

# **Moving to Cloud RAN and the Potential of Edge Data Centers**

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## White Paper

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## Moving to Cloud RAN

Mobile network infrastructure, such as the Radio Access Network (RAN), has traditionally used industry-specific hardware owned and operated by mobile operators. Software-Defined Networking (SDN), Network Function Virtualization (NFV), and Cloud Radio Access Network (C-RAN) are among the initiatives breaking that tradition. The result is that the RAN and Evolved Packet Core (EPC) applications are adapting to run on centralized off-the-shelf IT infrastructure that utilizes fronthaul connections to connect to the RAN nodes.

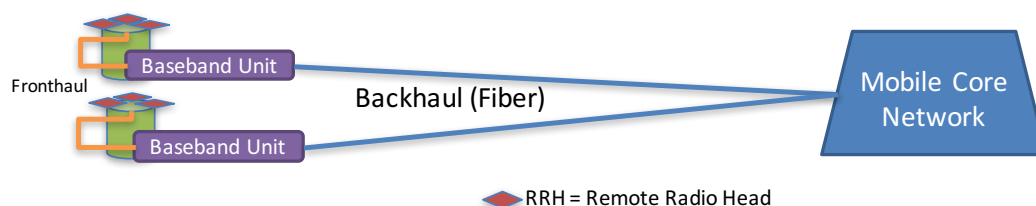
This paper explores the process of moving from today's conventional Remote Radio Head (RRH) deployment, where the Baseband Units (BBU) are deployed at the base of the cell tower, to an architecture in which the BBUs are deployed in one or more centralized locations.

The next step in this evolution is an architecture in which the BBUs are deployed in a central office, hub node, or data center with the baseband functionality itself running in virtualized software on generic computing platforms. This eventual architecture divorces the 1:1 ratio between baseband and RAN cells, and thus gives mobile operators the ability to support the same number of cell sites and sectors on less hardware, thereby potentially reducing costs and accruing other operational benefits. This would be an example of a C-RAN architecture, with aspects in common to today's data center architectures.

### Phased approach to C-RAN

Figure 1 below shows a typical RAN architecture today – the radios at the top of the tower are connected via fiber to the BBUs in a secure, climate-controlled enclosure at the bottom of the tower. The BBUs are then connected via fiber backhaul to the mobile core.

**Figure 1: Current RRH Deployment Architecture**

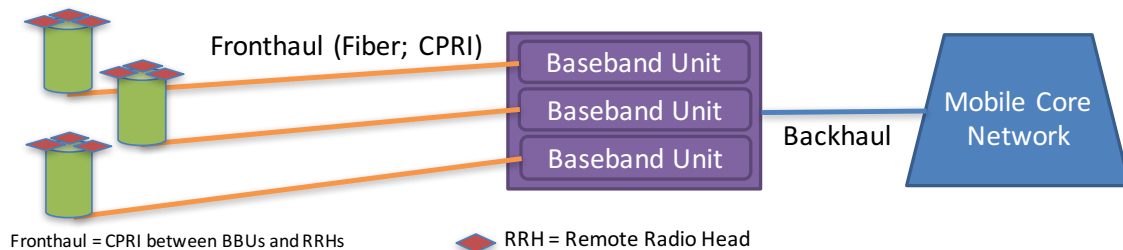


Source: iGR, 2016

The first step towards a true C-RAN deployment is to move the BBUs from the bottom of the tower to a centralized location (Centralized RAN Architecture). This location may be a new dedicated structure, a central office or a Data Center (Figure 2). This must be localized as there are distance limitations between the BBUs and the RAN sites.

Note that many BBUs can be centralized into one data center. In this scenario the 1:1 ratio of baseband to RAN cells is retained. This option may be referred to as “stacked” BBUs.

**Figure 2: Centralized-RAN Architecture**



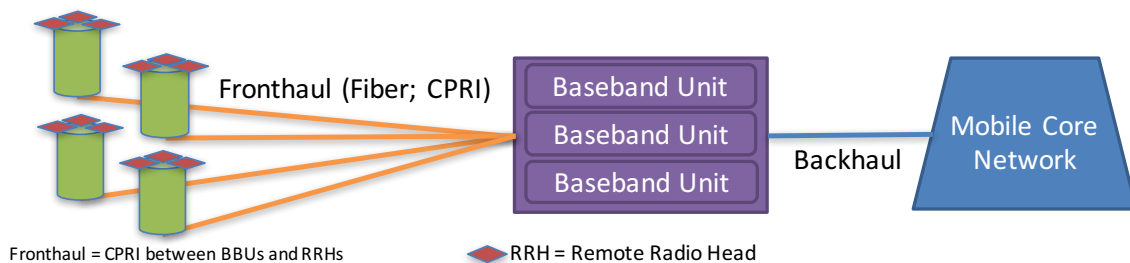
Source: iGR, 2016

Centralizing the RAN also introduces “fronthaul” to the architecture. Fronthaul is typically used when referring to the fiber connection between remote radio heads/units (RRHs/RRUs) and baseband units. The connection between the baseband units and the EPC is still referred to as “backhaul.” Note that while fronthaul can be provided by microwave or copper connections, nearly all fronthaul links today use fiber. It is iGR’s understanding that the requirements for CPRI are relatively strict in terms of reliability, latency and throughput. Microwave (millimeter wave) and copper may be suitable under certain circumstances, but at present point-to-point fiber connections are preferred.

Evolving to a Cloud RAN Architecture requires running base station functions as software on commercial servers deployed at the BBU hub locations, decoupling the hardware and software platforms of wireless base stations (Figure 3). So instead of dedicated hardware, BBU processing is functionally “pooled” in software and then connected via fronthaul to the RRHs while also being backhauled into the mobile core.

Note that in Figure 3, more towers are supported by the same three BBUs. This illustrates how the same number of “virtual” BBUs could support more towers than in the “stacked” model shown in Figure 2. Alternatively, since the theoretical gain posited by iGR’s C-RAN model employs a 1:0.8 ratio of RRH to BBU, the model could have shown 2.4 BBUs.

**Figure 3: Cloud-RAN Architecture**



## The Importance of Distance and Location

The connection protocol that is used today between the RRH and the BBU is called the Common Public Radio Interface (CPRI). The requirements for CPRI are relatively strict in terms of reliability, latency and throughput – as a result, point-to-point fiber connections are typically used since fiber supports very high bandwidth (several gigabits per second), provides low latency (in the millisecond range) and high reliability.

The performance requirements of CPRI necessarily limit the distance between the RRH and the BBU. By extension, this means that the edge data centers or hubs must be located close to the radio heads and the cell sites. And multiple, smaller edge data centers will be used instead of larger, centralized configurations.

Smaller, more localized edge data centers have to be sited in suitable locations that provide ample power, fiber connectivity (to connect to the rest of the network) and security. Careful design of the edge data centers is required to ensure that they meet the requirements – after all, the reliability of the wireless network depends on the edge data centers' ability to support the radio heads and cell sites.

## The Benefits of C-RAN

iGR's research suggests that operators moving to a C-RAN environment will see cost savings over their existing distributed networks. In addition to CapEx and OpEx savings, operators may well realize other quantifiable benefits, such as:

- Increased flexibility
- Reduced maintenance
- Faster/easier upgrade cycles
- Reduced downtime in the event of BBU failure
- The ability to deploy new services/technology in fewer physical locations in less time and at a lower cost
- Alternative business models for equipment ownership.

## Use of edge data centers for Baseband Unit hosting

One of the key questions that arises in the evolution to C-RAN is: Where do those stacked/pooled baseband units go?

These clustered BBUs are an excellent example of today's generation of performance IT equipment, so naturally the environment within which they are housed has distinct parallels and similar requirements. The location and housing options range from:

- Suitable existing operator-built facilities

- Upgrades to existing built facilities
- New build facilities
- New “in-field” structures (enclosures)
- Third party data center environments.

Regardless of which option is deployed, the one common aspect is that such an environment can be considered a new technology space.

But as the network continues to evolve and scale, so the size of the local data center also has to grow and adapt. For example, content delivery servers will be deployed in the data centers to move content closer to the edge of the network, and additional baseband processing power will be needed for additional RRHs and small cells. Data centers will need to be relocated if the demographics of a metro area’s mobile subscriber base changes.

To accommodate growth and changes in the mobile network, use of edge data center architectures makes sense. If data center and BBU support capabilities are required at a specific location, an edge data center can be easily deployed. And if additional capacity is required, a modular approach to the edge data center can quickly be added to provide “capacity on demand”. Similarly, if the specification and application of the new equipment changes, so too can the specification of the edge data center. As well as being geographically flexible and easily scalable, edge data centers offer additional advantages important to the mobile operator seeking to migrate to C-RAN:

- **Secure** – the baseband units and associated network hardware must be in a secure location to prevent tampering and to ensure the integrity of the network traffic. The data center must also offer protection from weather and accidental damage.
- **Energy efficient** - mobile operators are reducing network operating costs, which necessarily includes reducing the power requirements of the RAN. Modular data centers can offer flexible cooling options, including adiabatic free air cooling, that results in lower energy bills compared to conventional brick-and-mortar facilities. In addition to saving money, lowering power consumption also allows the mobile operator to promote the environmental and ‘green’ aspects of its operation, enhancing its brand and reputation.
- **Fast deployment** – instead of the years of planning, design, and build associated with brick-and-mortar, a modular unit can go live within 15 to 20 weeks from the date of order, depending on the configuration and unique needs of the operator.
- **Low maintenance** – centralizing the baseband units and associated content servers within an array of modular data centers allows the operator to reduce the number of visits needed to its various cell site locations for maintenance. Today’s modular data centers are extremely reliable. A properly designed modular data center reduces maintenance and operating costs when compared to converting

traditional brick-and-mortar locations for use as C-RAN nodes through remote monitoring and control capabilities.

- **Enhanced wireless performance** – key LTE Advanced (as well as the upcoming LTE Advanced Pro) features work best when there is a minimal delay between baseband units. C-RAN enables this benefit by co-locating the baseband units, thus reducing the delay between them.



# Methodology

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## Disclaimer

The opinions expressed in this report are those of *iGR* and do not reflect the opinions of the companies or organizations referenced in this paper. All research was conducted exclusively and independently by *iGR*.

## About CommScope

[CommScope](#) (NASDAQ: COMM) helps companies around the world design, build and manage their wired and wireless networks. Our vast portfolio of network infrastructure includes some of the world's most robust and innovative wireless and fiber optic solutions. Our talented and experienced global team is driven to help customers increase bandwidth; maximize existing capacity; improve network performance and availability; increase energy efficiency; and simplify technology migration. You will find our solutions in the largest buildings, venues and outdoor spaces; in data centers and buildings of all shapes, sizes and complexity; at wireless cell sites; in telecom central offices and cable head ends; in FTTx deployments; and in airports, trains, and tunnels. Vital networks around the world run on CommScope solutions.

## About *iGR*

*iGR* is a market strategy consultancy focused on the wireless and mobile communications industry. Founded by Iain Gillott, one of the wireless industry's leading analysts, we research and analyze the impact new wireless and mobile technologies will have on the industry, on vendors' competitive positioning, and on our clients' strategic business plans.

A more complete profile of the company can be found at <http://www.igr-inc.com/>.