Collaboration. Photo courtesy of Istockphoto

Open RAN – What is it and will it impact the satellite industry?

The evolution in radio access networks (RAN) towards an open architecture, supported by the O-RAN Alliance, has enabled increased opportunities, and streamlined the ecosystem for everyone active within it. There exist some excellent lessons to be learned by the satellite industry, although the unique challenges render a carbon copy model impossible.

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The mobile industry is undergoing a massive transformation that may have significant implications on the satellite industry down the road. As deployments and momentum behind 5G is continuing to build, so too is a whole new ecosystem of hardware and software developers of emerging mobile networking equipment that come from a different background than the traditional telecommunications world, with a deep-rooted belief in support of open-source practices, cross industry collaboration and cloud infrastructure as a vehicle for rapid innovation and commercial success.

In the roughly 40-year long history of cellular communication, the mobile network operator (MNO) market was initially developed by PTTs and some truly visionary entrepreneurs like Craig McCaw in North America, Jan Stenbeck in Europe, Sunil Mittal in India. This helped form companies that are familiar to many of us today such as AT&T Wireless, Vodafone, and Airtel. The vendor ecosystem that initially developed and helped bring technologies like GSM and D-AMPS to market has also some names familiar to many of us – Alcatel, Ericsson, Lucent, Motorola, Nokia, Nortel, and Siemens. The market grew beyond the wildest expectations at the time and moved from a business luxury to an essential part of everyday life for the population at large. Now, with more than five billion subscribers globally, the pressure to constantly innovate and deliver equipment and services at a lower cost is always present. The ever-increasing demand for R&D and cost efficiency lead to a massive and sometimes painful consolidation in the mobile infrastructure industry while two new entrants from China entered the markets, as well. Today, the radio access network (RAN) market is basically dominated by Huawei, Ericsson, and Nokia, with ZTE being a distant fourth. Many of the original equipment vendors either merged, went bankrupt or exited the market due to lack of acceptable returns on investment.

Consolidation of the RAN vendors was driven to a large degree on request by the MNOs as they grew in size and power, entered new markets and started to run multiple mobile standards in parallel. This increased complexity

significantly and MNOs needed bigger partners that could take on a greater responsibility end to end, scale up R&D and manufacturing and deliver the cost savings and spectrum efficient solutions that drives the MNO business forward. While this enabled MNOs to consistently deliver a greater EBITDA for service providers than the RAN vendor community had enjoyed, there is a global trend that is causing concern among some MNOs. The geopolitical landscape over the last few years has developed in a direction where new barriers are being put up and free access to technology is being restricted. Chinese vendors are being locked out from many markets in the name of national security and access to chipsets that are an essential part of RAN equipment is also being restricted through tighter export regulations put on chips that include American intellectual property rights (IPR). This has led to MNOs in some markets only having access to two major vendors for their mobile infrastructure needs - this is a concern among many procurement officers that favour diversity and choice.

An open marketplace

As a consequence of having fewer choices and supply constraints, many MNOs and RAN vendors look favorably on several initiatives that are well on their way to develop a more open, flexible, and competitive marketplace for hardware and software used for radio access network equipment.

The first important step on this journey was defined by 3GPP in Release 15 when they split the base station between a distributed unit (DU) and a central unit (CU). This allowed for virtualized RANs or cloud-based RANs to be deployed with pooling and sharing of hardware resources using a combination of commercial off-the-shelf and proprietary hardware. Software code for RAN functions can run virtualized using a combination of proprietary software, third party commercial software, and open source. Open RAN architecture aims to further disaggregate hardware and software as specified by 3GPP. The O-RAN Alliance is developing specifications to complement 3GPP by defining interface profiles, additional new open interfaces and new nodes. An example of this work is from the Telecom Infrastructure Projects OpenRAN project group that defines the OpenRAN reference architecture with three different elements with clearly defined and open interfaces between them:

There are a handful of new functional splits for RAN specific tasks defined that can be designated to the three main building blocks. One example of a functional split defined by O-RAN consists of the RU (Radio Unit) that handles the lower layer 1 functions (some PHY/RF). This unit is located at the cell tower next to the antenna. Then there is the DU (Distributed Unit for some PHY, RLC/ MAC/PDCP) along with the CU (Central Unit) being the interface towards the Core Network. Both DU and CU can be co-located and lend itself well to sharing and pooling of resources leading to a very cost-effective solution with a low total cost of ownership (TCO) and an ideal option for a distributed RAN deployment.

Disaggregation means a move away from the monolithic solutions traditionally offered by existing RAN vendors using a tight and proprietary dependency between hardware and software to a fully open and interchangeable and vendor neutral general-purpose platform, also called white box-based platforms, with interchangeable software.

The goal of the proponents of Open RAN is to challenge and enhance the existing vendor ecosystem and introduce supply chain diversity, flexibility and rapid innovation across the technology stack applying for instance building practices that have been prevalent in Cloud infrastructure deployments

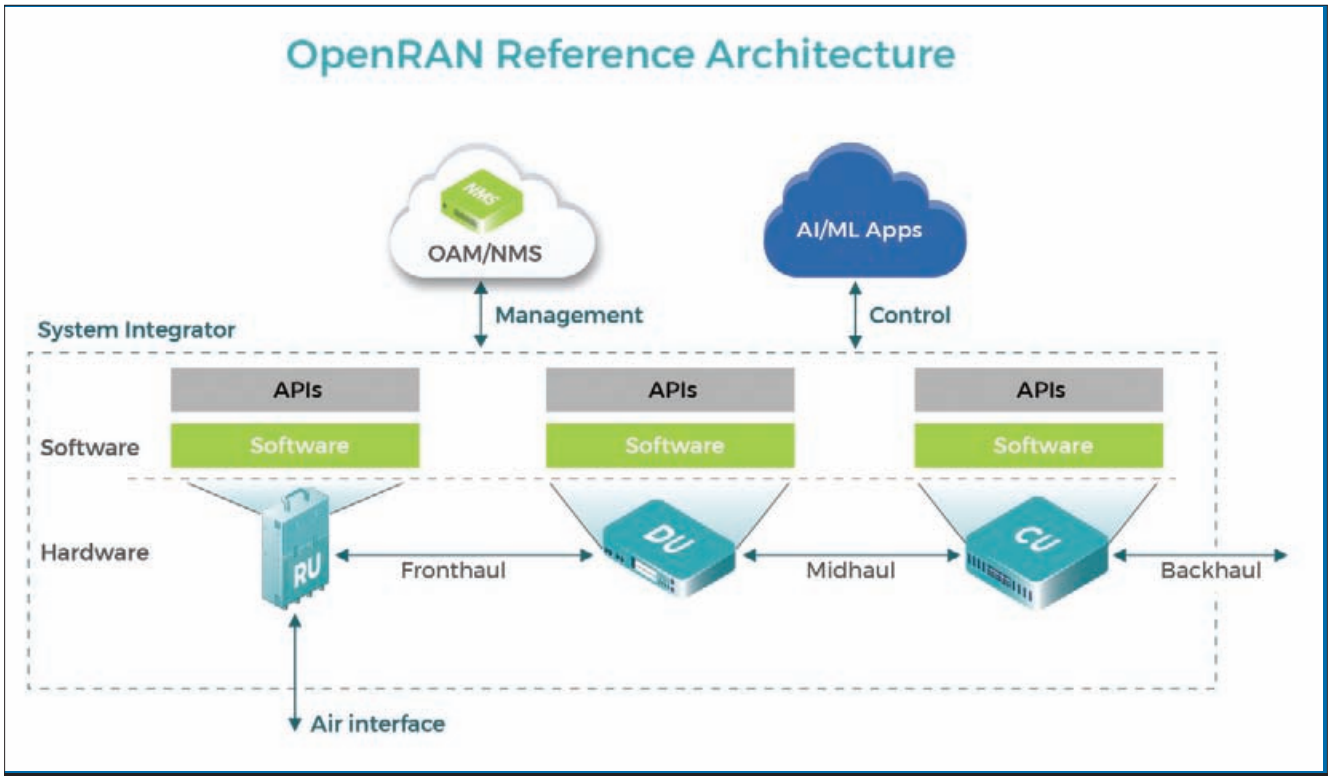

Figure 1. Courtesy of Telecom Infra Project, *https://telecominfraproject.com/openran/*

for some time, such as network function virtualization (NFV) and orchestration along with artificial intelligence and machine learning. However, this does not come without its own set of challenges, especially in handling real-time sensitive processing in the lowest layers of 5G radio baseband. One of the key challenges that will need to be overcome - despite Marc Andreessen making his famous claim a decade ago that "software is eating the world" - is a significant penalty is paid in terms of performance in wireless technology without proper hardware support.

5G is very complicated. However, the multi-standard technologies that most MNOs run are even more complicated and require immense computing power to manage Gigabits of traffic from thousands of users across hundreds of MHz of spectrum across various bands using multiple input/multiple output (MIMO) technologies. Hence the massive R&D budgets of Huawei, Ericsson and Nokia have allowed them to develop application-specific integrated circuits (ASICs) for their RAN processing needs that currently cannot be met cost efficiently with general purpose processor platforms or field programmable gate array (FPGA) based designs.

Even the big vendors are sometimes challenged by keeping up with demands. Quite famously, Nokia initially made the wrong bet on chip technology for their early 5G base station designs, resulting in the loss of big contracts in China; ultimately this played a part in a major management shakeup and redesign of the portfolio. Although Ericsson and Nokia (but not Huawei) are supporters of O-RAN, the Swedish vendor recently took a shot across the bow of the white box solution proponents claiming that its proprietary platform and ASICs are years ahead of any existing commercial off-the-shelf technology in terms of processing power for RAN specific tasks. They made the same analogy that Apple recently did with the launch of its M1 processor to replace Intel processors in Mac computers, that a very tight integration is indeed needed between software and hardware to get the most efficiency across all dimensions of a solution. This has been a poorly kept secret for some time and led to many calls from O-RAN members to the chipset industry to get behind their ambitions. We are starting to see some manufacturers now answering this call, although it will be some time until new chipsets specifically designed for Open RAN requirements will be generally available.

Other challenges are related to scale and the need for testing and integration. The MNO vendor community enjoys several orders of magnitude greater scale than the satellite industry does, but this is still only true for a select few. The barrier of entry for new RAN vendors is quite high, and it is difficult to scale to support the massive deployments MNOs are looking to do in 5G. When it comes to testing and integration, one of the advantages of a monolithic architecture is that it comes pre-integrated and tested. There are less dependencies on different vendors' software and hardware across the radio access network for which someone in an Open RAN deployment needs to take responsibility and ownership. Both O-RAN and TIP have rightfully identified the need for testing and validation and are making it a priority in their project groups to accelerate commercialization.

Despite Huawei not having joined the O-RAN Alliance, perhaps this will lead to some future, interesting IPR discussions as the Chinese vendor lay claim to a significant patent portfolio (important to note is that O-RAN does not equal open source but is based on the same FRAND principles as 3GPP). The support for the initiative is massive with Vodafone, Airtel, and AT&T, along with several other prominent MNOs behind it together with many well-known names in the infrastructure and chipset world like Ericsson, Nokia, Cisco, Dell, Intel, Nvidia, Qualcomm and ARM.

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While the Open RAN market currently generates just a few hundred million dollars in revenue, the forecast of expected growth varies greatly. Some predict it will be a several billion-dollar market very soon, while others take a more cautious approach. However, the growth in revenue is expected to be in the double digits year over year and a middle of the road assessment of the total market size put Open RAN at US$4-5 billion or about 10 percent of the total RAN market by 2025. While some of the technical, commercial and deployment challenges have been discussed above, most MNOs have made their first cut of 5G infrastructure vendors already and picked one or more of the existing RAN vendors as their partners for the first phase. As the 5G rollouts mature and the second wave begins in a couple of years, more opportunities for Open RAN will emerge.

Satellite industry benefits

So, what benefits can the satellite industry draw from this development, and what can we learn and apply to our industry and ways of working?

One question that consistently arises in satellite-focused webinars and industry events is: Why can't satellite communications be more like the mobile industry and rally around a standard, and enjoy the same economies of scale and ecosystem that they do?

I can see a few reasons and it applies a little differently depending on what sector of the satellite industry you look at. While the satellite industry the last couple of years has seen more investments in space-based technology than ever before, the size of investments is still small compared to the overall MNO industry. Money, innovation, and talent gravitate towards where the nice returns are, both personally and financially, and while the satellite industry is making great strides especially in the last few years, it still has some ways to go as an industry to enjoy similar benefits.

Secondly, key to the MNO industry's success, despite some being frustrated with both the process and speed of innovation, is 3GPP. This is the technical working group that for over 20 years has written the technical specifications that are the basis for the 2G, 3G, 4G and 5G standards. 3GPP provides the foundation that helps establish a market and an ecosystem that has both massive scale and stability over

time. Satellite technology used for telecommunication services in C-, Ku- and Ka-band, such as broadband access to enterprises and consumers and backhaul for MNOs, has less cross-industry cooperation. Judging by many of the new and proprietary NGSO constellations and V-HTS platforms in development, the industry has yet to agree on a standard that can potentially yield similar benefits. While some work is being done to leverage open standards and building practices in teleport infrastructure and how to connect to other telecom networks, little has been invested in standardizing satellite designs and air interfaces end to end to create a similar ecosystem to 3GPP. And many argue there are good reasons for it as satellite designs for high-speed broadband services are different than building a terrestrially based radio access network and include challenges that are truly unique to satellite communications.

Embracing 3GPP

Now, of course, there are always exceptions to any rule and what is inspiring to see is that several satellite companies particularly with interest in L and S-band are fully embracing 3GPP for predominantly narrow band access services from space. These are the use cases that looks at IoT, texting and voice services similar to what we are used to in terrestrially based cellular networks. These companies are set to leverage not only the massive user terminal chipset ecosystem from companies like MediaTek, but also well-defined BSS/OSS systems built for scale along with all the innovations coming from Open RAN and similar initiatives surrounding the entire mobile ecosystem. Disaggregated solutions will help add the flexibility and economies of scale these companies need to succeed with their satellite RAN.

In terms of the new base station designs and vendors that will emerge as a result of Open RAN, the satellite industry is poised to benefit from increased competition and eventually lower cost base station equipment. As anyone that has ever been involved in rural deployments of wireless technology knows, one of the key challenges is always about closing the business case and total cost of ownership. Many of the hardware and software vendors in the Open RAN community have a specific focus on connecting the unconnected with new and innovative solutions and the satellite industry is set to gain from this. The Telecom Infrastructure Project where Comtech EF Data is a member does a tremendous job at bringing companies together to collaborate cross-industry to solve the commercial and technical challenges of connecting the unconnected.

Many will argue that the best fit for the first generation of Open RAN is actually with rural and greenfield deployments as Open RAN will need some time to support high bandwidth multi-standard deployments and deal with difficult challenges like massive MIMO and interference cancellation that is more common in urban settings. As the GSM industry association (GSMA) point out in their analysis on how to reduce the digital divide and close the coverage gap, innovation needs to happen in two areas; network infrastructure including base stations, backhaul and energy, and innovation in business models including a service led approach through cloud enablement and collaborative deployment models. Connecting the unconnected has been at the core of what Comtech EF Data has been doing for years and we are happy to work and collaborate with satellite operators, mobile networks operators, infrastructure vendors and industry associations like TIP to make it happen.

As shown in Figure 1, the new functional splits that are being specified rely on a front-haul interface between RU and DU and a mid-haul interface between DU and CU. Front and mid-haul interfaces are very high-speed interfaces that requires low latency and delay variation making them a challenge even for LEO constellations. The opportunity for satellite backhaul still remains with the traditional backhaul interfaces, Abis, IuB, S1 and N3 that has for many years now been successfully backhauled over satellite to connect to the core network. An added benefit that comes with the new design philosophy is that introducing computing power closer

to the edge of the mobile network will allow for more traffic and services to stay local, making the business case for satellite even stronger as latency and bandwidth becomes less of an issue. A parallel, and interconnected development with Open RAN is happening that will leverage local or regional, private or public cloud infrastructure that distribute computing and storage capabilities far out in the networks in what is called EDGE computing. EDGE computing and the ability in 5G and Open RAN networks to provide service delivery closer to where it is actually consumed is in itself perhaps one of the most significant enhancements of mobile network infrastructure in a long time. Some envision that just like the APP/Play store helped bring new applications, services and companies to market leveraging the smartphone ecosystem (think Uber, TikTok, etc.), so will EDGE computing help bring new services, innovations and entrepreneurs inside 5G networks. This may one day help transform many businesses and value chains.

Usher in a new era

Industry 4.0 for instance will usher us in to a new era of industrial automation, machine learning and artificial intelligence, and 5G and distributed computing will help make it happen. You don't have to look far to also see several opportunities for a better satellite service delivery model happening at the EDGE. As an example, it has been a wish of the satellite industry for many years to leverage the inherent broadcast capabilities that come with GEO satellites also in radio access networks.

Finally, there is now a natural entry point in mobile networks for content delivery that fits well with satellite broadcast capabilities. Another possibility is that the local computing and storage capabilities may one day also lead to satellite modems as a service or as a cloud native or NFV application running next to RAN specific software.

While O-RAN in itself is not developing any new waveforms or mobile standards, it is working in a symbiotic relationship with 3GPP helping plug some of the holes in a few of the interfaces that has excluded competition and innovation from happening. And while 3GPP will continue to be the flag bearer of mobile standards and work within its well defined and rigid process of bringing specifications to market, O-RAN has proven that Internet speed of innovation can happen alongside it using ways of working that has made companies like AWS and Google what they are today.

Although building satellite networks is different than building radio access networks, there are discovery and insights that can move freely in between. The O-RAN alliance has shown that if supply is constrained, innovation is held back or competition is not sufficient, it is possible to challenge the status quo and make a change. One individual company would have difficulty making the necessary changes, but an alliance of companies coming together with a common vision can do it as proven by the few years O-RAN has been in existence. In the telecom world, a whole new ecosystem of hardware and software, applications and services are being developed that is open and inclusive and leverage the latest in Cloud technology, machine learning and artificial intelligence and apply an Internet age way of working and thinking to an existing technology and market.

As the satellite industry is moving towards a new era of NGSO, V-HTS and 5G supported satellite networks, we are at the cusp of a new space age that will propel our industry to the mainstream, and we will enjoy similar benefits. Comtech EF Data is embracing this transformation and look forward to working with our customers and partners to bring new innovations and solutions to market that will help make a lasting impact on society.

Global connectivity. Photo courtesy of Fotolia