Cloud Radio Access Network (C-RAN)

C-RAN also called as Centralized-RAN, is a cloud computing-based architecture for radio access networks. It is a proposed architecture for future cellular networks that supports 2G, 3G, 4G and future wireless communication standards.

CRAN is also regarded as one of the key technologies supporting energy efficiency strategies. The main characteristics of C-RAN system are: Clean, Centralized processing, Collaborative radio, and a real-time Cloud Radio Access Network.

This approach changes the traditional cellular access network's architecture by taking advantage of cloud computing, SDR (Software Defined Radio) and advance antenna techniques. Some base station functionalities could be virtualized and pulled back to the 'cloud' where resources can be shared as a pool. Remote radio units which are decoupled from the base station can be distributed geographically to provide the required coverage.

It can also enhance the performance of MIMO (Multiple Input Multiple Output) and Cooperative Multipoint (CoMP) by improved BS cooperation via centralized processing. The centralized and virtualized resource pool supports multi standards and allows radio resource being shared by different radio access technologies (RATs) to improve the overall spectrum efficiency and flexibility.

The challenges of the CRAN architecture lie in several areas, such as high computational requirements for the base station virtualization, I/O throughput and the timing and synchronization etc. In order to maximize the benefits of CRAN, these challenges will need to be addressed.

Areas with high concentrations of network users, such as transportation stations or large commercial complexes put high stress on the BTSs that serve them. Simply adding more base stations increases cost, and can lead to signal interference if the eNBs at the base stations are not carefully coordinated.

Separating the base station into two parts, the Baseband Unit (BBU) and the Remote Radio Head (RRH), allows network operators to maintain or increase the number of network access points (RRHs), while centralizing the baseband processing functions into a "master base station".

The C-RAN architecture is designed to allow mobile operators to move the baseband processing unit to a central location in support of multiple remote radio heads. Until recently, the BBU was almost always located on-site near the bottom of the cellular antenna. This model forced network operators to lease the space, run power to every BBU and cool the equipment inside, which resulted in high operational costs.

Fig.: C-RAN architecture

C-RAN offers mobile operators the possibility to centralize multiple BBUs in a single location, either at a cell site or at a centralized BBU pool location. This allows to simplify the amount of equipment needed at each individual cell site, among other benefits.

C-RAN architecture uses fiber to connect base station equipment to tower-top remote radio heads and antennas. In some architectures, the BBUs are linked and can share information, and in others they are simply located in the same building. Colocation of BBUs is increasingly popular for carriers deploying distributed antenna systems.

The deployment of a C-RAN architecture also allow operators to save money, as it can cut costs in at least two ways. First, real estate is almost always less expensive at a data center location than at a cell tower site. Through this architecture, mobile operators can consolidate base station equipment for multiple cell sites at a central office or data center. Second, power loss is much lower with fiber than with cable, so the fiber connection associated with C-RAN can reduce operating expenses.

Regarding the deployment of cloud-RAN architectures, this model will allow mobile operators to be in a position to meet increasing requirements relating to latency, data rates and traffic volume through the use of network functions virtualization techniques and data center processing capabilities in their networks, which supports resource pooling, scalability, layer interworking and spectral efficiency.

Centralized RAN is an architecture in which the mobile operator maintains direct control and ownership of the baseband equipment. On the other hand, cloud RAN implies this equipment is owned by another service provider, or the baseband processing is handled in software run on a generic "white box" server.

The OneCell solution's design yields critical advantages, because it:

- Improves wireless user experience
- Adds capacity without interference via cell virtualization
- Simplifies capacity planning and upgrades
- Reduces macro network interference
- Reduces deployment costs
- Provides a future-ready solution

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C-RAN may also lay the groundwork for the "5G" networks of the future. Analysts expect 5G networks to connect mission critical machines as well as personal mobile devices. For that, these networks will need faster response times than today's LTE networks. This will require low latency communication between base stations, so co-located base stations may be a cost-effective way to implement next-generation architectures.

Name: **Mrs. Archana Ingle**

Designation: **Assistant Professor, H.O.D. EXTC Dept.**

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Signal Processing