STRATEGIC WHITE PAPER

With ultra-broadband, deliver the right to compete

Ultra-broadband is the most transformative technology since electricity, and one of the most promising assets for governments seeking to boost their economies and social development in an open digital world. According to independent studies, a 10 percent increase in broadband penetration can increase a country's GDP growth rate to 1.4 percent – even more in some emerging regions. Ultra-broadband can drive productivity, innovation and growth in all sectors of the economy, not only in the digital sector, and therefore is central to any competitiveness strategy.

Yet 4.3 billion people remain unconnected to the Internet, 90 percent of whom are in the developing world, while 2.5 trillion digital data items are created worldwide each day. The disparities and the slow move to close the gap continue due to the lack of infrastructure, the inefficient use of spectrum and network resources, or inappropriate market structure.

This white paper examines initiatives to offer universal and affordable ultra-broadband service to this underserved population, with particular attention to methods for financing and deploying the required sustainable infrastructure and business model in even the most challenging economic environments, allowing all citizens to compete and thrive in the global marketplace.

Alcatel·Lucent

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A transformative technology

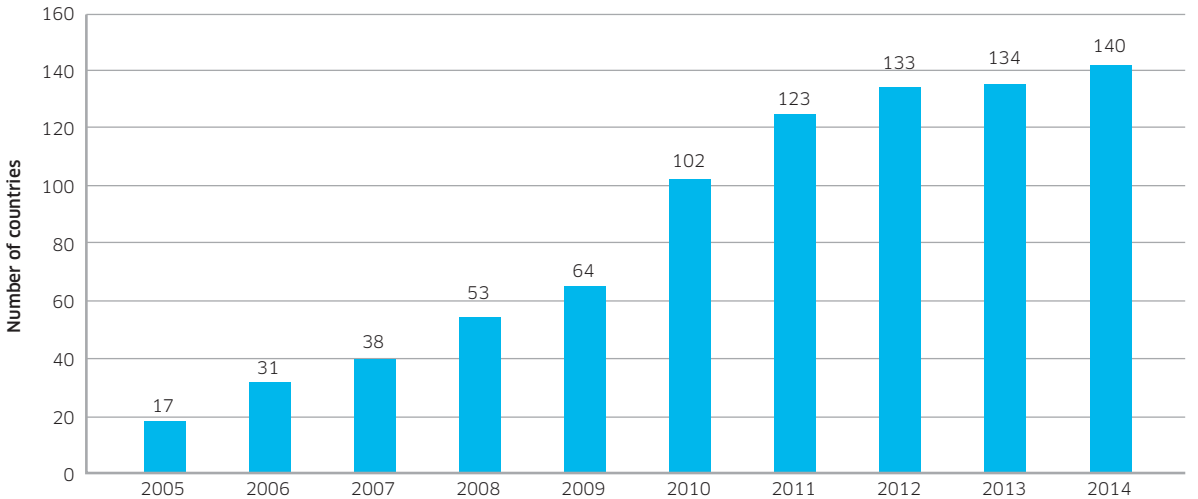
Ultra-broadband is the most transformative technology since electricity, with the power to create a new economic landscape. Broadband connectivity is strongly affecting four of the largest sectors of the economy - health, education, transportation and electricity - which comprise nearly 25 percent of GDP in member countries of the Organisation for Economic Co-operation and Development (OECD). Efficiency gains from broadband in these sectors can have a measurable impact on growth simply because of their size. Additionally, ultra-broadband enables innovative tools that extend and ease access to public services, health care and education, places basic social services within the reach of all citizens and enhances business growth.

The International Telecommunications Union (ITU) has stated that access to broadband could be the catalyst that lifts developing countries out of poverty to enter into an open global digital world using the same competitive asset as established knowledge economies. As such, ultra-broadband has become essential to every society – a foundation for broad social and economic benefits that enables business and regional competitiveness.

In recent years, national broadband plans and initiatives have grown in popularity and numbers. To date, 140 countries have developed a national plan, strategy or policy to promote broadband, and a further 13 countries were planning to introduce such measures in the near future. Still, nearly a quarter of all countries still do not have any plan.

In order to bridge the digital divide, respond to a financial crisis with stimulus funding or set in motion the foundation of prosperous development, governments are making broadband a priority, using their powers to encourage investment, adoption and usage. Guided by each of their economies, social and business landscapes, existing infrastructure, level of funds and policy, they are coordinating both public and market-based opportunities while drafting digital development strategies to make broadband both universal and affordable. They are proving that universal broadband can succeed in any country, region or economy, fulfilling the right of all citizens to compete and thrive in the international marketplace.

Figure 1. Number of countries with national broadband plans from 2005 to 2014



Source: ITU

Challenges and opportunities

The world has witnessed an unprecedented explosion in data over the past two decades. Consider the Internet, where the number of users jumped from 16 million to 1 billion in only 10 years (1995- 2005), then nearly tripled in 2013 to 2.9 billion, or 41 percent of the world's population, according to multiple sources. It has become the superhighway for "big data" generated by billions of digital sensors, photos and videos, GPS devices, social media sites, cell phones and everyday transactions.

The data explosion occurring every minute:

- Over 4 million Google search queries
- Nearly 50,000 apps downloaded by Apple users
- Over 200 million sent email messages
- Nearly 2.5 million pieces of content shared by Facebook users
- 350,000 tweets
- 220,000 new photos posted on Instagram
- 300 hours of video are uploaded to YouTube

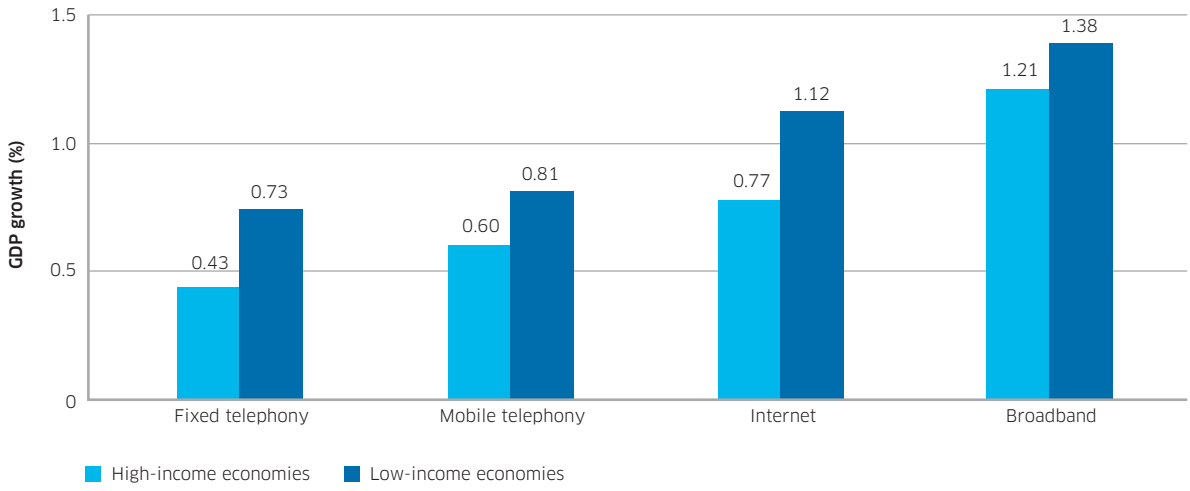
This data explosion is calling for a tremendous level of investment in ultra-broadband infrastructure – the largest such investment since electrification in the 20th century.

These investments are needed even as telecom operators and service providers are redefining their markets. All public and private players will need to be part of the new ecosystem, which will return benefits that more than pay for financial outlays.

According to independent studies from consulting firms, universities and financial institutions, the benefits of a 10 percent increase in broadband penetration for emerging markets can increase a country's GDP growth rate to 1.4 percent, even more in some regions, depending on their economic structures. Other studies and findings strengthen the case:

- The European Cities Monitor report[1] cites "the quality of telecoms" as the third-ranking priority when businesses consider relocating.
- For every euro spent on broadband, 14 euros can be generated for the local economy[2].
- Broadband is responsible for 20 percent of new jobs across all businesses, and 30 percent of new jobs in businesses with less than 20 employees[3].

Figure 2. Growth effects of broadband services on GDP in high and low-income economies



Source: Christine Zhen-Wei Qiang - The World Bank, Information and communications for development (White paper, 2009)

Consequently, ultra-broadband is the key enabler for achieving the three dimensions of sustainable development in a competitive market environment: economic growth, environmental balance and social inclusion. Influential factors include:

National

- The attractiveness of a country and its industries, based on the weight of its overall information and communications technology (ICT) industry, the impact of broadband access, efficiency in business operations with easier internationalization, and access to a global digital economic world.

Region and city

- Competition among big cities to attract investors, develop tourism, and create the foundation for a smarter city management.

Citizen welfare

- Strengthened citizen engagement, social inclusion; a more informed society and transparent governance; extended digital services; better education with easier e-learning access; better care with a cost-effective and timely e-health system; cultural development, including access to online libraries, museums; entertainment, including gaming; as well as e-shopping, social media access; and other 21st-century lifestyle expectations.

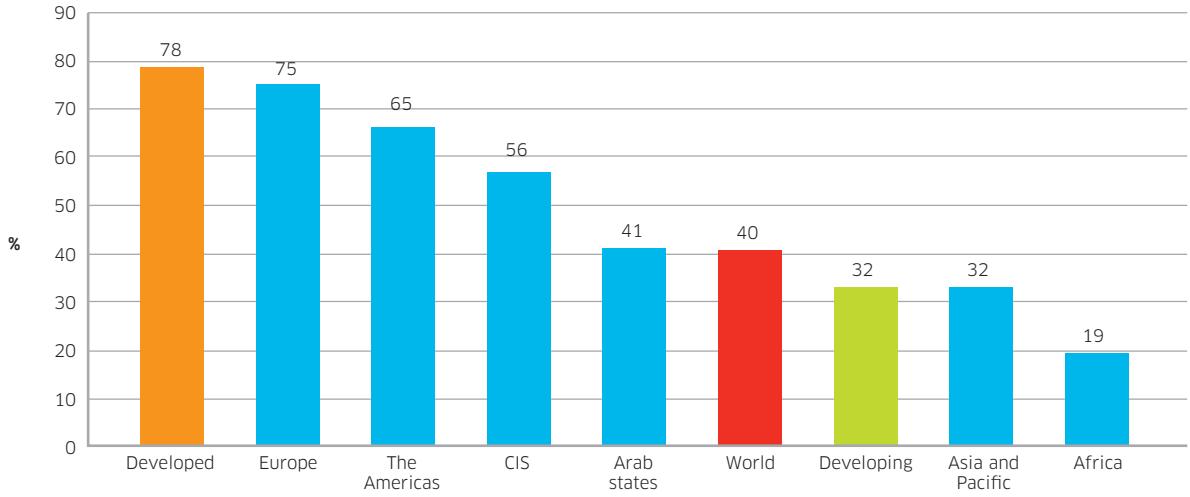
A game-changer in the global competitive digital landscape

Broadband services still remain inaccessible or unaffordable for many citizens and businesses, leaving large parts of the world at a competitive disadvantage. To address these inequities, the United Nations Broadband Commission in 2000 established a set of goals:

- **Make broadband policy universal**: By 2015, all countries should have a national broadband plan or strategy, or include broadband in their universal access / service definitions.
- **Make broadband affordable**: By 2015, entry-level broadband services should be made affordable in developing countries through adequate regulation and market forces (amounting to less than 5 percent of average monthly income).
- **Connect homes to broadband**: By 2015, 40 percent of households in developing countries should have Internet access.
- **Get people online**: By 2015, Internet user penetration should reach 60 percent worldwide, 50 percent in developing countries and 15 percent in least developed countries (LDCs).
- **Ensure gender equality**: By 2020, broadband should redress gender imbalances in access to information and communication technologies.

In 2015, despite notable progress with a growing understanding of the issues, there is still a long way to go, taking into considerations the 4.3 billion people who remain unconnected to the Internet, of which 90 percent are from the developing world, where fixed broadband services account for 30 percent of average monthly incomes. And with the current growth rates, the gap will persist with only half of the world's population predicted to be online by 2017 according to the latest ITU report[4].

Figure 3. Percentage of individuals using the Internet, by region, 2014

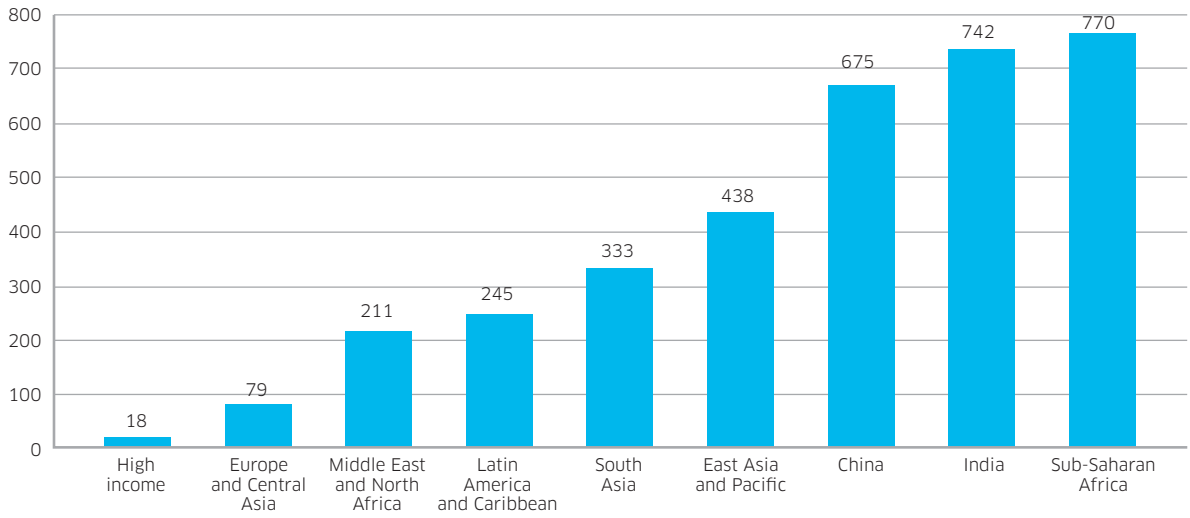


Note: *Estimate
Source: ITU World Telecommunication/ICT Indicators database

Regulatory and financing dimensions

Numerous governments, private sector and international financing bodies are engaged in national broadband plans, working together to remove such barriers to investment as no viable business case, accessibility to long term funding, reluctance of established players to open up the market to competition, market imbalances, difficult regulations and political trends.

Figure 4. Population without access to affordable broadband (millions)



Source: ITU

These factors are best addressed through a national strategy plan linked to regulatory and legal reforms, set up by the government which aims at supporting and encouraging private sector investment, while also seeking more effective ways to regulate concentrated markets and promote competition. As proposed by the World Bank, broadband development is “an ecosystem of mutually dependent and reinforcing components of supply and demand” in which integrated policies will maximize its benefits across all sectors of the economy and society.

As revealed in OECD and Alliance for Affordable Internet (A4AI) surveys, some policy initiatives have been well identified to promote broadband investments, including these objectives:

- Establish a healthy market competition and an open environment.
- Encourage lower cost structure for industry by streamlining processes for infrastructure deployment and sharing.
- Improve access to passive infrastructure (conduit, poles, ducts and masts) and coordinate civil works as an effective means to encourage investment.
- Ensure access to rights-of-way in a fair and nondiscriminatory manner.
- Encourage and promote the installation of open access to passive infrastructure when public works are undertaken.
- Allow municipalities or utilities to enter telecommunications markets. Where market distortion is a concern, policy makers could limit municipal participation to basic investments (such as the provision of dark fiber networks under open-access rules).
- Provide greater access to spectrum (which is a significant market barrier to mobile broadband provision), and adopt more market mechanisms to promote more efficient spectrum use.

As part of the ecosystem approach, government also should create a strong environment for demand-side components such as consumer and business applications, local content and cloud-based services that will attract users and add value to the network. Digital literacy among the general population is critical for adoption and success, and should be integrated into educational curricula and mass media.

Funding sources

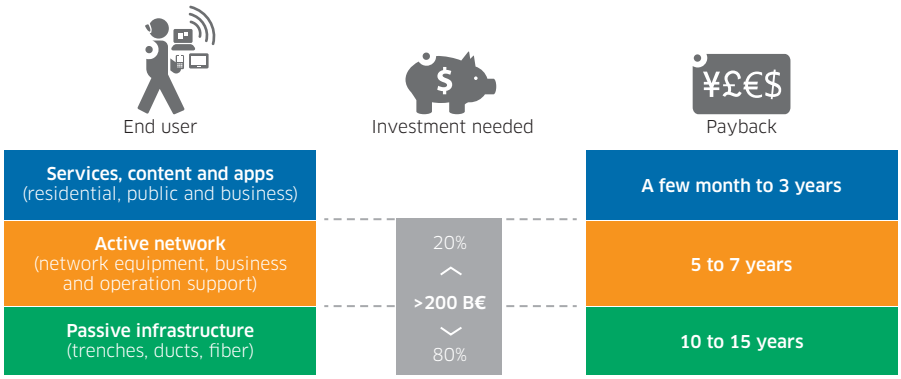
The first source of funds for ultra-broadband deployment is coming from the private sector. Traditional modes of operation rely completely on commercial operators assuming all risks and making all investments.

Emerging economic models increasingly trust in infrastructure sharing, the creation of a wholesale services market and the sharing of risk with the public sector through Public Private Partnerships (PPPs). These emerging models are about distinguishing the nature of investments and mitigating the risks among different stakeholders. Telecom infrastructure and services involve three different kinds of investments:

1. Long-term passive infrastructure, as sites, ducts, masts, poles and cables
2. Mid-term active equipment involving access, transport and control platforms
3. Application and content-related investments as cloud, CDN and SDP platforms

All of these types of infrastructures have different investment requirements and could be shared differently. As an example, sharing civil passive infrastructure makes sense cost-wise and does not materially impact service differentiation.

Figure 5. Title to come



Sharing the risk means mitigation of risk by the best suitable stakeholder. For example, legal, regulatory, macroeconomic, political and security risks are best suited for government, while demand and commercial risks are better addressed by commercial retailers. Network design, technology, schedule and demand/volume risks are more suitable for wholesale infrastructure operators. When risk is spread out and allocated wisely, funding becomes less risky and more abundant.

Table 1. Public/private contributions

PUBLIC SECTOR	PRIVATE SECTOR
• Public policy	• Funding
• Regulation	• Resources
• Planning	• Agility
• Social responsability	• Expertise
• Environmental responsability	• Technology
• Citizen protection	• Innovation
• Funding (partial)	• Private incentives model

Every year governments, private investors and international financial institutions allocate billions of dollars' worth of equity, grants and loans for broadband and telecommunications projects.

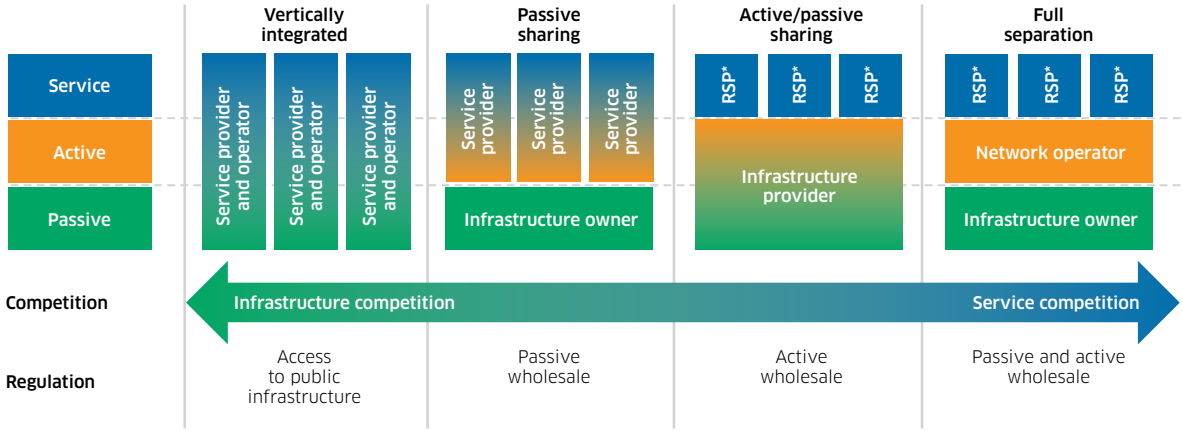
Public financing can come in the form of equity, as in the case of Australia; subsidies, as in China, universal access service funds, as in Colombia; output-based aid, which is a performance-based subsidy; spectrum, as an in-kind payment to avoid financial contributions; other in-kind payments such as tax breaks and holidays; or granting rights of ways or use; or public policies such as infrastructure sharing, hedging policies or government contracts to mitigate demand risk.

Private financing can come in the form of privatization of state-owned companies, PPPs, concessions and joint-ownership companies.

PPP financing can not only include governments and operators, but also equipment suppliers, contractors and even communities using many different forms of financing. Such funding can come in the form of equity provided by investors, sponsors or financial institutions; debt coming from bank loans, mezzanine funding as subordinated loans, convertible loans, redeemable shares or stock warrants. Multilateral agencies can provide funding suitable for long-duration projects, as is also the case for institutional investors such as pension funds, insurance companies, sovereign wealth funds or infrastructure funds.

With a reliable legal and regulatory framework and a coherent commercial business case, contract financing also is possible.

Figure 6. Selecting the right regulatory framework



*RSP = Retail service provider

Project typology

National broadband typologies can take many forms. The one chosen to increase a country's competitiveness in any one area must take into account that nation's unique social and economic factors, as well as the regulatory and technologic environment. Typical models include:

- **Commercial Broadband (or Commercial Network Build Projects)**: An established telecom operator provides commercial broadband services to all or part of the region. Market principles apply, so the extent of coverage will depend on the business case.
- **Government-Driven Broadband Initiatives (or Public Sector Network Build Projects)**: Scenarios where the government shares financial, technical, and/or operational risks with the private sector through joint ventures, consortia and public private partnerships. In this model, the open-access network infrastructure is sold to retailers, who then provide Internet and other services to consumers. These initiatives are being aimed at expanding network capacity by removing bottlenecks in access and transport. There are three primary types of initiatives involving three key technologies:
  - ¬ Fiber-based National Backbone
  - ¬ FTTx-based Next Generation Access
  - ¬ LTE-based Open Wireless Access

Project typologies depend on economic, technical and financial considerations customized to a region or country's specific conditions, such as existing infrastructure, population density, its economy, end-user needs and the demand for broadband services, and consequently its revenue potential of the expected services, the cost of the necessary infrastructure, and financial performance of the project.

National open-access fiber backbones

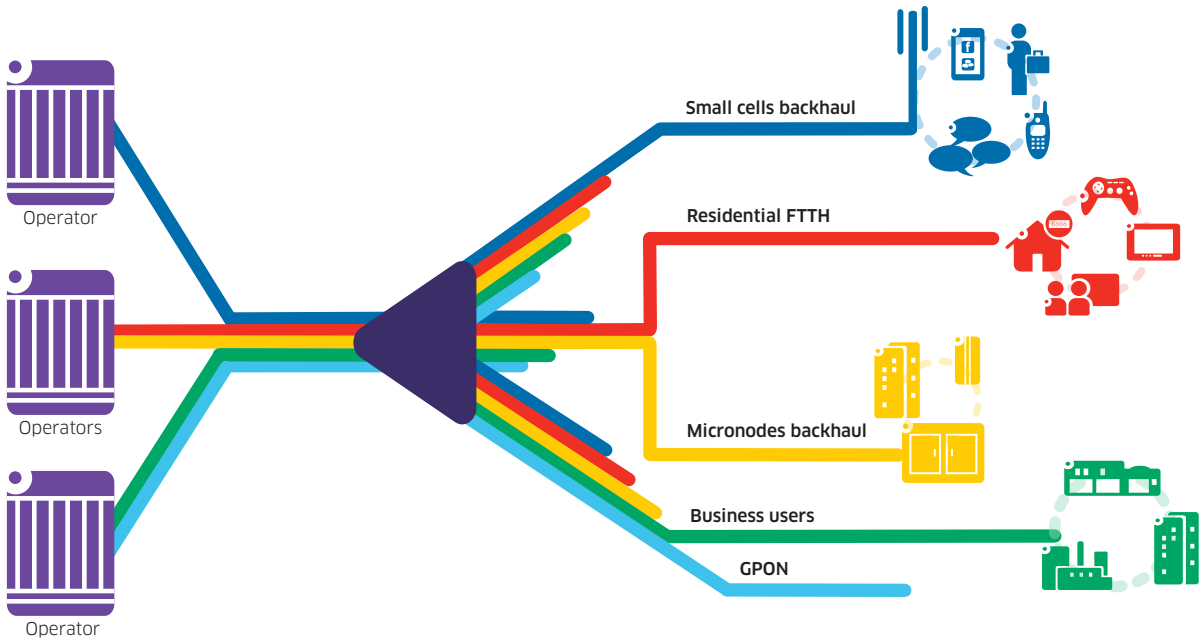
Building out a national fiber backbone is a capital-intensive project, requiring the acquisition of rights of way and the construction of ducts, poles, data centers, nodes, the fiber itself and other physical assets for the network. Once it is in place, it can provide a transformative open platform for ultra-broadband access between population centers and international submarine cable access points. Experience shows that such a network initially would host few independent operators, one of whom may cover only urban markets. Well-crafted regulatory and operational policies will assure affordability and encourage a critical mass of users and services.

National fiber backbones already have been successfully deployed or are in development in Brazil, Colombia, Mexico, India, Kenya, Nigeria, Sri Lanka, Ghana, Argentina, Venezuela, Peru and numerous other locals in the developing world. For instance in Columbia, the state-owned telecom operator UNE EPM has significantly upgraded the country's national broadband infrastructure through the deployment of a 100 gigabit-per-second (Gbps) backbone based on Alcatel-Lucent equipment. It connects all major urban areas and international submarine cables, serving approximately 14 million people.

Next-generation access network - FTTx

Next-generation technologies can extend the benefits of existing fiber backbones, allowing multiple service providers to bring ultra-broadband directly to all homes and businesses. Fiber to the most economical point (FTTx) comprises the many variants of fiber optic access infrastructure. These include fiber to the home (FTTH), fiber to the building (FTTB), fiber to the node (FTTN) and fiber to the curb (FTTC). These can incorporate copper pair cables leveraging some form of high-speed copper, such as VDSL2 Vectoring or G.fast. Using ultra-high-capacity fiber access nodes, last-mile providers can leverage multiple technologies, allowing service differentiation, network separation and competition on top of a collaboratively built infrastructure.

Figure 7. Fixed access network - wholesale model

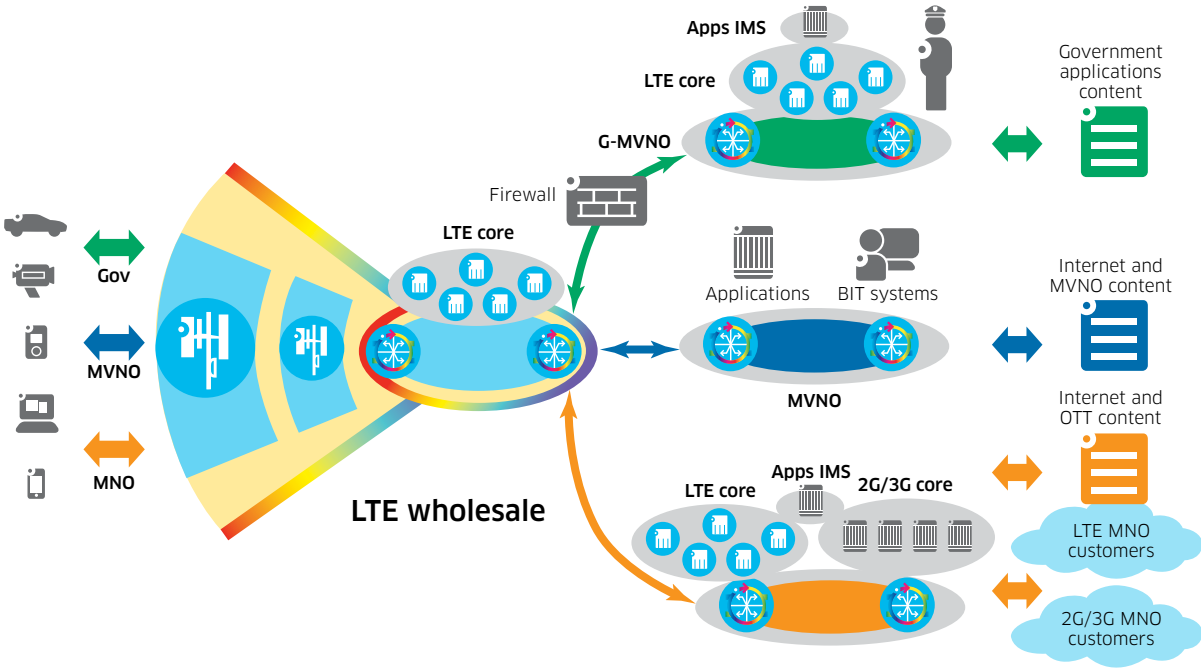


Australia, New Zealand, Singapore, Israel, Lebanon, Qatar and other nations are employing these technologies in order to deliver last-mile ultra-broadband. The Australian government is deploying a fiber network delivering broadband speeds of up to 100 Mbps aiming at covering at least 93 percent of the population, and wireless networks delivering speeds of 12 Mbps or more to those living in remote areas. In New Zealand, the Ultra-Fast Broadband Initiative (UFB) based on Gigabit Passive Optical Network (GPON) solution is bringing ultra-broadband downlink speeds of at least 100 Mbps to homes, schools, hospitals, and businesses, reaching 75 percent of New Zealanders.

Open-access wireless network to all cities

4G Long Term Evolution (LTE) is the global 3GPP standard for the fourth generation of mobile broadband communications for high-speed data, video and voice services. Using this next-generation mobile technology, policy makers can close the digital divide by accelerating deployment of services at affordable prices, particularly in rural and unserved markets, since investment and deployment of cables and other physical infrastructure is drastically reduced. LTE is the first IP-based mobile generation technology, making it a naturally open access platform fully interoperable and well suited to render mobile broadband services.

Figure 8. Open-access LTE network - wholesale model



A wholesale open-access LTE model can reduce investment risks and improve the profitability of LTE services for mobile network operators (MNOs), and boost retail competition. In this model, a mobile virtual network enabler (MVNE) using a substantial portion of spectrum deploys a nationwide LTE network overlaying the existing 2G/3G and 4G networks from MNOs. Rather than building their own LTE infrastructure, the MNOs can choose to rent LTE capacity from the MVNE, or to roam in and out through the national roaming services. Commercial and government virtual network operators will also use this common infrastructure, benefiting from its cost advantage and its public wholesale offering.

The wholesale LTE network can be further leveraged for public safety. LTE mobile broadband technology can complement existing LMR/PMR networks to provide a scalable, secure and cost-effective way to add mobile streaming video, high-speed internet access, multimedia messaging and VPN access to home agency applications and incident command systems – all under a unified infrastructure that can be securely shared by cooperating agencies. In 2012 the TETRA & Critical Communications Association (TCCA) characterized LTE as the “prerequisite” technology for radio access and public safety’s evolution towards IP.

Bridging the digital divide

Countries everywhere must enter the global digital world in order to compete and thrive. Broadband is a competitive right and a modern life necessity for all people and regions. Ultra-broadband is the key element for accessing the global marketplace – a foundation for the global economy that enables broad social and economic benefits.

With both wireline and wireless technical expertise, a global footprint and long-standing experience in government-driven projects, Alcatel-Lucent has helped numerous governments in shaping national and regional broadband plans, mapping demand/supply with the appropriate technology solutions, business and funding models, as well as the optimal policy and regulatory tools for successful implementation.

Alcatel-Lucent's methodology is based on creating sustainable projects that increase competitiveness, capitalizing on its experience in designing affordable communications solutions for people everywhere, with worldwide recognition in cross-industry collaboration initiatives for e-government, m-health and m-learning.

Alcatel Lucent's global experience provides any broadband initiative with a best-of-breed portfolio, meeting compliance and reliability requirements of governments, while reducing their operational costs. The company is home to Bell Labs, one of the world's foremost R&D and consulting organizations, responsible for breakthroughs that have shaped the networking and communications industry.

Acting as an independent party, the Bell Labs consulting team is recognized to provide pragmatic recommendations underpinned with independent, fact-based analysis, based on long-established engagements around the globe. Bell Labs has helped break down traditional barriers and unlock the growth potential of technologies. Its modeling and expert engineering advice has shaped strategy and collaboration across public and private sectors.

S&P Dow Jones Indices and RobecoSAM named Alcatel-Lucent as Industry Group Leader for Technology Hardware & Equipment sector in the 2014 Dow Jones Sustainability Indices review. In its 2014 report on Alcatel-Lucent, DJSI/Robeco SAM said: "Alcatel-Lucent and its research organization Bell Laboratories have continued to lead the discussion on eco-innovation and the communications technology (ICT) industry." Alcatel-Lucent also leveraged its leadership position to promote digital inclusion and digital literacy among disadvantaged communities throughout the world through the work of the Alcatel-Lucent Foundation.

Alcatel-Lucent is committed to making ultra-broadband a competitive right to all, with more sustainable, affordable and accessible communications. Its mission is to invent and deliver trusted networks to unleash the value of your nation, your region, your city and citizens.

Acronyms

3GPP	3rd Generation Partnership Project made up of several international telecommunications standard development organizations
A4AI	Alliance for Affordable Internet
4G	The fourth generation of mobile telecommunications technology, based on a set of standards used for mobile devices and infrastructure.
ATM	Asynchronous Transfer Mode
BRAND	Canada's Broadband Rural and Northern Development Project
DSL	Digital Subscriber Line
FTTx	Fiber to the home/premise/building/node/curb/cabinet
GDP	Gross Domestic Product
Gbps	Gigabits per second
IP-MPLS	Internet Protocol Multi-Protocol Label Switching
ICT	Information and Communications Technology
IRU	Indefeasible Rights of Use
ISAM	Intelligent Service Access Manager
ITU	International Telecommunications Union
LDC	Least Developed Country, as defined by United Nations indicators
LMR	Land Mobile Radio
LTE	Long Term Evolution
Mbps	Megabits per second
MHz	Megahertz
MNO	Mobile Network Operator
MVNE	Mobile Virtual Network Enabler
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development
OTN	Optical Network Terminal
P2P	Point to Point Communications
PMR	Professional Mobile Radio
POA	Points of Access
PON	Passive Optical Network
PSS	Photonic Service Switch
PVC	Permanent Virtual Circuits
RBI	Rural Broadband Initiative
Tbps	Tetrabits per second
TCCA	TETRA & Critical Communications Association
UFBLTE	Long Term Evolution
VDSL2	Very-high-bit-rate digital subscriber line 2
VLAN	Virtual Local Area Network
VPN	Virtual Private Network

Sources

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