



Copper switch off: Opportunity to drive infrastructure convergence?

How to successfully manage the migration from copper to future-proof technologies

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Authors:



Dr. Karim Taga

Managing Partner &
Global Practice Leader
TIME*, Vienna
taga.karim@adlittle.com



Glen Peres

Manager
TIME, Vienna
peres.glen@adlittle.com



Martin Hanuska

Manager
TIME, Vienna
hanuska.martin@adlittle.com



Antonio Sangiovanni

Manager
TIME, Rome
sangiovanni.antonio@adlittle.com

*TIME: Telecommunications, Information Technology, Media & Electronics

Executive summary

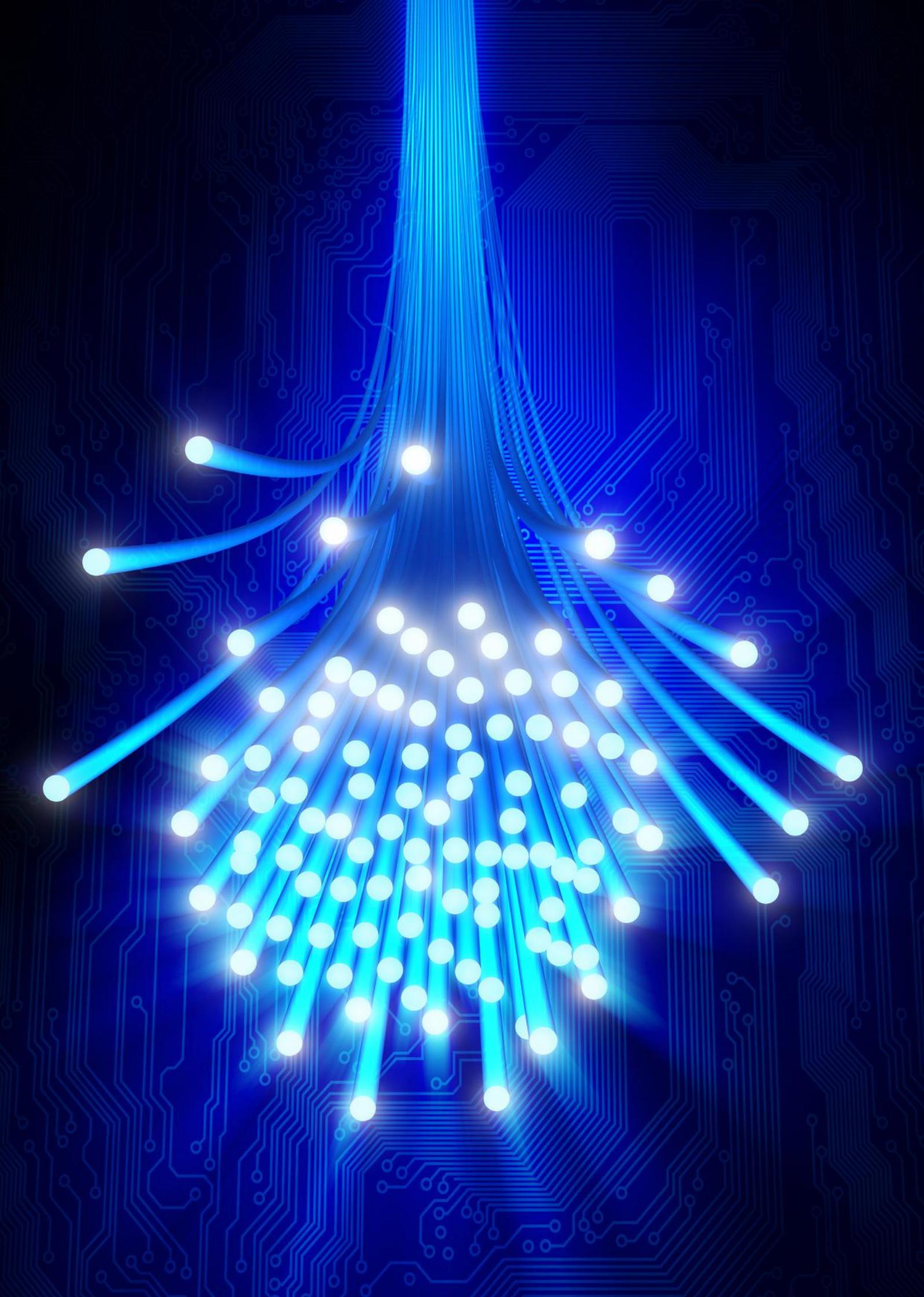
Copper switch off is on the agenda of most incumbents around the world. In Europe, for example, fiber rollout continues to gain steam, with more than 100 million homes in EU28 already having access to fiber-to-the-home (FTTH) broadband, while the share of legacy copper-based broadband connections continues to decline.¹ Mobile-based broadband solutions are seen as a valid challenger to legacy copper-based products as well, eating into areas with a “copper-only” footprint.

The main driver to decommission legacy copper networks is not only to save costs on running an expensive, energy-hungry, operationally inefficient legacy technology but also to free up capital and resources to be redeployed to focus on delivering gigabit broadband with the most efficient future-proof technologies – namely fiber, 5G, and others.

While there is general agreement that copper needs to be switched off, challenges still remain, including decisions like when to start switching off the legacy network; how to manage the various stakeholders, including the regulator, municipalities, wholesale, and retail customers; and how to manage the migration process to ensure churn minimization while also enhancing customer experience and customer value.

In this Report, we assess the main issues that operators face in managing the legacy copper network switch-off processes and highlight key success factors from operators successfully implementing the switch off of copper and migration to fiber and other technologies.

¹ Source: “FTTH Forecast for Europe – Market Forecasts 2021–2026.” FTTH Council Europe, 15 September 2021.

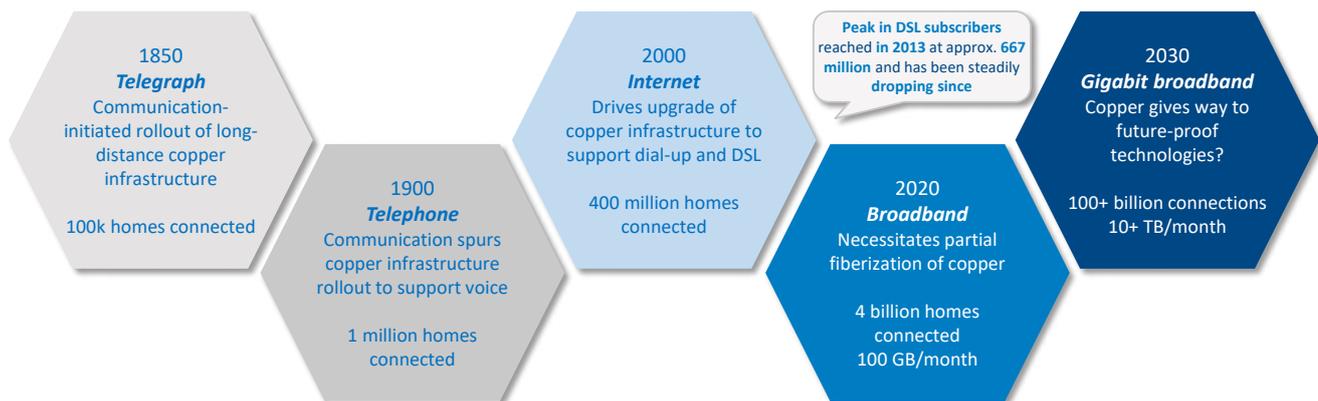


1. Copper: A 150-year legacy

The first copper networks in the world were rolled out more than 150 years ago with the advent of telegraph communication (see Figure 1). Pioneered by the Morse code, coverage had reached more than 100k connections in 1850. Accelerated by Alexander Graham Bell’s invention of the telephone, copper networks were upgraded to support fixed voice services and served more than a million connections at the turn of the 19th century.

The same copper networks continued to evolve to support dial-up and DSL-based Internet services with the advent of the World Wide Web in the 1990s, which served 400 million users at the turn of the 20th century. Today, with more than 8 billion users and an estimated 4 billion homes connected to the Internet, and with each household consuming more than 100 GB/month of data, it is finally time for copper-based networks to give way to more efficient and future-proof infrastructure so that the network can continue to deliver exponential growth in data.

Figure 1: The copper network legacy



Source: Arthur D. Little analysis

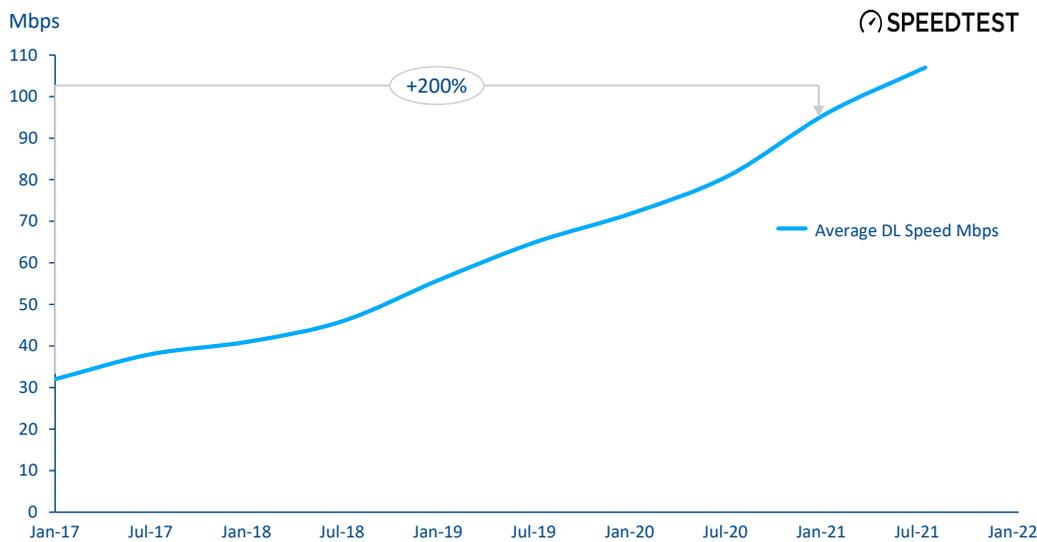
2. Demand for gigabit broadband continues to increase

Demand for high-speed fixed broadband continues to increase. In fact, Ookla Speedtest's Global Index reports that the average global download speed per home reached 110 Mbps in July 2021, increasing 200% during the last three years (see Figure 2).² The Index also shows that more than 50 countries already have achieved an average speed of more than 100 Mbps per home as of July 2021.

The COVID-19-fueled necessity of home office, home schooling, and home entertainment will continue to drive the need not just for higher speeds, but also for lower latency and increased data volume consumption driven by increased use of video calls, cloud services, and media.³

While legacy copper networks can still deliver speeds in the range of 100 Mbps, they do so inefficiently and with high costs, high energy consumption, and constraints like short local loop lengths (just a few hundred meters of copper wires, on average) and higher fault rates. As speeds continue to increase, legacy copper networks either will be unable to keep up or only able to do so at a much higher cost than alternative fiber-based technologies.

Figure 2: Need for higher bandwidth speeds continues to increase



Source: Arthur D. Little analysis, Ookla Speedtest Global Index

² Source: Speedtest Global Index.

³ Source: Eagar, Rick, et al. "Leading Business Through the COVID-19 Crisis." Arthur D. Little *Prism* Special Report, 2020.

3. Future-proof technologies deliver gigabit broadband more economically

Fiber is the most attractive future-proof technology to deliver gigabit broadband to homes, as it can constantly evolve to deliver futuristic use cases end users' demand. Additionally, fiber presents attractive cost economics in terms of lower total cost of ownership than copper networks, as well as lower energy usage and lower incremental cost of future upgrades.

Copper is expensive to maintain and difficult to operate, with some estimates suggesting that compared to fiber networks, legacy copper network maintenance OPEX is two to seven times higher, energy costs are three to six times higher, and network fault rates are five to 10 times higher.⁴ Additionally, copper-based customers exhibit a churn of 5%-10% points higher than fiber-based customers.⁵ Employing a team of qualified staff to operate copper-based networks is also challenging, as this skill set is no longer freely available in the market. In fact, a European operator commented that

it pays a premium to continue to engage its post-retirement copper engineers on special short-term contracts, just to be able to keep its legacy copper networks running. Increasing environmental consciousness and the corresponding focus to reduce operators' carbon footprint is another reason to dismantle, exchange by exchange, the legacy copper-based infrastructure, rather than just decommissioning parts of the copper network.

In addition to fiber, other mobile-based fixed wireless technologies (FWA) are attractive alternatives for rural broadband solutions, where it is too expensive to roll out fiber to homes. These alternatives incrementally bring fiber closer to the rural communities while using wireless links to allow broadband into users' homes. In many markets, such as Norway, Sweden, and Italy, operators have announced plans to deploy FWA solutions as alternatives to the legacy copper network.

⁴ Source: Taga, Karim, and Glen Peres. "Open Access Fiber." Arthur D. Little, July 2020.

⁵ Source: Ibid.

4. Incumbents are switching off copper

Switching off existing legacy copper networks is on the agenda of most incumbents across the globe. In this section, we share some examples from several regions.

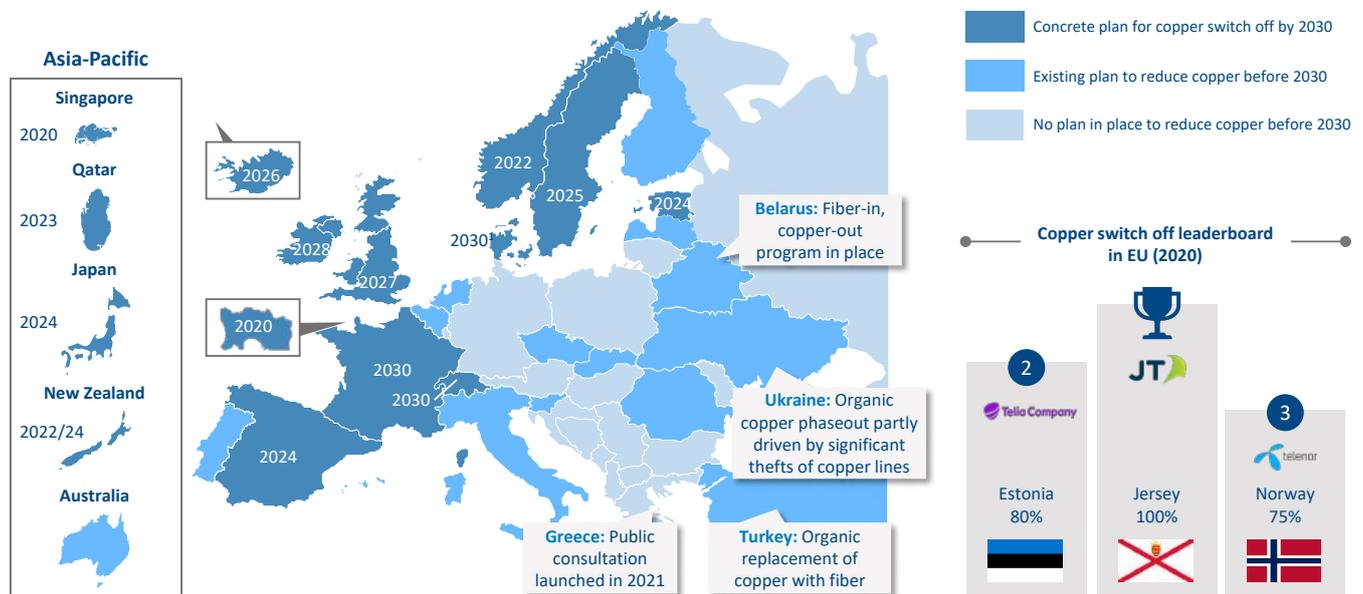
Copper switch off in Europe

In Europe, more than a dozen countries have announced plans to consider copper switch off in the next decade, with a handful of operators successfully implementing copper sunseting projects (see Figure 3). Smaller dynamic markets like Singapore and the island of Jersey have already achieved 100% switch off of their legacy copper networks. Other markets like Norway, Sweden, Spain, Portugal, Estonia, and the Netherlands, among others, have active programs in place to accelerate copper switch off. Markets like France, Italy, the UK, and Switzerland have made announcements regarding copper switch off, but we cannot yet report substantial progress in these regions.

Copper switch off in Asia-Pacific

Chorus New Zealand is aiming to start copper switch off in 2021-2022 (after the COVID-19 pause), synchronized with its ambition to complete full fiber rollout by 2022. Telstra Australia started its copper switch-off program in 2014 as the government-facilitated National Broadband Network (NBN) began fiber rollout. However, due to delays in NBN's fiber rollout, the copper switch-off program was put on hold. As of 2021, Telstra's copper switch-off program is restarting with a detailed list of switch-off dates per municipality being announced for the areas where NBN's fiber is available.

Figure 3: Copper switch off on agenda of many incumbents

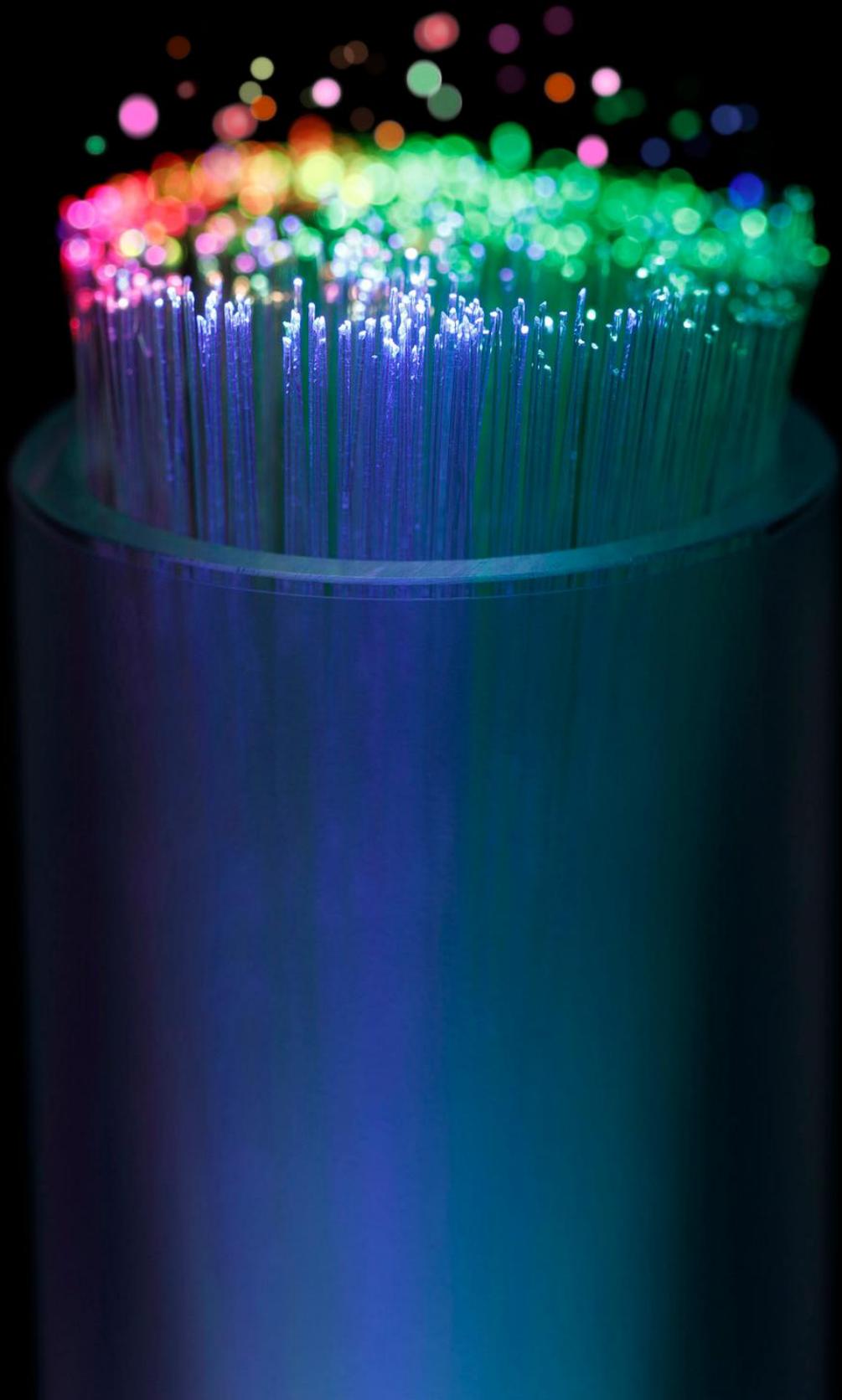


Source: Arthur D. Little analysis, BEREC, Wik-Consult

NTT Japan aims to switch off its legacy copper network by 2024 and migrate all its customers to fiber-based products. The company has already started tests of IP connections on the fiber network. Singapore is one of the leading fiber markets in the world, with full fiber coverage. The incumbent Singtel completely switched off its copper network as of 2020, moving all its customers to fiber-based solutions. Also during 2020, StarHub (Singapore's cable TV network operator) completed cable switch off and migration of its customer base. In Hong Kong, a leading fiber market with FTTH coverage over 90%, copper-based networks still exist in remote villages in rural areas and among the territory's 261 outlying islands. Since 2018, the Hong Kong Special Administrative Region government has implemented a subsidy scheme providing financial incentives to telecommunications operators to extend fiber-based networks to 235 villages in remote areas by 2025–2026, benefiting 110,000 residents. Over half of those networks will be completed by 2022 by PCCW and HKBN. Copper switch off is already completed in 90% of the area with fiber coverage and is expected to be completed in the remaining 10% of rural areas in 2025–2026.

Copper switch off in Middle East/Gulf Cooperation Council

Operators such as Etisalat, du, and Ooredoo in fiber-leading markets like UAE and Qatar have migrated almost all of their customers to FTTH-based products. We estimate that more than 90% of the copper network has already been switched off in those regions and that plans to switch off the remaining 10% will be completed by the end of 2021. Ooredoo has reported that it plans to switch off its copper network completely by 2023. Larger markets like STC in Saudi Arabia still have a fair share of customers on copper-based infrastructure and continue to offer copper-based products to customers.



5. The challenges of copper switch off

While most incumbents agree that copper switch off is on their agenda, many have yet to decide on timing for the switch off. To a large extent, that timing is driven by the different constraints under which they need to manage the switch-off process.

Regulatory constraints

Regulatory constraints are the biggest hurdle to kick-start copper switch off. In many markets, the incumbent must fulfill its significant market player (SMP) obligations of providing universal-access fixed services as well as regulated wholesale services based on its copper network. In many cases, the incumbents' wholesale customers have also co-invested in providing legacy solutions and are unwilling to switch off their networks, making it difficult for the incumbent to switch off the underlying common legacy network.

Most regulators specify a certain notice period (three years, on average) that the incumbent needs to serve its wholesale customers before the incumbent can switch off its networks. In some cases, when alternative wholesale solutions are made available by the incumbent, the notice period can be made shorter (one year, on average).

Handling local municipalities is another big challenge for operators seeking to switch off their networks. Municipalities' buy-in is needed not just to obtain the necessary permissions to switch off the network, but also to potentially expand the network footprint with alternative fiber or FWA-based technologies. Sometimes, uncooperative municipalities can delay an operator's switch-off process by many years.

Migration constraints

Migrating each and every customer from the legacy network to the new network is an enormous planning, communication, and logistical hurdle. There is a high risk of customer churn, but at the same time there is an opportunity to upsell higher-value products to the customer.

Managing the public image during the switch-off process is equally important. Telenor Norway CTO Ingeborg Øfsthus explained that it is not just the 300,000 homes that were successfully migrated during Telenor's switch off that determines the success of migration. It is also the handling of any public relations fallout that might have occurred with the homes that had problems during the migration. The company sought to actively engage with relevant stakeholders and customers and mitigate negative articles in the press and in political circles. At the same time, the company took advantage of the "wow" effect when neighbors saw the "upgraded" product in the home of the legacy customer who was migrated, encouraging neighbors to proactively migrate to new replacement solutions.

Additionally, some B2B customers have equipment onsite closely coupled with the legacy copper infrastructure. Migrating such B2B customers to other technology alternatives requires close coordination between the operator and the B2B customer, the customer's IT department, and, in some cases, the customer's suppliers.

Technology constraints

While fiber is the common infrastructure replacing copper in most cases, it is neither always feasible nor cost-efficient to roll out fiber in rural areas. In such situations, operators must consider other future-ready solutions involving potential mobile technologies to provide viable alternatives to the end customer.

Timing of switch off is another issue closely related to the technology constraint. Switch off can be initiated only after an alternative technology-based solution has been rolled out. Once the alternative network has been rolled out, however, the operator is in the undesirable situation of simultaneously operating two overlapping networks and is burdened with two costs for the same customer base. In that case, it makes even more economical sense to accelerate the switch-off program and decommission the legacy network as soon as possible to avoid redundant costs. Managing the timing of migration to align with the overall fiber rollout and copper switch-off program – and optimizing customer communication during the different phases of rollout and switch off – requires careful planning and execution.

Organizational constraints

Executing copper switch off is a relatively large, multi-year program consisting of multiple projects spread across the entire country, managing multiple local (e.g., municipalities) and national (e.g., vendors) stakeholders, coordinating internal and external communications (including media narrative), and requiring joint effort from cross-functional teams (e.g., fixed and mobile capabilities to deploy FWA solutions). While the copper switch-off program has a lot of synergies with an ongoing fiber rollout program, it still requires a well-defined transformation structure to be put in place for the duration of execution. It is not uncommon for operators to hire temporary specialist staff to handle this transformation.

6. Copper switch off case studies

In this section, we share some recent case studies as examples of what has and has not worked for operators on their migration journeys.

Telenor

Key learning: Constant engagement with stakeholders and willingness to deploy high-quality, mobile-based solutions to ensure replacement of copper results in a net higher customer experience.

Norway has seen a steep decline in the number of its legacy customers in the last decade, with POTS (plain old telecom service) customers decreasing from 1.3 million (2009) to 0.3 million (2019), and DSL customers decreasing from 1 million (2009) to 0.5 million (2019).⁶ As of 2021, Norway has reported that fewer than 0.1 million POTS customers and 0.17 million DSL customers continue to rely on the incumbent's legacy network. Telenor announced a bold plan in 2019 – the Sunrise project – to switch its legacy copper network off completely by the end of 2022.

Notice period. In September 2020, regulations in Norway required Telenor to keep the copper network open for five years until 2025 for wholesale customers. Telenor actively engages with its wholesale customers to provide equivalent replacement wholesale solutions and is in dialogue with the regulator regarding switch off earlier than 2025.

Product swaps to handle customer complaints. During the switch-off program, any customer complaints about the legacy network were resolved by offering an equivalent product based on fiber, mobile, HFC, and, in some cases, special solutions. This not only served as a test case for migration but also acted as a marketing incentive for other households in a neighborhood to proactively upgrade their legacy network products.

Engaging with municipalities. Telenor engaged with almost every municipality in Norway in which it operates its legacy network to jointly plan a replacement solution for its customers on a granular, home-by-home basis. As a result, the nature of the discussion was not just about switching off the legacy network but also about expanding the network footprint, facilitating the

growth of the fiber network where it made business sense, and rolling out mobile-based solutions in rural areas where there was no business case for fiber. Getting buy-in from the municipalities and local agencies considerably smoothed out the actual implementation of the network decommissioning.

Organizational synergies between fixed-mobile. The Sunrise project is also reported to have facilitated greater cooperation between the fixed and mobile divisions within Telenor, as the end-user experience after switch off in many cases needed a mobile-based solution that delivered not only a superior fixed experience, but did not burden the mobile network.

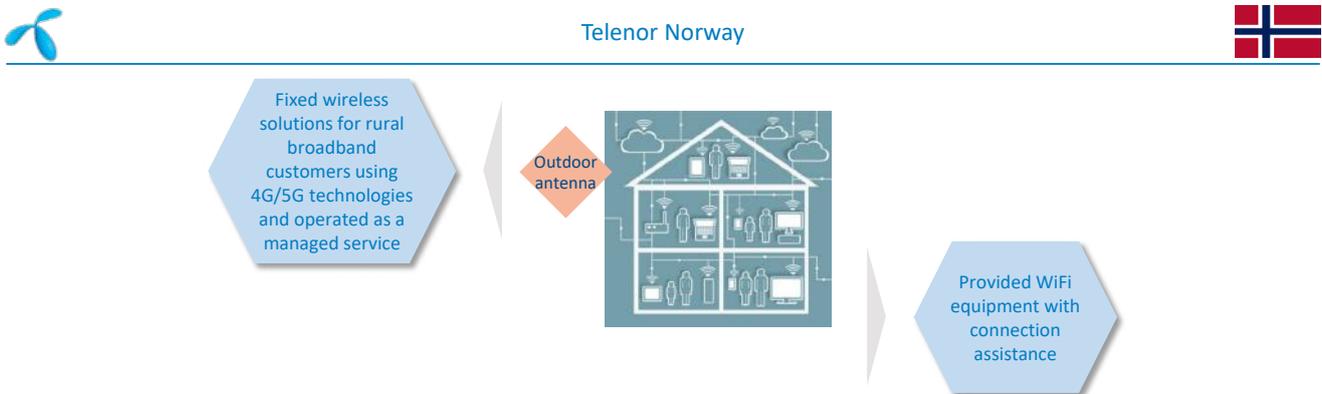
Managed FWA solutions. Telenor operated the cost per engagement of the fixed wireless replacement products as a managed service to ensure the customer had a better quality of experience than with the legacy product and that network externalities in the mobile network would not impact the overall experience of the fixed customer. Other efforts to ensure positive customer experience comprised professional installation of the equipment (including outdoor antenna), dedicated access infrastructure in certain rural communities, and redundant backhaul and power connections in some areas. The company provides a 4G/5G fixed wireless solution with outdoor antenna and indoor Wi-Fi routers installed by company representatives for rural customers migrated from legacy copper-based products where replacement fiber-based solutions are not yet available or fiber is not planned (see Figure 4 overleaf).

Environmental benefit. The copper switch-off program is expected to save up to 100 GWh⁷ of electricity per year, 140,000 KM of copper cables, and free up large amounts of indoor space that can be repurposed for other use.

⁶ Source: Based on discussion with Telenor Norway.

⁷ Source: Ingeborg Øfsthus, CTO, Telenor Norway, 5G Series Keynote, 23 September 2021.

Figure 4: Telenor Norway's fixed wireless solution for rural broadband customers



Source: Arthur D. Little analysis, Telenor

Openreach UK

Key learning: Stakeholder engagement, including working with customers to assist them to upgrade their onsite equipment. The pace of fiber rollout, however, is the main constraining factor to copper switch off.

After many years of being at the bottom of European FTTH rankings,⁸ operators in the UK, including the incumbent Openreach and alternative providers such as CityFibre, Community Fibre, Hyperoptic, Gigaclear, G.Network, Glide, and others, have announced ambitious fiber rollout plans. Openreach alone aims to roll out fiber to 20-25 million homes by 2026.⁹ In an effort to reach its goal, Openreach announced a program in 2019 to switch off its copper network completely, although implementation did not begin until 2021. The company's aim is to complete the switch-off program by 2026.

Engage with all stakeholders. Openreach operates more than 5,000 exchanges across the UK. It is following an exchange-by-exchange (and municipality-by-municipality) approach, starting with Salisbury in 2021. Openreach Chief Strategy Officer Richard Allwood has emphasized that engaging constructively with the government, municipalities, regulators, vendors, suppliers,

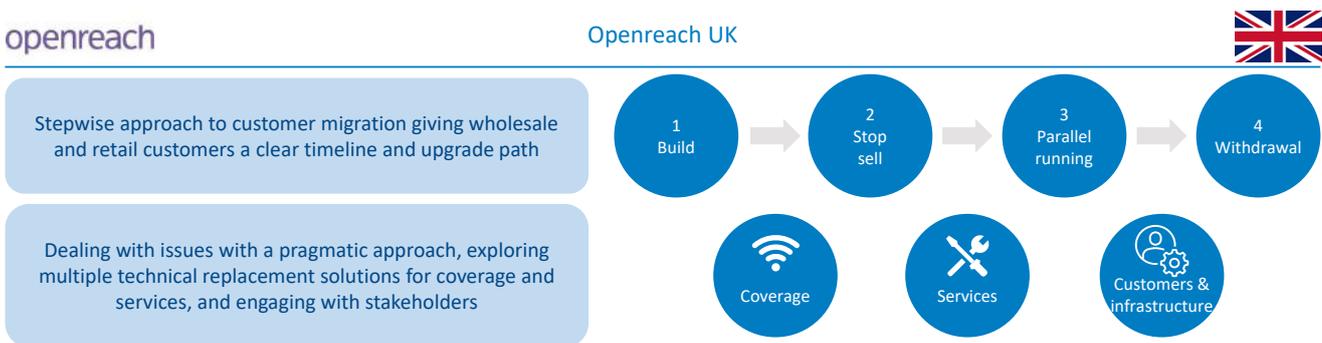
and wholesale and retail customers is essential for successful implementation of the switch-off program.

Public consultation. Openreach launched an industry consultation paper in March 2019 stating its intention to switch off its legacy copper network, the proposed approach, and the timeline for switch off. It also sought feedback from key stakeholders, while challenger operators shared critical feedback to ensure that the copper switch off should secure open access to the underlying infrastructure to all fiber operators in the UK and not result in Openreach again becoming an exclusive fiber infrastructure operator.

Move infrastructure to IP. End services as well as an intermediate service infrastructure are planned for all of those moved to an IP-based solution. A significant challenge is to engage with governments and some critical service providers to help them upgrade their legacy customer premise infrastructure to IP-based solutions as well.

Stepwise implementation. Openreach is following a four-step approach for the copper switch off in each municipality (see Figure 5):

Figure 5: Openreach's approach for copper switch off



Source: Arthur D. Little analysis, Openreach

8 Source: Taga, Karim, Glen Peres, and Martin Hanuska. "The Race to Gigabyte Fiber." Arthur D. Little, September 2020.

9 Source: "Retiring Our Copper Network." Openreach, 2021.

- 1. Build.** Build fiber to the premise in the exchange area to fully eclipse the existing legacy copper infrastructure.
- 2. Stop sell.** Offer only fiber- and IP-based products in areas with fiber coverage and stop selling any legacy copper-based products.
- 3. Parallel running.** Run both the legacy copper network and the new fiber network in parallel during the migration period. During this time, customers are actively engaged to migrate to fiber-based products.
- 4. Withdrawal.** Withdraw all legacy products from the market.

Pragmatic approach to connectivity solutions. Not all areas can have fiber infrastructure due to cost and operational reasons. In such areas, Openreach follows a pragmatic approach, using fixed wireless or mobile solutions when feasible or, in some cases, retaining FTTC infrastructure in the medium term until an alternative future-proof solution can be found.

Slower than planned. Even with stakeholder engagement and publicity, Openreach reports that the copper switch-off program is progressing slower than planned and that it is unlikely the company will achieve its goal of full copper switch off by 2026. A major constraint for faster switch off of copper is faster rollout of fiber, which is expected to speed up following regulator Ofcom’s announcement that it has eased pricing regulations on fiber.¹⁰

Jersey Telecom

Key learning: The first operator in the world to switch off copper was able to do so with a full fiber rollout and small geography to manage transformation.

Jersey Telecom – located on the island of Jersey, a British Crown dependency close to France with an area of approximately 120 sq. km and a population of 110,000 inhabitants – is a leader

in full copper-to-fiber migration. Jersey Telecom Managing Director Daragh McDermott reported that “we were the first operator in the world to upgrade 100% of the legacy copper network to fiber ... [and then] migrated all customers to the new network and switched off entirely the legacy network in December 2019.”

Clear objective. Jersey Telecom started back in 2012, with a clear objective to replace all copper connections to all premises with fiber and to switch off the copper network. To meet this objective, it focused first on fiberizing the entire network and leveraging the existing network of ducts to pull fiber, then on migrating customers to the fiber network, and finally on switching off the copper network (see Figure 6).

Government ownership synergies. As a government-owned entity, Jersey Telcom could take decisions in the long-term interest of the country and the company as well as coordinate within various other agencies of the government to resolve access to infrastructure-related issues.

Communication. Communication in the media, with customers, and with regulatory agencies was conducted non-stop from the start of the program in 2012 so that all stakeholders and users were aware that fiber was the only alternative for any legacy-based products.

Migration. Legacy broadband customers were first migrated to fiber-based alternatives from 2012–2018; in a second phase, legacy voice-only customers were migrated to fiber-based alternatives. Customers were informed at every opportunity about the migration.

Engage customers’ suppliers. Technicians directly interacted with business customers as well as with the customers’ suppliers to find solutions for legacy customer premise equipment, to ensure a smooth migration for the customers.

Figure 6: Jersey Telecom’s approach to switch off copper



Source: Arthur D. Little analysis, Jersey Telecom

10 Source: “Ramping Up the Rollout of Full-Fibre Broadband.” Ofcom, 18 March 2021.

Telecom Italia (TIM)

Key learning: Cooperation with the investor community and with the main competitor to leverage existing legacy copper assets to accelerate fiber rollout can be a win-win for the telco operators as well as the country in terms of increasing fiber penetration.

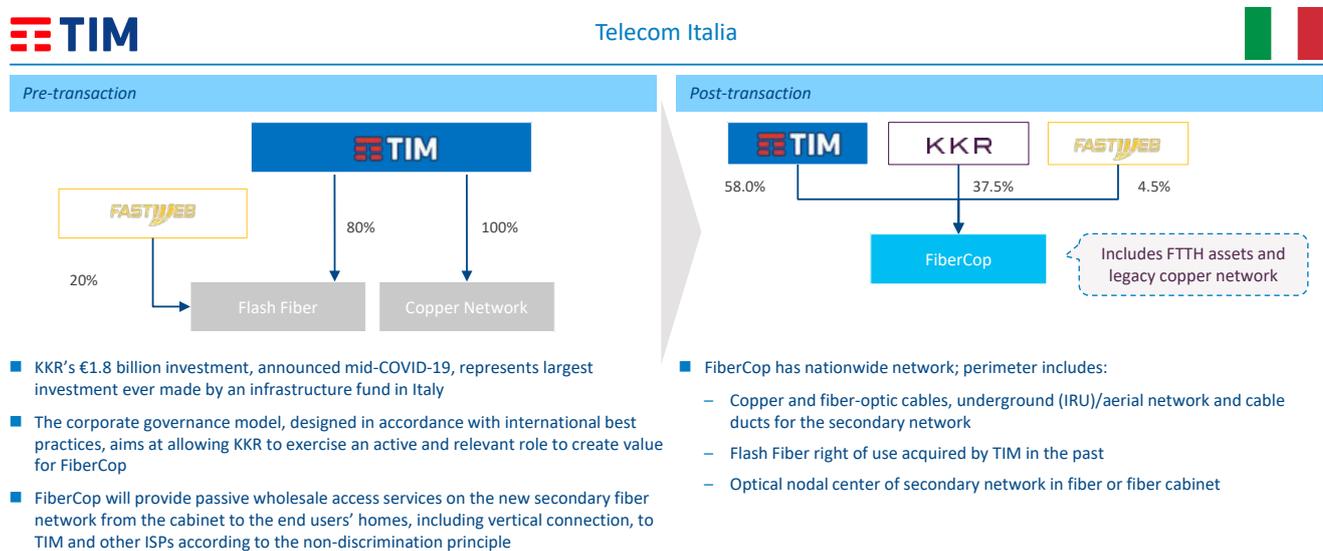
TIM announced as early as 2017 that it planned to undertake a copper switch-off program aiming to migrate 65% of its nearly 10,000 exchanges from copper to fiber by 2023. This ambitious plan has not been set in motion since then for a variety of reasons, of which lack of alternative fiber networks is the main constraining factor. Until recently, Italy was a lagging fiber market in Europe.¹¹

Multibillion-Euro monetization of legacy networks. In the last several years, however, a number of significant events have occurred that have put Italy on the fast road to achieving almost nationwide fiber coverage by 2025. Among these events were the creation of alternative fiber players like Open Fiber and the carve out of TIM's legacy copper network into a new entity,

FiberCop, which achieved a high enterprise value of €7.7 billion and also raised significant investment from new shareholders, including €1.8 billion from KKR (a shareholder in FiberCop). These transactions demonstrate that legacy copper infrastructure is still a valuable asset on the market and can attract significant financial valuations from new shareholders that can then be reinvested in rolling out nationwide fiber infrastructure and flattening out the peak funding requirement of fiber rollout (see Figure 7).

Restart pilot program for copper switch off. Following the successful carve out and creation of FiberCop, TIM has focused anew on kick-starting its copper switch-off program. As of Q3 2021, TIM has switched off the copper network in the city of Trento, after rolling out fiber across the entire footprint in this region. TIM worked closely with the municipal authorities to ensure timely fiber rollout and is continuing to encourage its customers to migrate to fiber-based products by offering higher speeds and discount vouchers. Meanwhile, TIM announced plans in 95 other municipalities to roll out fiber and switch off the copper networks by 2022.

Figure 7: TIM's copper switch off



Source: Arthur D. Little analysis, TIM's investor relations reports

11 Source: Taga, Karim, Glen Peres, and Martin Hanuska. "The Race to Gigabyte Fiber." Arthur D. Little, September 2020.

Conclusion

Although copper switch off is on management's agenda for most incumbent operators, not many have convincingly kick-started the switch-off process. Lessons learned from successful switch-off programs across the world can provide guideposts to other operators to replicate and improve.

Key learnings for operators considering copper switch off

Having a clear, long-term **infrastructure upgrade blueprint** that is not just about fiber rollout but pragmatically considers all potential future-oriented technology solutions, including fixed wireless access and other solutions, is a necessary condition before announcing legacy network switch-off plans.

A **bottom-up, municipality-by-municipality**, street-by-street, home-by-home approach is unavoidable, and incumbents must engage each and every municipality and related government entities and communicate with customers to ensure buy-in to the program. They must also use this opportunity to negotiate concessions with authorities to ease not just fiber upgrades but also potential network expansion projects.

The copper switch-off program can act as a **catalyst for other organizational synergies** within the incumbent, breaking down silos between the fixed and mobile business units and enabling implementation of converged infrastructure, processes, and end-user solutions.

The switch-off program should have a **clear set of KPIs** that triggers sequencing of upgrades and selection of future-proof replacement technology solutions, so that the entire project functions smoothly within predetermined financial targets and time is not wasted waiting for case-by-case financial approvals during execution of the program.

Incumbents should be receptive to **open access fiber business models** through partnerships with third-party financial investors, non-telco strategic investors (e.g., municipalities, energy companies), or even with competitors rolling out fiber. Such partnerships can lead not only to additional funding capacity but also may provide strategic capabilities (e.g., reuse of existing infrastructure) and reduce expensive footprint overbuild.

Key learnings for regulatory agencies to facilitate copper switch off

Engaging actively with operators during the copper switch-off process and providing clear guidelines in terms of permissions and planning cannot only ease the actual switch-off process but can also open new areas for collaboration, such as extending the infrastructure footprint and resolving coverage gaps. Additionally, the switch-off process can create opportunities for joint investment or joint operations of special rural open access fiber entities. Regulators should have clear notice period regulations in place that not only seek to protect existing wholesale customers of legacy products, but also seek to accelerate migration to future-proof technologies by encouraging both the incumbent and the wholesale customer to migrate faster. Copper switch off also fosters lower energy usage, promoting greater environmental sustainability for the telecom sector.

Notes



Contacts

If you would like more information or to arrange an informal discussion on the issues raised here and how they affect your business, please contact:

Austria

Karim Taga
taga.karim@adlittle.com

Japan

Shinichi Akayama
akayama.shinichi@adlittle.com

Singapore

Tomasz Izydorczyk
izydorczyk.tomasz@adlittle.com

Belgium

Gregory Pankert
pankert.gregory@adlittle.com

Korea

Kevin Lee
lee.kevin@adlittle.com

Spain

Jorge Abril-Martorell
abril.jorge@adlittle.com

China

Yusuke Harada
harada.yusuke@adlittle.com

Latin America

Guillem Casahuga
casahuga.guillem@adlittle.com

Sweden

Agron Lasku
lasku.agron@adlittle.com

Czech Republic

Jiri Steif
steif.jiri@adlittle.com

Middle East

Andrea Faggiano
faggiano.andrea@adlittle.com

Switzerland

Michael Opitz
opitz.michael@adlittle.com

France

Julien Duvaud-Schelnast
duvaud-schelnast.julien@adlittle.com

The Netherlands

Martijn Eikelenboom
eikelenboom.martijn@adlittle.com

Turkey

Coskun Baban
baban.coskun@adlittle.com

Germany

Michael Opitz
opitz.michael@adlittle.com

Norway

Lars Thurmann-Moe
thurmann-moe.lars@adlittle.com

UK

Nicholas Johnson
johnson.nicholas@adlittle.com

India

Ashish Sharma
sharma.ashish@adlittle.com

Poland

Piotr Baranowski
baranowski.piotr@adlittle.com

USA

Sean McDevitt
mcdevitt.sean@adlittle.com

Italy

Giancarlo Agresti
agresti.giancarlo@adlittle.com

Russian Federation

Alexey Pankov
pankov.alexey@adlittle.com



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