5G New Thinking

Insights Report

5G new thinking

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Executive Summary

5G New Thinking is a collaboration of diverse partners developing the tools, processes and business models that will empower rural and poorly connected communities to rapidly establish next generation and 5G connectivity for local benefit. It comes as a natural evolution of the 5G RuralFirst innovation project. Where 5G RuralFirst was focused on proving the value of connecting rural areas, 5G New Thinking is focused on making 5G a practical reality for these communities, empowering them to take control of their connectivity.

Digital communications technologies are widely acknowledged to be a key driver of economic growth. CBI research indicates that 94% of businesses[1] believe that digital technologies are a crucial driver of increased productivity.

The introduction of next generation and 5G digital services can be expected to deliver a range of economic benefits. These include increased productivity resulting in economic growth, as well as numerous consumer and social benefits derived from improvements in welfare.

Analysis from 5G RuralFirst suggests that, over a 10 year period, the UK's rural economy could grow by an additional £17bn[2] if good quality 5G services are accessible. However, the UK's rural areas suffer significantly from a lack of connectivity and coverage resulting in inequality and a significant barrier to this predicted growth.

This Insights Report is a chance to step back and examine the rural connectivity challenge in more detail, analysing the various regions, technologies and stakeholders that will be critically important to the success of 5G New Thinking. This report aims to provide key insights that will help inform the strategy and aims of the project, as well as aligning our understanding of these important issues.

The report contains examples and data from the three regions to add colour to the rural connectivity challenge, as well as the findings of our quantitative MNO decision maker research.

The research shows that MNOs are keen to roll out 5G in rural locations but there is some resistance towards working with rural neutral hosting providers. This resistance is mostly to do with a lack of faith or trust, and confidence in their ability to play fairly in the market. As a result, MNOs want to work closely with rural neutral hosting providers, be part of the infrastructure location selection, have the same SLA as their competitors and get clarity on how they can control their customers (or not lose them to the competition).

The report then also examines the technologies, approaches and network architectures that will be relevant to the 5G New Thinking project and will play a part in closing the rural connectivity gap. We have provided an overview of each element as well as relevant detail on related developments, initiatives or industry commentary.

[1] https://www.cbi.org.uk/articles/embracing-digital-in-every-sector/

[2] https://uk5g.org/media/uploads/resource_files/5G-RuralFirst-New-Thinking-Applied-to-Rural-Connectivity-1.pdf

The Rural Connectivity Challenge

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To date, mobile connectivity in the UK has been dominated by mobile network operators (MNOs) who have followed a conventional, vertically integrated business model. By and large, each operator owns its own spectrum and designs, builds, owns, and operates its own network, which it then markets directly to its own end customers.

However, this approach has resulted in just 66%[3] of the UK landmass being served by all four MNOs. The high capital costs of meeting a small addressable market in rural areas mean MNOs have focused investment in areas with high population density instead. It simply doesn't make financial sense for MNOs to invest in rural connectivity.

Ofcom's annual Connected Nations report[4] sheds more light on the situation, analysing the availability of broadband and mobile services across the UK and its nations. The latest report shows an increased appetite for digital services with average monthly broadband data use going up from 240GB per connection in 2018, to 315GB in 2019.

[3] https://www.ofcom.org.uk/__data/assets/pdf_file/0023/186413/Connected-Nations-2019-UK-final.pdf

[4] https://www.ofcom.org.uk/research-and-data/multi-sector-research/infrastructure-research/connected-nations-2019/main-report

£17bn

growth in UK's rural economy if good quality 5G services are accessible

However, the report also shows that while most of the country can get coverage from at least one MNO, there are stark differences in the level of choice available to customers in urban and rural areas. 96% of urban areas can get 4G reception from all four operators, compared to 62% of rural areas. 5% of the UK's landmass gets no mobile reception at all.

What's more, of the 610,000 or so premises (2% of all premises) that cannot get decent broadband from a fixed line connection, a lack of connectivity infrastructure means 53,000 also don't have access to decent home broadband (10 Mbit/s and above) via fixed wireless access connection.

Shared rural networks and neutral hosting (discussed later in this report) are identified as crucial for closing this digital divide in rural areas by making it commercially sustainable for MNOs to roll out coverage. Technological and regulatory developments mean it is now possible for local cooperatives and communities to invest in their own local infrastructure and work with MNOs to provide coverage.

Northern Ireland

In Northern Ireland, rural areas are defined as settlements with a population of 5000 or less, half the number used for rural classification in the rest of the UK. For context, there has been an 18% growth in the rural population between 2001-2017 (compared to just 6% growth in urban areas over the same time period). Almost 1.9m[5] people now live in rural areas across Northern Ireland.

1.9m

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The average annual salary in rural areas is approximately £2k less than in urban areas, and far more businesses are rurally based (58%) compared to urban (42%).

Average home broadband download speeds in Northern Ireland are 63Mbps in urban areas, falling by almost half to 35Mbps in rural locations. By breaking those averages down, we can start to see the extent of the digital divide between rural and urban Northern Ireland.

Superfast broadband speeds over 30Mbps are available to 98% of residential premises in urban areas but only 66% of homes in rural areas. When it comes to ultrafast (greater than 300Mbps) the gap is even bigger, falling to 65% of urban and only 11% of rural homes.

While only 1% of urban homes are unable to access a download speed of 10Mbps or more, this rises to 19% in rural areas, meaning one in five rural homes cannot access the internet with functional speeds.

4G services from all four MNOs are available across just 75% of the Northern Ireland landmass, leaving many regions underserved. Only 61% of premises in Northern Ireland have good indoor 4G coverage from all four operators.

A Department for the Economy spokesperson said: "Project Stratum (Stormont's plan to improve NI's broadband) aims to improve broadband connectivity by extending Next Generation Access (NGA) broadband

[5] 2018-based Population Projections by the Office for National Statistics (Published by NISRA)

infrastructure to approximately 79,000 premises across Northern Ireland that cannot yet access NGA broadband services."

Kate Clifford, from the Rural Community Network, said: "If you are interacting with government, the expectation is you go online to do that. If the government expects that then the government must put in the infrastructure in rural areas that enables people to get affordable, accessible, high-speed broadband to every household in Northern Ireland."

58%

of Northern Ireland's businesses are rural

County Londonderry resident Paddy McEldowney said "the scenery is beautiful, but the broadband situation is probably the biggest downside to living where we live. It's a big equality issue, no doubt about it."

£150m has been allocated to Project Stratum as a result of the Confidence and Supply Agreement, along with additional funding of £15m secured through the Department of Agriculture, Environment and Rural Affairs (DAERA).

The project is at mid-procurement stage. Following a data refresh, the deadline for the submission of tenders was extended to 5 May 2020. Contract award is anticipated in late September 2020 when more information will be available on the full scope of the project, its timeline and how long it will be before citizens see its impact.

The Borderlands

The Borderlands region (comprising the 5 local authority areas of Carlisle city, Cumbria county, Dumfries and Galloway, Northumberland county and the Scottish Borders) represents over 10% of the UK's total landmass. Home to just over 1 million[6] people the region welcomes 59 million visitors annually, as such almost 21% of the employment in the region is in the tourism sector.

The region is home to two UNESCO World Heritage Sites: The Lake District and Hadrian's Wall, as well as The UK's first Dark Sky Park in Galloway Forest Park, one of only four in the western world and of course, Gretna Green, the iconic wedding capital of the UK.

Over 10%

The Borderlands region represents over 10% of the UK's total landmass

The Destination Borderlands programme, a part of the Borderlands Inclusive Growth Deal, is keen to develop rich interactive content using mobile connectivity to attract a range of visitors from the UK and beyond.

The Borderlands economies, aggregated together, accounted for £18bn in terms of GVA in 2013 - roughly equivalent to the GVA generated by the economic activities operating in Tyneside (£17.1bn) or in the City of Edinburgh (£18.6bn).

While large parts of the Borderlands are rural in character, manufacturing activity provides employment for significant numbers of workers in the area. The manufacturing sector is recorded as the largest employer in Cumbria, the second largest in Northumberland and Scottish Borders, and the third largest in Dumfries & Galloway. These figures reflect the fact that, despite long-term decline in traditional industries (notably, coal mining, steel, engineering, shipbuilding, and textiles), manufacturing in its present forms retains a significant presence across the Borderlands. This diverse mix of industrial, agricultural and tourism highlights the multitude of use cases where a lack of digital connectivity poses a significant barrier to growth.

[6] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/816873/Borderlands_Growth_Deal_-_Heads_of_Terms_2019.pdf

Orkney Islands

While the Orkney Islands may have a relatively small population (estimated at 22,190 in 2017), the industry that the area supports far outstrips the current connectivity capabilities.

275,000 approx

tourists pass through Orkney each year

- **Tourism:** With around 175,000 visitors and an additional 160,000 cruise ship passengers and crews visiting the islands, approximately 275,000 tourists pass through Orkney each year.
- **Renewable energy:** There are 43.623MW of installed capacity from large wind turbines in Orkney – with 42 turbines larger than 50kW.
- **Salmon farming:** 16,756 tonnes of salmon – the UK's largest food export – was farmed in Orkney in 2017.

While England's rural economy is by far the largest (81% of the UK rural economy[7]), the rural economy in Scotland contributes a significantly larger share of its national GVA than in the other UK nations – fully 27% of total national output. According to Ofcom, only around 40% of the Scottish landmass has coverage by all four mobile operators, and 20% receives no coverage at all.

The Local Orkney Council said "In our area, we've got the worst broadband in the UK. What we want is parity. It's about getting coverage for our resident population and our visitors to achieve the same in Orkney as they can elsewhere."

216,756 tonnes

of salmon – the UK's largest food export – was farmed in Orkney in 2017

[7] https://uk5g.org/media/uploads/resource_files/5G-RuralFirst-New-Thinking-Applied-to-Rural-Connectivity-1.pdf

A spokesperson from Scottish Sea Farms said "We're 3 miles from Kirkwall on Toyness Marine Farm. We've got 10 cages, with approx. 35,000 salmon in each cage. Connectivity allows me to connect to the feeding systems and cameras from anywhere in the world. Fish farming has grown in the last 15 years in Orkney and is an important part of the economy. Good connectivity will help us improve production and be more sustainable."

MNO Decision Maker Research

While preparing this report we worked with research agency Coleman Parkes to conduct highly targeted quantitative research with UK mobile network operators (EE, O2, Three and Vodafone) on neutral host networks and 5G. In total we spoke to five senior decision makers for network services strategy from each of the MNOs with titles such as CTO, Heads of Network Strategy/Operations/Engineering, Head of Networks and Head of Engineering. A summary of the research findings is below.

70%

of MNOs are open to working closely with rural neutral hosting providers to rollout 5G

MNOs have already investigated the rural neutral hosting approach to 5G (85%) and 70% are open to working closely with rural neutral hosting providers to rollout 5G.

The key motivation for taking this approach is the prospect of improving their reputation and relationships with both national and local governments (80% and 70% respectively), rather than with local businesses and communities (40%).

The increased speed of deployment (75%), cost advantages of network sharing (65%) and the prospect of ready-made infrastructure for 5G (65%) also fall into the top five advantages of adopting this approach.

The MNO leaders surveyed recognise the benefits of neutral hosting and independent neutral hosting to fill coverage gaps (90%), efficiently connect rural areas (85%), and accommodate a wide variety of use cases (70%). Ecouragingly, all MNO leaders surveyed indicated they would prefer both data and voice services to be offered by neutral hosts, rather than just one or the other.

However, in order to support rural neutral hosting, 70% of MNOs would demand to have the same SLAs and architecture interfaces as their competitors. 50% would also want involvement in infrastructure location selection and 40% would want to choose the local provider. Encouragingly, only 20% specified they would want priority over competitor MNOs, indicating a good potential for these providers to work together in harmony.

When it comes to neutral hosting for 5G connectivity, there are some concerns amongst MNO leaders regarding the lack of control over the customer relationship (55%) and the infrastructure involved in delivering the service (50%). These concerns make sense given the MNOs are keen to be involved in location and provider selection for neutral hosting agreements. Interestingly, concerns about the profitability (20%) and scale (30%) of the arrangement are less pressing for MNOs at this stage.

55%

of MNOs have faith in working with neutral hosting providers

Although these numbers are positive, there is a clear divide in opinion when it comes to trust and confidence in working with rural neutral hosting providers. 55% of MNOs have faith in them, whilst 45% do not. This is probably why 70% of MNOs are keen to work closer with neutral hosting providers and 70% and are demanding the same SLAs as their competitors.

Spectrum sharing is also viewed as a beneficial component to modern mobile networks (80%) and is particularly important for 5G networks, but despite this, 60% of MNOs are not prepared for widespread spectrum sharing and report it is more trouble than it is worth (55%).

A key consideration however is that three quarters of MNOs (75%) feel strongly that spectrum sharing will only work if they get something in return, via some kind of quid pro quo arrangement.

MNOs are, unsurprisingly, optimistic about 5G with 85% believing it has the potential to improve the quality of life in the UK's rural communities. 75% also think it will benefit the UK economy by enabling more efficient business models for industries that operate in rural and poorly connected areas such as manufacturing and energy businesses.

Overall, the research shows that key decision makers at all four MNOs are already taking active steps to embrace rural neutral hosting and view it as an effective way of improving rural connectivity and efficiently rolling out 5G. They naturally share concerns around the degree of control afforded to them in a neutral hosting agreement and are predominantly concerned that they're given a fair and consistent experience compared to their competitors.

Shared Rural Networks

Following detailed discussions with MNOs (supported by Ofcom), the UK Government announced confirmation of the 'Shared Rural Network' deal in March 2020.

The rationale behind the SRN deal is that although strong competition promotes industry investment in mobile coverage in dense urban areas, rural areas have fewer potential customers and have not seen the level of investment needed to provide good coverage.

The deal aims to expand each operator's outdoor 4G coverage to 92% of the UK landmass by 2025[8], with specified increases in each of the UK nations. 4G outdoor coverage from at least one MNO is expected to increase to 95% by the same date.

By doing so, the SRN deal aims to benefit small businesses, public services and consumers, spurring economic growth in poorly connected areas and closing the digital divide across the country.

To hit these targets the MNOs are investing a combined £532 million in a contractual obligation to close almost all 'partial not-spots' (areas where at least one but not all operators provide coverage) in the UK's connectivity landscape. The legally binding coverage commitments will be enforced by Ofcom which will have the power to issue fines up to 10 per cent of an operator's gross revenue if they fail to meet their targets.

In addition, this investment is backed by £500 million from the UK government to provide new digital infrastructure in 'total not-spot' areas not commercially viable for the operators.

The Government has said the deal will improve connectivity for 280,000 households and 16,000km of roads across the country.

The Shared Rural Network agreement has three key elements:

- Existing masts would be shared by all four MNOs, at their own cost, in areas where some, but not all, MNOs have coverage.
- Mobile infrastructure built as part of the Government-owned Emergency Services Network in Great Britain would be made available to all four operators, delivering additional coverage, in some of the most remote, rural locations. Applies to England, Scotland and Wales only
- New sites would be built in a number of areas where there is no coverage from any operator. These sites would host all MNOs and would be funded by Government.

[8] https://www.gov.uk/government/news/shared-rural-network

It's important to note that the Shared Rural Network agreement is primarily designed to help close partial not-spots where fewer than 4 MNOs are available in a single area. The agreement does include £500m to invest in infrastructure for total not spots but this does not address the underlying problem with these not-spots: that they are often not financially viable to connect under the current MNO business model. What 5G New Thinking is enabling is a fundamentally new approach to rural connectivity that makes connectivity in these areas more commercially viable, not just simply funnelling grant money into the building of new infrastructure.

Rural Neutral Hosting

To meet the challenge of rural not-spots, MNOs' networks could be supplemented by 'neutral host' infrastructure, addressing the cost and practical challenges of developing rural coverage. Neutral hosting was acknowledged in the government's Future Telecoms Infrastructure Review[9] as a means of avoiding duplicate investments in less economically viable areas.

Neutral hosting allows third parties (including local communities and businesses) to build and own radio infrastructure, working with MNOs to reduce their costs and make coverage commercially sustainable. This concept of infrastructure sharing has been facilitated by new network slicing technologies and spectrum sharing regulations.

There are many potential forms of 'neutral host' infrastructure. At one end, a wireless infrastructure provider might supply passive mast and tower infrastructure only. At the other, a neutral host provider could deploy their own active equipment, transmitting on behalf of MNOs either in their own spectrum or the MNOs' spectrum and delivering a data stream back to the MNO.

Neutral host providers could boost network coverage in rural areas where there is insufficient demand to justify multiple networks.

[9] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732496/Future_Telecoms_Infrastructure_Review.pdf

Fixed Wireless Access

Around 610,000 premises (2% of all premises) cannot get decent broadband from a fixed line connection.[10]

Fixed Wireless Access (FWA) networks use a wireless link for the final connection to a home or business, avoiding the installation of a line into the building. The capacity in the wireless access network is shared between multiple users. The service needs to be managed appropriately to ensure there is sufficient capacity to meet user needs, especially in areas with capacity constraints.

FWA services can be delivered on networks that only serve customers at a fixed location, by Wireless Internet Service Providers (WISPs). In the UK, these networks most commonly use licence exempt or light licensed spectrum such as the 5 GHz band. They can also be delivered on mobile networks, where the capacity of the network is shared with mobile users, using 4G and 5G technologies.

The majority of WISP services are delivered over wireless networks that communicate via a wireless link between a provider's mast site and an external antenna fixed to a customer's premises

The results of Ofcom's data analysis show that as many as 1.6 million homes and businesses in the UK could have a good chance of being able to receive a decent broadband service from a WISP. Of these, 53,000 currently do not have access to a decent (10 Mbit/s and above) fixed broadband service.

In July 2019, Ofcom announced its decision to introduce a new local licensing approach to provide localised access to spectrum bands, which is expected to help the provision of FWA in hard to reach locations. More details included in the Spectrum Sharing section.

[10] https://www.ofcom.org.uk/__data/assets/pdf_file/0023/186413/Connected-Nations-2019-UK-final.pdf

Spectrum Sharing

The aim of spectrum sharing is to promote competition, encourage investment and innovation, and encourage the availability and use of high-speed data transfer services throughout the UK.

Radio frequencies are of significant importance to the UK economy and society because they allow all wireless communications devices, including mobile phones and wireless broadband, to operate. What's more, demand for mobile and wireless data is predicted to increase significantly in the future.

In order to ensure that a lack of access to the radio spectrum does not prevent innovation, Ofcom has introduced a new licensing approach to provide localised access to spectrum bands that can support growth and innovation across a range of sectors.

As of December 2019[11], the shared access licence became part of a new framework for enabling shared use of spectrum, aiming to make it easier for people and businesses to access spectrum for a wide range of local wireless connectivity applications.

Where spectrum is licensed on a national basis to mobile network operators and is not being used in every location, Ofcom will enable access to this spectrum for new users, following discussions with the incumbent licensee to ensure the new user does not interfere with their network or constrain their future plans. Unless the operator raises a reasonable objection, Ofcom will issue the new user with a three-year license for the spectrum.

The shared access licence is currently available in four spectrum bands which support mobile technology:

- 1800 MHz band: 1781.7 to 1785 MHz paired with 1876.7 to 1880 MHz;
- 2300 MHz band: 2390 to 2400 MHz;
- 3800 to 4200 MHz band;
- 24.25-26.5 GHz. This 5G-specific band is only available for indoor, low power licences only.

Two types of licences are available:

- Low power licence (per area licence). This authorises users to deploy as many base stations as they require within a circular area with a radius of 50 metres without further authorisation. People can apply for multiple licenses to cover larger areas as needed.

[11] https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf

- Medium power licence (per base station licence). Given the higher transmit power and larger potential interference area, this licence will be issued on a per base station basis and, generally, for deployments in rural areas only.

The 26 GHz band has been harmonised across Europe as the pioneer millimetre wave band for 5G. By enabling access to the lower 26 GHz band, Ofcom is adding to the spectrum options that would enable deployment of new 5G applications.

Local Access licences for licensed mobile spectrum bands are available for people and businesses to apply for immediately.

Dynamic Spectrum Access

Dynamic Spectrum Access (DSA) would dramatically increase spectrum utilisation through sharing tools. These tools such as dynamic databases, device-based sensing, simple electronic coordination, and smart radios are all available and deployed across the wireless ecosystem. The technical ability exists to automate frequency coordination, lower transaction costs, use spectrum more efficiently, increase time to market, protect incumbents from interference, and generally expand wireless connectivity across the UK.

As an evolution of Spectrum Sharing and shared access licencing, Ofcom is considering a future transition towards a dynamic spectrum access (DSA) approach, supported by a fully automated, central database of different spectrum users across the country.

Network Slicing

Network slicing is a specific form of virtualisation that allows multiple networks to run on top of a shared physical network infrastructure. In practice, network slicing allows a network operator to provide dedicated virtual networks, with functionality specific to the service or customer, over a common network infrastructure.

In the case of 5G, network slicing is expected to play a critical role in 5G networks because of the multitude of use cases and new services 5G will support, each placing different requirements on the network in terms of functionality, performance and security. Network slicing will maximise the flexibility of 5G networks and is likely to be a key technology for neutral hosting providers to understand.

Introducing 5G New Thinking

Neutral hosting can address the connectivity gap in rural areas by making it commercially sustainable to roll out coverage. Technological and regulatory developments mean it is now possible for local cooperatives and communities to invest in their own local infrastructure and work with MNOs to provide coverage.

5G New Thinking will help by providing a practical how-to guide for rural communities looking to invest in local connectivity. By developing this replicable and flexible approach, the project aims to help poorly connected communities build commercially sustainable, next generation networks using 5G technologies.

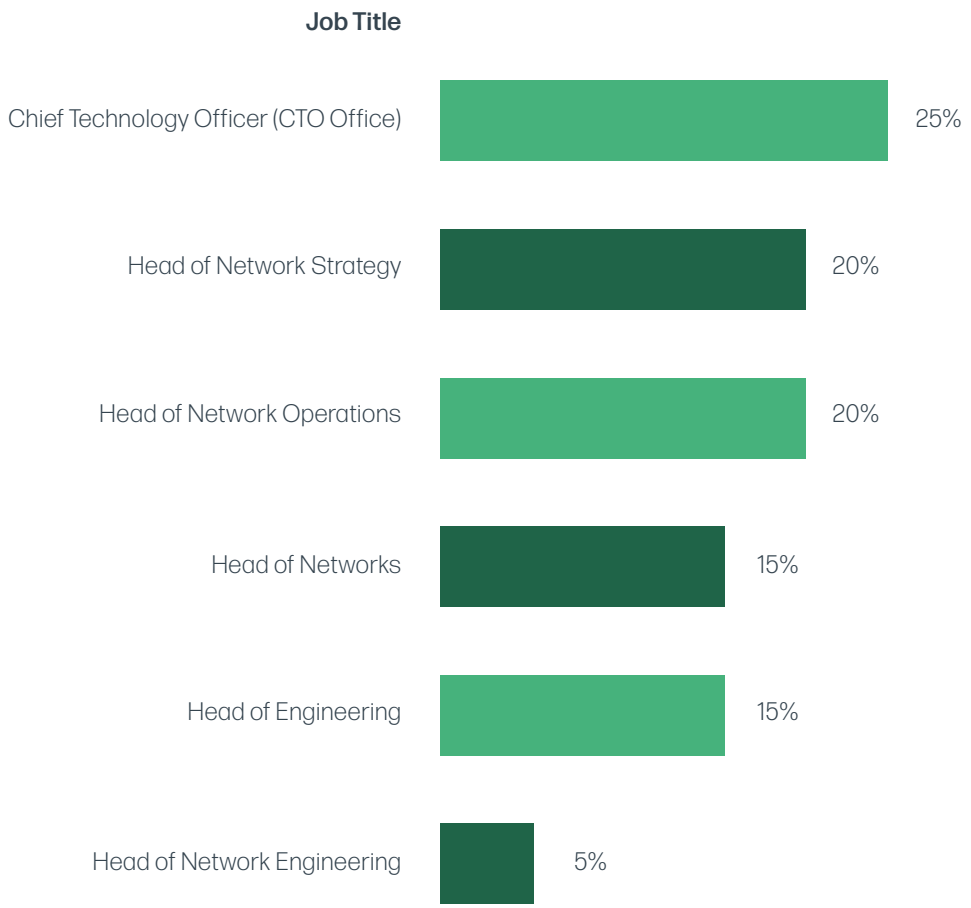
At the same time, by making this guidance widely available, 5G New Thinking aims to stimulate local investment in rural connectivity across the country, demonstrate the viability of this novel approach to MNOs, and start to close the rural digital divide once and for all.

5G New Thinking is committed to providing practical, replicable, and flexible guidance for poorly served communities to take control of their connectivity

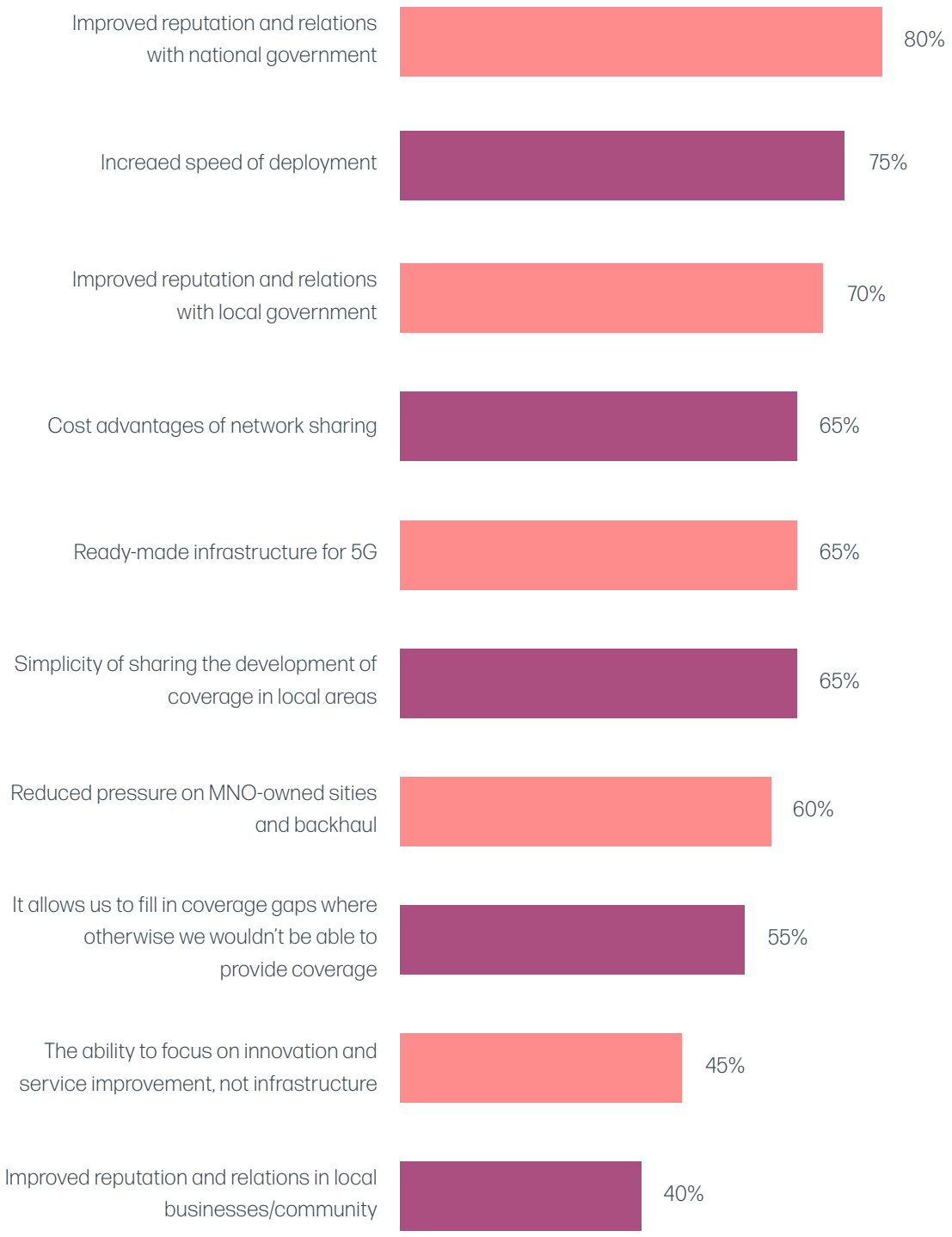
5G New Thinking is committed to providing practical, replicable, and flexible guidance for poorly served communities to take control of their connectivity. Deploying connectivity is a complicated process. While there have been numerous innovation projects and government interventions exploring rural connectivity, none of them have translated into real change. Expert and practical guidance is essential if new regulatory and technological developments are going to reach their full potential and have a substantial impact on connectivity in Britain.

5G New Thinking is unique because it covers all aspects of 5G deployment and rural neutral hosting, from the deployment of new technologies to the commercial feasibility and practicalities of different roll outs. In this way, the 5G New Thinking toolkit aims to deliver broad-scale and permanent connectivity.

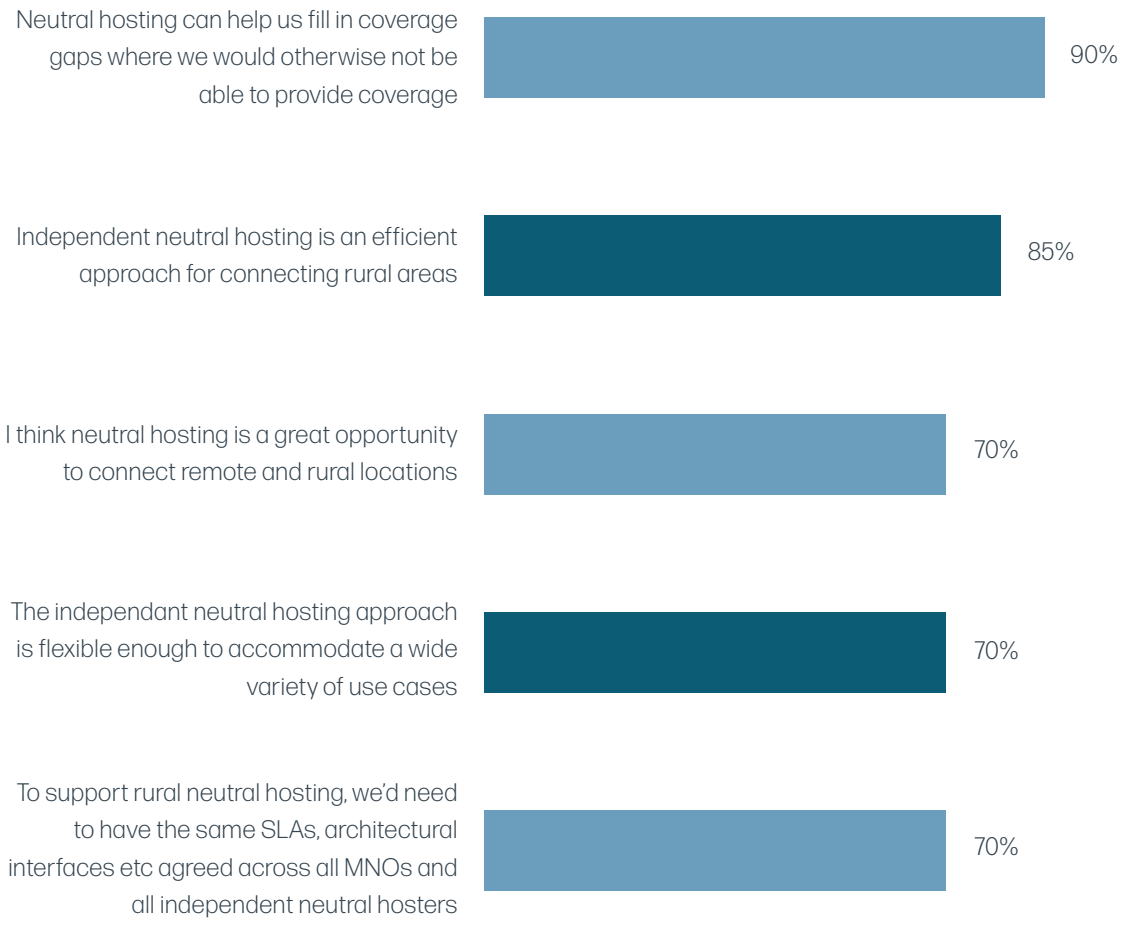
MNO Survey Results



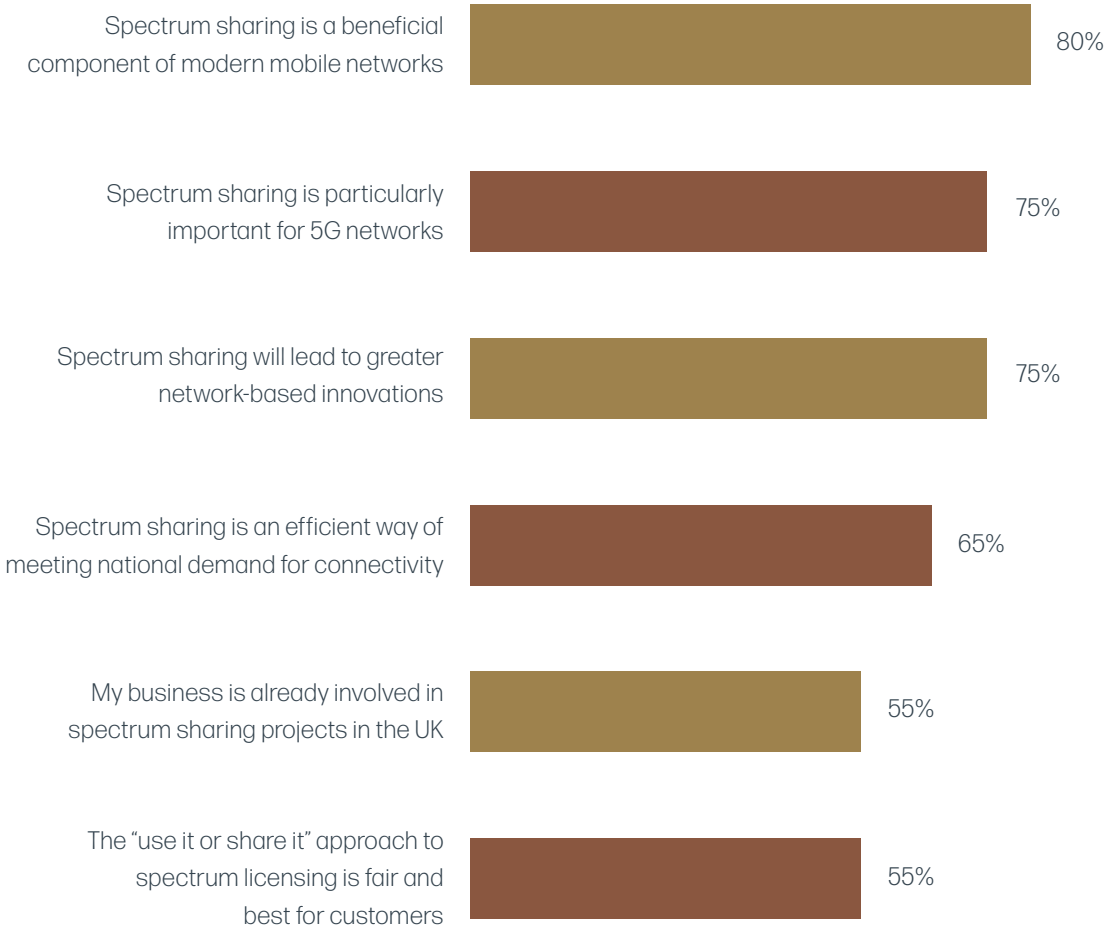
What are the key advantages of taking a rural neutral hosting approach to 5G connectivity?



To what extent do you agree with the following statements regarding neutral hosting?



To what extent do you agree or disagree with the following statements regarding spectrum sharing via Local Access licences (in which access to mobile spectrum by new users is permitted in locations where it is not being used by the existing licensee)?

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