The Need For Speed – Making M-CORD LTE/5G Work

Automated Fiber Switching (AFS) makes next-generation M-CORD deployments viable with mobile networks economics, service delivery and flexibility benefits.

Introduction

Today's Mobile Network Operator (MNO) infrastructure is built with proprietary vertically integrated Network Elements (NEs), leading to inefficient utilization of network resources. Further, it is very difficult to customize the current infrastructure for different wireless subscriber needs or locations, and legacy architectures do not support the needed speed of emerging services requirements. To that end, the wireless industry has developed the Mobile Central Office Re-architected as a Datacenter (or M-CORD) reference architecture for re-architecting the current mobile telecom infrastructure into a Data Center(DC) to achieve cloud-style economies of scale and agility.

The CORD reference architecture addresses the needs of various communications access networks with a wide array of use cases including:

- R-CORD: or Residential CORD, defines the architecture for Residential broadband
- M-CORD: or Mobile CORD, defines the architecture of the Radio Access Network (RAN) and Evolved Packet Core (EPC) of LTE/5G networks
- E-CORD: or Enterprise CORD, defines the architecture of Enterprise services such as E-Line and other Ethernet business services
- C-CORD: Cable-MSO CORD
- A-CORD: for Analytics that addresses all four use cases and provide a common analytics framework for a variety of network management and marketing purposes

With the simplification that Automated Fiber Switching (AFS) brings to CORD deployment and ongoing operations, the integrated AFS-CORD architecture can achieve a 75% reduction in OPEX. Maximum AFS benefits are realized when seamlessly integrated into the full array of CORD use cases for residential, mobile and enterprise deployment scenarios, as illustrated in Figure 1:

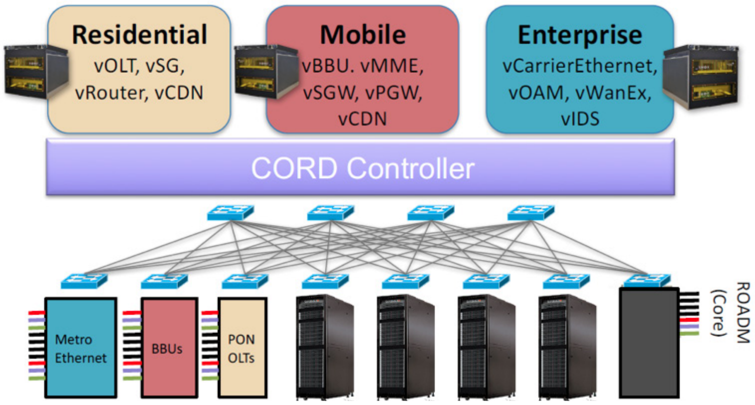

Figure 1 - Sample CORD Use Cases

M-CORD Overview

M-CORD (Mobile-CORD) targets mobile distribution networks and is influenced by emerging 5G standards. It specifies how NE functions can be aggregated or disaggregated, with instantiation on commodity infrastructure to reduce CAPEX costs. The goal of M-CORD is not only to replace legacy NEs with more agile counterparts, but to also enable the mobile network to quickly support more attractive and meaningful mobile services.

M-CORD transforms the traditional mobile network architecture, decoupling control and data planes. The control plane is logically centralized, and mobile network functions as well as MNO specific services are disaggregated and virtualized. In addition, virtualized functions and services are packaged as scalable entities in the overall mobile network use case services orchestration.

M-CORD is a reference architecture solution and built on the pillars of Software Defined Networking (SDN), Network Function Virtualization (NFV) and cloud technologies. It leverages open source software, disaggregation of Network Elements (NEs), and virtualization of Radio Access Network (RAN) components and other core functions of mobile networks. M-CORD is an ideal rapid innovation platform towards 5G networks, allowing MNOs to experiment with 5G technologies without waiting on ratification of standards.

Emerging 5G networks must not only support increasing data rates, but must also support a common infrastructure where new wireless services are based on vastly different network QoS requirements. To address such needs, a 5G architecture needs the ability to dynamically create programmable virtual networks, and differentiate traffic treatment utilizing solutions based on the concept of ***Network Slicing.***

Network Slicing utilizes M-CORD's key features of disaggregated virtualized RAN and EPC components, along with open source implementations for RAN and Evolved Packet Core (EPC) that allows customization and modification, as illustrated in Figure 2:

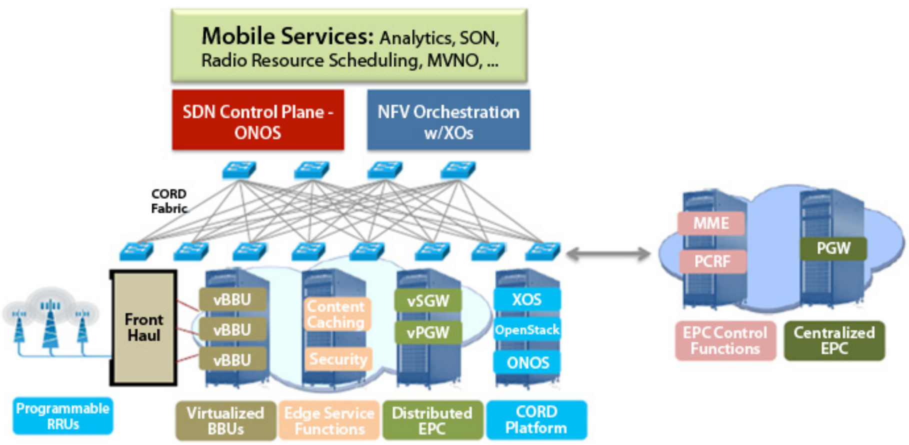

Figure 2 – M-CORD RAN Network Slicing Virtualization

M-CORD is based on the emerging RAN architecture with centralized baseband processing Digital Unit (DU) nodes providing on-demand allocation of computation/processing resources. The *Fronthaul* network connects the CO Virtual Baseband Unit (vBBU) pool, which is also referred to as a Digital Unit (DU) pool, with geographically dispersed Remote Radio Units(RRUs). Information is exchanged between the RRU and the DU Pool (or vBBU pool) over the Fronthaul access distribution network. The goal of decoupling the baseband processing from the RRUs is to enhance redundancy and maximize operational reliability of the DU pool.

The Fronthaul network communication protocol standard between the centralized vBBU pool and Remote Radio Units (RRUs) is the Common Public Radio Interface (CPRI) specification. To manage the connected radios, the vBBU uses the CPRI standard for the vBBU-RRU interface to transfer synchronization, radio signals, and control and management signaling. The best facility for CPRI is dark fiber, because encapsulating CPRI into another protocol introduces too much latency and jitter to comply with the specification.

For a geographical area with limited access fiber or rental wavelengths, a ring solution is an option, as well as a Passive Optical Network (PON) facility. An example of Fronthaul network options that save on fiber facilities is illustrated in Figure 3:

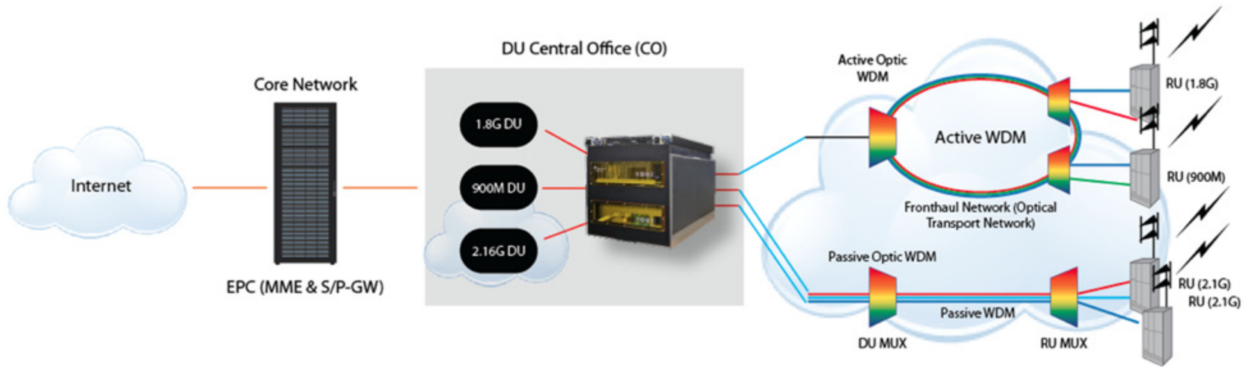

Figure 3 – M-CORD Fronthaul Network Connectivity

Centralization aggregates different vBBUs, and several dozens or several hundred Remote Radio Units (RRUs) require many fibers for direct fiber connections to DUs. It is also important that a fronthaul solution provide 1:1 or 1+1 backup mechanisms in case of fiber failure. The emerging Mobile Network Operator (MNO) Software Defined Network (SDN) model is to spin-up Software Defined Radio (SDR) vBBU-DU Virtual Machine (VM) computational resources based on the fiber interface on a given physical port as illustrated in Figure 4:

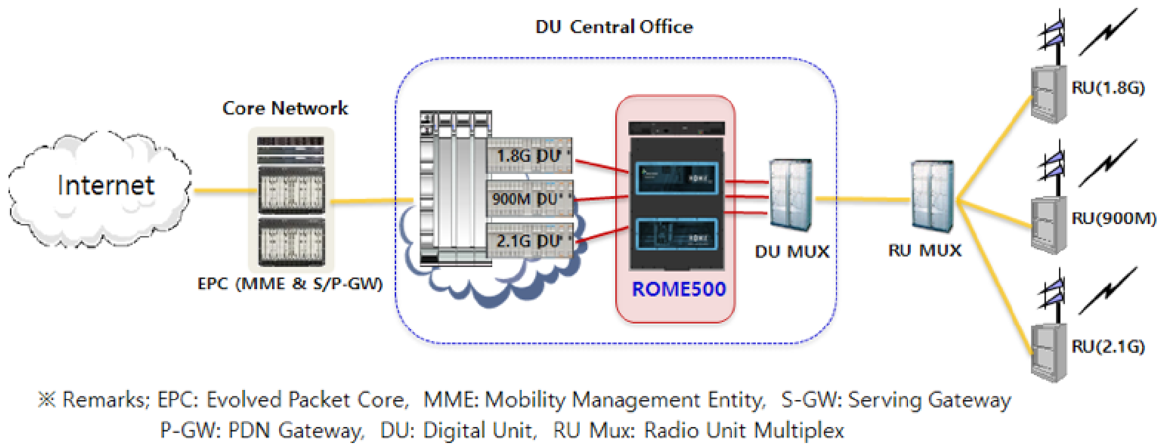

Figure 4 -AFS Fiber Interfacing To vBBU-DU

As such, these vBBU-DU nodes are in the same room, floor or building to form a "vBBU-DU Hotel", with a high-speed low-latency interconnection between them. In this way M-CORD could facilitate implementation of collaborative wireless radio networks to reduce interference and improve system performance.

When these deployments are seamlessly integrated with AFS products, the combined solution make expensive radio and processing equipment more effectively shared, reducing capital and operational expenditures. For example, when increasing the size of vBBU-DU Cloud, it becomes difficult to switch data from an arbitrary RRU to any vBBU-DU. When the size of a RAN reaches a certain level (e.g. more than 30 sectors), the resource sharing gain may become flat or marginal. Therefore, it's not economical to design a high-speed fully non-blocking mesh vBBU-DU Cloud. To balance scalability and flexibility, vBBU-DU sub-clouds (i.e. clusters) can be used with a hierarchical design for the vBBU-DU cloud at the CO as shown in Figure 4:

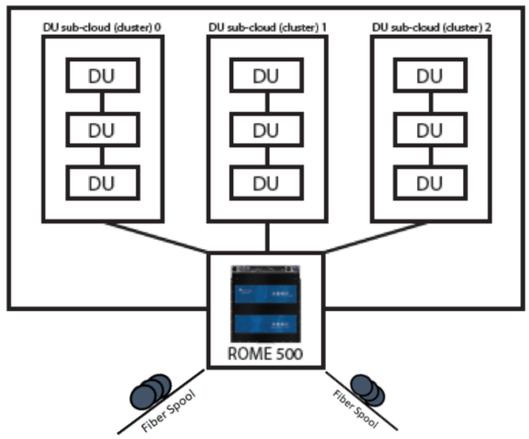

Figure 4 – AFS Enhanced vBBU-DU Cluster Spin-up & Utilization

When increasing cloud size, MNOs can install more vBBU-DU clusters, or upgrade clusters faster than with outdated manual fiber patch panel and cross-connect processes and procedures. AFS collocated with centralized vBBU-DUs provide equipment pooling gain to more efficiently utilize vBBU-DU equipment, and reduce capital costs. This means that vBBU-DUs whose CPRI ports were only partly filled from a cell site can be fully utilized at the CO. Therefore, the same number of cells can be supported by a fewer number of centralized vBBU-DUs. The combination of an AFS and vBBU-DU equipment redundancy migration controller will provide a backup vBBU-DU in a real-time way.

It is anticipated that the EPC core network will also migrate to the cloud, and the user plane of the EPC core network will use SDN-based switches and routers with extended functions. This SDN architecture approach coupled with an AFS enables MNO business model transformation possibilities to generate new business opportunities, such as a Base Station vBBU-DU equipment virtual resource rental models, cellular infrastructure and intellectual property agencies, and more premium mobile services.

A-CORD Adaptive Analytics Service

MNOs must also quickly detect, identify and resolve service impairments. Providing test and assurance functions as a service model can be chained together with other network service models. Service chaining enables test and assurance capabilities to be automated together with the main service deployment. These test and assurance services can then be used, in real time, to drive root cause analysis and enable closed loop automation of network control to improve the network's behavior and help reliably deliver new Service Level Agreement (SLA) based services.

A-CORD takes advantage of the M-CORD platform's ability to instantiate test and monitoring agents. CORD's monitoring as a service can be used within network service designs to enable operational readiness. The resulting service model combines a precise definition of the service function itself and the quality metrics needed to test and assure that service. This innovation requires performance monitoring information needed by analytics applications such as root cause segmentation along the service path.

An AFS providing protection switching and centralized remote OSP cable testing is a key component in standing-up real-world M-CORD networks. MNOs can use AFS products for testing multiple RAN fiber Fronthaul networks with the same OTDR using an AFS to select the fiber path to be tested. This approach enables a single OTDR to handle testing for an entire mobile CO, as illustrated in Figure 5:

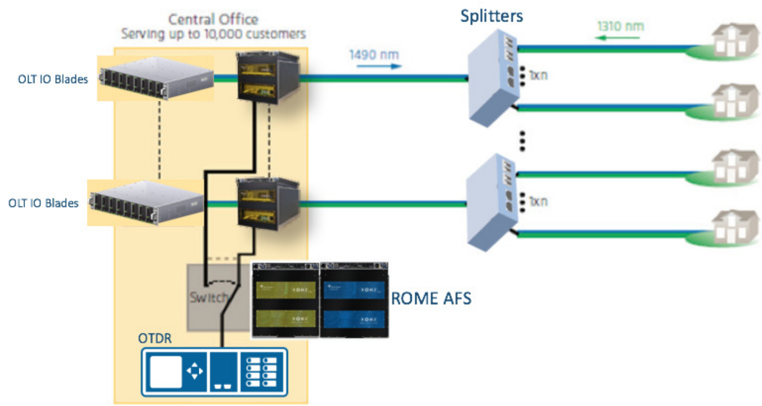

Figure 5 - Fronthaul Cable Plant Testing

With and AFS, the network operations center (NOC) can remotely test facilities from the NOC, enabling them to troubleshoot before sending any technicians to far flung geographical Tower locations. Expensive OTDR test equipment can be centrally located, readily available and shared over multiple fiber facilities. AFS can therefore save many hours of mobile network downtime and help MNOs to more effectively honor SLAs.

Conclusion

Traditionally, many fiber cross-connections within Base Stations, COs and Data Centers are done manually. Manual fiber cross-connection is time-consuming and complicated, and there is a definite possibility of misconnection. Moreover, skilled maintenance personnel must be dispatched to correct failures.

As we have seen, AFS technology can offer powerful operational benefits when integrated with M-CORD deployments. These benefits include:

- Faster time to revenue of new mobile services
- Transformation of the MNO business model
- Dynamically scaled M-CORD vBBU-DU appliance connectivity
- End-to-end Mobile network balancing
- Full operations model change with flexibility and automation
    - √ Moves/adds/changes and testing/diagnostics
- Remote testing and troubleshooting of Fronthaul network facilities
- Network optimization via near-real time fiber reconfigurations
- Minimized downtime and fewer outages

In order to deliver these benefits, AFS solutions must comply with several strict mobile Fronthaul access distribution CPRI network requirements, and should be transparent to bit rate and transmission protocol.

