloud-computing and mobile network parameters. This requires novel network management algorithms capable of efficiently taking into account the constraints from Cloud-RAN, transport network, and radio access network. In iJOIN, we adopt and extend the Software Defined Networking paradigm with an OpenFlow-enabled architecture, showcased in the demonstrator using the Ryu controller and OpenvSwitch network nodes.



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