Open and Virtualised Radio Access Networks: An Explanatory Guide for Policymakers

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Introduction

Mobile operators are exploring opportunities to transform their networks in significant ways as they build out 5G connectivity.

Motivated by the convergence of several technical, commercial and geopolitical factors, they are embracing new architectures based on network design principles of virtualisation, cloud computing and network automation. While adopting new technologies to optimise their systems, operators are also supporting a shift towards open interfaces in the radio access network (RAN). Opening up proprietary elements and interfaces in the RAN will diversify the network equipment and software ecosystem, bringing in new suppliers and additional market competition. Disaggregating the RAN will create new deployment scenarios, spur innovation, facilitate local equipment assembly, enhance security transparency, and minimise risks facing the industry as it scales up its networks for the future.

There is broad acknowledgement of these benefits. Mobile operators have been migrating towards virtualisation with 4G networks, and further virtualisation will happen with the service-based architecture of 5G. Similarly, open interfaces in the RAN is gaining momentum

as operators roll out 5G. However, to enable mass deployment of these technology principles, a number of challenges must be overcome.

Despite growing confidence in the open and virtualised RAN, there is a recognition that accelerated measures are needed to ensure equipment interoperability, security and reliability, as well as sufficient systems integration capabilities and skills. The mobile industry is undertaking a number of initiatives to address the challenges, principally through wide industry cooperation in international fora and standardisation.

Mobile infrastructure is a competitive differentiator, and each operator will make its own network design and configuration choices to align with different business strategies. However, policy has a role in this evolution, creating an enabling environment that will support the deployment of new RAN infrastructure. Policymakers can support the transition to mix-and-match RAN infrastructure by funding research and development, providing security assurance and certification, promoting and recognising specifications that enable interoperability, and accelerating 5G network deployment.

This guide provides an explanatory overview of the shift to open and virtualised RAN, and outlines a number of enablers that policymakers should consider to support the deployment of mix-and-match elements of open and virtualised RAN.

Open and virtualised RAN in this document is a generic terminology referring to the deployment of RAN using open interfaces, virtualisation principles, and various deployment techniques.

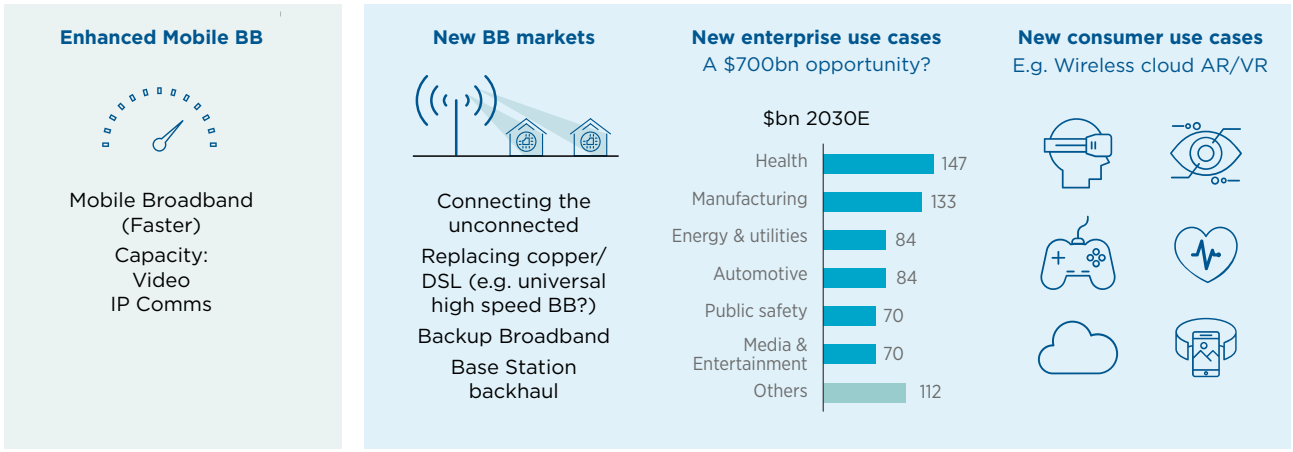
5G: The New Network Generation

Operators need to optimise their 5G deployments

5G promises to transform the world's economies, revolutionising production processes in many industrial sectors and creating unprecedented opportunities to generate consumer value.

5G is the fifth generation of mobile technology. It introduces evolutionary features including enhanced mobile broadband, massively expanded capacity for connected devices (i.e., the Internet of Things) and ultra-reliable low-latency connectivity for new consumer and enterprise applications (see Figure 1). 5G networks will build on technologies used in today's fourth generation mobile networks such as multi-antenna systems, small cells, virtualisation and edge computing centres. In order to provide continuity of service, 5G networks will co-exist for some time with previous generations of mobile networks.

Figure 1:
Three key areas where 5G can radically improve global Internet connectivity



In its 2020 Mobile Economy Report[1] , GSMA Intelligence predicts that, globally, operators will invest $1.1 trillion between 2020 and 2025 on networks across all mobile technology generations, with 5G accounting for about 80% of expenditure. Site densification, new spectrum bands, edge computing, increased backhaul capacity and other technical requirements mean that deploying 5G networks is costlier than 4G and requires huge capital investments by mobile network operators.

Operators are exploring opportunities to optimise their networks as they add 5G network components. Operators are also reviewing their equipment supplier strategies in light of technical, commercial and geopolitical considerations in the network supplier ecosystem.

An open and virtualised network can optimise deployment

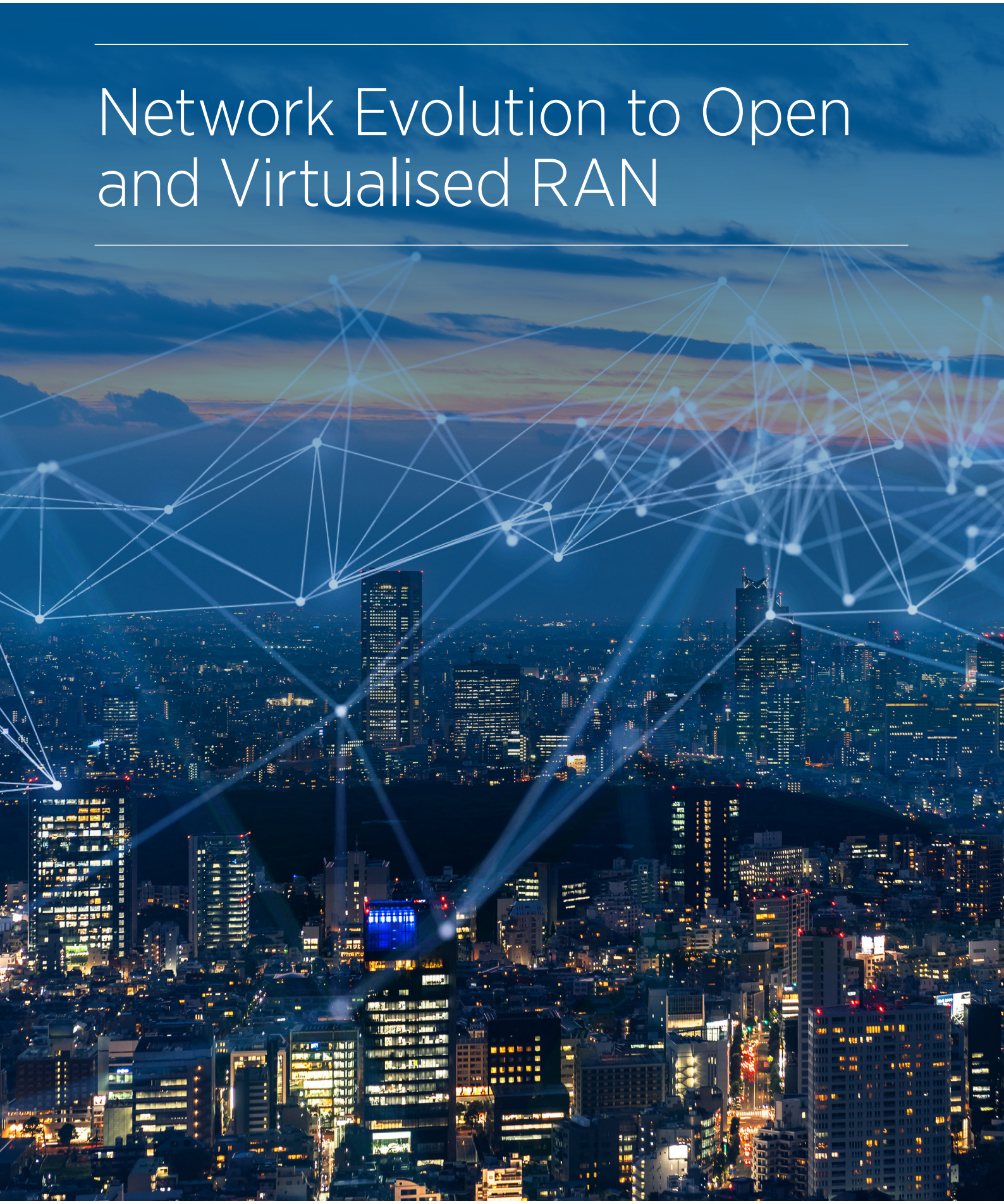
There is strong industry interest to accelerate the adoption of open interfaces and virtualisation principles in the transformation of mobile radio access networks. Open and virtualised networks are expected to deliver both technical and economic benefits, increasing flexibility and efficiency of the supply chain, reducing vendor lock-in and spurring innovation in RAN infrastructure.

Many operators are beginning to trial and deploy open and virtualised RAN infrastructure. Early deployments are typically based on limited-capacity network products with little mixing and matching of vendors, and are focused on rural or very limited urban coverage.

Market research company Dell'Oro Group[2] predicts open RAN spending to grow at double-digit rates over the next five years, with cumulative open RAN investments forecast to exceed US$10 billion. ABI Research[3] predicts that the market for open RAN will exceed the traditional RAN market by 2027 or 2028.

1 The Mobile Economy 2020, GSMA.
2 https://www.delloro.com/news/open-ran-market-expected-to-approach-10-b/
3 https://www.abiresearch.com/press/open-ran-radio-units-soar-more-us47-billion-2026/

Network Evolution to Open and Virtualised RAN



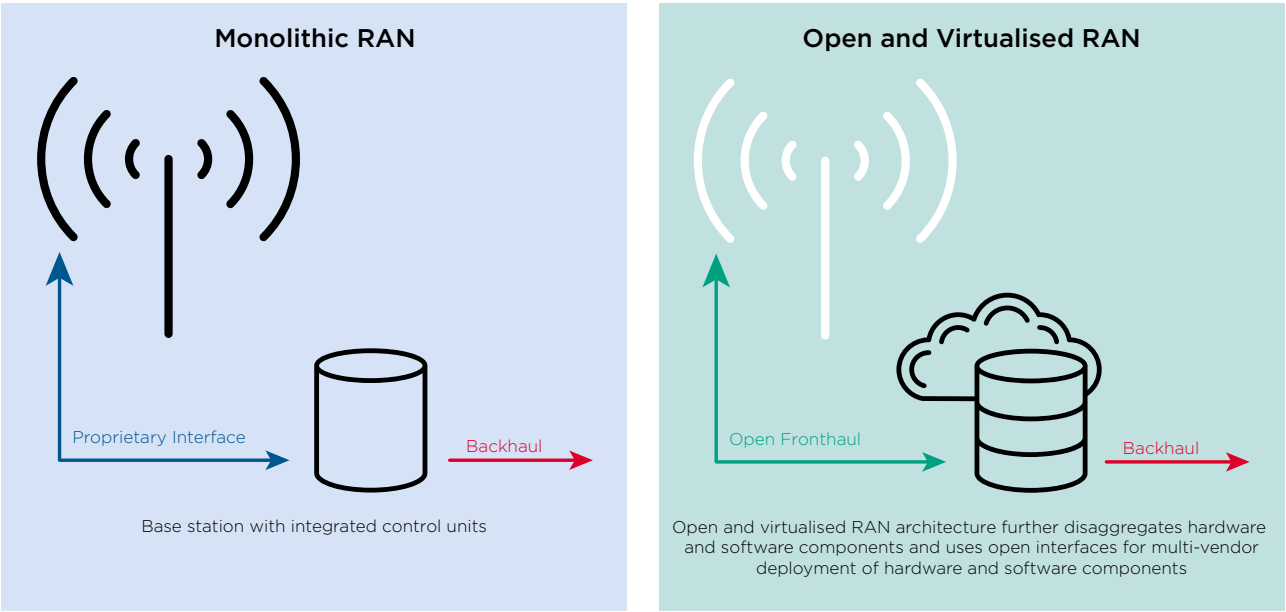
Two mobile network technology trends, going beyond the 5G-specific aspects, are network virtualisation and open interfaces. These trends also align with the trend of machine learning to automate network functions and operations.

Discussions on the future of the RAN often conflate virtualisation and open interfaces. Virtualisation focuses on decoupling the software features from the hardware platform. Open Interfaces is about opening up traditionally proprietary interfaces to allow multi-vendor deployment of hardware and software components. Virtualisation and open interfaces are different things, and an operator can deploy one without the other.

The convergence of these two technology trends creates new options for network deployment, enabling network innovation and optimisation. The shift to mobile network virtualisation first took hold with 4G networks, and further virtualisation will happen with the service-based architecture of 5G. Similarly, open RAN interfaces have been discussed for the past decade and is expected to gain momentum with 5G networks.

Figure 2:

The below depicts the evolution of the RAN as we move from a traditional monolithic RAN configuration to a combination of virtualisation and /or Open Interfaces (Open and Virtualised RAN)



RAN virtualisation: Moving more functionality to software

Virtualisation involves the use of common hardware with specialist RAN functionality implemented in software (Virtualised RAN). This allows the baseband unit (BBU) to be implemented in software running on general purpose hardware at a centralised location (Centralised RAN), while the remote radio head (RRH) remains on the cell tower. When resources are not centralised it is Distributed RAN (D-RAN) architecture (most legacy network deployments). The 3GPP standard defines different logical splits of RAN functionality between a centralised processing unit (e.g., the BBU) and the distributed elements, giving operators the flexibility to choose from a variety of deployment architectures. However, the interfaces between the different RAN elements are - in some cases - not fully specified and can be vendor-specific.

Open RAN interfaces: Mix-and-match multi-vendor components

Open RAN interfaces allow interoperable hardware and software from multiple vendors to be combined. The use of open interfaces between the radio base station components is more challenging because base stations have, to date, been based on proprietary implementations of the 3GPP specifications.

In simple terms, the mobile network consists of radio units, control units, distributed units, and the core network, with interfaces for each technology defined by 3GPP between each layer. Standardised implementation profiles — such as specifications by O-RAN Alliance, including at the lower layers, between base stations and within components of a base station — make it possible for networks to be built by mix-and-match of RAN components from different vendors (e.g., a network employs a radio unit from Vendor A and a control unit from Vendor B).

Benefits of Open and Virtualised RAN

A diversified equipment ecosystem

Rising concentration of the radio equipment market has been a challenge for the mobile industry, and this is exacerbated by intense geopolitical pressures that, in effect, limit the number of large network equipment suppliers that mobile operators can deal with. Three vendors have more than 80% of the global RAN equipment market. Around half of operators in a recent GSMA survey are concerned about diversity in the equipment supply chain and think it is important to bring new vendors into their network[4].

The established radio equipment vendors have a role to play in market diversification. In 2020, some of them indicated interest in providing open and

4 Network transformation 2020; GSMA Intelligence, November 2019

virtualised RAN equipment, once it becomes possible to match the cost and performance of current integrated systems. Existing vendors may also benefit from open and virtualised RAN deployments as systems integrators, licensing of patents or as providers of hardware and software.

The modularity of open and virtualised RAN will make it possible for new companies to emerge and participate in the supply of RAN hardware and software, local equipment assembly and systems integration.

Better resource utilisation and cost saving

Operators view open and virtualised RAN as an option for new installations, whether 4G or 5G. By reducing the cost of a set of network components, open and virtualised RAN will help to optimise the almost trillion-dollar global operator investment needed to achieve connectivity targets.

Virtualisation brings the benefits of cloud architectures to mobile networks, improving the utilisation of network processing resources and potential cost savings. While these benefits are already being captured with macro cells, they will be especially significant for the future deployment of 5G small cells, which will need to be configured and managed while minimising inter-cell interference.

These savings come primarily from improved asset utilisation and efficiency gains by increased automation of network operations. The cost savings will vary depending on the existing network infrastructure and the operator and country-specific factors.

Faster innovation and reduced vendor lock-in

Open and virtualised networks use generic processor platforms and the added value comes from innovative software solutions and operations.

Open interfaces expand the pool of suppliers from which operators can source hardware components, both RRH and BBU as well as the software components, which help them add new features and services quickly without being locked into a single vendor's product roadmap. This can also reduce the risk of being locked into a proprietary solution linked to a sole supplier — one that might cease to operate or choose not to develop a feature the operator requires.

Support for customised networks

One of the features of 5G is the capacity to create customised 5G networks (e.g., private networks) to deliver the unique connectivity requirements of, for example, car manufacturers, factories or rural communities. A GSMA Intelligence[5] survey in 2019 found that 61% of operators are investing in private wireless networks. These deployments are likely to require specific combinations of network functionality, performance attributes and cost profiles that can be more easily supported with the use of open and virtualised RAN infrastructure, while also avoiding being locked into proprietary solutions.

5 Network transformation 2020; GSMA Intelligence, November 2019

Challenges

Security and reliability of networks

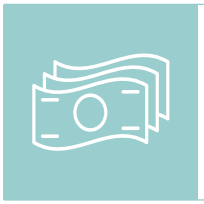
5G network infrastructure will perform a vital function for society and the economy by providing a wide range of mobile connectivity services. The increasing complexity of mobile networks has raised questions about potential security vulnerabilities in the global 5G supply chain.

Open and virtualised RAN disaggregates the network components and this potentially broadens the number of 'threat surfaces' for any network. On the other hand, these shifts present mobile operators with a greater set of options to procure and configure best-in-class, secure, reliable and resilient networks while adhering to national procurement restrictions and facilitating alignment with best practice security principles. This is in addition to the inherent improvements in security provisions, mechanisms and architecture of the 5G specifications.

Industry readiness

Among mobile network operators, GSMA Intelligence reports that the majority consider it is important to deploy open networking technologies, but are held back by internal expertise gaps. This has implications for retraining existing staff or transitioning skill sets. The same survey finds that 58% of operators identified e-skilling/upskilling of staff as very or extremely important.

Currently, there are individual initiatives to specify, develop and test open standards, with different bodies delivering solutions for a particular problem. Greater coordination of the initiatives and product certifications will promote the development of the ecosystem and increase the mobile industry confidence.



Cost-effectiveness

The promised cost savings in operations and control from open and virtualised RAN architectures are yet to be realised, as is often the case with early phase deployment of innovative solutions.

There is an implicit assumption that deploying open and virtualised RAN architectures will bring substantial cost savings. However, this ignores the operational complexity and costs that will ensue, for example, training to manage multiple vendor solutions. This issue was raised by 55% of operators in a survey by GSMA Intelligence[6]. The reality is being worked out by operators through RFPs, initial 5G deployments and network economics modelling, but the situation is likely to be unique for each operator.

6 https://www.mobileworldlive.com/blog/intelligence-brief-why-is-open-ran-not-necessarily-easy/

Policy Enablers

Support initiatives to mix and match RAN infrastructure elements

Currently, the main vehicle for taking forward open and virtualised RAN is wide industry cooperation in international fora and standardisation. Policymakers should consider the following enablers to support these initiatives to mix-and-match RAN elements.

Support R&D investments

At this stage of market development, policymakers can support R&D investments in open and virtualised RAN, for example, through R&D tax credits or funding of pilot deployment projects, test beds and interoperability initiatives, while allowing the market to choose the best mix of technologies. For example, the European Commission is supporting work in this area within the Affordable5G[7] project.

With the changes in the telecommunications equipment supply chain and the design of network infrastructure, policymakers should think how diversity of equipment supply as well as local assembly could support open interfaces and virtualisation. Looking to the future, there are opportunities for policymakers to support the long-term research efforts needed for 6G and beyond.

Support security assurance and certification

While open and virtualised RAN has the potential to increase the resilience of the 5G ecosystem, it is also a key instrument in strengthening network security. The GSMA welcomes the commitment and focus of policymakers on these issues through assurance and certification schemes, such as the European Commission's focus and support of 5G certification schemes.

To further strengthen resilience and engender trust in the security of the 5G ecosystem, we encourage — for all suppliers of components for RAN — participation in schemes such as the GSMA's Network Equipment Security Assurance Scheme (NESAS)[8] and appropriate certification schemes such as those proposed under the framework of the Cybersecurity Act in the EU.

Support interoperability initiatives

The success of open and virtualised RAN deployments will be built on the assurance that a radio module from one vendor will work seamlessly with a complementary hardware module or software application from another vendor. Even where open interfaces are specified, considerable effort and collaboration is required for interoperability testing.

Formal recognition of RAN specifications such as 3GPP and O-RAN Alliance, as well as support for interface certification and systems integration schemes to enable the mix and match of different RAN components, will help accelerate the integration of RAN infrastructure elements. Policymaker support for interoperability testing laboratories and certification schemes would accelerate the RAN ecosystem.

7 https://www.8bellsresearch.com/projects/h2020-affordable-5g/
8 https://www.gsma.com/security/network-equipment-security-assurance-scheme/

Accelerate 5G network deployment

Deploying 5G networks, whether traditional or open and virtualised RAN infrastructure, is costlier than 4G and requires huge capital investments by mobile network operators. The following policy enablers reduce the cost of 5G deployment by opening opportunities to integrate disaggregated RAN infrastructure elements.

Facilitate access to sites for network equipment deployment

All mobile networks require access to sites where RAN equipment can be installed to provide coverage and capacity. The increased use of small cells in 5G will require network equipment to be hosted on street infrastructure such as lighting and bus shelters.

Policymakers should provide access to street furniture and public sites to encourage the deployment of different configurations for a robust and high-quality network.

Encourage fibre roll-out for backhaul and fronthaul

Many countries and operators are promoting the expansion of fibre networks to support the growing digital connectivity needs of society. Fibre connectivity is critical to successful deployment of open and virtualised RAN solutions and supports 5G deployment generally. Policymakers can support 5G and open and virtualised RAN by facilitating fibre infrastructure deployment for both fronthaul and backhaul connectivity.

Agree an industry-wide intellectual property rights framework

Open and virtualised RAN requires an industry-wide intellectual property rights (IPR) framework capable of supporting the deployment of 5G and beyond. The IPR framework should ensure that patent holders get fair value for the Standard Essential Patents (SEPs) under reasonable and non-discriminatory (RAND) terms. New suppliers may only provide a subset of interoperable RAN modules, and it is potentially costly for them to licence an entire SEP portfolio. A potential solution is module-based SEP portfolios to allow licensing of only the relevant IP, thereby benefitting both existing and new suppliers. The mobile industry itself needs to agree to an industry-wide intellectual property framework, including common set of dispute-resolution rules and procedures.

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