Blueprint for mobile xHaul over DOCSIS®

An exciting new revenue growth engine for cable operators

Making the most of the HFC Plant

One of the next big opportunities for cable operators is transitioning into mobile operators and doing so in a cost-effective way that reutilizes their main assets – the Hybrid-Fiber Coaxial (HFC) plant.

Native Data Over Cable Service Interface Specification (DOCSIS) technology provides a good entry point for cable operators to move into xHaul (Backhaul, Midhaul, and Fronthaul) for mobile. The cable industry needs readily deployable technologies to take the DOCSIS network from a merely cost-effective xHaul network to a great high-performance solution, all without expensive upgrades and without moving to a more expensive fiber-only solution.

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Why should cable operators move into mobile?

The answer is quite simple – it's all in the economics. As operators try to fill the void of consumer cord-cutters and the loss of video and telephony subscribers on their networks, they need to find a new growth engine. According to a recent report by Kenneth Research, the opportunity for growth in the Wireless Backhaul Market was valued at $20.34 billion United States Dollars (USD) in 2016 and is projected to reach $63.69 billion by 2025, growing at a Compound Annual Growth Rate (CAGR) of 13.52% from 2017 to 2025[2].

In a recent report by analyst firm MoffettNathanson[1], cable operators are projected to continue growing their fixed broadband business and grabbing more share from the telcos for the foreseeable future. But with an already high market penetration, they are unlikely to see the same levels of unparalleled subscriber growth they enjoyed with broadband. Entering the mobile market provides cable operators with new opportunities to increase subscribers and revenue.

Traditional cellular deployments were in the form of high powered macrocells. However, new generations of mobile standards like LTE-A and 5G are able to offer even higher speeds and lower latency. Adding spectrum is certainly one way for new entrants into the wireless space to achieve the higher speed their customers desire, but it comes at a cost. The alternative approach is to borrow a page from the cable industry's old trick of node splitting. In node spitting, when you run out of capacity, you split the area into a smaller area with less customers. This allows physical spectrum re-use. The most aggressive version of increasing capacity and decreasing node size has been the transition from N+5 to N+0 where one node is replaced by 15 to 20 nodes.

The equivalent technique to this in the mobile space is to replace or supplement a macrocell with a substantial number of small cells to increase data capacity. Small cells are interesting because they enable higher frequency reuse due to their small coverage area. This means that instead of hundreds of users sharing a single block of spectrum on a macrocell, fewer number of users get to share the same block of spectrum on a small cell, which results in higher data throughput per user.

Densification presents a challenge to mobile operators. All that infrastructure building requires investments. For outdoor deployments, about 80% of total spending is attributed to backhaul, siting, and powering, while only 20% is spent on network equipment[3]. How can mobile operators scale their network an order of magnitude or more without doing the same to their economics?

The answer lies in the HFC plant. Simply put, cable operators own the infrastructure covering 80% of the small cell deployment cost. By virtue of

Key Technology:

Low Latency xHaul (LLX)

DOCSIS distributed hierarchical QoS

DOCSIS Predictive Scheduling

DOCSIS Time Protocol

its large footprint as well as reduced siting, installation, and utility charges, this "gold in the ground" allows the cable operators to offer their customers wireless services at a significantly reduced cost[3]. Cable operators continue to realize the increased revenue opportunity that comes with offering wireless services, which is why about half of CableLabs'® members are already mobile operators and we anticipate that number to increase.

Having favorable economics creates the opportunity, but is the DOCSIS technology up to the challenge?

How Low Latency xHaul (LLX) and other technologies make DOCSIS an ideal solution for mobile xHaul

Low Latency xHaul (LLX) is a part of a group of technologies that facilitate xHaul over DOCSIS. LLX is key to significantly reducing the upstream latency that mobile traffic may experience while traversing the DOCSIS link. Other companion technologies comprising part of this technology suite are precision timing and synchronization, predictive granting, and centralized or distributed hierarchical Quality of Service (QoS).

This paper starts with a baseline case of transporting mobile traffic over native DOCSIS technologies. It will then introduce four key technology areas that improve the performance and the cost of xHaul over DOCSIS networks. These technologies are:

- LLX, which utilizes the Band Width Report (BWR) message
- DOCSIS distributed hierarchical QoS
- DOCSIS Predictive Scheduling (DPS)
- DOCSIS Time Protocol (DTP) for timing and synchronization

Wired networks will increasingly become crucial for mobile network operators as they densify their networks and move into the 5G era, according to analysts at MoffettNathanson[1]. That will provide a path for cable operators to successfully enter the wireless market.

Users are increasingly turning to mobile devices to access fixed-line networks, further blurring the lines between the two markets. According to Cowan Research Analyst Gregory Williams[2], cable has the plant assets and unique footprint (reach) for small cell backhaul, midhaul or fronthaul. Cable is the only one that could deploy at scale at a reasonable cost, and expeditiously."

Benefits of HFC for wireless backhaul

Ubiquity

Capacity

Power

Speed & Simplicity

Automation

"Cable's infrastructure will ultimately win in wireless, just as it has already won in broadband." (MoffettNathanson[1])

An operator experience with mobile backhaul over DOCSIS

HFC infrastructure provides many strategic advantages for wireless backhaul when compared to pure fiber or microwave/wireless backhaul approaches. These include:

1. Ubiquity – HFC networks run down almost every street and into every building in a city. This gives significant flexibility to wireless teams when designing optimal small cell deployments with virtually no civil build requirements.

2. Capacity – Thanks to DOCSIS technology, HFC networks can handle large broadband capacities. Leveraging DOCSIS 3.1 and mid-split, a typical HFC serving area has gigabits of downstream capacity and up to 500 Mbps of upstream. In the future, as 5G and mm-wave technologies come to market, cable operators will be able to leverage DOCSIS 4.0 to provide multi-gigabit symmetrical backhaul over existing HFC infrastructure.

3. Power – One of the most notable advantages of HFC over fiber and wireless backhaul is its ability to transport power to small cells. Large Passive Optical Network (PON) and fiber deployments tend to eliminate the need for active field equipment. In order to deploy outdoor small cell in a PON or wireless topology, operators typically need to obtain permitting, add temperature/weather hardened transformers, batteries, and wiring, and complete significant electrical work. This power is perfect for feeding small-cell deployments, and often eliminates the need for onerous and complicated power upgrades.

4. Speed & Simplicity – HFC aerial architecture provides an ideal medium for fast small cell backhaul deployments. Attachment of a small cell to HFC "aerial strand" typically does not require any permitting, greatly reducing the time to build. This work usually takes just a few hours to complete.

5. Automation – Operators have invested heavily to enable automated provisioning and enablement over their DOCSIS infrastructure. These same systems can be leveraged to quickly and easily provision, turn-up and document new small cell deployments, often without any human intervention. This further accelerates deployment speed while reducing manpower and waste.

The reasons outlined above should make choosing HFC for backhaul an easy decision for both Multiple Service Operators (MSOs) and Mobile Network Operators (MNOs). However, because of its capacity and dedicated

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wavelength properties, fiber is often touted as the ideal wireless transport technology.

Conclusion

LLX uses a pipelined scheduling mechanism to provide lower latency. It does this by connecting the mobile schedular to the Cable Modem Termination System (CMTS) scheduler using the BWR message. LLX also defines a common quality of service framework for both mobile and DOCSIS so that the relative importance of different traffic streams is maintained across the two systems. The result is that the DOCSIS system has fiber-like performance and latency.

LLX is further enhanced by using a new distributed hierarchical QoS structure that allows for grant sharing in the CM. There are two primary use cases. The first is when a scheduling service like PGS is used that is wasteful of grants. The second use case is when traffic presented to the Cable Model (CM) by the eNBs placed on different flows than what were indicated in the BWR message.

DPS is useful for flows that are not completely covered by BWR, such as those that originate at the eNB. It also helps if the BWR message does not arrive in time at the CMTS. DTS characterizes the round-trip and one-way delay for a DOCSIS network. When combined with the native DOCSIS 3.1 timestamp, it can work with an IEEE 1588/PTP network to provide highly accurate timing to a CPE.

LLX is implemented with minimal impact on existing RAN and DOCSIS equipment. No hardware changes are required. The software is engineered to have minimal impact to existing implementation. This will facilitate rapid industry adoption and implementations are available today on commercially deployed equipment.

References

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