Written submission to the Infrastructure Commission for Scotland from the Institution of Engineering and Technology (IET)

The Institution of Engineering and Technology (IET) is an international professional body with over 160,000 members which acts as a voice for the engineering and technology professions. Spanning a range of disciplines from power systems engineering to data analytics, our primary aim is to provide a global knowledge network between business, academia, governments and professional bodies, promoting ideas which enhance the positive role of science, engineering and technology for the society and the economy of the future. While the roots of IET lie in electrical engineering, IET members are multi-disciplinary but primarily create infrastructure based around electricity or data; often both.

With an active membership of 10,216 in Scotland, the IET has networks of volunteers in Scotland and a dedicated Engineering Policy Group, drawn from within the IET, acting together with other engineering organisations. The IET has a wide-ranging programme of events in Scotland which illustrate how engineering and technology can transform Scottish society in areas as diverse as: energy systems, digital transformation, healthcare technology and transport.

Executive summary

Since the declared mission of the new Infrastructure Commission for Scotland (ICfS) is to place “practical and realistic options on the public agenda for further detailed consideration by the Scottish Government and Parliament”, the IET would like to draw attention to the following:

- While the IET welcomes the inclusion of the concept of “enabling infrastructure” within the definition of infrastructure used by the Scottish Government, the importance of “invisible” infrastructure, for instance the data streams which power modern society, are often not recognised. With machine learning and digital transformation ever more evident, the ways in which data is gathered; collated; secured and managed; must be a priority in the next thirty years.
- The over-arching objectives of the ICfS mirror the four principles endorsed by the Scottish Government in successive infrastructure plans (i.e. low carbon, employment, sustainability and quality). These are very laudable objectives but need to be supplemented by two additional ones which cover: infrastructure resilience and; cyber security.
- Water, communications, some transport links and ICT all depend on the energy network, particularly the national electricity grid. Due to this inter-dependency, any disruption to electricity supplies would have a cascade effect, which would
be catastrophic. To avert such a “low probability but high impact” event, Scotland needs a resilient energy system. There are two aspects to this: first, to have a balance of power generation sources; secondly to have rigorous standards; tests and; modelling to ensure that the energy system is resilient and can be quickly and safely reinstated in the event of any mishap.

- Cyber-crime is on the increase and the threat to critical national infrastructure is direct. Government must prioritise and raise awareness of cyber security within the public sector; in the private sector (which controls large swathes of infrastructure) and especially; in the supply chain, particularly in small and medium sized organisations which are often vulnerable to cyber- attack.

Within specific sectors of IET activity, the following trends need to be noted as they will determine infrastructure priorities in Scotland in the next thirty years.

- As domestic energy consumption accounts for 30% of current energy usage, a nationwide programme of “deep retrofit” insulation will save on 30 years of on-going energy and maintenance costs while providing many thousands of jobs. A retrofit programme could be started via social housing while developing the finance mechanisms to incentivise the private sector. This project could be activated within a short time frame and might be an initial focus for any proposed Scottish National Infrastructure Company. The IET has examined this issue in a recent publication, Retrofit 2050.

- The Scottish Energy Strategy sets out two pathways: electricity and hydrogen. This is not a binary choice and it can be argued that a “mixed energy” future is in the public interest. Later this month, the IET Energy Panel is launching a substantive report on hydrogen. This report will contain numerous case studies illustrating hydrogen use and assessing the engineering risks and uncertainties involved with transitioning to hydrogen for heating.

- With mobile access, increasingly an essential service, the potential of 5G as a key enabling technology is already evident. It can power a communications revolution which will allow the operation of autonomous vehicles; which can foster the machine to machine communication behind the Internet of Things and; which could enable applications such as the engineering technologies behind the precision farming of the future. While telecommunications are a reserved area, Scotland is a special case in that for large portions of the country, public investment may be needed to ensure 5G coverage for areas which commercial providers cannot provide for.

- Immediate priorities in communications technology involve the adoption of full fibre (as opposed to copper wire technology). Looking further ahead, other models of connection involve integration of satellite communications to enhance bandwidth. This will become increasingly relevant as the cost of launching satellites drop.

- Within the transport sector, good digital connectivity is the key to providing Mobility as a Service (MAAS), a new concept whereby customers can access multi-modal transport choices via a single interface which covers: journey planning; payment and; ticketing interface. An appropriate, reliable transport and open access digital infrastructure is necessary to deliver this. The issue is examined in a detailed report published by IET in March 2019 entitled - Could Mobility as a Service solve our transport problems.
• Plans to phase out the sale of new petrol and diesel vehicles in Scotland by 2032 will herald huge changes not just in the type of vehicles on the road but also in the supporting infrastructure. If the target deadline is to be met, electric charging points will have to be installed on a large scale in housing developments, on streets and in the work place. For more remote locations, rapid charging points may have to be installed by the public sector.

• Looking ahead, infrastructure will have to be viewed not just in a national but also in an international context. Electricity inter-connectors, data centres based abroad and even satellites based in space will have to considered in the context of how they relate to Scottish infrastructure. These installations, although outside the national territory are also Scottish infrastructure.

1. Introduction

1.1 Scotland is now at an interesting juncture. The establishment of a new Scottish Investment Bank, the choices set out in the Scottish Energy Strategy, together with the possibilities of greater autonomy afforded in the wake of Brexit present new horizons for the nation. The correct decisions on investment in infrastructure, matched by a commitment to training and building skills within the work-force, will determine the future for Scotland in the coming decades.

1.2 The nature of the settlement of devolved power presents both conundrums and opportunities. While the Scottish Government may lack the fiscal levers and regulatory powers to directly influence decisions, nonetheless via pilot studies, targeted local investment and; procurement policies Scotland can exercise considerable influence in dealing with its own affairs. National infrastructure relies on local infrastructure to support it and much of it is also subject to devolved powers.

1.3 Investment in infrastructure will provide the basis for economic growth if deployed in conjunction with a commitment to training and education, in the context of an environment which promotes and fosters research and innovation. As Government is only able to provide limited funding much of the work of encouraging infrastructure investment will depend on leveraging the private sector.

1.4 Not only in Scotland but globally, the goal of achieving a low carbon economy will be a major challenge in the next thirty years. One consequence of the massive shift towards renewable power in Scotland in the last decade has been an impressive reduction in carbon emissions, achieved in large part by the closure of power generation plants which used fossil fuels. The challenge now will be to match these gains in relation to transportation and within the built environment, particularly by cutting carbon emissions in relation to heat.

1.5 The other global trend which will impact Scotland is the increasing importance of data and the multiplicity of use of this data within the modern economy. Digitalisation, (both in relation to a rapidly growing web-based economy and in a transformation of public service provision) is an on-going revolution which is producing profound economic and social consequences. The 2017 Digital Plan for Scotland aims for 150,000 digital technologies roles by 2022. Public services in health and social care, justice and social security are being transformed and this trend will continue.
1.6 The ways in which we live, work and shop are changing rapidly with knock-on effects for commuting patterns, city centre retail establishments and virtually every aspect of life. It is impossible to second guess technological improvements over the next thirty years, but we need to recognise that some major features of current technology trends are: a convergence between the cyber world and the physical one and; the emergence of inter-dependencies between different sectors of the economy. Present and future Infrastructure planning will have to take these trends into account. Above all else however in the decades ahead, it should be recognised that the ability to create value from raw data is currently the major engineering achievement which is already generating profound consequences, but which still has a long way to go.

2. Invisible infrastructure

2.1 The Scottish Government definition of Infrastructure set out in 2018 is: “The physical and technical facilities, and fundamental systems necessary for the economy to function and to enable, sustain or enhance societal living conditions. These include the networks, connections and storage relating to enabling infrastructure of transport, energy, water, telecoms, digital and internet, to permit the ready movement of people, goods and services. They include the built environment of housing; public infrastructure such as education, health, justice and cultural facilities; safety enhancement such as waste management or flood prevention; and public services such as emergency services and resilience.”

2.2 This definition of infrastructure with its emphasis on physical structures probably represents a commonly view but it fails to take account of the invisible infrastructure which increasingly underpins modern life. Smart cities now use networked digital technologies to control infrastructure. These include city operating systems, centralised control rooms, intelligent transport systems, smart energy grids, smart meters, sensor networks smartphone apps and sharing economy platforms. This reality can be seen in the Ruggedised project in Glasgow which looks at several smart solutions relevant to a sustainable, resilient low carbon city.

2.3 The technologies which enable “Big Data” (e.g. the Cloud, fast chips, the Internet of Things and machine learning) enable vast amounts of data to be collected and processed. These technologies integrate, report and analyse information, allowing real-time prediction modelling. The incorporation of this data into the design, performance and maintenance of infrastructure has profound social implications (e.g. the use of wearable sensors in the care of the elderly). Smart systems which “learn” through artificial intelligence to direct the movement of vehicles or patterns of lighting are part of an invisible infrastructure which needs to be planned, managed and maintained as much as any physical infrastructure.

3. The infrastructure of a smart city

3.1 Trying to define “infrastructure” in the context of a modern economy is no easy task and there is no agreed definition. One of the declared strategic drivers of the
ICfS, (i.e. prioritising “investment to deliver inclusive economic growth”), will involve the identification of key current trends, one of which must be: the digitization of the economy. The web-enabled economy which has fundamentally changed the ways we live, work and shop, is undoubtedly one of the “fundamental systems” within the Scottish Government’s definition of infrastructure, but it can also be argued that data itself ought to be viewed as infrastructure.

3.2 The National Infrastructure Commission in its 2017 paper “Data for the public good” endorsed the idea that data should be seen as a part of the UK’s infrastructure and advocated systems of developing standards and formats for data capture and sharing. The NIC recommendation on creating a “digital twin” model for UK infrastructure has not been followed up by funding or through the creation of a pilot study. The concept of a digital twin, a virtual model of a physical product, process or system, comes from manufacturing but it can readily be applied to infrastructure. Infrastructure elements (e.g. a road system, a footbridge and a stadium) could be managed via a digital twin using real-time information.

3.3 Investment in “big data” on a city-wide basis can produce considerable savings in relation to planning, maintenance and efficiency. In 2017 the UK Government gave the city of Glasgow a grant of £24m to develop as a “smart city” (i.e. a city is where hard and soft infrastructures are integrated with technology and securely connected). With the development of Glasgow as a smart city, are there plans to develop a Glasgow digital twin? Should a pilot study be set up to examine this idea?

3.4 In Scotland there is currently a considerable drive towards digital transformation. The foundations being laid within the next 5-10 years will determine the outcome over the next 30 years. A key element of this transformation will be the establishment of open standards in the development of local, national and international infrastructure.

4. Guiding principles

4.1 The over-arching objectives of the ICfS, set out in the Call for Evidence, mirror the four principles endorsed by the Scottish Government in successive infrastructure plans. The current Scottish Government Investment Plan 2019, quotes the principles outlined in the 2015 plan. These principles are that:

“We will seek to prioritise infrastructure investment based on our guiding principles of:
1. delivering sustainable economic growth through increasing competitiveness and tackling inequality;
2. managing the transition to a more resource efficient, lower carbon economy;
3. supporting delivery of efficient and high quality public services; and
4. supporting employment and opportunity across Scotland.”

The IET endorses these principles but feels that two more need to be added. These two principles might be:

5. promoting public protection through cyber security vigilance;
6. striving for resilience, particularly in relation to our energy systems on which other infrastructure elements depend.

5. Resilience

5.1 In the context of any infrastructure planning, the inter-connection and increasing inter-dependency of different types of infrastructure must be recognised and considered. While a digitally enabled inter-dependent economy allows the more efficient use of resources, the down-side is that a failure of the system would be catastrophic. Water, sewerage, transport and communication are to varying degrees heavily dependent on the energy system, particularly the national electricity grid.

5.2 In the past decade several trends are coalescing, which raise concerns about the resilience of our energy systems. The rapid shift to renewable energy sources (which are by their nature intermittent); the closure of coal-fired power plants and; problems in nuclear facilities which affect base load capacity are issues which concern many power system engineers. Any failure of electricity grid will have rapid knock-on effects for water, sanitation, transport and communication.

5.3 New networks of digitally connected infrastructure present unintended vulnerabilities and unforeseen cascade effects which need to be first: investigated; understood; planned for; and anticipated. The threats to which our complex inter-dependent systems must be resilient are both diverse and changing. Some (extreme weather events) are predictable while others (cyber threats, sabotage, political or industrial upheaval and solar storms) are random. Foreseeable trends such as driverless vehicles, decentralised energy systems, as well as integrated digital control structures (both at a domestic level and within systems such as gas, water and electricity), underline the need for effective resilience planning.

5.4 In the past, attempts to raise the issue of the resilience of the electricity grid at Holyrood have elicited the response that this is an area for Westminster. Is the emergence of the Infrastructure Commission for Scotland an opportunity to embed resilience thinking within the devolved nations? Could it be argued that the concept of Scotland as a self-contained resilient nation assists the national resilience of the UK? As exemplified in the well-known large-scale disruption in Lancaster in 2015, help is needed from outside and a nation which is a network of semi-self-contained resilient cells may be an appropriate model to aim for?

5.5 The current Scottish Government Investment Plan 2019, quotes the principles outlined in the 2015 plan. Should not the concept of resilience, at least at local authority level within Scotland be adopted as a guiding principle within the next Scottish Government Investment Plan? The concept of resilience is also mentioned in the very last word of the current Scottish Government definition of infrastructure. It needs to be a basic guiding principle and ought to be listed within the "overarching objectives" of the ICfS.
6. Cyber security

6.1 The essence of infrastructure resilience – the capacity to recover rapidly – is also critical in relation to cyber security. Consumers, organizations (public and private), and those responsible for critical national infrastructure all face cyber threats. Perpetrators, who are often difficult to detect and can also be based abroad, fall into a range of categories including: cyber-criminals, non-malicious insiders, malicious insiders, hackers, hacktivists and nation-states. Motivations include: financial fraud, industrial espionage, the theft of intellectual property and sabotage. There are also threats to national and physical security as well.

6.2 While the level of threat varies from potentially disastrous attacks on critical infrastructure to the mass of low grade (but high volume) unsophisticated threats which make up most cyber security challenges, increasing levels of connectivity are spreading the risk. New developments such as autonomous vehicles, drones and the Internet of Things (IoT) will also present cyber security challenges. The increasing inter-connectedness of our everyday lives makes the range of targets broader and the task of protecting them harder. The so-called fourth industrial revolution is characterised by a fusion of technologies. This hyper-connected world has huge cyber security implications.

6.3 Government must show a lead in relation to cyber security. Often, cyber security is still seen as rather an intangible concept. This is not just an issue for major organizations but also for all those in the supply chain. Since much critical national infrastructure (CNI) resides in the private sector, the burden of protecting it is likely to fall there, although the ambit of CNI can be very wide. The interdependence of modern systems extends the boundaries of what is deemed critical, since failure in one system may cascade to affect others. It is noteworthy that the theft of 40 million credit card details, in the “Target” attack of 2013 was caused by the successful compromise of a single air conditioning contractor!

6.4 Promoting cyber security vigilance must be a major task for all governments in the coming years. This concept needs to be adopted as an additional overarching objective by the Infrastructure Commission for Scotland.

7. Sectoral analysis

7.1 The IET covers a wide range of engineering applications. We have specialists within the built environment, energy engineering (in both the transport and power sectors), and engineers who specialize in data analytics. The following notes outline an analysis of the infrastructure needs on a sectoral basis for engineering and technology, and place priorities within sectors in both a short term and a long-term time frame.

7.2 Built Environment

Some of the current trends which have infrastructure implications within the Built Environment include the following:
1. As domestic energy consumption accounts for 30% of current energy usage, an effective way towards a low carbon future is by reducing demand through a programme of “deep retrofitting” (e.g. a combination of energy conservation, insulation and small-scale energy generation measures) to reduce the energy demands of the nation’s housing stock. This can be an effective way to combine energy efficiency with large scale job creation, spread throughout the country.

2. Initially this could be pioneered through the social housing sector which can take a long-term view of the project. Ideas such as an “energy mortgage” (a long-term loan attached to the property and not the owner) could take this concept to the private sector. Some sort of tapered finance mechanism backed by initial capital spending will be necessary. Further information on retrofitting is available in the IET publication Scaling up Retrofit 2050.

3. The built environment sector is directly involved in the construction and maintenance of the nation’s physical infrastructure. Construction is however an area which has problems with low productivity and poor innovation. Research and development funding is being made available through the Construction Sector Deal. Government support for construction needs to continue.

4. Another engineering development within the built environment sector is: Building Information Modelling (BIM) - the production of a 3D virtual model to plan all aspects of a project. The title is a misnomer in that the concept covers all civil engineering applications.

5. BIM is useful not just in initial planning but is also beneficial for maintenance and has health and safety applications as well. Looking further ahead, it is a natural step in the development of smart buildings. The wider adoption of IoT approaches is a logical extension to BIM. The consequences of this are that smart buildings which use sensors to control lighting and heating can make a significant contribution to reducing energy demand.

Time scale

Five years – As the technology is already established and, in some instances “low tech” (e.g. loft installation), a programme of domestic comprehensive retrofit energy conservation, on a district by district approach could be set up almost immediately. The current Scottish Government Investment Plan 2019, quotes one of the principles outlined in the 2015 plan as being: “supporting employment and opportunity across Scotland”. The job-creating potential of a comprehensive domestic energy conservation retro-fitting project is huge, and the benefits can be spread across the country. In all sectors but particularly within the private sector, currently the main barrier is an absence of a customer demand. Earlier attempts such as the UK Government’s “Green Deal initiative” did not achieve sufficient political backing and funding. This project could be activated within a short time frame and might be an initial focus for any proposed Scottish National Infrastructure Company

While BIM technology was encouraged by the last coalition UK Government, in recent times the project does not have the same level of official support. Promoting BIM and energy efficient smart technology in buildings within Scotland ought now to be a considered. The use of technology in the homes of the elderly which can detect an person falling (as currently used in the Grampian Fit homes) can be used to promote social benefits such as enabling people to stay independent.
Thirty years- In the longer term, the impact of other developing technology trends will be felt within the built environment. For instance, in relation to power generation there are considerable opportunities for micro-generation which will allow the development of the grid as a two-way system. Similarly, in the context of an electric vehicle revolution many homes in thirty years’ time will have to provide their own electric charging points. A car battery can then feed into the grid if the vehicle is not being used.

7.3 Transport

Scotland with a relatively small population unevenly distributed over a large land mass relying on a large mixture of transport modes (ferries, road transport, rail transport and air routes), will need to invest considerably in transport in the coming years. The following trends should be noted:

1. Transportation is in a period of considerable change. The mass electrification of vehicles is an immediate prospect while further ahead, there is likely to be an autonomous vehicle revolution. The more complex vehicles become, the more expensive they are, and this could change our current ownership model. In conjunction with this, the development of digital technology has the potential in the long term to increase opportunities to live and work outside of large conurbations and reduce commuting.

2. Scotland is ahead of the rest of the UK in aiming for a 2032 deadline on which to phase out sales of new petrol and diesel vehicles; the most likely outcome being a mass uptake of electric vehicles. This will be an energy transformation as much as a transport one, with a huge change in behaviour as vehicles charge-up during the evenings and at night-time, or in working hours. There will then need to be a flexible charging system to encourage charging in times of low demand (although this concept itself will have less relevance).

3. Scotland is behind the rest of the UK in the development of autonomous vehicles (AV) technology. This revolution is likely to happen in stages with passenger AVs decades away. However, it is possible within a few years to envisage night-time convoys of autonomous goods vehicles which could free up motor-ways or, to have AVs operating in closed environments such as ports and airports. Scotland must ensure that the 5G enabling technology behind this revolution is in place.

4. The development of Mobility as a Service (MaaS), whereby multiple mobility and transport options will be accessed through a single MaaS offering will depend on encouraging the private and public sectors to come together to provide an end-to-end customer travel experience that delivers multi-modal transport choices within a seamless planning and payment ecosystem. Fast, efficient and reliable transport and digital infrastructures (particularly, an excellent mobile service) are needed for MaaS to work. The issue was examined in a detailed report published by IET in March 2019 entitled - Could Mobility as a Service solve our transport problems.
Time scale

Five years – The Scottish Government has already set up some pilot schemes for electric vehicles, but public investment will be needed for rapid charging points, particularly on long distance routes. The wide-spread provision of charging points, at home, at the work-place and along the streets is an immediate priority. If there is to be a hydrogen alternative within the transport sector in Scotland, it could be encouraged within specific sectors (e.g. bus fleets).

Thirty years – As we move towards a digitally transformed society, easy access to technology such as 5G has the capacity to significantly change current modes of working, increasing employment prospects in rural areas and small towns, with the potential to radically change current commuting patterns. In terms of Scottish regional planning this is potentially significant.

7.4 Energy

Scotland is a major energy producer and energy exporter in many forms. The use and conservation of energy will continue to be important as a variety of new technologies, ranging from data centres to blockchain, are very energy hungry. Some of the main features of our energy system include the following:

1. Electrical power systems are undergoing unprecedented and ever-increasing change that will increase the levels of complexity and uncertainty to significant levels.
2. The present trend towards green energy generation will continue. This is to be welcomed but care needs to be taken that the Electricity Grid will not become less resilient as a result.
3. The recent closure of fossil-fuel power stations, together with the planned closure of Scotland’s nuclear power plants in the foreseeable future, will place new emphasis on the nation’s future energy resources.
4. The National Grid Electricity System Operator in its recently announced Zero Carbon 2025 plan is aiming for totally “clean” power within 6 years using smart digital systems to control the system in real time.
5. In 2018, the Scottish Energy Strategy set out two pathways – electricity and hydrogen. With an established electricity grid, the electricity route, in applications such as transport, has inherent momentum. If hydrogen is to achieve a significant presence, it needs to be supported.
6. At present hydrogen (aside from some pilot projects such as the new Western Isles Ferry) is not much evidence but has potential in that it can be distributed on an existing network and this has been done before (e.g. town gas was 50% hydrogen).
7. Hydrogen can be compressed locally for transport (like CNG now) and could better facilitate the “transition” away from internal combustion engines over the next decade.
**Time scale**

*Five years* – With the closure of high carbon emission generating plants, Scotland has already achieved impressive carbon reduction but there needs to be a focus on sectors such as transport and heat, so that further carbon reductions can be attained. Scotland needs to continue to invest in energy infrastructure in a variety of ways with: a major focus on energy conservation; the encouragement of “green” sources of power, particularly off-shore wind and; continued support for new sources of power (e.g. hydrogen, marine energy, geothermal). While striving for a mix of power generation sources, attention must also be paid to management issues as a significant overhaul is needed to run a complex system incorporating a wide spectrum of sources from large offshore wind farms to household solar panels.

*Thirty years* – In the past, power was generated by a small number of large scale plants, under the control of a system operator. The future grid may be very different with the development of a two-way system with millions of intermittent small energy sources (not under the control of the system operator) connected to the electricity distribution system. Future demands from: electric vehicles, heat pumps, HVDC interconnectors, “smart grids” and associated control systems, will all act to increase the complexity and unpredictability of this system. Understanding the changing nature of system dynamics is fundamental to addressing the potentially catastrophic risks of grid failure. Reducing these risks will require a mix of initiatives including enhanced monitoring, control, automation and special protection schemes.

### 7.5 Communications

A communications revolution is taking place which has the capacity to change radically how we live and work. In Scotland, with a low population density and significant geographical challenges, there are areas which still do not have 4G access. The Scottish Government is investing up to £25m in a 4G Infill Programme to address “notspot” problems, although masts will only be built where at least one provider has committed to deliver services from each site. The UK Government via its *Universal Services Obligation (USO)* and the Scottish Government via the R100 programme both aim for broadband coverage to the most remote areas. Meanwhile a 5G revolution is in prospect. Some aspects which need to be considered include:

1. 5G can provide speeds up to 20 times faster than current 4G technology. It will be a key enabling technology allowing new technologies such as *augmented reality* and the optimisation of traffic management systems. Poor coverage can mean that rural areas, which have the most to gain from new digital services such as *telehealth*, have the poorest connections.
2. The [2018 Digital Connectivity in Scotland report](https://www.gov.scot公开) from the Scottish Affairs Committee in Westminster noted “intense political disagreements between the
UK and Scottish Governments on the roll-out of broadband in Scotland”. This was noted as a cause of concern.

3. In the short term, there must be continued commitment towards both universal broadband coverage as well as investment in full fibre. While UK Government funding for full-fibre investment, particularly through the national rollout of the Gigabit Voucher Scheme is welcome, it must be questioned how this will operate in Scotland. The fact that half of the total value in a bid under the Gigabit Voucher Scheme must come from vouchers given to businesses rather than residents is a major concern to large areas of Scotland’s lightly populated rural hinterland.

4. Technology such as 5G will be an enabler of radical change from autonomous vehicles to telemedicine. This technology will be the driving engine behind the machine to machine communication of the Internet of Things (IoT). However, 5G, if not implemented properly, will serve to reinforce the urban/rural divide.

5. The benefits of improved connectivity to rural areas are significant (enabling remote working, improved access to markets/suppliers, increased data storage capacity, enhanced security and more business flexibility). More information is available on this in the joint report produced last year by the Scottish Rural College and Rural England CIC.

6. The recent IET publication 5G Further,Faster suggests that a new approach to the way in which radio spectrum is allocated in the UK is urgently needed. The IET point out that the Ofcom consultation attached to the release of the 700 MHz spectrum will achieve only 76% geographical coverage of Scotland. The IET states that “securing any extent of 5G coverage outside of urban Britain will be one of great policy challenges for government, regulator and industry”.

7. While 5G is being currently tested in Edinburgh and Glasgow (with funding from commercial providers); the regulation of telecommunications is reserved for Westminster (i.e. regulated by Ofcom). However, the Scottish Government Programme of Government 2018-19 promises that it will develop a 5G strategy.

Time scale

Five years – particularly for rural areas, mobile coverage is already inadequate. Mobile phone operators have barely completed the rollout of 4G and large percentages of the population only have access to 4G from one operator. It can be argued that as an initial step, the adoption of a roaming strategy (as suggested by some Scottish MPs at Westminster) may be a good initial step. 5G networks will enhance many services including health and social care services, future hands-free farming and industrial automation. In effect it is an area of shared responsibility as planning applications in relation to infrastructure (such as masts) are a local matter.

It is encouraging that trials of 5G in rural areas are already underway. Lesson learnt from the 5G Rural First test bed and trials need to be carefully examined. This initiative led by Cisco with the University of Strathclyde as a lead partner features trials on Orkney. The new Scottish Infrastructure Commission needs to assemble and collate information in relation to the deployment of 5G in Scotland so that the country can leverage this key enabling technology to its best advantage.
Thirty years – In thirty years’ time, 5G will be well established. We are likely to be on
the cusp of other new satellite-based technologies for which Scotland’s unique
landscape and population distribution may be singularly appropriate. In this context,
the establishment in 2018 of Space Hub Sutherland is particularly significant. This is
an example of a small scale £17m public investment working with other partners
(Lockheed Martin and Orbex) which has the potential to produce major results for the
broader Scottish economy in the 21st century.

8. The Future

8.1 The Scottish Infrastructure Investment Plan 2015 recognised that while nationally
planned infrastructure attracts business investment and stimulates economic activity
this plan also acknowledged that small scale local interventions to our infrastructure
networks can, together, make a nationally significant contribution to supporting
economic growth and tackling inequalities. Improved cyber security awareness and
enhanced resilience will not be achieved via a “top down” approach. These issues
must be tackled at a local level and within smaller organizations.

8.2 Technology does not operate in a vacuum. The organisational framework is also
very important. Lessons from abroad, particularly from smaller countries such as
Estonia (e.g. the X road project) in respect to digital transformation can provide
useful lessons. The “whole-of-government” digital licensing platform being developed
by Singapore is something else worth examining.

8.3 Looking ahead, infrastructure will have to be viewed not just in a national but also
in an international context. Electricity inter-connectors, data centres based abroad
and even satellites based in space will have to considered in the context of how they
relate to Scottish infrastructure. In the inter-connected world which is emerging,
these installations can also be viewed as Scottish infrastructure.

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