Response to Digital Communications Infrastructure Strategy Consultation

Predictable Network Solutions Ltd. Beacon House Newtown West Pennard Glastonbury BA6 8NL Phone: +44 (0) 3333 407 710 info@pnsol.com www.pnsol.com	**Martin Geddes Consulting Ltd** 17-19 East London Street Edinburgh, Midlothian EH7 4BN mail@martingeddes.com www.martingeddes.com

Q1 Views are sought on:

a) Is this an appropriate role for Government?
b) What other high level principles the Government might adopt?
c) What resources do you consider the Government should aim to deploy to effectively manage its role?

We welcome the regard from DCMS and HM Treasury for ICT and broadband, which are of increasing importance to public life in the UK. We applaud their ambition to ensure that the UK should have a communications infrastructure that meets the needs of users and encourages investment. This is an appropriate role for Government.

However, an even more important role is to have an oversight of the risks and hazards. There is a risk that the infrastructure may not economically be able to sustain the desired outcomes. There is also a risk of major systemic failures because of vulnerabilities inherent in the provision of digital connectivity. No other actor in the ICT ecosystem is able to perform this role. Individual commercial providers have responsibility only for components or aspects of the overall system, and are principally answerable to stakeholders other than the public.

This oversight is especially important in the broadband industry, which is less technically mature than other engineering disciplines, and thus struggles to appropriately measure, model and manage risks and hazards. In the next ten to fifteen years we would hope to see the state of the art in understanding, modelling and managing large distributed systems such as the ICT infrastructure developing a firmer scientific basis. Government can help to foster this.

There is a vibrant ecosystem of commercial players, most of whom are focused on developing products and services that can be successfully sold in the market. Their primary goal is to gain market share rapidly enough to cover the costs of developing and deploying the product or service. Issues of reliability are thus generally postponed to 'later'. This is understandable, since investment in robustness is hard to justify for something that may not be successful. However, once a product or service is deployed, retrofitting reliability, robustness and security is extremely difficult. These things are much simpler when incorporated at the beginning, when key design decisions are being taken. Meanwhile commercial pressure is to devote resources to new features and new products and services.

Many of the broadband and ICT products and services available today exhibit these problems of reliability, performance, security and manageability. This has been demonstrated by recent highly-publicised security vulnerabilities, such as 'Heartbleed' and 'Bash shellshock', as well as a constant stream of mass password and personal data thefts. Even without these crises, however, there remains a problem of maintaining acceptable performance of the plethora of applications and services on which business, government and society increasingly depends.

There is a conflict underlying the current universality of ICT and broadband. ICT and broadband services are affordable because they are statistically shared. This has the consequence of making them 'rivalrous' resources, i.e. use for one purpose impinges on the ability to support others. Whilst delivering ever-higher peak speeds may enable new services (e.g. 4K TV on demand etc.), this is not necessarily sufficient to maintain the performance of existing services. Indeed, mass deployment of such new services may threaten the performance and commercial stability of the current baseline.

As with other forms of critical national infrastructure, a key role of government is to be concerned with the extent to which the operation of market forces does (or does not) meet the long-term needs of the country and its citizens. Therefore, in addition to ensuring that market conditions continue to deliver a stream of new products and services, government should be paying attention to the risks and hazards associated with the continuity of performance and economic sustainability of all digital services.

The investment community is already cautious about the long-term viability of the current situation; the broadband infrastructure is the route to market for digital products and services, but, as it does not provide any suitable performance guarantees, all such products and services are subject to an unmonitored and unquantified risk. Thus a key role of government should be to adequately monitor this risk, and to intervene when the market fails to deliver what society requires.

As an analogy, consider the provision of water services: measuring only the pressure of the water supply, and not its potability, does not guarantee fitness-for-purpose. Similarly, measuring only the speed of broadband does not guarantee its fitness-for-purpose either.

Section 1

Q2 What potential opportunities are there for Government to leverage its combined buying power to support policy objectives?

Government could use its buying power to improve the quality and reliability of products and services. This could be achieved by insisting that appropriate measures and procedures be applied by its suppliers in the development and deployment of ICT products. This should be done in such a way that the resulting improvements create public good or positive externalities that can benefit the wider ecosystem. For example, any open-source software used in government applications should be subject to rigorous testing and security assessment, resulting in improvements to the open-source software base.

Note that this is not the same as requiring warrants, since this merely imposes penalties for poor quality, rather than helping to eliminate it. Commercial players typically enter into contracts in which the cost of failure is considered only in monetary terms (e.g. penalty clauses) - if at all. As digital infrastructure becomes increasingly central to the economic and general well-being of the country, such a view becomes too narrow as the monetary penalty fails to adequately reflect and internalise the cost of the impact on the individual and society.

Q3 If migration to IPV6 is required, are there any barriers to that migration and if so how might these be addressed?

As technical experts in this field, we judge that there is a significant likelihood that IPv6 migration will not occur at the mass scale. It is becoming clear that many of the emerging hazards (such as certain kinds of cyber threat) are intrinsically linked to the design of IP.

There are fundamental design issues in the Internet Protocol that cause many to see it as unfit for future needs. Its design reflects the understanding of networking of the early 1970s, and does not reflect the fundamental principles now seen as being core to long-term success. In particular, it lacks necessary security, mobility, assurance, resilience and manageability features. None of these can be easily retro-fitted to the present architecture.

For example, the use of controls such as firewalls and network address translation functions have become essential (if somewhat inadequate) tools in addressing these shortcomings. One of IPv6's intended benefits is to remove the need for such features, but this would seem to have the effect of making the network infrastructure more vulnerable by increasing the attack surface.

The shortcomings of the current approach have been recognised, and alternatives are being developed, for example in EU-funded research projects such as IRATI.

Section 2 - What might future demand look like?

Q4 Is an ongoing disparity of provision of broadband services inevitable? If so should this be addressed and how might this be done most effectively?

Given the inherent disparity of the costs of providing services between areas of high and low population density, some unevenness of provision seems hard to avoid. However, making the most effective use of available capacity can go a long way to mitigating disparity in access to essential services. This can be achieved by providing appropriate performance, rather than higher speed as a (weak and sometimes costly) proxy for performance.

The UK broadband market is based around the construction and resale of connection/association monopolies. For example, a home can only subscribe to one ISP at a time on a single line, and is thus limited to the services that one ISP offers. Although this market structure provides some certainty of return on investment, it inhibits the delivery of broadband to subgroups that are not commercially attractive to the monopoly holder. It is possible that promotion of retail competition fragments the market and inhibits rich wholesale offers for applications like M2M/IoT or assured teleworking. One way of improving the provision of broadband to 'hard to reach' groups would be to find an alternative market structure to overcome this downside of a monopolistic approach, while still providing sufficient certainty of return on investment.

For example, if a particular location is not served using nationally licensed spectrum, it should be possible for an alternative provider to use it for that location. Alternatively, a more extensive and flexible wholesale market for services would allow the monopoly of a geographical incumbent to be shared between multiple service providers in a cost-effective way that still provides return on investment in infrastructure. Such services would allow finer-grained sharing of the infrastructure, requiring providers to provide suitable fit-for-purpose performance guarantees, rather than just connectivity.

Q5 How symmetrical will digital communications networks have to be in the future? Will this differ across user types? What implications does this have for fixed and wireless broadband provision?

The question should be whether the performance in each direction is adequate, rather than whether it should be symmetrical. This becomes particularly relevant when considering shared-media last-mile systems such as cable or GPON etc., which is a more significant distinction than that between fixed and wireless. In shared-media last-mile systems, the performance delivered to individual endpoints depends on the usage by others sharing the same media. This affects the relative costs of scaling performance.

Clearly, different user types have different requirements, but the infrastructure need not provide a 'highest common denominator' service to all users. For instance, cloud computing provides cost-effective alternatives for services that generate large volumes of data, so that these need not be delivered from broadband endpoints.

Q6 Which countries should be our benchmarks on communications infrastructure to ensure that businesses remain in the UK and continue to invest?

Countries with broadly similar geography and population distribution (e.g. not Singapore or Australia).

Q7 What metrics do you think should or will become relevant in comparing network performance in different countries? What metrics should most appropriately be used as the basis to set objectives for government policy?

The current set of metrics does not sufficiently reflect the quality of the UK broadband infrastructure relative to other countries. Metrics should reflect the end-user experience of services they use, rather than peak or mean speed as reported by a speed-test measurement. Furthermore, end-user satisfaction is dominated by the frequency of 'bad' experiences, so the metric should relate to the probability of such experiences, rather than whether 'good' experiences can be delivered on average.

In reporting such metrics, it is the fraction of users who receive an unsatisfactory service that is the most important measure, rather than the average experience over an area. This is one of the ways that government buying power could be exploited to improve the quality of service provision. For example, structuring SLAs in terms of the probability of 'bad' outcomes, rather than any average or quantiles over a period, would focus attention of the delivery ecosystem on improving satisfactory service delivery.

Section 3 - Scenarios

There are a number of general points about scenario planning over these sort of timescales:

1. *While it is sometimes possible to predict individual technology trends, it is very difficult to anticipate the synergies between them that ultimately generate new opportunities.*
2. *These scenarios present the sort of extrapolations that large businesses typically perform, which history tells us are almost always wrong. In particular, extrapolations of growth in any particular area tend to ignore constraining factors.*
3. *All scenarios underestimate the creativity of this market, and the potential for global delivery that the Internet provides to allow new developments to spread extremely rapidly.*
4. *Since it is impossible to predict where large changes will occur, the most important attributes of broadband must be stability, resilience and flexibility, in particular its ability to continue to deliver services on which people have come to depend. Although the original design of the Internet was intended to be very robust (to meet military requirements), the commercial deployment of the Internet infrastructure, especially in its broadband access, involves a great many interdependent elements and so has become essentially 'fragile'.*
5. *One of the largest hazards is that many actors, including local and central government, assume that broadband will continue to be suitable for delivering services they wish to offer. This expectation is not explicitly captured, let alone quantified.*

We are approaching these scenarios from two perspectives:

1. *where are the implicit constraints that have been ignored, and*
2. *where are the underlying hazards, both to technical performance and financial viability, that are under-represented.*

Scenario 1

Q8 Do you agree with this scenario or elements within it? Where do you agree/disagree? If you disagree what alternative scenario do you envisage?

This is a largely consumer-focused scenario, and does not adequately cover the shift to distributed businesses and home working. We agree (3.7) that AV downloads may be the largest source of demand (which has a timeliness constraint). However, the assumption across the scenarios of ever-expanding consumption of AV content seems to imply a reduction of economically productive activity, and, taken to an extreme, fails to consider the inherent limitations of human attention. Specifically, there are only a finite number of hours in a day and a limited number of video streams that an individual can consume simultaneously. Furthermore, the shift to consuming AV content on small screens such as tablets, mitigates against a shift to higher resolutions. (3.8) We foresee that WiFi demand will remain strong,

(though see potential issues in our answer to Q9) however we also envisage that 5G as currently envisaged will not be the 5G that will be being planned, several of the objectives of the current 5G programme being physically unrealisable. (3.9) The current UK internet structure will be an obstacle to the movement of CDNs into the network, although the relatively compact geography of the UK (compared to, e.g. the USA) may mean that this does not have a significant effect. (3.10) There is the question as to whether confidence in the safety, integrity and reliability of the IoT will permit this level of growth. (3.11) Agree, but see point 5 in our introductory text above. (3.12) Generally agree but there is an additional hazard to the corporate sector around resilience: it is no longer possible in the UK to get assured independent services (for example, route diversity is no longer a purchasable option within exchanges from BT OpenReach). Although it is, in principle, possible to check initially that two routes are diverse, there is no procedural framework to ensure that this diversity is maintained. This is increasingly affecting critical national infrastructure and will affect businesses to the extent that it may become a barrier to inward investment.

Q9 What are your views on the technology commentary underpinning this scenario? To what extent might the infrastructure/technology discussed evolve irrespective of demand and how far will it be a direct consequence of the level of demand?

(3.13) The assumption that the vast majority of connections will be wireless ignores the problems of interference. In dense urban environments, WiFi performance is already degrading significantly due to the profusion of visible SSIDs and their associated beacon broadcasts. (3.14) There are already operational scenarios where the performance stability of radio is not sufficient to support certain applications (e.g. interactive gaming and interactive video conferencing for business use). Consumers who are entirely reliant on wireless connectivity may find themselves unable to exploit it for such purposes, regardless of the headline speed. This represents a new 'digital divide'.
(3.15) We anticipate that current initiatives to optimise network cost/performance will be largely ineffective due to the behaviour of TCP/IP, whose propensity to consume all available capacity will defeat them. (3.16) We agree that, unfortunately, the current siloed infrastructure model will still exist, not because it is the best technological approach, but because of a `fiscal drag' where investors are unwilling to permit the appropriate changes. (3.17) We do not see deployment of the appropriate precursors of the appropriate service isolation in the common infrastructure. (3.18) While we agree that quality of delivery is paramount, we don't see the connection between the location of the CDN and the consumer quality, given the structure of the UK broadband market. As for new entrants, we agree that the existing technical offerings do not provide a suitable managed service. (3.19) Don't disagree with this. (3.20) While the inability of users to control their service delivery is not what we would prefer, we think this part of the scenario is quite likely (but see our answer to Q10 below).

Q10 Are there technologies not identified here that you think will have a major impact on the performance of existing infrastructure or the deployment of additional infrastructure in the next 10-15 years?

We are participating in the active development of new technology, orthogonal to SDN and associated optimisation approaches, that will make much more efficient and effective use of existing infrastructure. This will increase its operational lifetime and hence economic return. Without this, there is a significant risk of financial collapse in the telecommunications supply chain, due to the pressure to upgrade/replace equipment before its deployment cost has been recovered.

We also expect this new technology to deliver more flexible performance (probably under the control of the end user). Wide deployment of such technology will challenge the assumptions that underpin current wholesale and retail ISP provision.

Q11 Are there wider environmental issues not reflected in the scenario e.g. the price or availability of energy that will affect any of the scenarios and in what way?

The impact may be seen as 'positive' for broadband, in that concern over the environmental impact of travel and the increased demand for remote working could combine to raise the value potential of the (assured) delivery of certain services. Constantly increasing peak speeds have a commensurate energy cost, which may result in pressure to slow their seemingly inexorable rise.

Q12 How likely is any unforeseen disruption to this scenario and what area might it occur?

We have discussed potentially disruptive technologies in our answer to Q10, and general issues regarding the undependability of predictions at the start of this section.

The largest disruptive factor is the potential financial instability of infrastructure providers. There is growing complexity (and hence cost) in maintaining existing services, which, when combined with a lower rate of return on wholesale service, directs a growing proportion of revenue and investment into retail marketing activities and 'content acquisition' rather than technology maintenance and enhancement. This process may be underpinned by a (possibly unconscious) understanding that national providers are 'too big to fail' and could therefore expect public support in the case of severe difficulties.

Scenario 2

Q13 Do you agree with this scenario or elements within it? Where do you agree/disagree? If you disagree what alternative scenario do you envisage?

(3.21) We would agree that will be an increasing demand for fit-for-purpose outcomes from the consumers. (3.22, 3.23) Agree. (3.24) Agree, however, the issue of the variability of performance in such locations is already a major concern. What may become an issue is if those health monitoring devices require preferential access (e.g. to signal authorities of an imminent heart attack of the wearer), as the level of assurance of outcome required is not likely to be available in these timescales. (3.25) Agree. (3.26) Definitely agree. See our answer to Q5 about the need for symmetry. We agree the need for bespoke tailoring of services to particular end users, one that may change by time of day (e.g. home office during day, supporting gaming during evenings). (3.27) We anticipate that the issues of complexity may curtail this - use of IP for this purpose (see answer to Q3) will create issues of security and manageability that will inhibit wide scale deployment. (3.28) Agree, we also expect the shortage of suitably educated technical people within the UK who can both understand and tackle the inevitable emerging complexity to have become a critical factor.

Q14 What are your views on the technology commentary underpinning this scenario? To what extent might the infrastructure/technology discussed evolve irrespective of demand and how far will it be a direct consequence of the level of demand?

(3.29) No comment. (3.30) The assumption that elevated user experience will occur from this scenario is not well founded. Small cell technology has challenging economics for its deployment and in-life management costs, including its strong demand for stable performance of backhaul - which is likely to be the general broadband infrastructure. (3.31) See answer to Q10. (3.32) Unclear what is meant by 'fibre virtualisation'. Can't agree with the points on caching as the costs (in the UK) of the core network relative to the access network would mitigate against the economics for this. This cost ratio is related to UK geography (and hence unlikely to change!) (3.33) It is unclear that the consumption density (even in urban areas) will make the use of 4G a sensible economic alternative to other broadcast approaches. May be some use within specific locations (e.g. alternative views of the action within a football stadium). For comments on 5G see our answer to 3.8 above. (3.34) Seems likely. (3.35) Seems unlikely - this would require a level of coordination and interworking of which there are no current indications.

Q15 Are there technologies not identified here that you think will have a major impact on the performance of existing infrastructure or the deployment of additional infrastructure in the next 10-15 years?

See answer to Q10. Immersive distributed VR could be potential major new source of demand, if the performance consistency needed to bootstrap consumer demand can be achieved over existing infrastructure.

Q16 Are there wider environmental issues not reflected in the scenario e.g. the price or availability of energy that will affect any of the scenarios and in what way?

See answer to Q11

Q17 How likely is any unforeseen disruption to this scenario and what area might it occur?

See answer to Q12

Scenario 3

Q18 Do you agree with this scenario or elements within it? Where do you agree/disagree? If you disagree what alternative scenario do you envisage?

(3.36) This scenario seems a bit too "LEGO Movie" - it is unlikely that everything will be this awesome! There are too many vested interests and legacy systems for the required level of cooperation and consolidation to have occurred. (3.37) We would agree with the statements on user demand and the blurring of the consumer/small business distinction. While the corporate market will remain separate, we would envisage large portions of that demand being carried over the retail infrastructure (e.g. small offices, council outposts etc.). We agree that improvements will initially drive an expectation of even better, however, once the inherent performance requirements have been met this will cease to be a driver, and new performance demand will arise only from new services (once everything 'works', why do you need 'more'?). There may be a demand for an increased quantity of good performance, but not for more performance per se. We do not foresee the complete abandonment of copper for voice: as an exchange-powered, highly-resilient and mature infrastructure it is very difficult to completely replace; the fundamental technical issues that prevented BT's 21CN becoming a national voice service replacement remain. There are foreseeable circumstances that will take out ALL the rest of the communications infrastructure in the UK (e.g. a Carrington Event); the survival of a civil society across such an event should be part

of Government concerns. (3.38) We are not personally convinced by this trend to 8K (e.g. 3D TV and Blu-Ray have not followed their predicted trajectories). For the same national safety issues we envisage that broadcast radio will have to exist, since all other streaming approaches (just like VoIP) are dependent on myriad interlocking services correctly operating. (3.39) We accept that cloud systems will have symmetric connectivity, we also accept that content will be cached closer - but this is likely to be in home or the immediate locality in order to keep the latency (for things like remote filestore access - the UK being sufficiently physically compact to have low enough latency for video streaming) low enough for demanding application needs. (3.40) We see the major hazard to this as the complexity of the implied co-ordination for which there is currently no identified solution. (3.41) We don't see this level of demand for capacity - though we do see the use of optical fibre as a means of mitigating the increasing effects of mutual interference existing in both wired and wireless broadband deployments. We agree that a new set of service metrics will replace the existing ones predicated on speed, though not necessarily the precise set suggested here. We look forward to a commercial framework in which contractual service commitments necessarily result in a satisfactory service delivery; current arrangements - even between major corporations - do not achieve this. (3.42) see comments on 3.33.

Q19 What are your views on the technology commentary underpinning this scenario? To what extent might the infrastructure/technology discussed evolve irrespective of demand and how far will it be a direct consequence of the level of demand?

(3.43) Agreed. (3.44) It is unclear that such services will come from a single supplier, i.e there will need to be an effective wholesaling of connectivity and performance between the various infrastructure players and a high degree of cooperation. As for 5G see answer to 3.8. The denser radio network has substantial implications on the general broadband infrastructure. (3.45) We see the economic case for fibre being around a lower total cost of ownership (see 3.41 above) (3.46) We see this as a possibility using the technology envisaged in our answer to Q10. (3.47) We see the issues of reliance on IP (be it v4 or v6) and complexity as the limiting factors. (3.48) see our answer to 3.39 - streaming content is not as latency-sensitive as some other applications. (3.49) see response to 3.38, however work that we have done on the relative efficiency of broadcast and streamed media would imply that this was an infeasible scenario (see answer to Q21). (3.50) We don't see the technology precursors to support this, let alone the commercial drivers - in fact we see the opposite, a collection of emerging and unexamined hazards. (3.51) While there are some examples of dynamic resource allocation in the UK infrastructure today, it seems unlikely that these can be extended and integrated into a system with the level of coherence envisaged here. (3.52) We hope so, but it will not be possible if everything is still predicated on the use of IP - see answer to Q10.

Q20 Are there technologies not identified here that you think will have a major impact on the performance of existing infrastructure or the deployment of additional infrastructure in the next 10-15 years?

See answer to Q10.

Q21 Are there wider environmental issues not reflected in the scenario e.g. the price or availability of energy that will affect any of the scenarios and in what way?

The scenario envisaged in 3.49 where there is no broadcast TV implies a substantial increase in power consumption by the whole internet delivery chain (and consumers) far in excess of the potential savings. Even if the internet delivery chain consumed minimal power when effectively idle this case appears to hold. Given the UK's commitments to its reduction in carbon footprint, this would seem to be a retrograde step.

Q22 How likely is any unforeseen disruption to this scenario and what area might it occur?

See answer to Q12.

General

Q23 Are there factors, for example technical or unrelated to the regulatory framework, that could create bottlenecks and delay future infrastructure deployment in the UK in this timeframe, that would result in demand not being met or the UK not being seen as a leading digital nation?

See answer to Q12.

Q24 Do you expect commercial providers to deliver future infrastructure and meet demand on a purely commercial basis, or is some form of public intervention likely? If public intervention is likely how might that work with the commercial provision of infrastructure? What form might that intervention take?

See answers to Q1, Q4 and Q7, and comments about public safety in relation to phasing out of established infrastructure.

Q25 Which current or draft legislation might prevent or facilitate the emergence of any of the scenarios?

No comment.

Q26 Do you have views on which scenario (or combination of scenarios) is most likely and should influence the development of future strategy?

The second scenario seems the most likely, with suitable regard to our detailed comments above. We would recommend that an evaluation of the hazard space should be performed - other long-term planning activities with which we have been involved start from a list of things that need to be avoided. Such a list needs to be created and should be the primary concern of government strategy. While we understand that elements of this would overlap with National Critical Infrastructure, maintaining access to digital services increasingly necessary for daily life takes the continuity of connectivity and performance concerns further.

Section 4 Competition and regulation

Q27 How might efficient investment in communications infrastructure be supported, for example by changes in the regulatory framework?

Many of the scenarios envisaged here make assumptions about a level of cooperation and resource sharing that is unlikely given the current commercial/regulatory framework of the transfer of monopolies. Much of the perceived value of major telecoms providers is in their 'ownership' of those monopolies. For example, pension funds see them as suitable investments because of their ability (as infrastructure-backed assets) to generate a consistent cashflow, as much as for their potential capital growth. Achieving several of the elements of the scenarios may create some uncertainty as to this.

Allowing the monopoly on connectivity to be broken up while maintaining both emergent performance and market confidence will require a different regulatory approach. Separation of the value of connectivity-providing infrastructure from the value of fit-for-purpose data transportation services (c.f. separating roads from haulage) would allow a richer market to emerge. Such richer markets may be able to capture a larger fraction of the end-user value, thus ultimately supporting the development of new infrastructure, and improving the necessary confidence in returns required by the capital markets.

Q28 Are there any further measures necessary to incentivise the rollout of future mobile infrastructure in currently underserved areas?

Allowing national spectrum monopolies to be broken in not-spots, especially for small cell deployment.

Q29 Is there a role for a revised USO or USC to ensure that minimum consumer demand requirements are met and to reduce the potential for a new digital divide? What might this look like?

A USO of connectivity and a lower bound on performance (noting that performance is different from speed) would go a long way to reduce any digital divide. A USC of a higher performance could then be overlaid on this.

Q30 In terms of supporting future innovation and long-term investment in infrastructure, what areas of broadcasting regulation may have served its purpose by 2025-2030 (or indeed earlier). What future technical developments may also have longer term implications for regulation and wider public policy?

Current broadcast technology is substantially more energy-efficient and capacity-efficient than any delivery system using broadband networks. While there is a constant drive to provide more choice, the presence of a high-quality, universally available national television and radio service provides a benchmark against which new services must compete, thus ensuring a quality 'floor' that might otherwise disappear.

Q31 Are there changes to the EU Framework that the UK might seek to encourage more competition in UK markets?

We see the Communications Act as a reasonable framework. We are concerned that EU/BEREC pronouncements are tending towards conformance with a specific operational practice, which will not produce the desired emergent properties of the data transport within the broadband network. These statements have already constrained developments in disadvantaged areas of the UK.

We have seen pronouncements that would appear to break unyielding constraints of physics or mathematics. We therefore urge that a common and shared basis of scientific understanding be developed.

Q32 Should Government seek changes to the European Framework which put more reliance on competition law and how might this be done?

The later scenarios presented by DCMS here would require a new approach to separate the provision of infrastructure from the provision of connectivity and performance. Such a separation is not a scenario that is envisaged in the EU regulatory framework, especially for pricing.

The general thrust of Equivalence of Inputs (EoI) style pricing for organisations with SMP is focused on the cost of the creation and operation of the infrastructure. Moving this to a connectivity and performance based pricing model would require a re-thinking of the EoI aspects. The things that make up the "inputs" and the "outputs" will have to change. This will be a challenge.

Q33 In what ways can you see competition driving technological change in the UK in the future?

We are concerned about consolidation destroying competition. SMP legislation helps to ensure a 'level playing field' among large providers. However, innovation (even in the network infrastructure) is likely to come from small players, who are also the drivers of skills development and future employment. The market needs to be structured so that such smaller players can conceivably enter and get investment.

We foresee that the main source of highly-innovative technological change will not be in the area of physical equipment, but in the coordination of the 'supply chain' of elements to deliver services. This requires the management and large scale (and bespoke) orchestration of infrastructure built by others, and resolution of the associated complexity issues.

Q34 How can the regulatory framework keep up to date with new business models and changes in technology?

The UK approach has a flexibility and openness to different technical and market approaches that some other regulatory frameworks lack. It is important that this is preserved and that EU regulation compliance does not become a restricting factor in the quality of the outcomes able to be delivered and/or the flexibility of the 'data transportation' market to adapt to changing requirements.

Q35 Are there any changes to legislation other than the Communications Act that would incentivise the provision of communications infrastructure?

We note that issue of State Aid has been an obstacle to several initiatives. It may be possible by viewing broadband as 'connectivity + performance' rather than 'access to infrastructure' to align policy objectives. From a 'connectivity + performance' viewpoint, 'connectivity' could be seen as something that should deserve state aid, whereas 'performance' (perhaps above some lower bound 'obligation') is something that should not.

Q36 Would there be benefits to investment from a focus on broadband only services? Are there any barriers to the emergence and adoption of broadband only services, whilst still providing necessary access to emergency services?

See our answer to 3.37 in Q18.

Section 5 – Facilitating and Encouraging Investment

Q37 How might copper access networks evolve over time alongside other access technologies? Is there a role for policymakers in helping manage any transition from copper to other access networks?

Since 2006, when the Essential Requirements Guidelines were changed by Ofcom, there has been no requirement for safety of life voice calls to deliver adequate conversational quality within the UK. VoIP does not have the same inherent properties as POTS; although it provides an adequate replacement for many uses there are some, as in our answer to Q18, where it does not.

We note that US telcos have endeavoured to turn off their copper, or not to replace it where it was damaged - as on Fire Island after Hurricane Sandy. We also note that this policy had to be overturned as the replacement approaches did not fulfill the basic security of supply and operation quality needs of that community.

The role of policymakers should be to protect the basic outcome requirements and to ensure that operational conformance does indeed meet these requirements.

Q38 Views are sought on whether there are any additional actions the Government should consider to ensure:

a) That the provision of all areas of the UK's digital communications infrastructure remains competitive in order to ensure that the UK can take full advantage of growth opportunities in the Digital Age;

Measurement is de-facto regulation; the use of measurement tables has become a strong driver of the actions of large broadband and telecoms providers. We strongly believe that by focusing on the appropriate measurements the market will, on the whole, respond with suitable actions.

Those measurements have to be strong proxies for fitness-for-purpose, as it is from the delivery of fit-for-purpose outcomes that the citizen-consumer derives the appropriate value. The whole supply chain's ability to gain reward is limited by the ultimate delivered value.

b) Aside from legislation and adapting the regulatory framework in the broad sense which other actions should the Government take to encourage investment in communications infrastructure?

Contrasting the relative technical merits of the national PSN (Public Service Network) and the KPSN (Kent Public Service Network) would be a good starting point. The KPSN has created an outcome-focussed, collaboratively-managed "right-scaled" approach in which the public of Kent capture the benefits of the inherent statistical multiplexing. The PSN has created a conformance framework, which significantly constrains the scope for network-level technical innovation, while leaving the public purse underwriting all the emergent risks. This is because conformance to a set of technical specifications relieves the supplier of any responsibility for ensuring that those specifications actually deliver the desired outcomes.

c) That potential investment in the provision of digital communications infrastructure offers a suitable risk and reward profile to ensure that they can be financed by the private sector

Providing a framework that separates provision of infrastructure, connectivity and performance while measuring the delivery of fit-for-purpose outcomes in a suitably general and neutral fashion could enable a vibrant private-sector market to develop that goes beyond today's resale of monopolies.

Q39 Views are sought on:

a) The case for the UK to invest to gain 'early mover advantage';

Developing the points made in Q38, together with building on new developments in network protocols and structure (such as being researched in the EU IRATI and PRISTINE projects), could put the UK in a world-leading position.

b) What areas in particular the UK should aim to see investment;

As previously stated, we see the key issues as being the organisation and management of network infrastructure, not in the incremental development of the underlying technologies ('game changing' rather than just 'more' and 'faster'). There are formal/mathematical bases for this work in which the UK is currently strongly placed; modest investment in furthering and implementing this academic work would pay large dividends. Such approaches may be disruptive to the business models of current incumbent vendors, and so require new, agile companies to bring them to market.

c) Are there any actions not covered elsewhere in this report that the government should consider to ensure digital communications infrastructure is in place before it is needed and such that it helps generate need.

We highlighted at the beginning of this response the importance of understanding hazards and risks, in particular considering the 'failure modes' of the system and not just its 'success modes' (as the market is driven to do). This implies the need for education in the appropriate modes of thinking, for example a 'Bayesian' rather than 'frequentist' view of probability. Stronger statistical education has become a feature of the education system since the Royal Society's intervention in the late 1980s. However, many leaders in both public and private sectors completed their education before then, and so, unless they had taken steps to update their educational background, may lack some essential intellectual tools for dealing with the issues inherent in large-scale statistically multiplexed systems. We therefore suggest that the government should engage in appropriate education and training of senior personnel.

Q40 How can we maximise the current R&D and innovation UK landscape to help take advantage of the opportunities provided by future technologies? What needs to be done by Government and its agencies, and industry to tackle any gaps?

The government should be directing some of its R&D funding towards the development of approaches to managing the emergent complexities, since these are an increasingly significant factor in the costs of operating telecommunications systems.

There is a need to create a 'universal performance' commitment, as the complement of 'universal service'. This will mitigate the underlying risks created by the lack of performance stability, which are being reflected in current investment decisions.

Q41 In which future communications technologies do you consider the UK has, or could achieve, an international leadership position?

The UK has, and could further develop, a leading position in dealing with the complexity, organisation and management of the end-to-end assured performance supply chain. (This encompases the whole ICT supply chain, not just the telecoms portion.) The telecommunications aspect has been demonstrated by a pilot ISP delivering efficient assured services over the current wholesale broadband infrastructure. There are significant export opportunities in constructing solutions to both the contractual and technical sides of this problem.

Q42 What more might government and industry do to exploit future technologies, associated new applications and emerging business models?

The existing IP-centric approaches have created a plethora of disparate solutions for what are effectively common problems: privacy, authentication, integrity and service adaption. This complexity is reflected in high and rising maintenance costs, and hence a risk to the long-term sustainability of internet-based systems (including the Internet itself). There is a dearth of understanding of these issues, and hence a need to create a suitably educated (and professionally developed) workforce. This is a challenge for both business (to recognise and reward the self-renewing skills requirement) and for the education system. There is a vast difference between basic system administration skills and the level of understanding that is needed.

We envisage that several new business models for the delivery of 'connectivity + performance' could emerge. These would enable more cost-effective use of (and hence more reliable return from) communications infrastructure. A 'quality arbitrage' exists in abundance in the current infrastructure deployments and charging structures. We also see that the exploitation of such arbitrage might be seen as a threat to existing infrastructure

incumbents. Government might need to step in to protect Ofcom from such incumbents' lobbying. (We see the existing Communications Act as sufficient protection, given that Ofcom's hands are not tied.)

Q43 What role might local bodies have in facilitating the future delivery of digital communications infrastructure?

We can envisage a development of 'assured service delivery consortia', such as the KPSN. These can create publicly provided infrastructure for both public and private use by constructing appropriate separation between connectivity and performance. We see that the separation of connectivity and performance enables a framework that would be consistent with the underlying ethos of State Aid.

Q44 How can councils maximise the digital communications infrastructure in their local area to support their work on economic regeneration?

See our previous answers regarding the KPSN. We must stress that an outcome-based framework is the key factor , and NOT a conformance-based tendering process for a complete outsourced solution. This is because you can never outsource the tail risks: they are the ones that government is always left holding. The former can construct (using suitable outsourcing) a collaborative environment for the delivery of network infrastructure that supports fit-for-purpose application outcomes. In contrast, the latter is all too often the precursor to a drawn-out operational/commercial/legal fight that saps both money and people's time. Even large players (see our answer to 3.41 in Q18) can't contract for this properly, so what hope do local authorities have?

It is already an issue today for business consumers (especially small ones) to get large suppliers to deliver on meaningful connectivity assurance. Current SLAs provide at best fiscal remedies; they do not mitigate the underlying risks of failure. Being associated with a larger consortium might go some way to redressing this power imbalance.