Superfast or superfit?

The case for UK broadband policy reform

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July 2017

About the author

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Introduction and summary

This is a critical moment for UK digital infrastructure policy. The context is one of rapid political, market and technological change. As a nation, we face important decisions over topics like post-Brexit regulation, universal service delivery, Openreach independence, TETRA replacement and 5G readiness. The imperative is to reflect on whether our historic approaches will meet our future needs. Where we anticipate a shortfall, we must act to protect our long-term national interest.

This paper aims to educate policymakers about one specific shortfall: the growing ‘capability gap’ between broadband demand and supply. Notably this is not principally an issue of delivering more capacity. Furthermore, this gap is not the result of regulatory or supplier failure.

The ‘capability gap’ is a symptom of a young industry built on immature technology that faces novel demands. It is systemic in nature, and crosses all geographical and political boundaries. Consequently, it must be addressed by governments and regulators everywhere.

The good news is that we can realistically achieve a ‘better, cheaper, faster’ broadband future for the UK. The capability gap can be substantially narrowed within the lifetime of the present government. Rather than being a policy reversal, we can build upon our past achievements: a well-regulated wholesale market, with substantial retail competition, offering a diversity and abundance of supply.

Such future success requires a policy change: to transcend the current supply-led ‘superfast’ approach, which risks becoming an expensive ‘superfat’ and unhealthy ‘superidle’. It is not worth coming top of the national league tables of over-investment in empty networks that still don’t deliver the capabilities needed. The booby prize is to win internationally on the wrong terms.

Our collective national opportunity is to redefine success around a demand-led ‘superfit’ model. Connected vehicles, health monitoring, flexible teleworking and smart homes are arriving and spreading fast. We can take the lead in creating a world-class platform that is fit-for-purpose for tomorrow's ‘Internet of Everything’, as well as today's common applications.

The time to act is now. Many rural MPs are already finding their mailbags full of angry constituents who lack adequate coverage or capacity. As a result, they cannot access key entertainment or work applications. On our present trajectory, all MPs will find their mailbags swelling with angry 'superfast' broadband users. Constituents will be unable to access vital energy, health or transport services due to shortfalls in capability. This will cause an outcry that cannot be ignored.

This unwanted situation is avoidable by two readily attainable changes in our policy approach.

Firstly, our policy **metrics need to reflect the readiness of broadband infrastructure** to support both present and future demand.

Secondly, the **money needs to move to incentivise the right market behaviours** to create a correspondingly fit-for-purpose supply.

When these reforms are enacted together, this will help to position the UK with a world-class infrastructure ready to attract capital and talent on a global scale.

Understanding the ‘capability gap’

People matter more than packets

The first step to understand the 'capability gap' is to grasp what it means for broadband to be fit-for-purpose in the eyes of end users. In talking to people around the country, this author hears stories of the positive difference good broadband makes, and the problems caused by its absence or failure. These go beyond the simple matter of whether broadband (superfast or not) is *available* where needed.

Consider for a moment a couple who are both deaf, one profoundly so. They can get broadband, but the service where they live is insufficient for their needs. Applications like Skype fail to deliver acceptable video sign language at their home. They require a rock-steady video frame rate with perfectly synchronised lip and hand movement, as there are no audio cues to cover for glitches.

For them, the current offer is not fit for purpose, even if they can satisfy their love of cricket via online streaming video. It has to have sufficient *performance* to meet a wider range of needs.

Another example is an elderly lady who cares for her invalid husband. She has taken to using online grocery shopping, and indeed has become dependent upon it. The performance and availability of this application are not guaranteed by today’s infrastructure. Should her shopping experience seriously decline due to growing streaming video use at peak times—not a hypothetical scenario—then her life will be significantly impacted.

The occasional successful availability of the application out of peak hours is not enough to make it fit-for-purpose. It has to be *dependable*, too.

Then again, there is the story of a family who are using satellite broadband in their rural home, as it is the only available option. All too easily the children use up the whole allowance in just a few days if left to access streaming video. The monthly overage charges, if left unchecked, can easily reach a thousand pounds or more.

A fit-for-purpose infrastructure has to be *affordable*. That can only be achieved by supporting the maximum number of uses over the minimum duplication of infrastructure, so it can have the greatest reach at the lowest cost.

This also means we can’t afford to keep building separate access networks for energy, healthcare, industrial or emergency use. For example, when a farm tractor breaks down or tumbles into a ditch, the sensors and communications systems need to be able to access a common ‘information grid’. Fitness-for-purpose is about supporting as wide a range of uses as possible on a truly general-purpose national infrastructure.

These parameters of availability, performance, dependability and affordability define the nature of application demand. Success in a 'superfit' policy regime requires us to construct a matching information exchange supply.

The third wave of broadband supply

As the digital demands of the population have evolved, the UK's policy and regulatory bodies have responded to help drive supply forward. It would be churlish to dismiss the successes of past and present policy approaches.

In the 1990s, before broadband, Oftel delivered unmetered access to the dial-up Internet in response to consumer demand. Then in the early 2000s, the Access to Broadband Campaign pushed hard for rapid roll-out of the broadband availability. The political establishment responded. Ofcom was created, and the result was a broad success to the credit of the industry. This 'first wave' of broadband was all about *coverage*, with users valuing the always-on nature of early broadband.

Over time, people came to use broadband for more uses, with more concurrent users, and with more demanding applications. The second broadband wave, our present 'superfast' era, has been about delivering ever more *capacity*. We have just passed our milestone for making superfast connections available to 90% of homes. This legitimate achievement took just six years from commitment to delivery, only one more than originally planned.

We are now at a transition point again. More *capacity* alone does <u>not</u> solve the emerging and future problems that users face, as we shall soon see. The third wave of broadband is about fitness-for-purpose, and the *capabilities* of the network to enable that.

We earlier examined what fitness-for-purpose might mean to people. Those needs eventually have to be translated into delivery requirements for packets. What does 'fit for purpose' mean for the capabilities the broadband service must offer? To answer this, let us digress for a moment away from broadband to another utility service, namely electricity.

Broadband is not yet a true utility

Where is the standard 'socket' for broadband?

One of the great unsung fit-for-purpose innovations in British society, one we are all familiar with, is the BS1363 13 ampere power plug and socket. This is superior to other plugs by virtue of its solid construction and safe design.

Firstly, the three square prongs make for excellent electrical contact. It is practically impossible to wobble the plug to cause sparks or intermittent connectivity. The 'success mode' of clean, continuous power is fully covered off. But that's not all.

When the earth prong goes into the socket, it opens up shutters than reveal the live power. Small children can't put sticky fingers in the socket, to the occasional regret of a frustrated parent of a screaming toddler. Yanking on the cord also does not easily apply undue force to the electrical components causing a dangerous fracture. Another great thing about a British plug is the fuse. If there is too much demand, then it cuts out, rather than going on fire. So as a design, the 'failure modes' are also well covered off.

When you stand in the store to buy an electrical appliance, it is easy to tell what the rated demand is in terms of volts and amps. The capability of the supply is also clear, both for the whole dwelling, as well as in-building distribution like multi-socket power strips. You know your cooker needs a special supply, and that you can't power your tumble dryer off an AA battery soldered onto a socket.

In summary, a fit-for-purpose interface between supply and demand does three things: it enables 'success' for specific uses; it sufficiently limits 'failure' for those uses; and it clearly communicates what uses it is suitable for to the buyer.

Broadband: 'bare wires' or 'hard-wired'?

What is missing in broadband is the conceptual equivalent of the standardised plug and socket. The interface between demand and supply is defined at an electrical level, but the overall service of information exchange is (mostly) undefined. As a result, we are left with two less than satisfactory approaches to service delivery.

One technical approach is how we use 'over the top' applications like iPlayer today. It is as if we leave an unshielded live information 'virtual cable' exposed directly to end users. 'Success modes' are enabled, since many applications work some of the time, but the constraint on their 'failure modes' is weak.

In this model, users are not sufficiently 'insulated' from one another. Performance 'brown outs' from overload are common, as our example with video sign language demonstrates. As your children come home from school and go online, the performance of your important work application tangibly plummets.

Alternatively, we have vertically integrated network services, more like how traditional landline phone calls or cable TV work. The information 'virtual cable' from the appliance is 'hard-wired' into the wall, and it can't be switched over.

Whilst performance is predictable, and the service is usually fit-for-purpose, it is a highly inflexible approach. The price of constraining the 'failure mode' is a severe limit on the number of 'success modes'. Vertical integration reduces consumer choice, with a high cost for any services delivered.

The need to 'insulate' the application from other uses may even result in a complete parallel infrastructure, as we have created for smart meters at a cost of billions of pounds. The resources spent on special-purpose smart meter connectivity could have delivered an enormous improvement in the general-purpose infrastructure useful for transport, healthcare and emergency services.

We certainly can't afford to build duplicate infrastructures for every industry and application whose needs diverge even slightly from basic Internet access.

We must transcend 'purpose-for-fitness'

As this thought experiment about power sockets shows us, the kind of fitness-for-purpose we take for granted with electricity is missing for broadband.

Indeed, what we have with ISP services is the exact reverse: a 'purpose-for-fitness' model. You buy the service and then find out what it might (however transiently) be useful for by trying out different devices and applications! The consumer broadband experience is more Arthur Daley than John Lewis in terms of its service promise: you got whatever your got, without any recourse if it is unfit-for-purpose.

What we would like is an infrastructure that supports a large variety of applications that are available everywhere. Performance and dependability should come at an affordable price. For a "never knowingly undersupplied" infrastructure to work, we need to define what the broadband "socket" supplies from the "information grid". To answer this question, we must further unpack what service the information "socket" offers and the device "plug" receives.

How broadband supply is built

With some poetic license for a general audience, the supply of any telecommunications service can be characterised by four factors: *coverage*, *continuity*, *capacity* and *consistency*. Each has multiple facets, and fitness-for-purpose is the result of them existing collectively.

Coverage about the existence of connectivity. Most obviously, it requires the physical infrastructure to be within reach of your device's network cable or radio. Less obviously, users must have the permission to be able to access it. For instance, multiple ISP services allow you to 'roam' onto the WiFi of other customers or affiliated networks. Coverage includes the idea of being able to access a diversity of services, possibly concurrently, and being able to secure them from intruders or attack.

Continuity is a way of defining resilience. The most obvious issue is one of service reliability and time to identify, isolate and fix faults. Yet this factor it is richer than that. Technologies like DSL (used for copper-based broadband access) have 'line speed retrains' and re-authentication that cause 'micro outages'. When we bond together different access technologies, or share radio networks, we may get brief service interruptions due to transient loading effects. A mobile phone may experience gaps in continuity due to hand-offs between cells, and transitions between 2G, 3G and 4G.

Capacity is the 'quantity' aspect of supply. If you want to download a gigabyte of movie to a user in a minute, there is an absolute minimum capacity level required in terms of megabits per second.

Finally, *consistency* is the most misunderstood factor, being the 'quality' part of supply. The timeliness with which information is exchanged at the 'socket' needs to be constrained. It also cannot vary too much or too fast. Network scientists call this essential stability property 'stationarity'. Without it, even the cleverest adaptive application cannot work.

More speed is not the answer

Not all bandwidth is the same

Different kinds of access technology naturally vary in their properties across these factors, even when they have the same 'bandwidth'.

A key reason for deploying fibre-optic cable to the home is that is has strong continuity of service, and often excellent consistency due to idle resources. That it has enormous (over)capacity too is a bonus! The good operational maintenance costs compared to copper help to lower prices in the long run.

For media like cable and cellular the capacity of the access medium is dynamically shared between users, so by default they have poorer consistency than unshared access like DSL and fibre to the home. Satellite has enormous coverage and good capacity, but also lacks the consistency we would like for real-time use.

The UK has invested a lot of resources in higher capacity through fibre to the cabinet and VDSL. This technology has different coverage, continuity and consistency properties than simple DSL. The result is not always an improvement on its predecessor technology.

Success in delivering 'superfit' broadband is simple, at least in theory. The demand for timely information exchange from our "information socket" needs to be met through these four supply factors. Each factor can affect the availability, performance, dependability and affordability of that information exchange.

Dynamically matching supply to demand

The whole computing and communications industry is involved in a long, slow process of moving from fixed and inflexible supply to a responsive on-demand model. For computing we have cloud-based service delivery, and for telecoms we have technologies like software-defined wide area networks. An on-demand model targets supply to match demand on ever-tighter timescales.

At the longest timescales, we make architecture choices over coverage, like where to locate street cabinets, and how long the local copper loop will be. We select and install equipment that defines the supply service capability.

Different technologies have different "switching" times for service coverage, affecting whether changing demands can be met with a fresh supply. With dial-up you could connect to a new ISP service within seconds. In contrast, today's commercial model for fixed access broadband coverage is a "single transferrable monopoly". You subscribe to a one service provider at a time per access line, and the switching time is typically in the range of months to years.

At shorter timescales, we can reconfigure our broadband lines to have different coverage range, capacity, and continuity. At the shortest timescales still, we can schedule packets differently to offer multiple levels of quality with different levels of consistency.

Success in future is not about predicting demand by gazing into a crystal ball, and creating a static supply with a Soviet-style five-year plan. What is required is a system that can dynamically flex to support changing demands. This requires us to have “option value” baked-in, so we can support a diversity of needs for availability, performance, dependability and affordability.

This still requires long-term infrastructure planning, a job sometimes better suited to governments and public institutions than markets. It is all too easy to bake-in constraints that are expensive or impossible to remedy later. The adoption of standards -- as happened for domestic power supplies -- may not happen in a fragmented industry without intervention.

‘Speed’ is not the same as fitness-for-purpose

We have examined the nature of demand and supply, and the need to match them dynamically. How well are we doing at this with today's policy approach?

There is evidently a richness to both application demand and the properties that broadband supply offers to meet it. Yet the retail broadband market has adopted a naïve approach to characterising supply. The primary focus is on ‘speed’, by which we mean a user runs a ‘speed test’ application. This spits out a number for peak upstream and downstream data transfer rates.

These numbers are the result of what happens when many factors interact with each other: transport protocols, on and off-net link capacity, traffic management, transient loads from other users, as well as the speed test application design and hosting. Many of these factors are outside of a broadband service provider’s control. These ‘speed tests’ (when run at scale) also act as denial-of-service attacks on the customer experience since they stress the network by design. This makes ‘speed’ an odd (if common) choice of policy goal.

There is one important technical fact here that every policymaker needs to understand: the essence of network demand is *not* for this ‘speed’ as measured by ‘speed tests’. What is required is sufficient coverage, continuity, capacity and consistency. The measured “speed” is definitely not the same thing, not even for capacity! Indeed, what we colloquially call ‘speed’ for things like Web pages is really ‘user application responsiveness’. This is a result of both capacity *and* consistency interacting.

The figure for peak transfer rate under maximum load is not a good reflection of performance for applications other than a ‘speed test’. A network optimised for speed tests may be very poor at real-time applications, for example. A single metric simply cannot capture the richness of coverage, continuity, capacity and consistency requirements.

Why ever more 'speed' is not the answer

The initial leap from dial-up to broadband was not only a jump in 'speed', but was also a great improvement in continuity, as the service was always on. By definition more speed has required more capacity, which has value for many applications. It is true that historically more speed has been a good proxy for better consistency, as the network could be 'over-provisioned' more readily with idle capacity.

However, there are decreasing benefits to more speed. To the surprise of many, the unthinking pursuit of speed can result in lower fitness-for-purpose. As it is a relatively technical discussion, a list of reasons is captures in the appendix.

An important collective effect of these technical factors is a loss of that essential consistent stationarity, and a growth of inconsistency as 'non-stationarity'. This results in the widespread failure of interactive and real-time services. Whilst these terms may not yet be common in the lexicon of policymakers, they ought to be. You might think of it as a statistical 'global warming' inside of networks due to our profligate resource use policies!

The current UK policy incentive is to drive people to select 'faster' broadband networks and packages. However, a 'faster' ISP service doesn't necessarily imply greater fitness for purpose. It may have worse coverage, continuity and/or consistency. In a 2014 report[1] commissioned by Ofcom, it was found that speeds above 10mbit/sec had little impact on improved user experience.

Furthermore, to deliver the consistency required we have a de facto a policy of 'superfat' and 'superidle', rather than 'superfast'. This works against the need for affordability, using large amounts of capital to run networks idle to avoid resource contention effects.

[1] http://stakeholders.ofcom.org.uk/binaries/research/technology-research/2014/performance-eval.pdf

More speed alone risks a policy ‘car crash’

Focus on speed leads to the capability gap

The capability gap is a shortfall in the fitness-for-purpose of the UK's digital infrastructure for the applications we can reasonably anticipate. It crosses all four supply factors, especially coverage, continuity and consistency.

The technical issues could occupy a book, not just a white paper. To briefly summarise, the key problems are:

- **Coverage:** Users are only able to select a single service provider, resulting lock-in and lack of diversity of network services. Switching times are very long, and the process is prone to errors. There is a lack of security isolation of services needed for 'industrial internet' uses.
- **Continuity:** There are persistent and widespread ‘micro outages’ on fixed access from architecture and operational management choices. The systems for service monitoring do not automatically detect performance faults, and their isolation in the supply chain is more craft than science.
- **Capacity:** Users in rural and select urban locations face a significant shortfall in capacity, especially in the uplink. The amount of (user and taxpayer funded) network capacity that is effectively unusable (as it must be idle to maintain consistency) is large and unquantified.
- **Consistency:** Weak performance isolation between users resulting in growing non-stationarity and application failure. Users are unable buy assured quality for their critical applications. The ability of the fixed broadband network to support mobile backhaul is significantly limited.

The gap will harm the UK if not addressed

There are very specific harms that can be foreseen should we fail to address these capability gaps.

The immediate problem is a growing unfitness-for-purpose. Users have a diversity of needs, yet we are attempting to deliver everything with the cost structure of real-time interactive video. This ‘coals by motorcycle courier’ model has inherently unsustainable economics. As a result, ISPs drop service quality to avoid spending on (yet more idle) capacity, and applications that previously worked for users stop working.

Any reversal of performance improvement creates a consumer loss of trust and confidence in their suppliers and a crisis of legitimacy for Ofcom. Humans have a cognitive bias called the ‘endowment effect’ that makes them over-sensitive to losses. The 'turning point' in service quality that triggers this varies by access technology and provider.

The service quality ‘performance cliffs’ are not being measured or modelled by the industry or regulator. The scaling limits of our architectures are not well understood. In short, the safety case for our national infrastructure is absent, and the risks to continuity and consistency are not quantified. Should other industries (media, travel, retail, etc.) experience failure of their digital distribution system, it will create intense political pressure for action.

The standard approach to scaling (by using idle capacity to solve consistency issues) results in huge wastage. This is typically 50-90% of network resources in the experience of my industry colleagues. This drives up costs, reduces investment, and impairs our ability to service the needs of the weakest in society. By better scheduling and sharing of resources it is possible to have a massive increase in efficiency and effectiveness.

If this is not addressed, the unsustainable economics of broadband will create a pressure for vertical integration, monopoly, and taxpayer subsidy or bailout.

The lack of fungibility of services means that a fully functioning competitive market is not possible. End users cannot judge whether a 300mbit cable service or a 10mbit DSL service will be more suitable for their online gaming application. This problem extends from the retail level all the way down the supply chain. Buyers of wholesale services cannot be certain that their inputs will result in a working application, now or in future.

The consequence of this continuing is twofold. Firstly, there will be a failure of the UK policy, as the only way of ensuring services work with clear attribution of responsibility will be vertical integration. Secondly, other countries who manage their supply chain better will become the 'digital hubs'. This mirrors, say, the transfer of business from London to Rotterdam with the arrival of container shipping.

Looking forward, a key transition is to the ‘industrial Internet’, with 5G being a vital enabling technology. The readiness of UK infrastructure to support 5G backhaul is somewhere between ‘unknown’ and ‘unlikely’. This will affect the UK's future position in the ‘Internet of Everything’, with consequences for jobs and growth. The acquisition of ARM by Softbank is an indicator the importance of this sector.

Is the problem real? Show me!

The sceptical reader will no doubt want some evidence that these issues are real. Here is a selection of data points. It is not meant to be a survey of the fitness-for-purpose of UK digital infrastructure.

The Institute of Directors, not an organisation given to hyperbole, says the UK has a “poverty of ambition”[2] when it comes to broadband. Their demand for high-speed services should be seen as a proxy for fitness-for-purpose.

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[2] http://mkhan6131.com/uk-poverty-ambition-comes-broadband-says-iod/

The Engineering Employers Federation, a manufacturers association, says[3] that download speed not biggest broadband concern. Their issues are reliability and resilience.

A survey of tourism businesses in Suffolk stated[4] that "37% of businesses feel that the quality of broadband in the area is holding them back".

According[5] to Fix Britain's Internet, a movement set up by Sky, TalkTalk, Vodafone and the Federation of Communication Services, "two-thirds [of people] say they feel 'let down" by their internet connection at least once a month. 56 per cent of users said they were unable to perform even the simplest of online tasks".

Bell Labs forecasts[6] that "By 2020, 19 per cent of the worldwide consumption demand forecast for connectivity will not be able to be met by today's network operators".

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[3] http://bit.ly/1X6PJ4j

[4] https://twitter.com/Suzanne_UCS/status/723190866026860545?s=03

[5] http://www.craveonline.co.uk/design/1017407-bad-internet-connections-affecting-mental-health

[6] http://www.telecomtv.com/articles/telcos-and-service-providers/bell-labs-warns-that-telcos-will-be-unable-to-profitably-meet-traffic-demands-by-2020-13484/

The time for ‘superfit’ has arrived

A framework for superfit regulation

To address these systemic capability issues, we need a systemic response. This demands a framework for ‘superfit’ regulation that has three key properties.

Firstly, it must be technically sound. Having the science and engineering in good order cannot be taken for granted. For instance, the FCC and BEREC have both embarked on ‘net neutrality’ rules that contradict what the science tells us. In contrast, Ofcom laudably took a lead in getting high quality science advice[7] before rule-making.

Secondly, it must be market-based. Progress is typically made via market entry and exit, no by incumbents acquiring a revolutionary zeal for change. The job of the regulator is to help the market to function, and the hard work of trial and error that involves. This requires a reinvigoration of retail competition through better transparency and lowered switching costs. It also requires the UK to preserve and grow its successful wholesale access strategy, since this is what enables new technology and commercial experiments to happen without incumbent permission.

Finally, it must be forward-looking, in two ways. We need to anticipate and enable the technical needs of the future, and prepare for the industrialisation of the Internet. We also need to manage failure to protect the weakest in society. This means we need to have a long-term safety case that ensures that we limit the harms from absent, inadequate or unaffordable infrastructure.

Within this framework, there are two broad areas that have to be addressed: new metrics for demand, and moving the money for supply.

New metrics for demand

A demand-led superfit model is centred on user outcomes, not network inputs. This requires a change is what is measured and managed.

The prerequisite is for Ofcom to establish a common scientific base and framework from which demand-led regulation can be performed. Unlike power distribution, where we know it is volts and amps that matter, we haven't even yet agreed industry standard metrics and measurement tools for basic things like network quality. Getting the science right should be an easy political ‘win’, especially given the UK is a leader in the field of network performance measurement.

[7] http://stakeholders.ofcom.org.uk/market-data-research/other/technology-research/2015-reports/traffic-management

The first step is a consultation to scope this activity: what are the requirements that should be met for a good framework of user-centric metrics? Key concerns must include how well the metrics reflect the actual user experience; and the ability to (de)compose supply chains metrics (including a retail/wholesale split); and the isolation and attribution of faults (including in-building vs network supplier).

Ofcom can then tender for the scientific and technical advice needed to fully develop this framework. It may be necessary to work in collaboration with standards and engineering bodies.

In the meantime, the use of ‘speed tests’ should be reconsidered and limited to where truly appropriate and absolutely necessary. These create perverse incentives and high costs. Ofcom needs to consider how it will move to a more experience-led reporting system, both for the overall state of the market, as well as individual suppliers and users.

A functioning market requires transparency, so retail users can compare providers. Ofcom should establish typical baskets of applications for different segments, reflecting both present and future demand. The demand these place on the network can then be quantified and become a benchmark against which different supply services can be compared. Initially the resulting supplier metrics may only be consumable by industry technical experts. Over time Ofcom should develop a consumer-friendly means of presenting the contracted service experience.

In this process, the UK should take advantage of a benefit of Brexit. The European regulations on broadband transparency focus on irrelevant internal network mechanisms. An industrial policy for packets is unnecessary. These requirements should simply be ignored, focusing instead on the overall end-to-end service quality and fitness-for-purpose.

Ofcom should examine the safety case of the UK's digital infrastructure. There should be longitudinal measures of technical hazards like the growth of non-stationarity. Furthermore, there should be a public risks register that Ofcom should (in collaboration with industry) maintain and manage so that we do not get unpleasant technical surprises when we discover unforeseen scaling limits, or other design constraints.

Finally, a demand-led approach should define the network termination point at the information exchange level. What does the ‘socket’ logically offer? This is a key point of regulation, and should also abstract away the physical implementation. It should not matter if the network is a single technology (e.g. 3G, cable) or multiple technologies bonded together, if the user outcome is the same. It may be necessary to regulate the physical outlet as well as include measurement functionality in customer access gateways.

Change the market incentives

Move the money to create supply

An industry associate often quips “The answer is ‘money’. Now, what is your question?”. If the UK wants to have different and better outcomes for its digital infrastructure, the only way of making this happen is to create different financial incentives. These can be seen as aligning to the four categories offered earlier: coverage, continuity, capacity and consistency.

With respect to coverage, BT has shown a remarkable ability to innovate and act when faced with an overbuilder offering a competing network. This emphasises the value of competition in creating incentives, but at a price of allowing BT to unfairly leverage its dominant market position. The government should simply commit to enforcing existing Competition Act provisions to prevent this in future. If this is insufficient, a more proactive approach to licensing BT's build-out plans may be required.

The fees that Openreach can charge wholesalers and ISPs should be restructured to reflect user value, not input cost. These should create a significant upside for enabling new and valued capabilities, such as multiple concurrent retail services with fast switching. There should also be a downside to delivering technology that cannot be unbundled, falls short of its advertised capacity, or lacks the continuity or consistency required.

Openreach should be rewarded for offering services with more tightly defined performance characteristics (which are then successfully delivered). A loose or, ambiguous service definition should result in a lower payment, as should failure to deliver on the promise. Rather than having a war of attrition with the regulator over open access to holes and poles, Openreach should be focused on raising the value of its offering to society.

Ultimately questions of BT's structure as a supplier should be answered by BT responding to demand-led incentives, rather than being engineered by Ofcom (who then take all the blame). If BT can sweat its copper assets and still deliver the end user service outcomes, there's not a problem to be addressed. The evidence to date is that there are significant limitations in fitness-for-purpose that result from BT's technology choices.

Ofcom should study the technical feasibility and economic benefits of opening up the Openreach Equivalence Management Platform (EMP) to multiple input suppliers. This platform is the nucleus for a commodity trading system in network access. The ability for users (individually, or as communities) to secede from Openreach and ‘declare independence’ should be investigated. If Openreach refuses to raise the value of their offer, others can enjoy the benefits instead.

The need for continuity of service is important for real-time applications, as well as mobile backhaul. Again, the financial rewards that Openreach can claim for its service should be tied to what value it delivers to end users.

It is also important to keep some level of powered copper infrastructure in case of disasters and emergencies. The recent flooding in Lancaster offers a study in what can go wrong. There is also a need for diversity in supply for the same reason: the market is not set up to address 'tail risk' events. Ofcom needs to audit the safety case for the UK's digital infrastructure. Just as banks face ‘stress tests’, so should our broadband supply.

Finally, there is the consistency of the offer. Advocates of ‘net neutrality’ are *de facto* arguing for a system of rationing of quality. This is both technically inefficient and commercially unfair. The UK should commit to a market-led approach where network resources are given on the basis of willingness and ability to pay.

UK policy should be to lead the way in developing more technologically advanced broadband networks, with richer commercial models. These should include having the ‘optionality’ needed from more levels of performance and resilience. The UK should encourage development of quality-assured services needed for the ‘Internet of Everything’. This is the opposite of the EU approach, which encumbers their development with heavy-handed regulation.

Where next for UK broadband?

The proposals in this paper are intended as the beginning of a debate, not the conclusion. Moving from a supply-led industry to a demand-led one is going to be a long process.

The broadband industry faces a transformation from a ‘fat’ to ‘lean’. This revolution in quality management — from ‘push’ to ‘pull’ — has already happened in manufacturing and other services industries. By adopting a superfit model, the UK can be at the vanguard of this inevitable process of change. Is already underway with cloud services for computing, and networks need to catch up. The question is, where to begin?

Ofcom has in the past solicited public comment on a proposed universal service obligation (USO) for broadband. This is an opportunity for the UK to up its digital infrastructure game, and do it in a way that reduces cost and delivers more public benefit.

The present consultation asks questions about the service definition centred on speed. This is the wrong measure, and will have perverse effects. For instance, by setting aiming to deliver 10mbit/sec, the result will be to maximise cost (i.e. subsidised capex spending on often idle capacity) and minimise coverage (reach of DSL) and continuity (more line retrains).

The review of the universal service obligation is an opportunity to redefine the market in terms of outcomes, not inputs. This will encourage innovative technological solutions to delivering the user benefit to more people at lower cost.

All it takes is the political will to indicate that what matters to government is the experience its citizens can enjoy, not the prestige of league tables on speed. The 'superfit' policy works to prioritise people, not packets.

Technical appendix

Why is ‘speed’ such a problem?

More speed can hurt performance. This happens in many ways:

- By driving our copper infrastructure harder for speed, we may find we trade more capacity for lower continuity. Access lines being driven to their limit are less stable.
- Statistical effects and protocol interactions in faster networks result in the performance "insulation" between users breaking down. This impairs consistency.
- Architectural changes make it easier for users to "interfere" with each other, also impairing consistency. This can be due to adding additional buffers in the network (e.g. in street cabinets), or changing design rations (like the relative capacity of the edge and middle of the network).
- For mobile, there are trade-offs of coverage with capacity and consistency. Driving the market to compete on peak burst speed impairs coverage and utility for interactive applications.
- With mobile, there is also a trade-off of capacity and continuity. A denser network to handle higher speeds has more hand-offs, which result in lower service continuity.
- "Faster" bearers (4G, cable, VDSL) may have significantly worse consistency than "slower" ones (DSL) and cannot support the same applications at the same quality.
- The capital cost of more speed drives more network sharing, and the dynamic load effects of interacting populations of users can negatively affect continuity and consistency.

GEDDES Fresh thinking

To learn more

I recommend reading the presentation Essential science for broadband regulation.

To understand the criteria for a good regulatory metric for broadband, see How should regulators measure broadband quality?.

Read more about the science of quality at qualityattenuation.science.

There is a reading list of articles, papers and presentations on my website. This includes a detailed reading list on this topic of broadband quality regulation.

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Get in touch

Thank you for reading this paper.
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I offer educational workshops in this subject area, and frequently work as a 'thinking partner' to senior executives.

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