Defining 5G

The role of 5G and how will it impact the digital revolution

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Early 5G mobile technology will be operational by 2020 in time for the Tokyo Olympics. But it is getting harder to define the objectives for new generation mobile systems and the role of 5G is not yet clear, let alone the technology. 5G will undoubtedly have a fundamental impact in multiple sectors, but what will these be and what should be done in preparation?

Getting to 5G

New mobile generations have arrived approximately every 10 years starting with the analogue 1G Nordic Mobile Telephone system in 1984. GSM, which became the dominant 2G system, arrived in 1992, the key development being the digital transmission of voice. This was followed in 2001 by 3G where digital transmission was generalised to include services beyond simply voice; IP networking was also introduced. Finally, in 2009 4G LTE networks entered service offering much better data rates and system capacity.

LTE was a triumph for the 3GPP organisation that produced it since it rapidly became the first truly global mobile system without serous rivals. LTE now reigns supreme as a conventional cellular system and operates alongside the ubiquitous WiFi system which, although only capable of short ranges, actually carries the bulk of the worldôs wireless data traffic.

The process leading to the realisation of 5G is now well underway. The most likely initial platform will be the 2020 Tokyo Olympic games, although large scale deployment is unlikely to be underway before 2022. An important first step was made in February 2017 with publication of the ITUôs high-level requirements for 5G. To meet these requirement, the 3GPP machine is now well into planning and early system specification and, as with 4G, is the undisputed world leader in this regard. There is also increasing activity from semiconductor manufacturers, equipment manufacturers, network operators and others. This includes setting up numerous research centres and test-beds worldwide. The stakes are clearly high and there is already much jockeying for position ï but what will 5G be used for?

What is 5G for?

The main contributions of 4G were higher data rates and better capacity, both major enablers behind the phenomenal success of the smartphone. In addition, 4G extended the range of applications covered to include public safety systems such as fire and rescue services. For the first time, it also provided special features for Internet of Things (IoT) applications.

ITUôs requirements for 5G are mostly about still higher data rates, better spectral efficiency, lower latency and more capacity. At the ITUôs specified peak downlink rate, it would take less than a second to download a full 4k resolution movie. But some have questioned whether this is really needed ï there is after all only so much video users can consume and other applications do not require as much bandwidth. Also, most data consumed by smartphones is actually carried over WiFi networks and not cellular at all.

Others claim that the role of 5G should be about enabling the explosive growth of IoT services driven by sky-high forecasts of the number of devices needing to be connected. In reality, however, most IoT devices are low bandwidth ï for example, remote smart metering applications require bits per second rather than the Gigabits on offer from 5G. Of course there will be orders of magnitude more IoT devices in future leading to more demand, but on balance it seems unlikely IoT will be a major driver for 5G.

In February 2017, the System Architecture Working Group at the 3GPP defined how they see the service requirements for 5G. The focus here is on a 5G being a multi-faceted system capable of meeting a wide range of requirements for different applications. This is really a continuation of an existing trend to generalise mobile systems from originally just a simple mobile telephone service with 1G, to a system capable of supporting applications ranging from unmanned vehicles and augmented reality through to factory automation and the smart metering. Applications will include emergency services, satellite communication and, of course, also cover conventional telephony and high bandwidth mobile broadband.

Others think the focus of 5G should be on efficiency of power usage, better network coverage, very high capacity networks, better spectral efficiency or the convergence of fibre and mobile technologies. One interesting approach pioneered by the IET is that networks should be õdemand attentiveö in that they simply provide the resources needed for any given mode of communication without the user being constrained in any way. In other words, the application defines the communication capabilities required rather than the application being designed around the communications facilities available.

What 5G could look like?

One thing that seems clear is that 5G will be much broader than earlier mobile systems. This is inevitable for a system that must support data rates from a few bits per second in an IoT application through to Gigabits per second for mobile broadband. Support must also be provided for access modes varying from short-range in-building systems through to global satellite communications.

Similarly, support must be provided for a much wider range of devices than before. These must include IoT devices embedded deep within buildings where normal mobile coverage is poor; emergency services radios where high reliability and inter-device communications are needed; devices on moving platforms such as trains and even aircraft; and of course ever-more sophisticated portable mobile terminals.

So what type of system will be able to provide these capabilities and more? For one thing, more bandwidth will be required. The GSMA divides 5G spectrum into below 1GHz, 1-6GHz and above

6GHz. Some sub 1GHz spectrum is needed for long range applications and penetration deep into buildings, but availability here is very limited. More spectrum is available in the middle band for higher data rates and greater capacities, but this is likely to run out before too long. In the end, most new spectrum is likely to be at 6GHz+, leading to a range of technical and cost issues.

Mobile systems before 5G have all supported a single air interface, albeit with an increasing range of options on the bandwidth used and other parameters. This will need to change with 5G where a single system could not fulfil the range of capabilities needed.

Similarly, a wide range of network architectures will need to be supported. This will involve the migration of functionality to the network edge making networks more autonomous and less centrally controlled. Application functionality and content are also expected to move into the mobile network to support, for example, very high volumes of video streaming.

One issue not talked about much is how 5G will interwork with WiFi, a system that while not nearly as glamorous as mobile systems, actually carries around an order of magnitude more data. Will it compete, coexist or simply develop in isolation. This is not helped by the fact that WiFi is developed outside the 3GPP community. In truth, some interworking in already in evidence in 4G and this is likely to continue, but we believe these two systems will continue to evolve largely separately.

Is it affordable?

The EU estimates it will cost ú57bn to rollout 5G in Europe. But network operators are well past the days of seemingly endless growth and high profits. Nowadays operators in developed countries are being challenged by over-the-top providers, most especially the internet giants, on one side and by increasingly assertive regulators on the other ï and of course there are always the shareholders to worry about. In addition, 4G rollouts and still ongoing and, in the case of combined fixed and mobile operators, there is pressure to spend more on fixed fibre networks. On top of this, operators will have to pay for new spectrum to implement their 5G networks.

In this situation, can network operators really afford to invest the sums needed to get 5G started and then roll it out across a country? In the end, they will probably be compelled to deploy 5G and hope new revenue streams will emerge to help pay for it ï for example from IoT services. One trend that might help is the move to convert network functionality into software. So-called network function virtualisation (NFV) and software-defined networks (SDN) could significantly reduce the cost of mobile networks in future.

Our view

5G will fundamentally differ from earlier generations which were basically one-size-fits-all systems with variations to adapt to different use cases. Instead, 5G will be a portfolio of capabilities which can be assembled dynamically to suit the application. The challenge faced by 3GPP is how to make all these different capabilities work together and fit within a single coherent whole.

Although more defuse, 5G will be of fundamental importance and reflects the wider digital revolution which is all about connecting previously separate concerns. Cost is clearly a concern, but as with previous generations, solutions will be found and before we know it 5G will become a reality and thoughts will shift to what happens with 6G.