FTTH COUNCIL
ASIA PACIFIC | FIBER TO THE HOME APAC

THE ROLE OF FIBER IN 5G DEPLOYMENTS

By Technology & Standards Committee

White paper

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I. Introduction

Digital technologies have greatly impacted the way we live. The multitudes of gadgets and the digital services we access through them deeply influence the way we live and work. However, we often fail to notice that reliable broadband connectivity is driving these technologies and services, and an interruption in the service can lead to severe consequences. Currently, optical fiber is the only available technology that can meet today's bandwidth needs as well as provide a future-proof broadband network that supports a large number of services that are yet to be realized.

"Fiber to the x" (FTTx) is a common term used in the industry to refer to a system that brings optical fiber close to the premises. In today's context, FTTx is mostly used to refer optical fiber used for last-mile connections. Similar terms such as FTTH (Fiber to the Home), FTTB (Fiber to the Building), FTTN (Fiber to the Node) and FTTC (Fiber to the Cabinet) are also used based on where the fiber optic communication path is terminated. The total number of FTTH-FTTB users in Asia is growing, and the increment for each year is more than the years before. The number of subscribers in Asia grewby 68% from 2015 to 2016, with the total FFTH/FTTB subscribers passed 290 million recently.

Fiber was the only medium available to carry voice, data and video – all in one channel – at high speed in as early as 1980s, when the first generation of mobile communications (1G) was popular with analog voice as its foundation. Ten years later (1990s), 2G technology enabled mobile telephony to support digital voice. In 1998, mobile broadband access started with 3G technology supported by iOS- and Android-based smart devices. Recent deployment of 4G technology over Fiber to the Antenna (FFTA) infrastructure promises multifold improvements to mobile service providers to offer subscribers higher speed and larger coverage along with secure, reliable and better signal integrity.

Today, consumer wants seamless high-speed broadband connectivity at home, office and on mobile vehicle, anytime and anywhere. Fixed and mobile network bandwidth demands are increasing exponentially and more and more bandwidth-hungry applications and users are being added on the networks every day.

A game changing mobile technology, 5G is around the corner with initial rollout anticipated by 2020. The standardization of 5G technology is yet to be finalized; however, pre-testing and trials are taking place in several countries in Asia and the rest of the world. Workable 5G standards are expected to be ready by 2018-2020, and global service providers are in race to emerge as the first provider of 5G networks. In February 2017, the ITU-T defined 5G base station requirements to be 20 Gbps download and 10 Gbps upload. This can be realized through the implementation of optical fiber-based networks.

2. What is 5G?

Historically, we could see a 10-year cycle between each generation of mobile communications technology - from 1G to 4G, driven by the changing user requirements; but the case may be different for 5G. In 2014, for the first time in history, the number of mobile gadgets surpassed the number of people in the world, but more than half of the world's population does not have a mobile phone yet. Mobile phone and smart device numbers had increased from zero to seven billion just in three decades and will continue to increase every year. According to Cisco's forecast, mobile data traffic is expected to increase 700% in five years (7Exabytes per month in 2016 to 49 Exabytes in 2021) and grew 63% in 2016. [1]

Globally, there are already more than 1 billion 4G LTE subscribers out of the total 7 billion mobile subscriptions. With more and more users adopting 4G, the consumption of high-speed broadband is likely to grow further and create the demand for faster, higher-density next generation wireless access networks. For that reason, we expect 5G rollout to happen much earlier than the usual 10-year cycle between each generation.

As mobile communications evolved, subscribers benefitted from digital voice (2G), data transfer (3G), higher capacity and coverage (4G). Now, 5G is expected to provide super-fast Gigabit speed, ultra-low latency, higher security, very high reliability and massive machine-to-machine communications for IoT infrastructure to support multiple devices and services on real-time basis anytime, anywhere.

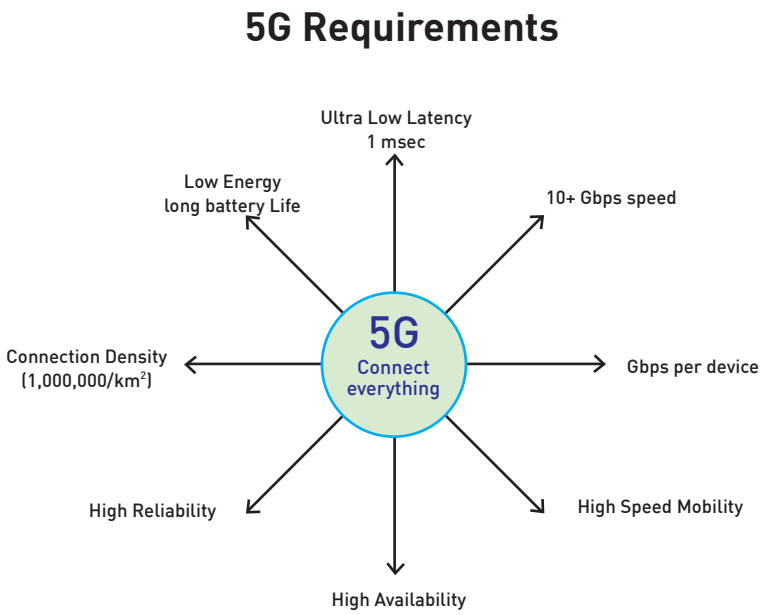


Figure 1: Desired system parameters for 5G

3. How fast is 5G?

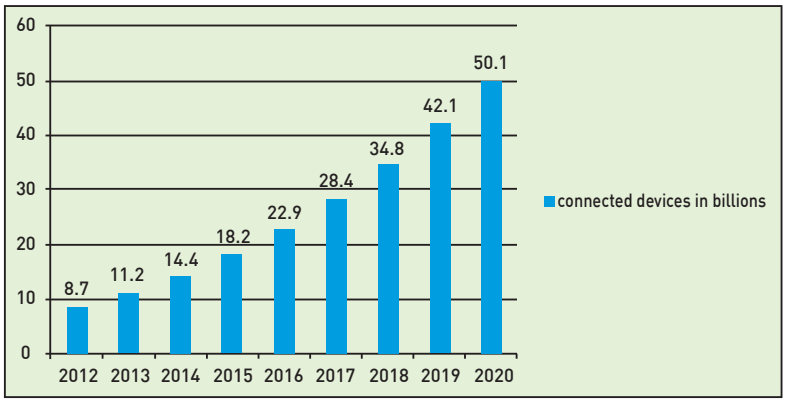
- 5G technology could potentially provide ~10Gbps mobile broadband access. Globally, several tests and trials have been conducted by telecommunications service providers for the planned commercial rollout after 2018.
- Korea Telecom plans 5G trial during "2018 Winter Olympics" with latency of 1ms at high-speed of 20Gbps.
- NTT DoCoMo plans to deploy 5G solution for "Summer Olympics& Paralympic Games in 2020" with a target speed of 10Gbps.
- China Mobile plans to complete the testing of 5G technologies and products in 2017, perform trials in 2018 and use 5G at "Beijing Olympics" in 2022.
- Telstra plans to use 5G at the 2018 Commonwealth Games.
- Till date, up to 70 Gbps speed was achieved in laboratory conditions.

With 5G technology, users will potentially enjoy 4K/8K video, hologram, 360° Virtual Reality (VR) in the forthcoming games.

4. Why is fiber essential for 5G deployment?

"There are a lot of wires in wireless.... And those wires are fiber. We need to re-think how to plan the physical cable routes. " Peter MACAULAY (Former President – FTTH Council APAC)

As the discussions suggest, 5G is expected to deliver more than 10 Gbps speed, massive connectivity for countless IoT devices, high speed mobility to deliver reliable, seamless connectivity to users even when they are traveling in high-speed train, bus or car. Ultra low latency is very critical for self-driving connected cars, remote robotic surgery in healthcare, industrial automation systems and big data transfer between the data source and destination. The number of IoT devices was 8.7 billion in 2012 and will be more than 50 billion after 2020[2]. The performance of all these applications and quality of services will depend on the availability of optical fiber infrastructure.



The Number of Connected Devices (2012-2020) Source: statista.com

Figure 2: Data consumption trend

Even for FTTH/FTTB where fiber reaches to customer premises, wireless technologies are helping users connect their mobile devices to the network. When 3G and 4G network deployment started, the number of towers was increased to achieve high percentage nationwide coverage. Cellular technology and fiber technology are complementary to each other and backhaul of cellular towers was realized over optical fiber networks.

A recent report from IHS Markit[3] suggests that fiber will play very important role in both front and backhaul of 5G networks. For a high-frequency 5G spectrum to cover high connection density and high speed mobility, mobile service providers need to deploy several thousands of towers, base stations and radio heads much closer to users and devices while all these cellular towers and base stations need to be connected with future-proof high speed optical fiber networks.

5. Evolution of front/back haul connection for wireless

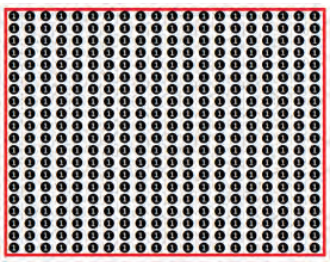
Base stations are being deployed closer and closer for 3G to 4G/4GAdvanced to 5G at separation from 10km to 2 km and further to 0.5km.

Let's consider a theoretical wireless deployment case in a flat terrain with no trees, no building in the area of 10x10=100 km^2

3G....10km → 4G....2km → 5G.... 0.5km

3G
1 site every 10 km
Cell density=1 cell/100 km^2

4G
1 site every 2km
Cell density= 5 x 5 = 25 cells/100 km^2



5G
1 site for every 0.5 km
Cell density= 20 x 20 = 400 cells

From this, it is clear that mobile service operators would install small cells more closely to users in to provide high speed, reliable and larger coverage for 5G technology.

6. Low-cost FTTA deployment to support high-speed 5G

5G will also be a good opportunity for cable operators as fiber is necessary to meet targeted requirements of 5G with higher capacity and coverage, better signal integrity, low latency and reliability. The cost of fiber deployment is relatively high; however wireless operators need to invest heavily in the fiberization of cellular infrastructure to support future-proof and reliable capacity requirements.

Fiber-to-the-Antenna (FTTA) will deliver several benefits over traditional systems. However, cable and mobile service operators will face challenges while installing the optical fiber. The cost, materials, network design, installation time to connect thousands or millions of towers and cells quickly and the skill sets for field installers are the challenges that need to be addressed. Manufacturers of optical fiber cables and connectivity materials should provide all-weather connectivity materials, factory terminated fiber cables for front-haul, and high-fiber count cables in smaller diameter to reduce civil work in the backhaul of fixed and mobile networks.

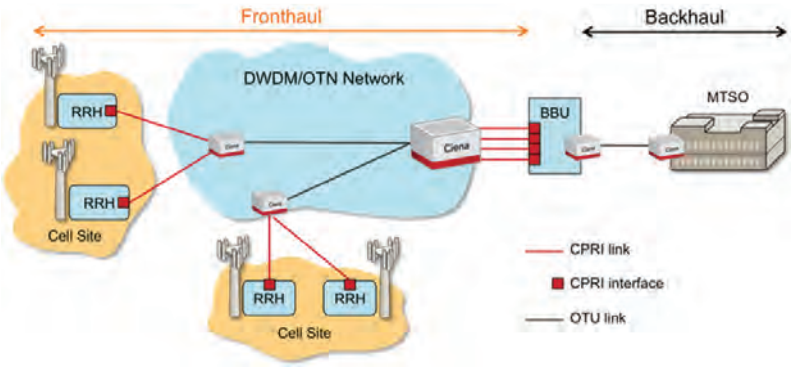


Figure 3: Network architecture for front-haul and back haul based on optical fiber technology

Remote Radio Head (RRH)

Mobile Switching Telephone Offices (MTSOs)

Baseband Unit (BBU) connected to a Radio Unit (RU)

Shared Access Models

New shared access models are needed to reduce the cost of fiber deployment. NG-PON2 technology provides one option of combined FTTH & FTTA service with both FTTH and FTTA using separate wavelengths over common fiber infrastructure. Design combining FTTH + FTTA will reduce the deployment cost significantly.

PON Standards

The following PON technologies can be used to support high-speed broadband connectivity to home, building/premises/towers:

- 2004: G-PON ..... 2.4/1.2 Gbps, 1490nm down, 1310nm up
- 2009: NG-PON1 ... 10.0/2.5 Gbps, 1577nm down, 1270nm up
- 2015: NG-PON2 ... 40.0/10.0 Gbps capacity, 80/10 Gbps option
- 2016: XGS-PON ... 10/10 Gbps

FTTH is Changing with NG-PON2

- Updated Design Rules (OLT-ONU was 20 km, now 40 km) = lower cost per user
- Higher Splitter Ratio (now 1:256) = lower cost per user
- Higher Speeds (DS/US was 2.4/1.2Gbps, now 40/10 Gbps) = one technology, lower cost

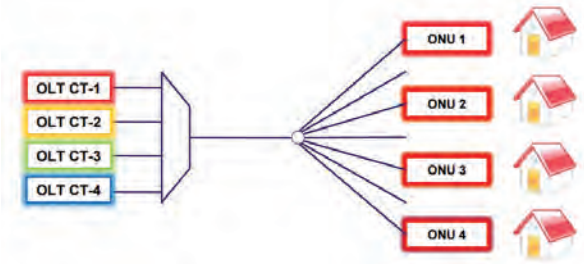


Figure 4: FTTH network architecture

FTTH is changing with co-existence

- Mix and match G-PON and NG-PON2 on the same fiber

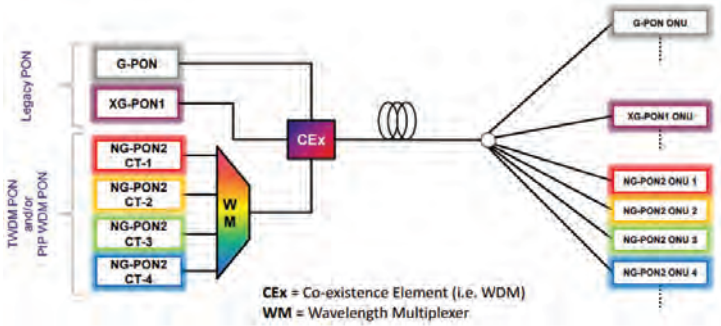
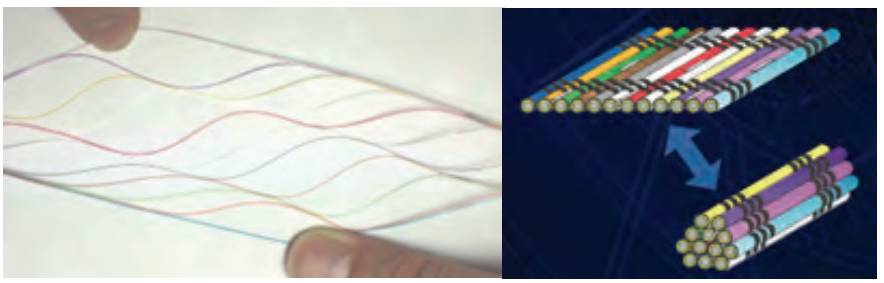


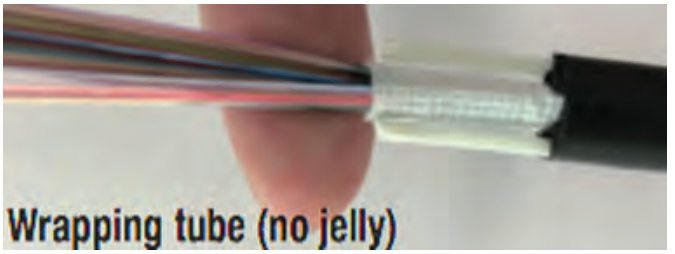
Figure 5: Co-existence of various PON technologies

Fiber Infrastructure: Cable, installation and civil work cost

Driving down the product, installation and civil work costs are the biggest challenges for cable operator for the mass deployment of fiber optic networks. In order to help them deploy fiber optic network efficiently and at lower costs, a new type of fiber optic cable has been developed. With high level of fiber packing density, this cable is called as "Spider Web Cable" or "Ultra High Fiber Count Ribbon Cable" or "Wrapping Tube Cable". With its successful design, cable diameter is reduced by 40% and cable weight is reduced by 50%. At the same time, this high-density, dry core cable offers impressive reduction in installation time, in addition to mass fusion splicing.

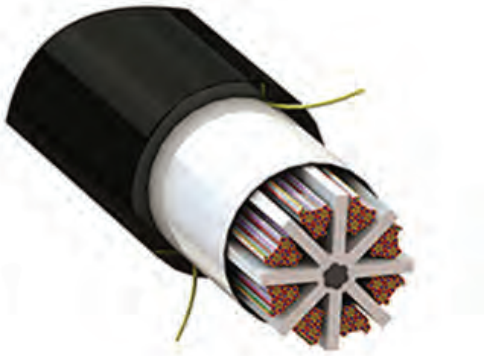


Spider Web Ribbon Space saving



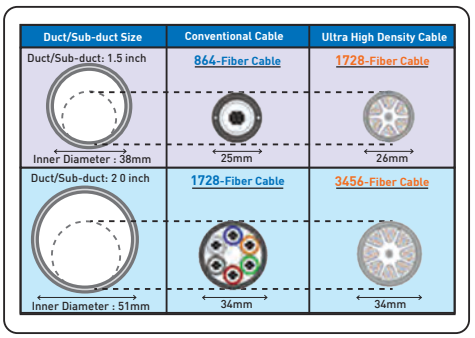
(Source: Fujikura Ltd/press release 07072016)

Reductions in diameter and weight will result in significant savings in time and cost to cable operators as it helps them use the existing ducts without additional material and civil work to increase their infrastructure capacity. The cable is also provided with a dry water-blocking tape that requires no cable flooding gels. The use of a completely dry cable speeds up overall installation, termination and splicing while significantly saving time and costs.

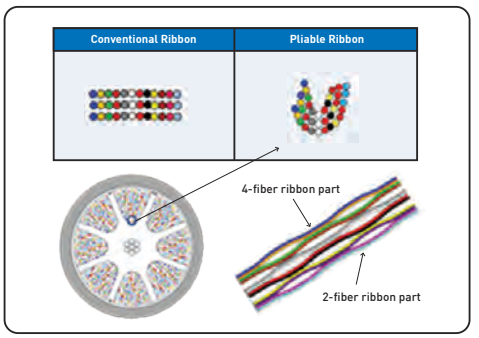


Ultra High Fiber Count Ribbon Cable

Cable Density Comparison



Pliable Ribbon



(Source: Sumitomo Electric Industries, Ltd. / press release/ sei.com/company/press/2016/08/prs076.html)

Sharing access fiber infrastructure

One of the costly works in fiber deployment is the civil work required for laying the cables. Sharing the access fiber infrastructure will benefit multiple mobile service providers in each country, so it's time to invest in such initiatives. The "Open Shared Access Fiber Infrastructure" enables a faster deployment of high-speed access infrastructure and supports new applications.

The FTTH Council Asia-Pacific whitepaper on " Fiber as a Service" shows these sharing/rental options.

7. Conclusion

The rigorous developments around 5G suggest that leading mobile operators are prepared for the commercial rollout of 5G by 2020. The 3G and 4G deployment showed us that wireless and wired technologies are not competitors but complementary to each other. FTTH/FTTB technology brought reliable high-speed broadband connection to millions of users in Asia and worldwide; however, high-speed mobile connectivity is just catching up. Integration of optical fiber and 5G technology will enhance the connectivity experience while also enabling connectivity across millions of personal devices, machines, robots, cars, and more. Capabilities of 5G around data transfer, storage and analytics will help users derive more value from communication services. Self-driving cars, remote surgery and smart traffic controls will soon become the order of the day. The next generation optical fiber access technologies could support effective and efficient delivery of 5G services and also provide future-proof infrastructure for any speed, any number of applications to any number users and devices.

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