Open and Disaggregated Networks
By Sandra Mogami, RTI Newsroom

The maturing of the telecommunications sector shows the natural tendency of operators and companies to adopt the concept of open networks. FTTH (fiber to the home) networks can also be virtualized, replacing proprietary legacy equipment, such as OLTs, with white box hardware. The following report shows the evolution of technology, the deployments in the world and the solutions already available in the market.

With the growing demand for bandwidth driven by connectivity and digitization everywhere, the telecommunications industry is challenged to design and build its networks in a sustainable way. Currently, the main path to the development of new generation infrastructures are open, disaggregated, and virtualized architectures, capable of ensuring the expansion of systems with lower operating costs, flexibility and agility in provisioning services.

The Open Networking Foundation (ONF) is one of the leading organizations behind the SDN movement and was founded in 2011. SDN concepts evolved out of a six-year research collaboration between Stanford University and the University of California at Berkeley in the USA. ONF is working globally to promote a revolution in the network equipment market, along the lines of what represented the migration of mainframes to computing through the collaborative construction of the next generations of mobile and broadband networks. ONF's more than 200 associates are the world's largest operators and technology companies, such as Telefonica, AT&T, Intel, China Unicom, Deutsche Telekom, Google, NTT Group and Türk Telekom, as well as equipment suppliers and system integrators.

"ONF started its activities with the development of OpenFlow for network programming and since then has made several advances, not only in terms of technology, but also in projects, always focusing on what the operator market needs," says Amanda Espíndola Raymundi, a telecommunications engineer and ONF ambassador in Brazil. The ambassadors are professionals in the sector who help in the dissemination of work and rapprochement with the technical community in their respective countries. In Brazil, ONF has five ambassadors to date. ONF's approach is based on the separation of data flow and traffic management, with the second being guided by an open standard, operating in a layer outside the equipment. The concept applies to several areas, such as networking (switches and routers), fixed broadband FTTH (fiber to the home), with virtualized OLTs in white box models, and O-RAN - Open RAN in 5G networks. With this approach, the hardware, operating system and applications are no longer sold in a monolithic package, reducing the complexity and costs of proprietary equipment.

"The disaggregated architecture allows operators to choose components from different vendors, giving them flexibility throughout the life of the deployment. This results in significant savings and a better overall customer experience. The closed equipment is like a black box. We don't know what happens inside them, and often to make architectural developments, you need to change the whole system, demanding purchasing processes that can take months in large companies," says Amanda.

Specifically for the fixed access network, ONF has developed SEBA (SDN-Enabled Broadband Access), a reference architecture enabled for SDN and built with components and support for virtualized access technologies, such as PON and G. Fast, and VOLTHA (Virtual OLT Hardware Abstraction), which offers an abstraction of the hardware layer for the equipment, enabling the use of white box OLTs.

In legacy network architectures, OLT hardware is so heavily coupled to software that operators rely on the pace of equipment vendors to evolve their networks. Therefore, several groups have been working on developing architectures to transform legacy networks, based on SDNs, network role virtualization (NFV) and cloud technologies. In addition to ONF, the initiatives of OCP (Open Compute Project), TIP (Telecom Infra Project), as well as standardization organizations such as BBF (Broadband Forum) stand out.

In ONF, the period between 2011 and 2016 was considered phase 1, with the standardization of the OpenFlow protocol for the separation of data plans and control of the network and SDN implementations based on disaggregation and open source. Phase 2, from 2016 to 2021, was marked by the development of platforms by ONF's internal engineering team and testing by some Tier 1 operators. And now, in April 2022, phase 3 began, which consists of the increasing adoption and advancement of the project developer community. To this, ONF has opened the source code of its entire portfolio of production-ready platforms. "Previously, the ONF engineering team was the one who developed the code. Now the work is done in conjunction

with Intel. In this new phase, greater adoption and contribution to the development of these codes by the open source community is expected," says Amanda.

"ONF projects have reached maturity and adoption in the market. It's time to be released into the open source community. We are pleased with the progress we have made towards more open and interoperable networks. With our development team joining Intel, we are optimistic that contributions will continue to grow," says Andre Fuetsch, board chairman of ONF and vice president of AT&T and Network CTO.

The transition includes the four areas of development of ONF. In addition to software-defined broadband (SEBA/VOLTHA), there is also public 5G (SD-Core, SD-RAN), private 5G networks (Aether) and Programmable Networks (P4, SD-Fabric, PINS), all already with deployments or pilots in progress, as detailed below.

Some ONF projects under implementation

Telefónica Brazil and Radisys
Radisys, from the USA, part of the Indian group Reliance, has been working with Telefônica Brazil on passive optical network field testing (PON) with Connect Open Broadband to demonstrate the benefits of open software and white box hardware. "This is the first implementation in the country, and we are very happy with the results so far," the companies said in an official statement.

According to Radisys, the architecture met the network needs and provided an upgrade path for the XGS-PON. "Connect Open Broadband enables service providers to implement programmatic integration of new equipment rather than total removal and replacement as their network and technology needs evolve."

In Brazilian tests, Telefônica implemented its own gateway units in the customers' facilities. Because Radisys hardware is an OLT white box, service providers can combine solutions on their networks without facing interoperability issues. In addition, provisioning and updates can be done through the Radisys Management System (RMS), an element management system that eliminates the need to physically perform field work.

One of the key benefits of open disaggregated broadband solutions is the ability to move control and management of the network to the cloud. By introducing virtualization into these roles, RMS enables service providers to integrate their operations support systems (OSS), enterprise support systems (BSS), and network components from multiple vendors into a single web-based interface with simplified operations. As part of the testing, Telefônica installed Radisys' OLT *RLT1600X*, an ONF-certified solution that supports GPON and XGS-PON without the need to change or upgrade PON hardware, simplifying the network with low-cost operations.
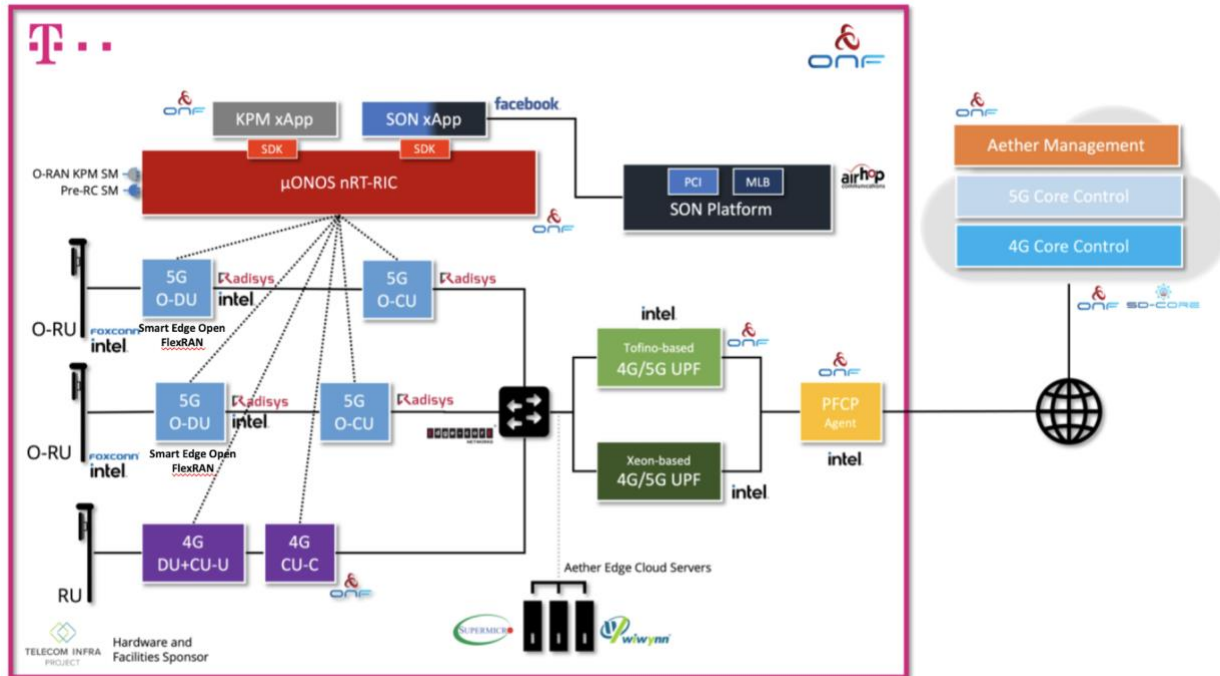
Figure 1 – Architectural diagram of SD-RAN trial network at Deutsche Telekom

Deutsche Telekom: eight suppliers participate in field tests with SD-RAN 4G/5G
In October 2021, ONF and German operator DT (Deutsche Telekom) announced the launch of the SD-RAN Berlin Trial in Germany, the first field test implementing fully disaggregated open RAN using ONF's RAN Intelligent Controller (RIC) software platform, as defined by the O-RAN architecture.

Operators are investing in open RAN to enable a new generation of modular and customizable 5G solutions to accelerate innovation and enable the combination of components from eight vendors: AirHop, Edgecore, Facebook, Foxconn, Intel, Radisys, Supermicro and Wiwynn.
The live test (figure 1) showed horizontally disaggregated hardware as well as vertically disaggregated software components, including an open source near Real-Time RIC (nRT-RIC) and xApps from the ONF SD-RAN project. "By integrating proprietary and open source components, the test was an example of how future open RAN deployments should take shape," ONF said.

Deutsche Telekom also offers disaggregated broadband solution to customers in Stuttgart and through the Access 4.0 (A4) platform, which combines open source components and supplier owners into an optimized solution to provide FTTx services.

Kajeet: ONF private 5G Aether network
Kajeet, a provider of wireless connectivity, software and hardware solutions for more than 3,000 businesses, schools and districts and state and local governments in the U.S., announced that it will adopt the private open source Aether 5G platform developed by ONF. The Kajeet

solution provides a cloud-based platform for private LTE and 5G services, both internal and external, with mobility between public and private cellular networks and out-of-the-line cloud managed service.

ONF has deployed and demonstrated Aether's capabilities in various global locations in conjunction with its key supplier and carrier partners. Launched in 2020, the solution provides configurations for universities, municipalities, industry, and businesses to have access to a secure, cloud-based private 5G platform to more easily connect people, locations, and devices. Kajeet's private 5G platform provides cloud-based SIM management, device and network management, and end-to-end smart network slicing with QoS and SLA (service level agreement) assurance.

Growth of the Market

In North America, Infinera, one of the largest suppliers of vertically integrated optical transport network equipment with 40 years of operation and a legacy of the companies it acquired such as Tellabs and Coriant, bets on open optical networks to support the growing demand for bandwidth. This trend is confirmed by a recent study by ACG Research and sponsored by the company with 52 communication service providers and web providers. According to the report, all projected network segments point to annual traffic growth of between 46% and 39% by 2025, which represents a strong motivation for service providers to reevaluate their architectures and adopt open optical networks.

"Our goal is to respond to the current moment of evolution of the sector, due to the arrival of 5G to the market and to eminent investments in Latin America," says Andrés Madero, CTO of Infinera for Latin America and the Caribbean.

Another advantage of open networks is the diversification of supply chains. The Covid-19 pandemic drew attention to the nature and risks of global supply chains due to shortages and delays in delivery of all types of products.

Another bet is that open optical networks will become a requirement due to the offer of a variety of optical engineering technologies from various vendors implemented in heterogeneous environments, with various network elements, including routers and optical transponders. "The big challenge is integration and operability, which can be solved with a good implementation of software and automations that enable operators to simplify network processes. This is because one of the great advantages of adopting open networks is that the innovation cycle will be much faster and more agile, which will allow operators to reduce their investments and remain competitive within the Latin American market", believes Madero.

In addition, compact modular technologies will take on multiple personalities. "With coherent optical motors in all types of sizes and packages, including 400G ZR and 400G ZR+ pluggable

optical motors and 800G built-in motors, 2022 is the year we will revisit the optical line system to ensure it can cost-effectively support wavelengths with multiple capacities," says Madero.

ACG research showed that 78% of respondents predict the implementation of 800G optical engine technology by the end of 2022. The research also explored the expected time for the adoption of 400G pluggables, as well as 800G embedded optical engine technology. "With network capacity demand doubling almost every two years and a growing need to transport 400G customer services cost-effectively, ready access to the latest optical engine technology has never been more important," he says. Infinera's 2x800G ICE6 optical engine has shown growth in deployments around the world, including Telstra in Asia Pacific and Sparkle in Europe.

To address the increased operational complexity, one of the main barriers that prevent service providers from fully adopting the open optical network, the solution is software automation. In the study, 78% of respondents indicated that they will have implemented the SDN control in their optical transport networks by the end of 2022, including 63% that were already implemented in 2021 or earlier.

With the optical network open, it is possible to introduce 800G optical motor technology and access the benefits of higher performance, including greater range of wavelength capacity and spectral efficiency, while operating existing optical line systems.

Suppliers and Integrators in Brazil

Edgecore Networks
Based in Taiwan, Edgecore Networks is a subsidiary of Accton Group, one of the world's largest companies manufacturing ODM/OEM network equipment. "We are pioneers in open networking and recognized world leaders in disaggregated network technologies for large-scale projects," says Victor Fernando Proscurchin, director of Edgecore Networks LATAM. According to him, Edgecore Networks has an active work in the main communities of disaggregated network technologies and, in addition to being a platinum partner of OCP and TIP, is one of the original partners of ONF. "We developed the first disaggregated equipment, such as data center switch, cell site router for 5G backhaul and Ip DWDM, as well as a full line of open WiFi access points," he says.

Edgecore Networks offers two models of OLT white box already used in clients such as AT&T and Turk Telecom: ASGvOLT64, with 64 high-capacity ports; and ASXvOLT16, first open 10G XGS-PON virtual OLT with 4 100G/40G QSFP28 fixed ports. QSFP28 ports support 100G and 40G operating modes and are configurable as 4 x 25 GbE or 4 x 10 GbE modes using breakout cables.

Radisys has proofs of concept and deployments in more than 60 carriers worldwide. In Brazil, the main operators are conducting tests with the technology, which should last until the end of the year. "Open broadband is a totally innovative and different model from what the industry is used to, but it will be the standard of networks in a few years. Therefore, we need to develop the market right now and be ready for when this moment comes," says Sergio Fabiano Siqueira, Head of Products and Development at Tellescom, a company responsible for market development and marketing of the solution in Brazil. With 14 years of existence, based in São Paulo and factory in Manaus, AM, Tellescom is a group of seven control companies 100% national and has been following the tests in operators, which seek to integrate the new standard to the legacy of equipment and systems.

Infinite IT Consulting, from São Bernardo do Campo, SP, a company that has operated since 2013 with optical transmission projects, offers technical support of the Radisys line in Latin America. The OLT 1600C has 16 hybrid ports and can accept both GPON (SFP C+, C++) and XGS-PON (SFP N1, N2, E1, E2). "The output throughput can reach 300 Gbit/s for the core in just 1U, standard pizza box," says Matheus Plastino, CEO and founder of Infinite IT Consulting, which manages the xPON and/or WDM/OTM infrastructure of more than 250 providers.

The OLT system was developed on top of Open Network Linux, Kubernetes, Docker and Containers. "If the user wants to change a module, simply update the container in specific, without having to buy new equipment," Plastino says. The management software contains the entire stack of APIs and microservices needed to control the white boxes. "The manufacturer just needs to send the container, the new code and the customer simply goes up the OLT controller, simply and quickly," he says.

Venko Networks

Venko Networks, a Brazilian company based in Porto Alegre, RS, and Curitiba, PR, was founded two years ago to offer disruptive connectivity solutions, under the premises of freedom of choice, open standards, disaggregation of equipment and applications, with software as the protagonist in the definition of technological architecture, especially XGS-PON and SD-WAN. An active member of ONF, Venko has set up a global network of partnerships with manufacturers of open architecture (white box) OLTs and universal CPEs and providers of virtualization and network orchestration platforms. "The disaggregated environment has as its definition to offer the option of choosing individual elements, prioritizing interoperability, avoiding vendor lock in and allowing access to products with more competitive values. That's why we have structured a complete ecosystem of solutions that will support the customer in this transition," says CEO Ricardo Pianta.

The products offered by Venko are modular, with a wide range of capacity and performance, approved by Anatel and with local support and warranty. In the line of 1U virtualized OLTs, the company works with the Zyxel, Edgecore and Radisys brands. Some models already offer the 1588/SyncE clock signaling feature, standards that will allow future integration of 5G transport with XGS-PON access networks. Other versions have as differential the highest volume of traffic

and density of ports. "You have to study each case. Our goal is to position ourselves as a platform that delivers all these possibilities according to the long-term customer intent", says the executive.

Another highlight is Tibit's pluggable OLT (micro-OLT), which works in open architecture. "Through a pluggable SFP+ OLT XGS-PON, you can transform switches and routers with SFP+ plugs into a high-performance, density XGS-PON OLT," he says.

To manage the networks, Venko has partnered with Netsia, a technology company of Türk Telekom, Turkey's largest operator, to offer BB Suite, a platform based on ONF's SEBA/VOLTHA model with backend integration, including OSS/BSS with carrier-level capabilities and complete management of the access devices lifecycle. At Türk Telekom, the solution serves 1 million families with triple-play services (voice, data and TV) over GPON and is prepared for the next requirements of 5G networks.

Finally, to address network service management in heterogeneous environments, Venko has signed an agreement with Intraway of Argentina, developer of the Symphonica platform, a cloud-native codeless service provisioning and networking solution that enables service providers to automate the entire lifecycle across multiple networks and technologies. "This is an ideal solution for the moment of consolidation of the Brazilian market, in which, increasingly, it deals with multiple services, multiple suppliers, with multiple technologies and equipment," says Pianta, noting that the migration to a disaggregated open solution does not occur from one hour to another. "We need to integrate the legacy at first. Symphonica solves the issue by creating a cover about the virtualized network so that it can also operate with the legacy," he says.

To demonstrate the platform and equipment in operation, Venko has set up a virtualized PON service structure in its Curitiba laboratory. "The environment is collaborative and open to both customers and suppliers. We are talking to several operators and providers in Brazil to perform on-site testing. As international experiences show, standardization and adoption of open networks are an inevitable trend", concludes the CEO.

Zyxel
Based in Taiwan and subsidizing in Brazil, Zyxel Communications developed the OLT white box SDA 3016SS 1U pizza box 16-door All-In-One, which is part of the ONF Continuous Certification Program for VOLTHA. According to the company, the product has achieved VOLTHA ONF certification meeting a set of standards related to performance, agility and interoperability. The OLT will be introduced alongside the release of ONF's VOLTHA version 2.10, which increases the scale and support for FTTB (fiber to the building), as well as models and APIs for integration with the BBF (Broadband Forum) framework.

Zyxel SDA3016SS simultaneously supports XGS-PON, GPON and Combo PON technologies. It has a compact design with 1U height, 260 mm depth and front access. It incorporates chipsets and a commercial x86 CPU module, empowering service providers to build open and programmable

PON platforms. Compatible with ONF VOLTHA, BBF OB-BAA, or third-party proprietary software, the equipment enables providers to reduce time-to-market and extend their access networks without standardization-related delays. It has two ports 100G QSFP28 and 25G SFP28 in the uplink interface. In addition, SFP28 ports offer the flexibility to adopt competitively cost-effective 25G SFP28 or 10G SFP+ transceivers.

"The equipment allows the PON access network to evolve beyond traditional monolithic architectures, where the control and routing plan is hosted on the same device," says Giovani Pacifico, Zyxel's director of products and sales in Brazil. With the disaggregated access network, service providers can control multiple OLT boxes as if they were cards in a chassis while scaling and customizing services based on customer needs.