Cloud-driven Architectures for Next Generation Small Cell Networks

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ABSTRACT

The proliferation of mobile devices and the associated exponential growth of mobile data traffic have increased the pressure on mobile network operators to scale their network capacity. While physical layer advancements provide moderate gains, newer technologies like small cells are needed to provide a radical improvement. Small cells bring users closer to the base station and allow for more aggressive spatial reuse of the spectrum. While there are various forms of small cells, given that a large fraction of the mobile traffic originates indoors (enterprises, hotspots, residences), this talk will focus on indoor small cells.

Small cells inherit the dense and uncoordinated deployment characteristic of WiFi networks. However, their use of the same synchronous access technology as macrocell networks, makes the problem of interference management significantly more challenging and critical for leveraging spatial reuse. With the help of a small-scale experimental OFDMA (WiMAX) small cell network deployed at NEC Labs America, we will discuss the various factors that influence interference management in such networks and derive guidelines for the design of an efficient radio resource management (RRM) solution along the three dimensions of time, frequency and space.

While the efficiency of RRM solutions dictates performance, the deployment and management of small cells themselves incurs both capital and operational expenses for operators. In addressing these dual objectives of performance and cost, cloud-driven radio access networks (C-RAN) have been proposed as a promising architecture for the realization of small cells.

In a C-RAN, the baseband processing unit (BBU) in a base station is decoupled from its (remote) radio head (RRH), allowing for centralized operation of several BBUs and scalable deployment of light-weight RRHs remotely as small cells. This allows for direct cost benefits through simplified cell-site equipment, maintenance and operations, as well as performance benefits through improved, centralized interference management. We will focus on the unique component of a C-RAN, namely its *front-haul* network that maps and transports the signals from the BBUs to the RRHs and show how different logical configurations of the front-haul manifest as different transmission strategies on the access network and discuss why they are critical in realizing the complete potential of a C-RAN. Then, with the help of a small scale experimental C-RAN test-bed deployed in an enterprise environment, we will present the design of a dynamically reconfigurable, software-defined front-haul network for C-RAN that tailors front-haul configurations to the observed traffic profile in the network. This allows it to provide not just improved capacity but also seamless mobility, reduced compute resource consumption (in BBU pool) and front-haul customization (for different operators and access technologies) simultaneously. We will conclude by discussing some of the limitations of C-RAN architectures in general as well as their current state in the industry.

Categories and Subject Descriptors

C.2.1 [**Network Architecture and Design**]: Wireless communication

Keywords

Cellular, Small Cells, Cloud RAN, Front-haul

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