Architecture views in 5G networks

Alexandros Kostopoulos, George Agapiou
OTEGroup

The COHERENT project[1] aims to design, develop and showcase a novel control framework for 5G heterogeneous mobile networks (HMN), which leverages the proper abstraction of physical and MAC layer in the network and a novel programmable control framework, to offer operators a powerful means to dynamically and efficiently control spectrum and radio network resources in their increasing complex HMN. COHERENT proposes the proper abstraction of physical and MAC layer states, behaviours and functions to enable a centralized network view of the underlying radio networks with significantly reduced signalling overhead. The centralized network view with sufficient but abstracted information on spectrum, radio links, interference, network topology, load information, and physical layer reality is essential to enable optimal resource allocation in the network. The innovative impact of the COHERENT project is the development of an additional programmable control framework, on the top of current control planes of operators' mobile networks, being aware of underlying network topology, radio environment, traffic conditions and energy consumption, and being able to efficiently coordinate wireless network resources cross the border of cells.

The COHERENT SDN architecture is inspired by the insights on the abstraction of low-layer states, behaviors and functions, with the aim to fundamentally improve the control and coordination among heterogeneous radio access networks, and to enable an open control framework which evolves with new radio access techniques. The COHERENT SDN architecture spans multiple planes as depicted in Figure 1, including data plane, control plane and application plane. Additionally, two abstraction layers are proposed for COHERENT SDN architecture, namely the *infrastructure resource abstraction layer* and *network service abstraction layer*. The infrastructure resource abstraction layer abstracts the underlying physical and MAC layer to the control plane, while the network service abstraction layer provides service abstractions for the applications and services.

The *control plane* in COHERENT SDN architecture configures the data plane according to the environment or an operator's policy. The COHERENT controller consists of a Network Operating System (NOS) running a collection of application modules, such as radio resource management for RAN sharing and spectrum sharing, mobility management, and traffic steering. The handling of data plane often requires multiple application modules. Therefore, the NOS should coordinate the application modules and unify a single set of forwarding decisions in each network devices. Owing to the

distributed nature of control plane, the control plane can span over multiple cloud regions. The concept of the cloud region could be in different aspects.
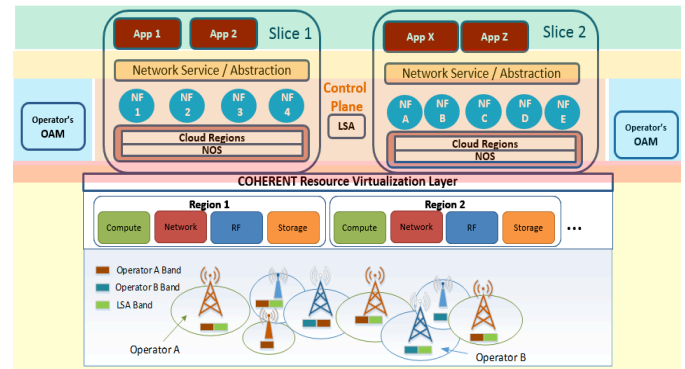

Fig. 1. COHERENT conceptual high-level SDN architecture

A key element in the preliminary COHERENT SDN architecture is the introduction of an *infrastructure resource abstraction layer* between **data and control planes**. The separation of data and control planes allows the applications to programmatically control the heterogeneous mobile networks with lower complexity. The infrastructure resource could be the resources of a mobile network, comprising access nodes, cloud nodes, networking nodes and associated links. 5G devices are also considered in COHERENT as the infrastructure resource since they may act as a relay / hub or a computing / storage resource. Through the infrastructure resource abstraction layer, the infrastructure resources are exposed to higher layers and to the end-to-end management and orchestration entity. The abstraction may be expressed by one or more abstraction models. The COHERENT intends to deal with the insufficiency of the abstraction models for heterogeneous radio access networks. More specifically, this layer provides the abstraction of the low-layer network states and behaviours of different underlying mobile networks. Furthermore, proper abstraction of physical and MAC layer will significantly reduce the signalling to implement physical layer cooperative technologies and the coordination between network entities for more efficient and scalable spectrum management and interference management.

Applications and services that use services from the control plane form the application plane in the COHERENT SDN architecture. COHERENT will provide application-centric network service abstraction in order to shield the upper applications layer and users from tedious and diverse configurations at the underlying network infrastructure among multiple networking domains. This feature implies a better understanding of global network infrastructure.