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Ultra Broadband Strategies:

A Look into Technology Choices and Business Models

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Introduction

There's a seemingly insatiable desire for higher and higher bandwidth among consumers and businesses, as users spend much of their time sharing or viewing all manner of content via a growing number of devices.

In the midst of this growing demand, the communications network marketplace is changing quickly and becoming more and more competitive. Providers of all types are scrambling to meet the growing demands for service and at the same remain viable businesses.

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The key challenges for providers include selecting the right mix of technologies that deliver the right services to market at the right time; making the ultra- broadband business case work; and selecting the right partner to support design, deployment, service activation, and beyond.

When looking at technologies, providers need to deploy a mix of fiber, copper, cable, and wireless. And they need to evaluate different access technologies and choose the best ones according to the situation at hand.

There are many technology options, each with their own trade-offs between cost, time to deploy the technology and begin generating revenues, and the quality of the service provided to customers in terms of broadband speeds.

When building a business case for technologies, providers need to carefully weigh the costs associated with different ultra-broadband technologies against the revenues that they bring and the speed at which those revenues can be realized. It's important to look at capital expenditures, operational expenditure, and time-to-market (TTM) considerations in building a ultra-broadband strategy.

To help create and execute a strategy for delivering ultra-broadband to more people, in the quickest and most cost-effective way, providers need to find a trusted partner. That's where Nokia comes in.

Nokia has been partnering with regional broadband operators since the introduction of ADSL in 1999. Broadband networks have evolved significantly since that time, and Nokia has led the way with innovations in DSL, fiber, and wireless technologies.

This ebook examines the market imperatives and technology choices available today, how providers can build a business case, and how a partner such as Nokia can help providers build a network for the future

Chapter 1—Market Imperatives and Technology Choices

The communications network marketplace is changing rapidly and becoming ever-more competitive. Gigabit fever is driving consumer expectations, and cable companies and alternative providers are scrambling to meet growing demands for service.

For providers, rapid deployment of services is essential, with a mix of technologies that will help deliver the most economic benefit and the best services to customers.

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This is indeed a large and growing market. MuniNetworks.org reports that there are now more than 500 municipal broadband networks in the United States, many offering their communities broadband speeds up to 1 Gb/s.

Cable companies are winning the broadband battle in the U.S, adding 3.3 million subscribers in 2016 alone, while telephone companies lost ground.

With exploding demand for services, many under-served communities are building their own ultra-broadband networks. Similarly, cable companies and predatory alternative operators are looking for new subscribers.

Today, regional service providers face a constant threat of new entrants to the market and are under pressure to improve services that keep customers loyal and at the same time set barriers that make it difficult for new players to enter the market.

The key challenges for providers are threefold:

- Selecting the right mix of technologies that deliver the right services to market at the right time.

- Making the ultra- broadband business case work.

- Selecting the right partner to support design, deployment, service activation, and beyond.

Technology considerations

If money was no object and time was not a factor, fiber would be used for every broadband connection. In reality, the economics of serving different groups of users means there is no "one size fits all" ultra-broadband technology. Having a mix of fiber, digital subscriber line (DSL), cable, and wireless is key to the operator's business case.

Given a provider's own set of specific circumstances, it needs to evaluate different access technologies and select the best ones according to the situation at hand, or even select different technologies for different areas in the provider's market.

This requires careful consideration of several factors, including the existing infrastructure, the density of households in the serving area, the broadband speeds that are needed, the time it takes to provide new services, and the costs.

Balancing these considerations can be summed up as "fiber-to-the-most-economical-point", or FTT$. Given that fiber to every home and business is the desired end goal but not always feasible in the short-term, FTT$ is about extending fiber infrastructure to the deepest point in the network that makes the most business sense.

In some cases, that point will be fiber all the way to the business or home. In others, it will be fiber close enough to then use the copper or cable local loop, or a wireless technology, to complete the connection to the customer and still provide ultra-broadband services. The precise point is determined by the economics of the business case.

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Technology options

Each of the technologies available today has trade-offs between cost, time to deploy the technology and begin generating revenues, and the quality of the service provided to customers in terms of broadband speeds. Here are some technology options:

Gigabit passive optical network (GPON). This is the most common fiber-to-the-home (FTTH) technology in the world today. Many operators use GPON to provide residential services of 1 Gb/s as well as business services, mobile backhaul, and remote node backhaul for FTTx micro-nodes. The initial capital expenditure for GPON is generally higher than for other technologies, but there is a strong return on investment (ROI) given the longevity of fiber and the potentially unlimited capacity for future services.

Next-generation passive optical network (NG-PON2). Operators can easily upgrade their existing GPON networks to support NG-PON2 technology. NG-PON2 enables providers to increase the capacity in increments of 10 Gb/s, enabling increased utility with these higher speeds. The technology provides a cost-effective option that supports 10/10G and 10/2.5G bit rates with fixed wavelength optics. Time and wavelength division multiplexing PON (TWDM-PON) provides four or more wavelengths per fiber, each capable of delivering symmetrical or asymmetrical bit rates of 2.5 Gb/s or 10 Gb/s.

G.fast. This is a flexible technology that delivers aggregate rates of 1 Gb/s over a distance of 160 feet of copper plant and as much as 300 Mb/s at 1,000 feet. A new amendment to the G.fast standard increases usable spectrum of G.fast to 212 MHz to deliver symmetric gigabit speeds. G.fast is a valuable tool for any fiber operator to ensure that high-speed services can be delivered to subscriber locations that are impractical for fiber. For example, fiber can be drawn to the basement of an apartment block or front door of a home and G.fast can be used over the existing in-building copper or coax cabling.

Very-high-bit-rate digital subscriber line 2 (VDSL2) vectoring. VDSL2 is commonly deployed in fiber-to-the-node and fiber-to-the-curb architectures. With the VDSL2 17a profile, downstream speeds of 100 Mb/s can be delivered on copper loops of 2,000 feet or more.

Cable. Most cable operators also consider FTTH as the ultimate end-goal. But the same strategy of drawing fiber closer to customers can still be used to increase the bitrate-per-user. Upgrades to existing hybrid fiber-coaxial (HFC) networks can be facilitated with a unified cable access solution, which overcomes bandwidth constraints by virtualizing the CCAP (headend equipment), eliminating costly analog optics, and extending IP closer to the customer. With Data Over Cable Service Interface Specification (DOCSIS) provisioning of Ethernet PON (EPON), providers can deploy fiber networks while managing the Optical Network Unit (ONU) as they would a cable modem. Cable networks still suffer from constrained upstream speeds, and the industry is working on overcoming this challenge.

Fixed-wireless. The latest 4G LTE and future 5G mobile technologies can be attractive options in hard-to-serve areas. Nokia's fastmile fixed-wireless solution uses existing LTE infrastructure to provide speeds up to 100 Mb/s to residences. Fixed-wireless access using 5G technology is a hot topic today, as many operators consider it a low-cost alternative to traditional fixed networks. When available, 5G will provide yet another option for delivering services. But 5G will rely heavily on fixed fiber networks for mobile backhaul and fronthaul.

Hybrid access. For rural areas where existing DSL is not providing enough throughput, it can be combined with existing LTE coverage for a hybrid access solution that increases speed and stability. This technology will be a useful tool for operators that struggle to increase the capacity of their rural networks.
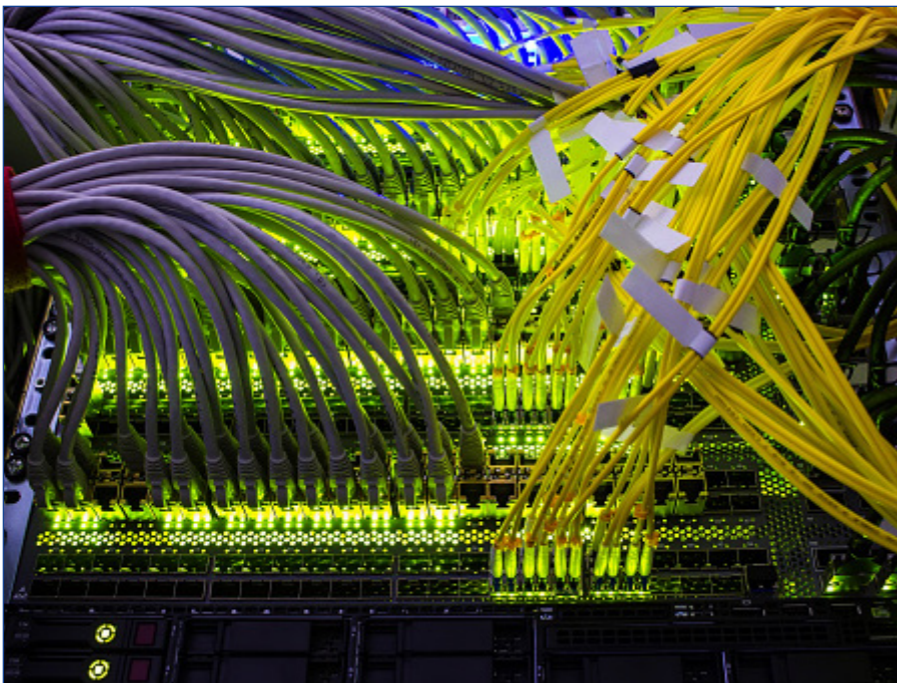
A need for scale

To deliver more bandwidth to more people, operators need to consider solutions that work together and can scale from dense urban areas to highly rural regions.

For example, Nokia's Intelligent Service Access Management (ISAM) portfolio allows different FTTx technologies to sit side-by-side on the same network. Nokia's highly flexible micro-nodes let companies deliver ultra-broadband services from telephone poles, manholes, walls and basements.

Speed, flexibility and reliability are increased, with pre-assembled and tested micro-nodes and Zero-Touch Provisioning for easy turn-up of services.

In terms of maximizing the lifetime value of a network, the adoption of open and standardized management models and a persistent network representation in the cloud can eliminate complexity while managing large numbers of micro-nodes (whether on- or off-line).

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Chapter 2—Building the Business Case

Providers need to carefully weigh the costs associated with different ultra-broadband technologies against the revenues that they bring and the speed at which those revenues can be realized. It's important to look at the cost and time-to-market (TTM) considerations in building a ultra-broadband strategy.

Capital expenditure

Capital expenditure (CAPEX) is a key consideration for any operator, and Nokia's FTT$ strategy recognizes that. Rather than embracing one technology, Nokia leads the market in providing a full suite of access technologies.
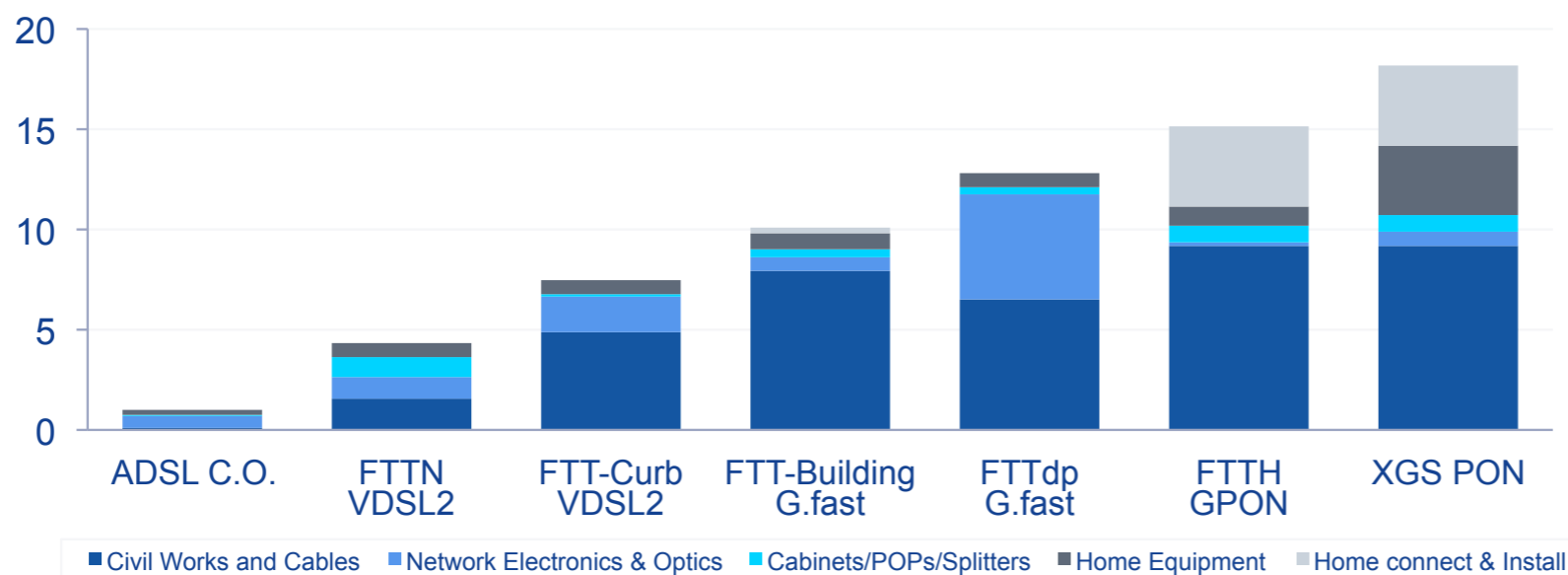
This enables Nokia to partner with operators to objectively determine the best technology without favoring any particular one. Nokia has spent several years consulting with operators large and small and working with Bell Labs Consulting on detailed analysis to create CAPEX modeling. Bell Labs Consulting provides a service to create detailed and personalized business modeling for individual operators.

Based on the assumption that all homes and businesses have an existing copper twisted pair connection, Nokia uses Asymmetric Digital Subscriber Line (ADSL) from the central office with no fiber investment as a cost baseline in figure 1 which uses an urban household density of 2500HH/km2. All other technologies are then compared with that baseline.

By far the most costly aspect of any deployment are the civil works to lay the fiber. Home equipment and

Relative CAPEX per sub (urban) for target morphologies

Bar chart x-axis: ADSL C.O., FTTN VDSL2, FTT-Curb VDSL2, FTT-Building G.fast, FTTdp G.fast, FTTH GPON, XGS PON

Legend: ■ Civil Works and Cables ■ Network Electronics & Optics ■ Cabinets/POPs/Splitters ■ Home Equipment ■ Home connect & Install

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installation also represent a significant factor for fiber connections. In essence, the more fiber centric the application, the higher the speed and CAPEX.

CAPEX per subscriber is highly sensitive to subscriber density, measured in households per square kilometer (HH/km2). As density falls, CAPEX per subscriber rises, illustrating the challenges of serving low density areas.

Operational expenditure

Operational expenditure (OPEX) is a constant challenge for every operator, representing a significant expense that can take years to show its cumulative impact.

One of the clear benefits of FTTH is that it has by far the lowest operational costs of any access technology. This is because passive optical network (PON) architectures use all-passive outside plant components, resulting in extremely low maintenance requirements.

The Optical Line Terminal (OLT) access node located in the central office shares each fiber connection over a number of subscribers, consuming little power in comparison with other technologies.

Time-to-market

Operators also need to consider (TTM), which can be critical in a competitive environment. Sometimes an access solution can be worth the wait, both for the end-user and the operator; for example, FTTH with its unlimited bandwidth and future-proof potential. That

is, unless a community broadband project or alternative operator sees a chance to provide it first.

Operators need to take into consideration how long their customers will wait and how fast competitors are able to react to an opportunity. No FTTH network can be built overnight, so Nokia has devised technology migration strategies that drive increased revenues today and finance longer-term FTTH deployments.

For example, difficult-to-reach areas can be connected with fixed-wireless or FTTx to deliver increased broadband speeds quickly. This secures the subscriber base and immediately increases average revenue per user (ARPU). These revenues finance the upgrade to fiber at a later date.

Building a network for the future

So far we've examined the different technologies available to provide ultra-broadband. We also looked at the business case, including costs and the importance of time-to-market; and getting services in place quickly to pre-empt the competition and secure subscribers. But then what?

An operator's investment in ultra-broadband services needs to last well into the future. Fiber infrastructure is future-proofed, but the choice of FTTx or FTTH technology might have limitations in terms of electronics and optics. From the beginning, it's important to have the vision for how to take the network to the next level when the time is right.

Chapter 3—Helping Operators Build a Network for the Future

Nokia has been partnering with regional broadband operators since the introduction of ADSL in 1999. Broadband networks have evolved significantly since that time, and Nokia has led the way with innovations in DSL, fiber and wireless technologies.

The company is committed to helping operators for the long-haul. It is the only vendor in North America that is technology-agnostic, so it can advise on and support the evolution of an operator's network right from the onset with DSL to next-generation fixed and wireless technologies, and beyond.

A trusted partner

Nokia is a worldwide leader in fixed broadband technology. The company's solutions power the fastest and best-performing telecom networks in the world, both small and large. In fact, Nokia has delivered more than 90 million fixed broadband lines in North America, far more than any other supplier.

"With more than 450 customers worldwide, Nokia is the only broadband technology vendor with a leading position in every region of the globe."

With more than 450 customers worldwide, Nokia is the only broadband technology vendor with a leading position in every region of the globe. Of the 20 largest

network operators, 18 trust the company for its broadband networks. These include AT&T, Verizon, Telefónica, BT, Vodafone, Orange, China Telecom, and Deutsche Telekom.

Nokia is also trusted by regional providers and community-based operators. Many municipalities, utility companies, and local service providers across the Americas, Europe, and Asia continue to partner with Nokia to make fixed and wireless ultra-broadband a reality. The first residential gigabit service offering in the U.S., Chattanooga's Gig City, relies on Nokia's solutions. So do a number of other regional providers.

A history of innovation

The company has earned this trust over a 150-year period that combines the heritage of Nokia, Alcatel, Lucent, and Bell Labs. It creates technology that connects the world, and its innovations span the history of communications.

Nokia invented telephony, lasers, transistors, and mobile phones—the ingredients of today's intelligent, secure, and reliable communications networks. The company's inventions and solutions connect people and organizations around the world, over land, under sea, and through the airwaves.

Although Nokia is a global company, it strives to remain close to its customers, with a local presence in more than 100 countries. Its broadband solutions regularly earn the industry's highest accolades, and Nokia owns more than 15,000 patents, including nearly 3,000 for fixed broadband technology.

More important than the awards and accolades, however, are the opportunities the company creates when it puts its technology to work. The corporate mission in fixed broadband is to provide more bandwidth to more people, wherever they are. The connections must be seamless, secure, available from any device and any kind of network. Nokia does this by providing extremely fast, wireless and fixed broadband access, backed by high-performance IP networking expertise.

Working with customers

Nokia's team, experience, innovations, and technology are designed to serve its customers. The company works with customers as business partners, bringing its global expertise to the local communities operators serve.

The solutions and professional services allow operators to deliver the ultra-broadband services their customers want. Nokia can help design, plan, and deploy services that are right for an operator's business strategy as well as its customers, and that will deliver reliable value for years to come. ●

For more information about how to deliver ultra-broadband to more people, in the fastest and most cost-effective way, listen to Nokia's new on-demand webinar at https://goo.gl/CFNsvo

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About Nokia:

We create the technology to connect the world. Powered by the research and innovation of Nokia Bell Labs, we serve communications service providers, governments, large enterprises and consumers, with the industry's most complete, end-to-end portfolio of products, services and licensing.

From the enabling infrastructure for 5G and the Internet of Things, to emerging applications in virtual reality and digital health, we are shaping the future of technology to transform the human experience.
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