After the closing of the Alcatel Lucent transaction, we have five business groups: Mobile Networks, Fixed Networks, IP/Optical Networks and Applications & Analytics (the Networks business); and Nokia Technologies. This section presents an overview of the Networks business and the Nokia Technologies business group.
Networks business in 2016

Our Networks business is conducted through its four business groups: Mobile Networks, Fixed Networks, IP/Optical Networks and Applications & Analytics.

Market overview

Through our comprehensive, end-to-end portfolio of products and services, we are addressing a market described as “network and IP infrastructure, software, and related services”. This market encompasses mobile network infrastructure, fixed network infrastructure, IP routing and optical networks as well as the software platforms and applications to optimize operations, business, network performance, and customer experience. While the majority of our products and services are targeted at telecommunications operators, an increasing focus is on the public sector and large scale enterprises, including webscale players and industry verticals.

Demand for our portfolio is driven by the increasing global demand for bandwidth and network capacity as people’s lives and enterprises become ever more digitized. Data-rich websites, Cloud-based applications and services, and video usage are ever more pervasive, and enterprises are increasingly digitalizing their processes and value chains. Furthermore, we see a convergence of disparate network technologies—across mobile, fixed, and IP and optical—enhancing network performance and profitability, as well as simplifying end-to-end networking services. In a similar manner, telecommunications and IT domains are increasingly converging, as networks become more virtual, managed through software applications and platforms via the Cloud. This includes software decoupled from hardware, open-source ecosystems leveraging APIs, as well as more of the intelligence moving from the core to the edges of the network to increase efficiency and decrease latency. As the only player that offers an integrated end-to-end portfolio on a global scale, we have a strong competitive position to capitalize on these opportunities.

Business overview and organization

Our Networks business is conducted through four business groups: Mobile Networks, Fixed Networks, IP/Optical Networks and Applications & Analytics. These business groups bring together deep expertise and leadership that span the key network technology areas: smart products and innovative services for mobile, fixed and IP networks, and beyond.
Mobile Networks

High-quality, reliable mobile broadband.

The Mobile Networks business group offers an industry-leading portfolio of end-to-end mobile networking solutions comprising hardware, software, and services for telecommunications operators, enterprises and related markets/verticals such as public safety and IoT. The product portfolio includes macro radio access network (“RAN”) offerings for mobile data and voice communication using existing 2G, 3G and LTE technology, as well as evolution to the future 5G standard. Mobile Networks also brings to market a comprehensive Converged Core offering, including market-leading Subscriber Data Management and IP Multimedia Subsystem solutions, enabling all-IP communication, including Voice over LTE (“VoLTE”). The product portfolio includes small cell access as well as back haul and front haul (x-haul) solutions. Additionally, a strong Services organization within Mobile Networks supports customers with the design, deployment, optimization, operation and maintenance of mobile networks, adding value to customers through the breadth, quality, efficiency and innovation of its services across five business areas: Network Planning & Optimization, Network Implementation, Systems Integration, Managed Services and Care.
Fixed Networks
More bandwidth to more users, sooner.

The Fixed Networks business group provides copper and fiber access products, solutions and services to deliver more bandwidth to more people, faster and in a cost-efficient way. The portfolio allows for a customized combination of technologies that brings fiber to the most economical point for the customer. It consists of advanced copper based solutions such as very high rate digital subscriber line ("VDSL2"), and innovative vectoring technology to reduce cross-talk interference and improve performance. The Fixed Networks business group is leading in the development of next-generation copper technologies, such as Vplus and G.fast, allowing for even greater bandwidth to the home. The Fixed Networks business group is also developing fiber to the home solutions, such as Gigabit Passive Optical Networks ("GPON") and leading in next-generation fiber access technologies like TWDM-PON. Additionally, digital home devices enable an enriched customer experience and smart homes. The service portfolio is comprised of deployment, maintenance and professional services such as copper and fiber broadband evolution, public switched telephone network transformation, site implementation and outside plant, as well as multi-vendor maintenance.
The IP/Optical Networks business group provides the key IP routing and optical transport systems, software and services to build high capacity network infrastructure for the internet and global connectivity. IP routers understand the global patterns of both the internet, private IP and Multiprotocol Label Switching (“MPLS”) services and intelligently route packets to the right locations. The transformation to all-IP architectures is driving demand for increasingly high capacity switching and routing. The IP/Optical Networks business group provides IP networking solutions for advanced residential, business and mobile services spanning the IP core, IP edge, mobile packet core, wireless backhaul and IP/Ethernet metro and aggregation. Furthermore, the IP/Optical Networks business group provides scalable, versatile and dynamic packet-optimized and optical transport solutions to maximize bandwidth, distance and resilience over long-haul, regional and metropolitan fiber infrastructure. Wavelength Division Multiplexing and wavelength routing are the predominant optical technologies, allowing for high data capacity by multiplexing many wavelengths over each fiber and programmability by dynamically routing wavelengths across the network. The IP and optical solutions are controlled and managed by carrier SDN and Network Management Systems that enable dynamic networking services and resource optimization over the programmable IP and optical fabric. To make the network as readily consumable and efficient as Cloud computing and storage is to IT applications, Nuage Networks offers automation and policy-based control of datacenter and branch network resources. Across all these offerings, a comprehensive service portfolio supports customers to deploy, maintain and optimize network design to accelerate the benefits of SDN, NFV, and programmable all-IP networks.
Applications & Analytics

Intelligent platforms that optimize and automate network performance.

The Applications & Analytics business group offers carrier-grade software applications and platforms to provide operations and business support systems, build, deliver, and optimize services, enable their monetization, and to improve customer experience. These include:

- customer and network operations software, such as device management and multi-channel customer care with orchestration workflows and service assurance;
- network management and self-organizing networks solutions for multi-vendor network management, and automation to optimize network performance;
- communication and collaboration solutions, including Cloud-based platforms, for integrated contextual communications services targeted at operator and enterprise customers;
- policy and charging solutions for implementing payment plans and policies;
- analytics solutions and algorithms to improve business performance by maximizing the value of subscriber and network data;
- comprehensive, automated, and predictive security solutions to defend networks, services, end-users and IoT devices against malicious attacks;
- IoT platforms to develop, deliver, manage and monetize services and ecosystems;
- CloudBand Cloud management and orchestration solutions enabling a unified Cloud engine and platform for NFV.

Additionally, the Networks business organization has two integral parts, Bell Labs and Services, which each provide support to our four business groups.
Bell Labs
Creating the technologies shaping the future of connectivity.

Bell Labs, our research arm, produces disruptive innovations for the next phase of human existence. This human challenge has been the charter for Bell Labs for 90 years and led to a wealth of industry redefining innovations, eight Nobel Prizes and countless other honors.
Business overview

Services

Our Services are focused on developing innovative services, solutions and multi-vendor capabilities around the mobile, fixed and IP networks and beyond. With our full service portfolio, we address the current and future needs of our customers, including mobile network operators, enterprises, governments, transportation industries and verticals. Customer satisfaction, quality and efficiency are key in service delivery. To achieve that, we leverage a combination of local engagement with the customers, the network of two Global Delivery Centers and eight Service Delivery Hubs as well as the next-generation delivery platforms. Altogether, our service portfolio and delivery are powered by 40,000 services experts around the globe.

Sales and marketing

The Customer Operations (“CO”) organization is responsible for sales and account management across the four network-oriented business groups. The teams are active in approximately 130 countries. They ensure that we are close to our customers, both physically and in terms of understanding the local markets, and help us build and maintain our customer relationships.

As the CO organization is divided into seven markets which are presented below. This structure is targeted at allowing us to gain speed and efficiency in dealing with customer requirements while preserving existing customer relationships.

- Asia-Pacific and Japan spans a varied geographical scope, ranging from advanced telecommunications markets, such as Japan and the Republic of Korea, to developing markets including Bangladesh, Myanmar and Vietnam. We work with leading operators in the market, including Indosat, KDDI, KT, LG Uplus, NBN Australia, NTT DoCoMo, Singtel, SK Broadband, SK Telecom, Smartfren, SoftBank, Spark, StarHub, Telekom Malaysia, Telkom Indonesia, Telkomsel, VNPT and Vodafone. We have close technology cooperation with leading operators in Korea and Japan as well as two Service Delivery Hubs in Japan and Indonesia.

XG-FAST for multi-gigabit speeds over existing phone lines

We recently worked with Deutsche Telekom to test XG-FAST, an extension of our commercially available G.fast technology developed by Bell Labs. The lab trial showed speeds of over 10 Gbps, around 200 times faster than today’s average residential broadband connections. With these fiber-like speeds, the technology can download a two-hour HD movie in less than ten seconds.
In **Europe**, we are engaged with all the major operators, including Deutsche Telekom, MegaFon, MTS Sistema, Orange, Telefónica, TeliaSonera and Vodafone Group, serving millions of customers. We have extensive R&D expertise in Europe, and some of our largest Technology Centers, which are working on future mobile broadband technologies, are based in this market. We also have a Global Delivery Center and four regional Service Delivery Hubs in Europe.

In **Greater China**, we are the number one player with headquarters outside China, and working with all the operators including China Mobile, China Telecom, China Tower and China Unicom. We also have extended our market presence to the public and enterprise sectors including railways and public security. In Taiwan, we work with all major operators including Chunghwa Telecom and Taiwan Mobile. In China, we have five Technology Centers, one regional Service Delivery Hub as well as offices spread over 40 mega cities and provinces.

In **India**, we are a strong supplier and service provider to the leading public and private operators. We have a Global Delivery Center, a Service Delivery Hub and a Global Technology Center in India.

In **Latin America**, less than 10% of the population use LTE services, and high speed fixed broadband is still in its early phase. With an aim of providing broadband services to the population of over 600 million people in the area, we supply ultra-competitive solutions to all major operators, América Móvil, AT&T, Oi, Telefónica, Telmex and Tim in the region, as well as local operator groups such as Avantel, Milicom, Nuevatel and Personal.

In the **Middle East and Africa** we have built a position of considerable strength, with our work alongside leading operators such as Airtel, du, Etisalat, Maroc Telecom, Mobil, MTN, Ooredoo, Orange, O2A Djezzy, Smile, STC, Telkom, Vodacom and Zain among our key customers in the market.

In **North America**, we count all the major operators as key customers. We also deliver advanced IP networking, ultra-broadband access, and Cloud technology solutions to a wide range of customers, including local service providers, cable operators, large enterprises, state and local governments, utilities, and many others. North America is also home to the company’s most important and thriving innovation practices—from the renowned Bell Labs headquarters in Murray Hill, New Jersey, to our development labs in Silicon Valley.

**TWDM-PON powers the first 10-gigabit community in the United States**

EPB Fiber Optics, Chattanooga’s municipal utility, launched the world’s first community-wide 10-gigabit internet service. This is powered by our TWDM-PON fiber technology, which uses many wavelengths to provide more capacity, and is available to every home and business in EPB’s service area.
Research and development

The Chief Innovation and Operating Office ("CIOO") is responsible for innovation steering in Nokia. Within the CIOO, the Chief Technology Office ("CTO") and Bell Labs organization are responsible for our research agenda and research portfolio. The CIOO develops disruptive technologies, incubates these technologies into novel prototype systems and solutions and then launches these via the business groups to generate growth and differentiation across our entire portfolio. The CIOO organization also steers innovation externally with customers, partners and governments, and has new solutions trialed in collaboration with customers and our business groups.

The four networks-oriented business groups are responsible for the product R&D within the Networks business.

The Networks business has a global network of Technology Centers, each with individual technology and competence specialties. These Technology Centers are located in China, Finland, France, Germany, India, the Philippines and the United States, among others.

We believe that the geographical diversity of our R&D network is an important competitive advantage for us. In addition, the ecosystem around each R&D site helps us to connect with experts on a global scale, and our R&D network is complemented by cooperation with universities and other research facilities.

As a result of its investments in R&D, our Networks business is one of the largest R&D investors in the telecommunications industry. We expect these capabilities to enable it to continue to drive innovation in the dynamic telecommunications sector, where product development constantly needs to improve in speed and efficiency in order to help operators cope with increasing subscriber demands and exponential data traffic growth.

Nokia Networks has a joint venture, TD Tech Communication Technologies Ltd., for development and manufacturing of TD-SCDMA and LTE technologies and related products in Beijing, Shanghai and Chengdu, China. The joint venture has supported the growth of our market position in China, and demonstrates that this partnering has been of great mutual benefit for both enterprises. Mutual customization of the most commoditized part of the portfolio allows Nokia to focus on lowering costs while producing a higher value offering.

Bell Labs, our research arm, focuses its research on key scientific, technological, engineering or mathematical areas, which require fundamental improvement in one or more dimensions, and combines these areas of research into so-called “Future X” solutions. These innovations are brought to the market through Nokia’s business groups or through technology and patent licensing. Bell Labs also engages directly with the market and customers through Bell Labs consulting.

Bell Labs’ successes over the last 90 years have been recognized with eight Nobel Prizes and many other honors, including National Medals of Science and Engineering, the Turing Prize, and the Japan Prize.
Networks business in 2016 continued

“We have a global network of Technology Centers, each with individual technology and competence specialties.”

Patents and licenses

Intellectual property assets are fundamental to Nokia, which now controls three distinct IP portfolios: the Nokia Networks, Alcatel Lucent and Nokia Technologies portfolios. The first two are of particular relevance to the Networks business. For information on the Nokia Technologies patent portfolio please refer to “Business Overview—Nokia Technologies—Patents and Licenses”.

The Nokia Networks portfolio includes around 3,700 patent families, comprising approximately 10,000 individual patents and patent applications, built on its work as an industry leader in R&D of wireless, broadband, and transport technologies.

The Alcatel Lucent portfolio includes around 17,500 patent families, comprising approximately 47,000 individual patents and patent applications, built from the wide-ranging R&D activities of Alcatel Lucent, including Bell Labs, in fields such as wireless, IP networking, ultra-broadband access, and Cloud technologies, and applications.

Nokia’s IPR portfolios include high-quality standard-essential patents (“SEPs”) and patent applications which have been declared to the European Telecommunications Standards Institute and other standards developing organizations as essential to standards including LTE, WCDMA, GSM, and other standards. In addition, we hold copyright registrations relating to certain aspects of our products and services. We continue to drive new patent generation from R&D activities across our businesses and seek to safeguard our investments in technology through appropriate protection.

We receive and pay patent license royalties in the ordinary course of business based on existing agreements with telecommunications vendors and other third parties. We have a number of patent license agreements in place with other major companies and patent holders, and these provide us with freedom to operate with limited risk of infringing SEPs owned by others.

Competition

At present, we consider Cisco, Ericsson, Huawei and ZTE to be our main competitors in the operator infrastructure business. We also compete with technology-focused companies such as Adtran (fixed access networks), Ciena (optical network equipment) and Juniper (routing). Additionally, we consider Amdocs, IBM, Oracle and other IT companies as our competitors in the Applications & Analytics domain.

400Gbps over existing fiber network

Alcatel Lucent, now part of Nokia, and Vodafone Spain trialed transporting data at speeds of up to 400Gbps over 400km between Madrid and Zaragoza, using existing optical infrastructure.

The trial used Alcatel Lucent’s 400G technology and showed that an existing optical network can carry data at up to 17.6Tbps, doubling the current speed of fiber. It’s the equivalent of transmitting the contents of 88 Blu-ray discs in a single second, while reducing power and space consumption by half.