The path to a virtualized RAN requires a flexible architecture

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Executive Summary

Operators are transforming their networks from the core to the edge to support a number of new use cases and industry verticals in a flexible way. They have many options for architecting their infrastructure for a diverse range of 5G and edge services. For the radio access network (RAN), deployment options include both workload optimized RAN and virtualized RAN, which can co-exist to deliver the next generation of 5G cloud-native RAN that is both agile and cost-effective.

For operators choosing to cloudify mobile networks, it is considered to be one of the most transformative technologies. Communications service providers (CSPs) have long sought to find agile and cost-effective ways to build and maintain network infrastructure. Standards-based and disaggregated solutions are effective tools to help CSPs reduce their operating expenses and capital expenditures while at the same time allowing them to provide connectivity more economically.

Inspired by the openness of the IT industry, mobile operators are hoping that standards-based server technologies will help them develop and deploy telecom networks more quickly. This virtualization of the network is one way in which a mobile network operator can respond to the explosion in mobile data traffic and the growth in wireless connections including Internet of Things devices.

Software-defined networking (SDN) and network function virtualization (NFV) are two technologies that are at the heart of this network transformation. And while SDN and NFV do make 4G more efficient and competitive, these technologies are an integral part of 5G. In addition, the standards group, the Third Generation Partnership Project (3GPP), has included a software-based architecture that allows for flexible deployments of session management control function and user plane function in its Release 16 of the 5G standard.

But making the transition to an open network will take time. Operators have to carefully accommodate the growth in network traffic by densifying their networks and adding capacity while at the same time managing their limited spectrum assets.

Making this journey to a more decomposed network can be daunting. According to the Network Transformation 2020 survey conducted by GSMA Intelligence in November 2019, 82% of operators see the commercial deployment of open networking technologies as being important and 25% say they are currently deploying these types of technologies. The GSMA Intelligence survey queried 100 network infrastructure decision-makers from operators around the world.

Nevertheless, some operators have committed to this new software-oriented network architecture even though the transition promises to be a technological and operational challenge. Making this change requires a joint effort from both vendors and operators.

AT&T is one global operator that has publicly committed to virtualizing **75% of its network by year-end 2020**. "We are on track to control 75% of our core network functions with software by the end of 2020 and we are nearly there," said Scott Mair, senior vice president of technology planning and engineering at AT&T in a **January 2020 blog post**. "Today, 100% of the data traffic that runs through the infrastructure connecting the elements of our core network together is backed by SDN."

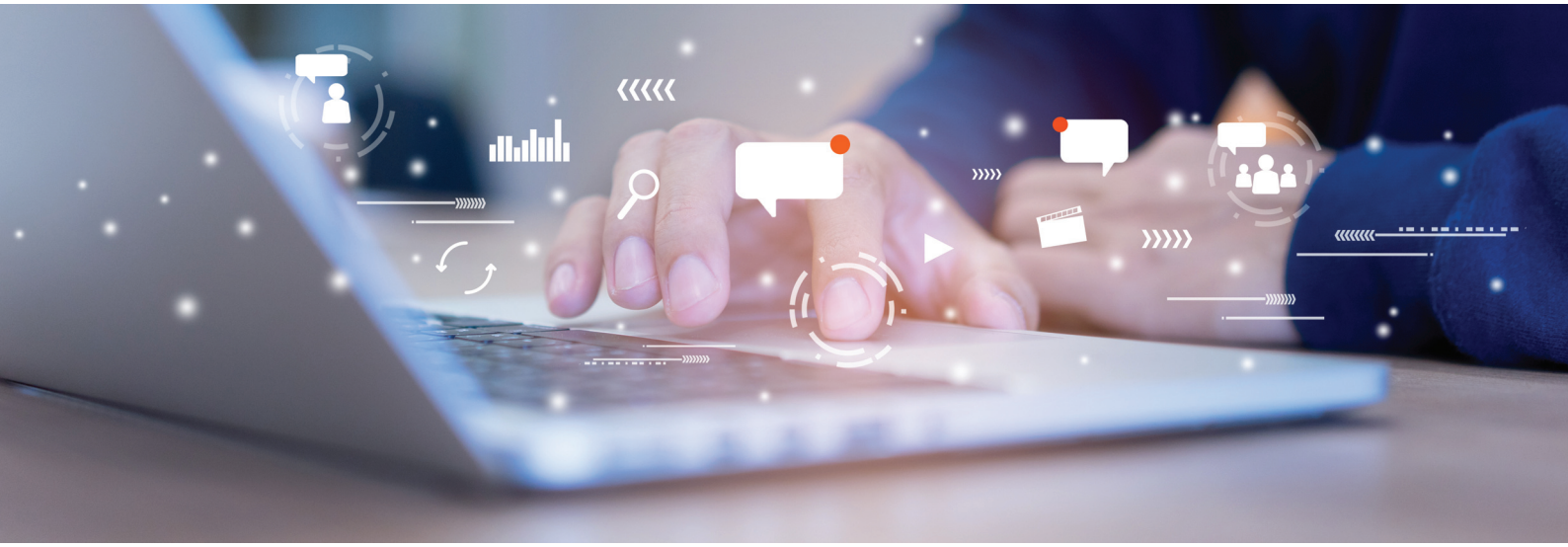
Advantages of Virtualized RAN

A key element to this larger network virtualization trend is the virtualization of the RAN (vRAN). This is becoming an important part of the RAN architecture roadmap.

Opening up the RAN provides a foundation for implementing innovative technologies to support new use cases and services, and also makes it easier for operators to deploy and maintain a network. In addition, it opens the door to more potential vendors because it makes it possible for operators to use commercial off the shelf (COTS) hardware and deploy new tools that were previously tied to specific hardware such as dynamic load-balancing and traffic steering.

"Open RAN will make it easier and faster to introduce new capabilities and new innovations in radio technology into the market and introduce new use cases into the market," said Gabriel Brown, principal analyst with Heavy Reading. Brown added that he expects this technology to disrupt the market.

According to the GSMA Intelligence survey of mobile operators, vRAN is in its early stages with the majority of operators (35%) saying that they are in the planning phase of the technology. Approximately 18% say they have no plans to deploy vRAN while another 18% say they are in the testing phase and 17% say they are in initial commercial deployment. Just 12% say they have deployed vRAN commercially at scale.



vRAN groups accelerate its deployment

Initially, different initiatives were created to accelerate the development and commercialization of vRAN.

The Telecom Infra Project (TIP) is an alliance with a goal to accelerate the development and deployment of networking technologies. TIP has an OpenRAN group that is working to define and build RAN solutions based on general-purpose vendor-neutral hardware and software-defined technology.

In addition, there is the O-RAN Alliance which is comprised of 22 mobile operators and 117 vendors, and research and development institutions. The Alliance has released 18 specifications and three sets of white box reference designs for open RAN.

In December 2019 the O-RAN Alliance conducted a plugfest to demonstrate multi-vendor interoperability of network equipment based on the group's recently published interface specifications. The plugfest was held in Asia, North America, and Europe at the same time with Beijing as the main venue. More than 70 companies participated in the Beijing event including Comba, Intel, Lenovo and ZTE.

To help verify its open interface specifications, China Mobile, China Telecom, and China Unicom has created the Open Wireless Network Test and Integration Centre (OTIC). OTIC's goal is to accelerate the implementation of ORAN products and help build a global ORAN ecosystem. In addition, these Chinese mobile operators will introduce third-party professional testing laboratories such as China Tyre Labs.

U.S. operator AT&T is involved in this new approach to the RAN and last year the company worked with the O-RAN Alliance to develop open interfaces. "Those that adopt those open interfaces will build new opportunities, create new types of services, as well as give them more competitive options for how they build their networks of the future," said Andre Feutsch, president of AT&T Labs and chief technology officer at AT&T, during a meeting of the O-RAN Alliance.

European operators Telefonica, Vodafone and Deutsche Telekom also are pushing ahead with open RAN efforts.

In May 2019 Telefonica launched a commercial deployment of open RAN technology in Peru through a wholesale operator called Internet para Todos. And in March 2020, **the operator announced** it was collaborating with Altiostar, Gigatera Communications, Intel, Supermicro and Xilinx to develop Open RAN technologies for 4G and 5G. The companies plan to launch Open RAN trials in the U.K., Germany, Spain and Brazil later this year.

Telefonica's collaboration will focus on distributed units (DUs) that are part of the baseband radio functions using Intel's FlexRAN software reference platform (more details on FlexRAN are below) and Intel's Xeon processor-based servers as well as appropriate Remote radio Units (RRUs) connected through open interfaces based on O-RAN's fronthaul specification.

In addition, Vodafone in November 2019 requested quotes for open RAN technology for its entire European footprint, which represents more than 100,000 sites. At a media event at the Telecom Infra Project (TIP) Summit in Amsterdam last year, Vodafone's head of network strategy and architecture Santiago Tenorio, invited Open RAN suppliers and incumbent RAN vendors to submit their bids. "That's significantly more than 100,000 sites, and all the technologies are to tender — 2G, 3G, 4G, and 5G," said Tenorio. "We've invited the incumbent suppliers in Europe of course, but we've also invited the open RAN suppliers."

And Deutsche Telekom **announced it was working with VMware** on developing an open vRAN platform that is based on O-RAN standards for both 4G and 5G networks. The platform will be architected by VMware and Intel and is based upon Intel's FlexRAN architecture. It will be tested and validated at Deutsche Tekelom's Bonn, Germany headquarters. Other partners that are part of the collaboration include Mavenir and Cohere Technologies.

In February 2020 the two Open RAN initiatives –TIP and the O-RAN Alliance — decided to work together to make sure they are aligned in the development of 5G RAN solutions and to avoid duplication. Both groups assert that this is not a merger but instead a "collaboration" on open RAN.

One area, in particular, where the two groups will share resources is by forming a joint O-RAN OTIC and the TIP Community Lab in Berlin. The two groups are already collaborating with Deutsche Telekom on that lab and testing new 5G New Radio platform solutions.

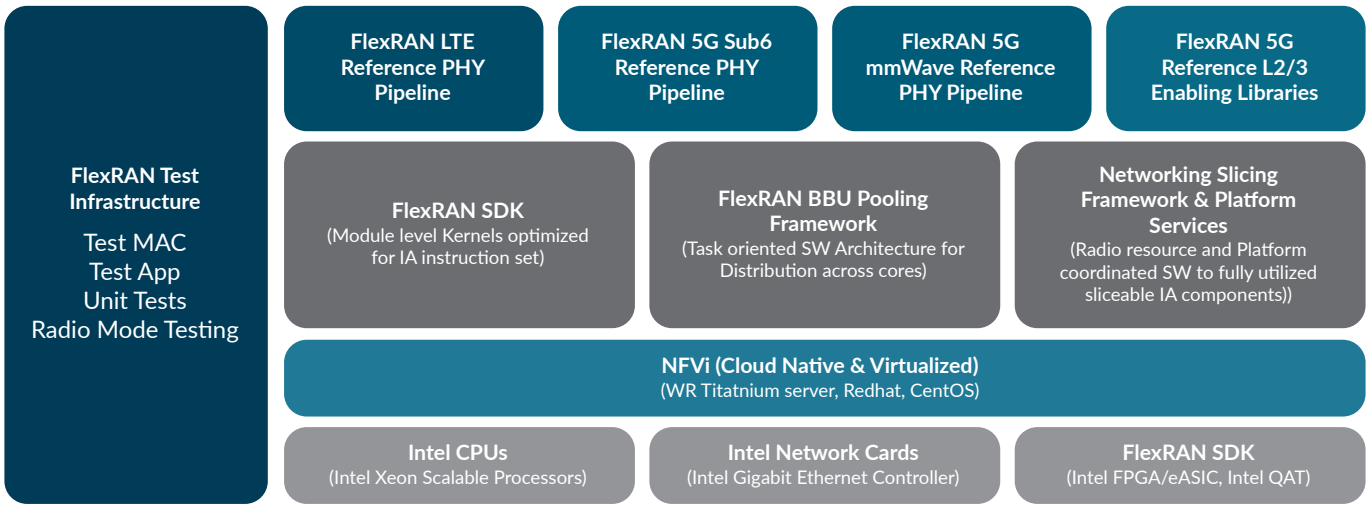
This collaboration will likely make Open RAN testing and deployments move more quickly as they have the combined resources of the O-RAN Alliance's operators and the TIP's networking experience.

Intel's FlexRAN solution can help this evolution

Software is critical to the success of 5G RAN deployments. For operators that want to implement vRAN, Intel has created a software reference architecture called FlexRAN; that is intended to help quicken development. FlexRAN uses a scalable platform design so that operators have the flexibility as they migrate to a cloud-ready network.

With FlexRAN, customers can build a cloud-native, fully virtualized 4G and 5G RAN on Intel® architecture based platforms for a wide variety of use cases, including indoor as well as macro deployments. It can be implemented on any part of the wireless network from edge to core.

FlexRAN makes it possible to efficiently implement wireless access workloads powered by a new generation of Intel® Xeon® Scalable processors along with Intel® FPGA or Intel® eASIC™ acceleration. These Xeon® Scalable processors bring a high efficiency into the wireless RAN and help operators optimize the data processing that is necessary in 5G.



Sucessful RAN L1 deployment is one of the major roadblocks to virtualization due to the strict TTI timing contraints. FlexRAN achieves this by harnessing the real-time capabilities of operating systems. The FlexRAN SDK also includes BBU pooling Framework and Network Slicing Frameworks, which act as building blocks to the LTE, 5GNR Sub6 and mmWave Reference PHY pipelines. In addition, FlexRAN supports L2/ L3 Reference PHY implementation to aid customers in optimizing their PHY solutions by using the benefits of Intel Architecture, Intel® Advanced Vector Extensions 512 (Intel® AVX512) parallel instruction set and close integration with NFV and DPDK technologies, resulting in block performance gain and increased efficiency per core.

Over 80 companies worldwide are now licensing FlexRAN solutions. One such example is **Corning who collaborated with Intel on a new virtual platform** that uses the FlexRAN reference software architecture to help accelerate and streamline in-building 5G deployments for mobile operators and enterprises. Indoor 5G coverage is an important area for operators. In the 2019 GSMA Intelligence survey of network operators, it found that 20% of operators see in-building 5G coverage as their top RAN investment priority, while 13% see it as their second-highest priority, which suggests that many operators are focusing more keenly on enterprise customers.

In the Asia-Pacific region, that figure grows to 28% of operators believing that in-building 5G coverage is their No. 1 investment priority when it comes to 5G RAN.

The platform from Corning combines their wireless connectivity portfolio with second-generation Intel® Xeon® Scalable processors, Intel's FlexRAN reference software, Intel® FPGA Programmable Acceleration Card N3000, and the Intel® Ethernet 700 Series Network Adapters (10/25/40Gb).

The virtual platform will be commercially available this year and Corning has already demonstrated the technology for several companies, including major operators.

Intel's comprehensive product portfolio

Intel is delivering an unmatched portfolio for 5G network infrastructure, spanning processors, FPGAs, structured ASICs, ASICs, switches, and Ethernet devices that can be used to create industry leading solutions, including for any RAN deployment scenario. Intel Xeon processors are being used in vRAN solutions. Intel also recently introduced the Intel Atom P5900 processor, the first Intel architecture-based System on a Chip (SoC) for wireless base stations, along with Intel's first next-generation structured ASIC for 5G network acceleration codenamed Diamond Mesa, and Intel's first 5G network-optimized Ethernet NIC.

FlexRan Customers

There are numerous examples of Intel's FlexRAN product being used by operators around the world. For instance, Rakuten is currently deploying a fully virtualized cloud-ready mobile network in Japan to achieve greater flexibility, efficiency and cost benefits.

Rakuten used Intel's FlexRAN in their development, and their network's vRAN is running on Intel® Xeon® processor-based servers along with the Intel® FPGA Programmable Acceleration Card N3000 as hardware acceleration. It supports radio access technology from Altiostar and core network software from Cisco, providing a network that is fully virtualized from RAN to the core.

Rakuten recently launched a commercial scale end-to-end cloud native network. The company has announced low-cost unlimited pricing plans and Rakuten Mobile CTO Tareq Amin told reporters **last September** that much of the initial network is complete and the company has constructed its own IP backbone as well as all its core network functions. At that time, he said that the company's virtualized RAN is already operating 182 virtual network functions (VNFs).

In addition, H3C, an Ethernet switch maker, and Comba Telecom Holdings are using Intel's FlexRAN 5G NR-compliant solution for 5G.

Comba makes wireless access, antennas, and subsystems for operators around the globe. The company provide a comprehensive 5G small cell solution that is based on Intel's FlexRAN architecture and uses Intel FPGAs. It is also powered by Intel® Xeon®-D processors, which would help operators to implement the scenario-based indoor 5G coverage.

Comba launched the world's first commercial 5G small cell with cloud architecture in 2019, which includes an Access Unit (AU), an Extended Unit (EU), and a Remote Unit (RU) that are all using Intel technologies. The AU is based on the Intel® Xeon®-D processor and the Intel® Stratix 10 FPGA that can handle the baseband processing for four carriers, each with 100 MHz bandwidth. The EU is also using the Intel Arria 10 FPGA to do the fronthaul processing function, while the AU is using the Intel Cyclone 10 FPGA for the DFE function.

At Mobile World Congress Shanghai 2019, Comba, Intel, and China Mobile demonstrated the company's 5G small cell technology. With four remote units, a base station unit and a 5G CPE, the company was able to achieve total downlink speeds of 3.5 Gbps and uplink speeds of over 760 Mbps.

Based on leading and mature cloud-based small cell solutions, Comba has launched large-scale commercial projects with China Mobile, China Telecom and China Unicom in more than ten cities.

Beyond the operator market, Comba's 5G cloud-based small cell solution is also widely applied in the vertical industry due to its flexible open interface design, such as the first 5G + industry application in Guangdong Province and the intelligent mining project in Shandong Province.

Conclusion

Operators are supporting various use cases and have choices in how they architect their RAN. Virtualization and cloud-based technologies can offer benefits for operators who are embracing open networking. It lets them blend software and hardware to become more adaptable and agile in how they offer services and respond to consumer demands.

With innovations like Intel's FlexRAN reference architecture that offers agile future-proof platforms, and tight collaboration among a growing ecosystem, mobile operators can accelerate their transition to 5G and beyond.

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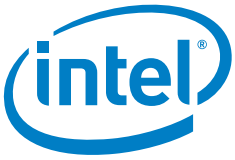

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