CRA Insights: The Economics of 5G

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October 2020

The economics of 5G deployment in the “race” to 5G: The role of open RAN

Deployments of 5G networks are rapidly progressing in several countries. The massive global investment in 5G infrastructure has focused attention on equipment suppliers, whose products are the building blocks of the new and upgraded networks. As we discussed in our last ***Insights*****,** the market for 5G radio access network (RAN) equipment is highly concentrated worldwide and exhibits high barriers to new entry. It is even more concentrated in the US due to the exclusion of major Chinese equipment vendors.

Carriers value a diversity of options in equipment vendors because diversity provides the carriers both more bargaining power to negotiate favorable prices and terms and more choices of equipment specifications, availability, and servicing to suit the needs of their networks. The high market concentration limits the options available to carriers. Exacerbating the detrimental effects of market concentration in the US is the fact that the largest excluded vendor, Huawei, is generally considered a global technology leader in 5G RAN equipment. Of additional concern to US policymakers is that there are no American companies making RAN equipment who are meaningfully competitive today.

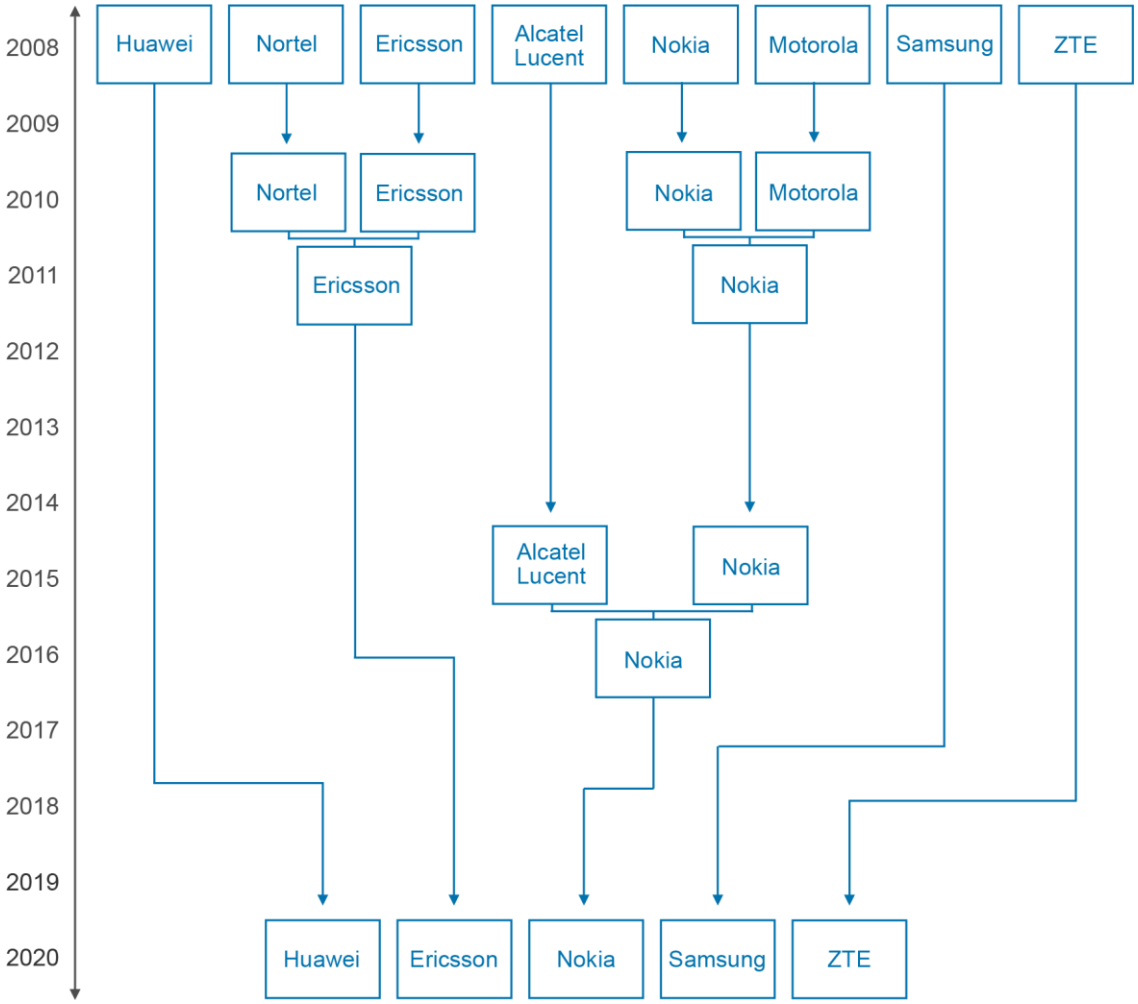
Against this backdrop, there have been increasing efforts by many industry participants to develop an alternative technology that could bring new entrants into the telecommunications equipment industry. The 5G RAN technology that has been, and continues to be, developed by the five major global suppliers (Nokia, Ericsson, Samsung, Huawei, and ZTE) is an evolution of the traditional approach to radio access equipment. In the traditional approach, the RAN components consist of hardware and software that, while they comport with interoperability standards, are nevertheless proprietary to the vendor. The proprietary nature of the vendors’ component hardware and software limits the ability of carriers to intermix vendors’ equipment in the same cell sites or even same geographic regions. In this *Insights*, we discuss the technologies known as “OpenRAN” and “virtualized RAN” (vRAN) that are anticipated to become alternatives to the traditional RAN ecosystem. We also discuss the evidence to date regarding whether OpenRAN and vRAN could become viable alternatives in major 5G deployments.

Background

The RAN equipment industry has undergone consolidation and has become significantly more concentrated over the past decade. Figure 1 shows the consolidation of global RAN equipment vendors over the years 2008–2020. In 2008 there were four major (i.e., those with more than 10% of the revenue share) suppliers of RAN equipment—Alcatel-Lucent, Ericsson, Huawei, and Nokia—

and four smaller suppliers—Motorola, Nortel, Samsung, and ZTE. By 2020, only three of the major and two of the minor suppliers remain. As Figure 1 shows, there has been no significant entry into the market for RAN equipment, reflecting the barriers to entry we discussed in our previous ***Insights***.

Figure 1: Consolidation of major worldwide RAN vendors 2008–2020



Notes:

1. Ericsson acquired a variety of Nortel's businesses over 2009–2011: Ericsson acquired Nortel's network divisions relating to LTE and CDMA in 2009; Nortel's GSM business in 2010; and certain assets of Nortel's multiservice switch business in 2011.
2. The majority of Motorola Solutions' wireless network infrastructure assets were acquired by Nokia in April 2011.
3. Alcatel-Lucent was acquired by Nokia in January 2016.

Sources:

1. Telefonaktiebolaget LM Ericsson, Annual Report, 2011, p. 88.
2. Nokia Corporation, Form 20-F, for the fiscal year ended December 31, 2012, p. 9.
3. Nokia Corporation, Form 20-F, for the fiscal year ended December 31, 2016, p. 2.
4. Based also on data provided by Dell'Oro Group.

What are OpenRAN and vRAN?

Because of the limited interoperability of traditional RAN network components, carriers typically procure all components of traditional RAN networks to be deployed in the same geographic area from a single vendor. OpenRAN and vRAN are designed to enable interoperability between network components, providing an opportunity for vendors to purchase components of their RAN networks from multiple vendors even for deployment in the same geographic area, and reap the benefits of diversity of choice.

OpenRAN and vRAN (collectively "open RAN") technologies aim to disaggregate hardware and software and create open interfaces between them based on community-developed standards.[1] Open RAN solutions are based on a general purpose, vendor-neutral hardware known as "commercial-off-the-shelf" (COTS) hardware, and on software-defined technology. The groups developing open RAN technology work on defining and building open RAN solutions for all generations of digital wireless technology from 2G to 5G.[2]

Several engineering and technology working groups and initiatives are developing and promoting deployment of open RAN standards and equipment. Two leading organizations are the Telecom Infra Project (TIP), formed in 2016 by Facebook, and the O-RAN Alliance, founded in 2018 by AT&T, China Mobile, Deutsche Telekom, NTT DOCOMO, and Orange. These two groups signed a partnership agreement in February 2020 that is intended to promote collaboration, joint testing, and coordination in development and deployment of open RAN technology.[3]

A number of American companies, including Altiostar, Affirmed Networks, Mavenir, Parallel Wireless,[4] and Airspan[5] have emerged as developers and vendors of open RAN technologies.[6]

Anticipated advantages and challenges of open RAN

Open RAN is anticipated to lead to significant reductions in network capital expenditures (CAPEX) and operating expenditures (OPEX) and shorten the time required for carriers to upgrade their networks.[7] The proponents of open RAN believe that the use of standardized hardware has the potential to substantially reduce the costs of entry for new competitors, thereby attracting new competitors and encouraging innovation.[8]

Despite the interest of many industry players in a virtualized RAN solution, however, open RAN is not yet a viable commercialized solution for use at scale. Santiago Tenorio, Head of Network Strategy & Architecture at Vodafone (a potential user of open RAN), concluded as of three months ago, "[w]e haven't even scratched the surface of system integration challenges."[9] Scott Perry, Vodafone UK's Chief Technology Officer, indicated that, while Vodafone is investing in open RAN, open RAN solutions are currently 4-5 years away from being ready for deployment at reasonable scale in dense urban and suburban areas.[10]

Similarly, Mohamed Madkour, the Vice President of Huawei's wireless and cloud unit (a vendor of technology competing with open RAN), concluded last month, "[w]e know that [open RAN] is not mature at the moment, and it will not solve any 5G problems right now."[11] AT&T's Laurie Bigler echoed a similar sentiment, indicating at an Open RAN Forum hosted by the Federal Communications Commission (FCC) in September 2020, "We really see that integration is the biggest challenge ahead. You really don't find the issues or gaps with the specs until you actually try to integrate two vendors' equipment together…There is considerably more work to do to fully validate the interfaces and to implement them at scale. So, we're likely to see a more gradual introduction of open RAN into our existing network."[12]

On the more optimistic side, ABI Research, a consultancy that provides research and strategic guidance on emerging technologies, expects open RAN to mature quickly and become a "viable

alternative for 5G network deployments in the next few years."[13] Indeed, as discussed below, one entrant into the wireless services market expects to have an open RAN network operational at scale within a few years and another entrant expects to be operational at scale in less than a year.

The potential for carriers to procure equipment from a broader range of vendors to build a best-of-breed multi-vendor network is seen as a benefit of RAN virtualization. There are several common criticisms of open RAN, however. First, the multi-vendor approach could increase the complexity of networks and potentially lead to interoperability concerns because virtualized solutions require a smooth interface between the equipment of multiple vendors.[14] Interoperability between multi-vendor network components has not yet been fully tested.[15]

Second, an additional challenge of multi-vendor solutions for RAN, as with any part of a communications network, is that it is sometimes unclear whose equipment is responsible when a system fails. The lack of a clear assignment of responsibility for a failure can delay and complicate repairs and corrections.[16] The complexity of solutions that rely on equipment from multiple vendors may therefore create resistance to adoption of open RAN technology.

Third, the scalability of open RAN equipment required for widespread deployment is also a concern. It is not yet known whether open RAN deployments in high-demand or dense areas will perform acceptably. In addition, the companies currently providing open RAN solutions lack scale both collectively and individually in comparison to the legacy RAN vendors such as Ericsson, Huawei, and Nokia. According to Vodafone's Mr. Perry, with the exclusion of Huawei from the UK, Ericsson and Nokia are the only vendors that can currently provide 5G RAN equipment at scale, and that equipment is traditional, proprietary technology.[17]

Attitudes in the US toward open RAN

In January 2020, a bipartisan group of US senators proposed investing at least $750 million in open RAN technologies to create US-based suppliers of RAN that would be an alternative to the Chinese companies.[18] Indeed, many of the nascent open RAN infrastructure suppliers are US companies, including software vendors Altiostar,[19] Airspan,[20] and Mavenir,[21] and could benefit from the proposed investment.

Other recent US-based initiatives to promote open RAN include a new Open RAN Policy Coalition that was formed in May 2020 to advocate for government policy encouraging open RAN adoption, and the FCC's Forum on 5G Open RAN on September 14, 2020. The Open RAN Policy Coalition has 31 members, including the major US carriers AT&T and Verizon.[22] The FCC advertised its forum as promoting American leadership in researching and developing innovative mobile deployment technologies.[23]

Deployments of open RAN worldwide

The global landscape of carriers launching open RAN deployments is highly dynamic and announcements of new deployments and trials arise nearly every month.

According to Dell'Oro Group, an industry source of market information about the telecommunications industry, sales of open RAN equipment will capture less than one percent of the RAN market this year, but Dell'Oro Group predicts that sales of open RAN will increase to nearly 10% of the total RAN market ($5 billion) by 2025.[24] The biggest early deployments are anticipated to be made by carriers without legacy networks or who are building networks in areas in which they do not have an existing network, also known as "greenfield" deployments.[25] In contrast, carriers deploying 5G via upgrades to their existing networks, also known as "brownfield" deployments, have largely been using traditional 5G technology.

The biggest open RAN deployment to date appears to be by Japanese carrier Rakuten Mobile. Rakuten, an e-commerce company, received regulatory clearance from the Japanese government in April 2018 to become the fourth nationwide carrier in Japan. As a new entrant to the wireless business, Rakuten is building a greenfield network throughout Japan.[26] In 2019, Rakuten Mobile was the first carrier to implement a fully virtualized multi-vendor RAN,[27] and in April 2020, Rakuten Mobile launched a fully virtualized 4G network that included equipment from Altiostar, Airspan, Mavenir, and Nokia.[28] In September 2020, Rakuten launched its commercial 5G network, currently limited to certain areas in six of Japan's 47 prefectures. Rakuten expects that its 5G network will be available across the entire country by the end of March 2021.[29] For its 5G network, Rakuten is using MIMO antenna equipment manufactured by NEC Corporation, millimeter wave antennas (in the 28GHz spectrum band) manufactured by Airspan, and open RAN management software provided by Altiostar.[30] According to Rakuten Mobile's CTO Tareq Amin, open RAN CAPEX is 40% lower than traditional RAN CAPEX, and he expects to achieve even higher savings on OPEX.[31]

DISH Network, a US-based provider of pay-TV services, entered the wireless retail space on July 1, 2020, when it acquired prepaid brand Boost Mobile from T-Mobile. Currently, DISH operates as a mobile virtual network operator (MVNO) using T-Mobile's network. DISH is planning to launch a 5G network by the end of 2020 and plans to cover 70% of the US population by June 2023 using open RAN technology.[32] DISH's network is another greenfield deployment. DISH announced that it is planning to use equipment and software from Altiostar, Fujitsu, and Mavenir.[33]

Telefónica, the major Spanish wireless carrier, announced that it is going to conduct 4G and 5G open RAN trials in the UK, Germany, Spain, and Brazil in 2020. Telefónica plans to commence post-trial deployments in 2021 and achieve significant rollouts in 2022, but has not announced whether the deployments will be greenfield or brownfield. The company is collaborating with vendors including Altiostar, Gigatera Communications, Intel, Supermicro, and Xilinx, Inc.[34] It has also announced a joint procurement scheme for open RAN software and hardware with Rakuten.[35]

Vodafone UK turned on its first OpenRAN 4G site in rural Wales using software supplied by Mavenir in August 2020.[36] However, while Vodafone UK has an established network and is a major carrier, its open RAN deployment consisted of just one cell site. The major German carrier Deutsche Telekom has partnered with equipment vendor VMware and chip supplier Intel to develop scalable and economic open RAN solutions based on O-RAN standards, but this endeavor is in very early stages and no deployments have been announced.[37]

Conclusion

The pattern of open RAN trials and deployments to date suggests that, at the current level of technological development, fully-virtualized open RAN 5G networks are more suitable for greenfield deployments than for upgrades of established major networks. Companies that are deploying 5G networks today are willing to conduct trials or deploy open RAN in parts of their networks, but carriers that already have legacy RAN networks are not engaging in significant open RAN deployment and are unlikely to use open RAN broadly in their networks in the near term.

The deployment of 5G networks using traditional technology has been underway for up to two years in several countries. Data provided by the GSM Association (GSMA) show that next generation wireless networks tend to be extensively deployed within a country in a relatively short period of time. For example, according to GSMA data, carriers operating in the seven major countries on which data were available to us deployed 4G LTE networks covering at least 80% of the population within 1.5 to 4.5 years from initial deployment, and they built out networks covering at least 90% of the population within two to five years, using traditional technology.[38]

In contrast, the timeline for research and development of robust RAN equipment has, in the traditional equipment industry, tended to span nearly a decade for each new technology

generation. In addition, as noted in our previous ***Insights***, the major traditional equipment vendors each invests between $1.9 billion and $19.1 billion *per year* in R&D. The potential that a new technology platform can substantially replace traditional RAN technology in a short period of time, or that the proposed infusion of financial stimulus by the US government at the levels proposed can sufficiently accelerate the progress of open RAN to render it a viable substitute for traditional technology in the eyes of the major carriers in time to affect the US position in the "race to 5G," may be unrealistic when viewed in context of industry timelines and investments. It appears that, if open RAN fulfills the hopes that many in the industry have for it, it will reduce entry barriers to becoming a facilities-based wireless services provider, as it appears to be doing in Japan with Rakuten and in the US with DISH. It may also fulfill the promise of elevating the presence of US companies in the RAN ecosystem. It is unlikely, however, to provide a viable short-term solution for established carriers to upgrade their existing networks on a broad basis in the initial, rapid phase of 5G deployment.

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