What is wrong with the 5G vision?

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There are many visions of 5G but they all tend to have a common theme of apparently perfect connectivity where any person or device can connect wherever they are, at whatever data rates they wish, and with minimal latency.

How this vision might be realised varies but many agree that delivering it will involve bringing together different communications networks as well as implementing new ones. Most envisage a solution where cellular, WiFi and IoT networks consolidate, and some would add broadcast networks and automotive car-to-car systems to that list. To deliver higher data rates and lower latency there is an expectation that in addition new wireless solutions at higher frequencies – mm wave bands – will be deployed.

The technical logic behind such a vision is reasonably strong. It recognises that different radio interfaces will be needed for different solutions such as broadband versus IoT. It builds on evolutions taking place within WiFi, IoT and vehicular communications. Finally, the implications of very low latency drive inexorably to mmWave deployments with their highly directive antennas and small cell sizes.

The problem is that this has not been coupled with a business case nor integrated well with the existing structure of operators and other players in the current communications environment. The business reality is that there is no new money. Subscriber numbers have levelled off and ARPUs are in gentle decline. Attempts by the operators over the years to introduce new services such as picture messaging, location-based services, m-health, m-payment, walled-garden Internet, video calls, and so on, have all failed to improve ARPUs, although in many cases over-the-top (OTT) providers such as Skype have delivered solutions. So either 5G will need to be delivered within the confines of current operator revenue or it will need to deliver new services that consumers are prepared to pay more for.

The prognosis for services that consumers will pay more for is currently weak. History has shown more failure than success here. Consumers can, and do, revert to using WiFi when prices for cellular data traffic rise. Many do not value data rates above 4G levels – for example only around 22% of UK households have chosen to upgrade their home broadband to BT's "Infinity" package despite it being available. The benefit of low-latency appears restricted to a small number of professional applications and in any case may only be available in city centres where mmWave solutions have been deployed. IoT systems will generate additional revenue but this can already be captured with existing solutions such as Weightless or GPRS/NB-IoT. Even if it were all captured by MNOs it would only equate to an ARPU increase of around 1.5% a year[2]. New services will undoubtedly emerge but almost certainly these will be delivered by OTT players. Only if these are both compelling and require high speed connectivity might they cause subscribers to pay for better data packages. However, the

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[2] Assume 50 billion IoT devices, which equals ten per person with a mobile phone. Assume an average annual revenue of $10 per connected device leading to $100/person. Current ARPUs are around $600/person so a rise to $700 over a ten-year period of IoT deployment. This neglects the increased costs of delivering the service.

business rationale for an OTT player to introduce a service that requires users to upgrade their connectivity is weak.

Alternatively, if there is no new revenue, then 5G would need to reduce operator costs. This was the case with 4G, which provided a more cost-effective way of delivering data than 3G through a solution optimised for IP data traffic. But 5G does not have any new air interface compared to 4G, nor does it promise much in the way of increased efficiency. Adding a new technology in such cases can only increase costs compared to deploying steadily enhanced 4G solutions, or indeed reducing new deployments to a minimum to conserve cost. There is an alternative argument that 5G will be needed to drive a competitive edge over other operators but this is a zero-sum game that ultimately operators will be forced to stop playing as their margins progressively reduce.

The argument that 5G integrates different types of networks is also flawed economically and structurally. The two most important networks are cellular and WiFi. But they have very different ownership which fits their deployment models well. Better integration between them in respect to the ability to roam seamlessly across WiFi without having to enter passwords and the ability to balance data transmissions between both systems is sensible but better implemented in the phone and by entities such as Google which have visibility and connections with both networks. This does not need a new 5G standard and does not bring benefits to operators – indeed it reduces the demand for their data services.

Finally, the business case for the "jewel in the crown" of 5G – its mmWave solution – makes little sense. Because mmWave cells are very small they can only be deployed in dense urban areas. This means that they cannot be used to deliver new solutions since subscribers would want these to be ubiquitously available. Instead, they can only deliver greater capacity. But most capacity is needed indoors, and can be readily delivered with WiFi solutions. Worse, operators are finding outdoor small-cell deployment in cities difficult and expensive, with sites being very hard to find and suitable ultra-high speed backhaul costly at best and unavailable at worst. Some claim that mmWave is needed in sports stadiums, but even were this true it is too small a market to make the development of a new technology and its inclusion in handsets sensible. In practice, there are bespoke WiFi solutions already available to address this application.

If not 5G then what? There are strong initiatives in place to develop each of the separate networks. Cellular has a path towards LTE-Pro which adds features such as support for emergency networks, increased data rates and more. IoT has narrowband IoT (NB-IoT) which integrates well with 4G networks, or unlicensed solutions for other operators. WiFi also has a strong evolution to simpler usage, higher speed, lower interference and more. The automotive community is working on inter-vehicle communications systems. If operators and manufacturers want to re-badge these developments as "5G" at some particular time such as 2020 then there is little harm in this, other than mild confusion across the industry.

That we have reached a position decoupled from economic reality may not be surprising. Those involved in 5G development to date are primarily academics and manufacturers all of who have vested interests in seeing work continue. The operators have no need to stop this activity even if they cannot see how it makes sense – it costs them nothing and it might lead to new technologies, more spectrum or other advantages. Regulators and Governments are keen to see benefits for their country and so talk up the promise rather than look at the reality.

The world can be made a better place. Cellular coverage can be improved, WiFi ease-of-use transformed, IoT delivered ubiquitously to low-cost devices with 10-year battery life, and transport reliability and safety enhanced with point-to-point wireless solutions. These are all advances that consumers want, that benefit society and that make economic sense. The future is bright as long as we are pragmatic about realising it.

Advice for key players

Many entities are involved in 5G including academia, large industrial players, operators, regulators, governments and international bodies such the EC and ITU. Our advice for each is detailed below.

Academia. It is the role of academics to push boundaries and research new technologies regardless of whether there is clear commercial viability. Work in areas such as mmWave solutions should continue so that we build our knowledge base and possibly make unexpected discoveries. However, a stronger linkage to business departments in the University which can show where breakthroughs would be most valuable might help researchers also address areas likely to have nearer-term implications facilitating spin-outs, start-ups and the ability to gain from research spending in the next decade.

Large players. This includes companies such as Ericsson, Nokia, Qualcomm and Huawei, as well as associated entities like Cisco and Google. These companies benefit from new generations of technology which lead to spikes in operator expenditure. They also gain marketing benefit from appearing to be at the forefront of research, simplistically seen in the boasts of having delivered ever-higher data rates than competitors to test vehicles in the R&D facilities. But in the case of 5G they are unlikely to engender a spike in spending and the data rates claims appear increasingly divorced from reality. A large player that changes their rhetoric towards a more logical and compelling vision could gain a lead on competitors blinkered into believing that the future is all about Gbits/s data rates. Qualcomm already appear to be moving in this direction and others may follow.

Operators. With a real-world constraint of APRUs and spending, operators are pragmatic. Most need not do anything differently other than ensure that they have appropriate strategies towards WiFi integration and IoT. Those that wish to control the future could publicly discuss the business models for the coming decade and show what expenditure and deployments they might expect to make in order to better guide the industry towards delivering optimal solutions for them.

Regulators. There are broadly two roles for regulators – the management of radio spectrum and the rules that govern competition. Regulators should not focus on spectrum for 5G, instead they should ensure that spectrum is available for each component. This involves delivering more spectrum for 4G solutions in bands such as 3.5GHz and 700MHz, delivering spectrum for IoT including enhanced unlicensed spectrum, and ensuring WiFi spectrum remains usable by controlling interference and helping optimise WiFi deployments in dense areas. For less-certain applications such as mmWave it may be more sensible to enable sharing solutions until there is a business case for band clearance. Regarding competition, regulators should enable new operating models to emerge understanding that operators will include companies that aggregate WiFi capacity, deliver IoT solutions, provide small-cell

systems, and likely other approaches. MNOs will need to adapt, possibly merge, change network and spectrum sharing models, with the definitions of markets such as the fixed market or the mobile market becoming blurred. This implies loosening competition regulation now to send signals to spur business innovation.

Governments. Governments typically want to encourage local industry to gain from selling new technologies, and ensure the early deployment of new wireless solutions to provide best-in-class services to their population. Many try to make their country a "leader in 5G". Rather than deploy test-beds and 5G research centres, the best approach is to focus on specific elements such as leadership in connected cars, in IoT or in WiFi management. These do not require research activities but can benefit from directed Government spending. For example, were Government to procure a national IoT solution, similar to the national smart-meter deployments underway in some countries, this would spur local industry to deploy IoT solutions and develop applications and services that could be subsequently be exported. Government-sponsored national WiFi solutions providing free WiFi across cities would equally spur national industry as well as delivering important services to citizens. In the next few years it is unlikely that the location of key vendors of chipsets or network infrastructure will change materially so countries should focus on deployment, applications and OTT services. Happily, this is often the most profitable part of the value chain.

International bodies. International bodies such as the EC are often effectively supra-Governments and much of the same advice applies as for national Governments, above. The EC is keen to promote European leadership in 5G but approaches this through large-scale research funding. This is rarely effective – it is an approach followed for many years with "Framework" and then "Horizon" funding but has not delivered a vibrant and successful European manufacturing industry, rather the converse. Instead, the EC should seek to harmonise national strategies, for example by encouraging a similar approach to IoT deployment across member states that would deliver economies of scale and make Europe of greater interest to global players. Fostering and funding standards bodies and forums is more appropriate than research entities. For the ITU the advice is similar to national regulators – focus on what is needed in the various components rather than on specific 5G spectrum.

Biography

William is a Director at Webb Search Consulting, a company specialising in providing the highest level of advice in matters associated with wireless technology, strategy and regulatory issues. William is CEO of the Weightless SIG, the standards body developing a new global M2M technology. He was President of the IET – Europe's largest Professional Engineering body during 14/15.

He was one of the founding directors of Neul, a company developing machine-to-machine technologies and networks, which was formed at the start of 2011 and subsequently sold to Huawei in 2014 for $25m. Prior to this William was a Director at Ofcom where he managed a team providing technical advice and performing research across all areas of Ofcom's regulatory remit. He also led some of the major reviews conducted by Ofcom including the Spectrum Framework Review, the

development of Spectrum Usage Rights and most recently cognitive or white space policy. Previously, William worked for a range of communications consultancies in the UK in the fields of hardware design, computer simulation, propagation modelling, spectrum management and strategy development. William also spent three years providing strategic management across Motorola's entire communications portfolio, based in Chicago.

William has published 14 books, over 100 papers, and 18 patents. He is a Visiting Professor at Surrey and Southampton Universities, an Adjunct Professor at Trinity College Dublin, a Board member of Cambridge Wireless, a member of the Science Advisory Council at DCMS, other oversight Boards and a Fellow of the Royal Academy of Engineering, the IEEE and the IET. In 2015 he was awarded the Honorary Degree of Doctor of Science by Southampton University in recognition of his work on wireless technologies and Honorary Doctor of Technology by Anglia Ruskin University in honour of his contribution to the engineering profession. His biography is included in multiple "Who's Who" publications around the world. William has a first class honours degree in electronics, a PhD and an MBA. He can be contacted at wwebb@theiet.org.