Scottish Government Planning Guidance: Digital Telecommunications

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1 Introduction

The context of the land use planning system

1.1 The land use planning system plays an important role in the delivery and enhancement of world class digital and telecommunications infrastructure across the whole of Scotland. This document explains the land use planning process, the specific roles and functions involved and the technical and operational features of the related infrastructure. It also provides good practice guidance on the siting and design principles of such equipment.

1.2 The document will be of interest to local authorities, telecommunications industry operators and their consultants, local communities, the general public and many other organisations and bodies. Working collaboratively is vital to successful delivery in the provision and consenting of such infrastructure.

1.3 This document is not planning policy but should be read in conjunction with the National Planning Framework 4 (NPF4) and the Local development planning guidance and it may be a material consideration in planning application and appeal decisions (Section 2 refers).

1.4 This publication replaces Planning Advice Note 62: Radio Telecommunications.

The context of modern digital connectivity

1.5 Modern telecommunications and digital connectivity has a central role in unlocking the potential of our places across all of Scotland. It is a fundamentally important utility which allows people to be connected for business and social purposes at work, home or remotely, with greater demands on fixed and wireless communications. It enables people to have immediate access to emergency services, healthcare, education, shopping, leisure etc. It supports living locally and helps to sustain and grow rural and island communities. Lack of coverage in some locations can disadvantage businesses, communities and individuals, both economically and socially, and can contribute to deprivation, social isolation and lack of wellbeing. Scotland competes within globally competitive markets, where productivity is vital, which has to be supported by a communications infrastructure that allow automation, innovation and efficiencies.

1.6 The planning system can assist in addressing the gaps in connectivity and barriers to digital access by supporting the delivery of new digital services and technological improvements, particularly in areas with no or low connectivity capacity. These factors are critical to NPF4 aspirations which seek to:

- tackle climate change and protect local environments from its damaging impacts by reducing the need to travel and to contribute to a net zero society.
- unlock opportunities for businesses, employment and remote working.
- support investment and population growth in rural areas.
- create better places by influencing the pattern and location of development and ensure connectivity is where it is needed.
- build 'smart' communities to facilitate more sustainable ways of living.

1.7 The Scottish Government's 2021 Digital Strategy a changing nation : How Scotland Will Thrive in a Digital World (2021) sets out ambition for high quality connectivity across all of Scotland. This includes closing the gaps in mobile provision and facilitating the grown investment in and deployment of 5G networks, as set out in the Scottish Government's 2019 5G Strategy.

1.8 Through the Reaching 100% (R100) programme, the Scottish Government is committed to ensure that 100% of premises in Scotland have access to superfast broadband. This complements the UK Wireless Infrastructure Strategy which sets targets for mobile connectivity across the UK.

1.9 At the time of writing, despite significant progress large parts of rural Scotland still have little or no mobile connectivity. These are often challenging areas in which to deploy mobile infrastructure because of areas of natural and cultural significance, topography and the economics of developing installations that might only serve small populations and low numbers of passing customers. To address the digital divide that has emerged in these areas, the Scottish Government, the UK Government and the Mobile Network Operators (MNO) are working together to transform mobile coverage countrywide in the Scottish 4G Infill (S4GI) and Shared Rural Network (SRN) programmes. To gain maximum coverage, it is likely that some of the SRN infrastructure will

be tall, but that should reduce the overall number of sites that may otherwise be required in some sensitive landscapes.

2 Overview of the land use planning system

2.1 The purpose of land use planning is to manage the development and use of land in the long-term public interest. For telecommunications and digital connectivity, this means ensuring that Scotland's connectivity aspirations are met, whilst respecting the built, historic and natural environment, and ensuring proposals comply with safety aspects within safeguarded areas (for example near an airport or Ministry of Defence site).

2.2 At the heart of the Scottish planning system is the principle that the development of land requires planning permission before it can be carried out. The Town and Country Planning (Scotland) Act 1997 ("the 1997 Act") provides that development means the carrying out of building, engineering, mining or other operation in, on, over or under land, or the making of any material change in the use of any buildings or other land[1].

The Development Plan

2.3 The Scottish planning system is "plan-led", which means that the development plan is the starting point for decisions on applications for planning permission. By law, planning applications must be determined in accordance with the development plan for the area unless material considerations indicate otherwise (Section 25 of the 1997 Act. refers). Such decisions are generally taken at the most local administrative level.

2.4 The development plan comprises:

- The National Planning Framework
- The applicable Local Development Plan

The National Planning Framework

2.5 This is Scotland's fourth National Planning Framework (NPF4), which was adopted in 2023. It is a plan for Scotland's long term

[1] See section 26 of the 1997 Act for a full definition: https://www.legislation.gov.uk/ukpga/1997/8/contents

development which guides where development and infrastructure is needed, sets out national planning policies, designates national developments and highlights regional spatial priorities.

2.6 NPF4 seeks to encourage, promote and facilitate an infrastructure first approach to land use planning, which puts infrastructure considerations at the heart of placemaking. For the purpose of applying the Infrastructure First policy the meaning of infrastructure applies to communications – including digital and telecommunications networks and connections. NPF4 encourages, promotes and facilitates the roll-out of digital infrastructure across Scotland to unlock the potential of all our places and the economy, support local living and reduce the need to travel. NPF4 (Policy 24) states that development proposals will be supported:

- that incorporate appropriate future-proofed digital infrastructure.
- that deliver new digital services or provide technological improvements, particularly in areas with no or low connectivity capacity.
- where proposals are clearly aligned to the delivery of local or national programmes for the roll-out of digital infrastructure.
- that deliver new connectivity where there are benefits for communities and the local economy.

and will only be supported:

- where the visual and amenity impacts have been minimised through careful siting, design, height, materials and landscaping, taking into account cumulative impacts and relevant technical constraints.
- where it has been demonstrated that before erecting a new ground based mast the possibility of erecting antennas on an existing building, mast or other structure, replacing an existing mast and/or site sharing has been explored.
- where there is no physical obstruction to aerodrome operations, technical sites or existing transmitter/receiver facilities.

2.7 A ‘Digital Fibre Network’ is designated as a “national development” by NPF4. See paragraphs 2.11 to 2.18 on planning applications which explains the development hierarchy. This NPF4 designation “supports the continued roll-out of world class broadband across Scotland. Our

strategy requires enhanced digital connectivity to provide high speed broadband or equivalent mobile services, prioritising those areas with weaker networks as part of the R100 programme…." [2]. This means works to deliver it could occur in any planning authority area and where the classes of national developments are met, planning applications should be processed as national developments rather than as a major application. NPF4 spatial strategy refers to this national development as a: "fundamentally important utility, required to support development, community wellbeing, equal access to goods and services, and emissions reduction from reduced demand for travel".

Local Development Plans

2.8 Local Development Plans (LDPs) set out how our local places will change into the future, including where development should and should not happen. It is a legal requirement for planning authorities to prepare LDPs.

2.9 LDPs should take account of the overall policy approach, as set out in Policy 24 of NPF4, to support the delivery of digital infrastructure, particularly in areas with gaps in connectivity and barriers to digital access. Planning authorities must have regard to Regional Spatial Strategies (RSS) in the preparation of their LDPs. Once statutory guidance on RSS has been prepared and adopted, the duty to prepare RSS will come into force. RSS will provide a long-term spatial strategy which specify the area/s to which they relate, and identify:

- the need for strategic development.
- the outcomes to which strategic development will contribute.
- priorities for the delivery of strategic development.
- proposed locations, shown in the form of a map or diagram.

2.10 LDPs should identify and support national developments which are located in their area of coverage.

Planning Applications

2.11 The specific procedures by which an application will be processed are dependent on whether the proposed development is classified as "national", "major" or "local" under the development hierarchy. More information on the hierarchy of developments is contained in Circular 5/2009. Specific provisions will also apply if a development is subject to

[2] National Planning Framework 4 (www.gov.scot) - Chapter 12. Digital Fibre Network

an Environmental Impact Assessment (EIA). More information on the EIA regulations is contained in Circular 1/2017.

2.12 Some minor operations or changes of use of land may not constitute development which requires planning permission. For example, many of the smallest antenna systems may be covered by the normal principle of *de minimis*[3]; or they may not have a material effect on the external appearance of the building, and therefore may not fall within the legal definition of 'development' requiring planning permission. However, other consents may still be required e.g., listed building consent or scheduled monument consent.

2.13 Once a valid planning application is submitted, planning authorities generally have up to 4 months to reach a decision on proposed national or major developments (and all EIA developments), and up to 2 months to determine proposed local developments.

2.14 Depending on the scale, nature and location of a proposed development, the planning authority may be required to consult with statutory consultees (e.g. NatureScot, the Scottish Environment Protection Agency, Historic Environment Scotland or, as regards safeguarded sites[4], 'relevant bodies' such as the Secretary of State for Defence or airport operators) to help inform the decision-making process.

2.15 More information on applying for listed building consent and scheduled monument consent is available here: Applying for Consents | Historic Environment Scotland | History

2.16 In reaching a decision on a planning application, the authority will consider what, if any, mitigation is necessary to make development acceptable in planning terms. For example, the localised impacts of ground-based apparatus may be such that the planning authority considers the provision of landscaping is required if planning permission is to be granted.

2.17 Planning authorities may consider the use of planning conditions and/or obligations for securing such mitigation. More information on the

[3] Minor to merit consideration
[4] See Planning circular 2/2003 (revised): safeguarded aerodromes, technical sites and military explosives storage areas. - gov.scot (www.gov.scot)

use of planning conditions and obligations can be found in Circular 4/1998 and Circular 3/2012, respectively.

2.18 The Scottish Ministers attach great importance to the prompt and efficient handling of planning matters as any undue delays could have serious consequences for the overall aims of infrastructure roll-out.

Permitted Development Rights

2.19 Permitted Development Rights (PDR) refers to those types of development which are granted planning permission through national legislation in the Town and Country Planning (General Permitted Development) (Scotland) Order 1992 ("the GPDO"), meaning they can be carried out without a planning application.

2.20 PDR are organised into a series of "classes": each class specifies the type(s) of development for which planning permission is granted. Most PDR are subject to conditions and/or restrictions. These may, for example, specify the maximum size or scale of what is permitted, restrict or dis-apply the rights in certain locations (e.g., conservation areas or national scenic areas), or provide that the PDR only apply to certain developers (e.g., statutory undertakers).

2.21 Class 67 of the GPDO sets out the PDR for development by or on behalf of an electronic communications code operator (ECCO) for the purposes of the operator's electronic communication network in, on, over land controlled by that operator or in accordance with the Electronic Communications Code. Class 67 covers a variety of different types of digital and telecommunications infrastructure, equipment and apparatus. Additional information can be found in Annex G of Circular - non domestic permitted development rights which sets out what sort of developments can be carried out and the limitations which apply in certain designated areas and other key provisions.

2.22 PDR do not alter or dis-apply the requirements of other regulatory regimes which must by complied with. For example, there may be a requirement to secure listed building consent, scheduled monument consent or to meet requirements under the Nature Conservation (Scotland) Act 2004 or the Conservation (Natural Habitats &c.) Regulations 1994.

2.23 Where an existing ground based mast is to be increased in height and/or replaced under PDR in a safeguarded area around an

aerodrome, technical site, meteorological technical site or military storage area, the developer must notify the relevant body, which is:

- the owner or operator of the aerodrome or technical sites identified on the map identified by the Civil Aviation Authority.
- the Secretary of State for Defence.
- the Met Office.

2.24 Planning authorities can advise developers whether a site is within a safeguarded area and which body should be notified. Similar requirements apply to PDR for new ground based masts in safeguarded areas and link to a prior notification/prior approval process.

2.25 PDR for certain types of development within Class 67 is subject to the condition that the developer must give written notice to the planning authority of their intention to carry out the development at least 28 days before development is to commence and must include a detailed description of the development, a plan showing its location and, if relevant, an International Commission on Non-ionizing Radiation Protection (ICNIRP) declaration (paragraphs 4.6 and 4.7 refer).

The granting of PDR subject to 'prior approval' regime

2.26 Depending on the type of development proposed under Class 67, the developer may need to, before carrying out the relevant works, apply to the planning authority for a determination as to whether prior approval is required in relation to certain aspects of the proposed development, such as its siting and design. Planning authorities have set timescales within which to make a determination as to whether prior approval is required and also to grant or refuse prior approval.

2.27 When determining applications for prior approval, it should be noted that the principle of the development is already established through the GPDO. Only policies relating to those matters subject to prior approval can be taken into account.

2.28 Prior approval can be granted or refused by the planning authority. There is a right of appeal to Scottish Ministers against the refusal of prior approval or against conditions attached to the grant of prior approval, as prescribed in Class 67 of the GPDO.

2.29 More information on the prior approval regimes which apply under Class 67 is contained within Annex A of this document and within Annex G of Circular - non domestic permitted development rights.

3 Working together for the delivery of highly effective communication infrastructure through the planning system

3.1 Many parties have a part to play – and collective interest – in the delivery of digital connectivity infrastructure. Recognising this can allow greater stakeholder input and constructive collaboration. It can also encourage trust between parties and promote open and positive working relationships. Early engagement and collaboration between relevant parties will better inform decisions on land use and is key to achieving best practice in the delivery of such infrastructure.

The role of central governments

3.2 The Scottish and UK Governments have a role in working collaboratively with the communications industry to ensure policy and regulation is kept up to date with industry changes, technological change and opportunities. This involves setting the overall strategy for connectivity, and in framing appropriate policy, guidance and regulation within their specific remit as follows:

- **Electronic communications** is a reserved matter for the UK Government and is regulated by the communications regulator (Ofcom).

- **Land use planning matters** are a devolved function of the Scottish Government.

The role of planning authorities

3.3 Planning authorities (including the national park authorities) must determine applications on planning grounds only. The following factors can assist in efficient and effective decision making within the planning system.

- **Engagement with Operators –** planning authorities should respond positively to requests for engagement and ensure decisions on applications and prior approvals are made timeously.

- **Expertise –** planning authorities are encouraged to consider having a member of staff with skills in this area who can act as a champion. This expertise could help in shaping any local digital strategy and

help to implement the delivery programmes at a national and local level. It could help provide a bridge between the operators, planning authorities and relevant stakeholders by helping to frame any proposed development within the wider context of the benefits such connectivity brings. This would provide positive outcomes in the smooth deployment of infrastructure and for building more effective relationships between local authorities and telecommunications providers.

- **Facilitating sites** – planning authorities are often large landowners within the local area and may hold land in strategic locations which is suitable for new infrastructure. An understanding and mapping of where there are coverage shortfalls could help improve connectivity more efficiently. Local authorities' networks and relationships with local business can also help to identify the need for improved connectivity and the availability of land and buildings.

- **LDPs** – planning authorities when preparing their LDPs should ensure connectivity ambitions are recognised in line with the NPF4's overall policy approach for digital communications infrastructure, set out in Local development planning guidance. Local authorities should take account of existing and future provision of digital infrastructure in developing their spatial strategy. Preparation of LDPs is a collaborative activity, and the communications industry is an important stakeholder in this. The Evidence Report stage offers an opportunity for early engagement particularly with relevant local authority departments, operators and providers in relation to programmed investment in digital within their area.

- **A point of contact for consultation/engagement –** it can be useful to have a designated point of contact available who can, for example, provide assistance on preferred locations in proposed new sites; offer guidance on proposals for significant upgrades in existing sites and any relevant infrastructure plans such as major new developments; and identify commensurate and proportionate information requirements for applications.

- **Determination of planning applications** – planning authorities should:

- Give appropriate weight to the advantages of the provision of technology, particularly to the local community and economy, as well as to other strategic policies of the local area, in line with NPF4.

- Understand the technical, operational and topographical constraints of delivering fixed and wireless communication infrastructure, services and networks.

- Work with the operator to find solutions that might help overcome barriers to the grant of planning permission.

- Not treat radiofrequency radiation, which is controlled and regulated under separate legislation, as a material consideration but ensure a declaration relating to ICNIRP (see paragraphs 4.6 and 4.7) has been submitted. This applies where the application relates to an installation of an antenna to be employed in an electronic communication network.

- Ensure that it has been demonstrated that communications infrastructure is not expected to cause any physical obstruction to aerodrome operations, technical sites or existing transmitter/receiver.

- Decisions should be made timeously, while working within due process and facilitating collaboration between stakeholders to address/mitigate issues, being mindful of local and national programmes – e.g., SRN.

The role of the operators/applicants for planning permission

3.4 The operator/applicant should ensure that development proposals incorporate appropriate, universal and future proofed digital infrastructure to ensure successful delivery of national and local programmes for roll-out of infrastructure across Scotland. This is with a strong focus on areas with no or low connectivity capacity and where there are benefits of such connectivity to communities, local economy and reducing the need to travel.

3.5 The following factors can ensure that operators and the wider industry adopt best practice in network roll-out:

- **Share information –** As part of the planning decision making process, operators may wish to provide the planning authority with details on any other mobile telecoms infrastructure on the building, site or local area to best inform the siting of any proposed apparatus.

- **Site selection –** Operators should ensure that landscape, visual effects and amenity impacts are minimised through careful siting and design, taking into account cumulative impact and relevant technical constraints. Operators should make use of existing buildings, structures, sites and masts, wherever practicable, to reduce the need for new development and reduce the environmental impact and visual intrusion of installation. This may involve redeveloping an existing site, including the installation of a replacement mast to accommodate additional equipment. It is vital that the implications of the development plan, any heritage assets and landscape, safeguarded sites or environmental designations are taken into account to ensure impacts are minimised and the most appropriate site is chosen. NPF4 Policy 4: Natural Places ensures our locally, regionally, nationally and internationally important natural assets are protected whilst Policy 3: Biodiversity supports development that helps to secure positive effects for biodiversity. Scottish Government Draft Planning Guidance: Biodiversity sets out a number of commonly used and widely applied 'principles' which can be followed when designing development so that nature and nature recovery are an integral part of any proposal.

- **Engage positively –** Operators should be proactive in their engagement with planning authorities, stakeholders, site owners and communities in pre-application discussions. Early discussions between the operators, planning authorities, statutory consultees and communities about the location, specific purpose of the proposal, design and style of proposals and any operational constraints is encouraged to helpfully clarify expectations and reconcile local and commercial interests.

- **Engage in the LDP preparation process** – Contributing to the preparation of the Evidence Report, and engaging with the Proposed

Plan, will help to ensure that LDPs provide a supportive context for digital communications infrastructure as per the ambitions of NPF4.

- **Submit good quality planning applications –** Operators/applicants when applying for planning permission should focus on the principles set out within the context of NPF4 as a whole. Applicants should provide details of the site selection process where deploying a new mast (e.g., to demonstrate that options for making use of an existing building, mast or other structure have been explored) and site-specific information on construction, maintenance and restoration. The supporting information should also demonstrate mitigation measures which seek to minimise impacts. Accompanying plans, design statements and visualisations should form part of the submission. Where relevant, an ICNIRP declaration (paragraphs 4.6 and 4.7 refer) should be included.

- **Remove redundant apparatus –** Operators must comply with any conditions requiring the removal of redundant equipment, and in any event should ensure that apparatus which is no longer in use is removed as quickly as possible after it ceases use.

The role of other stakeholders

3.6 Other stakeholders, including statutory consultees and local communities, also have a key role in the planning process. Early engagement is encouraged in order for local people to have their say and their representations taken into consideration. Timeous and open collaboration is essential with key agencies, such as NatureScot and Historic Environment Scotland, or other bodies, such as 'relevant bodies' in relation to safeguarded areas, which may, for example, include discussion around design and siting options and achieving mitigation solutions.

- **Local Development Plans -** Interested stakeholders have an important role to play in supporting the collaborative preparation of LDPs. It is helpful if stakeholders are able to help a planning authority to understand and respond to the connectivity issues and impacts caused by telecommunications and digital infrastructure in the area. Where such matters have been raised in local place

plans, stakeholders may wish to refer to those plans in onward engagement with the planning authority.

- **Local Place Plans -** Community bodies are able to prepare local place plans. Where a community has an aspiration for improved telecommunications and digital connectivity and the infrastructure that goes with it, this could be set out in a local place plan.

- **Consultation on planning applications -** When contacted by the planning authority, statutory consultees and development site neighbours should ensure they engage, as relevant, in the planning process and submit their comments within the given timeframe.

4 Siting and design factors

4.1 This chapter explains the benefits of carefully planning and designing proposals for digital infrastructure and the steps involved. The paragraphs include references to technical terms so you may find it beneficial to read in conjunction with Annex B of this guidance which provides a basic technical summary of how digital communications and fixed line networks operate. NatureScot standing advice on planning consultations for telecommunication masts in National Scenic Areas, National Parks and Wild Land Areas may also be helpful.

General principles

4.2 The Scottish Government's national planning policy is intended to encourage, promote and facilitate the roll-out of digital infrastructure, including fixed line and mobile connectivity, across Scotland.

4.3 As set out in NPF4, development proposals will be supported where the visual and amenity impacts of the proposed development are minimised through careful siting, design, height, materials and landscaping, taking into account cumulative impacts and relevant technical constraints. Infrastructure which is carefully planned from an early stage of the development process can mitigate adverse impacts and is vital in fulfilling policy aims. There should be no physical obstruction to aerodrome operations, technical sites, or existing transmitter/receiver facilities e.g., minimum antenna operating heights.

4.4 Good siting and design principles should not only be respected in sensitive areas but should be applied to proposed development across all areas of Scotland. This can create better places in which we live and work and help to make development acceptable to communities.

4.5 A range of constraints can affect site selection and the siting and design of electronic communications equipment, including:

- terrain or topography affecting radio coverage and wireless radio transmission backhaul.
- natural and historic environment considerations.
- capacity in urban areas where the data usage is in high demand.
- relationship with the landowner.
- availability and cost of access to the site and a power connection.
- availability of fibre to provide transmission links to the surrounding network.
- potential need for additional equipment may be needed where there is no clear line of sight (LOS) as objects and obstructions in way can cause signal weakness, resulting in slow and unpredictable service.
- radio frequency and compliance with ICNIRP (see paragraphs 4.6 and 4.7)

Protection from exposure of radio frequency electromagnetic fields

4.6 It is a statutory requirement that applications for planning permission or prior approval should be accompanied by a declaration that the development, if it involves the construction of one or more antennas, has been designed to operate in full compliance with the requirements of the radio frequency public exposure guidelines of the ICNIRP. This aims to protect people and the environment against adverse effects of non-ionizing radiation.

4.7 Public compliance is determined by mathematical calculation and implemented by careful location of antennas, access restrictions and/or barriers and signage as necessary. Members of the public cannot unknowingly enter areas close to the antennas where exposure may exceed the relevant guidelines regarding public access.

Site sharing

4.8 The Electronic Communications Code (Conditions and Restrictions) Regulations 2003, as amended, ("the Code Regulations") require an operator to share the use of electronic communications apparatus, where practicable. Site sharing minimises the number of sites required and reduces proliferation. In the light of this, operators have site sharing arrangements with each other and with the wholesale infrastructure providers. They also have similar arrangements with the utilities and some large landlords.

4.9 When operators are seeking to deploy new sites, they will therefore look first at maximising site sharing opportunities and facilitating prompt delivery without the need to search for new parcels of land and to have to enter into potentially lengthy negotiations and legal agreements on an individual basis. These potential sites may offer additional benefits, such as having existing or ready access to a power supply, access to fibre or an existing vehicular access. Sharing will often enable quicker and more economic installation and, subject to requirements, additional equipment may be undertaken under PDR.

4.10 The Scotland 5G Centre's Infralink toolkit can help to facilitate the process of facilitating site sharing on public assets. Comprising standard leases, wayleaves and pricing guidance, Infralink focuses on making the process of siting and operating mobile network equipment easier and faster. The toolkit is freely accessible at Home - Scottish Futures Trust – Infralink

Installing the smallest suitable equipment, commensurate with technological requirements

4.11 Although operators will aim to install apparatus providing the optimum radio solution, appropriate alternatives should also be considered. For example, for a new mast located on a public road, instead of a lattice mast with headframe and exposed antennas, a slimline pole with tightly packed antennas within a shroud may be preferred.

4.12 Small cell technologies (such as microcells and picocells – discussed at Annex B) usually consist of small antennas. These do not look dissimilar to an alarm box on buildings and can be installed on other structures in built-up environments like street lighting columns. These are not a replacement for a base station, as they can only provide

coverage and capacity over small areas, such as individual streets and buildings. They compliment the existing macro network, improving capacity or covering partial not spots, particularly, though not exclusively, in urban areas and the use of 5G technology.

Concealing or disguising equipment

4.13 Operators can use techniques or design solutions that help to camouflage or conceal equipment in order to minimise visual impact. This practice is encouraged wherever appropriate. However, using certain techniques can come with compromises in radio performance and so may not be achievable in all circumstances and/or may lead to the requirement for additional base stations. In addition, some camouflaging techniques can present bulkier and more obtrusive features, where the existing pole mounted antennas may represent a slimmer design requiring less support bracketing and ancillary support equipment.

4.14 Antennas may also be effectively concealed by similar methods. These can include features such as:

- flagpoles
- slimline poles or telegraph pole style designs
- church towers (generally behind louvres).

4.15 These techniques may not be appropriate for larger antennas or where ancillary development needs to be located around the antennas, in the case of 5G, solutions intended to conceal the development may have limitations where they add to the overall massing of apparatus and increase wind loading.

4.16 When a base station is upgraded, there may be a need to install additional antennas and equipment onto the site – this can result in increased height and width and possibly an increase in the footprint. Upgrading an existing base station is important because each one creates the parameters for the neighbouring stations; where the impacts of additional or larger equipment are not acceptable, another base station will need to be found to house the additional equipment.

New ground based mast

4.17 Should mast or site sharing not be possible then land suitable for a new ground-based mast is sought.

There are two main stages in the operator's site selection process.

1. The operator uses computer-based radio planning tools (or increasingly user evidence) to identify gaps in coverage, then predict levels of signal strength and coverage from nominal locations to fill these gaps. This analysis includes both geographic coverage gaps and capacity gaps or 'bandwidth'.

2. The operator looks at specific options to fill the gap(s). This starts with the operator identifying a specific area of search within which a number of alternatives may be suitable. However, within this search area, topography, physical features and existing development can limit siting options and design solutions. The search for a suitable site also takes into account local development plan requirements, landscape character, natural and historic environment considerations and visual and landscape impacts.

4.18 Whilst mast sharing or use of other infrastructure should always be considered, it may not be an appropriate environmental or technical solution in all cases. Whilst the overall landscape, visual and other impacts (e.g., peat and archaeology), of a network is minimised by mast sharing, localised visual impact may not be. Alternatives to mast sharing may sometimes be preferable – for example, where additional equipment would lead to clutter, detract from the aesthetics of the existing installation, or increase the structure height to an unacceptable level. Other constraints on mast sharing could include:

- **coverage problems:** the existing mast may be poorly located or of insufficient height to give the required coverage. Where multiuser third party sites originated for other purposes, such as utilities management and other forms of broadcast, these may not be optimum locations for radio coverage.

- **radio interference:** in many cases, antennas need a set amount of vertical separation. This may result in an increased height of a mast.

- **structural loading**: the existing mast may not be able to safely hold extra equipment. The existing mast may need to be strengthened or replaced with a larger structure, which could affect visual amenity.

4.19 There are many ways that the environmental, landscape and visual impact of a ground-based mast can be mitigated. These include:

- **placing a mast close to similar structures**. Visual impact can be lessened by siting masts in locations that already contain engineered forms and structures such as industrial and commercial premises or major road junctions where road signs, lamp posts and traffic lights are present.

- **placing a mast in or adjacent to existing trees**, which may include planting trees to help integrate it in the landscape. This option is likely to be more feasible in or near wooded areas. Care should be taken to avoid the unnecessary loss of existing trees and siting outwith the crown of the tree should be sought. In addition, it should be borne in mind that antennas would need to be located above the tops of the trees to operate effectively (with allowance of future tree growth for non-mature trees). NPF4 Policy 6 has an intention to protect and expand forests, woodland and trees, reflecting Scottish Forestry's Control of Woodland Removal Policy.

- **where no visual screening is available**, slimline lattice masts may be the most effective design solution. Their light-permeable structure can help to reduce the visual mass and bulk of the development. Locations where the mast can be backdropped by topography in main views are preferred.

- **appropriate colouring** – for example, masts that are most often viewed against the sky, are best left with a galvanised finish or coloured pale grey. Against a wooded backdrop, colouring the equipment a matt green or brown colour could be more appropriate.

Equipment housing cabinets

4.20 Equipment housing cabinets can range in size from small street-side cabinets to purpose-built buildings which can contain apparatus for

a number of operators. These are needed at every base station to support networks. They need to be located as close as possible to antennas, to reduce feeder loss through the connecting cables, and must be of sufficient size to allow for air circulation to reduce the potential of equipment overheating.

4.21 The cumulative impact of cabinets can be significant, especially when located on pavements or other areas of 'public road'. The cabinets should be coloured to blend in with its surroundings and, where appropriate, screened with landscaping and/ or planting.

Equipment compounds

4.22 With the exception of street pole installations (apparatus sited by statutory undertakers), fencing is normally required around ground-based masts and equipment housing. The scale of fencing required is dependent on the location. In urban areas, higher fencing may be required. In all cases its form and colour should be appropriate to the setting. In rural areas, there may be no need for fencing, or a post and wire stock proof fence may suffice. Security measures should be appropriate to the circumstances.

4.23 The impact of an equipment compound can be minimised if the compound is unsurfaced or by using natural surface material appropriate to the landscape's character. In some cases, the equipment can be attached directly to solid rock where it is exposed at surface level. Any hard surfacing should be permeable and kept to the minimum necessary. Compound enclosures will need to reflect local requirements - high palisade or chainlink fencing may be needed where security is an issue, timber stock proof or deer proof fencing may be suitable in some cases, and in other situations where locations are visually sensitive drystone walling may be utilised. Planning authorities should discuss appropriate options with the applicant.

Access Tracks

4.24 Access is required in order to build and maintain base stations. This can be a constraint in some locations due to a combination of soft ground, topography and the large heavy machinery needed to bring in the apparatus and construct the base station. Access tracks can also be vital for resilience reasons - some remote sites are backed up by generators for when power sources fail. At such times, when

connectivity is most needed (e.g., during extreme weather), any maintenance may not be possible without an access track.

4.25 Frequent use by vehicles on wet or soft ground can itself lead to deep rutting, particularly where several operators are sharing a mast or site with hydrology impacts leading to significant 'scouring'. In these circumstances, the construction of a new access may be less harmful. [5]NatureScot's good practice guide, 'Constructed Tracks in the Scottish Uplands' aims to increase understanding and awareness of the natural and historic environment impacts of track construction, management and use. The impact of a new access track can be reduced by:

- relating it to field boundaries and other features.
- following the boundaries of natural vegetation.
- following the contours of the land and fitting with the landscape.
- addressing land drainage issues.
- redressing all cuttings and banks with the existing indigenous vegetation stripped along the route.
- avoiding adverse impact on historic environment assets.
- using appropriate surface materials and greening of tracks.

4.26 Proposals should be designed and constructed in line with NPF4 Soils Policy 5. This will include following the mitigation hierarchy by first avoiding and then minimising the amount of disturbance to soils on undeveloped land and in a manner that protects soil from damage including from compaction and erosion and that minimises soil sealing. For the design and construction of temporary and permanent access tracks, best-practice should be followed, informed by site survey data (e.g., peat depth surveys). Mitigation measures include avoiding areas of deep peat and use of bog matting and low-pressure vehicles to minimise disturbance, floating tracks, appropriately designed cut batters and ensuring verges are quickly re-vegetated.

Ancillary equipment

4.27 Ancillary equipment can include handrail, ladders, fences, steps and ramps. These ancillary elements are often installed under PDR and their appearance and location may be defined by health and safety

[5] Constructed tracks in the Scottish Uplands (cairngorms.co.uk)

requirements. Where possible, the impact of ancillary equipment can be reduced by:

- installing equipment in areas that are inconspicuous.
- keeping equipment to the minimum and as uncluttered as possible.
- avoiding contrast with or compromising architectural detail to minimise impact.
- concealing equipment or exploiting architectural detail to minimise impact.
- colouring equipment to blend in with background.

Installation on buildings or other existing structures

4.28 Operators need to bear in mind the height, scale and architectural style of the building or structure when considering the appropriate design of the equipment to be used. Particular attention will need to be given when considering installing equipment which may affect the fabric or setting of historic environment assets (paragraphs 4.44 to 4.47 refer). Developments in designated areas may require other consents in addition to planning permission and PDR such as listed building consent. When placing equipment on existing buildings or structures, operators should aim as far as is practicable for development to:

- keep in proportion to the building or structure.
- respect architectural style.
- have minimal impact above the roofline as far as practicable.
- minimise impacts on important views and skylines.
- avoid creating excessive clutter.
- minimise fixings and other physical impacts on the building fabric.
- use clean lines and maintain symmetry.
- be coloured to correspond with the background or to reduce contrast.

4.29 A variety of solutions may apply, to minimise the visual impact e.g., placing equipment below a roofline or against existing rooftop structures, such as a plant room, and colouring it to match. Where possible, positioning equipment in a group with symmetrical order can help achieve a balanced composition.

4.30 New technologies can have different radio characteristics and, in order to meet ICNIRP guidelines, antennas may need to be located above a building's roof or may not be capable of being, for example,

face mounted. To accommodate more technologies and more frequencies, more ancillary apparatus to support antennas may be required – this apparatus generally needs to be close to the antennas to limit signal loss. These technical considerations will need to be taken into account in the assessment of planning applications.

Urban Areas

4.31 In urban areas, increased call and data transfer volumes put high demand on the capacity of networks, potentially leading to the need for more infrastructure.

4.32 Antennas on tall buildings often cannot reach the street immediately below due to the shadowing of the building itself. The roofscape of a whole town or city needs to be considered in planning a network within a dense urban area with mixed roof heights. Thick stonework and other building materials can inhibit signal strength within buildings and in lower floors such as basements. All buildings can block radio signal from antennas on adjacent buildings and street level antennas may not provide coverage to the taller surrounding buildings.

4.33 The way in which the 5G radio network operates means that additional elements of equipment are required to combine and regulate the interplay between the antennas and the radio equipment. This combined with the apparatus providing 2G, 3G, and 4G services, will lead to apparatus which may be significantly taller and have a greater visual impact than the networks which went before.

4.34 Most new apparatus will be concentrated in urban areas, where user demand is greatest. Areas that already have engineered forms and structures usually offer the best opportunity for siting equipment. However, these options may not always be available within the operator's coverage, or search, area. Less visually sensitive areas where the use of standard equipment may be more readily acceptable could include:

- industrial areas
- commercial buildings and business parks
- traffic junctions
- land close to railway lines
- land adjacent to main roads
- pylons
- telephone exchanges

4.35 Where located in suburban or residential areas, larger new masts should, where possible, be located away from direct views from main habitable windows. In these areas, operators often install smaller apparatus on roadsides and pavements as this represents the best balance of radio coverage and environmental and visual impacts.

Rural and Remote Rural Areas

4.36 'Not spots' (both total and partial[6]) can, and are more likely to, occur in remote locations. Historically, the operators have provided coverage to population centres, as this made more commercial sense. This has left large areas and dispersed communities with little in the way of mobile coverage. There are also large unpopulated areas where there may be no population but there are visitors and those travelling through on road or rail. Furthermore, the Scottish and UK Governments both aspire to have ubiquitous coverage because mobile broadband is a facilitator technology, and it is needed in these areas for interconnections via the internet of computing devices embedded in everyday objects. This enables technology to send and receive data to serve various applications (for example for agriculture, tourism, emergency services, monitoring protected species, air quality, applications for drone guidance etc). The Shared Rural Network (SRN) has been instigated to deal with both these total and partial not spots.

4.37 The often rugged and mountainous topography of rural Scotland adds to this challenge and signals can be blocked by hills and forests. Adding to the problem of receiving coverage from base stations is how the data is linked back into the network (backhaul). A lot of rural areas have no existing fibre infrastructure and the lack of existing masts, combined with topography, can make LOS between masts difficult to achieve. Likewise, easily accessible power also introduces complexity and expense in the provision of coverage in rural areas. This will have implications for the siting and appearance of new masts, where taller masts are expected but that should reduce the overall number of sites that may otherwise be required in some sensitive landscapes.

4.38 Whilst ground-based masts will be essential to provide these services, the landscape quality of rural areas can be damaged by insensitively sited electronic communication installations. The impact can be heightened where equipment can be seen over long distances.

[6] Total not spots (TNS) are areas where there is no coverage from any of the operators and partial not spots (PNS) are areas where there is coverage but not from all the operators.

Understanding an area's landscape will help in designing sensitive proposals. Landscape sensitivity is a measure of the ability of a landscape to accommodate change arising from specified types of development or land management. Landscape Character Assessments covering the whole of Scotland are available from NatureScot and can be used to inform sensitivity studies where relevant.

4.39 For equipment cabinet in rural areas, existing landscape features such as planting or rocky outcrops can provide effective screening.

4.40 Often the way to provide power to a remote location is by installing new overhead powerlines, but this will usually add to the landscape impact and in forested areas it will require maintenance of a clear corridor. When choosing a location close to a sensitive site e.g., SSSI, consideration should be given to any underground trenching work required. Impacts on the historic environment as a result of overhead or underground provision should be understood and mitigated. Planning authorities should be aware that power lines are often installed by electricity suppliers exercising their own PDR.

4.41 Another option in rural areas, often for resilience purposes, is to use a generator, though refuelling and maintenance will add to the operator's costs and where there is no access track, all-terrain vehicles can cause erosion, through operators typically visit sites for maintenance rarely and try to reduce this as much as possible. Ideally, a generator should be sited where it can be refuelled from an existing road or access track and connected by cable to the base station. The installation of a generator should comply with the design standard set by The Water Environment (Oil Storage) (Scotland) Regulations 2006.

4.42 In areas where a permanent mains power source is not achievable then solar arrays may be used as the primary power source to power base stations. In comparison to the mast these are relatively low profile pieces of infrastructure that typically site within the telecoms base station compound. Power via solar arrays usually works in tandem with a long-life battery and a back-up generator so that the base station can remain operational at times of low sunlight. The solar arrays can drip re-charge a battery (as will the generator) and, between them, significantly reduce the time a backup generator may need to be running.

4.43 Power via solar array has many benefits. This is a renewable power source so significantly reduces the carbon footprint of running a base station. It can negate the need to impact a landscape by using overhead power lines or underground trenching and it will significantly reduce the need to visit a site to refuel the generator, as the vast majority of the power will be supplied via the solar power and battery meaning the generator is only running by exception.

Historic Environment

4.44 NPF4 recognises the social, environmental, economic value and cultural identity of the historic environment. The planning system should protect and enhance the care and protection of the historic environment including listed buildings, scheduled monuments, conservation areas, historic gardens or designated landscapes, world heritage sites and historic battlefields, as well as non-designated heritage assets.

4.45 Historic Environment Scotland, as a statutory consultee in the planning process, provides specialist advice and should be involved in certain circumstances, which may include pre-application discussions. The Historic Environment Policy for Scotland (HEPS[7]) should be taken into account whenever a decision will affect the historic environment.

4.46 Potential impacts on historic assets and places need to be balanced against the benefits that increased coverage brings – at both the local and national level. Where possible, site selection processes should avoid historic environment assets (and their settings). However, where this is not possible, any detrimental impacts should be minimised. This could include the use of micro-siting or alternative design options. Locations with heritage designations, however, should not be subject to poor connectivity simply because locating equipment there may require non-standard equipment and creativity in deployment approaches. Appropriate archaeological mitigation strategies may be required to address impacts on some sites. Information and advice should be sought from the relevant local authority, and Historic Environment Scotland where appropriate, at the outset.

4.47 It is an offence to carry out works to listed buildings or scheduled monuments without first obtaining the necessary consents. Any impacts on their setting must also be considered as part of the site selection and

[7] https://www.historicenvironment.scot/advice-and-support/planning-and-guidance/historic-environment-policy-for-scotland-heps/

design process. Further information on these consents is available from Historic Environment Scotland: Applying for Consents | Historic Environment Scotland | History.

Public Roads

4.48 As statutory undertakers, operators benefit from rights within The New Roads and Street Works Act, as amended by the Transport (Scotland) Act 2005, supported by relevant Regulations and Codes of Practice for all 'works in roads' in Scotland. They can install and maintain equipment on public roads. In areas where there are no suitable buildings or land available for the installation of communications infrastructure e.g., suburban and residential areas, the option of installing equipment on the public road is often pursued. Engagement with the roads authority will allow for safety issues to be considered.

4.49 A standard 'street works' style installation would generally comprise a slimline mono-street pole with antennas and associated ground-based equipment cabinets. All streetworks equipment installed on the public road should comply with the necessary visibility splays and ensure that sufficient footway width remains to allow safe movement by the public.

4.50 Operators must comply with any conditions on planning permission or on PDR requiring the removal of redundant equipment, and in any event should ensure that apparatus which is no longer in use is removed as quickly as possible after it ceases use. The land should be restored to its condition before the development took place, or such other condition as is agreed between the operator and the planning authority. This helps to avoid the proliferation of unnecessary clutter in the street scene.

Annex A

Permitted Development Rights – subject to 'Prior Approval' of the planning authority.

1. Certain types of permitted development rights (PDR) under Class 67 of the General Permitted Development Order (GPDO) are subject to a condition that the developer must seek 'prior approval' of the planning authority.

2. There are two different processes under Class 67 in relation to a prior approval. Those processes are briefly summarised below and should be read in conjunction with the legislation set out in class 67 of GPDO and Annex G of Circular - non domestic permitted development rights. The Circular provides further background information on PDRs, explains what telecommunications development are subject to prior approval, the prior approval processes involved - including what information must accompany an application to the planning authority for their prior approval e.g. application form, plans sufficient to identify the site and its relationship with the surrounding land, dimensions, appearance etc. It is essential that authorities acknowledge receipt of each application which is seeking their decision on whether prior approval is required, giving the date on which it was received, so that the developer will know when the 28/56 day period begins.

Prior Approval for a new ground based mast which applies in certain circumstances.

3. While new ground based masts within the specified parameter within PDR should generally be acceptable in principle in planning terms, the planning authority can impose a requirement for prior approval with regard to siting and/or appearance of a specific proposal.

4, The developer must, therefore, submit an application to the planning authority for a determination as to whether their prior approval is required in respect of the siting and appearance of a new ground based mast (the PDR applies with certain height restriction and locations), as specified under Class 67 of the GPDO. The planning authority are, under the terms of the GPDO, only to consider the siting and/or appearance of the development when an application is made to them. The same restrictions apply should a subsequent appeal be made.

5. The developer must serve advance notice of the proposed works on any other owners and any agricultural tenants of the land. The planning authority undertakes neighbour notification and, as required, consults statutory bodies with an interest – e.g. Naturescot, Historic Environment Scotland or aviation/defence interests. This allows a period of at least 14 days for interested parties to make representations on the siting and appearance of the proposal to the planning authority for their consideration.

6. This prior approval procedure for a new mast allows for a period of up to 56 days, from when the planning authority receives the application, or longer period as is agreed in writing with the planning authority, for a determination to be made, within which the planning authority is to issue their decision on whether prior approval is required and, if it is, to issue a decision on whether it is granted or not.

7. Development may not commence until either:

- the planning authority confirms that prior approval is not required
- the planning authority confirms that prior approval is required and then gives that approval; or
- a period of 56 days (or longer period as may be agreed in writing with the planning authority) has expired after the date of the application without the planning authority either having confirmed that prior approval is required or, if it is required, having given or refused it.

8. Where no decision is given on whether or not to grant prior approval within the 56 days (or within an agreed extension between the planning authority and the developer), the developer can proceed on the basis of the details submitted with the application for determination.

9. There is a right of appeal to Scottish Ministers against the refusal of such an application, or against conditions attached to a grant of prior approval. (Insofar as they relate to the matters specified in Class 67). Since development can commence after the expiry of the 56 day (or longer if agreed) period, there is no right of appeal against the failure to respond to or determine such an application under this requirement.

Prior Approval that applies to certain apparatus on buildings and underground

10. In certain circumstances as detailed in Class 67 of the GPDO, before beginning development, the developer must apply to the planning authority as to whether prior approval will be required.

11. The development may not commence until either -

- the receipt by the applicant from the planning authority of a written notice of their determination that such prior approval is not required.
- the planning authority has given the applicant notice within 28 days following the date of receiving the application of their determination that such prior approval is required, the giving of such approval.
- the expiry of 28 days following the date on which the application was received by the planning authority without the planning authority making any determination as to whether such approval is required or notifying the applicant of their determination.

12. Where a prior approval application has been made and the authority has given notice that prior approval of the authority is required, the development cannot proceed until that approval is given.

13. The planning authority's consideration of applications for prior approval is limited to those matters specified in the relevant section of Class 67 of the GPDO (i.e., siting, appearance etc). Planning policies are relevant to the extent that they relate to these matters.

14. If the developer were to proceed without submitting the necessary details or without, or in contravention of, the planning authority's approval, the development becomes liable to enforcement action.

Annex B - A basic technical summary of how digital communications and fixed line networks operate

1. This annex provides a basic technical summary of how digital communications infrastructure operate and the physical components required to allow this. Digital communications infrastructure is generally defined as a set of fixed and mobile communications networks. This annex mainly focuses on mobile networks familiar to most as how they receive information on their mobile devices.

2. As technology has evolved, individuals have been able to do more and more with their personal mobile equipment. Second Generation (2G) technology gave us voice calls and text messages. Third Generation (3G) gave us access to the Internet and other data on the move. Fourth Generation (4G) created superfast mobile broadband at speeds roughly equivalent to those you would expect from a fixed broadband connection. 5G provides ultrafast mobile broadband and the capability to support a range of new technologies, such as connected automated vehicles, smart city applications and other internet of things (IOT) uses including industrial and real time monitoring. The future of connectivity will continue to accelerate through enhancements, advancements and innovations in next generation technologies.

What base stations are and their purpose

3. A base station is a fixed communication location which is part of a network's mobile device system. It relays information to and from a transmitting/receiving unit, such as a mobile phone or tablet, by radio waves which carry data, text, picture, video or voice. These signals are connected into the wider network through either fibre or microwave dish links.

4. A base station can be made up of several components including radio antennas; masts; equipment cabinets; underground cables; power supply; fencing; landscaping and access tracks. In order for mobile networks to function, they need a substantial network of "base stations" to provide sufficient radio coverage in any geographical area. Operators often need to upgrade existing base stations in their mobile network due to network consolidation, the introduction of new technologies or changes in the surrounding environment.

5. As telecommunications systems have evolved, there has been a need for more base stations to keep pace with customer demand (e.g., by accessing data on the internet puts more pressure on network capacity).

How base stations operate

6. Mobile networks operate by using and re-using the same radio frequencies and allocating them to geographical cells. Mobile Network Operators (MNO) divide the country into thousands of individual cells and at the centre of each is a base station. Base stations are connected to one another by central switching centres, which track calls and transfer them as the caller moves from one cell to the next. The area covered by each cell is governed by the anticipated capacity (i.e., volume of calls); the height of the antenna above the ground; the local terrain; the power output and the radio frequency. In general, the higher the frequency, the shorter the distance that the signal can travel.

7. Generally, the largest cells are in sparsely populated rural areas and the smallest cells are in town and city centres. The capacity of existing sites can, in some cases, be increased, but there is a limit to this and once this is reached it becomes necessary to split each cell into smaller areas, each served by its own base station. This is an effective solution in areas where many mobile users congregate, such as shopping centres and railway stations.

8. Mobile networks are a mixture of large macrocell base stations (paragraph 17 refers), smaller street side base stations and microcell base stations (paragraph 18 refers), in dense urban areas. All are comprised of a mix of antennas installed on supporting structures or mounted on buildings and connected by feeder cables to radio equipment housing located either in its own cabinets or within a building. The various types of base station are discussed below.

9. The management and licensing of the radio spectrum lies with the Office of Communications (OFCOM[8]). The operators own and use different frequencies and wavelengths depending on their ownership of

[8] https://www.ofcom.org.uk/home

spectrum. Different wavelengths bring with them different coverage characteristics and can determine design options for new infrastructure.

10. 5G and further generations use a broad range of frequencies, including higher radio frequencies (such as 3.4 gigahertz and millimetre wave bands – 28 gigahertz and above) to transmit data. Propagation both in terms of distance and through materials reduces as frequency increases. This dictates the siting of infrastructure including height requirements to ensure radio frequency is not blocked.

11. This can, therefore, create technical constraints in the delivery of effective infrastructure. Base stations may need to be situated higher in order for antennas to effectively transmit data over buildings, trees etc. In addition, more, and possibly robust, antennas will be needed to meet service demands and, particularly, in relation to operators sharing sites. Equipment, therefore, need to be carefully designed in order to meet such requirements in terms of providing effective coverage and to ensure ICNIRP compliance is met on public safety.

The role of base stations antennas

12. Mobile base stations generally use two forms of antenna systems, which are the most common on 4G and 5G technologies.

- Sector Antennas - these are vertically orientated to transmit and receive signals to and from mobile devices in the target area. These antennas are typically split into three 120-degree sectors that combine to provide 360-degree coverage – they are normally placed on masts or buildings. Any physical obstruction in front of the antennas inhibits the radio signal from the antennas and the closer the obstruction the greater the inhibition. This is why new masts tend to need to be taller than the surrounding buildings and trees etc. Such technical matters dictate the design of rooftop sites and, therefore, will need to address antenna ‘clipping’ and ensure ICNIRP compliance.

- Dish Antennas – these operate on a direct line of sight (LOS) basis to other dish antennas in the operator’s surrounding network. These antennas are often not required if there is fibre available. The dish antennas link an individual base station to the wider network, which in turn is linked to other national and international networks. These are located close to

the sector antennas on masts or buildings. Transmission dish links can be critical to network integrity, but their LOS requirements mean that they are also susceptible to interference by tall developments, such as wind turbines and tall buildings. Any physical interference to the transmission link could compromise an entire cell and impact on the wider network as transmission dishes can operate over significant distance (particularly those for the television and radio broadcasting networks).

13. Interference can require separation distance between antennas both horizontally and vertically influencing the final design of base stations. For instance, on cross water tidal path LOS may mean additional dishes are required.

14. As well as operating licence obligations, the demand for a new base station is driven by public demand for geographic coverage and ever-increasing amounts of data. Base stations are therefore sited to maximise the quantity and quality of coverage to any particular locality where there is such demand. However, a base station is only physically able to cover a limited geographic area and can only handle a finite amount of traffic at any one time. Therefore, base stations need to be sited in specific locations where they can be operationally effective. This specific locational constraint is unlike most other forms of development.

15. Each base station has a finite capacity to handle the traffic generated by users of mobile devices. The greatest level of growth in mobile traffic has been in data, and this trend is projected to continue. In some cases, new installations may be required to split existing coverage areas in order to provide more capacity, known as 'cell splitting'. This is likely to be more common in urban areas where customer usage is the greatest although may be required in rural areas where topography may prevent coverage of transport routes and areas of population.

16. All electronic communications base stations are often referred to as 'masts'. However, mobile networks are made up of a mix of different types of infrastructure: roadside masts, rooftop equipment and small cell technologies – many being largely unnoticed by

passers-by. The large, free-standing mast structures, such as those often found on hilltops or the side of motorways for example, represent only one element of the mobile network infrastructure, and small cells are an increasingly large proportion of networks, particularly in urban environments. All operators of radio transmitters are under a legal obligation to operate transmitters in accordance with the conditions of their licence. Operation of transmitters in accordance with the conditions of their licence fulfils the legal obligations in respect of interference to other radio systems, and as such will not cause significant and irremediable interference with other electrical equipment, air traffic services or other instrumentation operated in the national interest.

The role of base station cells

17. Macrocells provide radio coverage to a large area within a mobile network. Antennas for macrocells are usually mounted on either ground-based masts, rooftops or other existing structures. Antennas must be positioned at a height that is not obstructed by terrain or buildings and they provide radio coverage over varying distances depending on the frequency used, the number of users in the area and the physical terrain; and to afford the necessary LOS for the dish links that provide backhaul to the operator's network

18. Microcells, which include small cell systems, provide additional coverage and capacity where there are high numbers of users within urban and suburban macrocells. They are usually deployed later in network roll-out where macrocells are unable to meet the coverage and capacity demands. The microcell antennas are small boxes about the size of burglar alarms which are mounted at street level typically on the external walls of existing structures, lampposts and other street furniture however, they only have a range of around 100 metres. Microcell base stations are suitable for transmitting signals to pedestrians but are less suited to fast moving traffic. Microcells should not be seen as a replacement for macrocells.

Small Cell antennas

19. Small cells are a form of microcell but cover a smaller area – these are also known as femtocells or picocells – these can be used through campuses or in shopping centres and can help radio waves penetrate buildings.

Street poles

20. These are macro base stations however they offer a more limited solution for MNOs. This is because the amount of ground-based apparatus is usually limited due to space and constraints around complexed underground services on the public road. Importantly, the antennas tend to be of fixed orientation and, as they are tightly packed within a glass reinforced plastic shroud, cannot be tilted. These constraints have a direct impact on the efficiency of the radio coverage provided. The height of a street pole may require antenna 'clipping' to be addressed and ensure ICNIRP compliance (paragraphs 4.6 and 4.7 refer).

Fibre

21. Fibre optic communication is a method of transmitting information from one place to another. 5G will require more instances of fixed line fibre optic cable for reliable and high capacity backhaul. However, this can be constrained by the availability of fibre which in some rural areas may be several kilometres away. There are severe economic constraints of getting fibre to all base stations.

Microwave

22. The radio access network requires a 'backhaul' connection to the core network in order for the mobile base station or cell site to be operational. This is provided by fibre optic cables or, if fibre is not available, a microwave link. A microwave link requires a clear LOS between the two ends of the link. Microwave transmission dishes themselves generally vary from 0.3 metres to 1.2 metres in diameter, depending on the site location and terrain involved. Obtaining LOS may require a taller mast than would otherwise be necessary to provide coverage to the surrounding area. Where it is not possible to gain direct LOS between two locations, an interim (sometimes known as 'a hop')

site can be installed at a suitable position to bounce the signal between the two end points via more than one base station.

Satellite

23. Where LOS cannot be achieved to provide transmission links between 2 locations, satellite communications may be required to provide the link, depending on the system and other operational factors. This would typically involve the installation of a satellite dish with a diameter of approximately 0.6 metres to 2 metres on a ground-based support pole within the site compound. There may be instances where the satellite dish needs to be located remotely from the main site compound to achieve the necessary satellite connection. This may occur where trees, buildings or the terrain block visibility of the satellite. Growing networks in remote rural areas of Scotland will result in an increase in the number of satellite communications links required. This is however a sub-optimal solution as it has a far lower capacity for data than fibre or microwave link.

Fixed-Line Broadband

24. Fibre line broadband is generally delivered by Fibre to the Cabinet (FTTC) technology. A typical approach to fixed-line broadband deployment involves street cabinets hosting electronics near to underground cables. Alternative deployments comprise a street cabinet connected to the local telephone exchange by underground cables. In some locations, fibre services are delivered using Fibre to the Premises (FTTP) technology, which consists of underground fibre connecting premises to a central location, typically a building where access equipment is hosted. This architecture, assuming underground fibre, offers the least impact in terms of visible equipment in the streetscene.

Fixed Wireless Broadband

25. Wireless technologies, particularly Fixed Wireless Access (FWA), are often adopted to deliver broadband connectivity in rural and remote areas where traditional fixed-line broadband can be challenging or economically unviable to deploy. FWA is also commonly found in city and

other urban landscapes to deploy public access to Wi-Fi networks. This technology requires antennas to be positioned at height in strategic locations to offer the required extent of coverage/capacity to premises and for point to point backhaul connections to other network nodes.

Smart metering/ Internet of Things (IoT)

26. The Smart Network supports smart meters which enables them to communicate directly with energy suppliers thereby negating the need for meter reading. Smart meters give real time information thereby allowing people to better manage their energy use; save money and reduce emissions. The network supports the wider objectives for our society to be resource efficient, lowering carbon footprint and tackling climate change.

27. The Smart network allows for some everyday objects to have network connectivity, allowing them to send and receive data. The economic, environmental and social impact of the IoT will positively impact business in all industries, from manufacturing and energy to retail and healthcare.

Radio and Terrestrial Television Broadcast Networks

28. Radio and terrestrial television broadcast networks are largely mature networks, but still require changes from time to time to reflect technological advances. The broadcast networks form part of the UK Critical National Infrastructure and have a vital societal role to play in our security, entertainment and education. Installations within these networks range from main stations with the largest masts in Scotland that broadcast television services to hundreds of thousands, to smaller television relay stations, similar in appearance to telegraph poles that serve small local populations.

Glossary of terms and definitions

Backhaul

This term is used across the telecommunications industry, broadly to refer to the connection between the main network and the sub-networks,

International Commission on Non-ionizing Radiation Protection (ICNIRP)

Provides scientific advice to protect people and the environment from detrimental exposure.

Line of Sight (LOS)

Is the ability of one base station being able to see another one so that an uninterrupted transmission link may be obtained.

Mobile Network Operator (MNO)

these operators own spectrum and operate the physical infrastructure of their networks.

Spectrum

This term relates to the radio frequencies allocated to the mobile industry and other sectors for communication over the airwaves.

Transmitter

electronic equipment which generates radio frequency electromagnetic energy and is connected to an antenna.

Wholesale Infrastructure Provider

Organisations that sell infrastructure to telecommunication service providers.

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