Virtualizing Radio Access Networks

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Content

Key opportunities and challenges for telecom companies

Only a few years after the telecom NFV (Network Function Virtualization) revolution, a new trend in mobile digital communication has emerged: virtualization of the Radio Access Network (vRAN). Dedicated telecom appliances in the 'micro-datacenters' at the base of cellular radio towers are being replaced by industry-standard Intel servers, which run cloud-native network function software based on Kubernetes.

Once again, IT meets telecom and two worlds converge. What's more, this new telecom operator technology comes at precisely the right time for 5G roll-out. So why should mobile carriers adopt it, and what is the safest way for them to do so?

Business drivers for virtualizing Radio Access Networks

For the highly distributed radio access networks of mobile carriers, vRAN is what classic NFV is for the core network. It improves agility; for example, software updates and extensions are cheaper and easier to accomplish than appliance swaps. And it lowers total cost of ownership and ease of maintenance; for example, novel future features may be available in software form only, meaning that expensive hardware doesn't need to be updated.

In addition to these benefits come additional value propositions:

Transparency

Open-source software can be easily scanned for security backdoors; appliances with proprietary firmware less so. Countries considering telecom infrastructure a critical asset of their national security will go for transparent software and avoid deploying appliances from overseas vendors suspected of a political agenda.

Colocation

In the near future, telecom operators are likely to be expected to deliver value-add services (VAS) out of their radio-tower 'micro-datacenters', addressing ultra-reliable low latency communication (URLLC) requirements as from connected autonomous vehicles or life-supporting medical equipment. The 3GPP global initiative ensures that emerging technologies are compatible with usable radio access networks, service and systems aspects, and core networks and terminals. With each of its releases outlining key milestones, 3GPP Release 15 specifies a 1ms latency target, a figure that's likely to be realistic only if radio towers become part of the 'far edge' for VAS delivery.

Openness and inter-operability

Open RAN, specifically, promises standardized interfaces across all components, so multi-vendor deployments are supported and vendor lock-in is prevented.

vRAN can be utilized for 5G and LTE; solutions for 3G and before have also been announced by the leading software vendors. By 2030, standardized Open RAN is expected to cover more than half of all RAN deployments and establish a market estimated between tens to above 100 billion USD. Accenture attributes 49% of CapEx savings to Open RAN. Goldman Sachs sees estimates the CapEx savings of Open RAN technology at 50%, and adds 35% OpEx savings on top.

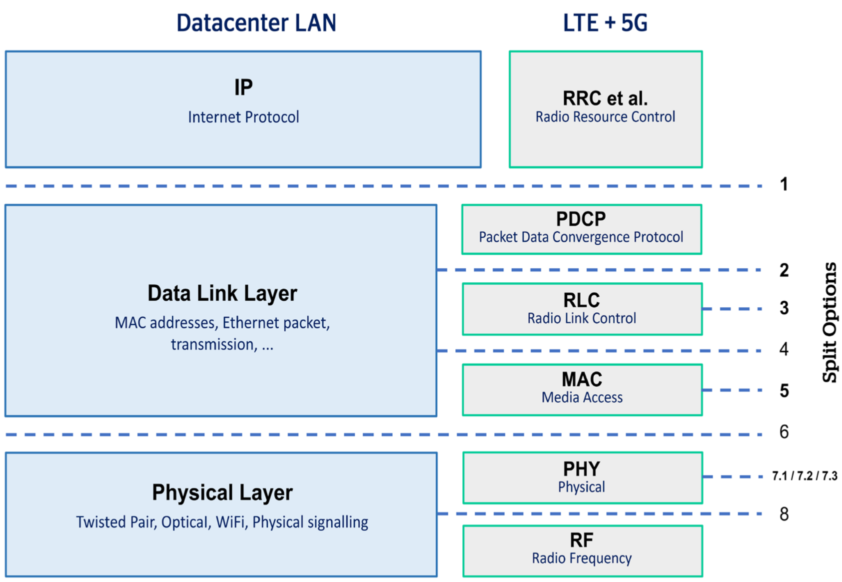

Figure 1: Datacenter LAN and LTE+5G RAN network stacks – a comparison

Development of vRAN

Only a few years after the telecom NFV (Network Function Virtualization) revolution, a new trend in mobile digital communication has emerged: virtualization of the Radio Access Network (vRAN). Dedicated telecom appliances in the 'micro-datacenters' at the base of cellular radio towers are being replaced by industry-standard Intel servers, which run cloud-native network function software based on Kubernetes.

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The beginnings

Traditionally, the BBU appliances have been housed in the 'micro-datacenter' shed at the foot of, or integrated into, a radio tower. This is called a distributed RAN (dRAN – see Fig. 2).

The idea emerged of centralizing the BBUs in a datacenter, and connecting only the distributed radio units (RUs) through a so-called front-haul network line. This – the emergence of the centralized RAN (cRAN) – was in effect the birth of all virtualized RAN (vRAN), because the deployment of virtualized BBUs (vBBUs) on a datacenter NFVi pod is an inviting bi-product of centralization. However, the RUs and antennae must stay where they are; and the front-haul connection is very sensitive to bandwidth, latency and jitter effects, which limits the viability of the solution.

In technical terms, the functional split between the RU and the vBBU would be between the PHY (physical) and MAC (media access) layers in Fig. 1 – split option 6. Everything PHY and below is RU and antenna matter, everything MAC and above is vBBU responsibility.

Where an optical or copper cable front-haul is possible over a short distance, cRAN solutions are clearly a viable choice. That can be the case, for example, between an edge satellite datacenter and several cell sites surrounding it.

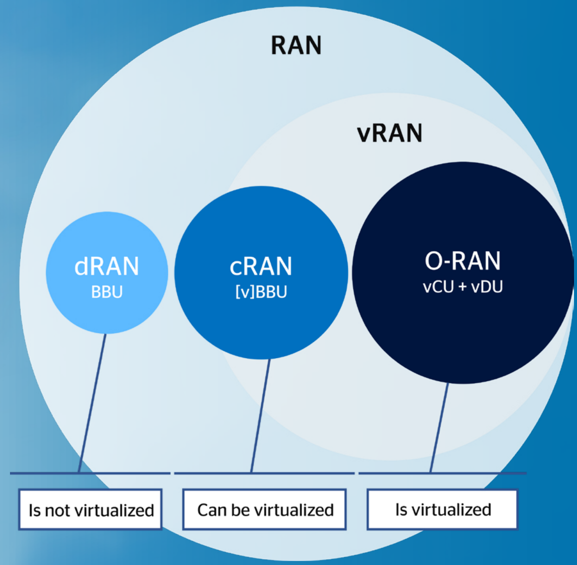

Figure 2: The evolution of RAN

Disaggregation enters the scene

The breakthrough of vRAN came with the disaggregation of computationally intensive real-time functions – RLC (radio link control) and below in Fig. 1 – and non-real-time functions – PDCP (packet data convergence protocol) and above. Fig. 3 explains the architecture. RLC and below functions (except RF) are combined in the distributed unit (DU or, when virtualized, vDU), whereas PDCP and above go into the central unit (CU or vCU). The mid-haul network connection – that is the name of the link connecting the DU and the CU – typically uses split option 2 (Fig. 1). Of course it is possible to run the RU and the vDU in different locations, too, as in the dRAN approach. However, for the split 7.2 between the two – discussed below under "connecting the radio unit" – all the bandwidth, latency, and jitter challenges apply again.

Disaggregated vRAN can be of the modern Open RAN variant, striving at standardization of all the relevant network interfaces – the front-haul, the mid-haul, and the back-haul (between the vCU and the cell-site gateway router of the datacenter running the core network). O-RAN, specifically, stands for Open RAN from the O RAN Alliance, an association of vendors promoting Open RAN technology.

A related development is control and user plane separation (CUPS), which keeps network control (e.g. connection setup) apart from payload traffic processing. CUPS eases disaggregation and improves scalability. (In Fig. 1, RRC proper is a control plane function. The user plane has its own protocols, such as SDAP – service data adaptation protocol.)

Needless to say, the DU – responsible for the real-time function in the RAN network stack – is a very sensitive component. It normally runs on an edge server in the vicinity of the radio tower.

Connecting the radio units

It is common today to use split option 7.2 (Fig. 1 and 3) for the front-haul; in other words, the lower part of the PHY layer would be handled by the radio unit (RU) and the upper part by the vDU. Interface specifications like Common Public Radio Interface (CPRI) and enhanced CPRI (eCPRI) have emerged for this purpose.

In 5G it has become standard practice to employ eCPRI and to always virtualize the DU. Virtualization of the DU is based on network function cloudification (NFC) with Kubernetes. NFC can be considered the successor of NFV.

One of the best-known architectural blueprints for disaggregated and virtualized RAN is the FlexRAN architecture by Intel. FlexRAN stipulates an Intel field-programmable gate array (FPGA) accelerator card to offload computationally intensive signal processing workload occurring in the DU. The typical hardware platform for the vDU is a two-socket Intel server with one or two FPGA accelerator cards, running (ideally) a real-time core Linux kernel and bare-metal Kubernetes.

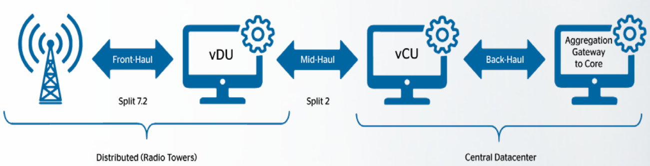

Figure 3: Disaggregated RAN

Role of the network integrator

While the vision of Open RAN is intriguing, especially the vDU, its split 7.2 eCPRI connection to the RU, and its hardware and bare-metal Kubernetes platform harbor technical pitfalls. Carriers wishing to deploy vRAN today have the choice between buying an off-the-shelf solution – which may be 'half-Open RAN' – and therefore risking vendor lock-in, or doing a lot of their own multi-vendor convergence testing.

A smart third option is to employ a system or network integrator who is knowledgeable in RAN technology. System integration costs are offset by the price advantages of adopting an open systems approach.

Atos has many years of experience in building IT cloud solutions, with both conventional hypervisors and with Kubernetes; since 2016, it the company has supported its telecom customers in NFVi implementation and virtual network function (VNF) deployment. Atos is also known for expertise in NFV management and orchestration (MANO) solutions, and operations support system (OSS) integration.

A capable network integrator can be expected to support telecom operators with the following vRAN services:

- Assist with the development of a **RAN modernization plan.** Questions to address include the size and distribution of existing radio towers, extension plans (such as campus micro-cell offerings), the accessibility of the tower sites, or the availability of edge datacenters nearby.
- Advise on **technology and vendor selection.** One important question when choosing an Open RAN product is how far back older mobile networks need to be supported: 5G and legacy LTE are implicit, but should 3G and/or 2G also be carried? In some geographies the lifecycles of 3G and 2G are far from over, and compatibility vRAN solutions are entering the market.
- **Design and build the infrastructure** from hardware – hyperscale architectures for the vCU and other central network functions, edge servers with FPGA cards for the vDU – through operating platforms, typically a Kubernetes execution environment.
- **Execute lab tests and proofs of concept** for the complete vRAN system. Atos operates a telecom solutions lab in Grenoble, France, which conducts interoperability tests and custom solution development. On top of that, many telecom operators wish to set up an on-premise reference proof of concept before starting the roll-out of a RAN modernization program. Together with partners, Atos can also deliver Labs as a Service (LaaS).
- Be **prime contractor** for the full roll-out and roll-out testing programs.
- Implement **xApps integration** between the RAN intelligent controller (RIC) and multi-access edge computing (MEC) platforms. This feature, which is new to 5G with O-RAN, offers powerful network control to 5G-based edge application of the future.
- Increasingly, **decarbonization** of the Radio Access Network plays a role. 5G is an energy-saving technology because advances in massive multiple-input and multiple-output (mMIMO) antennae and related technologies significantly reduce the broadcast energy needed to transmit a certain amount of information over a given distance – the 'GByte per kJoule' parameter; overall energy, asset and availability management of the (potentially solar-powered) cell sites is of increasing importance. Atos runs a number of projects to create a digital twin of a carrier's network and to employ data analytics and AI to optimize asset management, maintenance and energy cost.

Complex roll-out programs should by iterative, following a **PLAN-DO-CHECK-ACT** Deming methodology (Fig. 4): Execution of a **PLAN** – the **DO**ing – needs to be followed by a **CHECK** step, and by **ACT**ing on the results of this check, i.e. immediate implementation of necessary and viable improvements. Lessons learned in each iteration feed into the fine-tuned **PLAN**ning of the subsequent phase of the program.

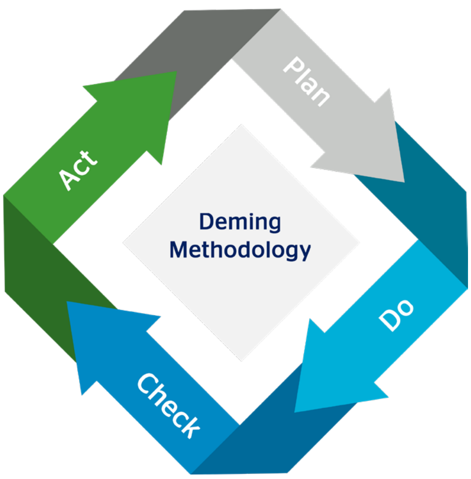

Figure 4: PLAN-DO-CHECK-ACT Deming Wheel.

Open RAN is a new technology in motion, subject to rapid ongoing development. Expertise is hard to find and needs to be updated and maintained. Experience from past enterprise IT cloud and from core-network NFV projects is a key foundation to continually evaluate the status of technology, and to keep vRAN projects smooth and open to ongoing technological progress.

Importance of a partner ecosystem

The Open RAN product scene is rapidly evolving and innovations enter the market fast. Another important role of an effective network integrator is therefore to connect with, and open up access to, specialist partners and niche providers.

For any telecom company, waiting for progress to slow is unlikely to be the right strategy. Cooperating and collaborating with the leaders in critical component technologies and making sure there is an innovation roadmap is the way to go. (After all, an open technology roadmap is one of the reasons why many telecom operators shun proprietary solutions and subscribe to open-systems solutions.)

A good system integrator will maintain close alliances with an ecosystem of technology leaders in two independent areas in order to ensure continuous up-to-date technology readiness (see Fig. 5):

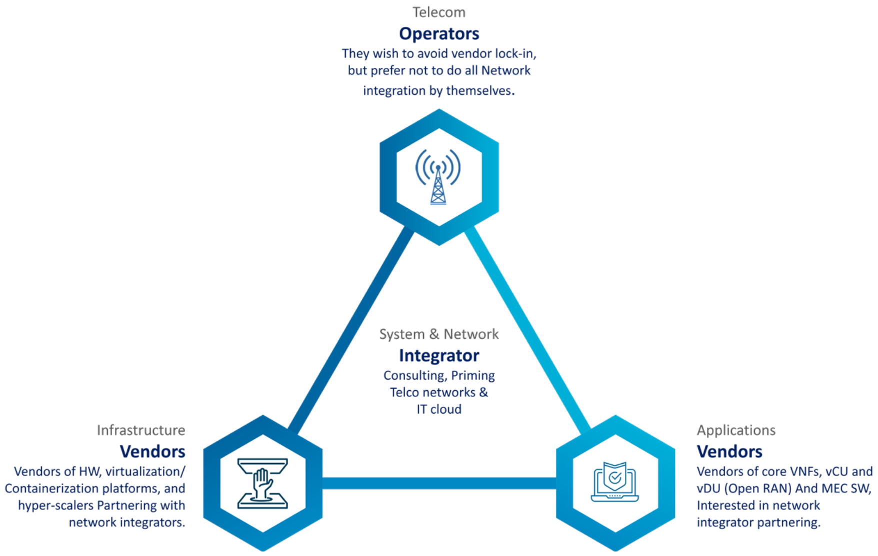

Figure 5: System integration partner ecosystem

Application-level

Application-level partners, who offer vDU and vCU software (typically Intel FlexRAN) and ensure eCPRI and split-7.2 compatibility with eligible radio units.

Infrastructure-level

Infrastructure-level partners, who offer suitable HW (servers, FPGA accelerators) and platforms (bare-metal Kubernetes, Kubernetes on OpenSTack, and more). That is complemented by the Atos BullSequana product line of datacenter and edge servers.

This kind of dual-type, carefully maintained partner ecosystem, in combination with years of cloud and NFV integrator expertise, strongly contributes to de-risking RAN modernization projects for any telecom operator that wants to be innovative and strictly vendor-independent.

White Paper

About Atos

Atos is a global leader in digital transformation with 105,000 employees and annual revenue of over € 11 billion. European number one in cybersecurity, cloud and high performance computing, the Group provides tailored end-to-end solutions for all industries in 71 countries. A pioneer in decarbonization services and products, Atos is committed to a secure and decarbonized digital for its clients. Atos operates under the brands Atos and Atos|Syntel. Atos is a SE (Societas Europaea), listed on the CAC40 Paris stock index.

The purpose of Atos is to help design the future of the information space. Its expertise and services support the development of knowledge, education and research in a multicultural approach and contribute to the development of scientific and technological excellence. Across the world, the Group enables its customers and employees, and members of societies at large to live, work and develop sustainably, in a safe and secure information space.

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Let's start a discussion together

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