Science and Technology Committee

Oral evidence: UK telecommunications infrastructure and the UK's domestic capability, HC 450

Wednesday 24 June 2020

Ordered by the House of Commons to be published on 24 June 2020.

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Members present: Greg Clark (Chair); Aaron Bell; Dawn Butler; Katherine Fletcher; Mark Logan; Carol Monaghan; Graham Stringer.

Questions 1 - 60

Witnesses

I: Matthew Evans, Director (Markets), techUK; and Professor Dimitra Simeonidou, Professor of High Performance Networks, University of Bristol.

II: Attilio Zani, Executive Director, Telecom Infra Project.

Examination of witnesses

Witnesses: Matthew Evans and Professor Simeonidou.

Q1   **Chair:** This is the first hearing of a new inquiry that the Science and Technology Committee is undertaking into UK telecommunications infrastructure and the UK's domestic capability.

In the light of the questions around Huawei's place in the UK's 5G network, the Government said they would develop a strategy to help diversify the UK supply chain, including seeking to attract established vendors who are currently not present in the UK to come to this country; supporting the emergence of new disruptive entrants to the supply chain; and partnering with like-minded countries to diversify the telecommunications market.

To assess these proposals we are beginning our inquiry with our first panel of witnesses. I am delighted to welcome Matthew Evans, the director of markets at techUK, and Professor Dimitra Simeonidou, professor of high-performance networks at the University of Bristol. We are very grateful to both witnesses for joining us.

Perhaps I may start with a question to both witnesses and ask them to describe how 5G will differ from the 4G networks that most of the country has become used to over the past few years.

Professor Simeonidou: Thank you very much. It is good to meet you.

I am sure you know a lot about 5G, so I hope you will excuse me if I go into the very basics. Up to now we have said that 5G is the next generation of mobile networks, but I would say that it is the new generation of mobile networks—quite a lot of commercial deployment has happened already in the past year.

In looking at 5G, I would like to refer to four main characteristics. The first one is doing what every other generation of mobile networks did: it promises higher capacity of connection—about 100 times more, with faster downloads of videos to our mobile phones.

The other characteristics start to get more interesting and differentiate 5G networks from previous generations. One is high reliability—no loss of connection. We know how much we have all suffered moving around and losing mobile signals in our car or on the train, so they are very reliable networks.

The third characteristic is what we call ultra-low latency. The networks respond very fast to service requests, which opens very interesting possibilities like remote surgery, autonomous cars, remote manufacturing or automation in different environments.

The fourth one—this is a breakthrough—is grey density[1] machine-to-machine communication. We are moving from mobile networks where we

have people communicating with people, or having access to data, to something where machines are communicating with machines so people are communicating among themselves and machines as well. That opens up possibilities for a full *[Inaudible]* in society and industry.

Q2 **Chair:** That is very helpful. Mr Evans, perhaps you can comment on the importance of 5G to your member firms.

Matthew Evans: Thank you for inviting techUK to give evidence this afternoon.

Dimitra is entirely correct in her analysis. It is an evolution in technology but a revolution in the impact it can have. The reason for that impact is that, unlike previous generations of mobile technology, this is not aimed really at the consumer. There are some interesting consumer applications, but this is all about industry, manufacturing, mobility and the role this can play in digitising our economy.

To give you some sense of that, Barclays bank has estimated that the economic impact of the digitisation aspects of 5G could be worth £25 billion to the economy by 2025, but the Government also regard as significant the economic impact on the services that could be provided if we were a leader in 5G. That is really the UK's strength. That could be upwards of £100 billion in incremental GDP growth to 2030, if we are able to pilot and export these service applications that 5G can enable.

Q3 **Chair:** I have read that the UK is about fourth in the world in the current state of roll-out of 5G. Is that an assessment with which you agree? Do you have a view on whether the roll-out of 5G versus completion of the 4G network should have greater priority?

Matthew Evans: My view is that we are in that leading cohort of countries in deploying 5G. Our view is that we must do everything we can to remain there.

As for the interaction between 4G and 5G, the two are very much interlinked. In the UK we are deploying something called non-standalone 5G. We can get into what that means later, if you wish, but it really means that 4G and 5G are built on top of each other in the UK, so there is a strong link—4G has evolved a long way and 5G will look a lot different in five years' time in what it can offer because of future software upgrades and standard releases.

We have to pursue both. We made great leaps forward with 4G. I think the shared rural network will help in subsidising 4G where it is uneconomic for the market to do so on its own, but they have to go hand in hand.

Q4 **Chair:** Professor Simeonidou, do you believe that in the roll-out of 5G one is able to draw any lessons from the roll-out of 4G in this country?

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[1] Correction: Witness says 'great density'.

Professor Simeonidou: Yes, definitely. The coverage, especially rural coverage, is something we have to look at very carefully when we are rolling out 5G. There is great potential in how different operators collaborate to fill gaps, especially in the rural environment.

I absolutely agree with Matt. We see 4G and 5G as a combined story exactly because almost the full deployment of 5G networks today relies on 4G infrastructure. We are going to see the roll-out of the combined infrastructure to fill gaps in connectivity that we have not filled through the roll-out of the 4G infrastructure up to now.

Q5 **Chair:** I mentioned that the UK is considered to be in fourth place internationally. Mr Evans agreed with that broadly. No. 1 on the list I was consulting was South Korea. Are there any lessons we can learn from how those few countries that are ahead of us are doing it, perhaps taking South Korea as an example? Are they doing things in a different way from how we have embarked on it?

Matthew Evans: There is always a danger in looking at different countries that have different legal systems, population densities, topography and geography. Where countries have been able to deploy this it is often with a close Government-industry partnership. They have prioritised certain areas. They are a lot better at deploying it around transport corridors, for instance, which 5G can definitely add to. There are certainly lessons we can learn. They tend to try to concentrate on lowering the barriers to deployment.

There are lots of things the Government can still do that it did not do in 4G. We have taken some positive steps, but there are still things to do with planning reform and trying to incentivise industry to work together that we could borrow from other countries.

Q6 **Chair:** Professor Simeonidou, do you have any observations on how countries that are ahead of us are doing it perhaps differently? Are there any lessons to learn?

Professor Simeonidou: Most of the other countries that have had faster take-up of 5G have a local vendor—for instance, South Korea with Samsung, or Japan with NEC. Focus on the local market for the local vendor has been a big driver at the initial stages of 5G. It is not any more, but initially it has been.

Chair: That is very helpful. We will come to that in more detail.

Q7 **Dawn Butler:** Thank you both for coming to give evidence today. Professor Simeonidou, how many 4G masts are there, and how many 5G masts do you think there need to be?

Professor Simeonidou: I am afraid I cannot give you the numbers. Matt probably has more information about the exact numbers than I do. You probably realise that as deployment evolves there are more; they are updating the numbers all the time.

I suppose your question really addresses the density of 4G mast deployment and the density of 5G mast deployment. If we are looking at the first roll-out of 5G, which involves a 3.5 GHz radius, the density is very similar from what I have seen in deployment, architecture and technical details.

When we go forward with 5G and start using a new type of technology—millimetre wave technology, which operates at higher frequencies and is to be deployed in dense environments like city centres, venues and so on—we are going to see higher density of this radio being installed for coverage in these environments. We are going to see more radio installed with 5G compared with 4G because of the specific new radio that needs to be installed to bring full capabilities in dense environments like, for instance, urban centres.

Q8   **Dawn Butler:** Matt, do you have any idea about the numbers we are talking about?

Matthew Evans: I can certainly write to you and confirm it, but it tends to be in the range of 40,000 to 45,000 masts that are currently used for cellular in the UK. As Dimitra said, we expect to see that densify, making use of small cell and millimetre wave spectrum, but it is hard to give a number because at the same time there is an industry trend towards consolidation. People are starting to share masts a lot more, so the numbers will probably fluctuate before settling down a little bit.

Q9   **Dawn Butler:** It would be useful to have an idea of the number we are talking about. Are you in agreement that it takes 20 to 30 years to identify whether there are any health trends in regard to the technology—for example, waves, megahertz, and so on?

Professor Simeonidou: I have to declare that I am not a public health expert. I do know that identifying health effects takes time. However, there are two international organisations. The first one is the International Commission on Non-Ionising Radiation Protection. The second one is the Institution of Electrical Engineers. They are looking very closely at the potential health effects of radiation.

There are two things I would like to mention. The first public health worry that arises is radiation. The radiation emitted by our mobile networks is non-ionising radiation. There is very strong evidence that that does not break down DNA and, therefore, does not cause changes in cells.

The second one is about heating. Some of the 5G technologies—the millimetre wave technologies—start coming within the microwave spectrum. Therefore, there are some concerns around heating.

According to international standards and recommendations, for both radiation and heating, the energy emissions from 5G networks are below the lower safety limits defined by the organisations I mentioned earlier. I know that the World Health Organisation is doing a comprehensive study and is due to publish a comprehensive report in 2022, but up to now

there is enough evidence to say that scientifically we do not see effects on human health from 5G or 4G deployment.

What is really worrying is the misinformation and radicalisation we have seen. In particular, during the lockdown period we have seen masts being burned. I think we all have a commitment—technologists and Government—to inform the public, be more transparent and establish trust about the technology we are deploying and the effect it may have on health.

Q10   **Dawn Butler:** I agree it is absolutely vital. Does Matt want to come in on that?

Matthew Evans: I completely agree with Dimitra. The other point to make is that 5G is new and is introducing new characteristics. It is moving into a different part of the spectrum, but it is fundamentally the technology we have experienced for the past 30 years in mobile cellular, so we have a really strong evidence base for it. I agree with Dimitra that we should be open and transparent, but we should also combat misinformation wherever it is.

Dawn Butler: I totally agree. I think the key to quashing rumours in regard to Covid and 5G is transparency and being open.

Q11   **Aaron Bell:** Mr Evans, in your opening remarks you said 5G was much more than just faster mobile broadband. Could you expand on that and explain the internet of things concept and the benefits it could bring to UK society more widely?

Matthew Evans: Dimitra will no doubt add on the technical work; her background is very much in IOT.

What 5G allows for the first time is a scale network that people can access and be confident in the standards. There have been other IOT networks and technologies out there, but this really brings IOT to the fore and allows for some incredibly innovative applications, be it helping to transform our public service delivery, digitising areas like manufacturing, agriculture and mobility, but also looking at applications that will help us on the road to net zero.

The economic benefit is hard to overlook when it comes to 5G. The IOT aspect really will help us to make better use of data; it will give better insight into operational efficiencies; it will help to allow for new business services, but it will also take action as well.

Q12   **Aaron Bell:** It is my understanding that lower latency is just as important as extra capacity. Can you give some examples of applications that would rely on lower latency?

Matthew Evans: Connecting with autonomous vehicles is usually the go-to application. Whenever you look at AI, it is the low-latency aspect that means 5G becomes more than just a network—it becomes more of a

computing environment that we can utilise. We can utilise AI and the power of the cloud, so we have far greater computing capacity where we need it. That could be for something like connecting autonomous vehicles, but it could also apply to how a port is managed; it could be in a factory so we are making the most efficient decisions, or in robotics. For anything that requires precision, essentially latency is a game changer in this iteration.

Q13   **Aaron Bell:** Professor Simeonidou, do you want to add anything to that, or is that covered?

Professor Simeonidou: For anything that has to do with remote operations and automation, 5G could provide solutions. Last year we saw the first successful remote medical operation. Remote manufacturing and the automation of manufacturing is another one, but I would like to make a distinction, as I think Matt did. There is a difference between low latency and high density of things.

When they go together it makes the system very powerful. For instance, with 5G we may have up to 1 million devices connected per square kilometre. Think about, for instance, social care and instrument-assisted homes. This is going to be revolutionary, because we can support a very high density of social care, keeping people in their homes and being able in a very non-invasive way to monitor their health, even their happiness.

All these things are very important as we move towards a fully digital society. Until 5G emerged we could not see technologically the capability to do that. We could do it on a very small scale, but 5G is bringing this scale and the technological capability to make things happen.

Q14   **Aaron Bell:** It sounds like you expect the functions of 5G to expand alongside the technological advances. When would you expect the future role of 5G to become clear as these advances happen?

Professor Simeonidou: Matt mentioned at the beginning a very important thing, which is that 5G now rides on 4G infrastructure. That means that at the moment, although we have commercial deployment of 5G, we do not have the full benefits. We start seeing increasing download speeds, but we do not have the full benefits of low latency and the full support of devices.

There is not enough technology readiness across all vendors to bring in standalone 5G systems at the moment. There are also evolving standards that have not been finalised to bring some key features forward.

Over the next years we are going to move from non-standalone to standalone 5G systems, which will bring the full benefits. In my opinion, we need three to four years at least going forward to see the full roll-out of 5G and, therefore, the industrial interventions that we know this system can support.

Q15   **Aaron Bell:** You have been involved in the 5G capability trials in Bristol.

What are the initial findings?

Professor Simeonidou: The 5G test bed trials programme has been supported and funded by DCMS. In my opinion, that has been an excellent intervention for the UK.

In our trials we focused on building an innovation test bed in the centre of the city, and then we expanded it to Bath and now to the manufacturing side as well. The idea of the test beds was to give early insight to vertical sectors—for instance, to transport to distant— *[Inaudible]*—to artists and to museums—to see how they can use 5G systems for their benefit.

We did an amazing trial with the Roman baths and museums. In Bristol we demonstrated how 5G could bring a better connection with history when visiting our museums. For instance, can we go somewhere and visualise how this place used to look in the past? Having the whole trail of history is part of the experience we are delivering. We have done this because 5G could support AI-VR experiences and bring those experiences very quickly—almost instantaneously—to the user.

We are now doing some work on manufacturing. We are not looking at the automation of manufacturing, but we are looking at the opportunity of 5G to support collaborative design, especially for the composites industry. A number of businesses need a lot of design houses with different skills to work together. Therefore, how can you bring together all these skills in real time—for instance, to design the next aircraft wing for Airbus?

By having the test beds and open environment we bring in industry early on and, therefore, increase the readiness level of UK industry in idea adoption.

Q16   **Aaron Bell:** I do not know whether you are aware, but there are proposals for larger-scale test beds. There is one in Staffordshire of which I am aware as a Staffordshire MP. Do you think the next step is to have test beds at a regional or county level before we try to roll out across the nation?

Professor Simeonidou: The test beds have been a great intervention, as I mentioned before. Under the DCMS programme the UK readiness for 5G on the technological side and in creating the 5G ecosystem is equal to, or even more advanced than, other countries.

In my opinion, this intervention in 5G with test beds should continue, not only at local and regional level but at national level. We have created and are still creating a lot of assets and, if they join up, they will give us the capability to create a test bed Britain for 5G. That is going to be absolutely critical for developing the next generation technologies for mobile networks.

Q17   **Aaron Bell:** Mr Evans, you are nodding. Did you want to come in?

Matthew Evans: It is interesting to hear what Bristol and Bath have been doing, but it is important to differentiate the roll-out of the 5G network, which is under way today right across the country, from what the test beds are doing, which is proving the business cases, the user cases and how 5G is being exploited. That is where the economic benefit lies for the UK and that is where we can specialise.

The two are obviously linked to an extent because, if you have a really good 5G network, you can attract entrepreneurs and innovators to come and invest in the UK, but they are separate in that sense. Therefore, what we are using the test bed and trial programme for is to build the technology on top of 5G and show what 5G enables.

Q18   **Aaron Bell:** That is obviously about working with partners in the public and private sectors as well.

Matthew Evans: Yes.

Q19   **Aaron Bell:** Would you favour a larger-scale regional test bed at this stage?

Matthew Evans: Yes. I think the 5G test beds and a trial programme have been really good. A £30 million 5G "create" programme was announced recently from that umbrella programme. We would like to see more of that; we want to see both Government and industry invest together, but to make sure we are telling other parts of the economy how they make use of 5G. That is about how they digitise more generally as well.

Q20   **Aaron Bell:** If there is a fixed pot of investment—there is not, but we all know money is not unlimited—where should investment in 5G technologies be targeted?

Matthew Evans: It is absolutely in those test beds and looking at how we can exploit them. We have particular strengths in the service sector, on which we can build, so I would go there.

The other aspect is making sure that we are digitising the whole of the economy to be able to take advantage of 5G and full-fibre technologies that will boost productivity as a whole.

Q21   **Graham Stringer:** Professor Simeonidou, can you tell us how in 5G the different layers interact compared with how they react in 4G? Does this present an extra security risk? Is more of the core migrating towards the edge?

Professor Simeonidou: I will try to give a short answer, if possible. The 5G network has some common components with the 4G network and some evolving components. We have the radio access network—the masts and antennae. This is common, although they are different kinds of radio.

Then we have the packet core, which is where all the service provision of the network happens. You may start thinking about the packet core as a physical IP network where you are compressing data and voice services; you do identification and authorisation there, and you also do mobility management, quality of service and all these things. Those are common and have been for quite some time in the architecture.

As we are moving to 5G networks, there are three additional things we have to pay attention to. One is the move to the cloud. What we see in 5G in architectural possibilities is commoditising equipment and moving the functionality from the box into the cloud. I am sure you will hear more in the next session about this, so I will not go into it in any detail.

The second one is moving the cloud to the edge when it makes sense, so the mobile network computing dense cloud is very important, because if we are looking at the requirements for a mobile network they are not the same across the network itself. There are places where they need either different support or services. Therefore, bringing the cloud to the edge is important.

The last one is what we call network slicing, which we started looking at with 4G but is fully enabled in 5G. Out of the same physical infrastructure we can create multiple networks. We can support multiple service providers and, for instance, not create a different network for broadcasting and a different network for emergency services, opening up the possibilities for enterprises like stadia and airports and ports to create their own networks and services.

Every time we move things from hardware to software we create new facets to the vulnerability of the network. You have a more flexible network. Every new degree of flexibility makes your network by definition more vulnerable, but not inherently so, because then you have the opportunity to include software development practices and assure security through intelligent AI, learning and so on within your software layers.

If we do exactly the things that we do right now but just move things into the cloud, we open new opportunities for security attacks. We have to do software in a different way; we have to develop this extra functionality within our software so we can ensure that our networks are very robust. Does this answer your question?

Q22   **Graham Stringer:** I think so. All the explanation was very helpful, but I think you said it was not inherently more insecure. Is that a fair summary of what you said?

Professor Simeonidou: That is a fair summary, but what I am saying is that we need different practices in our software development to adapt to this new software architecture. Therefore, there is a lot of opportunity to invest in, develop and commercialise the software layers that previously were hosted on boxes but now are hosted in the cloud.

Q23 **Graham Stringer:** Is communication with the cloud inherently more insecure?

Professor Simeonidou: That is not necessarily so. As I said before, if we take the same piece of software and move it from the box to the cloud it is not as secure, but we are going to produce different types of software. I am sure that the next session will clarify some of this, because hosting functions in the cloud needs different software development and a different way of providing assurances.

Q24 **Mark Logan:** Professor Simeonidou, what are the implications of having only three vendors in the current UK radio access network?

Professor Simeonidou: The UK is not unique in this. If we look at the supply chain, there are three big global vendors: Huawei, Ericsson and Nokia. They are very much present in the UK network. There are other vendors like NEC and Samsung, which are very successful in deployments in more local environments but not so much in the UK supply chain at the moment.

The telecom vendor industry is a very complicated one. It produces very complex systems and, therefore, quite a lot of vendors have not survived in the past 10 years of consolidation of the industry. Having three vendors is not unique to us. Around the world, it is a very similar environment.

In my opinion, rather than anything based on pure technological evidence, having vendor diversity in our infrastructure is a good thing. Having a multi-vendor environment, where we apply certain practices of deployment, operations and production and manufacture of this kind of equipment, is a good thing. In practice, having a multi-vendor environment that complies with national standards as well makes our infrastructure more robust and, I believe, more secure.

Q25 **Mark Logan:** To what extent do you think it is feasible for the UK to develop an alternative RAN vendor?

Professor Simeonidou: I would love to see a UK vendor. May I remind you that many years ago we had Marconi and a radio breakthrough? We had STC and the STC labs. Here in the UK we discovered optical fibre. In my opinion, it is very difficult at the moment to develop a full telecom vendor that can catch up with what is happening. It needs enormous investment in R&D; it costs billions per year for a very long time. All of it is at the vendor's risk.

A new vendor needs to have the market to survive. In the telecoms industry the service providers work with legacy and with trust, so trust and legacy should be built into this as well. It is not impossible. I am not sure whether catching up with 5G is possible, but there are other opportunities beyond traditional vendors. There are new architectures with the disaggregation of supply, say, based on commoditisation of hardware. Therefore, the vendor moves from making boxes to developing

software. That is a very interesting proposition for the UK, because I think we have skills in software development that can bring us into a position of leadership, but we have to see the whole vendor story in a very different way and right now it is an evolving story.

Q26   **Mark Logan:** How many years to date have we been living in a kind of 4G generation?

Professor Simeonidou: It is about 10 years from starting R&D on one generation to moving to another one.

Q27   **Mark Logan:** Thinking of 6G and thereafter, do you feel that for the UK that ship has already sailed and that for 5G it will be very difficult to catch up? Should we be looking at the next generation, or is 6G just too undefined to think further ahead?

Professor Simeonidou: In my opinion, I think 6G will look different from 5G. We are going to be looking at different architectures and probably working more with open standards and open software stacks. There is an opportunity there. UKRI is already funding projects on 6G. If you look at what is happening in our universities across the country, a lot of R&D work is thinking about next generations of mobile networks. That work has started already within the UK in R&D, as in other countries.

If you are asking whether we should invest now with a new vendor in 6G, it depends on what 6G is going to look like. Maybe the next panel will start to discuss this, because if we are looking at a disaggregated supply chain and a very different architecture we have an opportunity.

Q28   **Mark Logan:** Have some of the current providers, or major countries in the 5G ecosystem, leapfrogged from 3G or 4G straight to 5G?

Professor Simeonidou: Yes, this has happened, or some very big companies completely lost the opportunity to move from one generation to the other. That is why we have seen this consolidation in the industry, and we are seeing it happen all the time, with big mergers or acquisitions. That is why there are now three to five vendors playing globally.

Q29   **Chair:** May I ask Mr Evans to comment on the future competitive landscape?

Matthew Evans: I agree with nearly all that Dimitra said. The desirability of a UK vendor is without question.

As for the feasibility of it, as we currently think of vendors, it is quite hard to imagine how we could do that without causing a significant delay in the roll-out of 5G in the UK, because we would need to create a portion of the market for it to be able to access. I think that to do that would be untenable.

The criterion for success in the global vendor market is the ability simultaneously to develop, deploy and continue to evolve products on a

global scale in an incredibly complex ecosystem, so the benchmark for success is really high.

I know that your next panel will go into this, but at the moment there is some work on how we can introduce more diversity into the vendor supply chain. One of those initiatives is OpenRAN. That is breaking apart the monolithic architecture we currently have with vendors where they develop and sell both the box and the software that sits on top of that. OpenRAN looks to break that up into sub-components so companies can specialise in just one component, but it is much more interoperable between the different parts of those stacks. You could think of that over the long term, and that may be an area worth investing in.

Q30   **Chair:** Is that something you expect to happen naturally and organically in the market, or does it require a policy intervention to secure it?

Matthew Evans: I think operators are quite interested in this because they recognise that resilience to some extent relies on the diversity of vendors and suppliers, so there is a definite trend. However, if you look globally, at the moment OpenRAN sales would probably be less than 1% of global telco sales. It is new and really promising, and certainly the 5G test bed and trial programme could look to incorporate that and try to accelerate it, but it is not a quick fix by any stretch of the imagination.

What it can also do is not just allow a UK home-grown vendor but other players—a Samsung or a NEC—to enter the market in that particular layer. I do not think that would be a quick fix, but it would provide greater assurance to operators.

There are other things that the Government could do. There is talk of a national telecoms lab being set up. If that looked at wider network performance, we could start to make sure that operators are reassured that the equipment and techniques they are going to put into their network will not compromise the integrity of that network. Their primary goal is to make sure their network functions well for us all, and the more we can do to try to reassure operators about the interoperability of this type of equipment the better.

Looking at OpenRAN and trying to spur its growth is one area. I think that looking at some sort of national telecoms lab, which would be quite pioneering for the UK, would also help to diversify the supply chain, but probably over the medium to long term.

Q31   **Chair:** One of the questions for this inquiry—this is our first hearing; we have much more evidence to take—is the question of whether it is about allowing developments to happen or whether there needs to be, and it is feasible to have, a strategic determination to make it happen. You use the word "allow". Is that sufficient in your view, or does it need something more firm of purpose?

Matthew Evans: I think the Government could use the 5G test bed programme to really spur OpenRAN issues and sponsor and promote them. They could then start to take a decision on whether the technology and techniques are working, in delivering the outcome that we want, which is a secure network with a diverse set of suppliers.

We have to wait a little bit to see whether the technology actually develops as we hope and expect that it will, and then take a step. They can also play an enabling role—as I said, initiatives that can bring in other vendors and give the four mobile operators here in the UK assurances that that technology will interoperate with the existing technology.

The Government can play, initially at least, a strong enabling role; then it is an open question whether it becomes a firmer policy steer over time.

Q32 **Carol Monaghan:** Matt, will you explain to us who do not fully understand what is going on here what the difference is between core and edge?

Matthew Evans: I think Dimitra did try to explain that. In as simple terms as I can deliver—I am not a telecoms engineer, so it will have to be in simple terms—the access network is the towers, mast and radio interface. It is the things that you see, the physical infrastructure, as well as some of the digital communication equipment.

The core is the most sensitive part of the network; it manages communications between masts and different parts of the network; it is where the application layer lives, in being able to direct your call and data to the right device; and it is where the management layer is, the most secure part of the network. That is why there are different security approaches between the access network and the more sensitive core.

Q33 **Carol Monaghan:** Maybe I should have directed that question to Dimitra. I apologise for that.

Dimitra, if we have the core and edge, one being the masts and the other the management of it, surely there has to be an interaction between core and edge for them to work in unison?

Professor Simeonidou: That has been the case up to now. I would like to say that Matt offered a very precise explanation on this—so thank you, Matt.

The most vulnerable part of a system in a mobile network is the core, because that is where service provisioning is actually being decided. The radio access network is not exactly the edge, because the edge is something different and is less vulnerable. Up to now, we have had a situation whereby a vendor would provide both the core and radio access, and, usually, the operation was expected from a single vendor, from the core to access.

With the issues with high-risk vendors, we have seen vendors providing radio access that works with somebody else's core. This is a good thing. For instance, you may have radio access equipment from a high-risk vendor, since radio access is less vulnerable than the core, and it works with the core of a lower risk vendor. So we are going to see networks with one vendor for the core and probably multiple vendors for the radio access equipment—and it is possible to do that right now.

Q34 **Carol Monaghan:** So if high-risk vendors are dealing with the edge parts of it, they still need to interact with the core parts. Is that correct?

Professor Simeonidou: That is correct, yes.

Q35 **Carol Monaghan:** Is that a weakness or a potential source of concern?

Professor Simeonidou: There is no other way for a mobile network to work. You have your radio access that actually communicates with the core. It is quite clear that where your network is more vulnerable is at its core. Increasingly, it depends where the core is hosted; if it is hosted in the physical network or cloud, your radio access vulnerability is localised, and the security threats are less than if there were security attacks in the core of your network.

Matthew Evans: As Dimitra said, it is about the balance of risk mitigation. All vendors have different potential vulnerabilities. Certainly, the telecom supply chain review, the Government's year-long investigation, came to the conclusion that, ultimately, having greater diversity of vendors in the access network—having the three major vendors—was more beneficial than reducing diversity and removing the high-risk vendor.

That is exactly because, for instance, one telecoms mast cannot talk directly to another; it has to go through a secure gateway to the core and back to another radio network. So if one mast is compromised, for instance, it is quite a localised and isolated incident, and there are strong protocols in place to ensure that, if that happened, it would be detected and remedied relatively quickly.

It is also worth saying that the telecoms security Bill and requirements on operators present a real step change and probably put us into a real world-leading position on how we regard resilience across the whole system.

To give you a sense of the scale of that, the requirements will place 134 new principles and 250 new requirements as well as 227 new tests across the telecoms network, for operators and vendors, overseen by Ofcom as the regulator in this space. An incredible amount of work is going on at the moment on how those are implemented. While it is not always easy for operators, that strikes the right balance between potential risk and potential benefit.

Q36 **Carol Monaghan:** I think the big concern, as we have heard already this afternoon, is that the UK does not have the expertise to provide 5G elements at the moment, but you are saying that a lot of protocols will be put in place by Ofcom. If we do not have the expertise, who is going to deal with checking vulnerabilities and potential points of concern?

Matthew Evans: We do not have the home-grown vendor; that is clear. What we do have is a world-leading organisation in the National Cyber Security Centre, which definitely understands our telecom networks better than any other, and probably understands the interaction of different vendors' equipment better than anyone else in the world.

There is definitely world-leading expertise there, along with our operators. Ultimately, it is their reputation on the line if their network is compromised, and they work extremely closely together with the security services and with their vendor customers to make sure that our networks are secure. I have quite a lot of confidence in the approach that the Government are taking on this.

Professor Simeonidou: We do not have a home-grown vendor but we have developed in our universities world-leading skills and expertise in the telecom domain. Continuing to develop those skills is going to be fundamental, because we would like our service providers to have world experts so that, when they are actually designing and defining their networks, they can rely on our own home-grown networks rather than developing dependencies on vendors. Looking at the skills that we actually channel within our network operators is very important.

Carol Monaghan: I do not think that anyone would disagree.

Q37 **Dawn Butler:** Matt said, in regard to OpenRAN, how important it is that we build our local vendors, but also how we can in-build some security measures. If we get OpenRAN developing different aspects, we can build in additional bits of security rather than relying on one specific vendor that might be at risk.

You talked about localised risk. Do you agree that it is vital that we invest in our local developers and look at OpenRAN in a different way, because building diversity into our system is key to our security?

Matthew Evans: As I said, the feasibility of a home-grown vendor that covers all the stack is hard to see. With OpenRAN, as well as allowing more innovation, potentially more security within the network as a whole and, certainly, more resilience of suppliers, you could see that UK companies may be able to develop expertise and specialisation in one part of that software stack. Certainly, you can see UK companies that could do that—so I definitely agree on that.

Q38 **Katherine Fletcher:** This is an area that has got people worried. One thing that we are talking about is the delay to see the advantages of 5G. If we exclude high-risk vendors, how long will the delay be? You have

referred to the medium to long term for several developments. Can you quantify that? That is ultimately the choice: how many years are we going to be without 5G, if we want to exclude high-risk vendors?

Professor Simeonidou: This question has a complex answer. Because of the dependency between 4G and 5G, it could mean that, if we start to exclude high-risk vendors, our network service providers would need to refurbish the 4G networks. This is a big question, because it is going to take quite a lot of the investment in taking forward 5G and is going to introduce quite severe delay.

Q39 **Katherine Fletcher:** I am just trying to quantify it. I do not want to pin you down—I can understand if you want to give a range—but what is that delay? Is it 12 months or 12 years?

Matthew Evans: I think it would probably be a range of two to three years, particularly if, as Dimitra said, you have to rip out and replace the 4G infrastructure. You would be spending money just replacing coverage, and I think that would be where a lot of that delay would come from. But it would be used.

Q40 **Chair:** Professor Simeonidou, you are nodding in agreement. For the purpose of the evidence, do you align yourself with that assessment?

Professor Simeonidou: Yes, it is years.

Chair: I am very grateful. We have run over time, and that is a reflection of the interest that we have in your evidence. You have kicked off this inquiry very well. We asked some basic questions, which is appropriate for the start of an inquiry, and you have helped to educate us and taken us into some very important lines of inquiry, which we will pursue during the remainder. I hope that we can keep in touch and count on your advice during the rest of the inquiry.

<div align="center">Examination of witness</div>

Witness: Attilio Zani.

Q41 **Chair:** I am delighted to welcome our next witness, the executive director of the Telecom Infra Project. Thank you very much indeed for joining us today.

What are the advantages and challenges of building 5G on top of legacy networks?

Attilio Zani: First, thank you very much for the opportunity to be here. I thank Danielle Nash for setting up this opportunity.

The Committee is asking some great questions today, and I really enjoyed the previous session, where you heard some of the considerations around standalone and non-standalone networks.

In a non-standalone network, where you have a 5G radio antenna utilising a 4G core, the benefits are largely around speed of network rather than the network slicing capabilities that might be offered to enterprises and other businesses.

Q42 **Chair:** Will you explain a little about your organisation, the radio access network and the project you are doing in that space?

Attilio Zani: Certainly. We are a global trade association, a community of organisations with a very diverse membership, bridging telcos, IT companies, telecoms operators, vendors and systems integrators. We find that breadth of membership very useful when we are answering questions that the industry has.

Our purpose is very engineering led: we take standards and solutions required of us, such as 5G solutions, radio antennas, access and core network capabilities, and we piece together solutions in our labs that enable use cases to be facilitated in the marketplace.

The connectivity challenges that we get range broadly from super-rural areas to dense urban environments. As we trek towards 5G, we need to consider the necessity for excellent network capabilities in all those environments.

One of our key considerations in the Telecom Infra Project is the necessity for disaggregation that we have been hearing about. We apply that not only to the radio access network but to the transport layer, where the data is sent back to the core of the network, and the core network, whether it is in a central facility, in a cloud, or a combination of edge compute and core capabilities.

Q43 **Mark Logan:** What approaches have other countries taken to address the issue of legacy networks?

Attilio Zani: That is a great question. We see Governments around the world taking different approaches. We hear about wreck and replace in the United States, and we see Governments, such as the Indonesian Government, working very closely with operators and education to ensure that innovative solutions are brought into being for their population and businesses of the future.

Largely, we see a greater willingness to have public-private partnerships, such as the test trials in the UK, and the possibility of a UK ARPA. Those are things that Governments around the world are considering to accelerate the arrival of excellent networks that facilitate all these amazing and magical solutions that people are talking about in transportation, greater efficiency in manufacturing, remote surgery and many others.

Q44 **Mark Logan:** Are there any issues with interoperability? Is it more problematic for the UK, in our particular case?

Attilio Zani: No, the UK is not unique in that sense. Many countries around the world are keen to see interoperability facilitate a broad supply chain of vendors. We have to be very careful when we use the word "interoperability". It has been the lifeblood of the telecommunications industry from the very outset; the ability for the UK's networks to interoperate with every other country's networks around the world is the very basis of our ability to speak to other human beings all over the place. This network effect has been extremely valuable to the population, not only of the UK but of everywhere in the world.

The way we use interoperability is a little different. I would reference some of Mr Evans's comments about the interchangeability of components at every layer, whether it is software or hardware vendors, the access, transport layer or the core. It is about being able to have a diverse supply chain of vendors in each part of the network. Topography is really essential.

Q45   **Carol Monaghan:** May I ask about investment in telecoms? I have some figures on the amount spent on R&D by the big vendors. Nokia invested $2.53 billion in 2018, Eriksson $1.9 billion and Huawei $8.3 billion. Do these figures tell us anything other than that they consider R&D to be important to their success?

Attilio Zani: They tell us an awful lot. Research and development is an essential component of always having the best solution in place. We need to see innovation, and the players that you have described, and many others in our ecosystem, are very innovative. It takes research and development funds to drive innovation forward. A lot of that innovation can be used by companies to differentiate their solutions over and above what is considered to be a global standard and perhaps to corner the market commercially for shareholder value—and we welcome that. It is very important that companies have the opportunity to make money, succeed and grow, and drive greater and greater innovation. We love competition at the Telecom Infra Project.

The challenge comes when that market tends to consolidate, as it has done over the past 20 years or so. In 2012, eight of many vendors were still very active and innovating in the market. Now, fewer are spending those kinds of fees.

Our approach at the Telecom Infra Project seeks to build a diverse supply chain of vendors of all sizes. A great UK example is Zeetta Networks in Bristol, which came out of Bristol University. Equally, companies all over the world are investing time and effort in innovation. We see this as a very collaborative approach to building the future of networks, diversifying the supply chain but also the breadth and wealth of innovation and where innovation can come from.

Q46   **Carol Monaghan:** You mention Zeetta Networks as an organisation with great expertise. I should make a declaration of interest as chair of the APPG on photonics. We know that there is great expertise across the UK,

and we have lots of SMEs working in this area. If they want to expand, where do they look to, to get their investment?

Attilio Zani: There are a lot of angel investors. At the moment in the Telecom Infra Project, as one of many examples, we have an accelerator programme that seeks to take early-stage innovation and put it in our Telecom Infra Project ecosystem accelerator centres. These are physical locations hosted by companies such as British Telecom, and there is one of these facilities in Adastral Park. There, we give the opportunity to young start-up vendors to work with the likes of British Telecom and other telecoms operators around the world in full visibility of the investor community. That gives rise to the open end of the funnel being accelerated towards hardened and more robust solutions that are getting to scale a lot earlier.

That is one of our mission statements. Another component is the necessity then to take that open end of the funnel and push it through to testing and trialling and building those hardened solutions, as we like to describe them, which have robustness, interoperability and interconnectivity baked in, and then take them on to commercial scale.

Q47   **Carol Monaghan:** What you are describing is an example of very good practice, and that is what we would like to see more of. You have explained that there are organisations and SMEs coming through, but, in reality, at the moment, where do the majority of those types of companies get their money from?

Attilio Zani: Some may well be invested in by larger organisations, and some are getting funding from Governments around the world.

Q48   **Carol Monaghan:** Which Governments would be funding them?

Attilio Zani: I do not have the detail on that, but I could take it offline and have a deeper conversation with you and do a little research with you, if you like.

Q49   **Carol Monaghan:** Thank you. As for the UK Government, what do they need to do? What steps do they need to take to diversify the market?

Attilio Zani: First, they are already taking some steps that are to be applauded. As I mentioned before, the DCMS is absolutely to be applauded in the test and trial environment. The concept of a UK ARPA would be very welcome. I quite like the idea of forming international collaborations, such as the DTEN. That is of great value.

To put that aside, I think stimulation is very important. There also needs to be a regulatory construct that is pro innovation and supports the mobile operators that operate in the United Kingdom to benefit from an environment in which they can drive forward their tests and trials, and take those to commercial launch perhaps a lot sooner than they otherwise would have.

Then there is a component of getting very practical—and, as I said, we are an engineering-led organisation with physical labs and environments, where our community come together to build and solve problems. It is very important that, in the United Kingdom, as in other countries around the world, the responsibility is taken to drive forward those test environments in an increasingly collaborative way. So a combination of those components, bringing all those together, might be worth considering.

Q50 **Carol Monaghan:** Do you think the funds and resources that have been just now targeted towards this 5G test bed and trial are enough to support the development and deployment of OpenRAN?

Attilio Zani: One of the questions that I heard in the previous session was on the subject of how fast and when we can expect this. It is right to have high expectations and demand for these solutions being made available in the United Kingdom as soon as possible.

When I answer that question about how fast that happens, unfortunately it is an "it depends" answer, and it depends on the question that you wisely ask about the quantity of spend from the Government. If there is more spend, more alignment and a deeper and increased partnership between operators, vendor communities, systems integrators and Government, with greater funding, I think we can see those timelines shortened.

What is more, it is not only about those timelines; it is also about ushering in systemic change. At the moment, we have very few vendors, as we all recognise. With the great innovative solutions that they have, they have brought the industry a very long way. But for a transition into a new era, whereby we have an ongoing diversification to a funnel approach, bringing new vendors in the whole time, helping them to get to hardened and scalable solutions and keeping that flow going is really key.

The work that we are doing in the Telecom Infra Project really transcends 5G and the current situation with the number of vendors. It seeks to set up that excellent, underlying principle of innovation never stopping.

Q51 **Carol Monaghan:** Are you confident they can take on the big three?

Attilio Zani: Yes. We are very proud to have British Telecom as a member; it is one of the most innovative companies that I have come across, and it invests an awful lot in driving innovation in its labs and trials. Vodafone is also a recognised global leader. Both those companies sit on our board and are UK companies, as you know. They are working very closely with our ecosystem; they are driving, and explaining what their requirements are for 4G and 5G and beyond to our ecosystem. It is that interaction between vendors and operators that will really accelerate things.

Can we see deployments from vendors in our ecosystem? Yes—they have already started deploying solutions in the networks. So OpenRAN is a reality and also an inevitability and a necessity for our networks to be more resilient, commercially and technically, over time. This is very well understood by all companies in our industry.

Can the ecosystem of vendors compete with the big players today? I would say not. They are massive companies with huge resources available to them. We are very grateful that Nokia is one of our members and participates in our technical committee as well.

Q52   **Carol Monaghan:** If Nokia is one of your members, you might be slightly biased on the next question. Should we be using high-risk vendors?

Attilio Zani: I think that using the phrase "high-risk vendors" is not an entry point to the conversation that I typically make.

Q53   **Carol Monaghan:** That is how the Government are describing them.

Attilio Zani: Okay, well that is fine.

Q54   **Chair:** Why would you not use that terminology?

Attilio Zani: I do not know the specific risks of any individual vendor or the inner workings of their organisations to be able to comment on how risky it would be to use their solutions. I am not an expert from a security perspective.

Q55   **Chair:** So, being a specialist in the industry and having conversations and reading technical papers, you have not formed a view on whether there is any difference in the risk profile of the principal vendors.

Attilio Zani: I have my personal views. The organisation that I run seeks to invite all comers, vendors and innovators to work on driving innovation in this industry. We truly believe that disaggregation and interoperability is the solution to any risk, broadening the risk across a supply chain of a vast number of vendors, which can be switched out from the radio antennas and access—the core of the network. That will enable swift-moving operators, with that flexibility of commercial and technical solutions in place. If one particular vendor were to become considered high risk for whatever reason, that vendor could be much more readily switched out for another vendor.

Q56   **Carol Monaghan:** How easily could it be switched out? We heard this afternoon from the previous panel that high-risk vendors will be operating on the edge—hardware and masts and stuff like that. How easily can they be switched out, once we make a commitment to a particular vendor?

Attilio Zani: At the moment, the challenge to switch out is a hard piece of work. For an operator to rip and replace—that is the phraseology that has been used—you need to do that only once. When you have the new

ecosystem in place, providing those more interchangeable components, you do it cell site by cell site, rather than entire network by entire network. That is why the systemic change is necessary.

The challenge that operators have at the moment is in the fact that the phraseology, "rip and replace", is a little back to front, in my view—it should be "replace and rip". We need to have a robust network up and running before we start ripping anything out. That is just the way things work when deploying networks.

Q57   **Carol Monaghan:** The last panel were asked how long they thought it would take if we were not to go ahead with a high-risk vendor and we looked to develop our own network. What would you estimate on that?

Attilio Zani: If by our own network you mean the United Kingdom having its own vendor capable of doing an end-to-end network solution similar to those supplied by Eriksson, Nokia, Huawei and others, it would take a long time. As Mr Evans and Professor Simeonidou said, the time it takes to build a vendor that is supplying everything in that stack, from the access to the core, is hard. Hardware is actually quite difficult to create. But if we have a diverse supply chain, as we do in the Telecom Infra Project, we can start to draw on the capabilities that exist already.

This has been an issue that the Telecom Infra Project was designed and built to overcome years ago, and we are some way down the track and taking large strides towards building those capabilities—and not just UK capabilities.

Q58   **Chair:** Mr Zani, do you share the assessment of the witnesses in the previous session of the time it would put us back? They agreed it would be years. Is that your assessment as well?

Attilio Zani: It is, yes. I was nodding along to that, as they described the challenges and the timescale.

Q59   **Dawn Butler:** To go back to high-risk vendors, we know when it comes to cyber-security that there is no such thing as no risk. If you have vendors developing large parts of your core by themselves without diversity in the system, that creates higher risk. Lots of other countries have realised that a vendor such as Huawei is high risk. Is your reluctance to label them as high risk because of the consequences of that, in terms of replace and rip, as you put it? I think we have to be honest about the risk factor because, otherwise, people will see through that—that we are not being honest and not confronting the risks in front of us.

Attilio Zani: I think the risks commercially, technically and otherwise, are increased by having a low number of vendors supplying anything. You will be much better secured by the availability of solutions for a broad set of vendors, partially because there will be great competition to become more secure as a vendor.

The requirements that we gather in the Telecom Infra Project really speak to the fact that operators want to have very secure, capable and fast networks that are available to countries to utilise. It is that diversity of available solutions that we need to drive towards.

Q60   **Dawn Butler:** As the previous panel said, if we were just to do what we are doing now with 5G, we would be at risk with a lot of our systems, so we have to develop software and update our software to protect what we need to protect. On that level, would you say that Huawei is riskier than the others?

Attilio Zani: I really think that, as we softwarise the network—many people call it virtualisation of the network—as was intimated in the previous session, it is essential to adopt security solutions that are IT based, assuming that your environment is not just totally risk free from the edge. How telecommunications have worked historically is that you set firewalls and stop bad actors getting into the network at all costs. In the IT world—and this is one of the values of diverse membership that you have in the Telecom Infra Project—the paradigm is somewhat different. It assumes that there could well be bad actors inside that network environment, and you account for that and ensure that that software is continually being updated, as you say, and continually evolving. That ensures that whether there is a bad actor inside the network, or on the fringe of the network trying to get in, the network remains robust, does not give any data away and remains fully capable at all times.

Dawn Butler: Colloquially know as a Trojan.

Chair: Thank you, Mr Zani. We are out of time, I am afraid, but very grateful to have that briefing and to have you answering our questions at this introductory stage of our inquiry. That brings to an end our first set of hearings on our new inquiry. We will return to this in the weeks ahead. Thank you for appearing as a witness before us today.