Network Convergence: Are we there yet?

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The idea behind network convergence is an old one. Convergence is defined as the use of multiple communication modes on a single network. It is also supposed to usher in a whole new world of network convenience and flexibility.

For operators, network convergence offers numerous benefits. These include:

- Significant savings in the total cost of deployment and operations of new solutions.
- Reducing the cost of deploying fixed and mobile services in new areas, while allowing operators to explore new market opportunities efficiently.
- Simplifying connectivity by using fiber networks to connect everything and every thing, while having the flexibility to use other modes if necessary.
- Standardizing the operator infrastructure for flexibility, while future proofing for new technologies.

So, what is holding back the progress toward network convergence?

The chief reason is organizational structure. For example, many operators have business units with different priorities that promote products based on different networking architectures. Meanwhile, companies who want to embrace convergence do not know whom they can turn to for converged networks.

Lack of knowledge is another hurdle. Convergence requires a clear understanding of how the various types of networks work. Multiple schools of thought, competing architectures and different terminologies make it difficult for companies to understand the differences.

Another reason is economics. While convergence promises long-term savings, it requires significant investment in the short term. The question then becomes who should pay for this short-term investment, which can be substantial.

Governments and regulators also play a vital role in driving convergence. Many regulations and legislation were enacted in an era when fixed line services were well established and mobile networks were emerging. It takes a strong vision and political will to introduce new regulations. The situation is further convoluted in Asia where telecommunications infrastructure is seen as a critical one and have designed specific laws and regulations to protect the infrastructure from misuse or attacks.

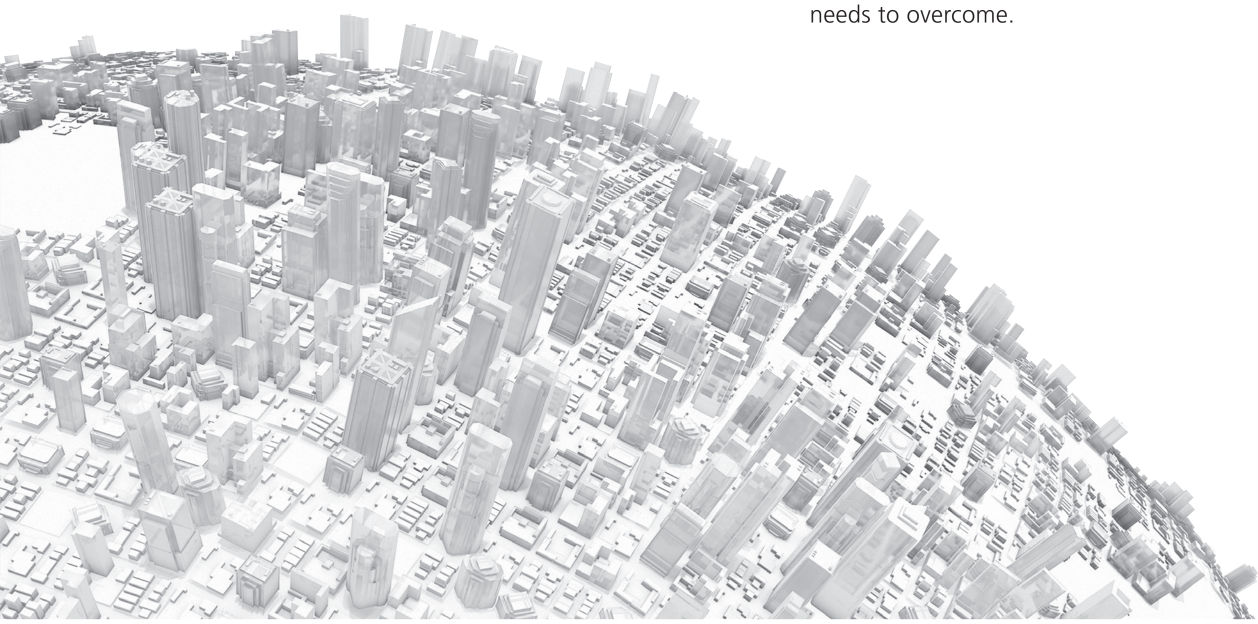
The above are some reasons that kept the progress in convergence at bay. Then, 5G (more specifically 5G NR) changed it all.

5G offers network speeds that were only previously available with fixed-line broadband speeds. But beyond network speeds, 5G also allows techniques like network slicing to drive new use cases and revenue streams for operators.

However, to enjoy the 5G benefits, operators need to build their networks. Supporting separate fixed line and mobile network environments is an expensive proposition and convergence offers a way forward. A converged network also makes economic sense in dense urban environments where real estate is costly.

Another driver is digital transformation. Workloads on both fixed and mobile networks are soaring as companies and consumers embrace a connected environment. Advanced solutions for smart cities that rely on internet of things (IoT) devices and sensors are also driving operators to relook at their network design.

This report will look at the changing convergence landscape, key trends that will shape its growth and the challenges that it still needs to overcome.



Dialing into the 5G Effect

Looking at 5G as an upgrade from 3G and 4G is short-sighted; it offers much more. Three major use cases that highlight 5G's benefits include enhanced mobile broadband (eMBB), massive machine type communications (mMTC) and ultra-reliable and low-latency communications (URLLC).

eMBB, which allows downlinks and uplinks to operate at speeds higher than 1Gbps, let applications like real-time video streaming to be available en masse. It can also drive the mass adoption of virtual and augmented reality applications for mobile devices.

mMTC supports real-time machine to machine (M2M) communications, empowering new applications like autonomous vehicles, smart city applications and smart manufacturing. Meanwhile, URLCC reduces transmission errors and lowers round trip time (RTT). The boost in reliability will make applications like remote surgery possible and even insurable.

While 5G supports these use cases, it needs to be designed carefully. How operators tackle interference, latency and backhaul transport needs will be major concerns. It is where network convergence offers answers.

Densification

Mobile devices rely on operator macrocells for coverage. While 4G (especially 4G LTE) saw an increase in macrocells, 5G and the expected surge in bandwidth demand will require more – especially when the higher 5G frequencies that promise faster speeds are constrained by distance.

Physical space on the top of cell towers limits the number of macrocells that can be installed. It is also becoming more expensive to install in urban areas. Furthermore, crowding macrocells together creates another problem: interference.

Many operators are turning to low-powered microcells and picocells, which can transmit the same frequencies while reusing the existing spectrum. However, data volumes will only soar as more subscribers and data-hungry apps come online. The current use of microwave point-to-point (P2P) links will not be enough and offers an important case for connecting cell sites using fiber. In turn, this will create a demand for converged networks.

Centralization of RAN

In a traditional radio access network (RAN), the radio and baseband processing units are deployed at the cell site, in an architecture commonly known as "Distributed" RAN. This architecture offers advantages to operators in terms of simplicity and coexistence with legacy technologies, but it does not enable operators to exploit the full benefits of interference management and load management features available in the most recent versions of LTE and 5G NR standards in highly-loaded areas. The ability to centralize baseband functionalities for multiple cell sites provides spectral efficiency gains and minimizes interference, increasing the capacity of the network and improving the end user experience.

The so-called "Centralized RAN" consists of a group or cluster of cell sites equipped with antennas and radios controlled by a set of baseband elements located in a central location, typically not further than a few kilometers away from the cell sites. The interface between the radio unit and the baseband unit is called "fronthaul" and can be implemented in multiple ways: CPRI, eCPRI, ORAN fronthaul specification, etc. In 5G RAN, the baseband unit functionality is split between two logical nodes called DU (Distributed Unit) and CU (Central Unit), hence increasing the variety of Centralized RAN architectures depending on the location of these two nodes.

The ultimate decision as to which architecture will be used in each scenario may depend on the business/service requirements, transport network capabilities/assets and the availability of tight RAN coordination features.

The availability of fiber is essential for the implementation of Centralized RAN architectures as it provides the bandwidth, flexibility and scalability to support the continuous evolution of the RAN. Operators with fiber assets will be better positioned to deploy advanced RAN networks and to better serve their customers in a highly competitive market.

Multi-access Edge Computing

New latency-sensitive applications, like smart grids and autonomous vehicles, rely on instantaneous processing with no lag.

So, operators are looking at multi-access edge computing (MEC) closely. It reduces network congestion and improves network performance by bringing some of the processing capabilities and applications that were traditionally deployed at the data center, closer to users and their terminals.

Large public venues, like stadiums, are great examples of MEC. It enables localized venue services to be available to consumers via a MEC server onsite, offloading the backhaul or centralized core network.

The European Telecommunications Standards Institute (ETSI), which is developing a MEC standard, is looking to go beyond supporting mobile access technologies. It will support Wi-Fi, Li-Fi and fixed wireless access, enabling fiber to play a more significant role in MEC architectures.

Greenfields vs. Brownfields

Convergence offers a cost-effective answer to building a fiber-rich FTTH network. It allows large operators to use a single fiber network to support a variety of 5G use cases, thereby maximizing the utilization rate of assets and extending the return on investment. Smaller operators can also benefit from pooling their interests with larger incumbents to increase the funding sources and enjoy greater economies scale.

However, these are greenfield cases where multiple dark fibers are deployed. In some scenarios, deploying these may not be economically viable or physically impossible. It creates a bottleneck for 5G deployment.

Here, convergence can help to address these brownfield scenarios by utilizing available infrastructure.

DWDM

When aggregation points in access networks are spread across optical line terminals (OLTs) at central offices and Ethernet switches, dense wavelength division multiplexing (DWDM) offers a solution.

A converged DWDM layer gives operators the flexibility to allocate wavelengths for fronthaul and backhaul deployments. It is possible because the vast WDM spectrum often remains unused. The flexibility can also allow operators to share the costs of equipment such as reconfigurable optical add-drop multiplexers (ROADMs).

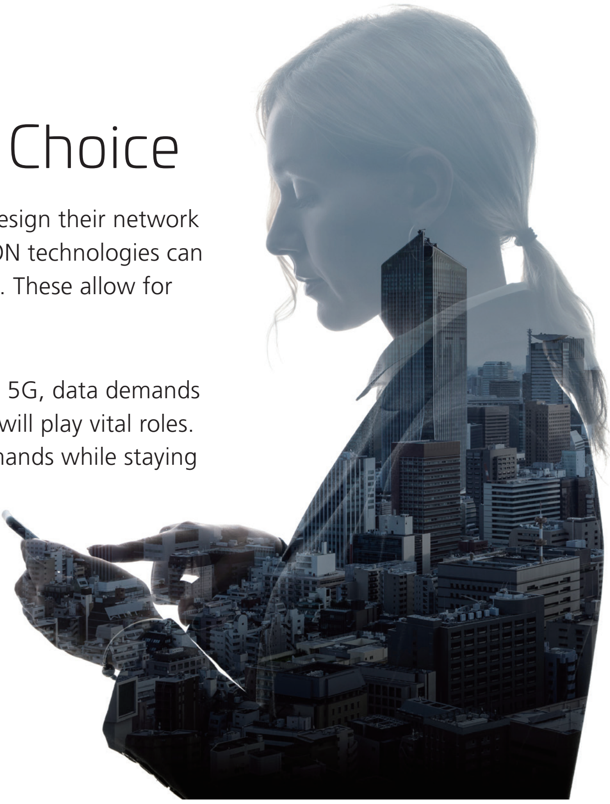
NG PON2 with P2P WDM Overlay

When there is a common passive optical network (PON) and the access points are aggregated in central offices, next-generation PON2 with point-to-point WDM overlay offers an alternative solution. Essentially, it helps operators to reuse existing network resources and share power split-based optical distribution networks for all services except fronthaul. The dedicated WDM overlay fiber can help operators to meet the higher bandwidth requirements.

A Matter of Flexibility and Choice

Convergence offers operators the choice of how they want to design their network architecture and support future access technologies. Multiple PON technologies can also be combined with WDM overlay using coexistence modules. These allow for more efficient use of fiber in converged networks.

It is clear that the current architecture will need to change. With 5G, data demands will increase while other concerns such as latency and reliability will play vital roles. Operators will then need to find a balance in meeting these demands while staying economically viable. It is where convergence offers the greatest promise and one that is spurred on by 5G.



Going Rural: A Converged Alternative

Much of the discussion about 5G is centered around dense urban areas. Here, convergence offers an answer to cost efficiency and interference.

However, 5G has the potential to connect to rural communities. Convergence technologies can help operators to extend their coverage, increase their market coverage and improve their margins quickly.

For example, when an FTTH network is absent or only a copper fixed line is available, fixed wireless access (FWA) offers a viable converged alternative. Instead of running a fiber to each house, operators only need to connect to an optimally-located FWA antenna, which can then provide broadband connectivity to the immediate vicinity.

Why FWA will work where technologies like WiMAX failed is because of the broad support from operators and its mature ecosystem of operators and vendors[1]. Also, operators do not have to acquire additional spectrum.

However, FWA has its challenges. The biggest lies in standardization. GSMA noted that without one, it would be difficult to realize its full potential and there is a danger of technology fragmentation[2]. In this regard, the completion of 3GPP release 15 (and eventually release 16) standard holds promise.

1 Fixed Wireless Access: Economic Potential and Best Practices
2 Fixed Wireless Access: Economic Potential and Best Practices

A Convergence of Challenges

Convergence offers a rational and economically-sound forward for operators, especially in handling the bandwidth demands and resources constraints as 5G adoption soars.

Convergence faces its own set of challenges. To be viable, operators and governments need to address each carefully it spurs innovation and revenues, and not negatively disrupt an entire industry.

Regulatory Framework

The biggest hurdle for any technological advancement lies in regulations. Regulations help to develop a market framework for operators and ensure that the services they provide meet the minimum requirements for the public.

The problem is that many regulations were designed when the services provided by operators were functionally distinct[3]. The inadequacy of these regulations in dealing with converged solutions can be barriers.

An additional issue is that many countries, including the U.S., see telecommunications as a critical infrastructure that needs safeguards against military or terrorist attacks[4]. It makes it difficult for governments to encourage a flexible infrastructure while ensuring that proper safeguards exist against possible external infiltration.

Governments at some Asian economies have taken note. Countries like China, South Korea, Japan and Singapore are adding new frameworks or relooking at their current regulations to encourage convergence. Until the regulations become clear and the governance framework well established, convergence will remain constrained across Asia.

Narrowband vs. Broadband

New applications, especially those designed for 5G, are bandwidth hungry. It is not an issue for larger economies who already have extensive fiber infrastructure. However, many economies in the region still rely on an operator infrastructure based on narrowband technologies.

Enabling convergence will be a considerable investment that some governments may not be ready to make. However, their reluctance to spend will need to be balanced with the loss in economic opportunities as the global economy reaps the benefits of convergence.

Competition

Convergence lowers barriers of entry for operators to explore new markets and revenue streams. However, it also allows other industry players to play a significant role in the market. So, there is some reluctance in the operator community on embracing convergence.

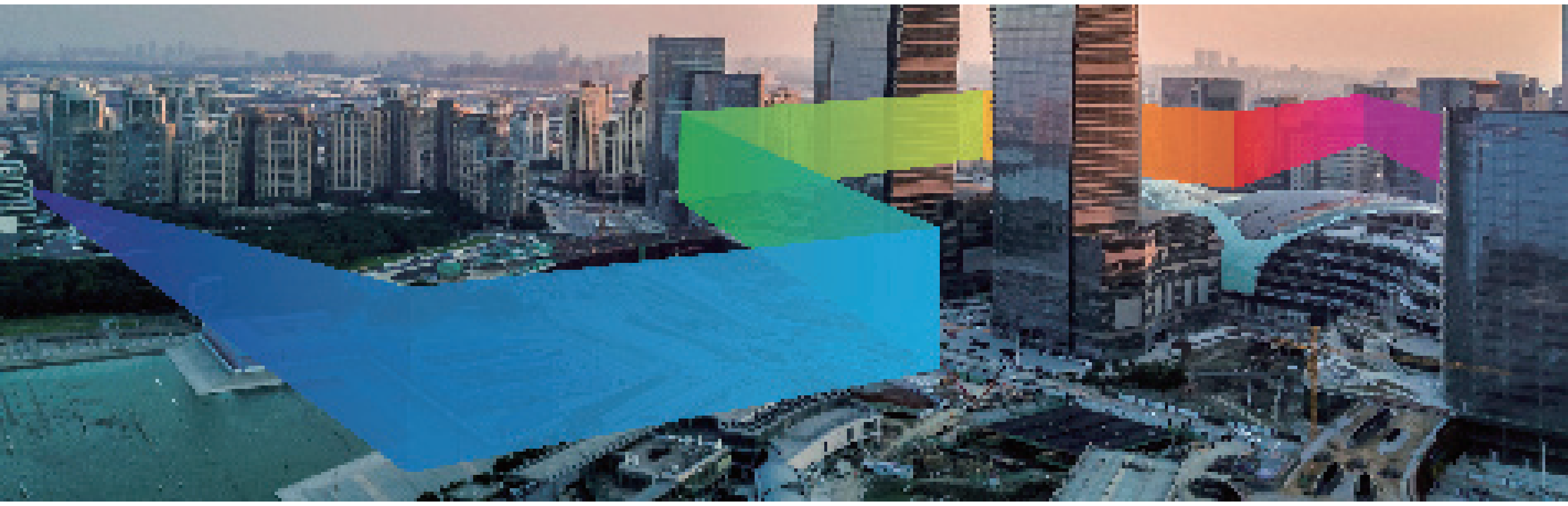
There is also the issue of license sharing, where one incumbent gives another industry incumbent the right to build an infrastructure that can be co-owned. These are concerns that governments, regulators and market incumbents need to address together – a critical issue that China addressed early in its development of the telecommunications market.

Changing business models is never easy. Governments and regulators can introduce regulations that require operators to open their networks but needs a lot of convincing. Efforts in China and South Korea point to r encouraging examples where the different stakeholders work together.

[3] Technological convergence: Opportunities and Challenges

[4] https://www.fcc.gov/general/critical-infrastructure-and-communications-security

Preparing for a Converged Future



The argument for converged networks is clear: it offers a more economical option that future proofs the network for 5G and more[5].

According to the FTTH Council Europe study *5G and FTTH*: the value of convergence, the additional investment in a 5G-ready full-fiber network is between 0.4 to 7.2%. The cost savings can reach between 65 to 96%.

However, it is not just economics that will drive network convergence. For example, it can spur innovation by enabling better consumer experiences. Industries, from banking and healthcare to logistics and manufacturing stand to gain from the increased flexibility and convenience.

Converged networks will also empower new services and applications. Autonomous vehicles, smart grids and smart city applications promise new ways to live and work but depend on operator network flexibility in design. Convergence will allow operators to reuse current non-fiber infrastructure for meeting new bandwidth demands. Meanwhile, it can open up new markets and revenue opportunities.

However, convergence is not just a technology play. It requires regulators, government bodies, operators, equipment vendors and service providers to work together. Since convergence has the potential to blur the traditional borders between fixed and mobile operators, government policies and building the right industry ecosystems to support it will matter.

It is where CommScope with its products, expertise and continuous work with the FTTH becomes crucial. Its strength in wireless and wireline solutions can help network architects and operators to decide the best design.

So, are we there yet on convergence? Not yet, but it is only a matter of time and will.

[5] Two for one: build future proof fiber and get 5G for "free"

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