The Digital Lottery: The Impact of Next Generation Broadband on Rural Micro Businesses in the North East of Scotland

1 Abstract

Reporting on a study in the North East of Scotland, this paper presents the impact on rural micro businesses of public policy-led next generation broadband (NGB) upgrades to broadband infrastructure. Two major strands of research are presented, digital connectivity and micro business development. Examining digital connectivity, we conclude that digital divides can now feature five levels of inequity, which cannot be portrayed by existing spatial urban/rural classifications. Policy-led broadband programmes do not address local broadband disparities, fall short of addressing digital inequity issues, and often the most in need remain underserved by their broadband service. Examining micro businesses, this paper concludes that such businesses, regardless of their information and communications technology (ICT) skills and methods of exploitation, exhibit the same level of broadband need as their urban counterparts. Further, the rapid and exponential development of ICTs requiring at least an NGB connection is surpassing the ability of businesses to access a 'fit-for-purpose' broadband connection. It is evident that some rural settlements are becoming 'digital deserts'. However, contrary to being solely linked to one's proximity to population centres, this research demonstrates that lack of access to NGB can occur anywhere over 1.5km from an NGB fibre connection and is determined by proximity to the digital engineering infrastructure connectivity nodes, rather than proximity to urban centres. These digitally isolated spots may or may not be situated in densely populated urban areas. This finding suggests a need to rethink how we frame our perceptions of digital inequity at the territorial level as access to, and experience of, digital connectivity is restructured and organised as a result of NGB upgrade locations and the impact of technologies associated with the digital revolution. We recommend that in order to address these emerging digital disparities, interventions should adopt a co-production, multi stakeholder approach involving actors from community, policy and private sectors in order to realise place-based digital solutions.

2 Introduction

Alongside other infrastructure assets such as water and electricity (Skerrett *et al*, 2012), '*The internet is now an essential part of our lives and a critical element of the world economy …*' (OECD, 2016, no page). At a supranational level, access to a fast and reliable digital connection is regarded as essential in underpinning economic growth and resilience (EC, 2013, 2014; UN 2015). The advantages of this technology for businesses include greater access to markets, increased productivity and efficiencies, and growth (OECD, 2010; United Nations ITU (UN), 2019). These advantages are particularly emphasised for rural micro businesses, which often suffer from poor access to services and therefore experience barriers to market entry (Farrington et al, 2015; Philip et al, 2017; SRUC, 2018).

A 'fit-for-purpose' digital connection is considered a ubiquitous feature of contemporary business functionality. Despite much public investment in broadband (Asymmetric Digital Subscriber Lines (ADSL)) in the 1990's, market failure, particularly in rural areas, continues to be a stubborn issue, with many rural businesses still underserved by their digital connection (Malecki & Moriset, 2008; Philip et al, 2017; Riddleson & Singleton, 2014). In conjunction with these inequities, the need to remain in the forefront of the digital economy in a rapidly evolving and globally connected digitised world has led to numerous policy-led Next Generation Broadband (NGB) initiatives (UN ITU, 2019).

For the Developed North, (fibre) NGB is predominantly the technology of choice, many adopting the European Union definition of 30 Megabits per second (Mbps) download speeds as a de facto performance standard (UN, 2015, 2019). Commercial investment in NGB in the UK is most prominent in urban areas driven by population density and economies of scale. Due to market failure, rural areas, and therefore rural businesses, have seen little inroad to NGB infrastructure deployment, resulting in a greater 'digital divide' between the urban/rural and shallow and deep rural areas (Farrington *et al*, 2015). The relationship between business location and NGB access is posited as key in unravelling the complexities associated with ICT exploitation in rural micro businesses and benefits to business (Galloway et al, 2011; Salemink et al, 2017; Townsend et al, 2016).

Looking beyond spatial proximity, little contemporary literature contextualises the related impacts of skills, attributes and exploitation of innovative ICTs in rural micro businesses. By this we mean, moving beyond a homogenised view of this group (Galloway et al, 2011; Palmer-Abbs, 2017), whilst also contextualising the fast paced, transient ICT sector (Basu & Fernald, 2006; Booz and Co, 2012) in conjunction with a rapidly digitising society (Dutton & Blank, 2013). There is a gap in the literature which comprehensively updates our understanding of this complex and transient phenomena.

This paper presents key findings from an exploratory case study based in the North East of Scotland. The core aim of the study was to track changes to the broadband infrastructure during the policy-led NGB telecommunication network upgrades and examine the impact of these changes on rural micro businesses. By doing so, the intention was to offer greater insights to the digital inequity debate (Farrington *et al,* 2015; Philip *et al,* 2017; Salemink *et al*, 2017). For the purpose of this paper, the EU definition of micro businesses (10 or less employees) is adopted (OECD, 2005).

The study is presented as follows: Section 3 presents an overview of the digital inequity, rural business and associated ICT literature, while Section 4 reviews the outcome of the NGB programme and the impact of this on rural businesses and their associated ICT practices. Section 5 presents the new digital territories as a result of the NGB upgrades across the infrastructure, with specific analysis of rural micro businesses' digital experiences and subsequent growing urban/rural and rural/rural digital divides. Suggestions of how better to illustrate these territorial digital inequalities are presented, followed by concluding remarks.

3 Territorial Digital Divides and Digital Impairment in Rural Micro Businesses

3.1 Policy Interventions and Delivering NGB

Over 164 countries now have national broadband plans (NBP) (UN, 2019). Countries in the Global North are predominantly following a dual approach to upgrade their existing broadband infrastructure (Farrington *et al*, 2015). Fixed fibre upgrades are targeted for more densely populated areas and the use of alternative technologies (altnets) for the more difficult to reach areas (DCMS, 2011; Federal Communications Commission (FCC), 2010; Parliament of Australia, 2013; Williams *et al,* 2016) (see Appendix A Box 1 for a glossary of selected technical ICT terms used in this paper).

This deployment approach has been adopted by The United States, (American Recovery Investment Act (ARRA) ($2 Billion) and Universal Service Fund (USF) (FCC, 2010)); Australia (National Broadband Plan, 2010) (Parliament of Australia, 2013) and New Zealand (Ultra-Fast Broadband project, UN, 2015; New Zealand Ministry of Business Trade & Employment, 2015); and European Union (EU) member states ((NGB predominantly Fibre to the Cabinet (FTTC) (European Commission, 2015). These policy interventions have set a variety of targets, including universal speeds of 4 Mbps (United States), 80% coverage by Fibre to the Premise (FTTP) (New Zealand), 93% fixed NGB (FTTP) coverage of 100 Mbps (Australia), and 30 Mbps for all citizens by 2020 (EU) (ibid). As (then) an EU member, the UK government in partnership with the UK devolved governments (Scotland, Wales and Northern Ireland) committed to achieving 95% NGB coverage by premises by 2017 through the £530 Million Broadband UK (BDUK) intervention programme (Department of Culture, Media and Sport (DCMS), 2011; 2017; UK Government, 2017).

There is, however, a noticeable lesser commitment to rural areas supported by national rural extension funds. For instance, relevant rural commitments require only 5 Mbps coverage to 90% of premises (New Zealand) (UN, 2015), up to 12 -25 Mbps (Australia) (Parliament of Australia, 2013), or at least 2 Mbps (UK) (DCMS, 2011). However, such is the pace of change in digitization, that since the agreement of this procurement process (BDUK) (ibid) the UK Universal Obligation Agreement (UOA) recognise 10 Mbps as a minimum broadband capability (Ofcom, 2017).[1]

To meet the 'difficult to reach areas' the use of altnets is presumed by many to be a solution. The most prolific of these altnets is satellite; however, as technologies mature, wireless and 4G are starting to feature more widely (Williams *et al,* 2016). Whilst offering download speeds of up to 30 Mbps, satellite technology is greatly affected by latency issues and is generally regarded as an inferior technology to fixed fibre NGB (Europasat, 2016). For the

[1] *Decent broadband performance, is defined as 10 Mbps (download) and 1 Mbps (upload) and minimum standard of latency and contention and a data cap of at least 100GB per month under the Universal Agreement Obligation (Ofcom, 2017, p.23)).*

consumer, the high capital expenditure and running cost of satellite, when compared to fixed broadband services, also make this technology less appealing. Further, the deployment of satellite across rural areas incurs similar challenges observed with the fixed NGB upgrades (lack of infrastructure and poor market opportunities) (Farrington *et al,* 2015; Salemink *et al*, 2017). Whilst mobile network connections (3G, 4G) and the use of other technologies, such as dongles, are suggested in-place of fixed NGB, these suffer the same investment constraints and therefore are not a viable alternative nor replacement for fixed broadband services (Philips et al, 2017). Whilst an interesting additional set of technologies for 'on the move' or 'temporary' digital communications, these technologies remain in many people's eyes the poor cousin of the NGB capable technologies.

Despite these efforts to meet broadband requirements of individual and businesses in a transient digital market, the translation of the aforementioned NBPs into practical and deliverable targets at the premise level has been extremely variable at the intra national, regional and local level. This is predominantly due to the complexities which affect decision making at the delivery level on cost, performance and coverage grounds. As suspected previously, this is a particular handicap for deep rural areas (Farrington et al, 2015; Palmer-Abbs, 2017).

The dual approach illustrated by most of the NBPs, of fixed fibre NGB for more densely populated and connected localities and altnets for more difficult to reach areas, has been adopted by the devolved Scottish Government in delivering their NGB programme (2014-2017), which ran simultaneously with the Community Broadband Scheme (Highlands and Islands Enterprise (HIE), 2016; Scottish Government, 2013). Underpinned by the UK Government's BDUK programme, the £250 million Superfast Extension Programme (SEP) and other funding avenues (European Rural Development Funds (ERDF); Scottish Local Authority investment (HIE, 2012; Scottish Government, 2011, 2012)), the projects sought to deliver 90% NGB coverage of speeds between 40-80 Mbps by 2020, exceeding the minimum NGB EU indicator of 30 Mbps. These targets account for all NGB upgrades (commercial & public sector) in urban and rural areas. The initial target (2014-2017) would meet the UK BDUK target and associated deployment criteria (DCMS, 2011).

3.2 The Rural Digital Landscape

The urban-rural digital divide is typified by poor digital speeds, high costs and lack of access to wider networks, often described as the 'rural penalty' (Malecki, 2003). The condition of existing telecommunication infrastructure in these localities (long copper lines, bundling of lines, limited access points to core networks) is a significant challenge (fiscally and technically) when upgrading to (fixed) NGB relative to urban areas (Farrington *et al* 2015; Malecki & Moriset, 2008; Riddleson & Singleton, 2014). Performance is also greatly affected by internet service provider algorithms (limited data package movement), which significantly impairs broadband performance, particularly where 'digital bottlenecks' occur (Clark *et al,* 2014). Such challenges are a predominant feature in the most difficult to reach rural areas.

Whilst the existing and ongoing policy-led NGB interventions are welcomed, concerns have been voiced that such approaches, as with the deployment of ADSL broadband, may fail to overcome deeply entrenched digital divides (Farrington *et al,* 2015; Salemink *et al,* 2018). For example, despite upgrades to the digital infrastructure, Ofcom report (2017) that whilst 91% of properties in the UK have NGB (92% achieving the 24 Mbps the UK Government's definition) the most underserved areas are predominantly found in rural areas (66% coverage). In addition, almost half of the UK rural properties that could not access the UK basic UOA of 10 Mbps were actually connected to fibre optic upgraded cabinets, albeit via long local copper network connections (Ofcom, 2017. Fig 19). Of these, the worst affected nations remain Scotland and Northern Ireland, with 27% and 23% of premises, respectively, unable to access sufficient broadband speeds (ibid, p.23). As noted by Philip et al (2017), these figures translate to much lesser capabilities on average across rural areas at sub regional levels (deep and shallow rural areas). With 10 Mbps defined as a fundamental human right for UK businesses and homes in March 2018 (Ofcom, 2018), the minimum performance targets of the BDUK programme works) were obsolete by project end.

There is much debate as to what the best approach (technical and fiscal) is in overcoming these challenges as NGB upgrades progress. Policy-led centralised approaches have been criticized for their inability to address deep and localised rural broadband issues (Farrington *et al,* 2015; Philip *et al,* 2017), whilst community-based approaches are epitomised by an overreliance on the citizen and volunteer 'burn-out' (Ashmore, 2015; Salemink et al, 2018). Many call for a collective approach (policy and community based) to addressing digital inequity, recognising the combined

power of indigenous knowledge (need and location of interventions) and state support (technical and fiscal) in developing a participatory customised rural approach (Salemink et al, 2018).

3.3 Defining Territorial Digital Divides with Context and Clarity

Since the introduction of dial-up and then ADSL broadband (1990-2000s), rural digital inequity has been well-documented. The potential to receive NGB in rural areas has injected a new vibrancy to this debate. To date, many authors have focused on the complex nuances of digital accessibility and the opportunities and challenges this presents for rural businesses practices and associated ICT exploitation.

In response to the complexity of the subject, academic research approaches have developed to better represent the nuanced phenomena. Early approaches included a focus on spatial issues (Grimes, 2003; La Rose *et al,* 2007; Riddleson and Singleton, 2014); rural small business (Galloway *et al,* 2011; Malecki, 2003); e-commerce (Chong, 2008; Zhu & Kraemer, 2006); and Information systems (IT) approaches (Thong & Yap, 1995). As alluded to previously, the current narrative more richly embeds these complex dynamics within a single study (Ashmore, 2015; Farrington *et al*, 2015; Philip *et al*, 2017; Townsend *et al,* 2016), expressing spatial digital divides through descriptions which encompass urban/rural accessibility classifications (Department for Environment, Food & Rural Affairs (DEFRA) or Scottish Government classifications).

However, at a multi-national level there are limitations to using this approach (Farrington *et al*, 2015). Urban/rural settlement classifications vary from nation to nation, based respectively on specific political, social, economic and geographical characteristics (Philip *et al,* 2017). For example, in the UK, England and Wales adopt the Department for Environment, Food and Rural Affairs (DEFRA) definitions, whereas Scotland applies the Scottish Government Urban/Rural (six or eight-fold) classifications (UK Government, 2013; Scottish Government, 2018). In their *Technical Report of Rural Internet Use in the UK*, Farrington *et al* (2015) introduced the terms Urban, Shallow Rural and Deep Rural to overcome cross national variations (England and Wales and Scotland) in Urban/Rural Classifications. The narrative conveyed differing digital connectivity performance across these geographies, widening our idea of how and where opposing digital experiences occur. Philip *et al* (2017) apply this approach again in their related paper "*The digital divide: Patterns, policy, and scenarios for connecting the 'final few' in rural communities across Great Britain*" contextualising the OfCom post code broadband data. This approach supported a more localised 'finer grained analysis' at the sub post code level (ibid, p.389) of settlement density patterns and the associated accessibility to commercial NGB in rural areas. In their findings (Ibid), those in deep rural areas are the most digitally disadvantaged due to their peripherality, dispersed nature, and therefore the ability to access the infrastructure capable of delivering NGB performance. However, analysis should go further to unpick the 'lived experience' of those in deep rural areas, particularly at the sub regional level, as larger mixed areas which include deep rural and considerable urban settlement and associated broadband data, often mask accurate accounts of deep rural broadband performances (Philips et al, 2017). There is reason to believe, such is the complexity of the contemporary digital ecosystem, that an updated portrayal of the phenomena in rural studies is required based at the premise level, on place-based studies (Galloway *et al,* 2011; LaRose *et al,* 2014; Palmer-Abbs, 2017, Philips & Williams, 2019). Salemink *et al* (2017) suggest that this work should include interdisciplinary literature to fully address these issues.

3.4 Location

The digital inclusion literature identifies a need to establish a more comprehensive understanding of why and how rural businesses select their locations, specific relationships they have with these spaces, and how this affects their ability to access a reliable digital connection (Galloway *et al,* 2011; Philip & Williams, 2019; Salemink *et al,* 2018). Galloway *et al* (2011) criticise the UK digital policy interventions for a 'one brush fits all' approach to rural business ICT support, stating that these approaches do not recognise the diversity and related needs of this group. There are those who suggest rural businesses should find other means to access suitable broadband for their business (relocate or pay for alternative solutions). However, it is argued that if broadband is considered a public service then equitable access and cost should be available to all regardless of their location (Skerrett *et al,* 2012). Whilst recent studies explored community NGB deployment, accessibility and technology performance, more work is required to fully understand the implications of rural business location (Lacohee & Phippen, 2011, 2015; Salemink *et al*, 2017, 2018; Townsend *et al,* 2016). There are few studies which comprehensively analyse the contemporary digital footprint in these areas after the BDUK related NGB deployments (Galloway *et al,* 2011; Grimes, 2003; 2007; Philip et

al, 2017). In light of this, it seems pertinent to undertake studies at the sub-post code, place-based level, specifically in rural areas capturing the new digital landscape and re-evaluating this in the rural context.

3.5 Business Characteristics and Practices

The importance of a 'fit for purpose' digital connection in rural areas, particularly in the most peripheral communities, is said to offset the negativities associated with these locations such as poor infrastructure, low access to services and limited economic activity (Philip & Williams, 2019; Salemink et al, 2017; SRUC, 2018;). For Small and Medium Enterprises (SMEs), who are considered the backbone of most nations' economic growth and innovation (EC,2017; Finke & Bosworth, 2016), accessing NGB is pivotal in supporting them to achieve their full potential (EU, 2014; OECD, 2010; Scottish Government, 2013). In the Scottish business community, rural micro businesses are believed to benefit significantly from NGB, potentially '*generating an additional £9.4bn in annual business turnover*' for the national economy through the realisation of greater digital accessibility (SRUC, 2018).

Present views of contemporary rural businesses illustrate that they are as variable as urban businesses in their type, practices and functionality (Bosworth *et al*, 2018; Finke & Bosworth, 2016), recognising that rural economies are less agrarian based than initially perceived (Halfacree, 2007; Woods *et al,* 2010; 2011). However, that should not detract from the 'ruralness' of their activities, as highlighted by Bosworth *et al* (2018). Despite adopting what could be understood to be urban activities (office based, customer facing, etc) these businesses have an intrinsic link between identity and locality and their rural credentials e.g. 'identify with rural', 'serve the rural', 'draw from rural assets', or are located 'in the rural'. In their review of rural English businesses, they (ibid) talk of the rural gentrification of products and marketing, the use of tacit knowledge (based on plastic production and use in agriculture) for culinary products (Lakeland Plastics), and estate management services derived from farm management skills; however, explicit discussion of businesses digital practices (connection and ICT exploitation) is scant. The use of contemporary data-rich ICTs, the limitations and impact of rural businesses' digital connectivity in exploiting these (predominantly pre NGB), and the impact this has on responding to internal and external business demands are discussed in the following sections.

3.6 Business Characteristics and Internal ICT Needs

There is reason to believe that the positive adoption of NGB and associated ICTs is a product of business and management practices and the types of ICTs employed within these organisations. In an age of rapid digitisation there is no plausible reason why a rural business requires a lesser digital connection capability than an urban business (Palmer-Abbs, 2017; Salemink, 2016). Contemporary ICT applications extend across a plethora of products, services and systems (Gupta *et al,* 2013) and are now seen as a ubiquitous part of business practice (Oxford Economics, 2011). Many ICTs are now based and run on third-party systems (e.g. Software as a Service (SaaS), Platform as a Service (PaaS)) (Gupta *et al,* 2013), completely altering the user's access and experience of ICTs. For instance, simple ICTs such as the Microsoft Office package (Excel, Word, Access) now operate online, constantly running background checks and updates (Palmer-Abbs, 2017).

As with previous studies undertaken during ADSL broadband upgrades, it is likely that the most significant variables affecting NGB and associated ICT exploitation in rural micro businesses are internal and external factors. Due to the size of these entities, often two employees or less, key variables are known to particularly affect adoption and exploitation rates of ICTs. These are the Business Executives' (BE) attitude towards technology adoption and business innovation (Thong & Yap, 1995; Tornatzky & Fleischer, 1990) when a degree of usefulness is observed (Legris et al, 2003); ICT prowess and business knowledge (Jones *et al,* 2011; Palmer-Abbs, 2017; Raisanen & Tuovinen, 2020; Zhu et al, 2003, 2006); and Communication Choices (Aquila-Obra *et al*, 2006; Simmons *et al,* 2011). For example, Volery et al (2015) links BE characteristics with their entrepreneurial agility in managing multifaceted decisions associated with business development and digitisation. Simmons et al (2011) see communication choices as integral to the BE experiences and preferences and key to the blending of existing and new digital communication strategies in business development. However, without the knowledge and expertise to exploit ICTs at the BE and organisational level, little impact can be expected from adopting ICTs (Raisanen & Tuovinen, 2020; Salemink et al, 2017). There is a complexity to this multifaceted milieu of internal business factors which affects the effective

digitisation of rural business activities, one which is intertwined with digital connectivity and the business environment within which these entities operate.

3.7 Environmental Context: External Pressures and meeting ICT demands

The environmental context is described as the setting within which business conducts its work: its industry, competitors, access to resources supplied by others, and dealings with governance (Tornatzky & Fleischer, 1990). As complex ICTs become a ubiquitous feature of everyday business life, the literature suggests that the most poignant of external pressures felt by rural micro businesses are likely to be those from customers, large organisations and business (Chong, 2008; Simmons *et al*, 2011).

Digitally aware customers (public, private, individuals, organisations) now exhibit a multitude of needs and expectations, from a plethora of complex ICT communication tools (Oxford Economics, 2011; Zhu *et al,* 2006). For example, pressure is often felt from larger, better connected organisations (public & private) who often have well developed ICT systems (Management software, media file exchanges, digital tax returns), which small businesses are duty bound to use (Townsend *et al*, 2016; Zhu *et al*, 2006).

The competitive pressure as a consequence of improved digital accessibility could be both advantageous (in terms of opening up markets and business growth) and challenging (increasing global competition) for rural businesses (Galloway *et al,* 2011). Regardless of an industry's characteristics (e.g. innovation tendencies, communication practices and behaviours), few remain untouched by digitisation (Oxford Economics, 2011) and there is a need to contextualise these pressures against the backdrop of a fast paced and transient global digital society. Once a digital world leader, the Global North (Graham *et al*, 2014) now needs to look towards new digitally dominant countries e.g. China and new emerging nations in the Global South (Graham *et al,* 2014; UN, 2019). It is these players, and their customers, who will shape innovative digital technologies in the future and therefore the performance requirements of contemporary broadband infrastructure and associated business transactions (Graham *et al*, 2014; Oxford Economics, 2011; United Nations, 2019). Further research is necessary to understand the true value, or impact of a competitive NGB service, in rural micro businesses in conjunction with these developments (Raisanen and Tuovinen, 2020; Farrington *et al,* 2015).

This paper seeks to address the gaps in the literature which explicitly track and explore the deployment, accessibility, and impact of NGB on rural micro businesses; the decision processes associated with business location and their practices (business & ICTs); and the impact thereof of NGB on this business cohort.

4 The Approach

4.1 Methodology

The research reported here was conducted through a mixed method longitudinal study over a three-year period (2014-2016) with the Business Executives (BE) of rural micro businesses. This pragmatic approach (Teddlie & Tashakkori, 1990) was adopted for its ability to interrogate, at varying intervals, the specific phenomena, applying the most appropriate method to the stage of the research. It offered a means to gain an in-depth understanding of the participants and track change over time (technical deployment of NGB and user experiences). This method offers both a means to verify and generate theory, offering a synergy in the pursuit of the research questions (Bryman, 2004; Teddlie & Tashakkori, 1990;).

Early discussions with various groups (Local Authorities & Regional Development Agencies, Federation for Small Businesses (FSB)) concluded that no comprehensive publicly available database or list of businesses was available (2014). Discussions with Companies House and a review of Office of National Statistics (ONS)(2012) data revealed that only VAT registered businesses' details were accessible via Companies House records and therefore this list would not include the smallest business, often non VAT registered (incomes exceeding £73,000). To ensure inclusion of these business, the Companies House (VAT registered) business list for the study area was supplemented by businesses listed in the British Telecom Telephone Book. Key sector businesses (largest contributors to regional GDP & those identified as growth sectors) were included in the research database (Palmer-Abbs, 2017). Conversations with Local Authority Development Managers identified that initial postal surveys would be the best survey methodology due to limited online activity at the household level where micro businesses may be located. A

stratified random selection of businesses (Bryman, 2004; Creswell, 2003) was taken from the research database, based on the Office of National Statistics UK Standardisation Industrial Classification of Economic Activity 2007 (ONS SIC, 2007; Scottish Government, 2013). A Three Stage approach was adopted as follows:

Stage of research	Method adopted	Objective
Stage 1	Baseline Postal Survey	*Establish a baseline of business activities, ICT knowledge, use and perceptions on the impact of NGB.*
Stage 2	Open Interviews with key actors in BDUK roll out programme	*Elicit opinions, knowledge and expectations of BDUK programme from actors involved in the delivery of NGB.*
Stage 3 Part B	Early semi -structured interviews	*To elucidate an in-depth understanding of business characteristics, the influences thereof on ICT use, and digital connectivity experiences and needs.*
Stage 3 Part A	Longitudinal Panel Survey (Wave 1-5)	*Drawing from the Stage 1 & 2 findings design a survey instrument to track changes in NGB deployment and business ICT perspectives, attitudes, behaviour and impact of NGB*
Stage 3 Part B	Late semi -structured interviews	*To explore the impact of the NGB deployment on businesses and embed findings with the Longitudinal Panel Survey results enriching the understanding of the phenomena*

Table 1 Research Stages, associated methods and objectives

The Stage 1 Baseline Survey (BLS) sample included a cross spectrum of businesses (sector, location and associated broadband performance, business size, age, stage, market orientation VAT/PAYE registration, from a varied geographical base (e.g. close to towns, in villages and in isolated areas)). A total of 1,500 postal survey questionnaires were distributed with 127 usable responses (13% response rate: typical for this type of survey) (Ilbery*, et al,* 1995; Smallbone *et al,* 2012). Businesses invited to take part in this early survey were asked to continue with Stage 3 of the research, 63 businesses agreed to continue, representing similar characteristics to those in the Baseline Study.

Stage 3 Semi-structured (early and late stage) interview participants (n = 21) were purposefully selected (Bryman, 2004) from these businesses ensuring representation of a variety of locations, NGB accessibility, VAT registration types, business types and ICT skills. The business Longitudinal Panel Survey (n = 63) consisted of five identical quarterly surveys (closed and open questions) designed to be able to capture changes (Likert scale 1-5) over time of the ICT-related business practices. This included OOKLA speedtest (speed, latency) to assess businesses broadband performance and related impacts on business functionality. This test was deemed the most accurate of all those available (Bauer & Clark, 2010). Surveys were distributed in multiple ways to ensure inclusivity (postal paper and online surveys (Lime Survey software)).

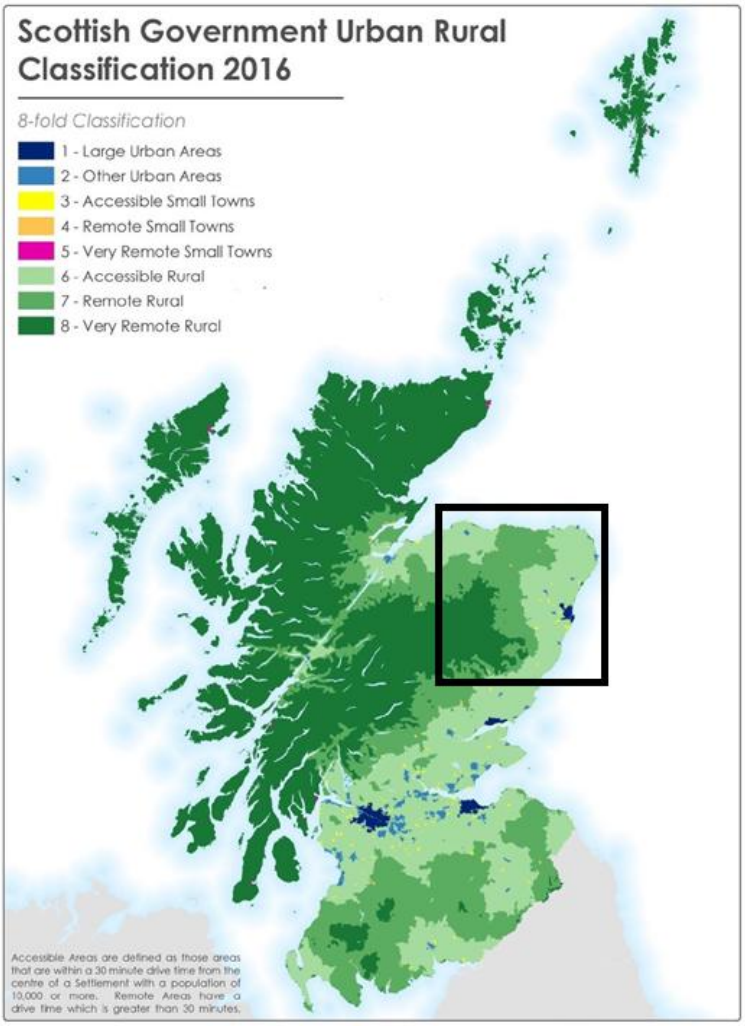
The Baseline Survey findings were analysed (descriptive and Pearson x^2 test of association) using Statistical Package for the Social Sciences (SPSS v 23) and in tandem with the Stage 2 face-to-face interviews, findings were thematically grouped and used to develop the Stage 3 design. The Stage 3 face-to-face interviews were predominantly conducted in a workplace office or coffee shop. These were electronically recorded, scripted and then thematically analysed using NVivo software and NodeXL. The Stage 3 Survey results for each business were triangulated using Microsoft Excel to establish changes in business opinions, digital needs and usage, NGB access and broadband performance. Qualitative thematic analysis was applied to the data to enable triangulation of the findings from each stage of the research (Cresswell & Plano-Clark, 2007; Teddlie & Tashakkori, 2009).

While the wider research project investigated a number of research questions, this paper presents findings from the following three questions: RQ 1. *What is the relationship with, and impact of, placed based locations for rural micro businesses and their associated ICT needs?* RQ 2. *What are the outcomes 'in practice' of the policy-led up-grades to the NGB infrastructure on rural micro businesses?* and RQ 3. *How has this affected their ability to access a 'fit for purpose' digital connection?*

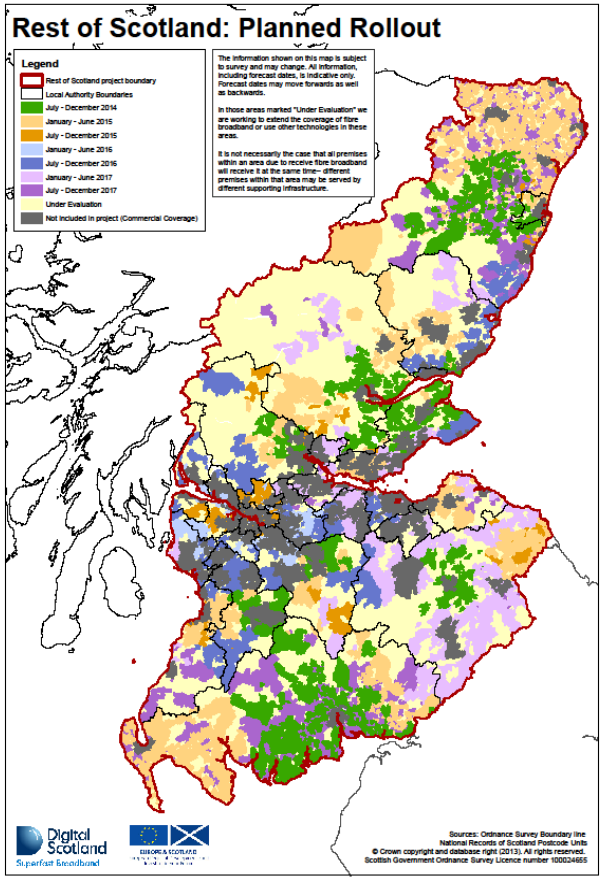
4.2 Longitudinal Study Area & NGB Deployment Method

4.2.1 Longitudinal Study Area

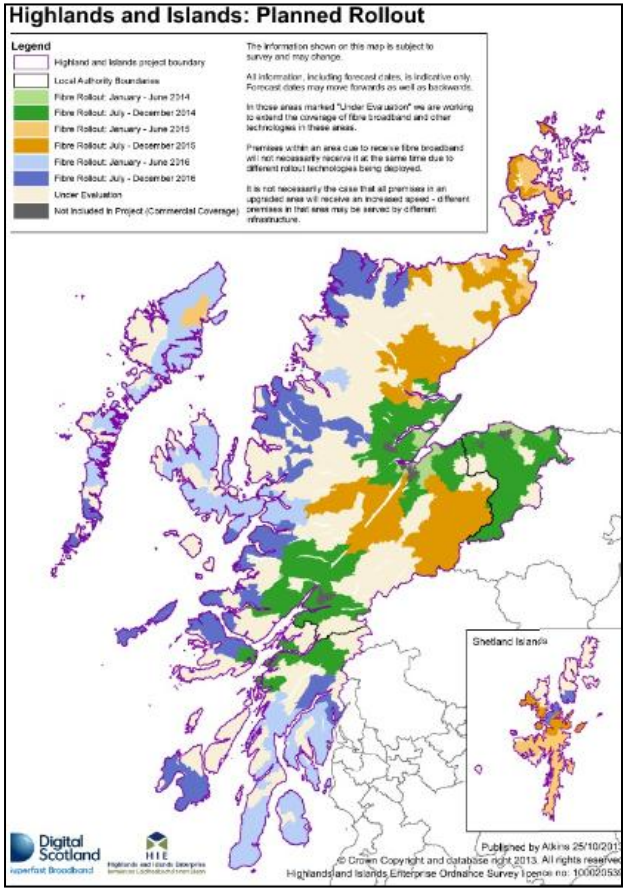
The North East of Scotland was selected for this longitudinal study due to the rural characteristics (geography & business) (Bosworth *et al,* 2018) and corresponding digital inequity issues (Philip *et al,* 2017). At the onset of this research (2014), 78% of UK premises had fibre optic coverage, with a predominance of this in urban areas (72% by post code area) (Philip *et al*, 2017). The most remote areas of the UK, such as the North East and Highlands and Islands of Scotland, were known to be some of the most digitally underserved areas in the UK, with many premises receiving broadband speeds well below the aforementioned UK Broadband UOA (HIE, 2012; Independent, 2015).



Map 4-1: *Source:* Scottish Government: Urban / Rural 8-fold Classification Map of Scotland: Insert: The North East of Scotland



Map 4-2 Source: Digital Scotland (2014): NGB Deployment: Rest of Scotland



Map 4-3 Source: Digital Scotland (2014): NGB deployment: Highlands and Islands

The Digital Scotland Post Code Maps (Maps 3 and 4) indicate the predicted timeframes for fibre upgrades to exchange areas between 2013 – 2018 (Scottish Government, 2018)[2]. Areas closest to urban settlements received the earliest connections (2014), while the more difficult to reach areas were predicted to receive upgrades by 2017/18. The spatial units for the upgrades are post code identified, which are not indicative of blanket coverage. The public procurement contracts (Highlands and Islands (H &I) & Scotland (rest)) required a minimum fibre coverage by post code area of 75% with fibre, targeting the EU designated 'white areas' (DCMS, 2011). This target accounted for both commercial coverage and additional public investment areas. In the Highlands and Islands region an 'outward in' approach was adopted, whilst in Aberdeenshire, an 'inward out' approach was undertaken. Both regions had geographies which formed the North East of Scotland study area of this research (Moray & Aberdeenshire).

The deployment of the NGB upgrades to the existing broadband infrastructure networks (i.e. DSL, ADSL, and ADSL2+lines) include a range of network arrangements e.g. Fibre to the Cabinet (FTTC), Fibre to the Premise (FTTP), Fibre to the Exchange (FTTX) with the 'last mile' connected via the local DSL (copper cable) broadband network (BT, 2016; DCMS, 2011; Digital Scotland, 2014; HIE, 2012). There is a minimum viable distance (800m-1.5km) to maintain full NGB performance, after which point outputs can dip below that of a good ADSL connection (24 Mbps D/L) (Grubesic & Murray, 2000).

5 Key Findings: Analysis and Discussion

5.1 RQ 1. *What is the relationship with, and impact of, placed based locations for rural micro businesses and their associated ICT needs?*

This research revealed that in addition to technical and fiscal constraints, those responsible for delivery of the BDUK programme had differing opinions as to how the policy investment should be orchestrated. This contributed to the disparities felt by rural communities at the end of the BDUK programme. For example, decisions of where deployment would occur were based on the triangulation of three factors (technical feasibility, whole cost, and number of properties upgraded), and areas offering the best Value for Money (VFM) being selected. The technical delivery team (BT PLC) were tasked to provide NGB to properties up to a cost of £1,500 per premise. Properties whose connection upgrade exceeded this cost were referred to the Local Authority (LA) or Development Agency (DA) whereby investment decisions were based on the public sector VFM procedure. Variations in key priorities were evident at a regional and national level and this generated differing interpretations of the deployment criteria. Some agents involved in the NGB deployment sought targets of 24 Mbps (download) (the upper performance level of ADSL broadband). Others felt that the primary objective was to future proof the current broadband infrastructure by maximising fibre NGB across the network, to enable NGB capabilities in non-served areas (e.g. 30 Mbps) during subsequent upgrades.

5.1.1 Business Location and Digital Connectivity

Drawing from the Stage 2 interviews, most BEs confirmed that they had a specific and integral relationship with their location. Many of the businesses owned and/or operated from premises in, or adjacent to, their homes or were located in the communities they served. These relationships were considered an integral part of the businesses and had been for many years, with relocation considered difficult or, in some cases, impossible. As illustrated by business 4 (local garage): *'We've been here for fifteen years now - MOTs, servicing and repairs is the main business…'.* Community related businesses included those involving repairs, sales and servicing (MOT garages), agricultural machinery, professional industries (veterinary practice), retail (florist shops), and hospitality (bistro, accommodation). Businesses who owned and operated from their premises (offices, homes, business operational buildings) ranged from international business consultants to farmers who had diversified into multiple new entities (up to five business lines). These choices were predominantly based on a multitude of business decisions (e.g. reducing overheads for business start-ups, exploiting rural assets and business opportunities) (Bosworth *et al,* 2018). For example, Business 13, an international business consultant, offered a clear and measured decision to locate in their current business location: *'The factor of locating here was accessibility to work, the central belt, the isles and the airport and now running a consultancy business from here. '*

[2] These areas are indicative and subject to change depending on further ground surveys

For many, broadband services were sufficient for their business needs at the time that these choices were made. Due to poor rural digital connectivity, many have since reconsidered their broadband situation and, despite NGB being a necessity for business, moving is considered an unrealistic business option due to the integral relationship they have with their location. For example, Business 15, who operated multiple businesses (farm, leisure facilities and shop, holiday rentals and HR consultancy) and whose rural assets were the basis of these business opportunities, felt that: *'Relocation is not an option for any of the businesses really. It's our home as well as our livelihood and has been for a long time…'.* Many interviewees operated multiple businesses from a single premise, in some cases multiple businesses were located across different sites.

These working arrangements often facilitated the needs of multiple businesses, run by members of a single household, and critical to household incomes: *'There's certainly a few businesses operating out of this little cabin, five in total.'* (BE 13 single site - multiple businesses).

These employment arrangements were not considered lifestyle choices, but a means of offsetting limited local employment opportunities (SRUC, 2018; Scottish Government, 2016). The functionality and management styles of these business replicated those of larger urban firms, such as multiple or departmental activities (e.g. marketing, sales, purchasing and production). Interviewees indicated a range of ICT (simple and complex) needs and business practices, the majority of which required on-demand access to a continuous and reliable broadband connection: *'The conjoined mixed veterinary practices work out of two centres (for about eight years now) from two existing businesses in two separate places.'* (BE 9 single business - multiple sites)

Many interviewees had considered alternative solutions for securing NGB, paying privately for fixed fibre NGB or a community satellite package. However, incurred costs were seen as prohibitive and time consuming. One interviewee had secured fixed NGB investment; however, due to significant initial costs (capital expenditure) this was only feasible with a government development grant, achieved due to the potential economic (regional) returns on the investment. Another interviewee, Business 1, who ran an electronic(e) business (pet products) had brokered an NGB Satellite deal between an Internet Service Provider (ISP) and eleven community colleagues (businesses and domestic); however, whilst initially appealing, this arrangement had proven to be too expensive and ineffective in the long term (due to running costs and technology reliability): *''I think you have to be prepared to put up £500-£800 but for us the installation was free (satellite) because there are eleven of us, we had to pay nothing for installation but we paid £189 each for hardware but the latency was an issue'.* Both latency issues (reliability of the broadband) and additional expenditures associated with purchasing further data packages to supplement capped monthly packages, proved too costly for many Satellite users.

5.1.2 Business exploitation of ICTs and perceptions of NGB

The Baseline Survey (BS) secured the business sector and geographical variations sought in the study (e.g. key income generators, growth sectors and peripheral and clustered settlements). Businesses exhibit a wide range and level of ICT experience and skills, exploiting a range of these technologies (basic to complex) in pursuit of their business objectives. Over half (n=116, 59%) of the BE's confirmed that they have had previous ICT experience, either work (large organisations (21.5%), small organisations (19.8%) or non-work (17.4%)); 19% felt they had a little non-work ICT knowledge. Over half (n=115, 54.7%) of businesses felt their broadband speed was wholly inadequate to meet their business practices; however, two thirds (n= 116, 66.3%) felt their broadband reliability was adequate. Office based OOKLA tests indicated broadband performances ranged from less than 2 Mbps to 80 Mbps (n=101 (<5 Mbps, 33%; 6 to < 10 Mbps, 35.3%; 10 to <24 Mbps, 26.5%; >24 Mbps, 2.9%) (download) with the majority of recorded upload speeds (n=98, 95%) up to 5 Mbps.

In keeping with previous findings (Palmer-Abbs, 2017; Salemink et al, 2018), many businesses had difficulties using data rich ICTs which employ simultaneous and multiple uploading/downloading large files to servers, such as Software as a Service (SaaS) and Service as a Platform (SaaP) services (Gupta et al, 2013). Businesses felt they would use these ICTs to a greater extent if NGB was available. Analysis using Pearson x^2 test of association confirmed a statistical significance (n=109, p= 0.003) between business executives' 'positive perceptions' of NGB and the importance of daily online business activity, upholding earlier views of a similar nature regarding ICT adoption during

ADSL technologies (Legris et al, 2003; Thong & Yap, 1995). There was no indication that BE's age, business size, type, market orientation, years in practice, time spent online, or intensity of ICT activity affected opinions.

Over three quarters (78%) of the businesses felt NGB would make a difference to their business growth; this was found to be 99% statistically significant, (n=61, x^2 = 9.4, df = 1, p = 0.002). A 99% (n=61, x^2 = 8.7, df = 1, p = 0.003) statistically significant advantage was acknowledged by the businesses in terms of accessing new markets or customers. 77% of businesses felt NGB adoption would save them time and money; again, a statistical significance was found (67, x^2=18.1, df =1, p = 0.001). NGB was seen to hold positive attributes for Business-to-Business (B2B) communication (n=65, x^2 =7, df 1, p=0.005), thus substantiating rural micro businesses' positive perceptions of NGB in the rural literature. Confirming that these opinions underpin proactive views towards innovation technology (Tornatzky & Fleischer, 1990) and when a degree of usefulness is observed by those in a position of authority (Legris et al, 2003). The findings also confirmed that NGB is viewed as an enabler in exploiting innovative ICTs (Volery et al, 2015), enhancing communications (Simmons et al, 2011) and business practices (Zhu *et al,* 2003; 2006), and increasing businesses productivity and growth (OECD, 2010; 2012; Oxford Economics, 2011).

5.2 The Impact of NGB Upgrades on Rural Micro Businesses

5.2.1 RQ 2. *What are the outcomes 'in practice' of the policy-led NGB infrastructure upgrades on rural micro businesses?*

5.2.1.1 Deployment Outcomes for the Businesses

Few businesses in the study area received NGB by the end of the scheduled NGB roll out. The evidence points towards a deeper and growing range of digital inequalities. National and regional headline figures [e.g. NGB coverage (95% by premises (UK); 84% (Highlands and Islands); 93% (Moray); 76% (Aberdeenshire) (Regional Development Manager; Local Authority Digital Manager, 2016)][3] mask a growing digital divide between urban and rural areas, but most significantly, across rural areas.

Analysis of the BE interviews and LPS (quarterly interval surveys) established that the breakdown of headline broadband coverage figures (ibid) suggested many areas with existing good broadband coverage have excelled, whilst others, often in the most digitally remote areas, had made very little or no progress (For full description of attributable businesses characteristics, broadband perceptions and performance data see Appendix A, Table 2). The research indicated that previous issues associated with digital inequity (peripherality and an aged broadband infrastructure) were compounded by the technical approach adopted by the public sector, a predominance of FTTC upgrades, associated regional coverage of '75% by post code area', and the need to substantiate VFM for public spending. Many existing and underserved areas suffered the same consequences incurred by commercial NGB investment strategies (i.e. little or no investment). However, the results observed in this study differ from those previously discussed (Philip *et al*, 2017).

Three specific outcomes were identified as a result of NGB deployment methodologies. Businesses located near core road infrastructures and based in villages received NGB upgrades to their exchange, or cabinets. These businesses could be located in some of the most remote villages in the UK (e.g. Braemar). They were most likely to receive the earliest and optimal NGB upgrades (24-80 Mbps) due to close proximity to connecting nodes and therefore shorter local network connections (via existing copper lines (ADSL, ADSL2+)). For instance, Business 12 (multiple businesses: car services, yoga & sports, accommodation), based in a small coastal village on a key arterial road, had good ADSL broadband, receiving some of the earliest NGB upgrades via FTTC (late 2014) with top speeds of 70 Mbps: *'Yeah, it (ADSL) worked fine. I was surprised that fibre was available, I heard great things, so we decided that we would change to it.'*

Conversely, nearly all businesses located in areas significantly distanced from urban centres and whose communities were more dispersed did not receive NGB. These businesses exhibited the poorest broadband services, barely surpassing 'dial-up' service performances.

[3] *Coverage does not constitute next generation speed performance; some areas will have an improved service but remain under the 30 Mbps download speed figure.*

However, many businesses, despite their close proximity (within a few miles) to villages or towns and commercially served NGB exchanges, were on broadband services comparable to the remotest of rural locations. Business 3 (international business, mineral extraction, production and distribution) based a few miles from an NGB-enabled village received broadband services of less than 2 Mbps (D/L). In most cases the business were within a mile of NGB-served towns and, despite the fibre network tracking past the foot of their road (a few hundred metres away), access to NGB was not an option due to the technology infrastructure network configuration (Riddleson & Singleton, 2014). This issue is illustrated by Business 15 (farmer, retail & leisure, HR consultant, holiday lets), who stated: *'NGB comes close but it's in the nearest village and town. It goes straight past on the road up this way',* and BE 28 (Landscaping (Construction)) based just 1.5 miles from the NGB enabled exchange, who realised NGB may never be an option in their current location*: 'I cannot believe we still don't have NGB. I have been told that since we only have 8 houses on our postcode and how far we are from the exchange it is highly unlikely that we will ever get NGB. Hugely disappointing…'* Conversely, some businesses located in close proximity to large remote rural businesses (distilleries) were able to link with private commercial NGB upgrades.

By the end of the study, most businesses saw relocation, private investment, or just putting up with the consequences, as their only options, raising much on the subject of digital inequity and universally available NGB (Skerratt *et al,* 2013). However, unlike previous studies many of these businesses were not considered remote, island dwellers (Townsend *et al*, 2016) or those in deep remote rural areas (Farrington *et al,* 2015).

Some businesses sought upgrade options or changes to their exchange*: 'We have looked into other options i.e. Bonded internet, moving exchanges but this is considered impossible or this wouldn't increase our speeds by much*' BE 28. For others, relocation was the only option for business survival. For one business (anonymised), splitting operational and ICT rich business management activities between two sites was the only option. Though the new office was rented in the nearest town and did not receive NGB (17 Mbps (D/L)), a balance was struck between proximity to the (6.5 km away) operational site and the need for NGB. For others, relocating to access NGB was more viable as NGB-served regional development agency offices were available and suitable for the business needs. This impact of these evolving digital disparities and the implications for business practices is now presented.

5.2.2 RQ 3 *How has this NGB deployment affected businesses' ability to access a 'fit for purpose' digital connection?.*

5.2.2.1 Business Practices and ICT Functionality

Thematic triangulated analysis of the business interviews and LPS data revealed that many participating businesses exhibited complex ICT practices regardless of their origins, practices, sector or location. Businesses with complex ICT practices ranged from a bistro to an international aerospace consultancy business. Some of these businesses were often at the forefront of innovation in their field, constantly (proactively) looking for new ideas to maintain this market position. Others, commonly those less ICT skilled BE, were more reactive to market demands in their ICT adoption. Businesses with less complex ICT practices could still be innovative in their business practices, often adopting new ICTs and novel business relationships (local & national based associates) in furthering their business objectives. In this case they often selected more readily available ICTs. Many of the participating businesses worked with associates (local and international) often on a daily or hourly basis (Townsend et al, 2016), harnessing a multitude of skills and knowledge essential to their everyday practices. Some businesses were more proactive than others in seeking to upgrade to NGB, often a reflection of their ICT usage and/or the ramifications of their current broadband service on daily activities.

New NGB adopters with an avid ICT ambition excelled in their newfound connectivity, using SaaP and SaaS, often moving business relationships to overseas associates, widening markets and growing in multiple ways: *'Yeah, that is fine we can do anything now, all that cloud-based stuff used to be a nightmare (on satellite)…*' (BE 1).

Earlier NGB adopters (24-30 Mbps), using the service for over 14 months, and who had complex ICT management configurations were the most likely to outstrip this broadband capability by the end of the research period. These businesses now looked towards Ultra-Fast[4] broadband to maintain their digital competitiveness.

Others benefitted from NGB upgrades, such as fibre enabled broadband, and with complex ICT needs, exhausted this new broadband service within the first month: *'Yes, and we very quickly stepped into using it, uploading is still an issue, could it be better, Yes!' (*BE 13). Supporting the argument for an immediate minimum UOA performance level of 10 Mbps for all (OfCom, 2018) is essential alongside the development of a suitable 'road map' in securing the NGB obligations to 'the final few'.

Businesses still waiting for NGB upgrades, and whose (business and ICT) functionality remained impaired, were clearly frustrated and disillusioned that yet again they were left behind, lacking the ability to function in contemporary business arenas: *'It's just the same if not worse, cloud-based stuff take forever'* (BE 15).

*'At any one time I can have access and know exactly what I am selling or table orders on this app. Every month things become more difficult as technology moves further away from our basic (broadband) ability…' (*BE 11).

However, for most whose broadband performance met business and ICT needs (predominantly good ADSL broadband of 24 Mbps), little advantage was seen in adopting NGB if it cost more. Feedback from some businesses suggested that in certain areas the cost of NGB was actually cheaper than ADSL broadband ISP agreements, illustrating another emerging digital divide.

This nuanced outcome of the NGB upgrades for the participating businesses is reflected across all of their business activities. The multifaceted nature of these rural businesses (use of contemporary ICTs and the business (simple or complex) management ICT procedures), associated broadband requirements and the ability to 'work around' problems when they occurred was wide ranging. The results of these factors, and the impact of the NGB upgrades, was experienced differently across the businesses depending upon the immediate nature of the task and the functionality of the ICT at that specific moment.

5.2.3 Internal and External Communications

Many of the businesses felt their ICT related activities (internal & external communications) and associated business functionality and progression were affected negatively by the lack of NGB during the study period. Most businesses adopted a blended (offline & online) communication approach, depending on stage and type of the relationship under consideration and the nature of that communication (e.g. for some face-to face was more pertinent whilst for others web based interaction was first contact). The basic requirement of all communications methods was that they were effective, efficient and relationship building. Those worst affected by a lack of access to NGB felt their communications were impaired, often resulting in a damaged professional opinion of the business, or a deterioration in working relationships with external parties (customers, associates). An example is seen in the case of Technology Consultants whose Skype calls were significantly impaired: *'We have to be careful not to max it out, we still don't use video'* (BE 6). Similarly, a bistro owner (BE11) indicated her ability to manage the business remotely in the way she chose, using multiple and blended configurations of SaaP and SaaS apps (Square Register, XERO) via her mobile phone and iPad, was constantly impaired by lack of sufficient broadband access.

Conversely, those on NGB, particularly at the upper performance limits, excelled and forged new working relationships easily, often globally advantageous for the business, confirming views that greater and competitive broadband (in this case NGB) enables both user adoption and new ways of working (OECD, 2010; 2012; Oxford Economics, 2011).

5.2.4 Upskilling, Knowledge Exchange and Competitiveness

These kinds of impacts extended to the businesses' ability to maintain and build both their business and ICT related skills. For most, this was predominantly orchestrated online, through either formal training (Continued Professional Development (CPD)) or informal activities (YouTube tutorials, Googling information, online support via third parties).

[4] *Definitions: Super-Fast Broadband achieving download speeds of 30 Mbps or more; Ultra-Fast Broadband achieving download speeds of 100 Mbps or more (UK Department of Culture & Sport, 2011; Broadband.co.uk found at https://www.broadband.co.uk/guides/ultrafast-and-hyperfast-broadband/)*

Upskilling and development of expertise was also achieved through additional (regional and international) support networks (associates, consultants or new employees) again heavily reliant on a reliable digital connection. These activities were often 'real-time' in nature, with great importance placed on the ability to seamlessly blend new knowledge within everyday business practices (sharing of documents, online learning tools, searches or third-party software support). Again, those on the fastest broadband (high end performing ADSL & NGB) excelled in this respect, easily using innovative ICTs running on SaaS, PaaS and remote servers, whilst those on the poorer broadband confirmed an inability to complete various tasks. Whilst variances were evident in 'how' and 'what' businesses achieved in relation to their ICT competencies, and abilities to embed this within management practices, the level of importance placed on a suitable digital connection was no less between the participating businesses in the research. These outcomes, as noted, were significantly affecting the businesses' ability to develop their knowledge base (formal and tacit) both positively and negatively with associated ramifications on business performance (Raisaen & Tuovinen, 2020; Zhu et al, 2003, 2006).

Where broadband was conducive (NGB enabled & high-performance ADSL) to operating contemporary ICTs, businesses were content with their business productivity, growth and new ways of working. Where broadband fell below a suitable performance level, businesses felt that they ran the risk of losing their competitive edge, often having to foot the bill for lost time or additional costs associated with these shortcomings. BEs spoke of how their poor broadband affected their 'ability to trust' in their capability to effectively complete internal tasks and communicate externally to the business with their clients and customers. For the worst served business this was felt significantly: *'Without it [NGB], we feel will have a massive impact on the growth of our business'* (BE 28).

5.2.4.1 Current and Future Business Aspirations and Business Survival

Most businesses had a clear idea of their 'ideal futures' and how NGB could serve these ambitions. Regardless of ICT capabilities these aspirations either did, or would, encounter more complex ICTs such as Cloud Computing, Artificial Intelligence (AI), Big Data, Simulation, Internet of Things, Robotics, etc. Whilst some businesses were more aware of the functionality and immediate business opportunities these held, others who may have less understanding of these technologies, but were proactive in their business innovation, had clear visions of the opportunities that these could hold. For example, future use of innovative technologies was exemplified by BE 13, who saw that use of AI and real-time video ICTs could underpin new and exciting ways to deliver enhanced techniques to analyse sports performance and then remotely hold tutorials with international sports clients. The other end of the extreme was the use of communication or media software capabilities (live streaming of events, media, Skype) to improve Bed and Breakfasts and Holiday accommodation lets. Again, those digitally impaired businesses saw a reversal in many online activities*: 'A lot of time is lost trying to do online tasks, starting again or revert to the postal service again'* (BE 3).

Businesses were very aware of how the inability to use such ICTs effectively would affect many of their immediate business aspirations and aspects of business development (productive, business growth, new markets). Due to these factors, many participating businesses saw little future for their business if NGB was not secured, some seeking a Gigabit service (jumping a technology gap) in order to keep pace with urban counterparts.

5.3 Analysis and Discussion: Rethinking Rural Digital Accessibility

5.3.1 Contextualising NGB Upgrades to the Broadband Infrastructure

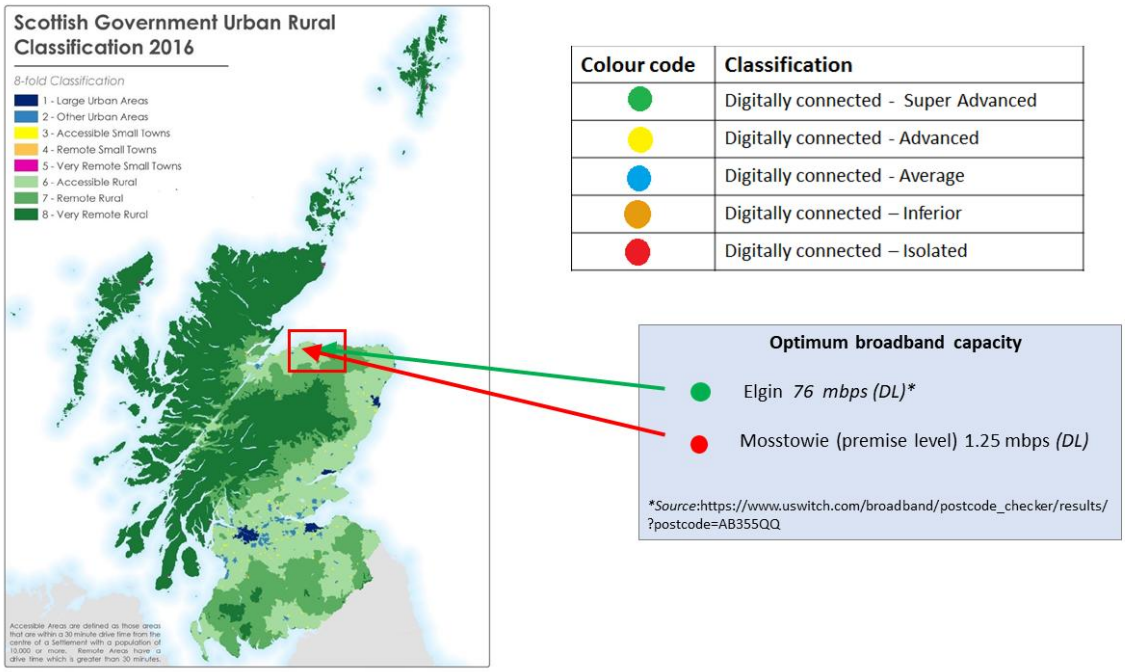
This study highlights that the deployment of NGB has produced many nuanced and complex challenges and unforeseen outcomes for the businesses under consideration. Throughout the survey period, it became apparent that a greater digital divide was developing than previously observed (Palmer-Abbs, 2017; Salemink et al, 2017, 2018). Feedback from the businesses and speed tests identified at least four different levels of digital connectivity:

- less than 2 Mbps
- between 2 and 10 Mbps
- between 10 and 24 Mbps
- above 24 Mbps up to 80 Mbps

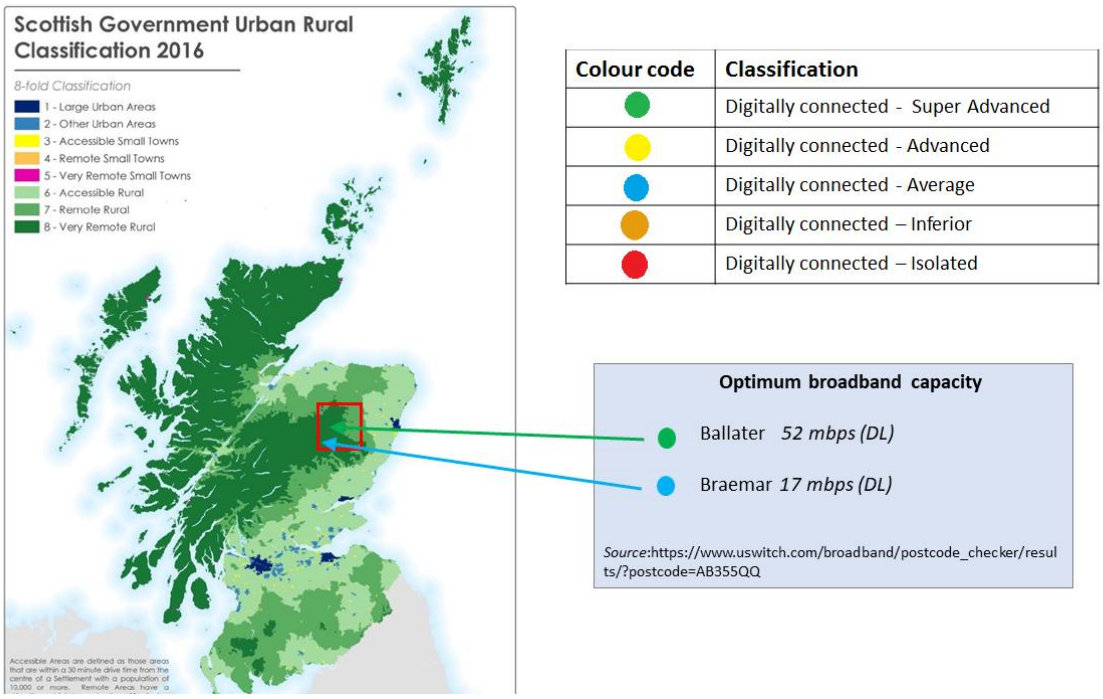
As may be expected, businesses situated in small villages and cluster settlements saw the earliest access to NGB, whilst those distanced from these more built-up areas, or in smaller clusters (10 properties or less) saw little, if any, furtherance in fibre upgrades to their network(s). The impact upon businesses who previously considered themselves close to population centres, and therefore with a greater likelihood to access services, did not translate to digital connectivity (Farrington et al, 2015). This realisation has destabilised many individuals' perspectives of their location. Many businesses in locations reflective of these population density and settlement patterns (i.e. ribbon villages or dispersed clusters of properties) by the end of the research period had resigned themselves to not getting NGB.

Initially, the Scottish Government Urban/Rural classifications (2018) were used to identify patterns of digital inequity being observed; however, these did not explain the findings. Despite the location of the participants being identified by the Scottish Government Urban /Rural classification as Accessible Rural (areas with a population of less than 3,000 people, and within a 30-minute drive time of a settlement of 10,000 or more) or Very Remote Rural Area (areas with a population of less than 3,000 people, and a drive time of over 60 minutes to a settlement of 10,000 or more), access to NGB varied immensely with quite unexpected outcomes. For example, if one considered Farrington et al.'s (2015) deep and shallow rural categories, some businesses located in deep rural areas attained NGB whilst those in more accessible rural areas (shallow rural) did not.

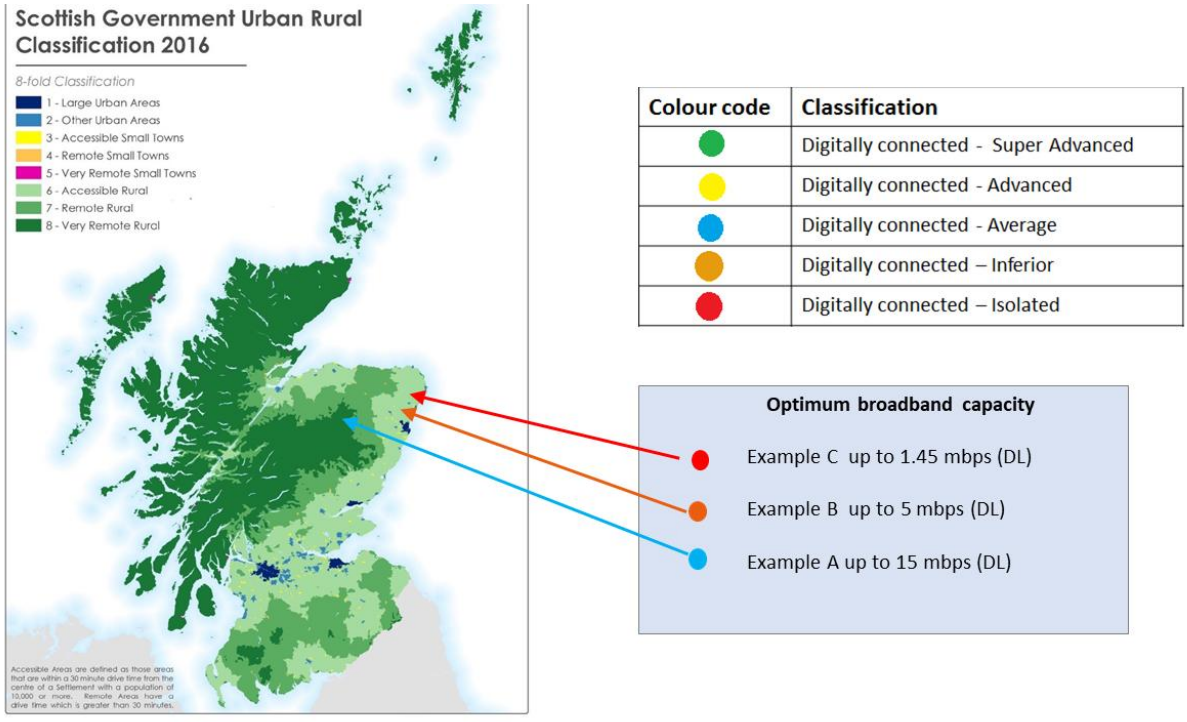
Further mapping of the businesses and a review of additional supporting information (AA route planner drive times and Post code broadband performance) revealed that some of these NGB areas were in some of the most remote (by road and rail transport) geographical areas in the UK, namely Ballater and Braemar. Conversely, some of the poorest served NGB areas were within 1 mile (1.5km) of major urban centres Maps 5.1-5.3 & Table 3.



Map 5.1: Mapping of digital performance:



Map 5.2: Mapping of digital performance:



Map 5.3: Mapping of digital performance

Location	Population	Distance from nearest settlement[3]	Size of nearest settlement[1,2]	Rural / Urban classification[4]	NGB status
Ballater, Aberdeenshire	1,500 [1,2]	Drive time 37 minutes Drive time 1 hour 9 minutes	Less than 10,000 (Banchory) Greater than 10,000 (Aberdeen)	Very Remote Rural	NGB active (2015/16)
Rafford, Moray	226[1,3]	8 minutes	Greater than 10,000 (Forres)	Accessible rural	Exchange activated (exchange only line (EO)): No NGB due to distance
Mosstowie, Moray	No data available below post code level	10 minutes	Greater than 10,000 (Elgin)	Accessible rural	Some lines activated with NGB only part post code coverage. House clusters not served across area
Blackhills, Kinmouth, Aberdeenshire	No data available below post code level	6 minutes	Less than 10,000 (Peterhead)	Accessible rural	NGB limited access across dispersed community
Hopeman, Moray	1724[2]	14 minutes	Greater than 10,000 (Elgin)	Accessible rural	NGB active 2015, cabinets activated sequentially
Mintlaw, Aberdeenshire	2774[1]	20 minutes	Greater than 10,000 (Ellon)	Accessible rural	NGB active 2015 (approx)
Polesburn, Aberdeenshire	442[1,5]	18 minutes	Greater than 10,000 (Ellon)	Accessible rural	NGB active 2015

Table 3: Location and accessibility

Source: Aberdeenshire Council, 2016. *City Population.* [Online] Available at: https://www.citypopulation.de/php/uk-scotland.php?cityid=S19000674 [Accessed 12 March 2017].
[2] Source: Moray Council, 2015. *Moray Council: Local Development Plan: Built Environment.* [Online] Available at:http://www.moray.gov.uk/moray_standard/page_100458.html[Accessed 12 March 2017].
[3] Source: AA route finder, 2015. *AA route finder.* [Online] Available at: http://www.theaa.com/route-planner/index.jsp[Accessed 12 November 2016].
[4] Source: Scottish Government eight fold Urban/Rural Classifications (2018)
[5] The population presented is for the wider area of Methlick, no data was present for Polesburn

The emergence of these differing digital localities, the growing urban/rural and emerging rural-rural digital divide, and ramifications experienced by businesses on their ICT practices and business survival are now presented.

5.3.2 New classifications and the Impact of the NGB Upgrades

This research presents alternative ways to conceptualise digital accessibility, one which is not based on transport-based accessibility, spatial patterns and population density (roads, cities, towns, villages) (Farrington et al, 2015). It is important to note that digital networks follow different spatial and drive time characteristics (Clark *et al,* 2014) to those distinguished by road transport (Scottish Government, 2018); 3 miles from an exchange is inconsequential in road distance terms but presents a significant performance degradation for a broadband-over-copper connection. Digital communication is characterised by differing relationships, namely digital speeds and reliability are determined more immediately and intensely by the factors which affect performance such as the legacy of the network configurations, and core network access points and data package blockages (Clark *et al,* 2014; Riddleson & Singleton, 2014). Therefore, whilst a business may be close in terms of drive time to a town, they may be significantly distanced from the digital network which serves their business premises. In addition, market forces (demand side) determine where infrastructure investment occurs, the most profitable post code areas seeing the earliest investment. Digital accessibility can therefore be presented as both the technology infrastructure configuration, associated broadband performance, the relationship of these with settlement configurations (settlement patterns, population density and dispersal), associated return on investment and the user ICT needs. Figure 1 illustrates findings from the research, with examples of new classifications in this respect:

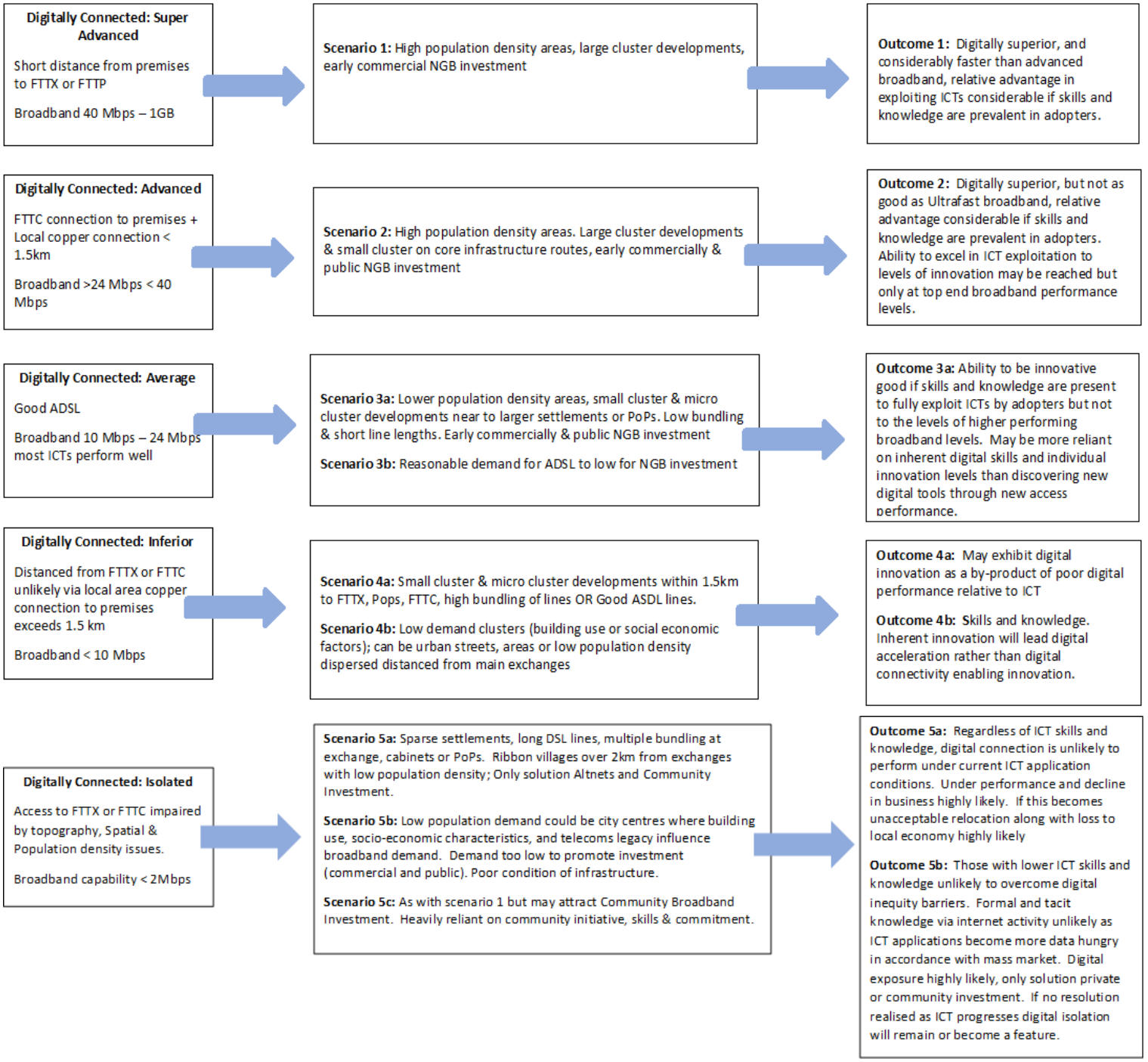


Figure 1: Conceptual Framework of Five fold digital typologies, related scenarios and description of likely locations and associated outcomes

Businesses who experience super – advanced digital connections will be enabled to excel in meeting their ICT based business objectives. Businesses with high IT skills will optimise their ICT effectiveness whilst those with lower IT skills will be more able to advance their ICT prowess; though this will be to a lesser extent than those who were more digitally adept. Innovation is most likely to be a result of trial, error and exploration, using web-based tools and learning resources.

This digital space will afford both upskilling and opportunity creation from the most advanced digital technologies, with a meeting and merging of activities creating 'super innovation environments'. There is potential for the most digitally able and proactive businesses to be world leading in these creative spaces.

Businesses who experience the middle ground digital connection performances (advanced and average) will positively benefit from this level of digital connectivity relative to their IT skills. Many current ICTs will function to a good – reasonable level in the immediate future. Innovation in this broadband spectrum will most likely be a result of existing BE innovation characteristics and their ability to exploit current and new ICTs. This group will also be empowered to use online learning tools and spaces upskilling their ICT and business-related knowledge. However, this group will lack some of the more advanced available opportunities compared to those working in 'super innovation environments'. In addition, unless further broadband upgrades are realised, this newfound broadband connectivity will be outperformed by advances in digital innovations. As a result, this group will experience a deterioration in their ICT related business practices.

Businesses who are the most digitally isolated (will) see an under performance and deterioration in achieving digital related business objectives. Businesses in the high IT skilled groups (will) see a decline in their ICT effectiveness, inferior to their digitally connected peers. Offsetting this with innovative workaround solutions may work short term but many may no longer be able to counterbalance this impairment. For those businesses with lower IT skills, many (will) see a drop in their ICT related efficiencies but due to their less complex ICT management styles, will experience this differently comparative to digitally adept businesses. This lower IT skilled group (will) experience a deterioration in their digital and business confidence as they struggle to understand the context of their poor digital climate (e.g. a broadband related technical issue or shortcomings in their ICT skills and knowledge). In general, both groups will lack the ability to access online skill and business development tools and tacit experiences, (continuing to) falling behind their peers in digital literacy and competencies.

The most vulnerable of these groups are the bottom two categories who are the most at risk of immediate ramifications on their business practices with current complex ICTs, many of which outstrip existing broadband capabilities. These groups will be found in the most digitally peripheral geographical areas, such as, those located in small, isolated and digitally dispersed locations where commercial demand for broadband is low. These areas will most likely be found in remote rural places but may also be a feature of central urban areas where property density is high and commercial broadband demand is low. In terms of current NGB upgrades, these groups are by far the most likely to have 'missed out' on the recent NGB digital upgrades.

6 Future proofing and new deployment practices

Limitations were acknowledged in the development of this study, e.g. low survey numbers and attrition rates, and an inability to generalise findings. However, the study adopted a reflexive analysis approach which overcame many of these issues. Coupled with other studies (Ashmore, 2015; Salemink, 2016) similarities are evolving between case study areas which are building a picture of a continuing rural digital divide and respective approaches which overcome these .e.g. participatory approaches.

The overarching outcome of this study is that despite policy interventions many of the rural micro businesses studied did not receive NGB (30 Mbps), remaining underserved by their broadband service. A number of factors affected this: policy VFM procedures; existing broadband backlog issues; the limiting procurement '75% by post code' methodology predominantly by FTTC, and the limited resources compared to the scale of the task (see section 4.2. & 5.2.2). In addition, by the completion date of the majority of the works, the minimum upgrade parameter of 2 Mbps was out-of-date compared to the UOA of 10 Mbps (OfCom, 2018), which we suggest is barely sufficient for current contemporary ICT business use.

The result of these combined events is a growing digital inequity between digitally remote and digitally superior areas in the North East of Scotland. Based on these aforementioned insights from this paper, and the similarities with other qualitative projects (Salemink et al, 2018), a local NGB inequity picture is emerging which is a stark contrast to that heralded in political spheres (e.g. 95% NGB coverage (UK) (section 5.2.2. & 5.3.1).

Many of the businesses in this research held a positive view of the opportunities that NGB afforded them , including the ability to use contemporary ICTs in new and innovative ways to build and grow their businesses and improve communications with customers (section 5.1). Those fortunate to receive NGB achieved many of their aspirations, extending both their use of ICTs, working relationships and markets. Those less fortunate, and who looked to adopt NGB, continued to see deteriorating ICT related business practices and working relationships. Many had considered investing privately in new NGB infrastructure or using Altnets. However, cost and technical performance, particularly with altnets (satellite) were seen as prohibitive (section 5.2.1). Most businesses felt relocation to access a 'fit for purpose' broadband was not a suitable option due to their relationship with their location (family & rural asset based businesses, community-based services) (Bosworth, *et al*, 2018). However, such is the importance of adequate broadband, some businesses did relocate or were seriously considering this option during the study period. Though in an age of inequity we must question the implications of such activities and the survival of our rural communities (Skerrett et al, 2012).

As Townsend et al (2016, p.7) stated, there is a 'lived reality' to working in digitally remote areas, where the competitive pressure and demands of those who are more digitally connected outperform those less connected. Despite NGB upgrades in the study area, many businesses were left telling the same digital inequity story but perhaps with an evolved perspective from previous studies (Farrington et al, 2015; Townsend et al, 2016). Whilst previously this may have been considered an urban/rural issue, this territorial debate now adopts a new dimension, one which needs explicit context of how these rural micro businesses experience these new territorial digital divides. Digital divides remain a fixture of those most distanced from NGB points of presence but these areas, as the new fivefold classification (section 5.3.2) describes, are not just those distanced by road; rather, they are those digitally distanced by just 1.5km from a fibre hub, and therefore can be anywhere across the digital network (urban or rural). However, those most disadvantaged by road and digital networks (remote rural and digitally isolated) (Scottish Government, 2018) will feel the impact of an advancing digitally connected society more severely as ICTs progress at the pace of the digitally advanced nations (Evening Standard, July 2017: Graham *et al*, 2014; i, July, 2018).

This impact is already felt in the worst connected rural micro businesses (section 5.2.3), with declining ICT skills and knowledge, business activity and communications, and consequently excluding participation in innovative ICT platforms (Galloway et al, 2011; Raisanen & Tuovinen, 2020; Salemink et al, 2017). Many of these tools may have basic functionalities (e.g. accountancy, word processing, sharing files) but the complexity of the coding and data richness of the performance of these ICTs dictates increasingly high broadband capabilities. In a world which is starting to talk of 1 Gigabit connections, and where digital equity is deemed a human right (Ofcom, 2018), the lack of NGB escalates the territorial digital inequity debate. In our opinion, unless place based solutions are developed, it is likely that the remotest areas (digital & road) will see declining populations as the impacts of the 4th Industrial Revolution permeate all levels of society (business, education, entertainment, etc). Digitisation has the power to mirror the impacts of previous water and electricity upgrades (Gupta *et al,* 2013) and the associated depopulation of rural areas; however, this time the impact may well be in localities we least expect.

If policy wishes to capitalise on the drive to harness digital technology in rural businesses, greater focus is required to deliver a ubiquitous broadband service. Future Scottish Government investment of NGB should take cognisance of the findings in this study and build relationships suitable to overcome the issues presented (greater community involvement in public/private projects) (Raisanen & Tuovinen, 2020; Salemink *et al,* 2017). A more appropriate, combined technical evaluation model and procurement mechanism is required to achieve the target of 100% NGB coverage, as a minimum. A specific focus should be made towards areas which have not received upgrades and those where fibre is below 30 Mbps (D/L), future proofing for 1 GB connections, and simultaneous upload/download capabilities. This should protect future works against a long lag of public sector action experienced as an outcome of policy rhetoric, detrimental behaviour of which the BDUK programme appears to

have suffered from; a point made at the Rural Geographers Innovation Café session in 2019 (Palmer-Abbs et al , 2019). We argue that actors need to look further than just state and private interventions to resolve this digital dichotomy. Sustainable solutions will require community, public and private interventions (fiscal and knowledge based), where all parties retain responsibility in achieving a 'fit for purpose' digital connectivity suitable for our fast paced 21st Century. Future co-production research should focus specifically on these deeply entrenched territorial digital divides. Participants should be formed from the most relevant and pertinent cross section of actors (third sector, community, private and policy). Whilst leadership is important, this approach should avoid hierarchical top down or community-based bottom up approaches (ibid) adopting a more shared vision 'new imagining' of what 'possible futures' these communities seek, and what digital solutions serve this vision (Palmer-Abbs et al, 2019). This approach echoes to some degree opinions shared by others (Raisanen & Tuovinen, 2020; Salemink et al 2018) in local based participatory solutions to 21st Century issues. Without this kind of intervention, there is a strong likelihood that NGB and future proofing activity will remain elusive across the most digitally peripheral areas, 'digital deserts' will grow, and communities in these digital 'not spots' will decline, with ensuing reorganisation to our society.

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Box 1: Glossary of terms

**ADSL:* Asymmetrical Dial subscriber line – A digital technology which allows use of standard phone lines to provided high speed data communication. Allows for higher speeds towards the customer (one way) than the other. Typically, up to 8 Mbps capability.

**ADSL 2:* Asymmetrical Dial subscriber line – is a copper line with a dual functionality (telephony and broadband) with the improved performance to ADSL. Typically supports 24 Mbps (download) capability.

****EO:* Exchange only lines: Properties are connected directly to the Exchange, often via copper DSL technologies

****Back haul* the intermediate links between the backbone network and the small sub-networks of end users at the 'edge' of the network.

Bundling: Grouping of telecommunication lines at the exchange to the core network

Core networks: This is referred to as the arterial or main section of the telecommunication infrastructure and is predominantly where fibre or NGB upgrades occur. It is linked to sub groups of the network via local network systems such as copper telecommunication technologies to the premises.

**DSL:* Digital Subscriber Line. A family of technologies generally referred to as DSL, or xDSL capable of transforming ordinary telephone lines (also known as twisted copper pairs) into high speed digital lines, capable of supporting advanced services such as fast internet access and video on-demand. ADSL, HDSL (High data rate subscriber line) and VDSL (very high rate digital subscriber line) are all variants of DSL)

NGB: Next Generation Broadband (NGB) also called Next Generation Access (NGA) or superfast broadband is the selection of technologies which is used to provide superfast broadband speeds across the telecommunication networks.

**FTTC:* Fibre to the Cabinet (FTTC) is access to network consisting of optical fibre extending from the access node to the street cabinet. The street cabinet is usually located only a few hundred metres from subscriber premises. The remaining segment of the access network from the cabinet to the customer is usually copper pair but could use another technology such as wireless

**FTTX:* Fibre to the Exchange (FTTX) optical fibre to the local exchange. Connectivity to cabinets or premises is generally copper cabling from this point on.

**FTTP:* Fibre to the Premise (also known as fibre to the home/building), is a form of fibre optic communication delivery in which an optical fibre is run directly onto a customer's living or office space

****4 G:* Fourth Generation Mobile Service is the fourth generation in mobile technology devices which succeeds 3G. Operating systems include IP telephony, games services, high definition TV, Video Conferencing, Social Media.

***Cloud computing:* Location-independent computing, whereby shared servers provide resources, software, and data to computers and other devices on demand

***SaaS:* Software as a Service: is ICT software licencing and delivery model in which software is licensed on a subscription basis and is centrally hosted by the provider. Examples of this would be management software, accounts software, messaging software

***PaaS* : Platform as a Service: is a category of cloud-computing service which allows the user to access a platform which hosts development, running and use of applications without the need for investment in the development and management of the system. Examples of this would be public cloud services, networks such as servers, operating systems, or data bases.

Points of Presence A point of presence (PoP) is an artificial demarcation point or interface point between communicating entities. In this paper we refer to this as a point of connection for fibre broadband e.g. FTTP/FTTC/FTTX.

**VDSL* Very-high-bit-rate DSL offers very high data rates over relatively short distances.

**VDSL2* VDSL variant, marketed as 'up to 80 Mbps BT Infinity

****White areas:* These are areas classified by the European Union as receiving no digital coverage. This can be fixed or mobile digital technologies but has predominantly been used to discuss fixed broadband services.

*Source: authors definitions. Those marked with * adapted from the glossary in* Royal Society of Edinburgh (2013) *Spreading the benefits of digital participation or those marked with ** adapted from Gupta et al (2013) The usage and adoption of cloud computing by small and medium businesses. International Journal of Information Management ***Skerratt et al (2012) Next generation broadband in rural Scotland: mobilising, meeting and anticipating,*

Business	Business Activities	Location characteristics *Denotes urban/rural classification (Scottish Government, 2016	Rural Assets	No of entities based at site	NGB Perspective	Post NGB perspective of connectivity & actions	Digital Speeds *Download (D/L) **Upload (U/L)	Previous experience and ICT skills	Business Management style
1	Electronic (e) business (retail)	*Remote rural Isolated property / dispersed rural community	Homebased (owner)	1	Positive	Moved to secure NGB	37.05 Mbps (D/L 9.19 Mbps (U/L)	Historical use of ICTs but felt skills were out of date Pragmatic in use of innovative ICTs	Proactive Business Innovator Progressed from simple use of ICTs to complex after NGB enabled greater use of SaaS/PaaS
3	Mineral Extraction, processing & distribution	*Accessible rural Small group of clustered properties	Business owned offices & site	1	Positive	Poor digital connectivity / requires NGB	1.45 Mbps (D/L) 0.25 Mbps (U/L)	Previous ICT knowledge from working in a large organisation Favoured the use of ICTs	Reactive to market drive in ICT use for business. Used simple ICT management configurations
4	Car MOT & services, parts and sales	*Accessible rural Ribbon village (e.g. built along a road and linear)	Businesses owned offices, outbuildings & site	1	If required	Suitable for current use		Relied on ICT knowledge from college course & associates support Favoured the use of ICTs	Reactive to market drive in ICT use for business. Used simple ICT management configurations
6	Aerospace technology innovation and support	*Accessible rural Isolated property / dispersed community	Business owned office adjacent to family home	2	Positive	Fibre enabled/ requires greater performance	18.58 Mbps D/L) 0.92 Mbps (U/L)	High ICT skills from working in an innovative sector Highly innovative in use and adoption of ICTs Also developed software in business practices	Complex and blended use of multiple ICTs. Proactive in finding ICTs to meet business needs.
9	Veterinary practices	*Remote Rural Ribbon village (e.g. built along a road and linear)	Businesses owned premises (2)	1 per premises	Positive	NGB good but looking for more due to work practices		High ICT skills from previous work in large organisation Pragmatic innovator in use of ICTs often ahead of mainstream users	Complex and blended use of multiple ICTs. Proactive in finding ICTs to meet business needs.
11	Bistro / Coffee shop	*Remote rural Clustered Village	Rented business premises (fixed) & remote access via home/on the move	1	Positive	Poor /inadequate just keeps struggling	*0.58 Mbps D/L) *0.15 Mbps(u/L)	Highland ICT skilled, taught ICt and business management. Highly innovative use of ICTs often very early user of new ICTs	Complex and blended use of multiple ICTs. Proactive in finding ICTs to meet business needs.
12	Car services, yoga, holiday rentals,	*Accessible rural Clustered village	Home based (owner)	4	Positive	Good / satisfied	70 Mbps (D/L) 11.99 Mbps	Mixed skills but sound knowledge of ICTs FORM WORK EXPERIENCE	Simple use of ICTs for business purposes.

							(U/L)	Innovative in use of new ICTs often marginally ahead of mainstream use	Proactive in finding ICTs to meet business needs.
13	Business consultant & start ups, accountancy, small farm, produce, sales & two charities (social enterprises)	*Very remote rural Isolated property / dispersed rural community	Business owned offices adjacent to family home	8	Positive	Fibre enabled/ reasonable performance but looking for more due to business practices	15 Mbps (D/L) 0.66Mbps (U/L)	High ICT skills from previous work in large organisation. Highly innovative in use and adoption of ICTs Often ahead of mainstream users	Complex and blended use of innovative ICTs. Proactive in finding ICTs to meet business needs.
15	Farming, holiday rentals, Human Resources, Retail, Leisure services	*Accessible rural Isolated property / dispersed rural community	Family / Business owned properties (up to 4) in a small cluster	5	Positive	Poor/ looking to invest in satellite technology	2.5 Mbps (D/L) 0.25 Mbps (U/L)	Few formal ICT attended some classes but felt more upskilling was required. Unsure of innovative ICTs.	If good for business, would use innovative ICTs. Often quite simple use of ICT in business management
28	Construction & landscaping	*Accessible rural Small clustered settlement of properties (5)	Business owned offices adjacent to family home and site which is used for storage	1	Positive	Poor/ is looking at alternatives	2 Mbps (D/L) 0.38 Mbps (U/L)	Good level of ICT skills from previous work. Pragmatic towards innovative ICTs	Favoured innovative ICTs if good for business Had moderate approach to management and configurations of ICTs

Table 3: Source Author: Sample of Participating Businesses characteristics, assets and broadband performance data

Your reference: RUST 2306

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Appendices A

Box 1: Glossary of terms

**ADSL:* Asymmetrical Dial subscriber line – A digital technology which allows use of standard phone lines to provided high speed data communication. Allows for higher speeds towards the customer (one way) than the other. Typically, up to 8 Mbps capability.

**ADSL 2:* Asymmetrical Dial subscriber line – is a copper line with a dual functionality (telephony and broadband) with the improved performance to ADSL. Typically supports 24 Mbps (download) capability.

****EO:* Exchange only lines: Properties are connected directly to the Exchange, often via copper DSL technologies

****Back haul* the intermediate links between the backbone network and the small sub-networks of end users at the 'edge' of the network.

Bundling: Grouping of telecommunication lines at the exchange to the core network

Core networks: This is referred to as the arterial or main section of the telecommunication infrastructure and is predominantly where fibre or NGB upgrades occur. It is linked to sub groups of the network via local network systems such as copper telecommunication technologies to the premises.

**DSL:* Digital Subscriber Line. A family of technologies generally referred to as DSL, or xDSL capable of transforming ordinary telephone lines (also known as twisted copper pairs) into high speed digital lines, capable of supporting advanced services such as fast internet access and video on-demand. ADSL, HDSL (High data rate subscriber line) and VDSL (very high rate digital subscriber line) are all variants of DSL)

NGB: Next Generation Broadband (NGB) also called Next Generation Access (NGA) or superfast broadband is the selection of technologies which is used to provide superfast broadband speeds across the telecommunication networks.

**FTTC:* Fibre to the Cabinet (FTTC) is access to network consisting of optical fibre extending from the access node to the street cabinet. The street cabinet is usually located only a few hundred metres from subscriber premises. The remaining segment of the access network from the cabinet to the customer is usually copper pair but could use another technology such as wireless

**FTTX:* Fibre to the Exchange (FTTX) optical fibre to the local exchange. Connectivity to cabinets or premises is generally copper cabling from this point on.

**FTTP:* Fibre to the Premise (also known as fibre to the home/building), is a form of fibre optic communication delivery in which an optical fibre is run directly onto a customer's living or office space

****4 G:* Fourth Generation Mobile Service is the fourth generation in mobile technology devices which succeeds 3G. Operating systems include IP telephony, games services, high definition TV, Video Conferencing, Social Media.

***Cloud computing:* Location-independent computing, whereby shared servers provide resources, software, and data to computers and other devices on demand

***SaaS:* Software as a Service: is ICT software licencing and delivery model in which software is licensed on a subscription basis and is centrally hosted by the provider. Examples of this would be management software, accounts

software, messaging software

***PaaS* : Platform as a Service: is a category of cloud-computing service which allows the user to access a platform which hosts development, running and use of applications without the need for investment in the development and management of the system. Examples of this would be public cloud services, networks such as servers, operating systems, or data bases.

Points of Presence A point of presence (PoP) is an artificial demarcation point or interface point between communicating entities. In this paper we refer to this as a point of connection for fibre broadband e.g. FTTP/FTTC/FTTX.

**VDSL* Very-high-bit-rate DSL offers very high data rates over relatively short distances.

**VDSL2* VDSL variant, marketed as 'up to 80 Mbps BT Infinity

****White areas:* These are areas classified by the European Union as receiving no digital coverage. This can be fixed or mobile digital technologies but has predominantly been used to discuss fixed broadband services.

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3	Mineral Extraction, processing & distribution	*Accessible rural Small group of clustered properties	Business owned offices & site	1	Positive	Poor digital connectivity / requires NGB	1.45 Mbps (D/L) 0.25 Mbps (U/L)
4	Car MOT & services, parts and sales	*Accessible rural Ribbon village (e.g. built along a road and linear)	Businesses owned offices, outbuildings & site	1	If required	Suitable for current use	
6	Aerospace technology innovation and support	*Accessible rural Isolated property / dispersed community	Business owned office adjacent to family home	2	Positive	Fibre enabled/ requires greater performance	18.58 Mbps D/L) 0.92 Mbps (U/L)
9	Veterinary practices	*Remote Rural Ribbon village (e.g. built along a road and linear)	Businesses owned premises (2)	1 per premises	Positive	NGB good but looking for more due to work practices	
11	Bistro / Coffee shop	*Remote rural Clustered Village	Rented business premises (fixed) & remote access via home/on the move	1	Positive	Poor /inadequate just keeps struggling	*0.58 Mbps D/L) *0.15 Mbps(u/L)
12	Car services, yoga, holiday rentals,	*Accessible rural Clustered village	Home based (owner)	4	Positive	Good / satisfied	70 Mbps (D/L) 11.99 Mbps (U/L)
13	Business consultant & start ups, accountancy, small farm, produce, sales & two charities (social enterprises)	*Very remote rural Isolated property / dispersed rural community	Business owned offices adjacent to family home	8	Positive	Fibre enabled/ reasonable performance but looking for more due to business practices	15 Mbps (D/L) 0.66Mbps (U/L)
15	Farming,	*Accessible rural		5			

	holiday rentals, Human Resources, Retail, Leisure services	Isolated property / dispersed rural community	Family / Business owned properties (up to 4) in a small cluster		Positive	Poor/ looking to invest in satellite technology	2.5 Mbps (D/L) 0.25 Mbps (U/L)
28	Construction & landscaping	*Accessible rural Small clustered settlement of properties (5)	Business owned offices adjacent to family home and site which is used for storage	1	Positive	Poor/ is looking at alternatives	2 Mbps (D/L) 0.38 Mbps (U/L)

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