Internet Society
UK Chapter

A brief history of Community Broadband Networking in the UK

By Andrew Stirling, 15th June 2020.

Executive Summary

The story of community network development is another chapter in the continuing story of the great rural-urban divide. It can also be characterised as a David and Goliath struggle, where David can win temporary victories over his own garden, but is aware that the national Goliath is still very much alive and well. Albeit on a somewhat flexible leash from the regulator. Every so often, Goliath has been given permission (and funds) to go into the garden and harvest the lowest hanging fruit, whilst David is left to pick over whatever remains.

Gloomy as this would seem, there is potentially a much brighter outlook for community broadband in the future if it can combine core strengths of good, locally-based customer service with the 'heavy lifting' of communication service provision (technical and administrative) being performed increasingly by cloud-based platforms that can enjoy the economies of scale that enable them to invest in growing capacity and innovation, providing the capability of supporting consistently high standards for local communication services around the world.

Public versus private service provision remains an ongoing debate

The best public service provision tends to be found in towns and cities – rural communities generally have had to wait or depend on local entrepreneurs to fill the gap. And yet broadband has more potential to be transformative for rural residents and businesses, than it has been for those in urban areas – who have many facilities on their doorstep. This has been brought home starkly during the current Covid-19 pandemic when travel from home has been discouraged or banned for all but essentials. As most of us shift our work and social interactions online, as much as we can, people without broadband really are feeling isolated and left out.

The driver of this rural inequality in broadband is the combination of high cost of network rollout & operation, as well as the prospect of only modest returns. This arises from the low density of population, which is typical in rural areas, particularly in farming communities.

Broadband needs to be considered as an investment in the community, which means that the social benefits from broadband need to be taken into account as part of an overall rural policy, with public funding to cover the gap left by tenuous commercial viability.

Public funding can take the form of subsidies to operators (from national and/or local government) but can also be in terms of local goodwill. This would include permission from local residents and businesses to use their properties for the routing of cables and mounting of boxes etc., as well as free marketing.
One difficulty with supporting rural services is that the policy emphasis on getting the 'market' to deliver UK public services has meant a need to ensure that any public investments are carefully targeted, such that they will not interfere with the plans of private companies. This is a particularly sensitive area for major operators, who are well resourced to challenge any perceived unfairness in the courts – but who are also not willing to make sufficient disclosure of their plans to enable the extent of likely rural gaps to be properly identified.

Thus far, UK telecommunications policy has been focussed on incumbents and their service coverage/delivery performance in national terms (as well as their behaviour towards competitors). Since the proportion of the national population living in rural areas is small, the poor broadband performance rural communities have endured over many years has had little visibility at the national level – particularly since regulators and governments prefer to set targets in terms of the percentage of population/households served.

New technologies, however, are opening doors both for operators and regulators to be able to address a finer granularity of operation and thus assist coverage gaps to be filled. The key technologies are:

- Wireless and optical fibre – backhaul and access links, whose cost/performance ratio has fallen dramatically in recent years. This helps the viability of broadband services in less dense areas. Further, the simplification of installation and operation of the network equipment (which now offers high levels of automation) has made it accessible to a wider base of potential users, who need no longer acquire deep technical skills

- Regulatory tools, including spectrum databases and more sophisticated radio propagation modelling tools, now enable much denser deployment of wireless links and networks – including a greater proportion under licence exempt access to spectrum.

Introduction

Community broadband is mostly a rural issue, arising from the decline of service viability with declining population density. The Internet is just the latest generation of service to play into the rural/urban divide.
Indeed, public services developed first in urban areas, naturally, given the ease of service delivery and relative wealth of the urban population. Over time rural communities came to expect similar services to become available to them too – and increasing national wealth enabled this to happen. Communications in terms of post and telecommunications were no exception. They were created by the Government to serve the nation and funded to provide complete coverage. When the publicly owned UK telecommunication network was privatised in the 1980s, its priorities became quite different and so its service obligations had to be set through regulation.

Since the earliest days of the Internet, there has been interest in getting connected to it and nowhere more so than in the UK. This has been one of the leading national markets for adopting digital technology, with a strong interest in the latest developments – for person and business applications of all kinds.

Initially, the Internet was the preserve of academic and industrial research institutions, followed by large corporates, who readily embraced the convenience and immediacy of electronic mail. These organisations could afford the high-price data connections to their premises – or, in the case of universities, received the connectivity effectively free.

In the narrowband era there was greater rural-urban equality in Internet access

The earliest form of Internet access, for most users, took the form of a dial-up connection, using the ubiquitous connectivity of the telephone system. The audible warbling noises which accompanied the start of such dial-up data connections became very familiar – caused by the modulator/demodulator equipment at each end of the telephone trying to work out how much data could be squeezed over the given line: starting low and then pushing higher – up to around 56 kilobits per second (a rate we would refer to now as *narrowband*).

These data connections were typically intermittent for consumers, since the telephone line had to be shared with voice calls and facsimile transmissions (being an earlier telephone-based data transfer mechanism specifically aimed at document transmission between offices).

Early Internet Service Providers (ISPs) used one of two charging mechanisms –i) a per minute charge for connections (which would be shared with the telephone service provider) or ii) a regular subscription charge. In the early 1990s, *Demon Internet* introduced a service with a £10 monthly charge - bringing direct Internet connectivity within reach of ordinary consumers, for the first time. Although, in principle, ISPs could leave the consumers connected indefinitely, they had only a limited number of access lines and had to ensure that consumers disconnected sufficiently often to allow sharing between all their subscribers. We refer to the ratio of subscribers to provisioned capacity as the *contention ratio*. This is a key parameter for consumer broadband services since ISPs tend to use greater degrees of sharing (i.e. a higher) contention ratio to increase their margins. Residential consumer services also tend to be asymmetric – with much higher downlink speeds, since these are the figures used in promoting their services. Few residential consumers think about the uplink speeds – unless they are uploading photographs, videos etc..

Other dial up services, from America Online (AOL) and Compu-serve, were already in existence, with a range of text-rich content available as well as email communications. These service portfolios were referred to as ‘walled gardens’ because they did not require direct Internet access. These developments paralleled datacasting services which broadcasters had established since the 1970s, using spare capacity in TV picture transmission systems.

In this dial-up world, the universal telephone service obligation, imposed on the dominant telecommunications operator (BT), helped ensure that rural communities could participate.

Discussions on whether a universal service obligation should now apply to broadband have been ongoing for nearly 20 years and now look closer to reaching reality, with the UK Government requesting Ofcom to draw up a mechanism. Given the greater competition now applying in the telecommunications market, the obligation requires more thought as to who should bear it and how it should apply. It's worth noting that the previous telephone service obligation resulted in poorer quality infrastructure in rural areas – 'self-burying' cable[1], use of aluminium wire and limited capacity switching hardware were installed because the operator had an incentive to reduce costs and no requirement to consider future upgradability.

Getting faster – towards broadband access

Starting in second half of the 1990s, building on the success of the World Wide Web and the richer media content interchange it supported, interest in much faster data connectivity started to grow. This connectivity, referred to as **broadband** was typically at least 10 times faster than dial up (over 500 kilobits per second as opposed to the 50 kilobits per second of dial-up access). The performance was normally asymmetric (as it still is), with download speeds being typically much higher than for upload.

Broadband could be delivered to consumers over cable TV networks, using DOCSIS technology, and over telephone lines, using Digital Subscriber Line (DSL) technology. However, there was virtually no rural presence for cable TV and the long telephone line lengths typical in rural areas adversely affected what could be delivered using DSL – along with the limited backhaul capacity to rural exchanges.

Broadband brought the possibility of much richer web pages (with more detailed images) and usable access to video clips, making services such as YouTube and the BBC iPlayer possible.

The road to better broadband collided with the opening of the UK Telecom market

The 80s and 90s saw increasing competition introduced in the UK's telecom sector, under the supervision of the regulator (Oftel). The cable companies introduced new higher capacity (hybrid fibre coax) distribution infrastructure suited to supporting television services alongside voice – and rolled out their network to around 50% of the UK's homes (mostly in urban and suburban areas).

The UK's original and dominant telco, BT, was not allowed to deploy high speed networks that could compete with cable – and would have frightened off the new (North American) Cable players that were successfully encouraged into the UK market, in the early '90s. The cable companies' brand new hybrid optical fibre-coax infrastructure would put them in a strong position to deploy broadband, when they eventually realised that this was going to be in greater demand than their original core voice and TV service offer – in contrast to the more mature US pay-TV market[2] in which they had grown up.

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[1] Which meant the hope that cable laid on the surface of the ground would eventually become covered up with soil and vegetation.

[2] The UK market Pay-TV had been established by BSkyB's satellite-based 'Direct-to-Home' service, which could offer services across over 90% of homes, as opposed to the 50% that cable networks could address.

The urban centred approach to cable deployment left rural residents out. They had to continue to rely on BT, which therefore lacked competition incentives in rural areas.
In common with many other telcos around the world, BT deployed Digital Subscriber Line (DSL) technology in order to offer its first broadband services (aside from its highly priced not-very broadband ISDN connections which were part of its offering for business customers). Whilst the technology delivered sufficient performance to meet the modest needs of urban/suburban markets, it could only deliver a less-than satisfactory broadband service in rural areas. There were two factors behind this:

- Initially only around the most populous quarter of the 4000+ telephone exchanges were equipped for DSL
- Line lengths tend to be longer in rural areas – with line originally being laid directly from exchange to customer premise – providing no convenient insertion point for DSL equipment to be close enough to customers.

DSL technology uses much higher frequency signals to carry data over the telephone wire and needs to be directly attached to the copper (or aluminium) wires which linked from telephone exchanges to the customers' premises. It was usually deployed in an asymmetric configuration in which upload speeds would be around a tenth of the download speeds (ADSL) – which were typically up to 20 Mbps per second, with many seeing only 5 Mbps A later generation (VDHSL, referred to as Superfast broadband), could deliver up to 76 Mbps (downlink), but relied on the service end equipment being within hundreds of metres of the customer premises.

DSL technology was gradually rolled out in rural areas, as the smaller telephone exchanges were converted, over a number of years. It then took a further decade or so to roll out the VDSL (fibre to the cabinet) technology (referred to as Superfast) to these areas – with a principal obstacle being the need to insert cabinets to break up the long line lengths connecting customers to the telephone exchange serving them.

Rural initiative and determination should not be overlooked

Rural people have often suffered lower standards of public service provision, across all sectors. Public transport is the most visible example of this, with sparse stops and relatively infrequent services.
However, enterprising rural residents and business owners have rolled out their own services in some areas – whether it be transport links (e.g. buses), electric power supply or broadband access for that matter. It was natural therefore for electronics/computer enthusiasts to look for practical broadband solutions that they could create, in the absence of useable provision by BT.

In the UK, local initiatives developed in:

- The West Country (Devon and Cornwall);
- Kent and Sussex

- East Anglia
- In Lancashire (NW England), there was a system called CLEO (using a combination of fibre and wireless links (arranged in a ring), to distribute affordable Internet access to schools. This ground-breaking initiative, led by Prof Barry Forde, provided valuable experience for the later B4RN (Broadband 4 Rural North) service which deploys fibre to the home in Cumbria and whose model is widely admired and is being replicated elsewhere in the UK too
- In rural Scotland (such as in the Western Isles, with the *Connected Communities* initiative, dating back to the early 2000s).

These community schemes required a backhaul point somewhere in their neighbourhood, but could then effectively distribute access around the community – providing a few megabits per second, back around the early 2000s.

Backhaul

Backhaul provision has been one of the largest costs associated with community broadband prevision. The opening up of the telecom market eventually produced competitive pricing for Internet backbone access, with multiple providers typically being available at Internet Exchanges. Unfortunately, there is not normally so much competition in the connection from Internet exchanges to suitable points of presence in rural areas (usually a telephone exchange). This has led to high costs for backhaul, which although regulated, are challenging to share for small scale community networks. In the UK there is a distance-related backhaul charge to the nearest 'Ethernet' exchange. This can be considerable for more remote rural communities – such as on the islands off the West Coast of Scotland.

Wi-Fi enabled the community broadband revolution…

Wireless technology was the natural choice for creating local broadband networks, particularly using affordable and easily available wireless devices complying with the IEEE 802.11 (Wi-Fi) standard. Roof top antennas could be fashioned inexpensively, using sawn-off Pringle™ cans, enabling broadband links between houses in a village, for example. Variants of this technology were provided with meshing capability, making use of attached personal computers in homes to run the necessary software to enable this. The initial equipment was based on the use of available spectrum 2.4 GHz band, but its limited range curtailed the extent to which mesh networking could encompass rural communities in their entirety.
Later, equipment using the 5 GHz band became available and was popular with community broadband deployment because it offered greater capacity and was relatively interference free in the early days. A greater power allowance was available at 5.8 GHz, enabling the technology to be used for backhaul links (point to point) with a reasonable range – over multiple kilometres. However, the 5 GHz signals require a clear direct path between sender and receiver, so hills and woodlands curtailed rural deployments in some areas.

Unlike commercial networks, which use a central access point mounted on a mast, Wi-Fi technology innovation enabled the use of a 'mesh' configuration whereby the access point on any property in a community could be used to distribute broadband access to neighbouring properties. This is a cost-effective and easily scalable way of growing coverage in a community. There is a recommended limit to the number of hops, to keep latency within bounds for interactive services such as voice and video calls.
To reduce installation costs, the community nodes would sometimes make use of truncated 'Pringles' cans on the roof, as directional antennas.

Advances in spectrum regulation helped start the revolution

The first key step towards enabling community broadband provision (as well as mobility of Internet access) took place first in the US, with the FCC's decision, back in the 1980s, to open up the 2.4 GHz band for sharing with licence-exempt users. It was far from being a desirable piece of spectrum. The band had been set aside originally for Defence applications, but the arrival of mass market domestic microwave ovens in the 1980s led to considerable interference. This made the band unattractive for commercial services. However, the FCC's offer was attractive to the IT industry, which came up with wireless data networking (local area) as a useful application for the new band. The availability of this spectrum on a licence-exempt basis encouraged development of IEEE 802.11 and enabled a much greater diversity of customers – who ranged from home consumers, through small businesses to massive multinational enterprises. All the end user needed to do was purchase a Wi-Fi access point and connect it to a broadband access service. European countries followed the US, allowing Wi-Fi technology to get started on this side of the Atlantic.
Then a higher frequency band 5 GHz band, with greater capacity opened up. Regulators imposed significant power limits and indoor usage requirements over many parts of the 5 GHz band, to prevent interference with earth observation services (operated through satellites) and they stipulated a special mechanism to protect the incumbent military radar systems around the middle of the band. However, just around 5.8 GHz, higher power was permitted (up to 4W effective radiated power) – under a light licensing regime (basically registering the equipment and its location, for a small annual fee).

TV white spaces and spectrum sharing point to the way forward

Wi-Fi technology provided a massive step forward for people in rural areas who wanted to take the initiative of deploying a broadband network in their own communities. However, the original Wi-Fi technology using 2.4 GHz and later 5 GHz spectrum had limitations of range, due to power limits imposed by regulators. These power limits were intended to protect other services in the band but also enabled greater sharing of the band between multiple access points – which is particularly critical in urban areas. Unfortunately, this made the technology less effective for broadband distribution in rural areas, given the greater distances between properties.

In the early 2000s, a group of major US technology players had observed that many rural areas of the US suffered from poor or non-existent broadband, with little prospect of improvement –

so they looked at how Wi-Fi's range might be extended. It was clear that lower frequencies could offer greater range for a given transmission power[3].

The group wanted to find spectrum below 1 GHz and fastened on clear capacity in the TV band (which are called the TV white spaces (TVWS)). This spare capacity is a product of the way high power TV broadcast networks are planned and the poor economics of covering remote rural areas. TVWS could offer much greater coverage area for any given transmission power and is more forgiving of trees and woodland than higher frequencies are. So, the technology appeared to be an excellent fit with the needs of community broadband. It was also looking interesting for a nascent "Internet of Things", particularly for broadband applications such as Closed Circuit video, from remote cameras. This was ably demonstrated in the densely wooded hills (Glentress) around Peebles, where coverage of the 2016 Enduro world series mountain biking event benefited from a TVWS link to a high definition video camera located in the heart of the forest.

The TVWS spectrum capacity was attractive, but there was a significant regulatory hurdle to clear since the use of TV white spaces would mean that licence-exempt applications (e.g. rural broadband) would need to be able to share the bands (UHF 470-790 MHz) without causing harmful interference to television reception (and to wireless microphones in theatres, studios etc.).

In the US, the tech industry had opened discussions with the FCC, leading to the first regulations in 2008 – and ultimate operation in 2012. In the UK, discussions started with the UK regulator, Ofcom, from 2006 onwards. Ofcom formed a UK working group with industry representatives – including from broadcast and wireless microphone manufacturers. This was followed by European working groups under the association of European communication regulators CEPT (working groups SE43 and FM53).

Links with universities have helped in terms of being able to access research funding in bringing innovative technology such as TV white spaces into rural areas. The University of Strathclyde (Professor R. Stewart) played a particularly important role in this with its foundation of the Centre for White Spaces Communication – under a grant from the Scottish Funding Council. The university has provided students from industry and regulators (including a number from Africa) with important early experience of the new dynamic spectrum access technology, that underpins access to the TV white spaces. Thanks to the University's work with locally based IT professionals, supported by the Scottish Government, Orkney has benefited from TV white spaces connectivity on its inter-island ferry routes. Where once only a ropey TV service was available to passengers, now they can remain connected and productive thanks to decent broadband Internet access.

The UK regulations took until 2016 to put in place. Since that time there have been commercial networks using TV white spaces technology. The first of these was on the Isle of Arran (Scotland)

[3] Power limits tend to be much lower for licence exempt applications than for licensed operators. The lower transmission power limit enables equipment to be less expensive and have less scope for causing harmful interference.

– rolled out by a company called Broadway Partners, in cooperation with Microsoft and Nominet. TV White spaces technology has proved a valuable additional tool, alongside other members of the Wi-Fi technology family, for addressing coverage gaps in the rugged and beautiful landscape for which Arran is renown.

Rural areas on the West Coast of Scotland bring their own charms and challenges
[photograph: Andrew Stirling]

Growing local skills

By themselves, community networks cannot deliver significant benefits to the locations they serve. It needs a combination of connectivity and skills in order to achieve the full benefits of Internet access.

However, there is a shortage of people with digital skills, particularly in rural areas of the UK. People who have the highest level of digital skills and the talent to develop them professionally tend to gravitate towards big cities, in the UK, US or elsewhere. So, it is hard to retain skills in rural communities.

It is for this reason that we have seen a number of initiatives to close the rural digital skills gap and have worked on one of our own: The Digital Blacksmith (DB)[4]. The Digital Blacksmith model seeks to generate revenues from assisting local businesses with applying digital technology and uses this revenue to retain digital talent in the rural community. The digital talent can then, working with schools, libraries and social networks of different kinds, propagate awareness of the importance of the Internet and encourage mastery of at least basic skills to enjoy the vast range of possibilities it offers. With many basic public services now moving online more rapidly, this rural digital upskilling becomes urgent.

[4] Further details on the model are available here.

Looking to the Future

We can expect to see the continuing rapid evolution of network technology – with cheaper fibre and faster wireless. In the wireless arena, Wi-Fi and cellular technologies (5G etc.) will compete and complement each other, linked to the availability of spectrum and the licence conditions attached to it.

The current pandemic may have played havoc with manufacturing, but lockdown across the work has demonstrated just how important broadband has become. Lack of a connection gives a major risk of exclusion as more and more public services move online. So, policy makers are now more than ever aware of the strategic importance of broadband infrastructure and the need to keep it up to date. This policy interest is likely to drive greater fibre penetration, with many properties in urban areas having fibre optic broadband connections – with the copper telephone wire consigned to the dustbin of history (although more likely, given the scarcity of copper recycled into electronic components to build brand new equipment).

We can also anticipate growing use of powerful and scalable cloud-based platforms to automate and simplify the task of running networks and offering Internet services – as well as their established data processing role.

Indeed, it is the major cloud-centred platforms (whose massive data centres are linked by a web of international backbone fibre connections) which have enabled the next wave of community broadband. By de-skilling the provision of communication services, these platforms can enable far more communities to rectify lack of broadband more quickly and cost effectively than in the past.

This has left the door open for more friendly local communication service providers (CSPs) to appear, using their close community links and naturally trying to include as many people as possible.
Locally-based services have been reversing the trend of centralisation/industrialisation of telecom services (and other utilities) which had been favoured by the high cost of equipment and the deep skills required to install and operate national networks, with earlier generations of technology.

Simpler network planning

A key element of simplifying the deployment of community networks is the process of planning. Wireless networks require one set of skills and wired/fibre networks another. Tools have been developed to assist in both of these key areas. Here are a few diverse examples:

- *RFTrack* – a tool for tracing spectrum availability and *BotRF* – a tool for radio link planning. Both of these tools were developed by The Wireless Lab at the International Centre for Theoretical Physics (ICTP), applying rf propagation modelling to help determine where equipment should be installed. . ICTP has worked closely with the Network Startup

Resource Centre, in Oregon, USA in researching enabling technologies for community network builders
- Build Fibre – https://buildfibre.com , a tool developed by Swedish technology company Rala.se, allowing communities to estimate costs and plan a fibre to the premises development.

The reinvention of customer service

Large and often dominant companies which resulted. In Europe these were originally owned by governments. Later, transferred to private hands, these organisations sought to serve their new investors well by saving costs and maximising profit. They ultimately tended to see customer service as a cost to be minimised, rather than a precious asset to be cultivated. Regulators and social media pressure have kept the pressure on for improved customer service, but large operators still seek to automate customer handling as much as possible.
In contrast, community broadband providers are helping to reinvent the industry, with friendly and personal service being at the heart of what they bring to their local customers. This trend is assisted by affordable, ubiquitous cloud platforms, which can, increasingly, host the technical and administrative tools necessary to establish and operate a communication service – centred on broadband access to the Internet. Fortunately, there is sufficient competition at the moment to keep such cloud-based platforms from taking a large share of communication service revenues.

Community broadband providers can often save money by benefiting from the goodwill of local people, who typically want to help each other and can facilitate network deployment by allowing inexpensive/free access to their land or property, to lay cables and mount equipment. If managed well, the community naturally feels a sense of ownership and therefore greater loyalty to their local provider. This phenomenon can be observed in many rural communities around the UK.

The UK has many thriving and innovative examples of community broadband providers

In the UK there is an association called INCA (Independent Network Cooperatives Association) which helps community network providers to assist each other and brings their voice to the top table in UK broadband policy making. INCA has an extensive membership list. Here are just a few examples taken from their list:

- B4RN (Broadband for the Rural North), which has rolled out a fibre to the premises (FTTP) network in communities across NW England. Founded by community network pioneer Barry Forde, B4RN has become a model for communities in other parts of the UK – offering affordable FTTP access and locally-based customer service
- Broadway Partners, in Scotland and Wales
- County Broadband, covering the East of England
- Lothian Broadband , in Southern Scotland
- Village Networks, around Buckinghamshire
- Wessex Internet, in South-West England
- Wight Fibre , based on the Isle of Wight

In conclusion

Governments promise to connect everyone – but with coverage statistics often based on population/household percentages, many geographic areas have been left out or behind. This is especially true in developing countries, where rural communities can account for over 70% of the population. As new generations of network technology appear and services evolve to exploiting them, the rural-urban gap tends to widen.

There is still much work for community broadband providers to do, but fortunately, powerful new technologies and support from bodies such as the Internet Society are there to support communities in securing their future.

About the author

Andrew Stirling studied Physics at Imperial College, London. His job at BBC R&D then launched him from the theory of electromagnetic wave propagation into the wonders of broadcast communication and content production, with its formidable and exciting technical challenges. He has since worked in consumer electronics (around home/car network technology development) and at the Communications regulator (Ofcom).
Starting his own company (Larkhill) in 2005, Andrew has provided strategy, innovation and regulatory advice to major industry players as well as to entrepreneurs and start-ups.
His first brush with community networks came with leading a review on the licence exempt use of spectrum (particularly with community broadband needs in mind). This gave him a great opportunity to meet some inspiring community network pioneers and to understand how much spectrum access meant to them.
In 2007, he started to assist Microsoft (and also Dell) with introducing proposals on access to the TV white spaces to Ofcom. This led to participation in UK and European working groups to define the critical coexistence constraints to protect the incumbent TV (and wireless microphone) services. He led nearly 20 companies in a landmark consortium trial of TV white spaces in and around the City of Cambridge – involving 5 pubs, a theatre as well as a few less colourful peripheral locations. The results greatly influenced UK and European regulators and assisted the UK to invest in making the regulations.
Andrew's attention then switched to Scotland, where lack of broadband in rural areas was an issue even more keenly felt than in England. Working with Microsoft, the University of Strathclyde and the Scottish Government, he helped assemble and lead a Glasgow TV white spaces pilot – and supported efforts in Orkney that eventually led to its starring role in the 5G Rural First project.
Latterly, the roll-out of the first commercial TV white spaces network on Arran, carried out by Broadway Partners (Arran Broadband) with Microsoft and Nominet support, claimed his attention and provided fascinating insights into how rural communities can work and what the

impact of broadband can be – transforming lives. This provided the inspiration for developing the Digital Blacksmith rural skills model which was described above.

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