Innovation in regulated infrastructure sectors

Summary report

12 January 2015

Civil Aviation Authority

Ofcom

ofgem
Making a positive difference for energy consumers

OFWAT

ORR
OFFICE OF RAIL REGULATION

About this document

This is UKRN's summary report on regulatory approaches to innovation. This forms part of our work on cross-sector infrastructure investment.

The sectors that UKRN's members regulate are critical to the success of the British economy. They also affect all of us as consumers, so enabling innovation at the right cost and at the right time is of great relevance to the work of regulators. This report focuses on current practices across the sectors in the way we, as regulators, support or promote innovation and explores current considerations in relation to cross-sector innovations, such as sharing of infrastructure.

About the UK Regulators Network

The UK Regulators Network (UKRN) is a network formed by the UK's economic regulators:

- The Civil Aviation Authority (CAA)
- The Financial Conduct Authority (FCA), including the Payment Systems Regulator (PSR)[1]
- Office of Communications (Ofcom)
- Office of Gas and Electricity Markets (Ofgem)
- Water Services Regulation Authority (Ofwat)
- Office of Rail Regulation (ORR)
- Northern Ireland Authority for Utility Regulation (Utility Regulator)

Monitor, the sector regulator for health, participates in the network and its projects as appropriate. The Water Industry Commission for Scotland (WICS) is a contributing member which generally participates in projects as an observer.

[1] Although it has competition and consumer protection functions, the FCA is not classed by HM Government as an economic regulator.

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1. Introduction

Purpose of this report

1.1. This report sets out existing regulatory approaches to enable or promote innovation and explores cross-sector innovation including the shared deployment of infrastructure.

1.2. This work examines:

- why innovation is important and the reasons why it is being employed;
- how regulators encourage or facilitate innovation, and the factors they consider in doing so;
- examples of cross-sector innovation, including technical, commercial and process innovation; and
- potential barriers to cross-sector innovation.

1.3. We collected information from the following participating regulators to help us with this work:

- CAA;
- Ofcom;
- Ofgem;
- Ofwat; and
- ORR.

1.4. This document is one part of the Cross-Sector Infrastructure Investment project. The purpose of the wider project is to ensure that regulators across sectors are enabling current and potential investors to engage with their sectors, share best practice and minimise any regulatory barriers resulting in different regimes in each sector. Further details of all UKRN projects are set out in the UKRN work programme.[2]

Document structure

1.5. The rest of this document is structured as follows:

- Section 2 – introduction to innovation in regulated sectors;
- Section 3 – review of current regulatory approaches to innovation in each sector;
- Section 4 – review of innovations across different sectors; and
- Section 5 – recommendations for the next phase of work

[2] http://www.ukrn.org.uk/wp-content/uploads/2014/05/UKRN-2014-15-work-programme.pdf

2. Innovation in the regulated infrastructure sectors

Importance of innovation

2.1. Innovation can be defined as the process of creating new methods, or the adoption of alternative methods, to create improved outcomes. For infrastructure businesses this can often mean technical innovation, process innovation or commercial innovation.

- **Technical innovation:** the improvement of existing and development of new technologies used to deliver goods and services more efficiently, more safely and/or more reliably.
- **Process innovation:** the improvement of management and operational processes, usually leading to a decrease in cost.
- **Business model innovation:** the use of new/alternative business models to deliver services that might not otherwise have been commercially feasible.

2.2. Innovation involves different and generally greater risks compared to those for business-as-usual activities. As a consequence, many innovation initiatives may not generate successful outcomes. These risks create costs in the short term, with the potential reward of greater efficiencies or advancements in technology in the medium to longer term. Learning can be obtained from both failed initiatives as well as successes.

2.3. While efficiency, safety and reliability are important outcomes from innovative techniques, innovation can have a positive impact on a variety of industry outcomes, including:

- increasing value for money for consumers (and taxpayers in certain industries);
- improving quality of service;
- reducing environmental impacts;
- providing resilience of service provision;
- increasing the capacity of networks and increase coverage;
- improving efficiency of service delivery/provision; and
- improving the international competitiveness of the national economy.

2.4. We recognise that there are benefits from innovation that apply to all regulated sectors. However, the nature of innovation will be different for each. We explore the differences between various regulated sectors below.

Sectors in context

2.5. This paper covers innovation and regulatory approaches to innovation in the economically regulated segments of five different sectors: energy (including electricity and gas), telecommunications, water (including sewerage), rail and airports. These sectors all have an economic regulator, each with their own set of duties to promote the interests of that sector's consumers. Each has a high level of infrastructure investment, but different levels of infrastructure competition, both in terms of "in the

market" competition and "for the market" competition.[3] A high-level overview of the markets and associated regulation is set out in the table below.

Figure 1: Sectors in context

Telecoms	• BT is the incumbent network operator with significant market power in fixed line telecommunications (landline voice and broadband) (except within Hull where KCOM operates), with competition at an infrastructure level from Virgin Media. • Retail-level competition as a result of Ofcom's access regulation allows Internet Service Providers such as Sky and TalkTalk to compete with BT to supply internet services to consumers. • The mobile market consists of four network operators and retail-level competition from virtual network operators who use the networks of the four majors. • Spectrum licences underpinning mobile services are allocated by auction.
Energy	• Energy network infrastructure is split into transmission and distribution networks. • Electricity Transmission networks transport high-voltage electricity across the country (onshore) with three monopoly providers across England, Scotland and Wales (National Grid, Scottish Power and SSE). National Grid Gas transports high-pressure gas across the whole of Great Britain. • Offshore electricity transmission and cross-border transmission (interconnectors) are licensed separately and often owned by third party private investors. • Distribution networks involve the delivery of electricity and gas from the transmission networks to customers, covered by 14 regional monopolies in the electricity market and 8 regional monopolies in the gas market.
Rail	• Network Rail is the monopoly infrastructure operator of UK railways, and responsible for renewal and maintenance of the tracks and signalling, as well as key stations. • ORR regulates safety, performance and access (including access charges) to Network Rail's infrastructure. • Passenger operations are franchised by Government on a route basis.
Water	• The water market is operated by 10 water and sewerage companies and 9 water-only companies, all of whom hold regional monopolies. • The prices that they can charge to customers are regulated by Ofwat. • There are also further local monopolies that operate within the regional monopolies' areas. • Additionally, there are water companies that operate outside of price regulation in special circumstances where they use the regional monopolies' supply to provide water to large businesses.

[3] "In the market" competition refers to the active competition between competing service providers, in this case competing infrastructure networks or assets, on an enduring basis. "For the market" describes cases where parties compete upfront for the opportunity to take on what then becomes a monopoly ownership.

Airports	• Airports are owned by a variety of UK and international companies, predominantly in the form of consortia and also commonly in a joint venture with local councils. • Only Heathrow and Gatwick are licensed and subject to economic regulation due to the CAA finding these airports wield substantial market power. There is "in the market" competition at all other airports. • National Air Traffic Services (NATS) is licenced by the CAA for the provision of air traffic services. This service is also subject to economic regulation.

3. Current regulatory approaches to innovation

Overview

3.1. In section 2, we highlighted how innovation is driven by the need for a change of processes or outcomes for the firms and their consumers. This chapter highlights some examples of the current approaches that regulators have taken to enable innovation in their sectors. Some degree of economic regulation or competition policy has been applied in each of these sectors for a variety of reasons other than just the need for innovation.

3.2. The nature of regulated infrastructure differs across sectors but all have common characteristics, in particular the need for economic regulation to address potential market failures associated with market power and the lack of an economic case for duplication of the infrastructure involved. This means that direct, head-to-head competition "in the market" between different infrastructure providers is often not feasible or economically desirable. Where these natural monopolies exist, particularly in the energy and water sectors for example, enabling the appropriate level of innovation is a particular challenge. This is in the context of ensuring that critical public services continue to run effectively, whilst also reducing costs and enhancing customer service over time.

3.3. Firms acting in competitive markets are typically most naturally incentivised to drive innovation. This is because they are driven to innovate, for example in terms of lowering costs or improving customer service, by other competing service providers as they seek to attract and retain customers. Conversely, a firm with significant market power does not naturally face the same pressure or incentives to reduce costs or develop new services. Where possible, regulatory approaches therefore seek to facilitate or replicate the competition that can drive innovation but also to protect consumers from excessively high pricing and poor quality service provision.

3.4. Where regulators do choose to act, their decisions have the potential to influence the level of competition and the speed and nature of technological developments. In some circumstances, these can work in opposite directions. In markets where there is the potential for significant technological developments (and therefore incentives for innovation are likely to be particularly important) getting the appropriate balance between sustainable competition and efficient innovation is likely to be a particularly important consideration.

3.5. Regulators have deregulated parts of their sectors where it has been possible to do so. For example, the separation of retail and wholesale markets in some markets has led to the creation of innovative product ranges on the retail side, enabling consumers to choose from a greater variety of priced services. These consumer demands, particularly in telecommunications, can have a strong impact on the level of competition and innovation. However, the relative impact of this on infrastructure-related innovation varies across sectors. Where natural monopolies occur, regulators will often apply price controls, which have a number of initiatives to encourage innovation by firms with monopoly power or significant market power. These can prove effective in encouraging firms to improve short-term efficiency resulting in decreased operational costs.

3.6. In addition, there may be a need to encourage innovation that will create social benefits. This can often be to correct for negative externalities. For example, in the energy sector, the move to a low carbon economy is a broader societal factor that Ofgem has considered in how it incentivises innovation amongst network operators.

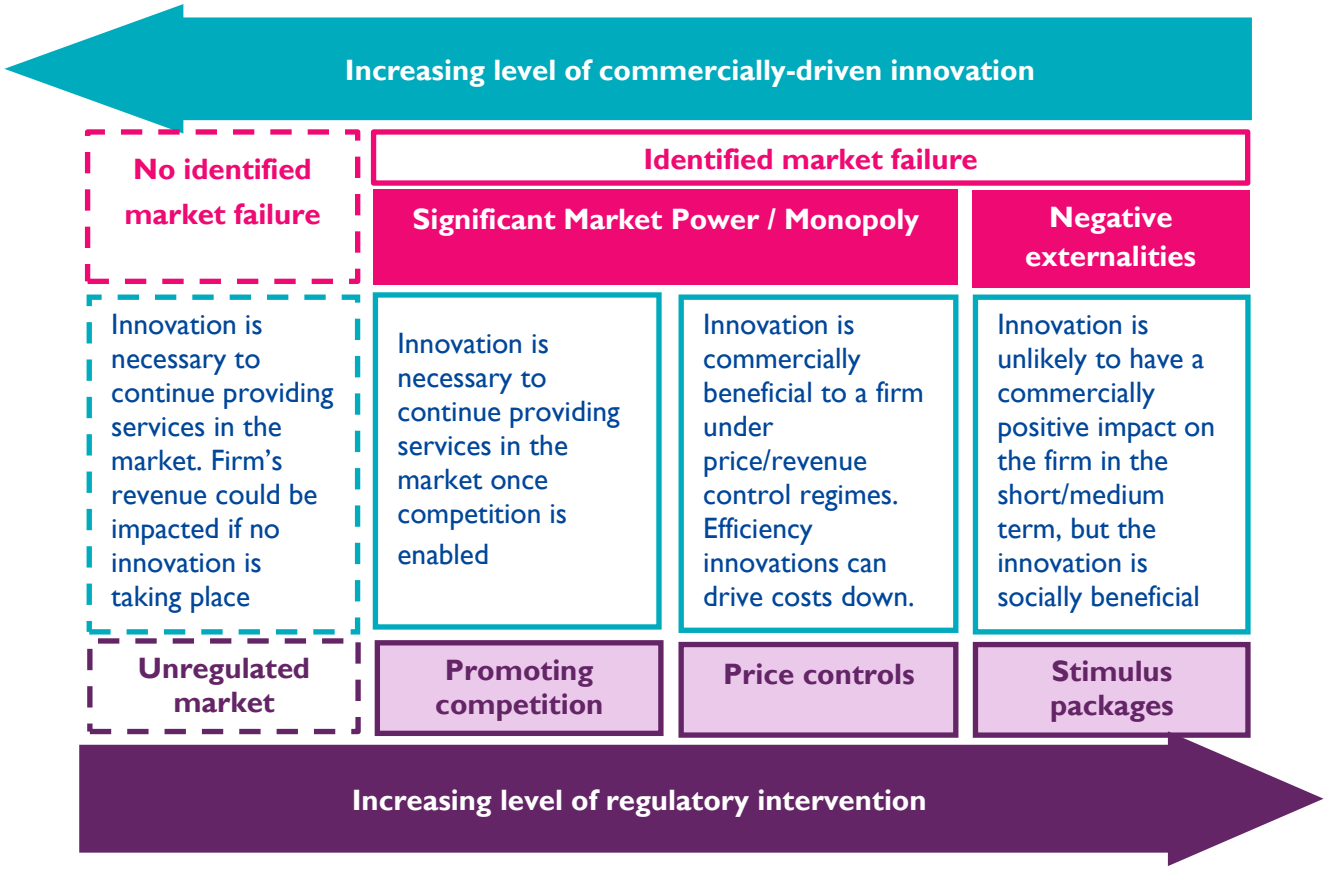
3.7. Despite the perceived need for regulators to intervene in many markets in order to enable or encourage innovation, regulators also recognise that there is a general risk that regulation can inadvertently stifle innovation. For example:

- radical innovation, involving significant technological development or considerable changes in business models, may not be prevalent where regulation focuses on price controls;
- longer term, risky and uncertain investment in innovation may be harder to achieve with structured price control periods;
- when new infrastructure technology is developed, using access controls too early may stop firms from investing in new infrastructure; and
- overly prescriptive regulation – for instance through licence conditions - may not give firms enough freedom to experiment with new business methods or technologies.

3.8. In this report we highlight the approaches taken by regulators to enable innovation where it has not been possible to fully deregulate markets. This is predominantly in the provision of core economic infrastructure.

3.9. In order to explain the different types of innovation across sectors, and how regulators look to incentivise these, we have applied the following framework to provide a structured overview.

Figure 2: Mechanisms of innovation in regulated sectors



3.10. In most cases, the price control is the primary regulatory tool through which innovation is enabled in natural monopolies, mostly to improve economic efficiency. However, in other cases, competition of some form may naturally exist or regulators may be able to create suitable proxies that can still

deliver significant value for consumers where direct head-to-head competition between infrastructure does not exist.

3.11. We also note that most innovations that have taken place within the five regulated sectors are not as a result of having been specifically foreseen by regulators, and therefore given direct encouragement, but are indirectly encouraged by the overall regulatory framework applied. Academia, researchers and co-operative industry bodies (including standards bodies such as the International Telecommunications Union) are also major innovators for new technical approaches in regulated markets. Often, the role of industry operators is to find ways to implement and adopt these new approaches, rather than necessarily conducting the underlying R&D work in-house. Three such examples are provided below. The following sections thereafter explore these concepts in greater detail and provide examples across the sectors of how these different approaches are applied.

Box 1: Network Rail South West Trains Alliance, High-Output Ballast Cleaning

Infrastructure provider, Network Rail, and train operating company, South West Trains formed an alliance in April 2012 with the aim of delivering an improved service for passengers with faster, more customer-focused decision-making. This means a single management team for both track and trains for the route, including for its largest station, London Waterloo. Some other key benefits include:

- faster decision-making;
- integrated response to disruption;
- pooled resources; and
- other operational efficiencies such as joint staff training and communications

One further example is the efficiency of track maintenance. The high output ballast cleaner is one of the longest trains on the railway, consisting of the cleaner itself and a string of conveyor ballast wagons. The cleaner scoops up the ballast the track sits on, before then sieving out any small, broken pieces and replacing them with the same weight in fresh stone. This provides a safe, well-drained and quiet bed for the track to sit on.

Through the Alliance, Network Rail and South West Trains were able to work together to plan and apply new technology and innovate new processes. This reduced overall disruption to rail users and improved operational efficiency by allowing the maintenance team to be more productive while they were on the track. Whilst Alliancing has been initiated by industry, it has been supported by ORR.

Box 2: Northumbrian Water and Aquology, Ice Pigging

Water operator, Northumbrian Water, embarked on a new method of cleaning its water mains. Water mains cleaning is required to ensure that the consumer receives high quality water.

Sediments build up over time on the inside of mains water pipe, which affects the quality of water received by the customer. Traditional mains cleaning techniques have required the use of:

- traditional pigging (using a large sponge to clear the sediments);
- pressure jetting; or
- scraping and lining.

Ice Pigging, a technique developed by Aquology, involves the injection of slushy ice in to a pipe. More water is then introduced in to the mains, creating high pressure that pushes the ice against the sediment and scrapes it off. The dirty ice is then flushed from the mains and taken for treatment.

The process is more effective than traditional methods as it only requires a small amount of water to be removed from the mains and the access to the mains required is much smaller. The result is that a process that could take up to three weeks for a 2km section of pipe is reduced to a few hours. This means less disruption for customers, who also benefit from the cleaner water.

Box 3: BT, Fibre to the distribution point (FTTdp) with G.FAST

BT is rolling out superfast broadband predominantly using Fibre to the Cabinet (FTTC) technology in order to deliver speeds of up to 80 Mbit/s to UK premises. In some cases, however, this technology is not able to deliver such speeds to premises that are located further away from the street cabinet where the fibre from the telephone exchange ends and copper is then used to deliver services to the premises.

BT successfully completed trials using G.FAST technology designed at achieving download speeds of 800 Mbit/s over the short copper lines to the premises, In order to make this work, the fibre needs to be delivered closer to the premises, to a telephone pole or a junction box both of which can be thought of as a distribution point.

This innovation could provide consumers with broadband download speeds that are approximately 40 times faster than today's average in the UK and drastically improve speeds for those who are located further away from their street cabinets.

Promoting competition

3.12. In competitive markets, innovation is necessary because if firms do not innovate, they will often lose market share and become less profitable. In a range of different ways regulators have therefore sought to promote competition in order to encourage innovation driven by industry.

Communications

3.13. Competition in the telecoms market typically takes place in one of two forms: at the full network infrastructure level (i.e. the end-to-end network from the user to the services they require) and at the access network level, which is the local network between the user and the local telephone exchange.

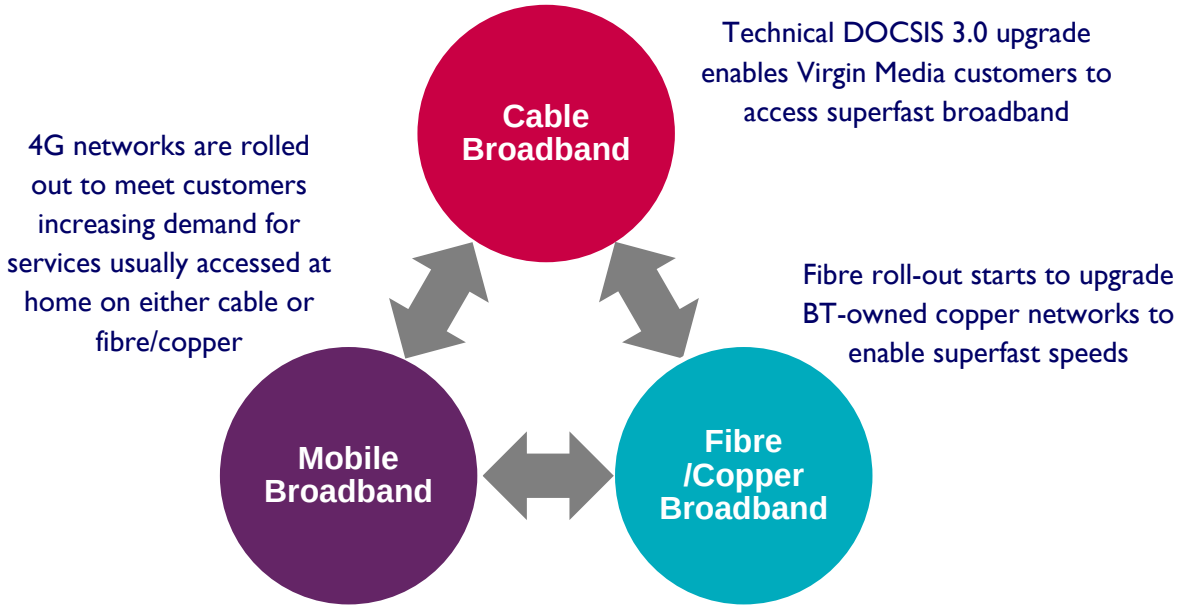
3.14. In telecommunications, technical innovation is common due to continuous improvements in the digital technologies that underpin communications, as well as competitive pressure. Communications providers seek to cope with an ever-increasing demand for data services. They tackle this through technical innovation, such as the roll-out of fibre-optic based Next Generation Access (NGA) broadband and the deployment of 4G mobile services. These innovations have enabled an increase in the quality of fixed and mobile data services and the deployment of 4G will in time also lead to an increase in the coverage of data services. There have been additional innovations designed to aid the roll-out of these new technologies.

3.15. At the end-to-end network level, competition in the fixed broadband market exists between BT and Virgin Media across approximately 50% of the UK covered by Virgin Media's footprint. Smaller niche providers of communications services also offer competing fixed services in particular localities, although these tend to be relatively small scale in terms of population coverage.

3.16. Competition between BT and Virgin Media in particular has driven forward the commercial roll-out of NGA networks to a significant number of households in the UK. One factor in BT's decision to roll out NGA networks is likely to have been Virgin Media's move to providing superfast speeds to its customers, leading to it gaining market share from BT.

3.17. To a degree, competition also exists between fixed and mobile services, because use of voice and data services in customers' home accounts for a significant portion of consumption of all communications services. Infrastructure-level competition in telecommunications is summarised in the diagram below:

Figure 3: End-to-end infrastructure level competition in telecommunications



3.18. Such competitive pressures will continue to be a key factor as the services used by consumers (voice, web browsing, video, etc.) are expected to be available across all types of communications networks.

3.19. Competition also takes place at the access network level. The regulatory intervention known as 'local loop unbundling' (LLU) saw the liberalisation of the access network that requires BT to offer access to their network to competing retail providers on equivalent terms. This was underpinned by the functional separation of BT's retail and wholesale divisions resulting in the creation of BT Openreach. Since then, competing providers such as Sky and TalkTalk have been able to offer their own broadband services without replicating unnecessary infrastructure build. There is now a total market share of 35% in the retail residential fixed broadband market for these two operators.

3.20. Additionally, spectrum, used for wireless services such as mobile services and broadcasting, is open to competition through spectrum liberalisation and the ability to trade. For mobile services, this has meant operators who used to be tied to a specific technology such as 2G or 3G for its licence holdings, could not use certain spectrum for newer technology services, such as 4G. Licences are now liberalised to ensure that there is no regulatory constraint on the latest technology being deployed on any spectrum being allocated to mobile services.

Energy

3.21. Electricity and gas networks are subject to economic regulation as they are natural monopolies. In these instances where competition is limited or does not exist, the regulator can take steps to act as a proxy for introducing competitive elements into their sectors to stimulate competition where this is a feasible option.

3.22. Recognising the importance of competition in stimulating innovation, the Offshore Transmission Owner (OFTO) regime developed by Ofgem and the Department of Energy and Climate Change (DECC) is an open, competitive approach that is built on encouraging innovation and new sources of technical expertise and finance. Bidders compete with one another for the opportunity to take on the long-term ownership and operation of transmission systems. By competing on the basis of both price and service quality, bidders have to innovate in order to be successful. For example, they may

need to employ new approaches to finance or insurance provision. Alternatively, they might seek to adopt new underwater surveying techniques that could enhance operational efficiency, minimise cable downtime and save operational costs.

3.23. OFTOs are an example of competition for ownership of the infrastructure ("for the market" competition), rather than actually between competing construction projects ("in the market" competition). The three rounds of competitive bidding to date have involved the ownership of assets worth £2.9 billion. Competitive forces have been effective in bringing down the price of bids also in large part due to the innovative range of financial and technical solutions employed by the market. This has resulted in lower costs for consumers which, for the first round of OFTO transactions, saved £200-£400 million[4] in costs compared to alternative approaches.[5] Ofgem has indicated an intention to extend the benefits of the OFTO network to new, high value extensions to the onshore networks in the future.

Water

3.24. The Thames Tideway Tunnel will be a new regulated utility company that will design, construct and finance a 25 kilometre sewer tunnel to prevent an average 20 million tonnes each year of untreated sewage discharging into the River Thames in London. The company will have its own licence with revenues determined by the regulator Ofwat and will collect bill payments for the tunnel via Thames Water.

3.25. Thames Water will continue to provide water and wastewater services to its customers as it does now.[6] The financing of the project will be provided by private investors that will be selected through a competitive procurement process overseen by Thames Water. This platform is similar to that of the OFTO process in the energy sector in that it uses competition for the ownership and financing of the asset and innovative financing solutions in particular to reduce the long term costs to consumers.

Airports

3.26. Following steps taken by the CAA to deregulate Stansted Airport in 2014, only two airports in the UK are subject to economic regulation via a licence. The vast majority of airports in the UK already operate on a competitive basis, subject only to the Airport Charging Regulation which regulates some aspects of setting airport charges.

3.27. Increased competition and innovation has been reinforced by significant changes in the ownership structure of UK airports. More than ten airports have changed ownership in the last three years. A number of these have been from a group structure to independent ownership. The most notable of these are the divestments by BAA leading to the emergence of three major airport groups. A number of smaller airport groups operate regional airports such as the Peel Group and Rigby Group.

3.28. Innovation is therefore a key factor in how airports differentiate themselves and attract customers (airlines and the ultimate end users, passengers and freight). There is continuous innovation in the products that are offered to consumers in terms of routes and airport facilities.

[4] Excluding tax
[5] https://www.ofgem.gov.uk/ofgem-publications/87716/140508coveringlettertocepareportfinalforpublication.pdf
[6] http://www.thamestidewaytunnel.co.uk/about-us/the-organisation

3.29. On the retail side, the most recent development has been the introduction of low cost long haul services from Gatwick. Likewise at Stansted, the deregulation of the airport accompanied a move toward greater long-term contracting with airlines with better incentives on both sides to achieve growth in passenger numbers.

Price controls

3.30. Price controls are a key tool used by regulators in order to ensure that service providers with at least a degree of monopoly power do not set excessively high prices and abuse their market power. An important consideration for regulators is how they can find a structure and a level for the price control that continues to incentivise innovation that will benefit consumers in the long-term. The following explores innovation incentives and mechanisms deployed through price controls.

3.31. It is also important to note that Ofgem, Ofwat and ORR employ the right to reject investment for innovation in business cases presented to them which may not be in the best interests of consumers and considered to be too risky for regulated companies to take on. Additionally, as mentioned previously, regulators also conduct their own policy research into innovation and innovative technologies, both to respond to proposals put forward by companies but also to help shape the direction of innovation in each sector.

Communications

3.32. Ofcom has used a technique known as 'anchor pricing' to encourage the wide deployment of innovative fibre-based NGA broadband services.[7] Ofcom's approach was to apply a control on the access prices set by BT for the widely available copper-based ADSL[8] broadband product. The price control ensures that the price for accessing legacy wholesale broadband services is cost-based and, because there is some degree of substitutability between NGA and ADSL, helps to ensure appropriate pricing for NGA services. However, this approach is also designed to leave an incentive for BT to undertake the expensive investment required to deploy NGA services widely across the UK. The control is designed to encourage effective innovation through the following.

- Cost minimisation: the dominant provider will migrate customers to the new product only if it is efficient to do so.
- Reward for efficiency: the dominant provider will be incentivised to innovate in cost-reducing technologies.
- Pricing flexibility: although the anchor product is controlled, the dominant provider can set prices accordingly for its new product, allowing for innovative products to be developed with an appropriate level of commercial risk.

3.33. This is just one example of encouraging innovation through control regulation in the communications sector.

[7] NGA networks are fixed services where some (or all) of the copper wire-based link between the telephone exchange and the customer's premise is replaced with fibre optics. This can significantly improve download and upload speeds, in most instances to the extent that 'superfast' broadband services can be provided (defined by Ofcom as services capable of offering download speeds above 30 Megabits per second).

[8] Asymmetric Digital Subscriber Line broadband is a copper-based technology and is currently the most common connection for fixed broadband communications in the UK.

Energy

3.34. Price controls in the energy sector are based on Ofgem setting the revenues for networks over an eight year period. This process incentivises the networks to find efficiencies in capital and operational expenditures with the savings being shared between the network companies and consumers. The industry is also focused on improving customer service and hence companies have incentives to look for innovative ways of improving network reliability.

3.35. Ofgem's recently revised price control framework, 'RIIO' (Revenue = Incentives + Innovation + Output), explicitly promotes innovation across the network businesses. RIIO builds on Ofgem's previous RPI-X[9] approach. It maintains many of the features of RPI-X including strong up-front efficiency incentives and a commitment through the regulatory asset value that funding for long-term investments will be provided by consumers now and through the life of the assets. The price control under RIIO is designed to:

- directly encourage the networks to provide well-justified business plans which demonstrate that they have considered alternative approaches and to highlight the need for and benefits of innovation; and
- provide a longer-term eight year period so that innovations involving higher cost in the short-term to drive uncertain long-term savings should still be sought by the network company.

3.36. This framework is intended to help stimulate more innovation in the sector. However, in addition an innovation stimulus (some of which pre-dated RIIO for electricity distribution) was introduced because of the step change needed in the energy sector to facilitate the low carbon economy. See next section for further detail.

Box 4: RIIO Price Control, Ofgem

RPI-X@20 was Ofgem's review of its RPI-X regulatory framework, which concluded that a step-change in the framework was needed to encourage network companies to deliver a sustainable energy sector and provide value for money. The replacement framework is the RIIO model, where revenue is set to deliver strong incentives, innovation and outputs. Technical and commercial innovation is encouraged through:

- core incentives in price control package;
- option of involving third parties in delivery; and
- a time-limited innovation stimulus which gives support for innovation, building on the Low Carbon Networks Fund that was established in electricity distribution from 2010.

Rail

3.37. ORR's periodic review of Network Rail's outputs and revenue also promotes efficiency and innovation. Network Rail is provided with specific efficiency targets for each year of its five-year

[9] RPI-X is a revenue-cap control based on the inflation of a general basket of consumption goods (RPI) minus efficiency savings (X). Firms are incentivised to be more efficient in order to gain further profit.

control period. Train operators (both passenger and freight) pay some variable access charges to Network Rail to meet the marginal costs of running their services (but not more than Network Rail's revenue requirement). This encourages operators to invest in R&D and innovation in efficient techniques to potentially reduce these access charges. More generally, Network Rail is encouraged innovate to reduce costs and 'beat' the efficiency targets assumed in the price control.

3.38. A specific mechanism with the price control is the Route-level Efficiency Benefit Sharing (REBS) mechanism[10], where train operators, if they opt in, can receive a capped share of Network Rail's outperformance or underperformance payments. This encourages a train operator to work with Network Rail to drive down industry costs. Take-up of the scheme has been limited as previous passenger franchises did not entitle train operators to recover Network Rail's outperformance payments. However, newer franchises will allow operators to recover outperformance payments.

Water

3.39. Ofwat does not apply a specific innovation mechanism as part of its price setting methodology for the price review period starting in 2015. However, the development of outcomes and the implementation of TOTEX (total expenditure) allow water companies to take longer-term riskier investments into account and therefore stimulate innovation.

3.40. It has also applied two specific mechanisms to stimulate effective investment management across price controls.

- The PR09 (Price Review 2009) overlap programme funds long term investment across the price control periods between 2010 and 2020.
- The transition programme allows companies to bring investment forward from 2015-16 into 2014-15 without incurring penalties for cost inefficiency.

3.41. The benefit of these mechanisms is the smoothing of investment cycles to prevent heavy cyclical investment programmes. In addition, Ofwat funds catchment-based studies to stimulate new ways of working and innovation.

3.42. Water has seen further innovations including those set out below.

- New bond markets and debt management innovations have featured in its financing. These have helped in saving costs for the water companies and customers.
- Catchment management techniques have driven sustained improvements in water quality whilst avoiding or deferring new infrastructure costs.
- Innovations in real time control and management have reduced supply interruptions whilst improving the efficiency of leakage control.
- The Service Incentive Mechanism has encouraged water companies to consider the full customer experience of interactions and has driven innovation in customer service.

[10] http://orr.gov.uk/what-and-how-we-regulate/regulation-of-network-rail/how-we-regulate-network-rail/periodic-review-2013/pr13-publications/route-level-efficiency-benefit-sharing

Airports

3.43. The CAA does not apply a specific innovation mechanism as part of its price control. However, its price controls do focus on efficiency which can come from innovation. In setting price caps, the CAA assumes a certain levels of efficiency will be met over the length of the regulatory control period.

3.44. Recent regulatory changes (the Civil Aviation Act 2012) have also provided greater flexibility for the CAA to set the appropriate form of regulation at airports as well as the duration of price controls. For example, in its most recent regulatory decisions, recognising the increased scope for commercial agreements to underpin future prices, it set a 7 year, licenced backed commitment for Gatwick. This is quite a different from the traditional, 5 year RAB-based approach that it was required to adopt where regulation was required. The greater flexibility permitted under the Civil Aviation Act 2012 will help stimulate more innovation in the sector both by the regulator and those that it regulates.

3.45. A key component of the CAA's price controls is the Service Quality Regime (SQR), a key element of which is security queuing. Security queuing is constantly rated the most frustrating part of the passenger experience at an airport. To address this issue, in 2003, the CAA set standards for security queuing times in service quality rebate (SQR) scheme as an element of its airport price reviews, and tightened the standard in 2008. In addition, to enhance accuracy and reliability of queue measurement, the CAA required Heathrow and Gatwick airports to replace manual measurement with automated technology. Average queuing time performance at Heathrow and Gatwick has now improved. Gatwick Airport has put in place facial recognition queue measurement (FRQM) technology, whereas Heathrow has recognised that FRQM is the forward-looking technology that will improve passenger experience.

3.46. The CAA has also encouraged innovation by placing greater emphasis on a process called constructive engagement (CE). CE was established during Q5 (control period 2008-2013) and encouraged airport and airlines to agree outputs that were used as starting positions for the CAA's price control analysis. The CAA sees CE as a mechanism that helps determine what would commonly happen in a well-functioning market, where parties would seek to reach commercial outcomes.

Stimulus activities

3.47. Stimulus activities (through funding or facilitation) are necessary to incentivise innovation where there would be a social benefit in doing so but not necessarily a sustainable (as opposed to short-term, within a price control period) commercial benefit. This could include benefits related to the environment, welfare for particular groups of society, or congestion on the infrastructure networks.

3.48. In some sectors stimulus packages may be provided directly by Government in seeking to capture the wider societal benefits of certain types of innovation. However, regulators also use stimulus funding packages for regulated entities where they align with delivery of the regulator's overall duties and consumers' needs. Such packages are often funded through companies existing revenue mechanisms but with additional requirements or conditions attached to the specific elements of innovation funding.

Communications

3.49. Stimulus funding packages are available in communications through Government funding initiatives. The Department for Culture Media and Sport has awarded £10 million to alternative Next Generation Access network deployment schemes that seek to use alternative technologies to deliver superfast broadband to areas that are currently hard to reach. This is part of Government's wider £1.2 billion superfast broadband programme.

3.50. However, much like energy below, Ofcom engages in activities that seek to promote innovation in spectrum use. These are activities that do not offer stimulus funding, but do seek to stimulate innovation for the wider benefit of the industry.

3.51. A current example of this is its TV White Space trials, where gaps in the radio spectrum that exist between frequency bands (called white spaces) are being used to trial services that may be beneficial for consumers and businesses. The advantage of these white spaces is that, compared with other forms of wireless technologies such as regular Bluetooth and Wi-Fi, the radio waves can travel longer distances and more easily through walls. Trials being conducted so far include the following:

- next-generation Wi-Fi in Glasgow;
- wireless broadband on ferries around the Orkney Islands;
- land - Private boat broadband on the Isle of Wight;
- flood detection sensor networks in Oxford; and
- live webcam streaming in ZSL London Zoo.

3.52. The last example demonstrates how infrastructure innovation could result in social benefits. Whilst the webcam streaming technology is currently being trialled at London Zoo, in the future, the devices could be used to monitor and protect endangered animals in the wild.

Energy

3.53. In 2004, Ofgem implemented the Innovation Funding Incentive whereby Ofgem allowed 0.5% of distribution networks' revenue to be spent on innovation projects. At the most recent distribution price control (implemented from 2010), Ofgem enhanced innovation stimulus by initiating the Low Carbon Networks (LCN) Fund.

3.54. The LCN Fund, worth up to £500m over the five year price control period, enabled electricity distribution companies to compete for innovation funding for specific projects as well as receiving funding as part of their revenue allowance (for smaller projects). This funding is paid for by electricity consumers. The arrangements include governance processes to ensure network companies share what they learn with other companies. Reports have to be published on each projects and knowledge is shared through the Smarter Networks Portal and the LCN Fund annual conference.

3.55. The RIIO framework has built on the LCN Fund to provide further innovation support across gas and electricity, transmission and distribution encouraging technical and process innovation.

3.56. The key reason to continue supporting stimulus packages in this form is the need to ensure energy networks are able to accommodate future demand at the least cost and recognising the need to move to a low carbon energy network. In its most recent price control decision Ofgem was able to reference £900m of benefits which companies should be able to realise for consumers in the forthcoming control period as a result of the earlier LCNF programme.

3.57. Ofgem now has three funds set aside specifically for innovation.

- Network Innovation Allowance (NIA): the NIA is a set allowance that each of the RIIO network licensees will receive to fund smaller scale innovative projects are part of their price control settlement.
- Network Innovation Competition (NIC): the NIC is an annual competition for funding larger more complex projects which have the potential to deliver low carbon and/or wider environmental benefits to consumers. The NIC will comprise of two competitions – one for gas and one for electricity.
- Innovation Roll-out Mechanism (IRM): the IRM is a revenue adjustment mechanism that enables companies to apply for additional funding within the price control period for the roll-out of initiatives with demonstrable and cost effective low-carbon and/or environmental benefits.

3.58. The second year of the NIC is underway and the stimulus programme overall has seen a number of successful projects developed by networks. One example is the Flexible Plug and Play project which is trialling ways to improve the control of the extra high voltage network to connect increased volumes of wind generation. The project will trial an open communications platform and develops an investment model for connecting renewable generation to the distribution system. This is a positive example of embedding innovation in the general business model of networks as UK Power Networks, the implementing distribution network, will offer this connection as a business-as-usual option for connections from 2015.

3.59. More recently, Ofgem has announced a further £46m of funding for innovation projects through these mechanisms. New projects which will consequently be supported include:

- trials to see if automatically turning off transformers when they're underused minimises electricity "losses" and lowers costs for consumers;
- developing a robotic device to inspect the condition of hard-to-access gas pipelines – avoiding the costs of digging them up;
- allowing National Grid to explore new ways to keep the national electricity system balanced as more renewables connect – ensuring security of supply at lower costs for consumers; and
- converting a telecom-cable repair vessel so that it can repair offshore electricity cables and developing a new way of joining together different types of subsea cables – so repairs are quicker and cheaper.

Rail

3.60. The rail industry also has two innovation funds that were provided as part of the current periodic review (PR13). These are both funded from Network Rail's (regulated) capital asset base.

- **The Innovation Fund**: the department for Transport ring-fenced £140m over this control period to fund innovation and the development of potential enhancement schemes in the next control period. It has been assumed that £50m of this £140m fund will be used to fund innovation expenditure. Administration of this fund is delegated to the Rail Safety and Standard Board as DfT put it in place to encourage innovation across the industry;
- **The Strategic R&D fund**: this fund was put in place by ORR and allows up to £50m to be added to the asset base, provided Network Rail can match this with equivalent cost-efficiency savings or third party contributions (for example, government grants or commercial partners)

Airports

3.61. The CAA has engaged in non-funding stimulus activities to encourage further innovation in the airports sector. One example of this is the implementation of the Future Airspace Strategy (FAS), which sets out the long-term vision on how airspace should change within the overall aim of modernising the UK's airspace system in the context of the Single European Sky objectives.

3.62. The implementation of the FAS can play a significant role in delivering economic and environmental objectives in relation to aviation. For example, by improving the overall efficiency of our airspace there will be opportunities to minimise aircraft emissions and air traffic delays.[11]

Summary of the comparison

3.63. Across the regulated sectors, the approaches adopted by regulators to facilitate the delivery of innovation tends to be dependent on:

a) the commercial viability of the relevant innovation;

b) the level of infrastructure-level competition in the market; and

c) the way the regulatory framework incentivises companies to take innovation risk

3.64. An overall summary of these different approaches as they are applied from one regulated sector to another is set out below:

[11] Future Airspace Strategy, CAA, June 2011, http://www.caa.co.uk/docs/2065/20110630FAS.pdf

Figure 4: Cross-sector summary of regulatory approaches to innovation

	Market	Economic regulation applied	Examples of approach(es) to promoting innovation	Areas in which innovations delivered
Telecoms	• National-level competition in mobile, National-level competition in fixed with incumbent having significant market power	• Facilitation of competition such as access pricing	• Measures to promote competition	• Fibre roll-out • 4G network development • White Spaces trial
Energy	• Regional monopolies in distribution • Monopoly for transmission networks in England/Wales and two transmission networks in Scotland	• Price control	• Competitive tender "for the market" (OFTOs) • Price control • Stimulus package	• Smart Grid technologies • Low Carbon networks • Offshore maintenance and insurance
Rail	• National monopoly or infrastructure provision • Services subject to competitive franchising	• Price control	• Price control • Stimulus package	• Track renewal efficiency • Alliancing
Water	• Regional monopolies for water and sewerage infrastructure provision	• Price control	• Price control	• Leakage management • Ice Pigging
Airports	• Large number of airports with effective competition. Only two airports regulated on the basis of the market power test	• Price controls and licenced backed commitments	• Price controls and licenced backed commitments	• Constructive Engagement • Service Quality Regime • Future Airspace Strategy

4. Cross-sector innovation and co-deployment

Opportunities for cross-sector innovation and co-deployment

4.1. Given the nature of the UKRN as a vehicle for improving cross-sector collaboration, this chapter focuses on the opportunities for, and potential barriers to, innovative approaches that may require collaboration by firms in one or more regulated sector.

4.2. There are various examples of infrastructure providers in two sectors co-deploying networks, sharing networks to provide shared services and managing network deployments (where networks are not planned to be shared) more effectively.

4.3. We have set out below an indication of some of the innovations that are being or have been applied across regulated sectors in the UK and further afield.

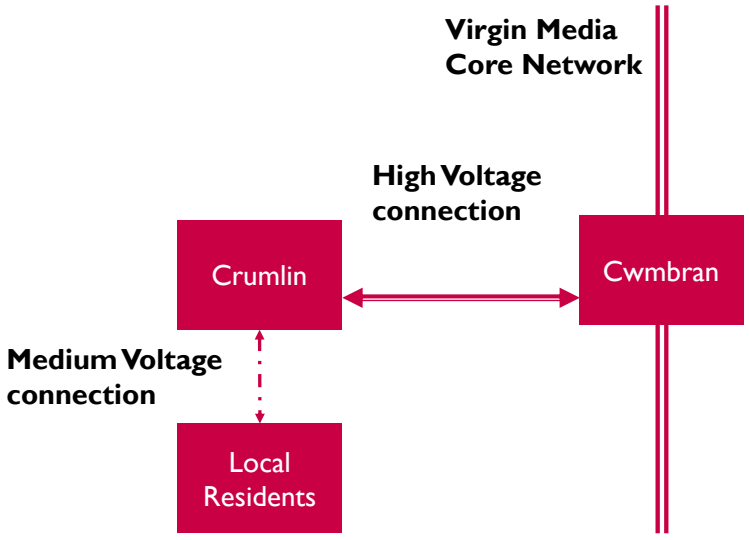
Cross-sector technical innovation

4.4. Technical innovations between sectors can often involve the use of one sector's infrastructure to deploy another sector's new network more quickly or at lower cost.

4.5. The telecommunications sector has been partnering with other sectors for some time in the development of fixed core networks. Electricity distribution networks had developed core networks (i.e. not the networks that deliver telecommunications over the final mile to homes and businesses) with smaller communications providers, before the networks were bought by Cable & Wireless, and then eventually Vodafone. Similar developments occurred between the Thames Water and Geo Networks in London to provide connections to businesses.

4.6. Subsequently, there was a push for the roll-out of next generation access networks (i.e. bringing communications services to homes and businesses). In partnership with Western Power Distribution, Virgin Media undertook a trial in July 2010 to deliver superfast broadband over electricity poles to the village of Crumlin in South Wales.[12]

Figure 5: Virgin Media/ Western Power Distribution trial, South Wales



[12] http://www.publications.parliament.uk/pa/cm201213/cmselect/cmwelaf/580/580we13.htm

4.7. The trial was technically successful (i.e. the combination of telecommunications and electricity infrastructure caused few technical issues) but we are not aware of any subsequent instances of overhead electricity networks being used for telecoms deployment since this trial. The potential reasons for this include:

- commercial viability, i.e. the balance of costs incurred against increased revenues provided by new customers;
- Virgin Media's business strategy, which has tended not to pursue new deployment as a priority; and
- potential planning or regulatory barriers such as differences in wayleave payments between sectors or lack of certainty about financial rewards for utility companies entering infrastructure sharing agreements.

4.8. A similar deployment has been announced in the Republic of Ireland as a joint venture between Vodafone and the Irish Electricity Supply Board (ESB). The two firms are investing 450 million euros in a broadband network connecting fibre to the premises and enabling speeds of 200Mbit/s to up to 1Gbit/s (see box 3 below). The fibre will be deployed over ESB's underground and overground electricity network assets. This move was made possible by the wish for Vodafone to expand its broadband network[13] and compete with Eircom and UPC as well as the change in legislation made by the Irish government that allowed ESB to share its infrastructure with Vodafone.[14] The result will be a fibre network available on a wholesale basis to prospective communications providers in Ireland.

4.9. One of the results of Ofgem's Low Carbon Networks fund is a project which Scottish Hydro Electric Power Distribution is undertaking. The project will examine the problems and impacts that the growth of hydrogen electrolysers used for electric cars and other forms of electric transport will have on electricity distribution systems and how they can be minimised. The project will also look at how electrolysers can provide other network services and relieve network constraints.

4.10. Eleclink[15] is another example of collaboration between the energy and transport sectors. The project involves the deployment of an interconnector for electricity distribution between Great Britain and France using the existing Channel Tunnel rail link. The project seeks to cut the costs of international interconnection which most commonly uses cables running along the seabed. The project is ongoing, with operations expected from mid-2016 onwards.

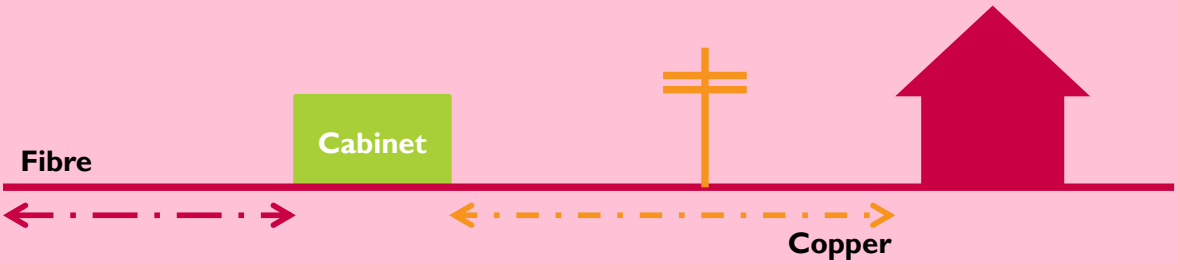
4.11. The water sector has also engaged in cross-sector technical innovation by generating energy from waste. In 2011, Thames Water opened a £1.5 million sewage sludge dryer at its water treatment plant in Slough, Berkshire.[16] Previous attempts to generate power from sludge at the company's Crossness sewage works in south-east London had been limited by the high water content of the sludge collected (75%). The main role of this process was therefore to reduce waste more efficiently. With the new dryer, the water content is reduced to 5% and the sludge is produced as flakes or granules. This enables it to be burnt like wood chip and requires less gas to be used to burn it and generate electricity. The electricity is used to power Thames Water's operations, generating £300,000 a year of operational cost reductions and also reducing carbon emissions by 500 tonnes a year.

[13] http://www.esb.ie/main/press/pressreleaseWS.jsp?id=4074
[14] http://www.lexology.com/library/detail.aspx?g=7216f65f-1fe8-455a-abe0-54203bff36cc
[15] http://www.eleclink.co.uk/what-we-do.php
[16] http://www.thameswater.co.uk/about-us/14556.htm

Box 5: ESB / Vodafone Fibre to the Home Broadband, Ireland

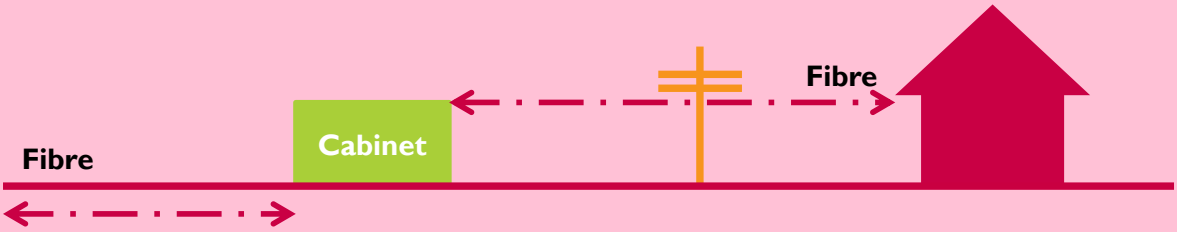
In July 2014, Irish electricity provider, ESB, and telecoms provider Vodafone signed a joint venture agreement that will see 500,000 homes and businesses in 50 towns across Ireland receive ultrafast broadband. The network is planned to be a fully fibre network, which should allow download speeds from 200Mbit/s to up to 1Gbit/s. This will benefit Irish broadband users, 43% of whom receive broadband speeds of 10 Mbit/s or less.

Traditional superfast broadband deployment involves fibre being deployed to the street cabinet, which then serves nearby homes and businesses using copper lines. Download speeds through this method are limited to 80 Mbit/s.



Faster speeds can be achieved by running fibre all the way to the home. However, upgrades to lines to a large number of premises are costly, involving high costs to replace the numerous underground copper lines with fibre.

By utilising ESB's existing electricity distribution network, the joint venture will be able to run fibre along existing electricity infrastructure in order to connect fibre all the way to the home. In a lot of cases, this will involve the use of wooden electricity poles, but without disturbing the existing electricity lines that hang between poles.



The joint venture was signed two months after the Irish government approved a change in legislation that allowed ESB to undertake activities involving the development of communications networks and the provision of communications services. As well as an allowance to perform these activities, the ESB (Electronic Communications Networks) Act 2014 also allowed for:

- the ability for ESB to provide access to its electricity infrastructure to another company;
- the ability to include electronic communications as part of the meaning of an *electric line* in previous ESB acts; and
- the ability to apply numerous sections of the wayleave regime (section 53 of the Electricity (Supply) act 1927) to the provision of access to ESB's electricity infrastructure for communications

Whilst ESB and Vodafone will build and manage the network, wholesale access will be made available to other telecoms operators. The venture also underwent a European Commission state aid approval, as one half of the joint venture (ESB) is state-owned. The first phase of work is expected to be complete by the end of 2018.

Cross-sector process innovation

4.12. In terms of process innovation, there are known opportunities for different utility companies to co-ordinate with other sectors when deploying new networks or improving existing networks. This is particularly true when considering the impact that network improvements have on vehicle traffic. Streetworks co-ordination can improve the deployment times and cut costs when network improvements involve digging up roads.

4.13. The government has developed legislation that seeks to encourage co-ordination of streetworks and minimisation of disruption. This includes the New Roads and Street Works Act 1991 (NWRWA), the NRSWA as amended by the Transport (Scotland) Act 2005, the Traffic Management Act 2004 (TMA) and the Code of Practice for the Co-ordination of Street Works and Works for Road Purposes and Related Matters. These instruments oblige street authorities to:

> ". . . use their best endeavours to co-ordinate the execution of works of all kinds (including works for road purposes and the carrying out of relevant activities) in streets for which they are responsible:
>
> (a) in the interests of safety;
>
> (b) to minimise the inconvenience to persons using the street (having regard, in particular, to the needs of people with a disability); and
>
> (c) to protect the structure of the street and the integrity of apparatus in it."

4.14. An evaluation of the Traffic Management Act in 2007-08 identified improved joint planning of major infrastructure schemes but at the same time identified issues such as:

- inconsistencies between authorities in interpretation and application of powers;
- lack of effective evaluation of the effect of the TMA; and
- the need for improved governance arrangements either through improved self-governance within the authorities or by centralised governance.

4.15. One theme that has been raised by network companies in terms of the challenges of successfully coordinating streetworks relates to having reliable access to underground network data. In the UK, the National Underground Assets Group (NUAG) has been collecting information on underground infrastructure assets with the aim of enabling safe works and helping Government achieve its Traffic Management Act objectives. Further information is provided in the box below.

Box 6: Infrastructure Mapping, National Underground Assets Group

The National Underground Assets Group (NUAG) is a not-for-profit organisation that has the aim to collect and present information on all underground assets (as well as associated above-ground assets) and share this information on demand. The National Records Sharing service is the vehicle through which this information is shared, funded by annual fees.

The desired outcomes of the group are to reduce road congestion, information management costs, improve health and safety and facilitate a more effective streetworks process. The service provides a single point of information for works promoters who can use the information to assist them in planning street works.

NUAG have developed its proposal, as a trial, in partnership with Greater London Authority, who have appointed a contractor to further build the scope of the scheme, including options to hold the asset owners' data centrally. The GLA scheme includes TfL, Highway Authorities and other London-relevant asset owners.

4.16. The National Joint Utilities Group (NJUG), which sits on the HAUC, is the UK's sole trade association representing utilities and their contractors on streetworks issues, promoting best practice and self-regulation.

4.17. The NJUG also highlight key case studies where successful partnerships have been formed between utilities and local authorities in delivering more efficient works. One such case was completed in 2010 on Borough High Street in Southwark, London.[17] Gas and water replacement works were combined with other utility works relating to the ongoing development of nearby London Bridge station and the new Shard commercial and residential tower.

4.18. Transport for London, the combined transport authority in London, co-ordinated the partnership with the utilities and the local authority, Southwark council. Additionally, the utility companies used a single utility contractor to undertake the work, resulting in good co-ordination and communication between the utilities and providing a central contact point for the authorities. Transport for London estimated that the co-ordination of the project removed the need for 384 days of works.

[17] http://www.njug.org.uk/wp-content/uploads/51_-_Borough_High_Street_Blueprint.pdf

Box 7: NJUG case study: Streetworks on Borough High Street, London

In 2009, a series of utility works had been planned for the busy and important Borough High Street, due to a series of network improvements and new works for local developments. Transport for London, organised a consultation meeting in order to cut the amount of disruption that could be faced by road users due to the number of activities taking place.

Morrison Utility Services became the joint contractor for the main utility companies: Thames Water who were carrying out mains renewal and other activities as part of a leakage reduction programme and Southern Gas Networks who were replacing gas mains and additional activities as part of the HSE abandonment programme (for the decommissioning of gas infrastructure).

Southern Gas Networks brought forward their investment plans to ensure that this work could be carried out at the same time as the water works. However, UK Power Networks also entered the joint agreement and contracting arrangements as it needed to install new infrastructure to the Shard development next to nearby London Bridge rail station. By using the common contractor, the electricity works could be integrated in to the gas and water works with minimal disruption.

The nine month project was completed in July 2010, with no delays in the schedule despite the ongoing utility diversion works needed by Network Rail for its remodelling of London Bridge station. Additionally, BT was able to use the works to carry out remedial repair to some of its equipment during the project period.

The co-ordinated project is considered a blueprint for subsequent utility improvement works.

Cross-sector business model innovation

4.19. A current example of commercial and business model innovation that has a cross-sectoral element and has the potential for synergies as a result is smart metering.

4.20. Smart meters give the ability for energy and water companies to obtain customers' readings automatically based on some form of communications network back to the energy and water companies. Customers will benefit from real-time information and up-to-date accurate billing. The roll-out of smart meters will be led by electricity and gas suppliers, who will aim to roll out the meters across the UK by 2020. The initiative was started by Government's consultation on smart meters in 2007 which was part of a wider initiative to improve the information provided to energy customers on their energy bills.

4.21. The water sector has some way to go to move towards smart metering. This is due to the fact that metering, smart or otherwise, is not as common in the sector. Of all water customers, 46% are metered, but in some parts of the country, that figure can drop to as low as 23%.[18] Unmetered customers are charged at a fixed annual rate.

4.22. Some companies in water-stressed areas have been moving towards smart metering. One example is Thames Water, a water company in London and other parts of the South-East. This area suffers from a demand exceeding supply frequently on peak days. Thames Water has therefore, after a successful trial in 2012, started a 15-year programme to extend smart meters to all of its customers.

[18] http://www.utilityweek.co.uk/news/a-smart-move-for-water/975152

4.23. The communications network for smart metering for the energy network will be delivered by:

- SmartReach, a consortium including Arqiva, BT, BAE Systems Detica, Sensus and EDMI, for the northern region of Great Britain; and
- Telefonica UK for the Central and Southern regions.

4.24. The technology used by the two contract winners will be different. SmartReach will use long-range radio to communicate to smart readers, suiting the more sparsely populated region. Telefonica will use its own mobile network to carry data, with additional technologies to support areas without coverage.

4.25. The implications for the water sector is that, whilst the Thames Water trials which used the long-range radio option were successful, a lot of water meters based in remote underground locations cannot reach alternative solutions as successfully. However, there is potential for long-range radio networks in the north to be used to carry smart metering data for water.

4.26. Ofcom has engaged with Government on the roll-out of the smart metering communications network. Last year, it published its statement on releasing lower level spectrum (870 MHz) which can be used for enabling the Home Area Network connections which allow smart meters to 'talk to' other equipment in the customers' home.

Summary of cross-sector innovation

4.27. The examples of cross-sector innovation described above are summarised in the table below:

Figure 6: Examples of cross-sector innovation

Technical	Process	Business model
• Virgin Media and Western Power Distribution, Vodafone and ESB – Broadband on electricity distribution networks • Scottish Hydro Electric Power networks for electric cars • Eleclink combining electricity transmission with an international rail network • Thames Water sewerage-to-electricity works	• National Joint Utilities Group for the co-ordination of streetworks for electricity, gas, water and telecoms companies • Successful co-ordination across many utility companies in Borough High Street, London	• Smart metering for energy and water networks requiring communications services

4.28. Overall the examples set out here tend to illustrate that cross-sectoral innovation is a relevant part of the overall landscape in these sectors, but it may be a relatively small proportion of overall activity in each sector. For regulators however, it still means that understanding the nature of these cross-sectoral innovations and the appropriate approaches to enabling them, whether through more

focussed funding support or through creating greater space and opportunity for the private sector to make gains from innovation, are a relevant consideration on a cross-sectoral basis.

Potential barriers to cross-sector innovation

4.29. Some of the cross-sector innovations possible, including those identified above and those that have yet to be realised, may face barriers in development. This section identifies some barriers that may exist to cross-sector innovation by assessment of three areas affecting cross-sector activities: commercial viability, legal and regulation.

Commercial viability

4.30. Through the recent work undertaken by UKRN we have come across very limited information around the potential commercial barriers to cross-sector innovation, partly due to the lack of information on failed instances but also the difficulty in isolating commercial aspects from others such as technical and legal challenges. One case where commercial barriers may exist is the provision of unmetered power to telecommunications infrastructure.

4.31. As described in section 3, recent Fibre to the Remote node (FTTRn) technology is designed to provide high-speed broadband access to those who either (a) live too far away from a street cabinet to receive it under the conventional roll-out method, Fibre to the Cabinet (FTTC), or (b) do not have a street cabinet between their home connection and the local telephone exchange. However, whereas cabinets can be powered by the local telephone exchange, remote nodes cannot (as they only have a fibre connection back to the exchange) and therefore rely on power from electricity networks. There has been some difficulty in agreeing an unmetered connection as remote nodes have an 'always-on' connection.

4.32. Other barriers are likely to be related to the technical specification. For example, railways provide a core transport network for many people, but are less likely to be the final access network for those in sparsely populated areas. These individuals are likely to use another form of transport to reach their homes or place of work after a rail journey. The implications for other networks – communications, energy and water – is that the rail corridors are unlikely to be suitable on their own for the building of access networks (e.g. rural broadband), which tends to be a large barrier to connecting certain services to every UK household rather than any issues in the core network.

4.33. Additionally, some technologies are potentially inherently unsuitable to deploy together due to safety or other operational considerations. The design of sewers in the UK means that it is difficult to deploy communications or electricity networks within them, and costly to maintain. There are also the health and safety risks associated with combining water and electricity infrastructure.

4.34. We would welcome further input from industry or academia to inform our understanding in this area. Equally, companies may not have been aware of the potential to innovate with companies in other industries. Greater awareness of the scale of the issue with commercial barriers would inform consideration of the proportionality of intervening in legal or regulatory barriers that may be identified.

Legal

4.35. Legal frameworks can impact in various ways on the ability to deliver and exploit cross-sector innovation. One such example of this is the differing regimes governing the terms and conditions for

access to private land across the utilities sectors. These include the settlement or payment conditions for landowners when network operators require access to private land in order to deploy networks. The various regimes are described at a high level in the table below:

Figure 7: Differences in land access regimes

Telecommunications	Energy	Water
• Voluntary wayleave agreements • No fixed length of agreement • National rate cards used in some instances • Communications Code operators can use the code for disputes, if they arise	• Easements costs based on the economic loss to the landowner, including disturbance and parts of the value of the land • Some cases of commercial negotiation	• Easements costs based on the depreciation of the value of the land caused by pipes • Statutory rights to conduct works or lay pipes with no objection allowed from landowners

4.36. A report written by Nordicity for the Department for Culture Media and Sport in 2013[19] identified that the differences in these regimes would typically result in differences in the compensation paid to landowners for access. In particular, the current telecommunications regime would result in higher payments than energy and water regimes due to the level at which agreements are commercially set, as opposed to agreements closer to costs incurred by the landowner in the energy and, more so, in the water sector.

4.37. The implication for cross-sector deployment is that a deployment of telecommunications infrastructure on, for example, electricity infrastructure may become less commercially viable because high wayleave payments under the communications code may be incurred, where previously economic loss-based energy regime easement costs were incurred. It is possible that this has contributed to the uptake of this type of co-deployment in the UK to date.

4.38. As in the case discussed previously in Ireland, relating to ESB and Vodafone, the Irish government passed legislation to allow the electricity company, ESB, to operate communications services and use sections of its way-leave arrangement to roll out the fibre broadband network with Vodafone. It specifically allowed electronic communications services to be referenced in the same way as existing electricity infrastructure in some legislation for the purposes of its operations.

4.39. This example in particular is relevant to the scope of the European Civil Engineering Directive on reducing the cost of broadband deployment (See box 8 below). Regulators within UKRN have already supported engagement with Government on the Directive and this will continue going forwards.

19 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/270165/Wayleave_Economic_Analysis_2013_10_23.pdf

Regulation

4.40. Section 3 above identifies different regulatory approaches to within-sector regulation. Each of the economic regulators has distinct statutory duties shaping their approach towards encouraging innovation.

- ORR has a duty to promote improvements in railway service performance and promote efficiency and economy on the part of persons providing railway services. ORR considers that the promotion of innovation through its price control is essential to the delivery of these duties.
- Innovation is not referenced as part of Ofgem's duties although similar to ORR, Ofgem has a duty to encourage network companies to perform effectively and efficiently. This is reflected in primary legislation. As part of the Utilities Act 2000 Ofgem is also able to have regard to consumers in the water and telecoms sectors in undertaking its duties.
- Ofcom has a principal duty under the Communications Act 2003 to further the interest of citizens in relation to communications matters and to further the interests of consumers in relevant markets, where appropriate by promoting competition. In achieving this, Ofcom must also encourage investment and innovation in its relevant markets (telecommunications, broadcasting and post).
- The CAA and Ofwat have no specific duties related to innovation although they do have secondary duties to promote economic and technical performance efficiency.

4.41. The regulatory framework underpinning the regulators' duties is primarily focused on consumers within their own sectors although there is no evidence from the cases we have observed to suggest that this is hindering cross-sector innovation.

4.42. Cross-sector innovation usually involves a higher risk investment into research or services that may not always result in a benefit to the consumers across all sectors. Within-sector investment cases are considered in the energy sector, the water sector and the rail sector as part of a review process by the individual regulators. In the communication sector, this will typically be a commercial decision taken by commercial operators, within the context of a competitive market place and an overall regulatory framework (which may include a price control). Cross-sector innovation may require co-ordination between regulators to assess the merits of the investment where applicable and be aware of the cross-sectoral benefits in order to approve business activities involving cross-sector innovation.

4.43. One movement towards legislation encouraging cross-sector innovation and deployment is the EU Directive to reduce the cost of broadband deployment.[20] The Directive enables telecommunications operators to request access to the physical infrastructure of network operators, including those in the electricity and water sectors, as well as to any physical infrastructure within buildings. The Directive should be implemented by EU member states by January 2016.

4.44. Led by Ofcom, the UKRN will continue to provide support to the Department for Culture Media and Sport to assist Government in transposing the directive into UK law.

[20] http://europa.eu/rapid/press-release_MEMO-14-150_en.htm

Box 8: European directive on reducing the costs of broadband deployment

The European Commission undertook work to speed up the deployment of high-speed broadband networks as part of its Europe's Digital Agenda. The result is a Directive that enables telecommunications operators to request access to the physical infrastructures of networks operators, including in the electricity and water and sewerage sectors as well as those of other telecommunications providers. EU member states may also provide telecommunications operators with the right to offer access to other network industries. Operators will also be able to access in-building physical infrastructures in order to deploy high-speed broadband networks.

The Directive also proposes changes to the management of network deployment. These include:

- a single information point for gathering information on existing and planned infrastructures, which defaults to the telecommunications regulator unless otherwise amended by the member state;
- a dispute resolution body in cases where access to physical infrastructure has not been agreed, which is expected to sit within or across regulators; and
- a deadline for permit-granting for works reduced to four months from six months previously

In some cases, parts of the directive are already active in some member states. Germany's multi-utility networks regulator, Bundesnetzagentur, has an infrastructure atlas in place, which is a detailed directory on the type, availability and geographical location of existing physical infrastructure of any network which can be used for the deployment of high-speed broadband networks. The atlas requires a large amount of effort to implement and maintain as there are over 700 suppliers of information.

4.45. Bundesnetzagentur's ability to map infrastructure across Germany is a relatively new tool for the deployment of NGA networks. In the context of assisting with transposition of the Directive, we hope to learn more about the benefits of its use in due course.

5. Summary

5.1. The aim of our work on this report was to map out regulators' current approaches to innovation and how they might relate to areas of potential cross-sector innovation and perceived barriers. We have summarised below.

- The level of regulatory intervention applied tends to depend on the level of commercial necessity of the innovation and the level of competition existing in the market. Natural competition typically provides the best incentive for innovation as it allows participants to take a long term view and seek to gain the full benefit of any innovation spending they incur.
- Where competition has been promoted by the regulator (telecommunications and in specific sub-sectors of other types of infrastructure) to remedy significant market power or allow "for the market" competition, innovation then becomes as necessary for market participants to pursue as it does in a naturally competitive market.
- Where innovation could decrease operational costs of a regulated company, regulatory instruments such as price controls are used to encourage innovation. This is seen in the sectors with natural monopolies or where substantial market power is present (airports, energy, water and rail).
- In some cases, where innovation has a socially beneficial output and commercial returns may not be seen until further in the future, regulators (Ofgem and ORR) have used a stimulus package to enable innovation.
- There are some examples of cross-sector innovation, including technical, commercial and process innovation. The scale of the potential of these innovations is not yet clear in all cases. One specific example is the potential for cross-sector infrastructure sharing to reduce the costs associated with the roll-out of new infrastructure. The Irish Government have used a legislative approach to support Vodafone and ESB as they seek to roll out fibre broadband on electricity networks.
- The European Commission's directive on reducing the cost of broadband deployment will require Government to implement legislation on a variety of issues on cross-sector access, including the provision of a single information point on infrastructure.
- Legislation on land access payments differ between the sectors could prove to be a barrier for cross-sector deployment.
- In line with their statutory duties, regulators primary focus is on the consumers for their particular sectors. There is no evidence to suggest this is hindering cross-sector infrastructure but regulators should be mindful of the potential barriers this could create and continue to engage where issues arise.

5.2. Going forward we welcome feedback from stakeholders on the scope of our work to date and particularly where further information can be provided to highlight where future innovation may be possible and potential barriers that may exist to its deployment.

5.3. Within the UKRN framework, Ofcom will continue to support Government's transposition of the Directive on broadband deployment. We hope that the findings of this report will help identify issues arising from the transposition of the Directive. Other UKRN members will also participate in this work where appropriate and ensure that proposals brought forward reflect a cross-sectoral perspective.

6. Invitation to comment

6.1. This document has been produced based on the experiences of members of the UKRN and desktop research. In order to better understand the scale of potential opportunities in cross-sector innovation and co-deployment, we now invite views from stakeholders on the following points:

a) If stakeholders have previously engaged, or plan to engage, with firms outside of their main sector of operation in order to develop innovative solutions in infrastructure

b) What problems and barriers stakeholders have come across in attempting to engage in cross-sector infrastructure innovation and co-deployment of infrastructure

c) What potential solutions, if any, could be developed in order for stakeholders to increase cross-sector activity in infrastructure innovation

6.2. Stakeholders may send comments to:

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or post them to:

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6.3. Whilst we are not planning on publishing stakeholders' comments on this report, should you consider any part of your comment to be confidential, you should identify which parts, if not all, of your response is confidential, and the relevant explanation for why this is the case.