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OPEN RAN: MATURE AND READY FOR DEPLOYMENT

WHITE PAPER

February 2021

INTRODUCTION

While the Open RAN momentum is continuously growing, most recently bolstered by the MoU among EU operators[1], traditional vendors have trouble deciding whether Open RAN is a serious threat or should be part of their R&D investment as they commit to Open RAN as the future architecture. At every stage, traditional vendors have raised concerns on aspects such as performance, security, and integration costs, creating fear, uncertainty and doubt among operators who are looking at options to build and evolve their networks.

It is worth restating that Open RAN is about having Open and Interoperable Interfaces for product nodes to allow multiple vendors to produce interoperable products and widen the supply chain. Open RAN does not describe or mandate how a node be implemented whether it be in virtualized software or dedicated custom hardware.

KEY TOPICS IN THIS WHITE PAPER

This white paper article focuses on the following Open RAN architecture aspects:

- Security Aspects
- Power savings with Open RAN based architectures
- Cost optimization with COTS
- Cloud benefits with Open APIs – Automation & Scaling
- Performance improvement with RIC and AI/ML
- Mature eco-system
- Faster Time to market
- Innovation

[1] https://www.totaltele.com/508561/TIM-joins-the-party-for-European-Open-RAN

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1. Security Aspects

Security aspects of Open RAN architecture have been already addressed in previous white papers[2].

2. Power savings with Open RAN based architectures

Statements have been made that Open RAN deployments consume up to 40% more power than current deployments. However, when comparing equivalent configurations of D-RAN/C-RAN with Open RAN, Open RAN actually provides power savings through the use of inherent architecture changes described in the O-RAN Alliance fronthaul 7.2 specification that focus on reducing transmission bandwidth when there is lower traffic and power saving features such as use of Section Type 0 for putting radio in low power mode when idle.

Fronthaul power savings

On an equivalent basis, power saving is achieved through following aspects:

- The speed of the O-RAN interface is a fraction of the interface speed when compared to CPRI and has a direct effect in lowering power consumption. The transmission bandwidth savings can even be greater than 4X for 4T4R radios using features available in the specification such as fronthaul compression and sending frequency domain samples as available from the O-RAN specification and can be much more for massive MIMO if layer information is sent instead of antennas with precoding done in the radios. The reduction in transmission bandwidth also has a direct benefit on lowering the power consumption of network interface cards (NIC), CPU packet processing and power savings through the complete fronthaul network.
- As designed in the O-RAN front haul interface specification, the used transmission bandwidth is proportional to the user bandwidth. If there is zero traffic, there is minimal front haul interface traffic allowing the power consumption to be minimized.
- With no traffic, the DU draws minimal power and uses minimal CPU core resources due to minimal traffic. This allows the DU to be overprovisioned supporting multiple RRUs per DU eliminating dedicated DU's per radio given step functions in power savings.

[2] https://mavenir.com/resources/openran-architecture-provides-path-to-secure-open-networks/

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RF power savings

The RF dominates the power consumption at a cell site for 5G as shown in the figure below from Huawei. Open RAN interfaces do not impact the radio (RF) power consumption. The RF power consumption is not impacted by the interface since the radio only performs time domain processing and uses optimized fronthaul. The Open RAN ecosystem is growing through white box radio developments such as Evenstar with Facebook, MTI and Mavenir. With the removal of margin stacking, licenses structure and the saving in power consumption through RF device innovation, the radio cost can come down substantially. There have been multiple announcements by Analog Devices, Maxlinear, Fujitsu, MTI and others related to innovative DPD/CFR techniques. Such innovation will be further strengthened by the entry of multiple new players in the Open RAN ecosystem. The power savings of radios with Open RAN based split 7 architectures has also been demonstrated by NEC in their Rakuten deployment[3].

Typical Maximum Power Consumption of a Single 5G Base Station

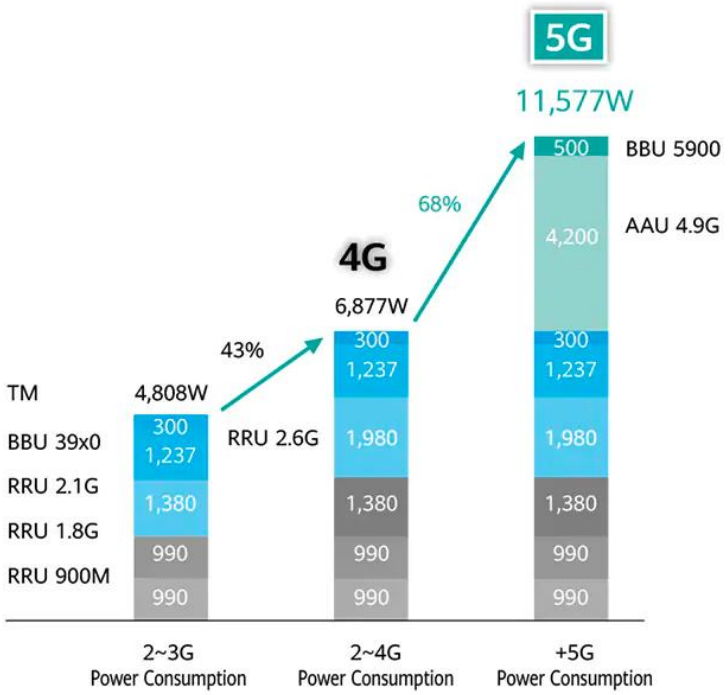

Figure 1: Source: Huawei

[3] https://www.nec.com/en/press/202003/global_20200324_02.html

RAN software power savings.

As the disaggregated RAN compute resources move to data centers, the power efficiency can take advantage of the global data center power optimization trends. The data center power consumption has increased by 6% since 2010 but at same time the amount of compute in the data center has increased by 550%[4]. With centralized baseband processing in the cloud, it is much easier to pool resources taking into account the workload variations across cell sites and time of day and implement usage-based power savings that can be adjusted dynamically.
A NGMN study in Europe shows that 80% of a wireless network carry only 20% of the traffic.[5] and pooling across sites could potentially reduce DU/CU capacity requirements with significant compute and power savings. With scalability and demand-based usage, processors (CPUs or GPUs) that are processing radio software can also run other applications during non-peak times. This is not possible with proprietary baseband systems using dedicated, non-reusable hardware.

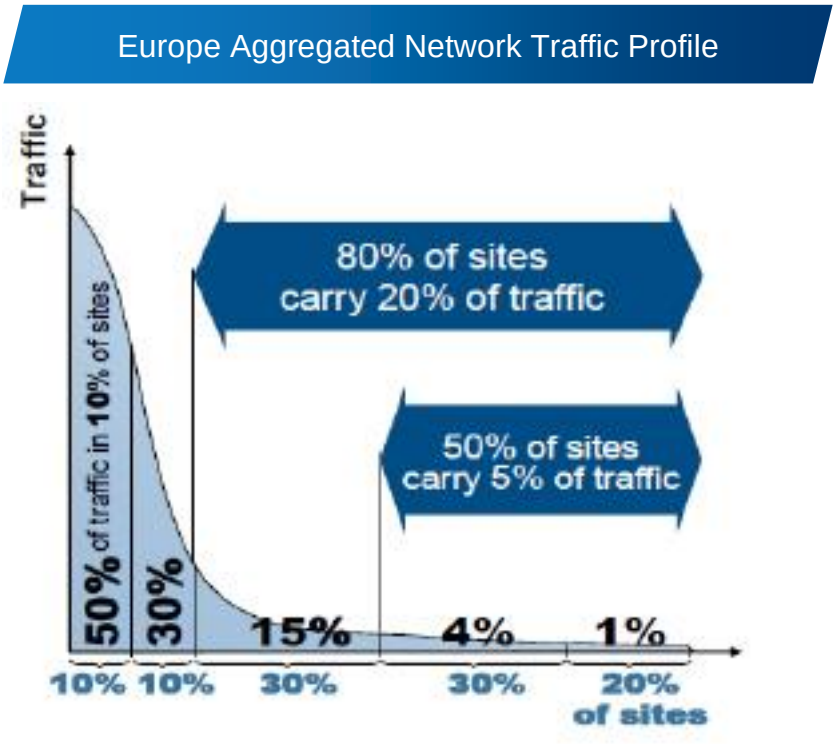

Figure 2: Source: NGMN

[4] https://www.datacenters.com/news/data-center-power-optimization-increase-efficiency-with-a-data-center-audit

[5] https://www.ngmn.org/wp-content/uploads/NGMN_RANEV_D2_Further_Study_on_Critical_C-RAN_Technologes_v1.0.pdf

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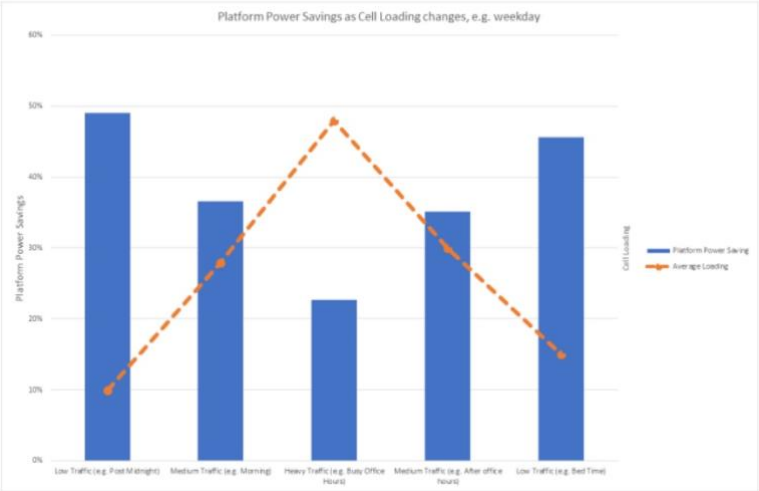
Platform Power Savings with load

Moving RAN to the cloud using open interfaces offers potential reduction of electricity cost, as the RAN processing can now be shared among cell sites. In densely deployed networks, as in city centers, the network traffic load can fluctuate very much during the day, with significant periods of minimal traffic at certain cell sites for extended periods. There are also many short gaps in the data transmissions even during highly loaded times. Modelling the cell load profile over a 24-hour period over different types of cells, demonstrates that power savings in the range of 30-55% can be achieved.

Elastic Power Savings



Advanced measurements using AI/ML can be performed to predict traffic patterns, traffic load, and end-user needs, from network level across nodes down to subframe levels with a cell. Based on this data, RAN compute and radio equipment can be dynamically activated to achieve the lowest possible energy consumption with maintained network performance. The dynamic compute provisioning optimizes utilization of silicon and prevents over-provisioning of resources. This results in reduction in power and energy consumption compared to traditional RAN architecture, improves scalability, and consequentially lowers the TCO.

This consolidation also enables telco operators to take advantage of existing compute and storage infrastructure offered by cloud providers, instead of incurring all such costs in-house. A public cloud hosted deployment will significantly reduce the investment burden on telco operators.

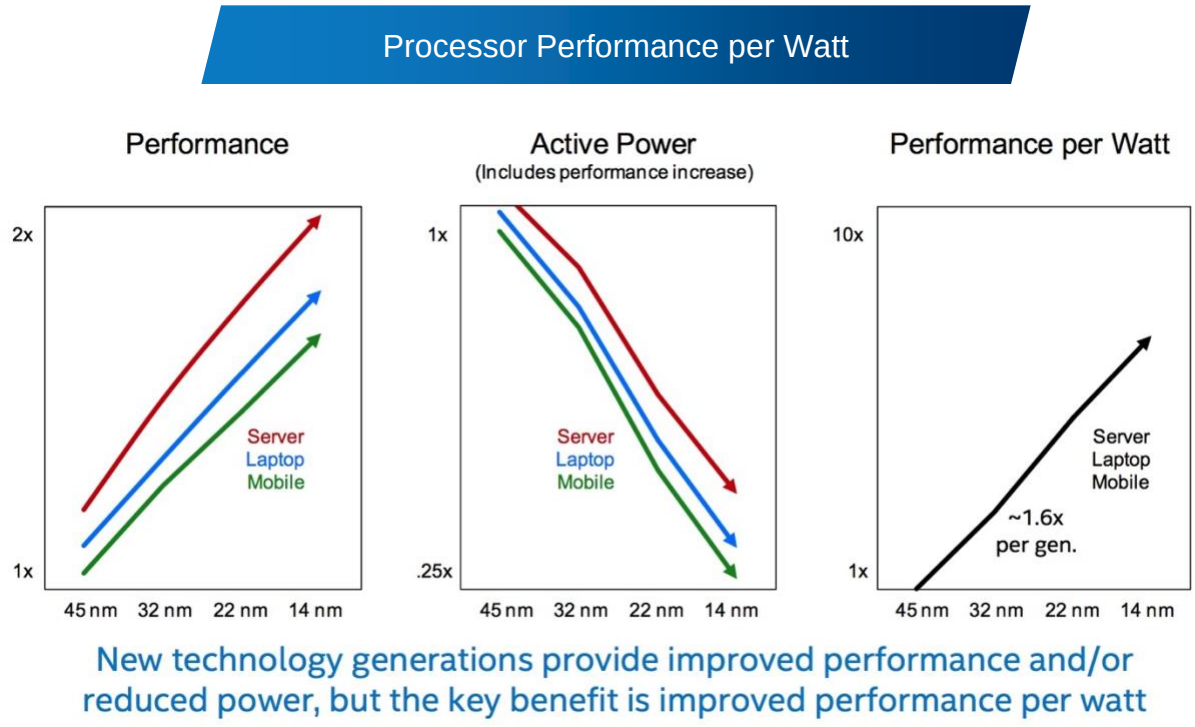


Figure 3: Source: Intel

When looking at processor roadmaps, power efficiency and capacity is improved with every generation of the processor technology providing performance improvements as the transistor feature size continues to shrink. Also, further optimizations are possible for dynamic power management using processor BIOS and power settings to control the voltage and frequency of the processor based on the network configuration and usage. The figure below shows roughly a 1.6X improvement in performance per watt every processor generation.

Accelerator power savings

To restate, just because RAN is now open – dedicated hardware can still be used for specialized functions for performance and power saving improvements. – **Open RAN simply implies interfaces are open**. Though the preference is for COTS hardware from a reuse preference, dedicated (e)ASICs, FPGAs, GPUs, and other such commercially open accelerators, are perfectly acceptable solutions to provide hardware function acceleration and power savings in the context of open RAN. The performance and power optimizations on these accelerators are also rapidly improving with every generation as they address the telecom market, and they are being made more generic to support a wider variety of applications with the same hardware.

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3. Cost optimization with cloud and COTS

- Operators throw away proprietary systems from traditional vendors every few years and are unable to use these proprietary radio systems for any other application. In the last 25 years, as we have gone from 2G to 5G, legacy telecom vendors have not changed and keep building proprietary systems while the whole world around telecom operators have embraced open systems and cloud.
- Proprietary radio implementation using closed interfaces support “rip & replace” strategies as the entire solution has to be fully replaced with every vendor, every technology change or feature requirement.
- Utilizing Open RAN based solutions in a web scale way enables operators to leverage general purpose off the shelf computing hardware.
- Centralized pooling for RAN will deliver commercial rate benefits in addition to the power consumption and capacity benefits. Usually, large data centers qualify for preferential rates in many parts of the world vs. individual cell sites. There are also other opportunities for alternative energy sources to be applied due to scale and easier logistics.
- If carriers adopt cloud technologies now, they will build not only 4G and 5G networks but will be 6G ready as there will be reuse with their current investments. There is now an incentive for open silicon vendors to apply their technology to telecom applications.
- Accelerator chips that are used for gaming, life sciences, algorithms can be used for telecom applications without sacrificing interoperability across Open Interfaces. Open RAN has standardized accelerator APIs so that various forms of acceleration can work with COTS hardware. The cost for building these systems will come down significantly due to a wider customer base for such accelerators.

4. Cloud benefits with Open APIs – Automation & Scaling

- With 4G/5G, there are a wide variety of use cases that need to be supported with flexible requirements on data rates, latencies, and functionality. Disaggregated RAN enables open API-based cloud implementations, which allow for scaling with the same software and hardware architecture to support different use cases.
- With cloud technology adoption in an open RAN architecture with a common application platform (Open RAN software to Packet Core to IMS), one can make use of the entire automation and CI/CD processes across the entire E2E network including the radio.
- Having an open disaggregated RAN architecture with cloud native implementations allows the use of different types of data centers that can be owned by operators or by hyperscale providers to host these RAN software workloads. These data centers could range from edge data centers such as AWS Outpost or Google Anthos to public and

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hybrid clouds and the operator has flexibility in deployment based on the use cases and transport availability and pay-as-you-grow models for scalability. For e.g., to support low latency application if the Operator does not have own data center, users could be serviced using radio software running on Edge data center from a hyperscale cloud provider partner.

- RAN deployment times and software upgrade times can benefit from innovation in IT industry moving from hours to minutes and new features can be added in days instead of months [see chart below called “End2End Network Automation” from a commercial Open RAN deployment in Rakuten which highlights benefits in E2E automation across customer activation, cell site deployment, new feature deployment and network availability]

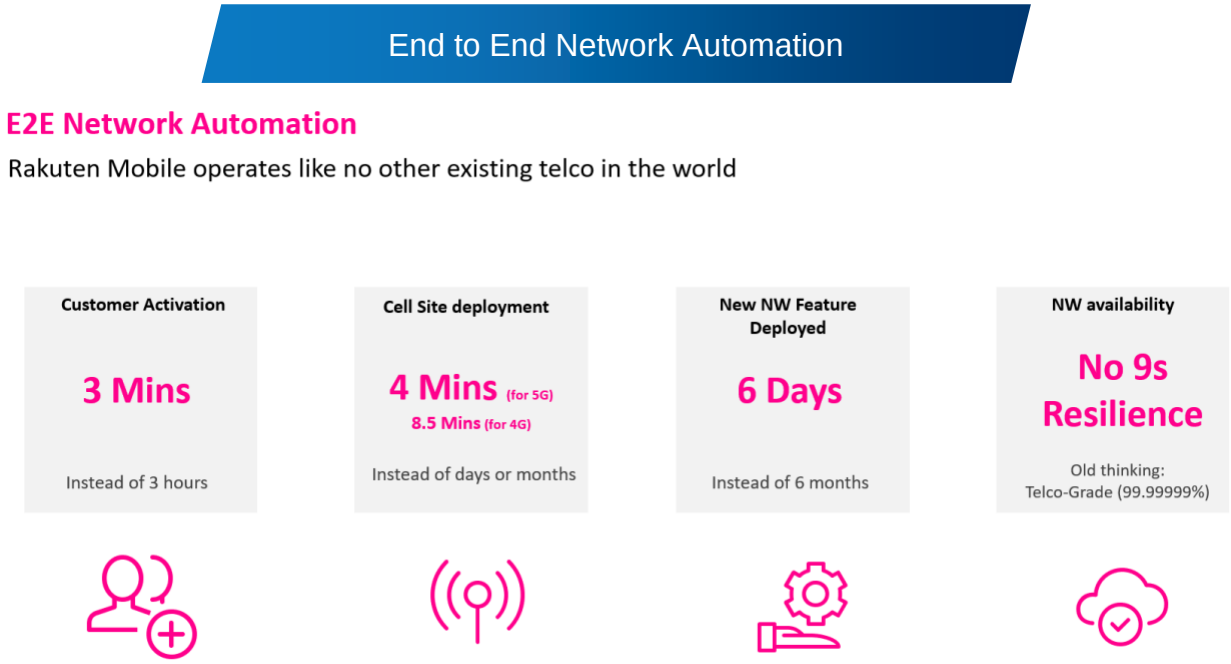

Figure 4: Source: Rakuten

- By adding radio as an additional application in the cloud, network data obtained from multiple sources in the cloud (including the RAN, Core, IMS etc.) can be now collected in a common datalake using a standardized and open observability framework interface. AI/ML based analytics can then be used to process the data from the datalake and obtain network wide insights and implement network wide performance optimization.

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5. Performance improvement with RIC and AI/ML

- Several operators such as Vodafone and Verizon have mentioned the Open RAN and virtualized solutions are already meeting or even exceeding their KPI expectations.
  - From Vodafone CEO[6]: "We have had trials taking commercial traffic for about a year now," he said. "It is a 2G, 3G and 4G trial and it is live and the KPIs [key performance indicators] are really good and in some cases better than the incumbent.
  - Operators such as Verizon have already adopted vRAN and are now aligning with Open RAN as well
- One of the performance benefits provided by Open RAN is the ability to add artificial intelligence and machine learning (AI/ML) based network optimizations with a standardized API so that the open community can contribute to applications to optimize the network without having to provide the entire solution. This functionality is being enabled by the
  O-RAN alliance with the Real time Intelligent Controller specifications. RIC enables mobility optimizations and provides greater control of the RAN to the operator enabling policy settings to tune the network.
- Centralization of RAN CU/DU processing enables feature optimizations that can use information across cell sites for the RAN processing at a centralized location and provide improved spectral efficiency and latency optimizations such as interference management with COMP, multi-cell scheduling and handover optimizations between cells connected to same CU/DU.

[6] https://www.lightreading.com/open-ran/vodafone-ceo-read-targets-urban-open-ran-in-2022/d/d-id/762704

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6. Mature eco-system

- The standardization aspects for Open RAN O-RAN started in 2017 and the O-RAN specifications are now mature in their fifth revision published with 237 mobile operators[7] and network equipment providers who are now part of the O-RAN ecosystem. There are O-RAN compliant products from multiple vendors, and this has been deployed and validated in commercial networks such as Rakuten, Vodafone, Telefonica, DT, TIM, Orange to name a few and is being deployed by many other operators worldwide.
- The OpenRAN Policy Coalition (ORPC) as of February 2021,has over 60 members. Coalition members represent a cross-section of the wireless communications industry globally, ranging from network operators to network solutions providers, systems integrators, cloud providers, edge device manufacturers, and more. The Coalition presently consists of the following members: Airspan, Altiostar, American Tower, Analog Devices, ARM, AT&T, AWS, Benetel, Bharti Airtel, Broadcom, Ciena, Cisco, Cohere Technologies, CommScope, Crown Castle, DeepSig, Dell Technologies, Deutsche Telekom, DISH Network, Facebook, Fujitsu, GigaTera Communications, Google, Hewlett Packard Enterprise, IBM, Inseego, Intel, JMA Wireless, Juniper Networks, Ligado Networks, Marvell, Mavenir, Microsoft, NEC Corporation, NewEdge Signal Solutions, Nokia, NTT, Nvidia, Oracle, Palo Alto Networks, Parallel Wireless, Pivotal Commware, Qualcomm, Quanta Cloud Technology, Radisys, Rakuten Mobile, Reliance Jio, Rift, Robin, Samsung Electronics America, STL Tech, Telefónica, Texas Instruments, U.S. Cellular, US Ignite, Verizon, VMWare, Vodafone, World Wide Technology, XCOM-Labs, and Xilinx.

[7] https://techblog.comsoc.org/category/o-ran/

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7. Faster Time to market

- Open RAN is both time and cost efficient in terms of deployment. Operators do not have to wait for customized hardware and set of features from a single vendor to start their deployment. Operators can go with whichever vendor(s) who is/are ready with the features they need and enable competition between vendors to serve their deployment needs in a timely manner.
- As the different parts of the Open RAN ecosystem have built up (hardware vendors, chipset providers, software players), the various vendors supporting the ecosystem have also come together testing interoperability. So, there are no inherent blockers in Open RAN technology itself.
- Open RAN enables virtualization, which implies faster development and innovation using open-source tools. This enables operators to ensure multiple sources of supply and not be dependent on single source as closed systems are today.
- With Open RAN deployments and container-based virtualization of applications, operators can use automation frameworks already widely used in the IT industry such as CI/CD processes for all applications, reducing deployment times and software upgrade times from hours to minutes.

8. Innovation

Lack of innovation and closed systems has put the whole industry in a bad economic situation. Operators spend billions to buy spectrum, spend billions to build networks and then spend billions to give phones free to people for them to stay on those networks. There is no money left to do anything innovative. Companies like Zoom, Twilio, Snap chat and many others make money running on these networks.

Open RAN also enables open-source eco-system for development. A comparison can be made with Linux and Microsoft, when it was mentioned that open-source software will make all applications on that platform open source and unusable, which turned out to be false[8]. The key is Open Interfaces. Open RAN, by enabling open APIs, enables innovation, while allowing vendors to differentiate within the applications and functionality provided by their hardware and software.

- Having an Open RAN architecture now enables multiple vendors and operators to co-operate, contribute and innovate on new technologies as the industry moves towards 6G.

[8] https://www.theregister.com/2001/06/02/ballmer_linux_is_a_cancer/

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About Mavenir

Mavenir is building the future of networks and pioneering advanced technology, focusing on the vision of a single, software-based automated network that runs on any cloud. As the industry's only end-to-end, cloud-native network software provider, Mavenir is transforming the way the world connects, accelerating software network transformation for 250+ Communications Service Providers in over 120 countries, which serve more than 50% of the world’s subscribers.

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