Gigabit fiber broadband in MDUs with G.fast

White paper

Multiple dwelling units pose a unique challenge in FTTH deployments. The cost, complexity and sometimes social and legal barriers to installing new cabling in an MDU risk creating underserved areas which then become weak spots for competitors to exploit. G.fast technology enables operators to deploy Gigabit services to customers in MDUs without needing to connect fiber to every living unit.

Contents

Introduction

Local and national governments are well-versed in the socio-economic benefits of broadband. Employment, education, healthcare, economic growth, urbanization: all improve as broadband coverage and bandwidth improve.

For consumers, however, it's much more straightforward. Do I have a connection and is it fast enough? These days, when a family goes on vacation, the first question isn't "Where can we have a drink?" but "How do we get internet access?" Followed closely by complaints from the kids if the connection isn't good enough to quickly download the new version of their favorite video game.

Combined, these factors are driving industry forecasts which show that Gigabit broadband will be a standard offering by 2020. As the first operator to bring a Gigabit to an area nearly always gets a competitive advantage, the race is on for CSPs to develop their networks. Pressure is particularly on incumbents as new fixed wireless access technologies like 5GTTH allow disruptors to get a foothold in any unserved or underserved parts of the incumbent's footprint.

The end goal, of course, is to connect all homes with fiber. This can be relatively straightforward, though still costly, in greenfield sites or areas with existing cableways or other suitable access. However, it's a significant challenge in multiple dwelling units (MDU). In many cases adding new cableways or pulling in additional cables is too expensive, not practical or even impossible. Leaving these MDUs underserved is a dangerous play in a competitive or highly regulated market.

G.fast technology enables providers to serve these MDUs and other difficult-to-access residences in order to complete FTTH coverage and protect the installed base. MDU residents get fiber-like services with their existing cabling and just a change of CPE.

The need for G.fast

A recent study[1] shows worldwide growth in next generation access coverage: the number of premises connected will grow by 27% between 2020 and 2026. The driving forces are customers and regulators demanding more bandwidth and operators competing for increased customer loyalty. Many operators are planning to migrate from FTTN to FTTP architectures to bring the desired bandwidth uplift. The resulting full-fiber access network also brings an endless potential for growth and increased OPEX savings.

A major stumbling block is the prevalence of multiple dwelling units. In the United States, MDUs are home to around 44 million households. 83% percent of these MDUs were built before the year 2000 and more than half before 1980[2]. The vast majority have comms connectivity based on legacy twisted pairs or coax with very little fiber or even Cat 5/6 cabling.

Drawing new fiber to individual living units in MDUs is a complex affair. MDUs vary enormously in size, construction and options for fiberizing, so nearly every MDU needs a unique approach. Aside the physical and practical considerations of deploying fiber, many building owners are resistant to the disruption of installing new cabling and there can be legal hurdles like space restrictions and aesthetic obligations or constraints which make it difficult to get permission.

1 Analysys Mason - FTTx conversion: worldwide trends and forecasts 2020–2026 March 24, 2021, where next-generation access is defined as any FTTx or DOCSIS technology that brings fiber closer to the premises

2 United States Census Bureau

Current connectivity on existing cabling in various deployment scenarios uses technologies such as Fast Ethernet and VDSL2. However, these limit the service offering to about 100 Mb/s, leaving these apartments with inferior services to other customers in a fiber rollout. Residents in MDUs, therefore, represent a unique category of underserved customer.

Underserved customers are, of course, ideal prey for competitors. The longer they remain underserved, the more likely they are to churn. So, a key factor in any network upgrade is time-to-market (TTM) for new services. A fiber connection to an MDU is generally quicker and cheaper than to an individual residence with a driveway or front yard. But the time and cost to then connect each apartment with fiber – assuming it is feasible – can drastically increase cost and TTM. Additionally, connecting a FTTH CPE frequently requires multiple technician visits, adding more cost and delay.

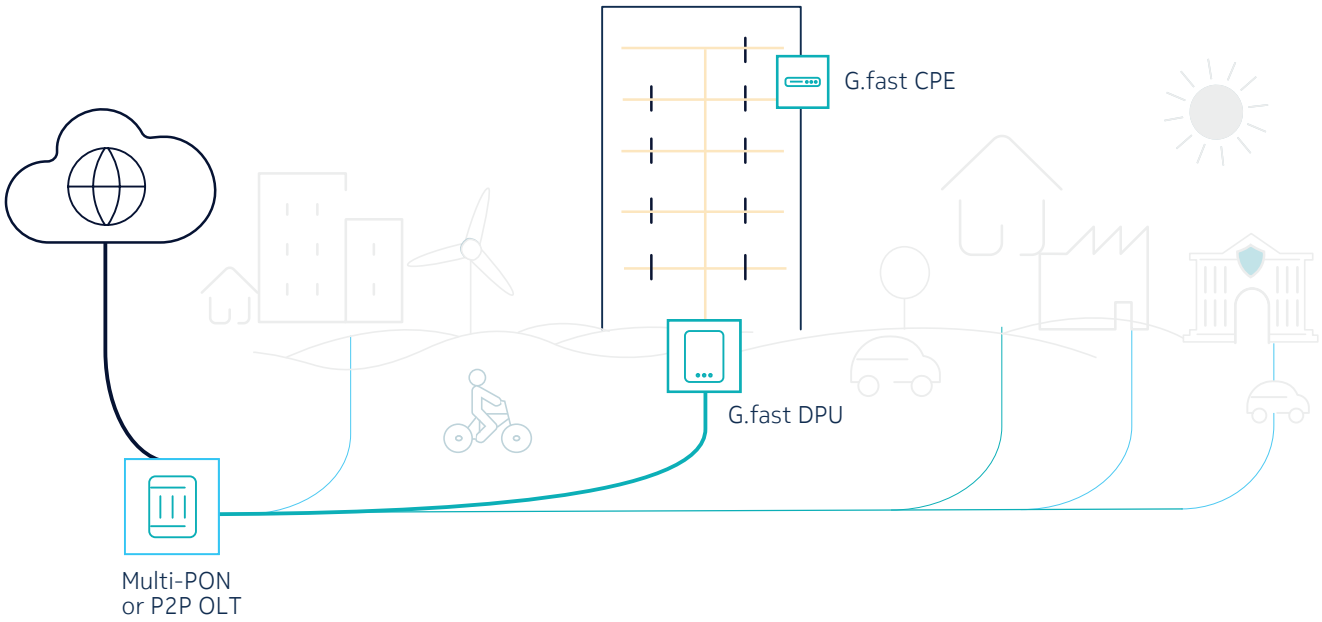
For these reasons of cost, complexity and competitive threat, operators need additional options in the MDU to complete a fiber rollout and be ready to offer services to any customer quickly.

The option increasingly favored is G.fast.

G.fast completes fiber deployments

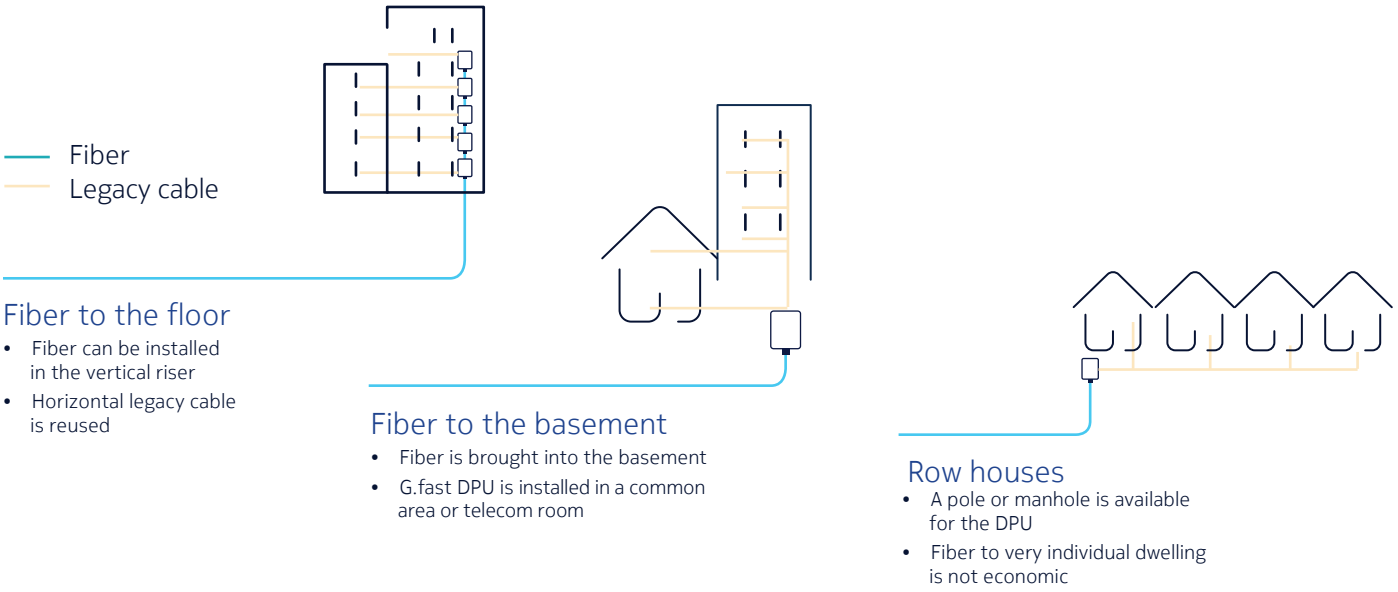
G.fast technology is designed to provide fiber services in FTTB and FTTdp deployment models in a fast and cost-effective way. Its key attribute is the ability to provide Gigabit bandwidth for download and for upload over existing twisted-pair or coaxial cabling and thus help operators ensure 100% coverage in any FTTH deployment without needing to deploy fiber to every home. The G.fast access node, called a distribution point unit (DPU), terminates the fiber network and provides broadband services over the legacy cabling. The DPU can be deployed within a few hundred meters of the G.fast CPE that provides broadband services via Gigabit Ethernet interface in the homes. G.fast DPUs have form factors and specifications that suit a multitude of sites: handholes, manholes, poles, walls or cabinets.

Figure 1. Typical G.fast deployment



G.fast is particularly effective as a fiber solution in MDUs where the usual deployment locations are the basement or an external wall. If fiber exists or can reasonably be installed in cabling risers, G.fast can also be deployed on each floor of an MDU.

Figure 2. G.fast addresses every MDU scenario



The G.fast DPU typically has GPON or XGS-PON uplinks and connects to subscriber terminals over twisted copper pairs or coaxial cable. Other uplink technologies like point-to-point fiber, GigE or 10GE can also be supported.

The number of subscribers connected to a DPU depends on the number of premises within reach. Reverse power feeding (RPF) increases deployment options: at locations with no access to local power, the DPU can draw power from the end-user over the same copper pair or coaxial cable as used for data transmission.

G.fast with the latest 212 MHz profile enables up to 2 Gb/s aggregate speed on very short loops and true Gigabit services on typical loops in MDUs. G.fast multiplexes upstream and downstream data using time-division duplexing and allows for a flexible split of aggregate speed in upstream and downstream directions. To allow for crosstalk cancellation, the upstream/downstream ratio needs to be the same for all lines connected to the G.fast DPU. The upstream/downstream ratio can be configured statically according to the bandwidth plan offered by the operator.

This ratio can also be adapted dynamically in function of instantaneous traffic demand. G.fast with the optional coordinated Dynamic Time Assignment (cDTA) allows for Gigabit speeds for download and also for upload for loop lengths up to 150 meters.

Due to the high frequencies used in G.fast, vectoring technology – already well-established with VDSL2 – is essential. Vectoring eliminates crosstalk interference between the lines in a binder so that each line achieves the best performance. Nokia has enhanced its industry-leading vectoring to ensure stable operation at the highest possible rates. Well-known VDSL2 capabilities and features such as bit swapping, Seamless Rate Adaptation (SRA), and retransmission have been adapted for G.fast and other features such as Fast Rate Adaptation (FRA) have been added.

Deployment considerations

A G.fast deployment presents some new network management challenges for which highly efficient solutions based on software-defined access network (SDAN) applications have been developed.

An important aspect for operators to consider is scale. A G.fast deployment can increase the number of active access network elements by a factor of ten compared to VDSL2 from cabinets, all of which must be provisioned and managed. SDAN can be applied to automate many deployment, provisioning and updating tasks. For example, automated provisioning makes G.fast DPU deployment a plug and play activity.. Installation becomes fast and efficient, without the need for a highly skilled technician onsite. The DPU can be pre-provisioned in the cloud-deployed SDAN access network controller so that, once it is installed, powered up and connected to the network, the DPU is automatically identified, provisioned and ready to go.

Powering many DPUs may also be a challenge, especially if they are installed in the outside plant, e.g. on a pole or in a manhole (FTTdp). Here, reverse power feeding removes the need for local power. RPF may also be attractive for indoor deployments (FTTB) for reasons of speed of installation and cost. The operator saves the initial cost of connecting the DPU to the power grid as well as lower ongoing energy costs.

Reverse power feeding of G.fast DPUs presents another challenge as no power is provided to the DPU until the first end-user plugs in the power injector (also known as power source equipment), which can be in the CPE or an external component. SDAN overcomes this issue by making virtual copies of each physical DPU, which are hosted in the cloud. Virtual copies are “always-on” and can be managed and provisioned at any time. Changes are automatically applied to the physical DPU as soon as it is powered-up.

SDAN has other advantages for G.fast deployments. Among others, it enables unified management of all access technologies in a deployment or a multivendor environment.

Future-focused

G.fast standardization started in the ITU-T beginning 2011. The recommendation was split into two parts, one specifying the power spectral density, the other the physical layer aspects. Both were approved in 2014 for 106 MHz on twisted pairs. Additional amendments paved the way for the current standard with frequencies up to 212 MHz, applicable to twisted pairs as well as coaxial cable. Today G.fast is a mature technology with widescale commercial deployments in operation.

Demonstrations have shown that 10 Gb/s speeds are possible over twisted pairs using frequencies up to 500 MHz. The MGfast specification, prepared in the ITU SG15 Q4 workgroup, is a new access technology and brings speeds in the range of 4-8 Gb/s over a single twisted pair or coax, together with other new capabilities such as support of ultra-low latency services, and simultaneous transport of streams with different quality of service requirements.

Looking ahead, we are many, many years away from fiber providing multi-Gigabit broadband to every household on the planet. In fact, that utopia is likely never to be reached. And from a socio-economic point of view, broadband coverage to the many is even more important than multi-Gigabit services to a lucky few. The industry recognizes the importance of continuing to invest in technologies that squeeze more bandwidth out of existing twisted pair and coax infrastructure so that we do not exacerbate the digital divide.

Conclusion

G.fast ensures that “no customer is left behind” in a Gigabit FTTH deployment. This makes customers

happy. For the operator it means enhanced Gigabit service coverage, differentiation, reduced risk of churn, and increased ARPU that helps fund the fiber roll-out. For these reasons, most service providers are now including both G.fast and SDAN as options alongside GPON and XGS-PON when developing FTTH proposals.

Nokia offers a broad portfolio of interoperable G.fast products, suited for any deployment scenario. When combined with Nokia's Altiplano Access Controller, operators benefit from the new capabilities that SDN and NFV bring.

Nokia FTTH and G.fast solutions, services and experience can help make your Gigabit deployment a success.

Further reading

Press release: Nokia launches Gigabit Connect to simplify gigabit broadband installation in apartment blocks

Press release: Nokia delivers five-fold speed boost for NetCologne's broadband network

Web site: Nokia G.fast solutions

Blog: G.fast for MDUs: I can't believe it's not fiber!

Acronyms

5G	Fifth generation mobile
5GTTH	5G-to-the-home
ARPU	Average revenue per user
CAPEX	Capital expenditure
CPE	Customer premises equipment
CSP	Communications service provider
DPU	Distribution point unit
cDTA	coordinated Dynamic time assignment
FRA	Fast Rate Adaptation
FTTB	Fiber-to-the-Building
FTTH	Fiber-to-the-Home
FTTN	Fiber-to-the-Node
FTTP	Fiber-to-the-Premises
FTTdp	Fiber-to-the-distribution point
FTTx	Generic for multiple configurations of fiber deployment
GPON	Gigabit passive optical network
G.fast	ITU G.9701, Fast Access to Subscriber Terminals
MGfast	ITU G.9711, Multi-Gigabit Fast Access to Subscriber Terminals
MDU	Multiple dwelling unit

NFV	Network function virtualization
OPEX	Operational expenditure
RPF	Reverse power feeding
SDAN	Software-defined access network
SRA	Seamless Rate Adaptation
TTM	Time-to-market
VDSL	Very high speed digital subscriber line
XGS-PON	10 Gigabit Symmetrical Passive Optical Network

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As a B2B technology innovation leader, we are pioneering the future where networks meet cloud to realize the full potential of digital in every industry.

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