Vodafone's call for the Gigabit Society

Vodafone Group December 2015

Ultrafast fixed and mobile broadband for Europe

In an era of global competition for trade, business and investment, there is no question that Europe must be at the forefront of state-of-the-art digital infrastructure. This is not a time to settle for quick-fixes or second-best. Europe needs to set a bold, ambitious direction that sends a clear signal to policy-makers, operators and investors that Europe will be a serious player in the digital economy and society of the future.

It is Vodafone's view that Europe should aim for a Gigabit Society: one where citizens and businesses benefit from widespread connectivity of 1 Gigabit per second by 2030 delivered by robust, reliable and future-proof fixed and mobile technologies. The 1 Gigabit per second downstream capability should be combined with significant upload speed capability to deliver true ultrafast broadband. Europe cannot afford to invest in technologies of the past like copper and instead needs to focus on the no regret option of investment in fibre to the home (**FTTH**), cable and 5G mobile networks, the technologies that can deliver ultrafast broadband.

This ambition should be at the heart of the European Commission's reform agenda to achieve a Digital Single Market because *"ICT networks provide the backbone for digital products and services which have the potential to support all aspects of our lives, and drive Europe's economic recovery."*[1]

The imperative of international competitiveness and regional development

Europe risks falling behind other advanced economies such as Japan, Korea and Singapore that have facilitated widespread FTTH infrastructure[2]; and those like the United States that have enabled the development of a strong mobile broadband sector and are seeing early signs of Gigabit FTTH network roll-out.

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[1] European Commission (2015) communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Digital Single Market Strategy for Europe, 6.5.2015, SWD (2015) 100 final.

[2] See OECD broadband portal, data as of December 2014.

This is not just a problem in and of itself. Vital sectors of the global economy rely on widely available cutting-edge digital infrastructure to innovate, produce and deliver goods and services. Increasingly, all sectors depend on customers having access to high-quality reliable infrastructure and services, including the cloud, government services and digitally provided education. From manufacturing and chemicals to the creative industries and sharing economy, for Europe to compete and prosper, for European companies to excel and expand, a strong digital vision is essential. Early evidence from the United States indicates that communities where Gigabit services are widely available benefit from additional GDP growth.[3]

Stockholm, with its early policy to make fibre available to consumers and businesses, has facilitated the emergence of the Kista Science City and its eco-system which comprises over a thousand ICT companies and developers, 24,000 employees, close to 7,000 students and over a thousand researchers.[4]

Capital and labour are increasingly mobile with some service industries becoming super-mobile (e.g. start-ups, programmers, creative industries) and highly dependent on ultrafast broadband infrastructure. In this context, the attractiveness of regions and municipalities and their long-term ability to maintain and develop economic activity will become more dependent on the digital infrastructure they offer. This is supported by recent OECD research on the effect of local FTTH networks in Sweden which shows that a 10% increase in fibre penetration is correlated with 1.1% higher employment and greater business creation.[5]

Widespread availability of world-class infrastructure will become ever more critical for harmonious regional development. It will attract jobs and investment, improve lives through services like telemedicine and e-learning and allow families to work effectively while staying in the communities they love.

Benefits for Europe's enterprises and citizens

Large enterprises

European businesses are heavy users of digital services. Our research estimates that about €117 billion was spent on telecommunications by business customers in 2012.[6] Large businesses stand to benefit greatly from the widespread availability of ultrafast broadband connectivity, a key enabler of the digitalisation of industry, of operational efficiencies and service and product innovation. Sectors as diverse as the automotive and car components, banking services, robotics, retailing and energy are heavily dependent on high speed connectivity for their own business needs and increasingly on that of their customers for growth and productivity.

[3] 'Early Evidence Suggests Gigabit Broadband Drives GDP', Analysis Group, David Sosa.
[4] Area Swedish ICT, Stokab, as socio-economic analysis – Summary, 2013.
[5] OECD, Development of High-speed Networks and the Role of Municipal Networks, 2015.
[6] WIK Consult, Business communications, economic growth and the competitive challenge, 2013.

Cloud services are requiring far higher bandwidth links between end-users and off-site data storage and processing facilities. Multi-site companies' requirements are also increasing particularly for those who are already focussed on big data applications such as real time processing and predictive analytics.

It is expected that every new car will be connected in a variety of ways (a combination of embedded SIM, tethering and smartphone integration) by 2025.[7] With Google's self-driving car generating around 1 Gigabyte of data for every minute of driving time,[8] state of the art digital infrastructure will be a prerequisite. KMPG estimates that connected and autonomous vehicles in the UK will amount to £51 billion value added annually to 2030, resulting in a +1% impact on UK GDP and 345,000 total jobs created in the UK automotive manufacturing and adjacent industries.[9]

Small and medium sized enterprises (SMEs)

For SMEs, ultrafast, reliable connectivity at an affordable price is a game-changer in enabling higher levels of productivity, improved business processes and closer interaction with customers. SMEs need vastly improved connectivity services compared to the ones that fixed line incumbents are providing today.[10] An FTTH environment would not only provide the speeds and reliability that SMEs need, it would facilitate competition in the design of services offered to SMEs so that their specific needs could be catered to, which is not possible in the current environment as explained below. The Gigabit Society would ensure high-quality connectivity at an affordable price, in which SMEs can place the confidence of their businesses and drive forward the digital economy.

SMEs in the services, new media and creative sectors are likely to reap the biggest rewards. The evidence is conclusive that in the transition to broadband, the biggest contribution to job creation was in the service industries, particularly financial services, education and health sectors.[11] Other SMEs will find themselves capacity constrained without FTTH. Even the most conservative forecasts of demand indicate that SME sized hotels, cafés, tech companies, science enterprises, and agricultural businesses will have connectivity requirements above 150 Mbps.[12] To fulfil their potential and remain competitive, these businesses need the Gigabit Society.

Widespread high capacity connectivity will provide the networks needed for data-intense cloud services such as data storage, data processing and virtual desktop integration. This has

[7] GSMA, Connected Car Forecast: Global Connected car market to Grow Threefold with five years, 2013.
[8] Source: Handelsblatt, 27 May 2014.
[9] KMPG, Connected and Autonomous Vehicles, The UK Opportunity, 2015.
[10] Ofcom estimates that 46% of premises in SME business parks in the UK have connections of 10 Mbps or less, 12% have 2 Mbps or less. 'Connected Nations 2015', Ofcom, 2015.
[11] 'The Effects of Broadband Deployment on Output and Employment', Crandall et al, 2007, 'The Impact of Broadband on Jobs and the German Economy', Katz et al, 2010, and literature review in 'Impact of Broadband on the Economy', ITU, 2012.
[12] 'The broadband requirements of small businesses in the UK', Broadband Stakeholder Group, 2015

particular benefits for smaller enterprises as cloud services are becoming vital for their operations and to connect with their customers; without the right digital infrastructure they will be unable to capitalise on this opportunity. In 2014, IBM found that 64% of Chief Information Officers interviewed considered cloud as a "crucial technology for customer engagement", more than twice the proportion that said the same in 2009.[13]

Citizens

It is forecast that machine-to-machine (**M2M**) communications will help to treat 7 million patients globally by 2018.[14] Remote patient monitoring, including through video link, is projected to result in global cost savings of up to $36 billion by 2018.[15] Some healthcare applications depend on large amounts of data being transferred and real-time monitoring and communications. Citizens will benefit not just from the applications that can be used in their own home, but also from the connection of local healthcare facilities to high-capacity networks. Complex diagnostics that involve the transfer and computation of significant amounts of data, such as genome sequencing that identifies susceptibility to fatal diseases, must be done today in large, specialised hospitals. In the Gigabit Society, patients will be able to visit their local healthcare facility which can transfer data to specialised institutions for remote processing.[16]

Virtual and augmented reality applications are among the most demanding in that they require very low levels of latency (low delay) to match the speed of human sensory reactions. In addition to exciting developments in consumer applications for games[17] and the potential for movies with multiple perspectives, virtual reality has the potential to transform education. In the Gigabit Society, higher education and training can be further democratised with the opportunity for interactive models of delivery at prices that are affordable for more people.

Digitally active families will appreciate the benefits of worry-free connectivity that meets their future demands. Ultra high definition 4K television typically requires 20-30 Mbps per channel.[18] But that is just today's standard. The next generation, 8K, requires 40-50 Mbps.[19] Even, as these bandwidth-hungry services are optimised over time, household bandwidth requirements are expected to increase as customers' expectations for crisp resolution grow. Today, video and TV streaming account for a massive 86% of the bandwidth usage on fixed line networks and significant future growth is predicted.[20] This is an important consideration for the Gigabit Society as new applications become prevalent that will need to compete with video for bandwidth in the household. These are likely to include virtual reality games,

[13] 'Moving from the back office to the front lines', IBM, 2014.
[14] IHS technology, 2014.
[15] FierceMobile Healthcare, 2013.
[16] 'Die Gigabitgesellschaft', Martin Schell, Fraunhofer Institut für Nachrichtentechnik HHI, Symposium Breitbandpolitik, Berlin, 2015.
[17] For example, the development of gaming devices such as Oculus Rift.
[18] Source Analysys Mason, 2015.
[19] Source Analysys Mason, 2015.
[20] CISCO Visual Networking Index 2014-2019.

applications and educational tools, which will not only require the same high bandwidth as TV (and per person rather than per channel), to work it will require performance with delays in transmission that are no higher than 1 millisecond, something that has not been achieved on copper networks.

The right ambition

The aspirational broadband targets for Europe should set the Digital Single Market on a course to deliver 1 Gigabit per second services. The networks needed to achieve this will be primarily FTTH networks, in combination with cable and future generations of mobile technology (5G and beyond) for ubiquitous connectivity and to cover the areas that are most costly to reach.

Signalling a clear direction would provide the medium- to long-term certainty needed to enable investors to commit to the significant levels of investment that are required.

The Digital Agenda targets may be set in terms of speed but connectivity requires more than just bandwidth. Future-proof technologies that can provide reliable, consistent performance at very low latency should be fostered. These aspects are just as critical as speed is for meeting the future demands of businesses and consumers.

The technologies to deliver the Gigabit Society

While broadband targets should aim to be technology neutral, there are clearly technologies more suited to achieving Europe's Gigabit Society; they are FTTH, 5G and cable.

Fibre

FTTH is the only technology that delivers the same quality to every customer, consistently, without degradation in quality over long distances or interference from adverse weather or external noise sources. Other forms of connectivity based on legacy copper infrastructure, such as FTTC-VDSL and vectoring, by their nature provide different quality of services depending on how close or far the customer is from the cabinet, meaning that while some households might receive high-speed connections, their neighbours in the same street can be left out. For example, Ofcom reports that around 2 million (or 7%) of UK premises that are connected to the upgraded copper network from BT cannot receive download speeds of 30 Mbps and that on average their download speeds are a mere 18 Mbps, with customers further than 300 metres from a cabinet expected to achieve speed half of the maximum possible.[21]

In Vodafone's experience, DSL technologies are also associated with greater service issues. In Spain for example, our customers experience 50% fewer faults on our FTTH network than on the copper network of the incumbent. The provisioning time is also twice as fast and can be tailored to the requirements of our customers.

[21] Ofcom, Connected Nations, December 2015.

There is no question regarding the technological superiority of FTTH compared to incremental copper upgrades which will inevitably become obsolete. Europe needs a step change in approach.

FTTH-GPON is already able to deliver a consistent download speed of 1 Gbps. We are offering 1 Gbps to our customers in Portugal for €149 per month. With fibre, there is virtually unlimited capacity and upgrades require only changes to the equipment at both ends. Over the next few years, we will be deploying FTTH networks capable of symmetrical speed of 10 Gbps,[22] this stands in marked contrast with FTTC-vectoring which can deliver a mere 100 Mbps without the same consistency and reliability.

Comparison of fixed access technologies

Technology	Status	Max speed (download / upload)	Typical speed	Latency	Max distance	Consistency of performance
ADSL2+	Wide deployment	Up to 24Mbps/3.3 Mbps	8-15Mbps	8-36ms	5000m	• "Speed up to" only • Actual performance not consistent across users • Actual performance highly variable and dependent on distance, weather conditions, quality of copper, external noise • Around 10Mbps drop for every 100m on vectored VDSL[23] • Around 200Mbps drop for every 50m on G.Fast[24]
FTTC-VDSL	Wide deployment	Up to 100Mbps/25 Mbps	20-50Mbps	5-10ms	1500m	
FTTC-VDSL vectoring	Early deployment	Up to 100Mbps/50 Mbps	20-50Mpbs	8ms	1500m	
G.Fast	In development	Up to 500Mbps/500Mbps		<2.5ms[25]	200m	
Cable DOCCSIS 3.0	Wide deployment	Up to 1.6Gbps/200 Mbps	100Mbps	~1ms	50km	Consistent and reliable performance for all users
Cable DOCCSIS 3.1	In development	Up to 10Gbps/1.5Gbps		~1ms	50km	
FTTH- GPON	Wide deployment	Up to 2.5Gbps/1.25 Gbps	1Gbps	<1.5ms	20km	• Consistent and reliable performance for all users • Fibre good for at least 30 years, upgradable by changing electronics
FTTH- NG PON2	In development	Up to 10Gbps/10Gbps		<1.5ms	20km	

[22] We have successfully trialled the technology in Spain in 2015, see https://www.alcatel-lucent.com/press/2015/alcatel-lucent-and-vodafone-conduct-first-twdm-pon-technology-field-trial-europe-deliver-super-fast.
[23] See ALU: https://techzine.alcatel-lucent.com/boosting-vdsl2-bit-rates-vectoring
[24] See Adtran: https://www.adtran.com/web/fileDownload/doc/32246
[25] Latency between the premises to the central office.

5G

5G and future generations of mobile connectivity will be a complementary, ubiquitous technology to fibre; they will require fibre backhaul to unleash their full potential. The risk for Europe is that without a pro-FTTH policy, 5G could be delayed as fibre backhaul becomes an even greater facilitator of 5G roll-out than for 4G because of the higher bandwidth usage that 5G will enable.[26]

The demands of consumers and businesses are increasingly wireless and mobile. Customers want to be connected anytime, anywhere. SMEs and larger businesses want to provide an improved level of customer service that is enabled by mobile connectivity and the ability to work effectively outside of the office. SMEs also testify that mobility provides greater agility and increased productivity.[27] 5G offers enormous potential for European industry and will help deliver a new wave of innovation in digital networks, which will benefit many industry sectors. It promises ultra-low latency services such as telemedicine and safety infrastructure for intelligent transportation. The internet of things promises to become a reality with 5G through its capacity to enable massive connectivity-based services such as remote monitoring, remote tracking, and factory management.

In the future, 5G connectivity is expected to deliver in excess of 1 Gigabit per second connectivity for specific services. This potential can only be fulfilled with high-capacity fibre backhaul links connecting mobile base stations. A significant increase in the number of small cell sites will be required. Research commissioned by Vodafone shows that from 2016 a capacity crunch for urban macro sites and a significant proportion of rural sites with microwave backhaul will begin.[28]

Where FTTH is widespread, the availability of fibre makes extending fibre to base stations far more feasible and efficient. This is well illustrated by the example of 4G in Stockholm where the world's first 4G deployment took place helped by the virtually 100% fibre coverage[29],

An FTTH policy can provide a clear direction towards the Gigabit Society and support the timely deployment of 5G.

Cable

Cable has played a key role in fostering broadband penetration and will play an important role in the Gigabit Society. The current DOCCSIS 3.0 standard which is widely deployed, is already technically capable of delivering speeds up to around 1 Gbps, although current commercial offers are typically between 100 Mbps and 500 Mbps. The increasing deployment of the new

[26] The world's first deployment of 4G took place in Stockholm where there is virtually 100% fibre coverage, which helped reduce the cost of 4G deployment, Area Swedish ICT, Stokab, as socio-economic analysis – Summary, 2013

[27] 'The Connected Future for SMEs', Vodafone 2013.

[28] Analysys Mason, Mobile backhaul market: Phase 1 report, 2014.

[29] Area Swedish ICT, Stokab, as socio-economic analysis – Summary, 2013.

DOCCSIS 3.1 standard promises to achieve download speeds which can even exceed a Gigabit per second. With its consistent and reliable performance, cable will certainly be one of the engines of the Gigabit Society.

How can we achieve this ambition?

This bold ambition requires a step change to the framework that governs the communications sector to orient investment driven by competition into future-proof infrastructure. It would be a mistake to delay the delivery of the Gigabit Society by leaving it to incumbents to make incremental network copper upgrades: those are temporary fixes which undermine competition and investment in future-proof infrastructure.

Customers are already impacted by the trend towards re-monopolisation where incumbents are upgrading their copper networks and not rolling-out FTTH. Europe has seen the market share of incumbents on their infrastructure increase significantly as a result of the introduction of FTTC-VDSL.[30] The process of upgrading copper networks by installing FTTC is cementing the dominance of incumbents over infrastructure and limiting the ability of competing operators to differentiate and invest. They do so by making unbundling uneconomical and pushing rivals to purchase active services. This risks unwinding the competitive gains of market liberalisation.

In contrast, FTTH networks remove investment and competition barriers, with access to passive infrastructure enabling significant investment by challengers[31] resulting in more infrastructure based competition and higher demand; consumers with FTTH connections use 1.7 times more capacity per line per month than other fixed-line technologies.[32] Customers benefit too from the ability of competing operators to tailor solutions to their needs; and by their ability to provide superior delivery, for example, by providing new connections quicker or on the date that suits the customer.[33] They are also more satisfied with their broadband services compared to DSL.[34] By enabling deeper infrastructure competition, a greater portion of the value chain is exposed to competition leading to greater opportunities for innovation and for product development independent of the historical incumbent.

It is vital that the policy decisions made in Europe promote a pro-competitive future, where customers benefit from these outcomes. The future must not be one in which competition is pushed back to the reseller level with full dependence on the incumbent operators, which would only maintain the incentives of these vertically integrated operators to discriminate against the customers of competing operators.

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[30] EU incumbents' retail market shares at January 2015 were 53% on DSL and 69% on VDSL. Source: Digital Agenda Scoreboard 2015.
[31] For example in as ofSeptember 2015, Vodafone covered approximately 1.2 million premises in Spain and 2 million in Portugal with FTTH
[32] Source: CISCO 2014.
[33] In Spain it takes on average 50% less time to connect customers on our FTTH network than on the copper network.
[34] See Diffraction Analysis, FTTH/B Makes a real difference – Usage Survey Results.

The development of FTTH not only provides future-proof technology, ready to enable the digital demands of the future, it also provides an opportunity to simplify the regulatory environment. This would enable regulators at a national and regional level to take a step back as infrastructure based competition grows.

It will be costly to have FTTH and 5G everywhere but this is the right objective to target by 2030. Policies should therefore aim at facilitating and reducing the cost of rolling-out networks. We need to learn from countries, such as Portugal, Spain and France who have developed comprehensive regulatory regimes to promote the roll-out of FTTH networks. The 2014 Cost Reduction Directive is a good step in that direction but much more needs to be done to lower costs and incentivise investment. Access to passive infrastructure (including ducts, poles and verticals) on a non-discriminatory basis by preferably separating the passive infrastructure from the fixed line incumbent should be implemented. Incentives to fixed line incumbents to deploy FTTH networks should be designed to escape the copper cul de sac. The cost of inputs for 5G should also be reduced to facilitate rapid and widespread deployment in particular this includes spectrum, site, and backhaul costs. Finally, where State aid is involved, the priority should be passive infrastructure that can be used to roll-out fibre and 5G networks.

Demand-side

Europe has so far lacked a coherent and comprehensive vision for stimulating the demand for high-quality, high-capacity services. To attract the investment required, and to achieve the full potential of the Gigabit Society, Europe and its individual governments need to take a leading role. This means driving the development of e-government services across all areas and departments with the intention of positioning Europe as a leader in the use of digital technology in health, education and other public services.

European citizens have keenly demonstrated their desire to connect with their democratic representatives through social media. There is an opportunity to leverage this appetite for engagement, for all levels of government to interact with the public through online platforms and to provide a new generation of interactive digital services. Government agencies would benefit too from the streamlined processes and new forms of communication made possible by the availability of high-speed, high-quality connectivity to their constituents. Furthermore, state-of-the-art digital infrastructure is the key foundation for Smart Cities.

Demand for video and TV streaming will be an important driver of network investment. The Commission and national governments have an important part to play in ensuring the availability of an attractive choice of content for European consumers. National regulators

must be empowered to deal with competition problems in the content market that are increasingly a result of leveraged dominance from the fixed line broadband market.[35]

Once a vision for a Gigabit Society is set, supporting policies and activities by government and relevant organisations will be critical to its success. Increasing digital literacy and raising awareness of the benefits and possibilities created by forward-looking digital infrastructure will be important to ensure all citizens maximise the potential of this new and vast opportunity.

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[35] For further information see Vodafone's submission to the European Commission's 'Public consultation on the evaluation and the review of the regulatory framework for electronic communications networks and services', 2015.