CORNING

5G and Fibre
Where Are We Now and Where Are We Heading?

1. The Promise Of 5G

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By now, we in the telecom industry are familiar with the term 5G. Indeed, 5G has entered into the mainstream vocabulary as the mobile operators bring to bear the might of their marketing machines to catch the attention of the fashionable and technically savvy early adopters. But aside from the polished commercials, let’s remind ourselves of what 5G really means.

Yes, 5G is faster 4G, for sure. But there’s much more to it than that. 5G also means wider coverage, higher levels of network reliability and faster response times (lower latency) and the ability to connect billions of devices, most of which won’t be mobile handsets. It is only when all these attributes are combined that we can truly realise the full promise of the “internet of things” (IoT) and the futuristic world of applications that will enable smart cities and the notion of tired commuters safely dozing at the wheel on their way home after a busy day.

But isn’t there a disconnect here? 5G services have now been launched in most European countries, at least in the largest cities. 5G handsets are widely available. But we haven’t really seen that step change in applications that has been promised. So what’s happening?

It is important to make clear that the commercial launches of 5G to date are really the first stages of the wider deployment and don’t exploit the full capabilities of the technology. A lot revolves around the full range of frequencies available in the 5G specifications and those that are actually used in these early stages of the rollout. In simple terms, the current 5G services are based on the lower frequency bands within the 5G range. These lower frequencies are more resilient and therefore the operators have been able to support this application largely based on upgrades to existing macrocell sites, which were built to deliver 3G and 4G services. The more revolutionary aspects of 5G capability will need the higher frequencies, and the laws of physics dictate that these signals are more fragile, so they will need many more antennae than the macrocell sites can support. So as a result, we haven’t yet seen the scenario where lampposts and other street furniture start to sprout new hardware, which is needed to support the mobile technology of the future. But one thing is certain; technology will need the bandwidth that only fibre can deliver.

2. Network Densification

One way to increase coverage/bandwidth capacity for a mobile network is to “densify” it by adding more sectors, meaning deploying more macrocells. This way, the number of subscribers connecting to a given cell and therefore sharing the available bandwidth is reduced so that more bandwidth can be allocated to each subscriber per cell. However, reducing the site-to-site distance in the macro layer is a challenge because finding new macrocell sites becomes increasingly difficult and can be expensive, especially in urban environments. Considering that frequency bands are auctioned off to the carriers by national regulators and with licenses costing billions, reutilization of the frequencies is a must. This can be facilitated with low-powered cells designed to cover small areas that, for example, are not getting enough coverage. These low-powered versions of macrocells are called small cells and both combined can boost frequency reuse for a more efficient use of the radio spectrum.

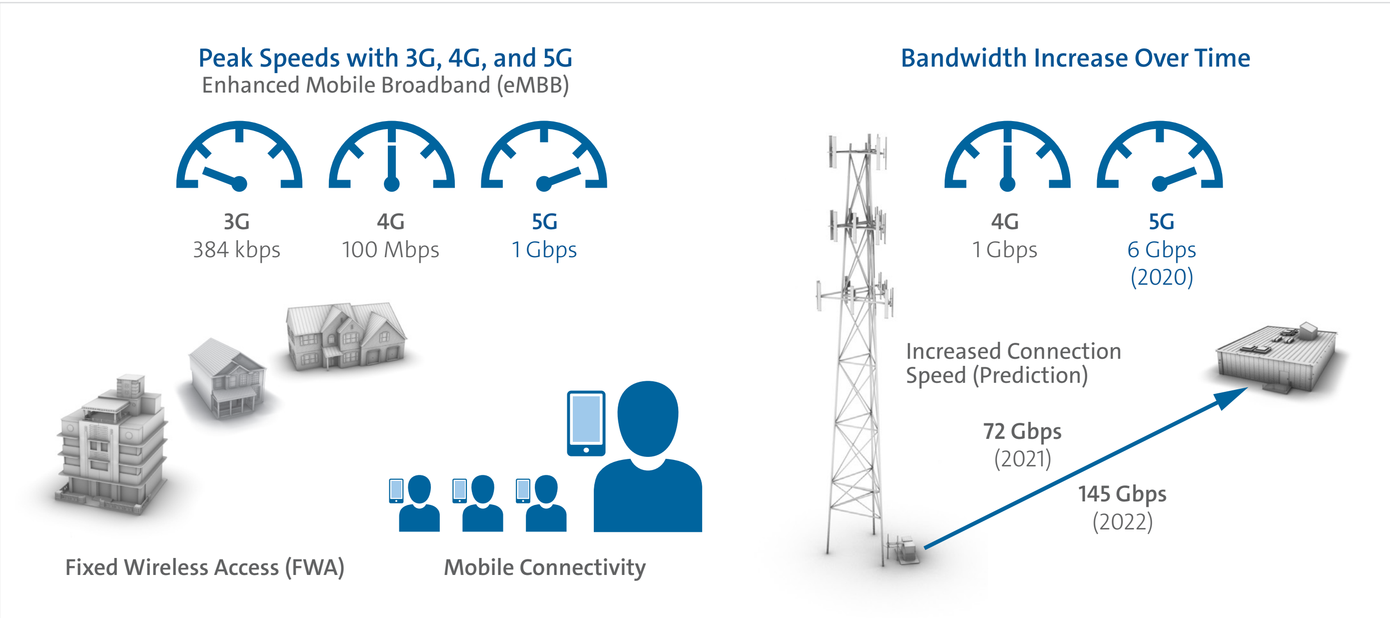
Densification of the macrocell layer will be necessary in countries with poor 3G and 4G in order to meet 5G targets of coverage and bandwidth. In those other cases where the density of cells prior to 5G deployment is good, mobile operators will only have to add the new 5G radios to the existing sites. This is particularly true if 5G is implemented in the sub 6 GHz band, where 3G and 4G technologies also operate, and therefore coverage reach is quite similar. 5G technology will also operate at higher frequencies in the millimeter-wave band. At these higher frequencies, there is plenty of spectrum available allowing for wider channel bandwidth, highest peak rates and a lot smaller-form-factor antennas. The trade-off is that coverage reach at these higher frequencies is shorter, yet it is expected that massive multiple input, multiple output (MIMO) and beam-forming antennas will help mobile operators to overcome this problem that otherwise would force increased cell densification.

This way, densification is defined as the deployment of new and smaller inter-distance cell sites in order to deliver 5G, which will be necessary to bring coverage to the right level in countries with poor 3G and 4G coverage, while those countries with good cell density will be able to reutilise much of the existing cell infrastructure.

But a key factor is that every new wireless site needs both data and power, and provision of this connectivity is the biggest cost element in network densification. It is therefore inevitable that mobile operators will avoid this investment until the nature of the services provided over the 5G network demands it, i.e., coverage reliability and latency in addition to the basic requirements of bandwidth.

3. Optical Connectivity Challenges

It is widely accepted that the only way to deliver the densified radio access network (RAN) capacity needed for 5G will be over fibre. This is a simple consequence of the amount of data that will need to be carried over the network. The cliché of "limitless capacity" has been associated optical fibre since the first commercial deployments in the 1970s, but it still holds true that no other technology can challenge fibre – that's why fibre's role in 5G will be critical. A basic comparison of the differences in data rates for the transition from 3G to 5G is shown below.



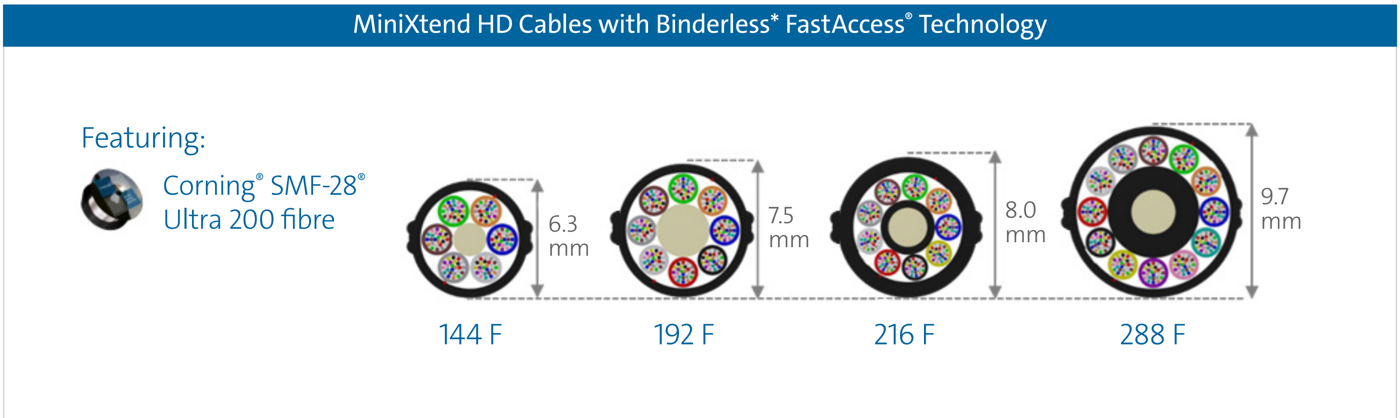
But how does the 5G RAN application influence the optical cable and connectivity products used in the networks compared to other optical networks, including fibre to the home (FTTH)?

Well, surprisingly little in terms of functionality of the end-to-end components, but the pursuit of improved reliability, flexibility, and cost effectiveness is more pronounced.

3.1 Optical Cable

The cable pathways for 5G RAN deployments will be very similar to those used for traditional telecom fixed-network deployments, i.e., mostly traditional duct and chamber routes or aerial routes on poles. So it follows that the advances in optical cable technology, which have been exploited by the fixed-network operators, will be relevant to the mobile operators – who in many cases are evolving into fixed-network operators anyway, and vice versa.

For example, if a new trench has to be cut, then it is highly likely that microduct cables will be installed. Miniaturised cables optimised for blowing are used to maximise the space available in existing duct. The activity of digging the trench is easily the highest proportion of the cost, so anything that can reduce cost will have a positive impact. Surprisingly, this starts with the fibre itself. Smaller fibre means smaller fibre bundles enabling smaller cables, which will fit into smaller microducts leading to smaller duct bundles. Reduction of the coated fibre diameter from 250 µm to 200 µm, along with other innovations in cable processing, means that, for example, 144 fibres can be packaged in a Corning® MiniXtend® cable of only 6.3 mm of outer diameter.



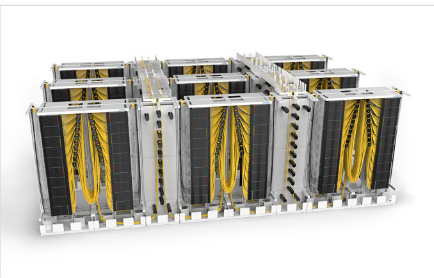
These MiniXtend HD cables are up to 60% smaller and 70% lighter than conventional duct cables and can enable more than 4x the number of fibres to be installed for a given duct diameter.

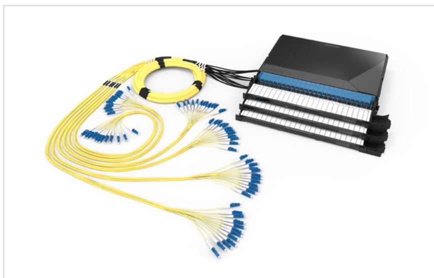
*Corning's proprietary binderless FastAccess® technology refers to the combination of a Corning FastAccess technology jacket with an innovative technology used to bind cable construction through the manufacturing process, eliminating the use of binder yarns and waterblocking tapes.

Of course, the fibre itself is the most critical element and Corning continues to lead the constant challenge to improve performance. The latest embodiment of this is in our SMF-28 Ultra optical fibre, which delivers bend performance that exceeds ITU G757.A1 while being fully backward compatible with standard G.652 single-mode fibres. SMF-28 Ultra fibre offers industry-leading attenuation, macrobend, and physical media dependent/polarization mode dispersion (PMD) performance.

3.2 Optical Connectivity Components

The challenges of the 5G RAN are similar to any other external optical network in terms of environment and deployment methods, and it follows that much of the functionality of connectivity solutions developed for optical access networks applies to 5G. However, there are some differences. For example, there will be greater demands placed on the central office connectivity to handle the increasingly diverse range of transmission equipment that will be deployed. This will be exacerbated by the advent of converged networks; more on that later. In order to meet these challenges, there is a need to increase port density and improve usability and scalability and increase the ability to house, for example, wavelength division multiplexing (WDM) optical components. This capability is embodied in the Corning Centrix™ system portfolio, which provides industry leading manageable port density of up to 17,280 ports/m², with intuitive patch cord management and a scalable architecture enabling easier network expansion.





Another aspect which differentiates 5G RAN infrastructures is the requirement to deliver power to the wireless devices. There is, therefore, a focus within R&D teams to develop hybrid solutions capable of incorporating fibre and power connectivity within the same package.

But one key aspect really unites all optical networks. That is the constant drive to reduce installed cost. That challenge has successfully been achieved in FTTH networks by deploying pre-connectorised solutions. At the end of 2019, Corning had supplied enough OptiTap®-based terminals, closures, and drops to pass 55 million homes. The product attributes of OptiTap, which have been so successful in enabling the FTTH business case, will also apply to 5G and converged network deployments.

Finally, the reliability of optical networks is now almost taken for granted, but, due to the safety critical applications which will run over 5G networks, the bar will be raised. It is always, therefore, important to select materials that are fully compliant with the most rigorous ITU, IEC, and Telcordia standards.

In summary, many of the challenges already encountered in optical outside plant networks will apply to converged networks, except with more focus on size, flexibility, and reliability.

4. Network Convergence

The evolution of FTTH networks is in a really healthy stage of its lifecycle. The FTTH Market Panorama, which is a key part of the activity of the FTTH Council Europe, has become the industry-accepted reference point for FTTH deployment and those reports show an impressive compound annual growth rate (CAGR) of 14% for homes passed. FTTH deployment was initially focused in Scandinavia, followed by Spain, then France, with the sleeping giants of the U.K. and Germany now picking up the pace. Many smaller countries have collectively contributed at various stages and it is these smaller states which have led the league table of penetration rates.

5G deployments are likely to be less fragmented across the different countries, but the two technologies cannot be considered in isolation.

By definition, an FTTH network means that fibre must be installed along every street, and, in most architectures, fibre must be accessible to easily connect to premises when a customer requests service. We discussed earlier the level of network densification needed for 5G and the fibre, which is needed to support and will run along the same streets as, the FTTH networks. So, it stands to reason that the two networks should converge. In practical terms, connecting a 5G site is like connecting a house you didn't expect to be there on an FTTH network. That's why operators are designing extra capacity into their FTTH networks. But the art of network convergence really lies in predicting where the additional capacity will be needed. The fact that different countries are at different stages of their FTTH and RAN deployments adds another level of complexity.

The FTTH Council Europe has created some excellent material on the convergence topic. The technology behind 5G network convergence is described in detail in a white paper which can be found here: https://www.ftthcouncil.eu/home/forms/form-D&O-White-Paper.

The key driver behind convergence is economic. It is clearly more cost effective to build one converged network rather than two separate ones, but the magnitude of the saving was a surprise to many when it was analysed in detail. Last year, the FTTH Council Europe commissioned a study on the cost saving, which concluded that between 65% and 96% of fibre costs for the 5G RAN build can be eliminated by rolling out an optimised and future-ready converged fibre network.

5. Conclusion

It is impossible to predict how the capability of 5G technology will benefit us all in the future. The early 5G deployments are only scratching the surface of the full capability of 5G, but it is clear that in order to unlock the potential, huge investment is needed in the fibre infrastructure needed to support it. There is significant investment being made now in large-scale FTTH deployments throughout Europe and there is enormous potential to make that investment go further by realising the potential of FTTH/5G network convergence. It is a critical time in the lifecycle of fibre deployment and correct decisions today will reward us long into the future.

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