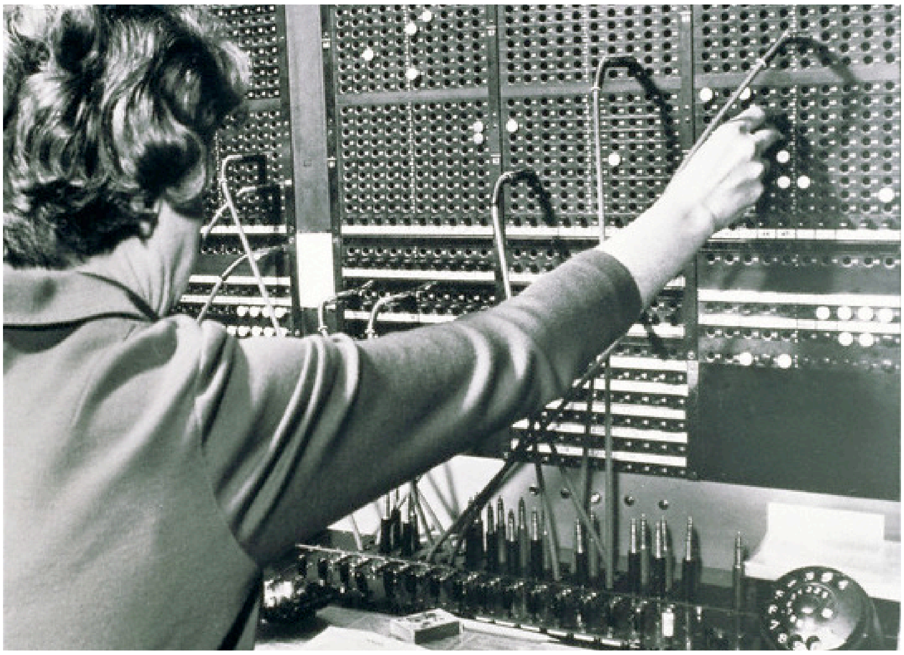
Network modernization

From telephony to IP

Executive summary

This white paper outlines the history of the communication network. Previously the network was used solely for the transfer of voice. Since the advent of the computer in the seventies, network capacity is also needed to transfer data. The need for data transmission capacity increased with the evolution of computers, operating systems and applications. The traditional copper technologies no longer suffice and make place for a fiber network with an all IP platform.

Enjoy reading



Moving from **Telephony as a Service** to **Voice over IP**

The RTT of yore had one specialty: telephony. Actually, it was telephony as a service. The RTT owned the complete infrastructure, maintained it and offered customers a line, a telephone set and associated services. The only thing the customer had to do was make phone calls, and pay the bill at the end of the month.

To offer this service, there was a dedicated infrastructure. A huge telephone switch, that required an entire building, was placed at the center of a town. Customers were connected via a star-shaped network of copper cables, with one pair of wires per telephone. The switches were in turn interconnected in loops or some kind of hierarchy.

Today things have changed. We can centralize the switching intelligence in one location, with, of course, a high level of redundancy and capacity. This implies that we need a place in a datacenter, which is smaller than the individual telephone switches of the past. The buildings where the switches were located have become obsolete and redundant. These buildings are all given new assignments. Some are or will be dismantled, while others are converted into residential buildings with apartments, shops, etc.

The copper lines have been reduced in length. ROPs (our abbreviation for Remote Optical Platforms) have been installed in “the last mile” to the customer. In these ROPs we have a DSL concentrator to concentrate customer lines in a multiplexer, which is then connected with fiber to our backbone. The analog phone is connected to the DSL modem, where analog voice is turned into Voice over IP. (X km of fiber).

Moving from **leased lines** to the **Internet**

1970 | **Telex Machine**
ISDN
Leased Lines

50 bps > 64 Kbps

Since the advent of the computer in the seventies the need for data transmission capacity has only increased. New technologies were developed to transfer more data faster and with fewer errors via the network.

‘70s: Telex Machine, ISDN & Leased Lines

The precursor was the telex machine, or “teletypewriter”, where special typewriters were interconnected via copper lines and some telex switches in the network. They used to work at 50 bit/s. Later came the computers and the associated modems. Technology in the ’70s allowed a speed of 200 bit/s over the switched network or over “leased lines”. These leased lines were copper wires which were directly connected together from endpoint to endpoint. Speeds increased over time from 1.2 to 64 Kbps.

As the analog transmission technology had poor quality (high Bit Error Rate, BER), we needed some communication protocols capable of recognizing, intercepting and correcting transmission errors. CCITT (now called ITU) standardized the X.25 protocol. The American government opted for TCP/IP. X.25 allowed the interconnection of computers via a network with the same design as that for voice.

1980 | **Frame Relay**

1990 - . . . | **ATM**
ADSL Internet
VDSL Internet

64 Kpbs > 2 Mbps

2 Mbps > 70 Mbps

At the same time, ISDN (Integrated Services Digital Network) was developed. This would allow the digital transmission of voice at a speed of 64 Kbps. The telephone network and the associated backbone became digitized. So, we still kept the same infrastructure of copper and buildings but offered a flawless voice quality, which was defined as “being able to understand what the other party is saying and of recognizing the speaker through his voice”. The best voice codec was using 64 Kbps. As ISDN allowed 64 Kbps on digital signaling, it soon ended up replacing the analog modems.

‘80s: Frame Relay

With the improvement of the transmission technology came higher transmission quality (lower BER) and speed improvements. X.25 became too slow and too complex, and was therefore replaced by a new technology at the end of the ’80s: Frame Relay, which supported speeds between 64 Kbps and 2 Mbps.

‘90s: ATM, ADSL & VDSL Internet

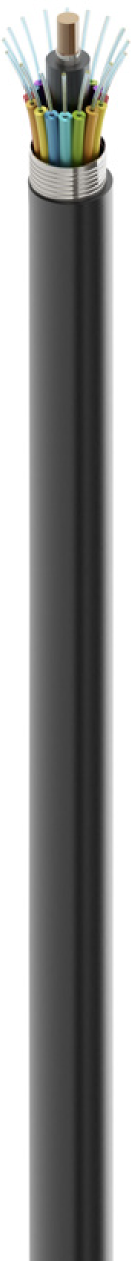
This communication protocol was replaced 10 years later by ATM (Asynchronous Transfer Mode), which was faster and allowed speeds from 2 Mbps up to multiple tens of Mbps.

It was also in the ’90s that the Internet really started to take off and leave the world of research and education to move into the business and general public spheres. On top of their existing infrastructure (copper lines, fibers, digital backbones), operators installed IP routers and ADSL (Asymmetric Digital Subscriber Line, ± 10 Mbps down, 1 Mbps up). The internet was born.

Soon several versions followed, each time increasing the speed further: ADSL2 (12/3 Mbps), Very-high-bit-rate digital subscriber line (VDSL, 55/3 Mbps) and VDSL2 (max. 70/15 Mbps).

1 Gbps

Moving from **copper wire** to **fibre**



1 Tbps

The limits of copper

Meanwhile, computers, operating systems and applications continued to evolve to the versions we are familiar with today. It is simple for current computers to multitask: videoconferencing with a laptop is now a minimum characteristic, as is having Gbytes of RAM and nearly 1 Terabyte of disk capacity. Users are able to exchange heavy files and images between computers and servers almost instantaneously within a same building over a LAN, with Ethernet connectivity of 100 Mbps over cable or 300 Mbps over WLAN.

Users expect to be able to do the same between sites as what can be done within one site. In other words, they expect high capacity between sites, so they can access all their data with any given application, whether working from another site or at home. Datacenters, the point where all company traffic converges, require Gbps connectivity. All datacenters are being connected over fiber, since current technology does not yet make it possible to reach such speeds over copper.

Copper has reached its technological limits. In some places the cables and wires have suffered from water infiltration, road works, multiple repairs, so that they have reached their end of life and need to be replaced. One of the technological issues is that the Bit Error Rate needs to be lowered. Every faulty bit means data retransmissions and increased transfer delays. The technology in the modem can only compensate for this to a limited extent. If we want to implement smooth transmissions, we need to migrate to fiber.

The advantages of fibre

Fiber easily supports speeds up to 10 Gbps and 100 Gbps. The first experiments to go to 1 Tbps have been successful. Today we have already implemented fiber to the curb. Our fiber goes into the ROP, from where we take it onward with copper. In industrial areas we install fiber to the building. There are already more than 700 zonings. The next step is the deployment of fiber to the home. This is a multi-year (multi-decade) project, as we need to connect 4 million homes and open all the roads and streets to cover the last mile.

Mobile technology

Moving from **the Internet** to **ubiquitous Internet** (and broadband)

1990s | **2G**

In parallel with all this, there was the advent of mobile technology. More than 20 years ago, Proximus started with mobile voice, known as 2G. This delivered adequate voice quality. GPRS was added later; it supported 114 Kbps and EDGE (384 Kbps).

114 Kbps > 384 Kbps

2000s | **3G**

3G
Proximus

The ever-increasing capabilities of smartphones was accompanied by an increasing demand for mobile data bandwidth. 3G was introduced around the year 2000, supporting up to 7.2 Mbps in the downlink.

7.2 Mbps

2010 | **4G**

4G
Proximus

4G arrived around 2010 with 300 Mbps downlink.

300 Mbps

2020 | **5G**

5G
Proximus

5G is expected in around 2020 and will support mobile speeds of 5 Gbps.

5 Gbps

Shared Bandwith

What is happening here is that the mobile world is going to match fiber in speed. Wow, does that mean that we no longer require fiber? Nope, the mobile world has a “shared bandwidth” concept, meaning that every antenna can cater for a limited amount of data. One user can have it all if he or she is the sole user. 10 simultaneous users get 10%; 100 simultaneous users get 1% of that same capacity. And transmissions still go “over the air” and therefore have a high BER. Fiber is dedicated and has a very low BER. It is still the only alternative for interconnecting buildings to deliver high-quality capacity.

The future of ICT

1980 | **The IBM era**

1990 | **The DELL era**

Moving from **mainframes** to **the Internet of Things**

Computers migrated from mainframes (the IBM era) to PCs (the Dell era) to smartphones and tablets (the Apple and Samsung era), and are now migrating to smart watches and wearables, as well as to intelligent things.

Computing power is now distributed all over our bodies and our everyday environments. Everything is connected and exchanging information all the time.

Just as our office working largely depends on computers now, so our future lives will be reliant on them: driving home will depend on computers (intelligent cars, intelligent infrastructure), as will our home living (domotics).

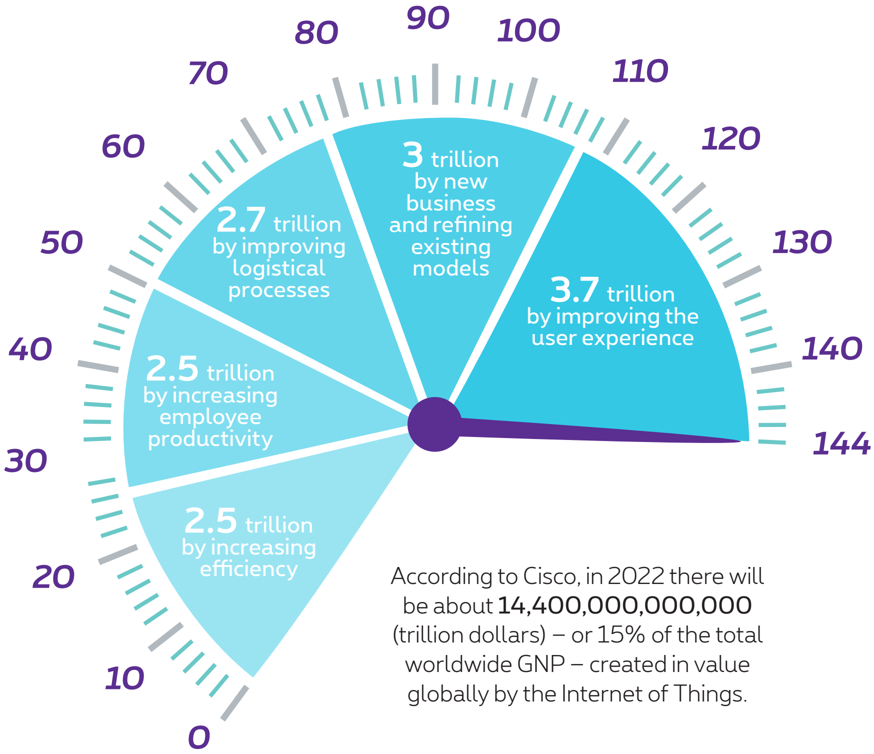
E-commerce is growing and will continue to grow further. Today, e-commerce is the digital equivalent of how we shop in physical shops. In the future, our smartphone (or wearables) will recognize our moods and automatically buy goods and services deemed to be the best match at that moment (for instance music or movies). Businesses will automatically capture the information on traction from their customers and have processes adapting to these trends. Things will generate a continuous stream of data, requiring businesses to react immediately to external events.

We are moving towards a network economy, where events in one part of it impact the whole. For example, a saturated highway may trigger several events (change of digital signage information to drivers, messages sent to radio stations, messages sent to tourist destinations, more capacity activated on the mobile network, etc.). This network economy is a real-time, instant economy, based on ICT offering unlimited capacities, being always on and providing zero delays.

2000 | **The Apple and Samsung era**

2015 | **Wearables**

2020 | Internet of Things



According to Cisco, in 2022 there will be about 14,400,000,000,000 (trillion dollars) – or 15% of the total worldwide GNP – created in value globally by the Internet of Things.

Added value of IoT

The five main drivers of the added value of IoT:

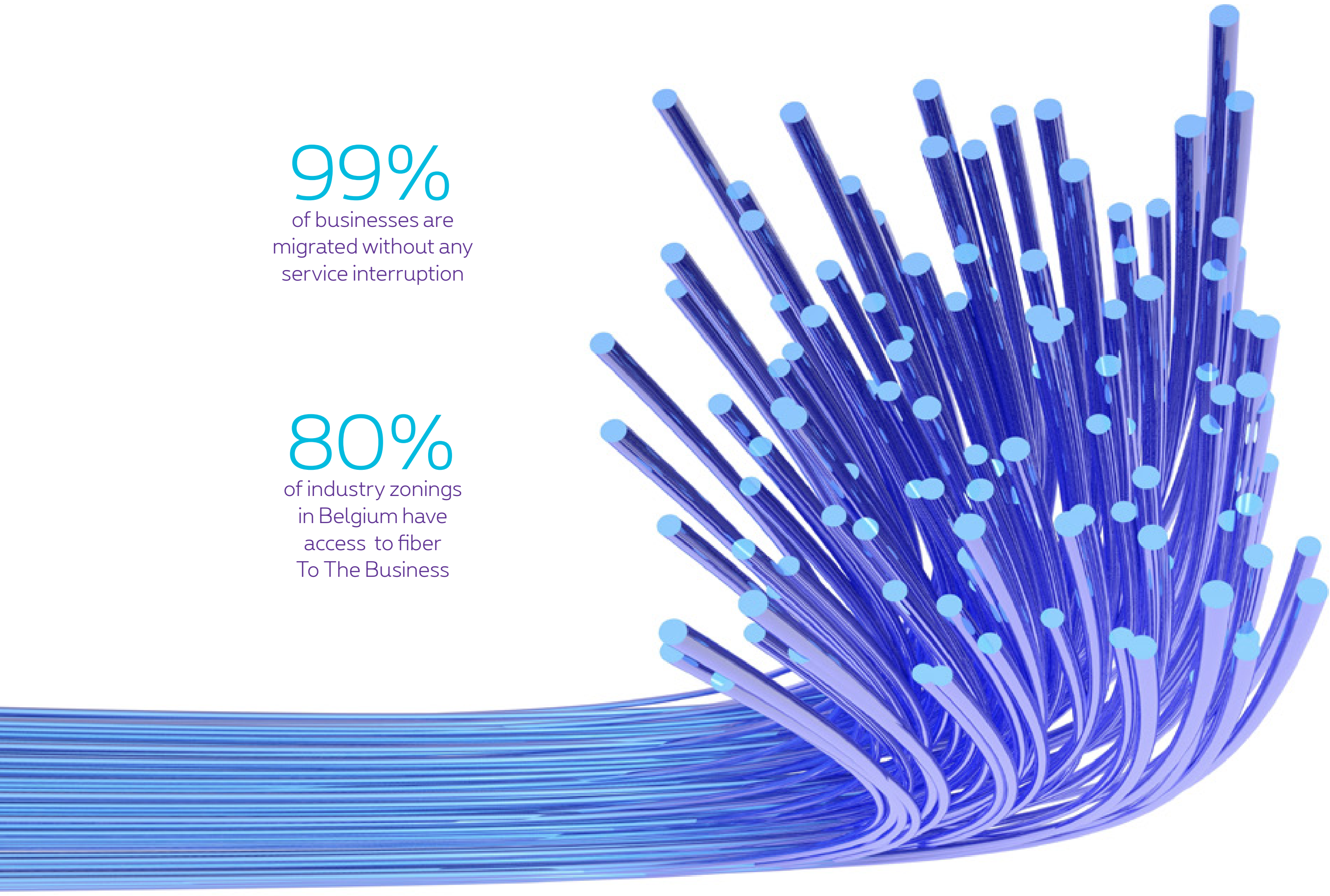
1. **Efficiency ($2.5 trillion)**
   IoT reduces selling, general, and administrative expenses and cost of goods sold by improving business process execution and capital efficiency.
2. **Employee productivity ($2.5 trillion)**
   IoT creates labor efficiencies that result in fewer or more productive man-hours.
3. **Logistical processes ($2.7 trillion)**
   IoT eliminates waste and improves process efficiencies.
4. **New business and refining existing models ($3.0 trillion)**
   IoT increases the return on investments, reduces time to market, and creates additional revenue streams from new business models and opportunities.
5. **User experience ($3.7 trillion)**
   IoT increases customer lifetime value and grows market share by adding more customers.

99%

of businesses are migrated without any service interruption

80%

of industry zonings in Belgium have access to fiber To The Business



Network simplification towards fiber

Our goal is to get everyone connected to fiber, as it is the only technology today offering low Bit Error Rates combined with capacities to individual users. Fiber allows us to connect people and businesses with Ethernet technology (1 Gbps and low cost), such that we can offer businesses "switched Ethernet" services: multisite connectivity with LAN characteristics: low delay and gigabit speeds. Fiber is also used as the backbone for the mobile network.

As we stated earlier, fiber has been present in our network for several decades now. We first started to use it in our backbone. We subsequently started deploying fiber to the curb in our Remote Optical Platforms. The last mile is still in copper. We have now started a massive deployment of fiber to the building. More than 80% of the industrial zonings in Belgium already have fiber allowing companies in these locations to get fiber right to their doorstep. Fiber to residential homes has started, but will take many years The traditional copper technologies are being migrated to a full IP platform. This is happening via technology outphasing (ATM/X25), switching outphasing (EWSD, S12) and finally building outphasing.

Today, 99% of businesses are migrated without any service interruption or interventions, as everything happens within our reach. Only 1% of businesses need an intervention on their premises. In these cases we install converters to connect the existing infrastructure to fiber. For example, a PABX with an ISDN connection will be connected to fiber via a small box and ISDN BA via an IAD (Internet Access Device). The price is the same but the service offered is much more stable and future-proof.

This huge network re-engineering project is also an opportunity for our customers, on the advice of our consultants, to rethink and redesign their own network to face today's challenges.

Conclusion

We have a strategy where we want to bring zero-delay broadband to every single square meter of Belgium with mobile and fiber. With LoRa we deliver zero-delay smallband for the Internet of Things. These capabilities are secured and managed to guarantee high availability.For organizations we bring connectivity with additional services. Our consulting services allow you to redesign your network, to take maximum advantage of our ubiquitous broadband strategy. Our managed services enable you to solve non-Proximus network-related issues (e.g. software issues, security issues, end-of-life products, configuration issues, etc.), in turn ensuring the highest levels of service availability to your customers. Our baseline is “always close”. Our networks allow permanent closeness between your organization and your customers.

More info

Proximus is your trusted partner for the management of a secure and always available network. Surf to **www.proximus.be** or contact your account manager.

Proximus PLC under Belgian Public Law, Bd. du Roi Albert II 27, B-1030 Brussels, Belgium
VAT BE 0202.239.951, Brussels Register of Legal Entities, Giro BE50 0001 7100 3118 BPOTBEB1