Whitepaper

Disrupting Disaggregation: The Art of Migration

DETECON
CONSULTING

Abstract

This document presents our perspective on the challenges facing fixed access operators. In an ever-faster changing world, it is difficult for fixed access operators to keep up with the latest demands. However, the increasing requirements for future networks and the lagging implementation by providers necessitate new technologies that can make networks more flexible in meeting future needs.

This Whitepaper describes past network developments and indicates how the migration path towards disaggregated fixed access can succeed. It also gives examples of operators from around the world that have already integrated such systems. It opens up a solution space for implementing access disaggregation for oneself and demonstrates how Detecon in its position as a management consultancy can help to advance the topic within telecommunications companies.

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Abbreviations

BNG	*Broadband Network Gateway*
CAPEX	*Capital Expenses*
DAA	*Distributed Access Architecture*
DOCSIS	*Data Over Cable Service Interface Specifications*
DSL	*Digital Subscriber Lines*
FADN	*Fixed Access Disaggregated Network*
FASA	*Flexible Access Systems Architecture*
FTTx / H / B	*Fiber to the X / Home / Building*
HFC	*Hybrid Fiber Copper*
IMS	*Information Management System*
IP/MPLS	*Internet Protocol Multi-Protocol Label Switching*
ISPs	*Internet Service Providers*
NFV	*Network Functions Virtualization*
NGN	*Next Generation Network*
O&M	*Operation & Maintenance*
ONF	*Open Networking Foundation*
OLT	*Optical Line Terminal*
OSS/BSS	*Operations & Business Support Systems*
OPEX	*Operational Expenses*
PON	*Passive Optical Network*
PSTN	*Public Switched Telephone Network*
QoS	*Quality of Service*
SDN	*Software-Defined Networking*
vBNG	*virtual BNG*
vCMTS	*virtual Cable Modem Termination System*
VOLTHA	*Virtual OLT Hardware Abstraction*
XG(S)-PON	*10 Gigabit Symmetrical Passive Optical Network*

Introduction

Access disaggregation is a trending topic of relevance for rising numbers of ISPs worldwide and is generating multitudes of opportunities for them. It involves the shift from proprietary, closed hardware and software from a single vendor to open, decoupled components that are assembled into complete switching and routing devices.

The future of networks is expected to be dominated by fiber-based, disaggregated, and software-driven networks in 2030. The goal is to revolutionize the networks by gradually introducing this change and moving away from the today's networks using network components and software from a single source, limited as they are in their technological development owing to a lack of competition. Separating the development of hardware from that of software leads to numerous positive effects from the viewpoint of operators:

→ **Ecosystem – more open market**
A more open market is one key to driving innovation and shortening the "time to market". The open playing field is an alluring opportunity for new players to attack traditional operators at any time. ISP incumbents should for this reason alone keep up with the trend if they do not wish to disappear from the map. Nevertheless, traditional operators and vendors will continue to hold a strong position in standardizations, etc.

→ **Operations – let the robots do the work**
Operational processes within ISPs have enormous potential for greater automation from network disaggregation, offering "Plug & Play" in real time. Mining this potential can also reduce OPEX and support the development of personalized solutions within the ecosystem.

→ **Cooperation – you are not alone**
Collaborations are an important feature of the disaggregated world. With the backing of standardization bodies and support from many different operators and vendors, open platforms that all ISPs can access and implement become a real possibility. Simplified standardized processes can be mapped in the system, and interoperability among ISPs is facilitated. Cooperation activities offer a platform for the "Lead & Innovation" role as they are open-source organizations that tackle any issues that arise and can benefit from the implementation of fast feature developments and agile deployment.

→ **Sustainability – think before you plug**
The issue of sustainability, which can also be advanced through the development of disaggregated networks, should not be ignored. Utilization of disaggregated networks, interconnected hardware, and energy-efficient software is a possible approach for the reduction of power consumption and costs. In addition, the system as a whole is more modular and can be reused much more frequently than in the past. Finally, zero-touch provisioning can mean that the deployment of networks requires far less movement of far fewer vehicles.

The following remarks will describe the background of access networks and how they have evolved before we look at what the migration to disaggregated fixed access might look like and what its prerequisites are. Moreover, sectors in the target market that have already begun participating in the development of disaggregated networks will be mentioned before we shine a spotlight on the Detecon approach.

_ Fixed access network background

The introduction of new services and keeping pace with the growing demands of users are not possible without the overhaul of current network infrastructures, including the replacement of legacy equipment and implementation of new architectures and standardized protocols. The next sections will discuss the PSTN to All-IP upgrade, provide an overview of FTTH/B development and introduce the way forward from black box to white box.

From PSTN to All-IP in the access networks

The upgrade to "All-IP" — the complete replacement of the current PSTN (predominately copper-based and the foundation of telephony networks for many decades) with an "All-IP" network structure — is the key element of network transformation. Prerequisite is that an NGN infrastructure is available. From the perspective of technology, NGN is based on a new architecture that modifies both the core and access parts of a telecommunications network and changes the way it delivers services to users via an IP/MPLS transport network and IMS for voice and multimedia services. NGN architecture is based on the following concepts:

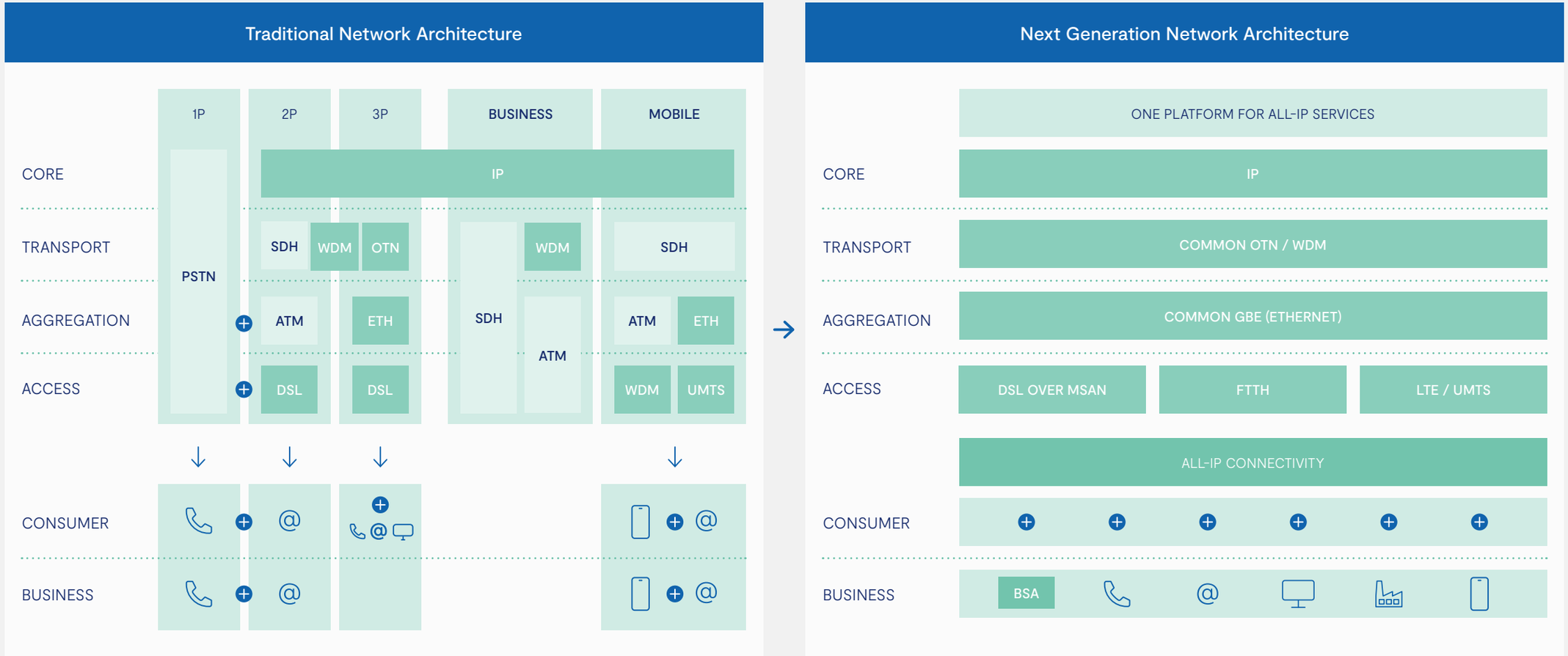
→ Unified packet transport layer for all types of services
→ Session-based control architecture for voice, video, and data services over the packet infrastructure
→ Common service delivery platform

Requirements which must be met by NGN networks:

→ Equipment and network interoperability between different operators with a functional architecture based on recognized norms and standard interfaces and protocols
→ Ability to serve fixed (copper and fiber optic), wireless, and mobile networks
→ Open service architecture with standard interfaces to third-party application service providers
→ QoS control mechanism with mandatory bandwidth allocation mechanism at access level as it is shared among various services
→ Shared management functions like provisioning, metering, billing, or QoS monitoring
→ Provision of generalized mobility features such as service continuity between fixed and mobile access leading to convergence or mobility (nomadism) features at fixed access
→ Integration of common technology for transport layer; IP/MPLS has emerged as the most suitable technology

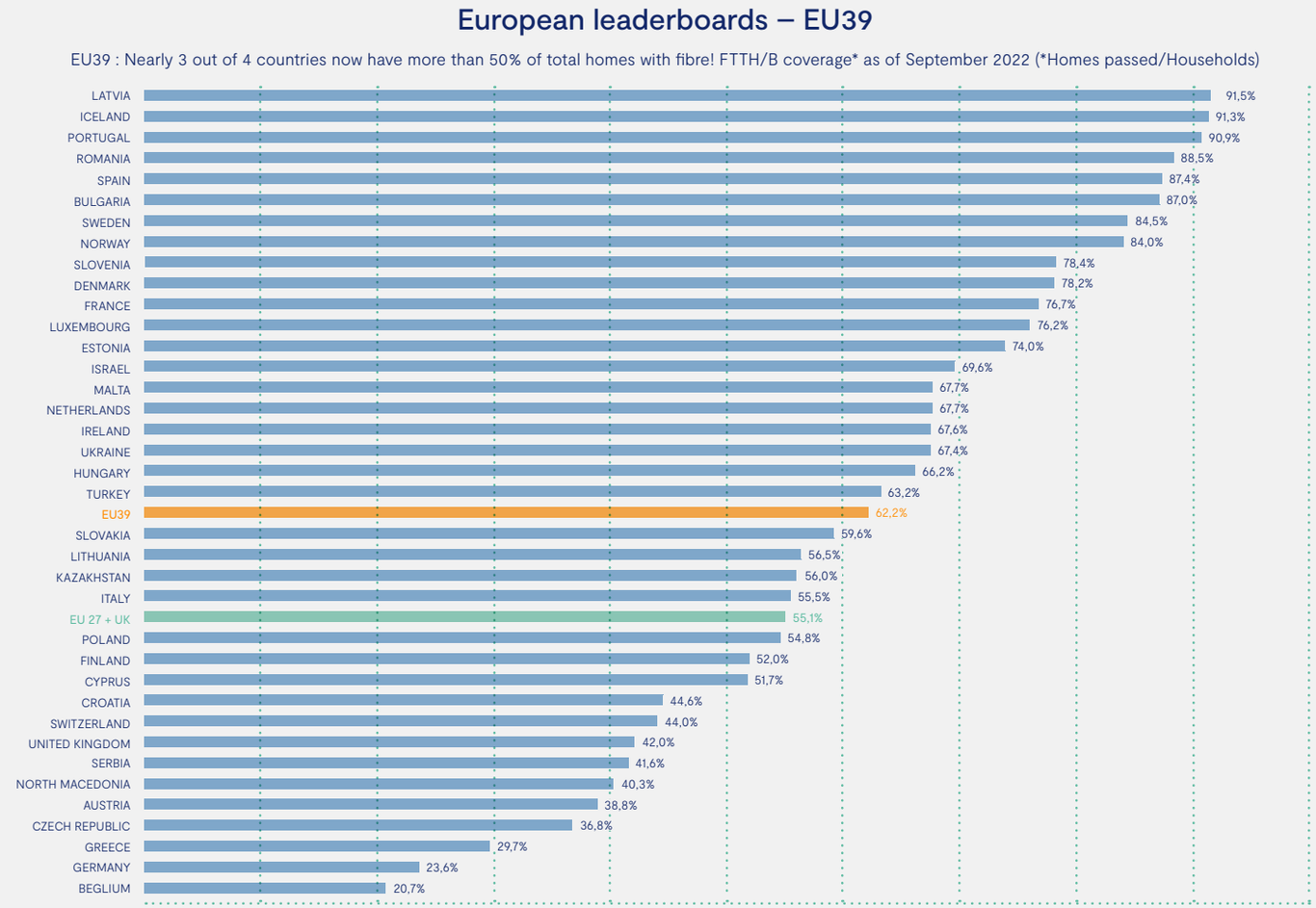
NGN ultimately leads to a new network concept blending the openness and flexibility of the internet with the quality guarantees inherent in the traditional PSTN, now broadened beyond voice only to include any multimedia or content delivery service. Traditional and Next Generation Network architectures and the technologies and protocols used for them in different network domains are presented in the figure below:

Figure 1: NGN Network Transformation



Source: On the road with All-IP, DLC Session 09.2019. Dr. Christian Krämer, Detecon

Figure 2: FTTH/B Coverage in EU39 Countries



Source: IDATE for FTTH Council EUROPE

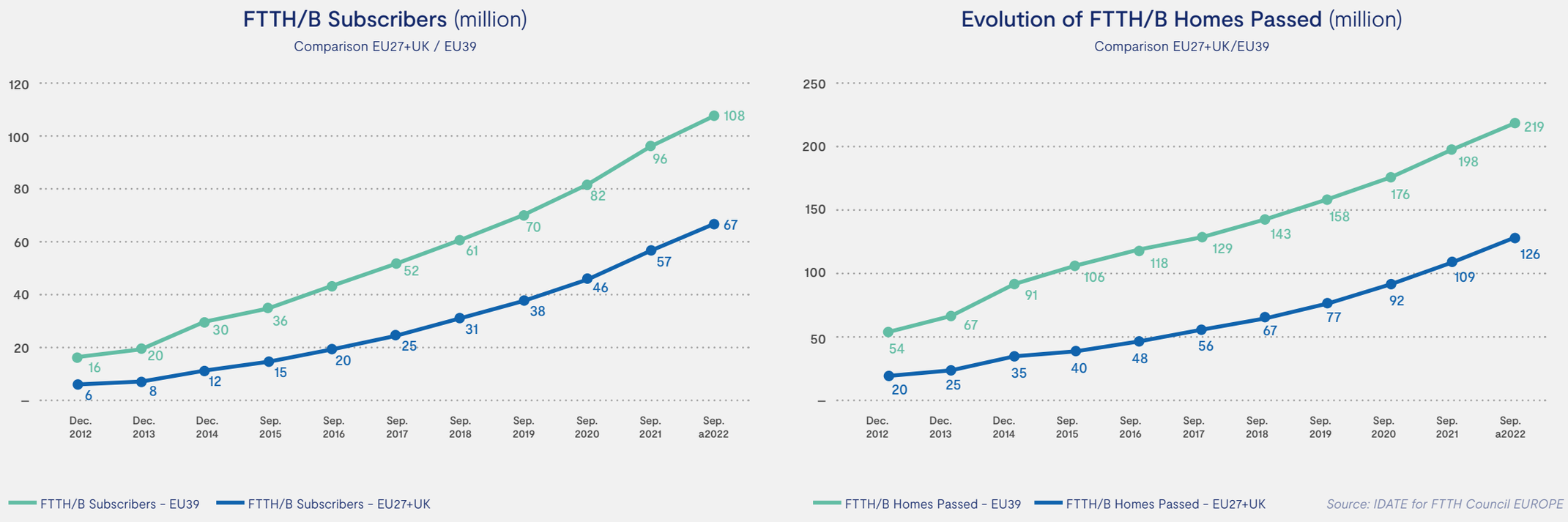
Current state of FTTH/B deployment

As of September 2022, many developed countries in Europe such as Germany, the United Kingdom, and Austria lagged behind the EU average with respect to FTTH/B deployment as depicted in the figure below.[1]

The numbers of FTTH/B Subscribers and FTTH/B Homes passed have been growing steadily in recent years as the figure below shows (based on IDATE FTTH/B Market Panorama). [1] This trend can be expected to continue in the coming years.

When compared to other regions of the world, European countries are lagging behind. Regions with the highest FTTH/B penetration are the Middle East (Qatar, UAE) and East Asia (Singapore, South Korea, Hong Kong, Japan).

Figure 3: FTTH/B Subscriber and Homes Passed Forecasts in Europe



From black box to white box

Conventional networks are closed systems containing “black boxes.” Components controlling the networks are made by equipment manufacturers in accordance with the specifications from network operators. In the modern world, where new applications and programs appearing every day require higher speeds and more bandwidth, this is not the best approach for operators. They need a solution that is more flexible and more easily adopted. Network operators in disaggregation use “white boxes” – hardware equipment that need not be obtained from top-line manufacturers – that can run any number of software solutions from various developers. By taking this approach, operators can more easily upgrade their networks in shorter time. The decoupling of hardware and software broadens the choice of manufactures, yet another factor that results in cost reductions for network operators.

One of the most significant advantages of the use of “white boxes” is the opportunity to combine standardized hardware configuration with a number of software protocols. When software protocols are combined in one hardware device, the result is a more efficient, flexible, and cost-effective solution. As network operators shift to disaggregation networks, they must assume more responsibility for the definition of technologies so they can mine the nascent potential to the fullest possible extent. Network providers offering conventional networks bought final solutions from vendors, but in disaggregation networks, network operator teams should define solutions that align most closely with their circumstances and collaborate with manufacturers and software developers in the creation of these solutions. The specifications of both the hardware and the software need to be open interface and well defined to assure their smooth operation. This approach frees service operators from dependence on vendor road maps, and they can themselves set the tempo of network upgrades. Having trustworthy partners — on both the hardware and software sides of the development — is crucial for success with this type of working method.

The first chapter outlines parts of the historical evolution of fixed access networks, including a brief description of access disaggregation. The subsequent chapters will concentrate on the migration to disaggregated fixed access networks and the related requirements and provide examples of disaggregated fixed access networks in various parts of the world.

[1] FTTH/B Market Panorama in Europe, September 2022

_ Migration to disaggregated fixed access

Necessity of migration from legacy networks to disaggregated world

In telecommunications business, network migrations are among the daily tasks of doing business. Networks must be constantly maintained or updated to keep pace with the general advances in technology and service and ultimately to protect previous investments. Surprisingly, migrations are quite often regarded as tedious, especially in view of the related cost. To be sure, migrations impact the ongoing operations of a network and today engage entire departments of experts who must seemingly expend substantial amounts of time and money just to keep the network up and running while (at first glance) adding nothing new. In many cases, assuring a friction-free migration may even require special developments (e.g., tools, processes...).

The sense of frustration and impatience inherent in this attitude may inadvertently lead to a lack of the necessary diligence during the migrations and result in inadequacies and failures that seemingly prove what a bad idea the migration was in the first place.

In consequence, many opportunities for business improvement fail to materialize because the conduct of migrations has not been considered as a vital part of network evolution from the very beginning. Quite frequently, planning focus is on the installation of new equipment and provision of new services, but does not give any regard to the transition from a network that is operating today to one adequate to meet future requirements. A change in attitudes and willingness to recognize the opportunities that are triggered by migration can only be of benefit.

This type of change in mindset can be triggered by recognizing several fundamental characteristics of migration.

Migrations...

→ are inevitable (unless you want to liquidate your business)
→ need to be integrated as constituent elements of transformation programs
→ can be conducted along the lines of standardized frameworks
→ need to be fully considered right from the development phase of new features or equipment
→ should be based on integrated features that will themselves support future migrations
→ should be assessed, planned, and carried out by migration specialists
→ generate tools for the support of migrations
→ should be designed on the basis of data collected upfront

When the aim is to transform a currently deployed state-of-the-art network into a new disaggregated one, migrations play a key role because most of these situations will play out within a brownfield environment.

Drivers — i.e., the challenges and obstacles existing in today's networks — that can trigger this type of transformation are outlined in the figure below. If operators' objective is to relieve the pressure that confronts them today, they will have to convert the networks of today into what is essentially a new ecosystem. The transformation involves a rather large number of separate migrations that are organizational and not only technological in their nature.

Perhaps the ultimate goal of the model for a software-centric, disaggregated access network is the simplification of future migrations containing integrated features and capabilities after introduction:

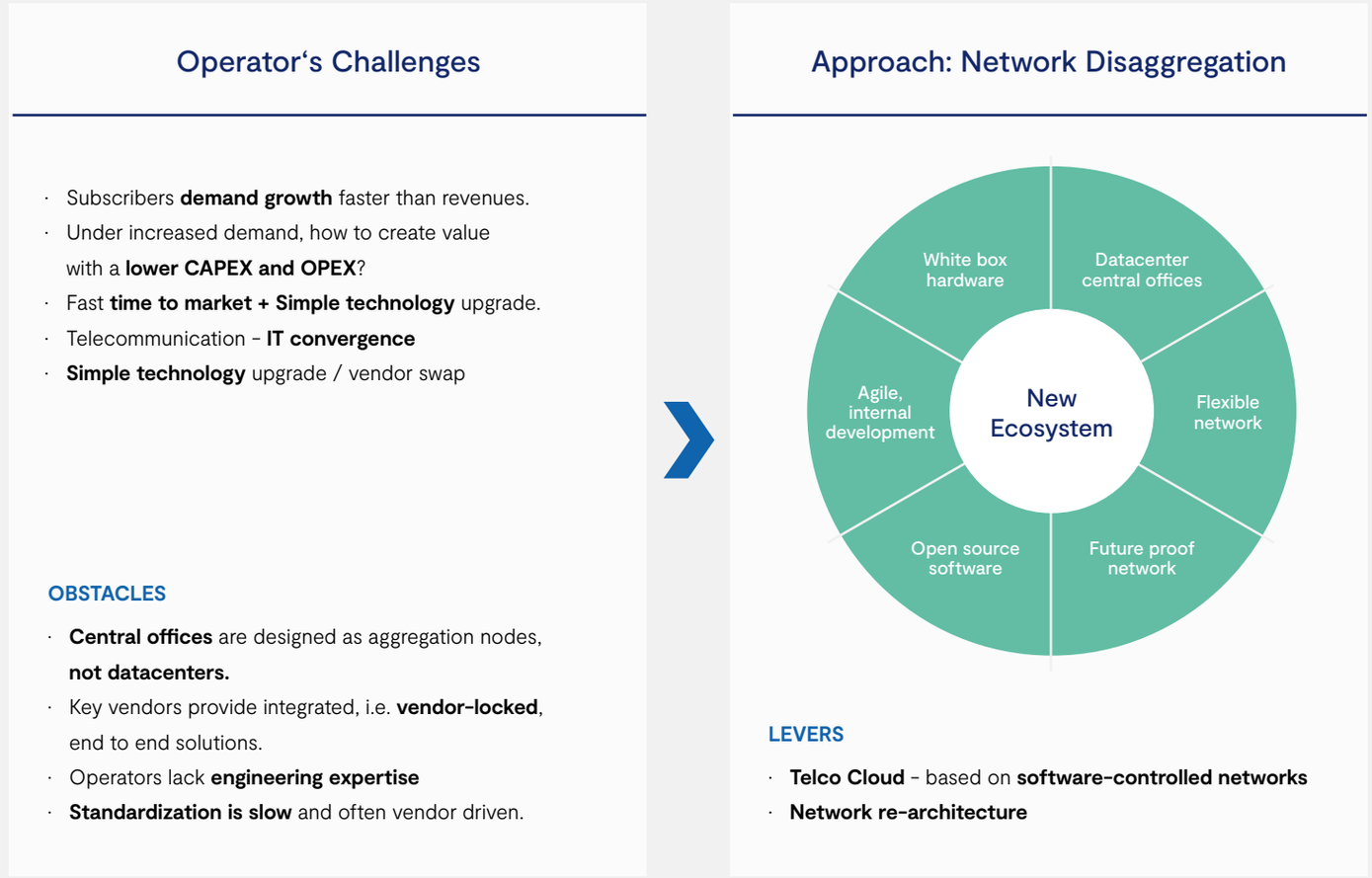
→ Deployment of white boxes with open interfaces broadens options on the market and simplify integration.

→ The separation of hardware and software facilitates faster modifications of the white boxes and the faster implementation of technological innovations such as an increase in performance, a decrease in power consumption, or the elimination of toxic materials (as sometimes required by legal statutes).

→ Disaggregation of complex black boxes and the centralization of controls enable quicker introduction of new features.

→ The modularization of software based on the separation of the user plane, the control plane, and

Figure 4: Challenges to operators in fixed access shape the approaches to disaggregation and are disruptive for the traditional telecommunications ecosystem



Source: Challenges and Approach for Fixed Access Disaggregation (→link). Klaus Hilbers and Pascale Beck, Detecon

the management plane means that the upgrade of software components can be dedicated and much more flexible.
→ Zero-touch provisioning and automatic control reduce manpower demands during a migration.
→ Automation and automated control always require up-to-date information about the components and network status in the databases, simplifying the procedures when setting up tools for automated migration processes.

Migration Requirements (especially when access disaggregation is the goal of the transformation)

General requirements for network migration

When operators are considering the launch of a network migration, there could be multiple factors demanding careful attention in advance, including the following:

→ Business objectives — A clear definition of the business objectives that the network migration will seek to realize is important. Possible targets could be the improvement of efficiency, an increase in capacity, a reduction of costs, or the realization of new capabilities.
→ Network architecture — The present network architecture may require an update before it is able to support new technologies or business requirements. This could involve an update of the network infrastructure (e.g., switches and routers) or the implementation of the latest networking technologies (e.g., SDN or NFV).
→ Security — Network security is a key concern in any migration project. A review and update of the security measures currently in place may be required to ensure that the network is protected from cyber threats.
→ Scalability — Design requirements to provide accommodation for future growth in the number of users or devices that will be connected to the network may play a major role.
→ Reliability — The network must be reliable and must always be available to support business operations. This may possibly be achieved by installing redundant components or incorporating high availability into the network design.
→ Performance — There may be a need to improve the network's performance so that it can actually support the growing demand for data and applications.

Possible upgrades could be the implementation of technologies such as QoS or optimization of the networks in support of real-time applications.

→ Budget and timeline — Establishing a budget and timeline for the network migration project is essential and must realistically assess the resources and time periods required for completion of the work.

→ Stakeholder engagement — The importance of close engagement with stakeholders — including IT staff, business leaders, and users — cannot be stressed too much; there is otherwise a risk of the network migration failing to meet the actual needs of the business, and the implementation as a whole would be a failure.

Specific requirements for fixed access disaggregated network migration

Several specific requirements must be kept in mind during the migration to an FADN, including the following:

→ Hardware compatibility — The FADN hardware and software should be compatible with the present network elements and systems and be able to operate seamlessly with them.

→ Network management and control — A resilient and flexible network management and control system for the FADN should ensure the network's efficient operation and facilitate troubleshooting and the diagnostics of any issues that arise.

→ Backwards compatibility — The FADN design should be backwards compatible with present systems and protocols as this will minimize disruptions to ongoing services during the migration.

→ Interoperability — The FADN components should be able to communicate and interact both with one another and with present systems to ensure trouble-free migration.

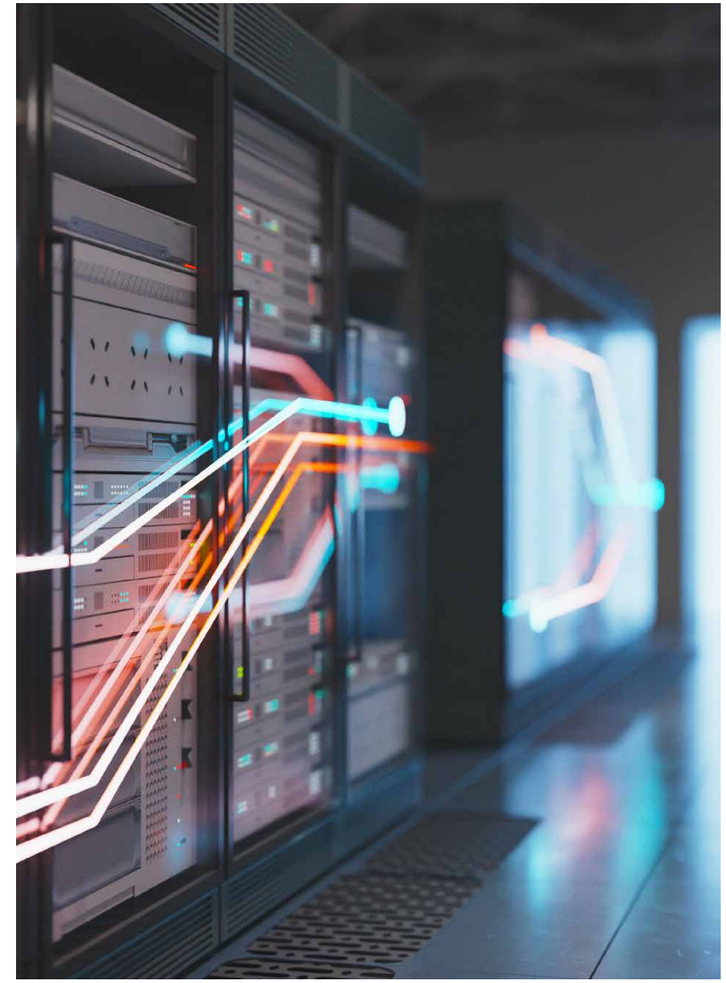
→ Bandwidth and capacity — The FADN should be able to handle the expected traffic loads and have the capacity necessary to accommodate future growth.

→ Security — The FADN should be designed with security in mind and should have resilient and effective security measures in place that will protect the system from unauthorized access and attacks.

→ Standards compliance — The FADN should be compliant with pertinent industry standards and regulations to ensure its correct operation and compatibility with other systems.

→ Testing and validation — The FADN should be thoroughly tested and validated before deployment to ensure that it satisfies the specified requirements and functions as intended.

→ Training — The support team and operators need to be trained in the use of the new network architecture and its O&M process.



Greenfield versus brownfield migration scenarios

There can be critical differences between the deployment of a fixed access disaggregated network (FADN) in a greenfield versus a brownfield environment.

➔ GREENFIELD

- Greenfield deployment of FADN occurs in an area where there is no existing infrastructure and a new network can be built from scratch.
- There is greater flexibility in the choice of technologies and the design of architecture because there are no legacy systems that must be considered.
- There is no need to interface with current systems and customers, reducing the complexity of the deployment process.
- State-of-the-art technology and protocols can be used, offering better performance and scalability.
- Since greenfield deployment is the creation of a new network, the customer base will also be new and there are no existing services that can be impacted during the migration.

➔ BROWNFIELD

- Brownfield deployment of FADN occurs in an area with a previously existing infrastructure.
- The deployment process is consequently more complex because the present systems and infrastructure must be considered and integrated into the new FADN.
- More careful planning and testing are required to ensure compatibility and to minimize disruptions to current services.
- The use of state-of-the-art technology may be constrained by the necessity of supporting legacy systems and protocols.
- Customer migration will be one of the principle concerns as the migration of current customers should not impact the services they are using.

In short, greenfield deployment of FADN is less complex because there is no existing infrastructure that must be considered, allowing greater flexibility in the selection of technologies and architecture, while brownfield deployments faces greater challenges because of the necessity to integrate the new network with existing systems and infrastructure and the more careful planning and testing required to ensure compatibility.

Architecture benefits of FADN

Fixed access disaggregated network (FADN) architecture offers a number of benefits to network operators, including the following:

→ Increased scalability — The separation of the control and data planes in FADN offers independent scaling of the various parts of the network, simplifying the addition of capacity and the handling of rising traffic volumes.

→ Increased innovation — The separation of the control and data planes in FADN offers greater flexibility in the choice of technologies and architecture. It is also a means for accelerating innovation, network evolution, and integration with new technologies.

→ Lower costs — By breaking up the network into smaller, modular components, FADN can reduce costs associated with upgrading or replacing proprietary equipment, decreasing in turn prices for equipment and services.

→ Network optimization —Since FADN separates the control and data planes, the control plane can be optimized for management and control and the data plane for data traffic, possibly improving network performance and reducing costs.

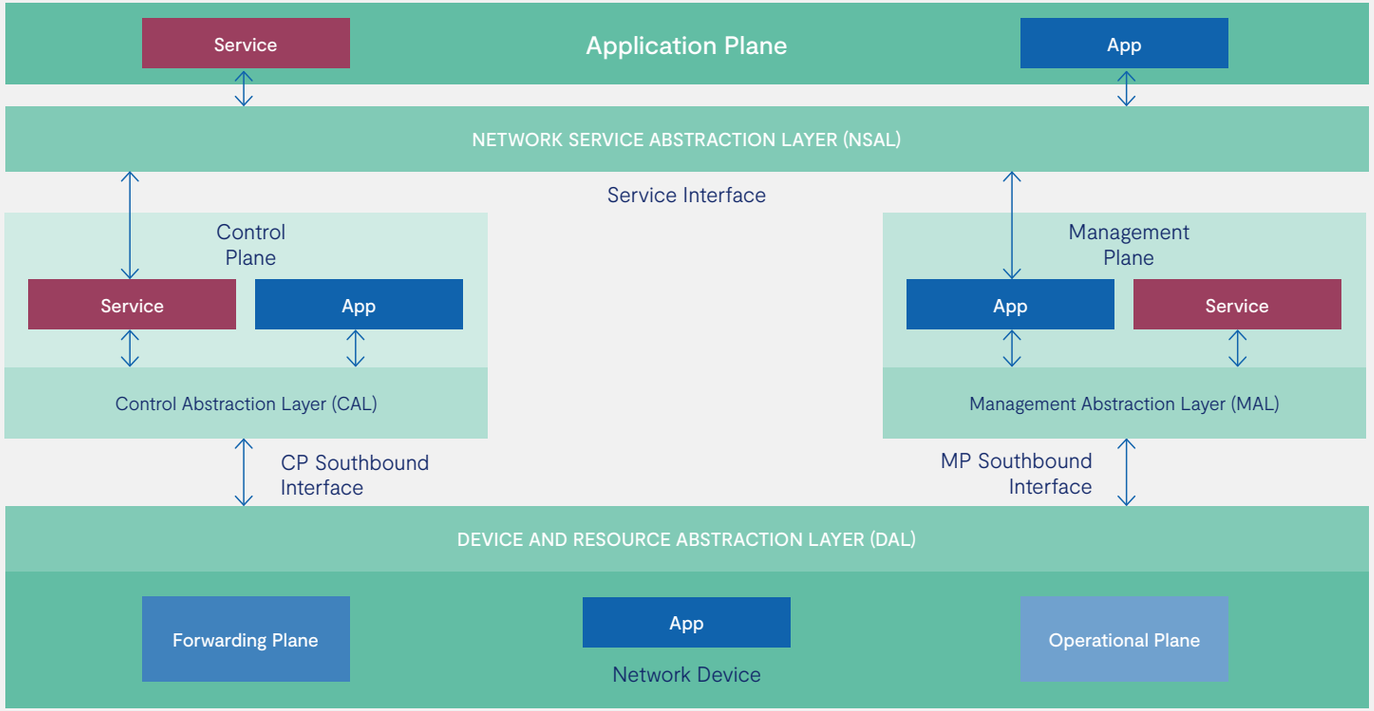
→ Flexibility in choosing vendors — Using FADN means that equipment from various vendors can be used in the same network, giving operators broader choice and more options when procuring hardware and software.

→ Improved security — By breaking up the network into smaller, more manageable components, FADN facilitates the implementation of security measures and heightens protection from unauthorized access and attacks.

→ **Ease of troubleshooting and maintenance** — Thanks to the disaggregated nature of FADN, network operators can identify and rectify problems more quickly and easily, reducing downtimes and improving overall network performance.

In summary, FADN architecture can benefit network operators in several ways: increased scalability, innovation, reduced costs, network optimization, flexibility, security, and ease of troubleshooting and maintenance.

Figure 5: The SDN-layered architecture according to RFC7426



Source: Overview of RFC7426: SDN Layers and Architecture Terminology, Evangelos Haleplidis, Mojatatu Networks, Canada

How to realize a successful migration

As noted above, migration concepts must be designed once the general decision in favor of a network transformation moving to a disaggregated access network has been made and the target network has been defined. The figure below depicts a high-level approach that could be used as a migration framework.

There are certain specifics outside the scope of this general template that demand special attention.

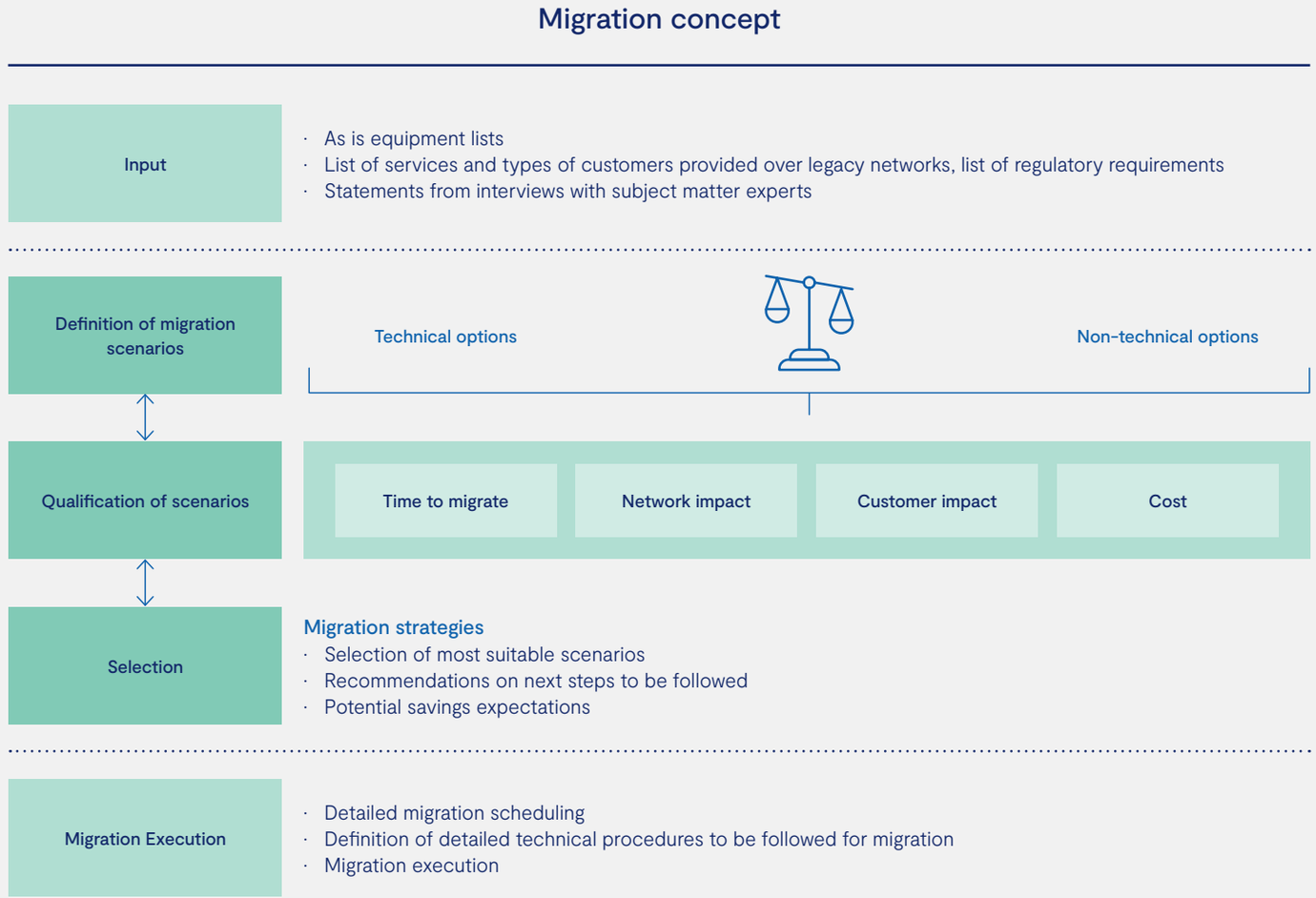
One factor that is frequently underestimated during the scheduling of a migration is the upfront assessment of the network as it actually exists. Defining the most suitable migration scenarios is not possible unless the reality of deployment in the field is known precisely because the content of the present database must be validated very early on. Ultimately, the quality of the data will determine the success rate of the migration phases. It must also be determined whether all the data needed for execution of the migration are available. If this is not the case, the means of collecting and providing the data must be reviewed.

Using tools for support during the conduct of the migration will be extremely helpful. A migration control tool can analyze the conditions necessary for the

launch of a specific migration procedure, observe its progress, trigger any needed actions, and conclude with an assessment of the results. A tool of this type must be carefully developed and tested well in advance. If it makes use of zero-touch procedures supported by network elements, a high degree of automation can be attained.

While there is a template that can be used as a guide-line, migration procedures must always be tailored to the conditions as they exist in reality. This is true of the migration itself, of course, but encompasses as well the operator and the latter's position on the market. The organization, market position, size and scope of the migration, and the regulatory environment must be carefully analyzed and given due regard for the calculation of a reliable cost case. Seamless service migration must be considered as an option in addition to a forced migration. We highly recommend involving experts with a strong background and broad experience in conducting migrations from the very first moment of a migration project.

Figure 6: Example of a Migration Concept



Source: Migration Strategy for Legacy Networks. Mariusz Kiraga, Detecon

_ Conclusion

Fixed access disaggregation technology migration is a process during which a traditional monolithic broadband access network is redistributed among multiple components that are smaller and more flexible. An analysis of the current status and future potential of the technology reveals the following possible benefits:

→ **Cost savings**
Disaggregation supports the reduction of capital and operating expenses because open and off-the-shelf components that are cheaper than comparable and traditional proprietary solutions can be used.

→ **Network flexibility**
The network can be more easily adapted to changing customer needs and market trends because components can be replaced or upgraded without impacting the entire network.

→ **Increased network efficiency**
Disaggregation enhances network efficiency by separating data and control plane functions, leading in turn to greater scalability and programmability.

→ **Faster service deployment**
The separation of functions and the use of open and programmable components foster faster and more flexible deployment of services.

→ **Improved network security**
Disaggregation strengthens network security because network administrators are able to isolate and monitor single components, reducing the risk of a general network failure or breach.

Fixed access disaggregation technology migration offers a number of general benefits for broadband access networks, including cost savings, greater flexibility, enhanced efficiency, more rapid service deployment, and heightened security. As the technology continues to evolve, it is likely that the range and scope of its benefits will broaden as well.

Finally, it should be noted that there is at this time NO ONE solution for tackling the issue of access disaggregation. Operators went their separate ways in the construction of their networks in the past, resulting in few opportunities to integrate standardized solutions for any given operator. The various standardization bodies are tentatively offering a few solutions, but they are largely no more than half-baked proposals and involve plenty of trial and error. In view of these circumstances, it is only logical that many operators continue to huddle in a defensive position, and the industry has yet to see the emergence of any pioneers in this field.

Examples from the market

Access disaggregation is a burning issue at all of the major ISPs; a number of operators around the world are working in this field, and some of them have already deployed the networks for commercial use.

Figure 7 gives an overview of various ISPs, indicating whether they have already moved into the deployment phase or are still in the trial stage or pre-commercialization of the disaggregation of their access networks. Still, it is striking how very few operators are currently making a move to the disaggregation of their fixed access.

In the discussion below, there will be a description and examination of some of the most promising developments, determining where ISPs are focusing their attention, and why there will not be any deployment in some regions for the time being.

Europe

Europe is one of the main drivers behind access disaggregation. Some ISPs have already joined cooperation efforts on standardization bodies — the Telekom Infra Project, the ONF, or the Broadband Forum, for instance. As yet, however, commercial implementations remain few and far between. Some of the most promising ISPs and their developments are presented below.

Deutsche Telekom is implementing access disaggregation under the name A4.0. The company is cooperating closely with service enablers to phase out the old platform based on BNGs and to install a new, disaggregated solution with white-box switches. Moreover, Deutsche Telekom supports a diverse group of forums and standardization efforts to ensure the ongoing development of the issue and to avoid any obstacles to interoperability with other operators. The A4 platform will probably be tested further during an additional development phase before the first commercial deployments finally take place.

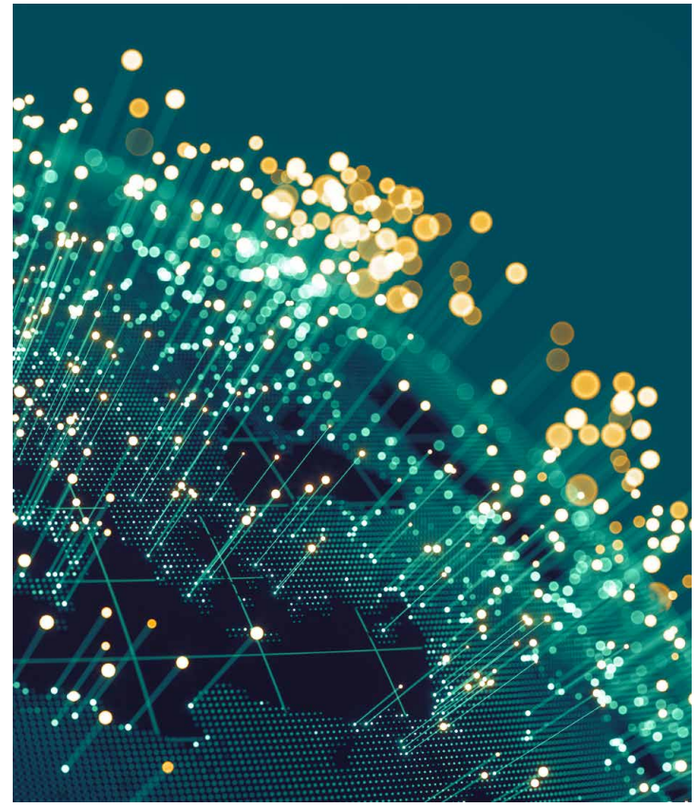
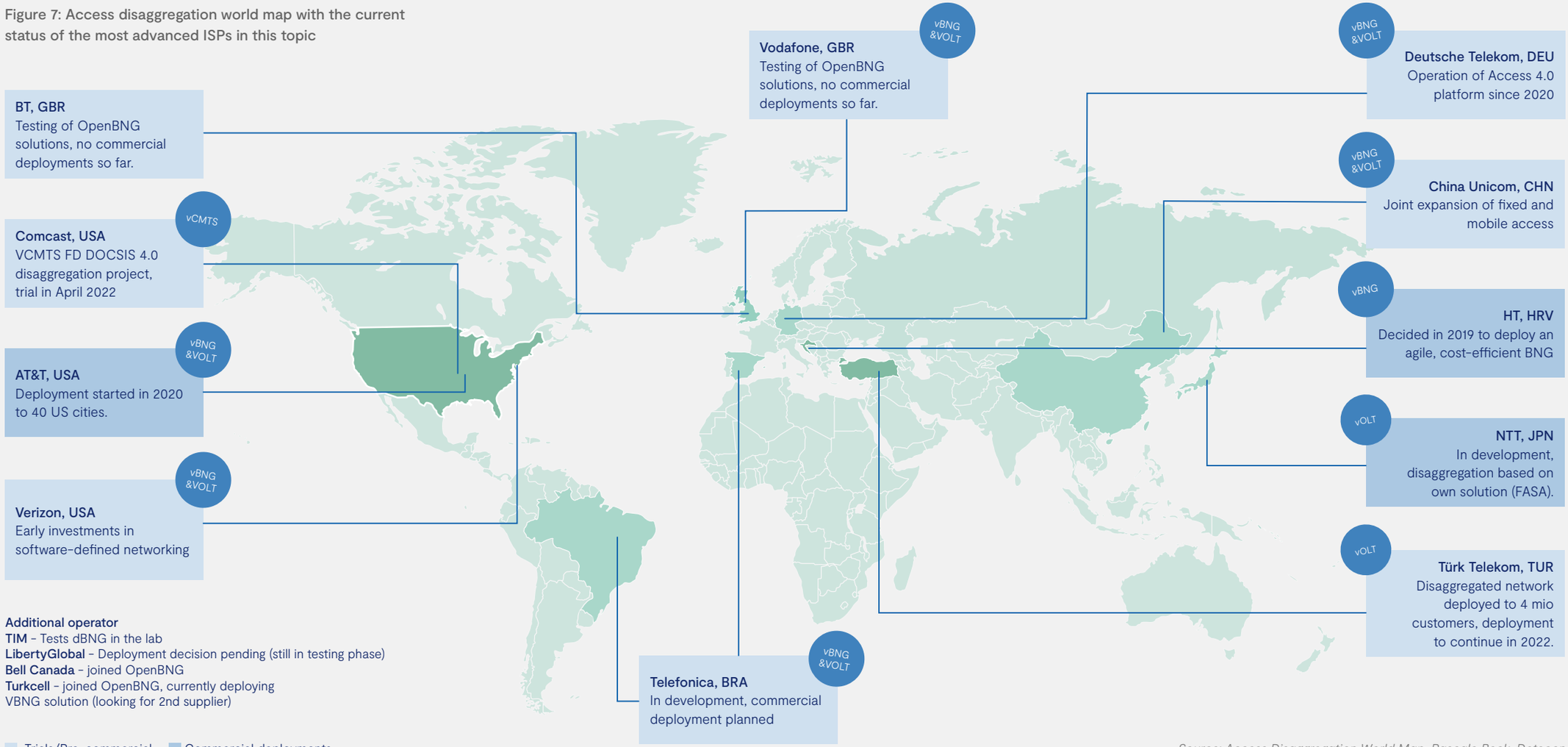


Figure 7: Access disaggregation world map with the current status of the most advanced ISPs in this topic



Source: Access Disaggregation World Map. Pascale Beck, Detecon

Vodafone is also on the verge of a achieving independence from vendor lock-in in the fixed access network. It is testing an open, disaggregated, multi-vendor BNG architecture and has partnered with Huawei to test access virtualization with independent virtual OLTs [1]. In addition, there have been some thoughts to deploy Nokia's SDN manager and controller, and testing and evaluations are still underway. The so-called Open BNG platform has been tested in several labs in Belgium (Nokia), Ireland (Casa Systems), India (Cisco), and the USA (Benu Networks). Vodafone, together with Nokia, also launched an SDN proof-of-concept in Europe in 2022; however, the current deployment status of its Open BNG platform has yet to be announced [2].

Türk Telekom is using technology based on the ONF SEBA reference architecture to virtualize their PON network (vOLT). The operator is using the Netsia Broadband Suite (Netsia BB Suite) to operate its virtual broadband access network as a new platform featuring full backend integration, including OSS/BSS, allowing full disaggregation and the opportunity to choose from among various vendors and avoiding lock-ins. In 2021, Türk Telekom announced that it had developed a disaggregated fixed access pilot network in two provinces of Türkiye. In December 2021, the process of disaggregating the access network continued, providing broadband access to more than one million households. Even larger rollouts are expected to be carried out in 2023 [3].

There are many more operators besides the three mentioned above (e.g., Telefónica, BT, HT Turkcell, or TIM) that are actively working on the subject and are engaging within communities as part of their efforts to drive its development forward. Research into HFC virtualization solutions as well as vBNG platforms is also apparently being conducted as can be seen at the operators Liberty Global and Charter Communications.

USA

Two operators, both of whom play a leading role in the telco industry, are pioneering technology development in the USA.

AT&T, one of the pioneers, has adapted its network architecture to include a virtual BNG managed by an open source access manager hardware abstraction software. Initial deployments were of XGS-PON using OLTs comprising white-box hardware that were recently launched with speeds as high as 1 Gbps in more than 40 US cities. Additional deployments incorporating the VOLTHA 1.0 software defined access specification into the ONF and providing a framework offering XGS-PON access in the cloud are planned for the future [4].

Comcast has installed the ONF Trellis software in its access network. In combination with the linked hardware design, it is an element of Comcast's DAA on markets with real customers. Trellis is an SDN-based leaf-spine switching fabric that is versatile and designed for use with a wide range of access technologies, including HFC, PON, and Ethernet. An SDN controller acts as the interface to multiple interconnected white-box switches, and incorporates the development of vCMTS [5]. In 2020, Comcast explored a flexible vBNG structure that supported the MSO service formats of a successful 10-Gbps network-to-modem link using vCMTS, the world's first fully operational 10G-capable, full-duplex DOCSIS 4.0 node in a production-ready environment using DAA [6].

Asia

The Asian market, especially China and Japan, is also seeking solutions for disaggregated access, but the approach of these two countries differs from that being explored on the Western market. China Unicom and NTT are the ISPs with the most promising work in network disaggregation in this region.

There are three operators in China supporting the development of a recommendation to the ITU-T: **China Unicom**, China Telecom, and MIIT China. The recommendation described signaling requirements for the cloud-based control plane and pooled user plane of vBNGs, including a reference architecture [7]. China Unicom in collaboration with ZTE has come up with an alternative, a new FTTH-based smart community solution aimed at the disaggregation of the current access network [8].

In Japan, **NTT** has introduced the FASA concept for the development of a future access network. The objective here is to separate network hardware and software so that a number of various vendors can be used. NTT is developing virtualization functions for optical access systems in its laboratories, and they are working as well on advancements in the ONF/SEBA architecture [9]. In 2020, they developed virtualized functions for OLTs, and they continue to contribute to the ONF community. In addition, they have proposed an innovative fixed and mobile network that can stay abreast with the demands for flexibility and capacity of networks [10].

Middle East and Africa

Major operators in the Middle East and Africa do not have any plans for driving forward issues of access disaggregation. Laboring under CAPEX constraints, they are more focused on rolling out their XGS-based services that exploit the forward compatibility of the current OLT GPON to XGS PON. In addition, the operators concentrate more on ORAN and do not consider virtual OLTs to be a priority at the moment.

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[10] https://www.rd.ntt/e/research/JN202105_13586.html

Detecon approach

Detecon is in a position to provide assistance during the transition to a disaggregated approach across all domains that drives access disaggregation:

→ Strategy
→ Technology
→ Market regulation
→ Implementation, Learn & Grow

Our expertise in access disaggregation covers its full life cycle from inception to strategy and architecture to implementation.

One of Detecon's activities as a management and technology consultancy is to encourage companies to keep strategic considerations in mind at all times when planning and implementing disaggregation. Questions include the appropriate approach to access disaggregation from the perspectives of business and technology strategies in today's environment. Moreover, we cooperate with the clients to come to agreement about potential options and the expected benefits. Focus is not limited to strategic thinking, however; customers and business are another major pillar. In this sense, we create assessments of customer needs and of business cases on top of disaggregated networks to generate even greater added value.

Thanks to our many years of experience in market regulation, Detecon can help operators to develop the right strategy relating to current or new rules governing newly developed disaggregation approaches to network elements.

One factor that is equally important for attaining goals of this nature is clarity about the financial support of the project. Drawing on our years of experience in financial modeling, we can provide support in the cost analysis of business cases, the search for alternatives, and the evaluation of possible implications. We also work with our clients to determine how current/future pricing structures and costs (CAPEX/OPEX) will change during the migration to disaggregated networks. Thanks to our years of experience in the technology sector, we can rely on a vast technological background to avoid the mistakes of past projects and to anticipate the right architecture for any given company.

Designing a disaggregated network requires the creation of a good vendor and partner ecosystem. Detecon strikes the balance between standardization and customization, determines the extent to which open interfaces are feasible during implementation, etc. We also consider vendor/supplier options and offer support during tender procedures, contract conclusions, and implementation.

But Detecon's work does not end with the above services — we also provide support in questions of organization involving capability requirements for planning, design, and operation. Furthermore, training programs, knowledge transfer, and workshop can promote the acceleration of access disaggregation in the company.

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_ The company

Detecon is the leading, globally operating management technology consulting company with headquarters in Germany, which has been combining classic management consulting with high technological competence for over 40 years. The focus is on digital transformation: Detecon supports companies from all areas of business to adapt their business models and operational processes to the competitive conditions and customer requirements of the digitalized, globalized economy with state-of-the-art communication and information technology. Detecon's expertise bundles the knowledge from the successful conclusion of management and ICT consulting projects in over 160 countries.

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From the concept to implementation

We accompany our clients from strategy and idea generation to implementation. We tailor the flexible, precisely fitting use of methods and tools as well as the networking with experts within our ecosystem to each individual project.

Our consultants are constantly developing their knowledge and using all their expertise to find the best solution for the specific needs of our clients. We focus on taking responsibility and create an infrastructure that allows both mobile working and working in a creative office environment. Fair and appreciative cooperation is the most important characteristic by which we define ourselves as a company in our daily collaboration. The second most important: the passion to shape the digital transformation!

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