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Discussion Paper

Digital Industry Governance and 5G

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Introduction

As changing user needs and advancing technologies lead to the evolution of a more diverse and complex ecosystem centred on communications this project will focus on understanding how an effective and efficient governance system needs to evolve.
The discussion below is organised around a series of key questions as follows:

- What challenges will the roll-out of 5G and the emergence of new use cases in different vertical sectors and the involvement of new players create?
- What can we learn from the successes and failure of 3G and 4G governance in the past?
- What are the lessons can draw from the rapid development and huge success (in terms of usage and value creation) of the Internet. What does it tell us about the advantages and disadvantages (in terms of the rate of innovation, access, security, privacy, etc) of uncontrolled development versus regulation?
- On which governance areas is it useful or even essential for government to focus if we are to develop an effective and efficient next-generation ecosystem?
- What governance areas are best addressed by industry organisations and initiatives? What aspects should be left to emerge from the operation of the market?
- What would an ideal digital governance system look like assuming global cooperation were possible?

1. What challenges will the roll-out of 5G and the emergence of new use cases in different vertical sectors and the involvement of new players create?

5G offers three distinct capabilities in addressing societal and industry current needs and in support of a range of possible future use cases. Mobile broadband is only one of these three capabilities. The other two are ultra Reliable and Low and guaranteed Latency Communications (uRLLC) and massive Machine Type Communications (mMTC) in support of Internet of Things (IoT). Mobile broadband standard is now complete and 5G equipment and services being deployed globally.
This mobile broadband capability is mainly to address capacity crunch that is being faced in 4G due to huge demand in mobile broadband for data. The roll out of mobile broadband is delayed by 2-3 years in the UK mainly due to the restrictions imposed by Government on High Risk Vendors (HRV).[1] In the UK this delay is estimated to be 2 to 3 years with cost of replacing 4G and 5G equipment being in order of £2B to mobile network operators (MNO). Associated to this cost is loss of revenue from 5G which is exacerbated by COVID-19 to tune of £41B in the UK in lost opportunities.[2, 3]

Consequence of the ban has many implications on MNOs business in addition to slowing down in roll-out of 5G. One impact is option limitation in pool of equipment vendors which is reduced to effectively only two major ones that are Ericsson and Nokia to meet the global demand. Other negative implications are same as supply and demand like any market that can increase cost and impair after sales quality of service and support. This restriction does not only impact 5G equipment. It affects MNOs who have 4G equipment from HRV as well. 5G is initially deployed as non-standalone network meaning 5G radio, 4G radio and 4G core are needed to be deployed together. However, 4G equipment from one vendor cannot be easily used to support 5G equipment from another vendor. Both 4G and 5G equipment have to be from the same vendor in handling interoperability and integration problems. As most legacy 4G system are from Huawei that means deployment of 5G first requires replacement of Huawei 4G

1 https://publications.parliament.uk/pa/cm5801/cmselect/cmdfence/1091/109102.htm
2 https://drive.google.com/file/d/1hHDPtr-dJkZurvDzGYfbEixfAx-Ocjlw/view
3 https://eandt.theiet.org/content/articles/2020/10/5g-rollout-delay-could-cost-the-uk-billions-report-says/

equipment with that of another vendor. This will further delay deployment of 5G networks and 5G services offering. With Huawei being barred from some markets and leaving Ericsson and Nokia as the main options to fill in the gap in market, question is; would these two vendors have sufficient delivery capacity to meet the market demand and whether their products are mature enough with at least similar performance and cost as that of Huawei.

To minimise the impact of dependency on few vendors Governments and mobile network operators (MNO) are rightly in favour of diversification of supply chain and support Open Radio Access Network (ORAN)[4] architecture where different companies can provide different aspects of radio access network. This brings about huge opportunities for many more large and small companies to participate in global supply ecosystem. However, ORAN technology is far from being ready for mass deployment. In terms of performance in capacity limited environment, such as in urban area, current ORAN solutions performance is by far less than that of 4G making ORAN, when is available, only suitable for less capacity demanding environments such as suburban areas. This will be the case until high-capacity ORAN is developed which will not be the case before 2025. Diversification of supply chain requires open and standardised interfaces to facilitate integration and interoperation of different sub-system solutions from different vendors to be developed and integrated in a complete ORAN architecture.

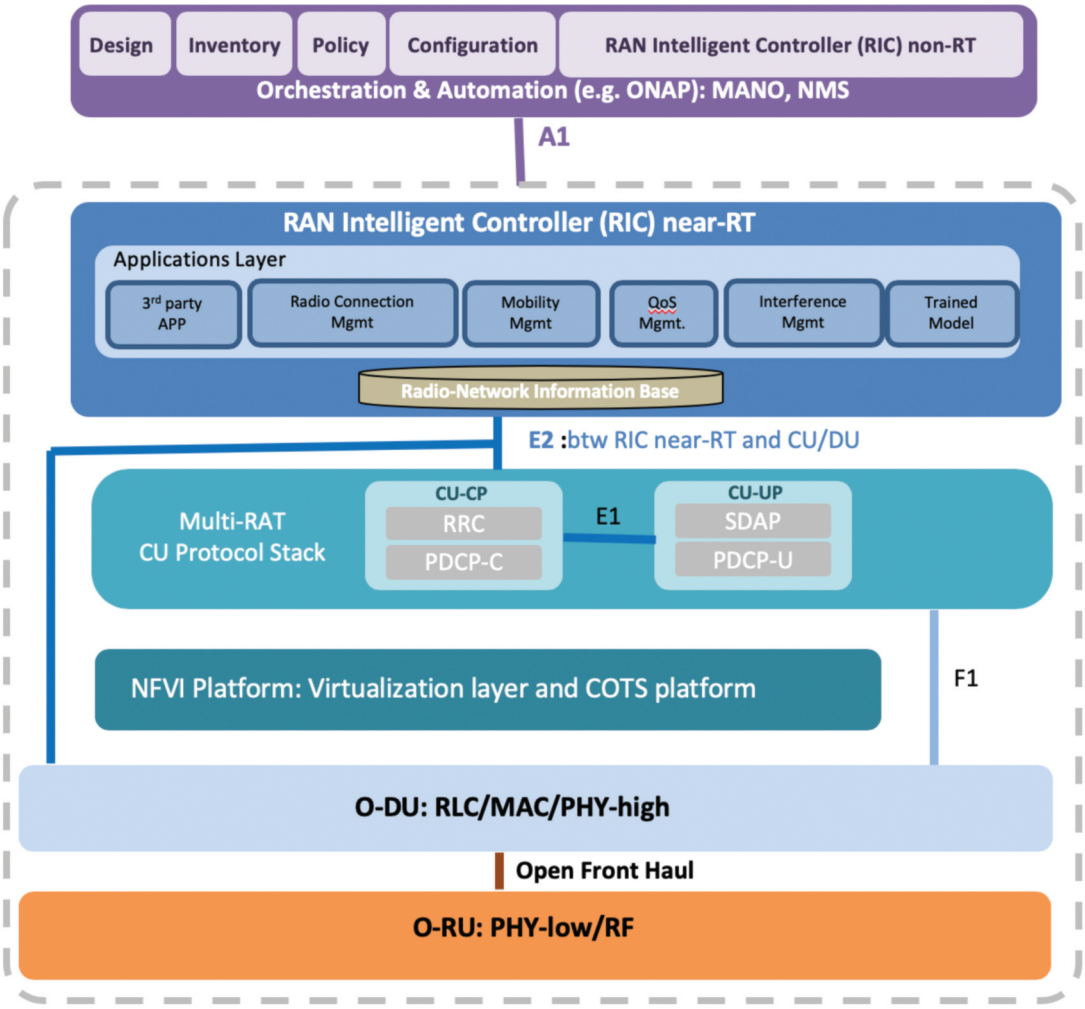

Figure 1: ORAN Generic architecture from O-RAN Alliance (from Reference 4)

4 https://www.o-ran.org/

ORAN architecture is based on many open interfaces as can be seen in Figure 1 compared with traditional closed RAN. However, the greater the number of open interfaces the more architecture is prone to network security and risks of interoperability between different products from different vendors. Another factor that contributes to 5G roll out delays is that for a non-standalone network (NSA) as is current option for 5G rollout, the market needs ORAN products for both 4G RAN as well as 5G RAN.

Both uRLLC and mMTC are incorporated in 5G specifications, by design, for efficient support of vertical sectors and industrial applications. They are to support many devices (machines) and sensors of different capabilities as well as the mission critical applications where reliability and/or low latency connectivity is required in industrial settings.

These capabilities can support different deployments of 5G network, namely stand-alone and non-standalone and in the form of private networks, public networks or a combination of private and public networks or hybrid deployment. Private network is strictly under full control of a vertical industry whereas public network is managed by MNOs for wide area mobile broadband. Hybrid networks are mainly managed by MNOs but a network slice is exclusively allocated for a specific enterprise. For industrial applications 5G is best deployed in form of stand-alone 5G network. This means that they do not need being complemented with 4G network. A stand-alone 5G network is a complete end to end 5G technology consisting of 5G New Radio (5GNR) and 5G Core (Service Based Architecture-SBA). 5G Core (SBA) is flexible for easy upgrades with future functions and future services through virtualisation of functions and separation between functions (in software) and underlying hardware platform. Stand-alone 5G in form of (public) wide area and private (non-public) is yet to be developed for commercial use. Thus, stand-alone capability is one of the technical reasons for delay in adoption of 5G in vertical industries.

Other reasons for delay in 5G roll out are the fact that for industrial applications where guaranteed low latency is essential for time critical use cases, the uRLLC aspect of 5G is yet to be available commercially. Moreover, further research and standardisation is required for high capacity uRLLC which is a subject of study in release 17 of 5G that may not be completed before September 2021 as shown in Figure 2.

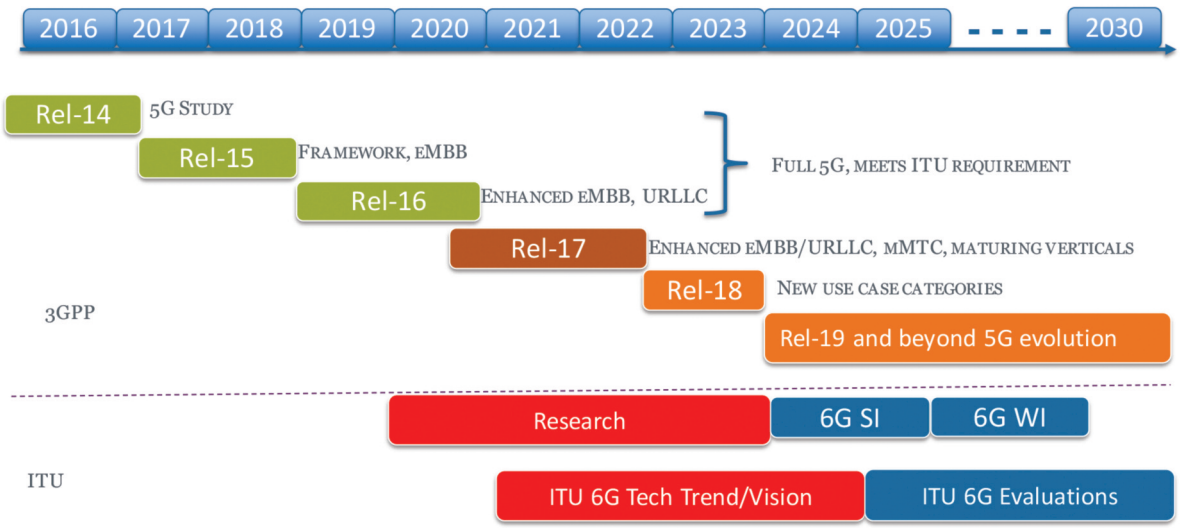

Figure 2: Standard roadmap for 5G and beyond

For mass connectivity, again the standardisation work is in progress in the Release 17 of 3GPP.[5] These are mainly technical and standardisation issues that have contributed to 5G deployment delay. From non-technical points of view, industrial use of 5G is mainly a business-to-business (B2B) model issue between MNOs and vertical enterprises for the hybrid deployment. 5G deployment whether in form of private or hybrid needs appreciation of 5G network capability as well as a compelling business case by vertical industries on 5G impacts on their cost saving and/or new source of revenue and enhancement in their productivity. Those vertical industries that have publicly announced their strategy in adopting private 5G deployment justify their case by putting high importance, in the first place, on their requirements on stringent network security and reliability of operation of better than 99.999% of time as well as on being in control of their own business data.

Additionally, lack of necessary skills in management and operation of private 5G in non-telecom industry is another factor that has hindered adoption of 5G. Some of these points are further elaborated on in the following sections.

2. What challenges will the roll-out of 5G and the emergence of new use cases in different vertical sectors and the involvement of new players create?

5G is different from previous generations of mobile/wireless systems in the sense that its innovative capabilities are designed for use in industry environment to improve productivity through automation, reliability and low and guaranteed latency in connectivity. 5G is more about connecting machines or Internet of Things (IoT) than connecting people as was the case with previous generations.

For vertical industry use cases, jury is still out on a win-win business model for stake holders in a B2B arrangement or when 5G non-public or Private network is deployed without cellular operator/service provider. The second scenario, private 5G, is the chosen path by some industries mainly because of network and data security where company data and intellectual properties are important. However, as such industries do not have appropriate skills in telecom network operation and management the barrier is to have people with such skill sets which are fundamentally different from people with IT skills. The use of digital twins provides some insight in the network operation and identify through appropriate alarms point(s) of failure or anomaly in traffic behaviour. Digital Twin solutions for Vertical (non-telecom) industries is, therefore, an important missing technology to give peace of mind to vertical industry in embracing 5G as a connectivity platform.

In the scenario of B2B a cellular network provider (MNO) could offer support and maintenance and provide a secure network slice (network capacity) to a business. Network slicing technology is subject of standardisation and is yet to be developed by equipment vendors for commercial use. However, for this business model to become acceptable, a win-win business model needs to be in place between mobile service providers and other industry sectors so that verticals can appreciate cost savings and/or increase in revenue in adopting 5G system. This will happen over time but will take some time as verticals need to appreciate and understand importance of 5G connectivity to their business productivity and costs.

These are some good lessons to learn from the way 5G standardisation was conducted. From the beginning, the verticals should have been involved with the telecom sector in identifying their specific requirements and in development of standards. Vertical industries examples are Health, Manufacturing, Automotive, Logistics and so on. Of course, all these use cases need to have clear business cases an important and enabling factor in adoption of any new technology. Some of requirements from vertical

5 https://www.3gpp.org/news-events/2145-rel-17_newtimeline/

industries are: security, latency, reliability (resilience) and interoperability with legacy IT system.

To help with faster adoption of 5G technologies and establishment of common understating more joint technology and use case trials need to be conducted between actors from different sectors. It is not too late to do so as future development of 5G standards in Release 17 and possibly 18 and 19 are about industrial 5G use cases and its autonomous operation.

3. What are the lessons can draw from the rapid development and huge success (in terms of usage and value creation) of the Internet. What does it tell us about the advantages and disadvantages (in terms of the rate of innovation, access, security, privacy, etc) of uncontrolled development versus regulation?

Internet is based on simple IP (Internet Protocols) that enable a variety of systems to be easily integrated. This simplicity in networking is at the expense of compromising quality, reliability, security and privacy. It is also important to appreciate the fact that Internet is not based on any global standard, unlike mobile standards, but mainly rests on a set of recommendations by Internet Engineering Task Force (IETF).[6]

Openness and user anonymity of Internet are main the reasons for it becoming widespread but at the expense of not being secure and with no guaranteed quality of service but mainly on best effort in delivery. The main innovation area in internet is in services and applications rather than in technology.

On the other hand, mobile systems are amongst most secure and reliable form of communication networks by being based on agreed global standards. Quality of service, in addition to security and privacy, are at the heart of mobile system design in standardisation process. Mobile networks are also under tight control of mobile network operators that ensure user identity privacy and data security. Global standard facilitates global market and due to this economy of scale enables fast return on investment. Innovation in mobile networks are mainly in technology whereas innovation in Internet is in applications and contents.

5G, unlike previous mobile generations with the purpose of connecting people, is a solution to societal and industrial challenges in the 2020 to 2040 period. It is about connecting machines of different sizes and capabilities. 5G integrates a number of services from different industries into one unified architecture whilst maintaining quality of service through advanced technical solutions such as network slicing and is future proof for easy incorporation of yet unforeseen services and functionalities through network virtualisation and its service-based architecture (SBA). 5G over the time will become an open fabric of connectivity. Tailored capacity, connectivity and security and privacy will be offered by network operators to other industries as Network-as-a-Service (NAAS) platform through standard and open interfaces.

Combination of above features will help in developing and implementing customised services, Service quality security and privacy to suit different industries' needs.

4. On which governance areas is it useful or even essential for government to focus if we are to develop an effective and efficient next-generation ecosystem?

5G can be seriously considered as the cornerstone of future digital transformation of society and economy. Four important factors need to be in place for the digital transformation to happen quickly and smoothly.

- Liberalization of frequency spectrum
- Open digital infrastructure
- Mutual and multi-lateral trust framework
- Unified data models

6 https://www.ietf.org/

Frequency spectrum availability is key enabler for tether-less connectivity, mobility for anywhere and anytime and overall system cost. More spectrum in useful part of radio spectrum needs to be farmed so as to enable cost effective coverage and capacity. Current licensing regimen need to be changed from nationwide blanket license to location based and on principle of acknowledged co-existence between different deployment of networks whether in form of public, private (non-public) or a hybrid of them. This will enable proliferation of many networks in support of many businesses and hence positive impacts on society and economy. Another important consideration is that instead of moving up in frequency spectrum, radio regulators need to move down and allocate or re-farm sufficient radio spectrum to help network operators to provide cost efficient coverage.

Digital infrastructure must adopt open, secure and standardised interfaces so that any business could outsource or develop its own services and applications. Open infrastructure with open and standard interfaces will help with diversification in technology and the services/content ecosystem. The interfaces should be based on a common standard to ease interoperability at different layers of protocol stack. This way mobile standards will enable service/application innovation as Internet has enjoyed by being an open architecture. The more important layers in a protocol stack are: the application layer, network layer, media (physical layer) and hardware (devices) layer where common and standard interfaces should be on global standardisation agenda.

Future communications will be more and more about connecting machines to the extent that at any time and in any location there will be more than 1000 devices per person. Machines of different types in capabilities and functionalities and different sizes ranging from small temperature sensors to machines as large as vehicles, drones, trains etc will be commonly deployed as combination of wearables, short range environment and ambient information sensing/actuating networks to wide area networks. Future networks will be a network of networks in providing complementary coverage whilst enabling different and smart services. Such devices need to certify each other in order to form a network. This certification process and its related algorithm needs to be dynamic and efficient in terms of signalling load and energy consumption as the network size and member devices in a network could dynamically change. This requires an efficient and multi-lateral trust framework to automatically and dynamically verify, authorise and certify devices/machines that belong to a network or to an organisation. Blockchain, for example, is possible technology for this multi-lateral trust algorithm. However, blockchain suffers from energy consumption and requirements for a huge amount of signalling. Resertach, therefore, need to focus on finding a new algorithm. An efficient trust framework should be defined by standard bodies that facilitates a business to develop its own trust algorithm whilst does not violating inter-operability between different devices.

Important part of interoperability is development of common and rich semantics and agreed data model standards by industry to simplify data management, integration of different services to create new services as well as help with data analytics and people data anonymisation for privacy preserving. To clarify this point, a good example of uniform data model is SWIM,[7] a System Wide Information Management (SWIM) concept that consists of standards, infrastructure and governance enabling the management of Air Traffic Management (ATM) related information and its exchange between qualified parties via interoperable services.

7 https://www.eurocontrol.int/concept/system-wide-information-management

5. What governance areas are best addressed by industry organisations and initiatives? What aspects should be left to emerge from the operation of the market?

Governments need to be forward looking and adopt digital transformation as their national strategy. It is important to put in place appropriate standard processes and regulatory policies with respect to the important 4 factors outlined above. This in turn will pave the way for creating market opportunities, competition and diversification in supply chain. Global standards facilitate the creation of a global market and faster return on investment due to economies of scale. With respect to standards, governments need to work with each other to agree on set of processes for standard that are inclusive, fair and inducive for small and large enterprises. For example, the establishment of common and rich semantics and data models will overcome current data silos between different countries, different businesses in one country as well as even between different networks within one organisation. Common data models will make transformation of data into useful information and their integration in creation of richer contents/services easier. Absence of such common data model, for example, has been an important reason for delay in widespread roll-out of smart city concepts. Another important factor contributing to delays in realising smart cities is lack of common and global technology standards. 5G with mMTC can be considered as an important technology pillar for smart cities covering many use cases.

Covid-19 provides a recent example of the problems associated with data silos where governments could not share raw data between themselves. Another reason that different countries could not cooperate in their battles against COVID-19 is the fact that different countries may have different and incompatible GDPR policies.

Common and globally agreed standards at different levels of; data, protocols and device will open many opportunities and speed up digital transformation of economy and society. It is not, however, too late to initiate this process of common standards, specially at data level, whilst wireless networks and IoT are being continuously evolved with new features and capabilities as is the case with 5G through 5G+ and future 6G. Easy transformation of data into useful information is critical in automation of network management as well as in industry 4.0 as automation-based AI/ML need rich set of data from different layers of protocol stack or different subsystems for learning and reliable predictions.

6. What would an ideal digital governance system look like assuming global cooperation were possible?

A suitable organisation should be set up to drive common standard for semantics and data models. This organisation should operate on international level and should be inclusive of different organisations from different countries. Perhaps in addition to United Nation ITU-T, ITU-R and ITU-D focusing on Telecommunication and Radio and Development respectively another organisation should be set up under UN focusing on rich and all digital services inclusive semantics and data format standards governance possibly called ITU-Da or ITU-Di standing for ITU- Data or ITU-Digital.

The regional standardisation organisations should work with this ITU-Di towards a common global standard which could also consider user data privacy through appropriate anonymisation framework, trust frameworks and security framework.

The future data governance should be flexible and agile enough to respond to unpredictable situations like in COVID-19 case and with regards to different GDPR policies in different countries.

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