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Open RAN and the link between competition and innovation

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This article was written by James Mackley, Noel Hall and Rene Hartikka. Views are the authors' own and do not represent Ofcom's views.

Network diversification and innovation – the benefits of "Open RAN" for UK mobile networks

High quality mobile networks generate significant benefits to UK consumers and the economy at large. As newer generations of mobile technologies are developed and deployed, they enable consumers to benefit from innovative services. A vibrant and innovative market for the supply of mobile network equipment is key to deployment of high-quality mobile networks both now and in the future.

Open RAN has the potential to enable new entry and increase the level of competition in the mobile equipment market. It could allow the supply chain to be disaggregated with the use of "open" and "interoperable" off-the-shelf hardware, vendor-neutral protocols, and software-defined technology – Ofcom's article, What is Open RAN and why does it matter? provides further information on Open RAN.

More competition in the mobile equipment market is likely to affect consumers in several ways, from vendor pricing to the resilience of supply chains and network security. These are important and timely considerations and are prominent in the Government's 5G Supply Chain Diversification Strategy and the Telecoms Diversification Taskforce report. In this article, however, we focus on the potential impact on innovation from new entry and more diverse competition driven by Open RAN adoption.

Within industry there are different viewpoints on how Open RAN technology is likely to evolve and whether it is likely to lead to more innovation. We review what the economic literature has to say on the link between competition and innovation and provide our thoughts on what this might mean for the mobile equipment market.

Market background

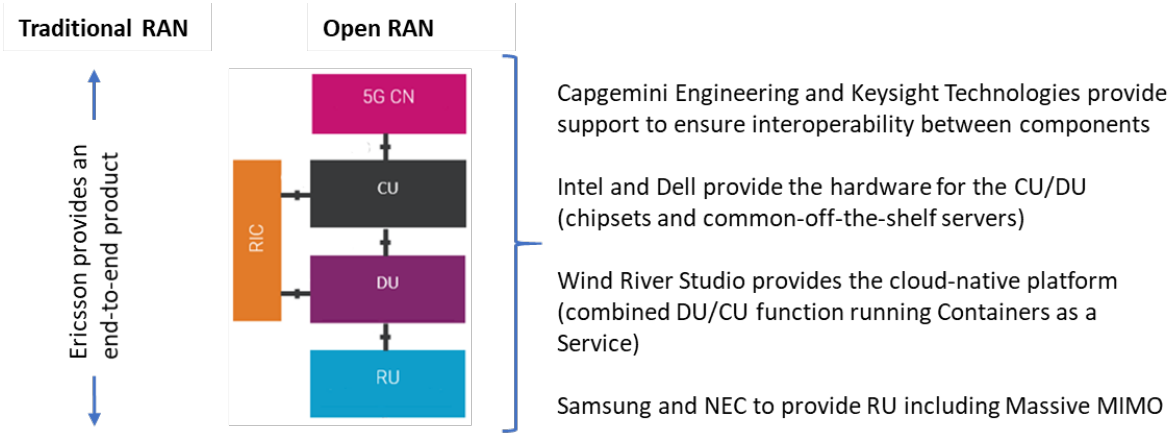
In mobile networks the access network is known as the 'Radio Access Network' (RAN) and provides the radio functions of the mobile network by transmitting signals between mobile handsets and the core parts of mobile networks. In most developed countries, including the UK, mobile networks supply services using 2G, 3G and 4G RAN equipment in combination with each other. 5G is the next generation of mobile technology and is providing new technical capabilities, including reliable and low latency communications. 5G is currently being deployed on new and existing cell sites but deployment is at an early stage.

The current mobile networks have been built using a "traditional RAN" architecture whereby the interface between the radio and baseband unit equipment is closed and vendor-specific, i.e. it uses propriety hardware and software. This means that mobile network operators (MNOs) have tended to use a single vendor at a particular base station (or collection of base stations) for all elements of the RAN network, i.e. "end-to-end supply". It has also resulted in a degree of vendor lock-in whereby

it is often costly and complicated for an MNO to deploy 5G using a different vendor to the one used for the existing services.

These market dynamics have led to relatively little choice for the supply of network equipment in the UK with the market being dominated by two providers (Nokia and Ericsson). However, the introduction of Open RAN architecture, which is currently being developed and trialled, could give MNOs more flexibility in choosing vendors as they deploy 5G and subsequently 6G networks. It could allow a "mix-and-match" approach whereby MNOs can use different vendors for discrete elements within the RAN network instead of using a single vendor for end-to-end supply. This is illustrated in Figure 1 below, where MNOs gain access to multiple hardware and software vendors for the Central and Distributed Units (CU and DU) as well as new vendors for the Radio Unit (RU) and Core Network (CN). Entry into the supply of RAN Intelligent Controllers (RIC) will be particularly interesting, e.g. whether RIC suppliers will be different to the CU/DU suppliers.

Figure 1: Illustration of potential entry across the value chain based on Vodafone's public partnership with Samsung for Open RAN



The link between competition and investment

The development and implementation of Open RAN has the potential to fundamentally change the market for the supply of mobile network equipment. Although there is considerable uncertainty around how the standard will develop, we may end up seeing considerably more suppliers of network equipment and a breakdown of the traditional end-to-end supply model. This has prompted debate about whether a move to Open RAN and interoperable architectures will lead to more innovation compared to traditional architectures.

The relationship between competition and innovation is complex. The extent to which additional suppliers will spur innovation will depend on many factors including both the nature and structure of the industry, the type of competition in the market, and the technological opportunities for innovation. There are two main schools of thought on which effects dominate this dynamic:

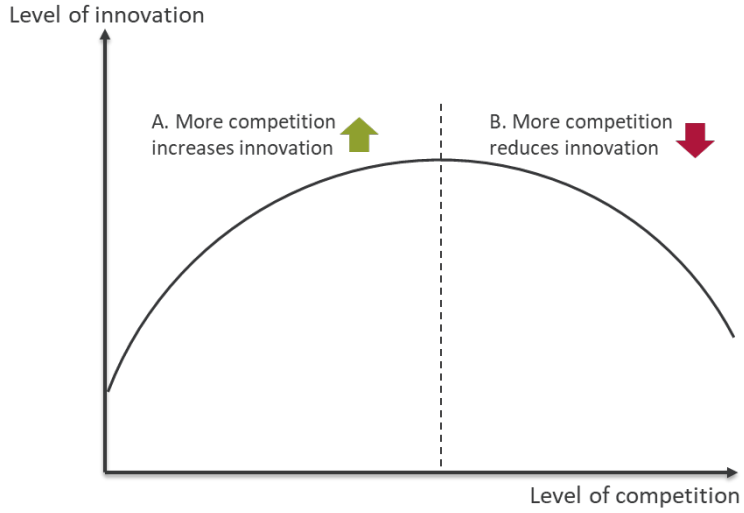
- Schumpeter (1947) suggested that greater competition leads to less innovation because: (i) some degree of market power is required to allow firms to quickly realise the additional profits created by the innovation; (ii) larger firms will earn greater profits from innovation

due to existing economies of scale; and (iii) larger firms are more able to fund R&D from internal funds which are not available to smaller firms (because of inefficiencies in capital markets). Due to these effects, any increases in competition would weaken firms' incentives to innovate due to 'rent dissipation' i.e. a reduction in profits due to innovation.

- Arrow (1962), in contrast, argued that greater competition has a positive effect on the level of innovation. His central idea was that innovation provides an entrant with the possibility of winning market share (and so gains the benefit from additional service volumes) whereas an incumbent will be cannibalising its existing service volumes and so will only gain the incremental cost saving/additional revenue that the innovation brings about.

The theoretical and empirical literature has carried on the debate about whether there is likely to be more innovation under conditions of monopoly or competition. Aghion et al (2005) reconciled these viewpoints to a degree by demonstrating that the relationship between the level of competition and extent of innovation appears to be inverted-U-shaped.[1] As shown in Figure 2 below, when initial competition is limited (portion A of the graph) additional competition leads to greater innovation – innovation is a way for firms to gain an advantage over rivals and earn greater profits. When competition is already high (portion B), additional competition can result in rent dissipation leading to a reduced incentive to innovate.

Figure 2: Illustration of inverted-U relationship between innovation and competition



In particular, Aghion et al. found that more competition promotes innovation where the initial degree of competition is low, the technological rivalry of the firms is high, and firms are closer to the technological frontier (and vice-versa). In addition, the peak of the inverted-U was found to be close to the median Lerner index (price-cost margin) across the studied industries, suggesting that 'low competition' and 'high competition' can be understood as being relative to a notional 'average' level of competition.

[1] Aghion et al. (2005) empirical modelling supported the non-linear inverted-U shaped hypothesis. It used price-cost margins as the main competition variable and a large panel dataset comprising 311 UK stock-exchange listed firms (across 17 industries) and matched with the internationally recognised NBER patent data base over 21 years.

Will Open RAN be beneficial for innovation?

What does the literature suggest the impact of Open RAN could be on the mobile RAN market – is more competition likely to increase or decrease innovation? Our review suggests that some of the conditions for a positive relationship between competition and innovation appear to be present in the mobile RAN market:

- **The initial level of competition is low:** The mobile RAN market is highly concentrated with Nokia, Ericsson and Huawei having a combined global market share of over 80%.[2] This would suggest it is more likely that the mobile RAN market is on the ascending part of the inverted-U.
- **Technological opportunity for innovation:** Mobile RAN is a technologically advanced industry and there are many ways vendors and MNOs looking to innovate, e.g. increased virtualisation and optimisation through cloudification. In particular, the disaggregation of software and hardware in RAN equipment could lead to more innovation given that software development is generally less capital intensive.
- **Vendors likely to be close to the technological frontier:** Advancements in the RAN industry tend to propagate at the international level, where successful innovations in one territory are shortly adopted by vendors in other territories, suggesting that firms in this market are likely to be close to the technological frontier.
- **High technological rivalry in the mobile-RAN market:** Vendors compete for MNOs' business by providing the latest product features and most efficient hardware and software.

The literature also suggests that the nature of the market will play an important role and may suggest that a choice of large firms will be beneficial for innovation in the RAN market. For example, Loury (1979) and Qiu (1997) both suggest that the incentive to invest is significantly impacted by any economies of scale. This is especially the case when the products are differentiated, such as in mobile RAN.[3]

Stewart (1983) and Qiu (1997) also both suggest that if the benefits from innovations in the mobile RAN equipment market are significantly shared across vendors, then a larger number of potential innovators might discourage firms to invest in R&D. Therefore, R&D investment incentives may be stronger with some continued use of proprietary platforms or exclusive dealing in the mobile RAN market. Having said this, the use of proprietary platforms or exclusive dealing may not be the socially optimal outcome once other effects, such as collective technical progress, price, and network resilience, are taken into account.

[2] gov.uk, 5G Supply Chain Diversification Strategy, paragraph 2.5.
[3] As a counterargument for the importance of scale, we note that Lee and Wilde (1980) show that if innovations face an ongoing cost, as well as a fixed element, then competition through entry could increase a firm's incentive to invest.

Regulatory support for the development of Open RAN

Although the future structure of the RAN market is uncertain, it is likely that Open RAN will present an opportunity to kickstart a new round of innovation in the supply of mobile network equipment. Looking ahead, there will be a need for industry and policy-makers to keep in mind the competing interests of players on different sides of the Open RAN debate. As Schumpeter put it, innovation results in 'creative destruction' whereby new innovations replace old technologies in a conflictual process. Therefore, in developing the policy approach to Open RAN it will be necessary to disentangle the need to respect the economic incentives of innovators (e.g. with good property right protection) from incumbent firms trying to prevent or delay the entry of new competition.

In June 2021, with funding from DCMS, Ofcom and Digital Catapult launched the SmartRAN Open Network Interoperability Centre (SONIC Labs). The aim of SONIC Labs is to build a better understanding of Open RAN and to inform technology roadmaps and strategies. It is testing interoperability and integration of open networking solutions, starting with 5G Open RAN. In December 2021, DCMS announced a further £15m to expand the programme over coming years. Further information about SONIC and how it is helping to shape the future of UK mobile networks is available on Digital Catapult's website.

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