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BEREC Report on infrastructure sharing

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Content

Executive Summary

Overview of this report

This preliminary report constitutes a provisional analysis of mobile network infrastructure sharing arrangements which are currently in place in various individual European markets. The report is a first step towards identifying best practices on mobile infrastructure sharing arrangements and seeking to develop a common BEREC position on sharing. The objective is to facilitate the enhancement of mobile connectivity in European markets, in particular with regard to the rollout of 5G networks, whilst protecting and promoting competition.

Background

Mobile infrastructure sharing (both passive and active) describes the process by which operators share infrastructure to deliver a mobile service to end users. "Passive sharing" is the sharing of the passive elements of network infrastructure such as masts, sites, cabinet, power, and air conditioning. "Active sharing" is the sharing of active elements in the radio access network such as antennas and radio network controllers (RNC). National roaming is a form of active sharing. Sharing is a feature in many European mobile markets and is often but not always concluded on a voluntary basis (i.e. “commercially driven”), and not as a result of regulatory intervention.

In some of the countries where mobile infrastructure sharing is already a factor in the market or under active consideration, NRAs have adopted guidelines trying to achieve a reasonable balance between incentivising investment and ensuring a fair and competitive market development through infrastructure-based competition. One of the factors taken into account is cost savings, which have to be assessed in the overall context of the market and the position of the sharing parties.

The future rollout of 5G is expected to make use of higher frequency bands, which will entail, amongst other things, more use of small cells. This will result in an increase in the number of base stations relative to existing networks. Consequently, there might be a greater impetus for new (models of) infrastructure sharing arrangements and NRAs might need to reconsider their existing approach to infrastructure sharing.

This report is based on NRA responses to a comprehensive questionnaire which was prepared by BEREC specifically for the purposes of this report (see Annex 2). In their responses, most NRAs state that there is some degree of passive infrastructure sharing, but the ways in which infrastructure sharing is managed or assessed differs from country to country. Differences arise from how information about infrastructure sharing agreements is treated and shared between the parties and the authorities and how disputes are dealt with. NRAs are often not informed about the detailed agreements in cost sharing models such as reciprocal sharing and cost-based pricing. There are also differences in the approaches regarding the inclusion of rules in spectrum awards that may foster, mandate or prohibit network sharing.

Most NRAs have the competency and authority to resolve disputes in particular with respect to passive sharing, but there are differences in how these powers are applied. Dispute

resolution takes the form of voluntary negotiation, public consultation and binding decision-making. There are also differences in terms of providing guidelines or rules with respect to infrastructure sharing with some countries providing detailed guidelines and some providing none at all.

Respondents reported several different types of sharing agreements:

- Passive sharing on a lease basis
- Active sharing agreements involving joint deployment
- Agreements where an MNO is permitted to use the network of another MNO for a specific technology, e.g. 2G.
- Sharing agreements that are related to specific locations like indoor sharing.

When it comes to assessing individual active sharing agreements, several approaches to making decisions, informal assessments and ongoing proceedings were reported. In some cases, remedies were imposed to address competitive concerns. The impact on long-term competition – coverage and deployment and spread of new technologies – was mentioned by NRAs but no single remedy was identified. In some cases, competition authorities have relied on fines whereas in other cases NRAs have imposed coverage obligations on operators to secure infrastructure competition.

With regard to the future trend in infrastructure sharing, most NRAs expect there to be pressure for more sharing arrangements due to greater network densification driven by 5G, which will in turn place a greater emphasis on cost management. As well as requiring more small cells, NRAs also expect 5G to need higher backhaul capacity. There is a consensus that this will lead to an increase or at least an increased call for sharing (passive, active, backhaul, active indoor, spectrum and others) but NRAs want to ensure that sharing arrangements do not result in competition being distorted. Some NRAs have also stated concerns that operators might rely on exclusivity contracts in order to impede rollout by other operators.

Key points

There are a number of general points which can be drawn from the assessment of the NRA responses to the infrastructure sharing questionnaire:

- There is a large range of experience amongst NRAs;
- There is a variety in the type of infrastructure sharing arrangements;
- The motivation for sharing is primarily market driven;
- Where sharing is the result of intervention it can be due to
    - a general regulatory or government policy of encouraging sharing,
    - conditions attached to spectrum awards,
    - a means to aid new entrants or

  - o access obligations in State Aid decisions;

- There do not seem to be common areas of competence among NRAs (except in the area of dispute resolution);
- Action against some anti-competitive sharing arrangements have come through the competition law framework;
- There is a great deal of uncertainty regarding the impact on sharing and implications for regulatory approaches stemming from 5G;
- There is a common view that infrastructure sharing is likely to be a key market aspect when 5G is introduced; and
- There is a view that developments in infrastructure sharing are likely to continue to be driven by the market.

1. Introduction and objective

Mobile infrastructure sharing (both passive and active) describes the process by which one or more operators share infrastructure to deliver a mobile service to end users. By passive sharing we mean sharing of the passive elements of network infrastructure (mast, sites, cabinet, power, conditioning), and by active sharing we mean sharing of active elements in the radio access network (e.g. antenna, radio network controller (RNC)). We consider national roaming to be a form of active sharing.

Sharing in a variety of forms is a feature of a number of European markets. Generally, sharing arrangements are the result of commercial negotiation, but it does sometimes result from regulatory intervention. In those countries where mobile infrastructure sharing is present, the assessment of its impact requires striking a reasonable balance between incentivising efficient infrastructure investment and promoting competition. The operators' motivation is to reduce the costs of infrastructure deployment to what they consider to be a commercially viable and economically efficient level. With the forecast increase in the use of small cells as a result of greater usage of higher frequency bands associated with 5G networks, there is likely to be a large increase in the number of base stations. This network densification may create a greater incentive for infrastructure sharing. As such, NRAs might have to consider and/or revise their general approach to arrangements made by operators for infrastructure sharing.

This report is intended to describe the infrastructure sharing arrangements currently in place in Europe, and it assesses the benefits and drawbacks of such arrangements. It is not intended to be normative or to describe best practice; rather, it provides a 'snapshot' of the current status of the market in this area.

This report is the first step towards identifying best practice and seeking to develop a Common Position on sharing with the objective of facilitating the enhancement of mobile connectivity in European markets. BEREC will work towards the development of a Common Position in the next phase of the project in the second half of 2018.

The report describes the different existing sharing models which are in place in the main categories of sharing (passive infrastructure, active infrastructure and spectrum). It describes the following:

- The current regulations and legal framework relating to infrastructure sharing;
- The scope of current sharing arrangements including the geographic scope, degree (passive/active/core/spectrum), time frame, technology (2G, 3G, 4G), agreement type (JV, lease, IRU), and commercial/regulatory drivers;
- The benefits and challenges from infrastructure sharing arrangements; and
- A brief summary of NRA approaches regarding 5G.

A total of 30 responses were received. The full questionnaire is included as Annex 2.

2. Current regulations and legal framework

This section describes the current legal framework and regulations for infrastructure sharing in different countries, including information-sharing requirements, NRA powers, infrastructure sharing obligations and any guidelines in place to support operators.

Publication of information about infrastructure sharing opportunities

Operators are obliged to publish information on passive infrastructure sharing opportunities in advance, in a public forum, in nine countries (Belgium, Bulgaria, Croatia, Greece, Italy, Latvia, Liechtenstein, Montenegro and Serbia). In Norway, the obligation applies only to the SMP operator. The obligations can take the form of online publication, notifying the NRA/Ministry or publication via a third party platform.

In some countries, although there is not a regulated approach that mandates operators to publish sharing opportunities, information regarding cell site location is available through either privately organised databases/structures or NRA managed portals. For example, there are privately organised databases/structures in Austria and the Netherlands. In the Netherlands, this is complemented by a requirement that mobile operators must coordinate site planning to minimise environmental disruption to local communities. A similar requirement exists in France that requires operators to consult other operators to gauge their interest when deploying new sites (excluding dense areas).

Following the transposition of the broadband cost reduction directive (BCRD[1]) most countries have a general passive infrastructure sharing obligation, although this does not translate into a requirement for publication of information on infrastructure locations or deployment plans in a number of countries (Czech Republic, Finland, Germany[2], Hungary, Malta, Poland, Romania, Slovenia, Spain, Sweden, Switzerland and Turkey). In Bulgaria, Finland and Italy, there is a Single Information Point (SIP) in accordance with the requirements of the BCRD that provides information on the location of physical infrastructure that can be used for infrastructure sharing.

NRA information gathering about infrastructure sharing opportunities

Most NRAs gather information on infrastructure sharing agreements in specific circumstances only. This is the case, for example, in Belgium, Germany, Greece, Latvia, Sweden, Italy, Switzerland and Norway (where the NRA gathers information in cases of disputes between operators, although for national roaming, there is an obligation on the SMP operator to send a reference offer to the NRA).

In terms of formal requirements for operators to notify NRAs about infrastructure sharing, there are no legal/regulatory requirements in most countries although there is a duty to provide information on request. Where there are requirements to inform regulatory authorities, there

[1] Broadband Cost Reduction Directive – Directive 2014/61/EU of the European Parliament and of the Council of 15 may 2014 on measures to reduce the cost of deploying high-speed electronic communications networks http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0061&from=pl

[2] https://www.bundesnetzagentur.de/EN/Areas/Telecommunications/Companies/FrequencyManagement/InfrastructureSharing/InfrastructureSharing_node.html

are different thresholds that determine requirements. In Cyprus, France, Greece, Romania, Montenegro, Portugal and Turkey, operators are obliged to inform NRAs of any infrastructure sharing plans. In Germany, shared use of certain assets (physical sites, masts, antennas, support cabinets and some degree of RAN sharing provided that there is no pooling of frequencies and logical base stations (e.g. Node B)) is allowed without any notification requirements; all other types of sharing agreements have to be notified to the NRA. In the United Kingdom (UK), there is no regulatory requirement to provide information on sharing arrangements but as part of their competition law compliance (and risk management), operators typically share terms of agreements with the NRA.

Infrastructure sharing obligations

In Norway, infrastructure sharing obligations have been imposed on the SMP operator following a market review – the dominant mobile operator has been subjected to infrastructure sharing obligations including national roaming.

There are also examples of more targeted regulatory approaches regarding mobile infrastructure sharing. In Austria, the NRA can grant a new entrant national roaming access to the mobile networks of existing operators for a limited term – this balances the need to promote competition and incentivises investment. In Belgium, the NRA can impose shared use with due regard for the principle of proportionality. In the event of disputes between operators, the NRA can impose cost sharing fees as well as the terms regarding shared use of antenna sites. It can also impose national roaming obligations on operators controlling access to end users. In Portugal, national decree law goes further than just allowing passive infrastructure sharing and actively obliges operators (where technically possible) to make sharing agreements regarding passive assets. Regarding active infrastructure sharing, the NRA assesses proposals on a case-by-case basis in terms of how such sharing agreements may affect competition. In Liechtenstein, operators are obliged to grant access to passive infrastructure assets and mobile operators are obliged to share sites subject to capacity being available. In Turkey, during 2011-16, exemptions from administrative fees were used as an incentive to encourage sharing agreements; these exemptions have now been withdrawn although the obligation for sharing agreements continues.

Infrastructure sharing associated with spectrum awards

Just under half of the respondents (12 out of 29) reported that their countries have introduced rules on regulating mobile infrastructure sharing during spectrum awards. Spectrum awards often include coverage obligations that are designed to stimulate infrastructure deployment, which limits the use of active infrastructure sharing arrangements. This is the case in Austria, Finland and Switzerland. In the forthcoming 3.4 - 3.8 GHz awards, Austria plans to prohibit active sharing in the three biggest cities (Wien, Graz, Linz) with the exception of non-replicable active components where sharing will be allowed. This proposal is still under consultation. A different approach is taken in Denmark in which the spectrum and legislative frameworks do not prohibit network sharing and where recently awarded spectrum licences allow operators to meet their coverage obligations through concluding roaming agreements. Any sharing agreements remain subject to general competition law.

Similarly, Belgium, Czech Republic, France and Romania imposed obligations on license holders to provide national roaming services for new entrants or to share spectrum with operators that have relatively less spectrum holdings. These obligations are adjusted to national circumstances. In Belgium, the obligation applies to operators that have 2G coverage so as to give new entrants without a 2G footprint time (9 years) to develop their own national network. A similar approach is taken in France in which 2G renewal awards during 2006-09 included obligations for national roaming agreements in so called 'white areas' and spectrum licences of the three incumbent operators in 2010 provided for a new entrant to benefit from 2G national roaming for the first six years.

The Portuguese NRA referred to national legislative stipulations in its 2011 auction (of 450 MHz, 800 MHz, 900 MHz, 1800 MHz, 2.1 GHz and 2.6 GHz frequency bands) to oblige operators to negotiate passive infrastructure sharing agreements. In Liechtenstein, the NRA included ancillary conditions in its spectrum awards that obliged operators to share passive assets – these ancillary conditions did not extend to active network elements. In Turkey, there were mandatory provisions for passive infrastructure sharing in larger population areas and provisions for active infrastructure sharing in smaller population areas. In Greece and Hungary, spectrum awards allow license holders to enter into passive infrastructure sharing agreements when no viable alternatives exist. Conditions are attached to any such sharing agreements. For example, in Greece, there is a requirement to notify the NRA and it is subject to an assessment that no sharing agreement restricts competition.

17 out of 29 respondents report that they do not have sharing regulations associated with spectrum awards but some of them are considering introducing such regulations in the future.

Dispute resolution

The majority of NRAs hold competence for dispute resolution, including in cases of passive infrastructure sharing agreements. Generally, issuing a binding decision on passive infrastructure sharing terms and conditions is only justified upon failure of voluntary negotiations attempted by the sharing parties. The procedure is often complemented with public consultations. Some NRAs also hold powers to assess sharing agreements ex post. In France, a national judicial framework empowers the NRA with its dispute settlement mechanism. In Greece and Hungary, the operators submit sharing agreements to the NRA who can evaluate and adjust sharing terms and conditions.

The Table 1 below shows examples of how disputes concerning infrastructure sharing are treated in the different countries.

Table 1: dispute treatment in some European countries

	Procedure	**Case by case**	**Other/unknown**
Special law, e.g. BCRD, Communications legislation	Croatia, Finland, Italy, Latvia, Romania	Bulgaria, Cyprus, Denmark	Czech Republic

	Procedure	Case by case	Other/unknown
General law	France, Ireland, Liechtenstein, Netherland	Greece, Malta, Montenegro, Norway, Serbia, Sweden, Turkey, UK	
Other/unknown		Germany, Hungary, Spain	Switzerland

Public consultations covering mobile infrastructure sharing

The majority of respondents report that there have not been any consultations regarding mobile infrastructure sharing. 12 out of 29 respondents report having held workshops or consultations concerning different areas of infrastructure sharing with the outcomes including position papers, guidelines and sharing obligations to facilitating spectrum and RAN sharing. In Ireland, the NRA set out its view on spectrum and network sharing following a consultation on its draft Radio Spectrum Management Strategy Statement (2016-18).The consultation sought high-level views and did not distinguish between passive or active infrastructure sharing. As a result of the consultation, the NRA was able to reaffirm its view that its key assessment criteria on network sharing agreements would be their impact on competition and end user benefits.

Guidance or specific rules with respect to infrastructure sharing

In terms of providing specific guidance/rules with respect to infrastructure sharing, there was an equal split between countries that provided guidance and countries that did not. Where guidance was provided, it tended to promote passive infrastructure sharing and took a much more circumspect approach to active infrastructure sharing. For example, in Austria, an old position paper from 2011 considered that there were no concerns on sharing passive infrastructure sites (subject to two operators not sharing more than 50% of their sites) whereas for active infrastructure sharing, each network operator was required to operate at least 50% of its sites outside of (active sharing) cooperation arrangements and only uses its own frequencies in the arrangement. Similarly, in Finland, the implementation of the BCRD sets out guidelines/law on co-construction of networks and, in Denmark, the implementation of the BCRD sets out law and guidelines on joint utilisation of passive physical infrastructure and high-speed infrastructure preparation of buildings.

Guidelines can be provided by NRAs, competition authorities or government ministries. For example, in France, the competition authority issued an opinion on sharing agreements assessment in 2013. In 2016, following the adoption of national specific provisions in French law[3], Arcep (the NRA) published sector specific guidelines setting out risk criteria for the analysis of sharing proposals and provided network-sharing recommendations, and then

[3] National law (Law n° 2015-990) empowered Arcep to request changes in the sharing agreements between mobile operators

invited the operators to present the modifications they made to existing sharing agreements, if needed, to ensure they were in line with its guidelines. In Italy, Latvia, Malta and Norway, ministries or government agencies are responsible for issuing guidelines; although in Latvia and Norway, the NRA provides guidance with respect to the SMP operator. In contrast, in Montenegro, Switzerland and Turkey, the NRA provides guidance on passive infrastructure sharing.

3. Current sharing arrangements

3.1. Scope

The questionnaire asked each NRA about existing infrastructure sharing agreements. Passive sharing is defined as sharing of the passive elements of network infrastructure (mast, sites, cabinet, power, air-conditioning). Active sharing is defined as the sharing of active elements in the radio access network (e.g. antenna, radio network controller (RNC)). National roaming is considered as a form of active sharing.

24 NRAs within the EU replied to the questionnaire. In addition, responses were received from Liechtenstein, Montenegro, Norway, Serbia, Switzerland and Turkey. The responses indicate that not all NRAs are fully informed about the details of ongoing infrastructure sharing agreements. As a result, this report should not be treated as an exhaustive summary of all existing (passive or active) sharing agreements.

Active sharing with joint deployment

Table 2 lists infrastructure agreements with sharing of active infrastructure and joint deployment.[4] It aims to summarize all active sharing agreements where each partner agrees to invest into some active infrastructure in order to share it. It gives further information on spectrum sharing, the geographic scope and the time frame.

Table 2: Active Sharing with Joint Deployment

Country	MNOs involved	Spectrum Sharing	Geographic Scope	Time Frame
Bulgaria (BG)	two MNOs	No	national	Permanent
Cyprus (CY)	MTN and Primetel	No	national	
Czech Republic (CZ)	T-Mobile CZ; CETIN	No	Country divided into two parts, excl. two biggest cities Prague and Brno	2013- 2033
Denmark (DK)	Telenor and Telia	Yes	national	2012-

[4] Joint deployment includes joint ventures that deploy infrastructure as well as agreements that divide responsibilities for deployment among the partners of the sharing agreement. Regionally separated deployments with reciprocal national roaming for the same technology are thus classified as joint deployment. RAN sharing with joint spectrum is also classified as active sharing with joint deployment.

Country	MNOs involved	Spectrum Sharing	Geographic Scope	Time Frame
Finland (FI)	DNA Ltd and Telia FI Ltd	Yes	regional, i.e. north and eastern part of Finland (50% of area, 15% of population)	2015-
France (FR)	SFR and Bouygues Telecom	Yes	excluding dense areas (more than 200k inhabitants) and rural white areas: ~85% of territory and 57% of population	N/A
Greece (GR)	Vodafone GR and WIND Hellas	No		2012-
Hungary (HU)	Magyar Telekom and Telenor		National except Budapest	
Poland (PL)	Orange & T-Mobile	Yes	National	2011
Romania (RO)	Orange and Telekom Romania	No	National except 11 municipalities	Obligation for three years. After that, commercially driven.
Spain (ES)	Orange and Vodafone	No	In rural areas with less than 25.000 inhabitants	2006-
Sweden (SE)	Tele2 & Telenor	Yes	national	2009-
SE	Telenor & Hi3G	Yes	rural	2001-
SE	Telia & Tele2	Yes	national	2001-
UK	Three and EE	No	national	
UK	Telefonica (O2) and Vodafone	No	national	

Annotations: All active sharing agreements with joint deployment are commercially driven. All agreements except the Swedish cooperations and Three/EE in UK cover all technologies. All agreements are joint ventures or agreements where the parties have similar involvement in network deployment with the exception of ES-Orange/Vodafone (national roaming), RO-Orange/Telekom Romania (national roaming), BG-Max/Mobitel (lease), CY-MTN/Primetel (lease) and CZ-T-Mobile/CETIN. The cooperation in BG-2MNOs also includes core network sharing which is the only core sharing of all above listed agreements. Active sharing that is limited to individual antennas was not included in this table.

According to Table 2 all active sharing agreements with joint deployment are commercially driven. The majority of active sharing agreements with joint deployment are organised in the form of a joint venture.

The agreements without a formal joint venture are an agreement between Orange and Vodafone in Spain (where each MNO roams into its partner's network in rural areas with less than 25000 inhabitants), and agreements in Romania, Bulgaria, Czech Republic and Cyprus.

For almost all active sharing agreements with joint deployment, subsequent technologies are included in the sharing agreement. One exception is Sweden, where different arrangements for 3G and 2G/4G are observed. For example, two operators (Telia and Hi3G) participated only in a 3G infrastructure sharing agreement (each with different partners). Tele2 and Telenor (each a partner of Telia and Hi3G for 3G) formed a joint venture including spectrum sharing for 4G. The second exception is Three/EE in the UK, where only 3G is actively shared.[5] In

[5] For 4G, sharing was limited to passive sharing.

addition to this exception, this generally indicates that active sharing with joint deployment for one technology often leads to the sharing for the subsequent technology and that active infrastructure agreements are often permanent agreements.

On the geographic scope, the available information indicates that active infrastructure sharing with joint deployment is often limited to non-densely populated areas. The agreement in Czech Republic excludes the two largest cities (therefore sharing 85% of the population), the agreement in France excludes the largest urban areas and the agreement in Finland only covers 15% of the population (but 50% of area).

National roaming (without joint deployment)

In contrast to Table 2, Table 3 aims to summarize those active sharing agreements, where not all partners agree to jointly invest into active infrastructure. Table 3 lists the agreements where a partner relies on the network of another partner for a specific technology and roams into that network without either offering a reciprocal offer (within a specific technology) to the partner or being part of a joint venture that deploys infrastructure. National roaming is not necessarily covering the whole nation, but rather increasing the coverage of the network that is limited in scope.

Several countries reported such agreements.[6] Table 3 lists the countries, the MNOs involved, the time frame, the technology and whether the agreements were commercially driven or were a result of regulatory intervention. Some agreements had a clear end date. Some agreements were or still are limited to legacy technologies (2G/3G). Individual agreements were directly driven by regulatory intervention. For some other agreements, regulatory intervention might have been a fallback option that enabled commercially driven agreements.

Table 3: National Roaming Agreements (without joint deployment)

Country	MNOs involved	Time Frame	Technology	Commercially driven / regulatory intervention
Austria	T-Mobile; Hutchison	2012-	2G vs 3G	Commercially
Croatia	Tele 2 d.o.o.; Hrvatski Telekom d.d.			Commercially
Denmark	Hi3G; Telia	N. a.	2G, 3G	Commercially
France	Orange; Free Mobile	2012 - 2020	2G, 3G	2G regulation; 3G commercially
Norway	Telia; ICE	2015-2021	2G, 3G, 4G	Merger remedy
Spain	Yoigo/ Telefónica; Yoigo/ Orange	-2019; 2017-	2G, 3G, (4G)	Commercially

Annotations: Sharing agreements above do not include spectrum sharing, except for Orange/Free; additional information based on publically available information for Hi3G/Telia in Denmark; T-Mobile/Hutchison agreement in Austria offers 2G and 3G in a reciprocal roaming agreement.

[6] Regionally separate deployment with reciprocal national roaming for the same technology is classified as joint deployment and thus not included in Table 3. The Netherlands reported an agreement that is in principle a passive sharing agreement but goes in parallel with a MVNO agreement between the same sharing parities. The MVNO agreement that grants access to the sharing partner as a virtual network operator in case of no coverage or no VoLTE capable handset available. This agreement is not included in Table 3.

Passive sharing

For passive sharing, the information that individual NRAs have is often limited (partly due to information gathering powers listed above). Based on the available information, passive sharing on a site-by-site basis seems common. In some countries, there was regulatory intervention to enable passive sharing. Montenegro for instance prescribes (passive) sharing obligation among all operators in the Electronic Communications Law. At the moment, all operators within Montenegro have passive sharing via lease agreements. In Norway Telenor as an SMP operator is obliged to offer co-location to others. Systematic passive sharing between two MNOs was rarely notified in the answers to the questionnaire. For the EIR/Three cooperation in Ireland, Three was obliged to continue the agreement with EIR as part of the remedies related to the merger with O2 Ireland. Further systematic passive sharing agreements were notified for Cyprus (CYTA/MTN) and Bulgaria. In the UK, EE and Three share sites for 4G within a joint venture.

Normally, it can be assumed that active sharing (except national roaming) implies also the sharing of passive infrastructure such as sites. These agreements are shown in Table 2 and are discussed there.

Special agreements

Several NRAs reported agreements with respect to specific infrastructure. In Belgium, passive indoor sharing in large buildings among all players is based on regulatory intervention.[7] Switzerland reports RAN sharing for indoor trains and tunnels (3G/4G) between all MNOs. Malta reports passive indoor sharing among all players with joint deployment that is often mandated by the premises' owner. Austria reports passive and partially active sharing (leaky feeder cable) for specific infrastructure (Vienna underground). Finland reports passive sharing for indoor coverage in trains.

So there exists a range of special agreements with respect to specific infrastructure for special locations. It seems that not all NRAs have knowledge and were informed about those agreements.

Further agreements

Some further infrastructure sharing agreements exist that do not fit in the categories described above. In France, there is regulatory intervention to share RAN and spectrum in rural "white areas" (those areas with limited mobile coverage). These agreements were first introduced by law for 2G deployments in the early 2000s, and then expanded to 3G by national law in 2015[8], and finally to 4G as an obligation in 4G authorizations. In another agreement that was driven by regulation, operators are required to share 5000 zones per operator in rural areas (2000 RAN sharing, 3000 passive site sharing). Two MNOs concluded a commercially driven RAN and spectrum sharing agreement in La Réunion.

[7] See https://www.modas.bipt.be/
[8] Law n° 2015-990 of 6 August 2015 for economic growth, activity and equality of economic opportunities

In Switzerland, two MNOs share some of the individual antennas. In Slovenia, some infrastructure sharing agreements are under study. In Turkey, there is RAN and spectrum sharing among all operators – partially due to regulatory intervention.

3.2. Cost sharing within agreements

NRAs were asked about forms of cost sharing within infrastructure sharing agreements. Only for a minority of agreements, NRAs were able to report some information. Information about cost sharing is often confidential. For a few agreements, reciprocal exchange of services was agreed, for a few other agreements, cost-oriented pricing was reported. For instance, in the UK, EE and Three share the cost proportionally, whereas Telefonica and Vodafone are each responsible for the costs of the half of the UK they manage. In the latter agreement, any additional investment required unilaterally is paid by the MNO requesting the investment (e.g. Vodafone wanting a new site in Telefonica's territory).

For passive sharing, some NRAs imposed pricing sheets.

3.3. Assessments and/or decisions on infrastructure sharing

There were two questions where NRAs were asked about formal or informal assessments of sharing agreements and decisions and/or ongoing proceedings with respect to infrastructure sharing. The answers were supplemented by research on websites of NRAs and NCAs. For passive sharing, several authorities imposed sharing or the terms of passive sharing (RTR, BIPT, CRC, NKOM). For active sharing, individual assessments in Austria, Czech Republic, Denmark, Finland, France, Greece, Hungary, Spain, Sweden, UK and Norway are described in Annex 1.

With respect to active sharing, the assessments raised different competitive concerns:

- collusion in the wholesale market (refusal to supply MVNOs, conversion of fixed into variable cost and thereby fostering collusion);
- effect on spectrum awards (circumvention of caps, collusion in spectrum awards);
- foreclosure from unused passive infrastructure (sites, …);
- information exchange that fosters collusion;
- reduction of competition on significant parameters such as coverage and/or development and spread of new technologies.

In the available decisions and for most of the competitive concerns, remedies were imposed or contracts were adapted in order to address these concerns. However, for a reduction of competition in long-run competitive parameters like coverage and development and spread of new technologies, no remedies were imposed. In Austria, MNOs were required to rollout the next technology independent of each other. In Czech Republic, the European Commission is still investigating the case. In Denmark such a reduction was accepted within the framework of Article 101(3) TFEU. In Finland, MNOs were required to offer coverage with their own network for 80% of the population. In Hungary, there is an ongoing investigation by the

competition authority. In Spain, the MNOs were fined – especially Telefonica for the delay of their own rollout of 4G networks.

To summarize, competition and regulatory authorities may tackle some competitive concerns with remedies – but they seem to be especially concerned about the long-term impact of infrastructure sharing on competitive parameters such as network coverage and the deployment and spread of new technologies. For the latter competitive concern, there were no effective remedies in the ex-post assessment but fines. In spectrum awards, individual NRAs imposed coverage obligations with an own network in order to secure long-run infrastructure competition ex-ante.

4. Benefits and challenges from infrastructure sharing arrangements

This section details potential benefits and challenges of infrastructure sharing arrangements, based on case studies and questionnaires circulated to NRAs. First, it describes potential benefits of infrastructure sharing agreements and then explains the potential challenges associated with infrastructure sharing. Thirdly, it focuses on the experiences of individual NRAs regarding infrastructure sharing and, finally, identifies potential barriers to infrastructure sharing. Due to the range of infrastructure sharing arrangements (both active and passive) currently in place in different Member States, only general preliminary conclusions are to be drawn from the data available. However, it is possible to discern broad trends from the data available. These are outlined below.

4.1. Benefits of sharing

There are a large number of potential benefits associated with infrastructure sharing. These include potential cost-saving benefits and the associated acceleration of coverage for areas where the coverage costs for a single operator deployment is high (often rural areas). There is limited evidence from NRAs that different benefits are accentuated by specific types of sharing (active compared with passive), although this link can only be drawn in certain circumstances and for certain types of arrangements. Active sharing, for example, is explicitly highlighted as helping drive better network coverage by several NRAs (Belgium, Bulgaria, Finland, Latvia) and can also be associated with spectral efficiency. This is not always the case however; environmental benefits are linked equally with both types of sharing by NRAs.

A number of NRAs, for example, identified infrastructure sharing (both active and passive) as a means of overcoming challenges related to deployment of infrastructure where deploying equipment infrastructure is not (easily) replicable (like in indoor) and even in dense areas where finding new sites could be very difficult (other examples: old city centres, national parks, highly secured places). Sharing might lead to increased consumer/customer choice (and associated benefits), especially in areas where it would otherwise be not economical to serve, as it helps multi-operator service, increasing choice for customers and hence benefiting social development. Moreover, spectrum sharing may have a potentially positive impact on customer experience. In fact, it could lead to better quality of service, through combining their spectrum partners are able to offer higher data peak rates to consumers. A small number of NRAs (such

as BIPT in Belgium) also identified the potential spectral efficiency benefits of active sharing agreements. For example, spectrum pooling for MOCN and GWCN configurations or sharing of backhaul microwave frequencies encourages the optimal use of spectral resources.

Sharing could have environmental benefits, as it reduces the visual impact of mobile networks on the landscape, reduces energy consumption, and mitigates citizens' concerns over base station radiation.

It should be noted, however, that in assessing benefits of sharing agreements, the competent authority shall ensure that the competition in the market is not hampered.

In relation to cost savings, many NRAs indicated that they did not have any specific estimation of cost savings related to sharing, and that these were likely to be highly context specific. Nonetheless, some NRAs provided data indicating that all types of sharing allow operators to significantly reduce RAN costs which represent the most important part in the total costs. Costs savings depend on the type of sharing. Some NRAs provided figures of cost savings:

- passive sharing cost savings: [16%-35%] CAPEX, [16%-35%] OPEX;
- active sharing (excl. spectrum) cost savings: [33%-35%] CAPEX, [25%-33%] OPEX;
- active sharing (incl. spectrum) cost savings: [33%-45%] CAPEX, [30%-33%] OPEX;
- core network sharing: according to Swiss authority, core network sharing cost savings are limited.

Where data was available, NRAs noted that RAN OPEX fell significantly as a percentage of overall OPEX in cases where network sharing was implemented. This saving was estimated to be up to 35% of the RAN OPEX costs in certain cases in Netherland, for example.

It should be noted that from the antitrust perspective not all network cost savings qualify as an efficiency that is likely to be passed on to and benefit consumers. Certain fixed cost savings (that is, cost savings that do not relate to incremental costs) are unlikely to be passed on to consumers in the form of lower prices or increased incentives to invest in a foreseeable timeframe. In addition, the extent to which savings in incremental costs are passed on to consumers depends on the market structure and more generally the level of competition in the market. At the same time, from the wider policy perspective, savings in overall costs which may lower the barriers to investment in network upgrades may also be relevant.

4.2. Challenges and downsides associated with sharing

A number of NRAs responding to the survey do not associate specific downsides or major negative impact with sharing as they have not observed such issues, or do not have specific data to support such views, especially if sharing agreements are properly framed by regulation (e.g.: ensures that agreements are open to third parties). BNetzA considers that analysis needs to be done on how sharing agreements could hinder competition, especially competition at infrastructure level.

Nonetheless, many NRAs are of the view that sharing decreases the incentives to investment and infrastructure competition for better coverage.

From a competitive viewpoint, many NRAs are of the opinion that non-participating MNOs might have difficulties to participate in shared infrastructures of other MNOs. This is true for both active and passive sharing. MVNOs could also be negatively impacted by sharing agreements due to being excluded from enhanced coverage/capacity on the host network; e.g.: an MVNO whose host operator itself is in a local roaming situation could in certain conditions not benefit from the service. Competent authorities (NRAs or NCAs) should be very vigilant on those issues that could lead to competitive imbalance.

In the case of active sharing, some forms such as GWCN and MOCN configurations, where spectrum pooling is allowed, could decrease the level of competition as partners may not be able to distinguish their services adequately because of similarities in their network coverage and quality of service, at the expense of competition, investment and innovation especially in dense and competitive areas. It can also require sharing confidential or commercially sensitive information between competitors. Active sharing could have a negative impact on competition if not assessed carefully, presenting risks of collusion between the sharing parties. For these reasons, in France, Arcep states in its 2016 network sharing guidelines that active network sharing would not be acceptable in dense areas and would require a close supervision in less dense areas, because infrastructure-based competition is considered both sufficient and proportional. When sharing is a result of regulatory obligations, competent authorities should carefully assess whether it leads to a loss of competitive advantage for the operator that was the only one covering that area, otherwise it would not be rewarding the risk taken by the operator.

From an operational viewpoint, sharing could have downsides as it requires an extensive period of planning between the sharing parties (Belgium). Moreover, sharing, especially active sharing, requires consent and coordination between the sharing parties, making site evolutions more time consuming because of the joint decision-making process. It may also be more complicated to make sure that high QoS is always provided throughout the “data chain” in a shared scenario. Also from a technical viewpoint, if network issues or failures arise, debugging may be more complicated. In a more specific example related to the consolidation of existing networks, there could be an expenditure of capital associated with this. The cost depends on the degree of consolidation, which could entail significant removal costs (Belgium).

Active and passive sharing could increase the electromagnetic field emissions. This would create issues if official electromagnetic field emissions limits were exceeded (as operators would in this case not be able to share networks unless the regulation was subject to a revision). In consequence, legal provisions on the maximum radiation power (non-ionisating radiation) reduce the available antenna power (ERP) per MNO on the same mast.

Sharing, especially passive sharing, may significantly load the host network site with the equipment installed by the guest operators, which could limit potential future network development such as the installation of new additional modules related to the introduction of new technologies.

In terms of resilience, with fewer independent mobile networks, infrastructure and mobile coverage as a whole may be more vulnerable as there is less redundancy and less option for connecting to cellular services. Robustness in case of emergencies or natural disasters may be reduced.

4.3. General experiences with sharing agreements

Negative experiences (Austria, Belgium, Hungary)

The challenges and downsides identified above are mainly resulting from experiences the respondents have been involved in. These go beyond general competition concerns (as existing infrastructure sharing agreements are subject to competition law).

In addition to that, some NRAs have observed or are expecting some negative economic effects relating to market structure. In Austria, the NRA expects that due to sharing agreements incentives for investment will decrease in the long term. In Hungary, a potential risk is identified that MNOs, which do not participate in sharing agreements, can suffer competitive disadvantages. Finally, in Belgium, practical examples show that sharing agreements raise issues especially in view of finance, operations and strategy, in particular the relative difficulty of establishing such arrangements relative to the occasionally modest financial benefits. Due to the alignment of competing objectives from different operators, such projects generally become very complex and therefore take significant resources. On the one hand, the scale of an agreement is very important to assess if sharing is worthwhile or not. On the other hand, the larger the agreement is, the more complex the sharing is likely to be.

Neutral experiences (Belgium, Cyprus, Czech Republic, Ireland, Italy, Malta, and the Netherlands)

In addition to the negative experiences, there have also been respondents which are quite neutral.

In Belgium, it was observed that only passive infrastructures are part of existing sharing agreements and that such agreements are focused on covering difficult access areas like tunnels or transport routes. Furthermore, it has been observed that less dense areas covered at a minimum level by one operator are quite rapidly exploited by competitors due to the (highly) competitive situation. Lastly, in Belgium operators do not depend on regulatory provisions because existing sharing agreements (which are market-led) seem to be efficient. In general, according to the Belgian response it seems that due to experiences made, it is not viable to share existing networks, but it is easier to reach sharing agreements with a view to new networks on condition that there is a major change to the existing network, like a large number of new sites and/or new network elements required.

Netherland observed so far marginal impact on the market and assumes that site sharing reduces costs and hardly reduces useful network competition.

Positive experiences (Austria, Bulgaria, Croatia, Denmark, France, Greece, Montenegro, Norway, Poland, Romania, Spain, Sweden, Switzerland, Turkey)

The large amount of the contributions regarding the experience with sharing agreements has been positive. With a view to the benefits of sharing infrastructure, some of the survey participants have stated that supervision is not needed and no contentious issues were observed. In Denmark an active sharing agreement on Radio Access Network (RAN) is seen

to work fine, although the parties involved are in fierce competition. In France, also RAN sharing is efficient and resulted in better 2G/3G coverage, as it was a prerequisite for authorization, as defined in the NRA sharing guidelines. In addition, the rollout of 4G based on such an agreement was noticeable accelerated. In short term, it was observed that infrastructure sharing in the form of national roaming had a strong impact on cost saving and therefore on competition. Finally, this has resulted in a decrease of retail prices and thus consumers have benefited from such agreements (Spain, Romania and Poland). Also on a wholesale level, two respondents answered that they observed infrastructure sharing as a possibility for undertakings to enter the mobile market on a larger scale, which is an advantage especially for newcomers. Furthermore, Norway describes infrastructure sharing as a prerequisite for newcomers to enter the mobile retail market.

This again has a positive effect on the quality of the offered services as well as on a larger coverage of networks and makes new technologies widespread (Turkey, Switzerland). Lastly, it is worth mentioning that, in contrary to the complexity, Montenegro has also stated that sharing agreements were reached easily.

4.4. Barriers to increase infrastructure sharing

The last section of this chapter reflects on an assessment of the respondents with regard to possible barriers to an increased infrastructure sharing in their countries. As the results of the survey have shown, mainly seven barriers can be seen.

Insufficient space on existing masts (Austria, Bulgaria, Croatia, Cyprus, Czech Republic, France, Montenegro and Norway).

In the answer to the questionnaire, from a practical point of view Portugal considered that the lack of space on a cabinet or in a tower, as well as spectrum planning to avoid interferences, could be a barrier in spectrum sharing.

According to the answers of the questionnaire, the main barrier seems to be insufficient space on existing masts respectively sites. In many cases, it is hardly possible to install additional equipment. This is not only a result from a lack of space, but also due to an increased energy consumption caused by the additional equipment. The installation of additional antennas can be problematic due to the length restriction of poles and masts. Poles on rooftops are even more limited in length. To that extent, in many cases it can be assumed that existing infrastructure has to be changed to grant a shared usage. Having in mind the lack of space and the need for more equipment and electricity supply, this leads to the second most frequently mentioned barrier regarding infrastructure sharing, which is landlord pricing. However, several measures can be considered against this barrier. Norway has in its SMP decision a list of relevant measures like removal of equipment on masts and in cabins that are not being used, moving equipment to provide space for more cabinets, strengthening of masts, extending masts, expanding cabins, replacing cabins, replacing masts and replacing antennas. When multiple measures are possible, the starting point should always be that the easiest and most reasonable alternative is selected.

Landlord Pricing (Austria, Bulgaria, France, Malta, Netherland)

The need for more space at sites and the leasing of new sites leads more likely to additional agreements with landlords and therefore potentially to higher rental costs. This again makes infrastructure sharing more expensive. Especially with a view to 5G and the relating need for a much larger amount of cells, this might result in higher costs, which could have an impact on infrastructure sharing. Mentioning additional sites, rental costs can also be driven by landlords who will impose high-value prices for prime sites. Lastly, the rental of additional space will also depend on the willingness of landlords.

EMF restrictions (Belgium, Bulgaria, Norway, Poland, Switzerland)

Against the backdrop of barriers, another issue identified by the contributors is the Electro Magnetic Radiation (EMR). For example, in Poland the level of admissible electromagnetic radiation is 0.1 V/m^2 and is seen as a possible barrier for infrastructure sharing. In addition, Switzerland stated that the threshold for non-ionizing radiation could be an obstacle for sharing infrastructure. To sum it up, public concern regarding EMR should not be underestimated while assessing barriers (Norway).

Administrative processes (Belgium, Bulgaria, Denmark, Greece, Malta, Norway, Spain)

Another barrier can be aggregated under the term “administrative processes”. This includes permits of civil works (Bulgaria, Denmark), slow processing of building permits (Belgium, Denmark), local taxes for antennas and pylons (especially in the Brussels communes and Walloon provinces, Belgium) and the access granting to (private) large premises (Malta, Norway). At least Greece stated that also the licensing period per site could be a burden.

Coordination effort (Austria, France, Hungary, Netherland)

As already stated above with regard to negative experiences concerning infrastructure sharing, the coordination effort is also seen as a potential barrier. With a view to the 5G rollout as mentioned before, it is expected that a much larger amount of sites will be needed. As the amount of sites increases, also the number of sharing agreements is expected to increase or at least the complexity of such agreements to become higher. In addition, Netherland stated that the network planning is MNO specific. This means that the existence of a site of one operator may be irrelevant for the network optimization of another operator. In the context of network planning, other issues regarding potential barriers to increase infrastructure sharing is raised by some respondents.

Technical issues (France, Netherland, Spain)

Infrastructure sharing usually requires the same technical standards which are often ensured due to network equipment from one vendor. As not all MNOs use the same network supplier or make use of different technologies/protocols, this can also cause technical difficulties and thus needs close cooperation. As mentioned cooperation in a competitive environment can be

quite complicated, additional technical cooperation on top of this complexity can therefore be identified as another barrier.

Competition (Norway, Romania)

According to Romania, multiple and/or extensive agreements may raise competition issues. Norway contribution also raised competition concerns but from an operator point of view. This is because market players do not want to give up market shares or first mover advantage by having active sharing agreements with a competitor.

5. Future evolution of sharing arrangements and the role of 5G in shaping requirements/regulatory framework

Most countries expect that infrastructure sharing will become more important in the future.

Cell densification associated with higher frequency bands that will provide a lot of the spectrum for 5G will result in increased demand for radio sites. Increased backhaul capacity from these cell sites are expected to lead to further infrastructure deployment requirements. As a result, most respondents expect an increase in both infrastructure sharing and spectrum sharing. Efficient use of national resources and environmental concerns are also expected to be drivers for greater infrastructure sharing.

Most NRAs are currently considering how 5G will impact infrastructure-sharing agreements. Given that 5G will probably require an increased number of cell sites and backhaul upgrade, some NRAs speculated that infrastructure sharing would increase the deployment of further infrastructure. On the other hand, there are also NRAs stating that infrastructure sharing would not necessarily be a prerequisite for 5G deployment.

Many NRAs highlighted that the issue of infrastructure sharing in the context of 5G will be driven by industry. In this context, for example, RTR believes that other business models (outside of the usual MNO model) will become more important in the development of 5G.

Most NRAs, however, believe that continued market monitoring will be required before NRAs can take informed decisions in the context of deployment of 5G.

The development of best practices – and their relevance to 5G – will also rely on past experiences of NRAs in addressing potential challenges related to infrastructure sharing agreements.

Impact of the rollout of 5G on infrastructure requirements

Answers from NRAs showed their expectations in a denser network of macro sites (Austria, Cyprus, Denmark, Finland, Germany, Italy, Montenegro, Slovenia, Spain), more small cells (Croatia, Denmark, Finland, France, Germany, Hungary, Italy, Malta, Montenegro, Netherland, Norway, Poland, Romania, Serbia, Slovenia, Spain, Sweden, UK, Switzerland, Turkey) and the implementation of massive MIMO (Belgium, Malta). The requirement for more small cells is seen especially for mm-wave bands like 26 GHz or above and densely populated

areas. Some countries mention the requirement for more backhaul capacity or fibre backhaul (Norway, Sweden, Switzerland, UK). More operational infrastructure would be required like optical fibre, energy, different submeters to monitor energy consumption per operator and reinforcement of sites (France). More sharing is expected for fibre backhaul (Croatia), equipment sharing if site reinforcement is impossible (France), small cells (Netherland, Serbia) and indoor coverage (Norway). Some countries express a general need to share more infrastructure (Germany, Greece, Hungary). Exclusivity agreements among site owners and one operator might impede the rollout of other operators (France). Individual countries mention the change towards central or virtualized base stations (Malta).

Changes to infrastructure sharing

For some NRAs, sharing will be required in order to lower cost (Belgium, Czech Republic, Hungary), to increase coverage (Czech Republic) or to increase capacity (Belgium). Many NRAs see an increase or an increased need of passive sharing (Bulgaria, Cyprus, Poland, Sweden, UK), active sharing (Bulgaria, Croatia, Poland, Turkey, UK), spectrum sharing (Belgium, Croatia), active indoor sharing (Finland, Malta, Slovenia), fronthaul (Malta), backhaul (Malta, Sweden, UK, Switzerland), dark fibre (Poland), ducts (Poland) and sharing through user authentification (UK). New types of sharing are also expected, including specific providers of connectivity cooperating with MNOs (Austria, Spain), municipalities or public services participating in sharing (Germany) or even verticals (Austria) may be involved in sharing. Some countries do not expect a specific change for sharing and 5G (Romania). Netherland states that the existence of private network may further promote infrastructure sharing. Serbia expects a changed model of charging for shared infrastructure.

Regulatory changes

Some NRAs state that local authorities and/or legislation should support 5G (Bulgaria, Norway). Some countries think that the regulatory framework is appropriate and sharing agreements have to be mainly commercially based (Finland, Netherland, Sweden, Switzerland, Turkey, UK) and competition law provides a sufficient framework to assess which sharing is desirable (and allowed) and which not (Netherland). Some countries think that infrastructure sharing might be related to licence exempt spectrum bands (Denmark, Ireland). Some countries explicitly mention that competition has to be maintained (Czech Republic, Denmark, Serbia). Individual countries see a risk that MNOs through exclusivity agreements with infrastructure owners could impede the rollout of other MNOs (France) or want to impose the sharing of passive sites. An individual country states that service competition may suffice (Belgium).

To sum up, countries expect that 5G will be especially related to more small cells and higher backhaul capacity. It is believed that there will be an increase or at least an increased need in sharing (passive, active, backhaul, active indoor spectrum and others). Some countries state that operators concluding exclusivity agreements with infrastructure owners could impede other operators' rollout. It should therefore be ensured that sharing does not lower competition.

Annex 1 – Individual assessments of active sharing in various countries

Austria: T-Mobile / Hutchison 3 Austria

For the reciprocal national roaming agreement, the regulatory authority issued an informal statement that the national roaming had to be temporary and that the national roaming should not be applied to new technologies (at that time, to the upcoming LTE rollout).[9]

Czech Republic: CETIN / T-Mobile

CTU assessed ex-post the infrastructure sharing agreement between T-Mobile and CETIN and published an informal opinion in May 2015.[10] CTU has no competence to enforce competition law. The assessed network sharing agreement concerns the Czech Republic with the exception of Prague and Brno. Differently to most other sharing agreements, the agreement is between the two largest MNOs. The smallest MNO, Vodafone, operates an independent active access network.

The assessment states that, in the short term, CTU expects no negative impact on the retail level of competition. However, in the long term the effects on innovation and deployment of new technologies need to be monitored. Since infrastructure costs are only a minor component of total costs of operators, CTU did not see a risk that cost communalities restrict retail competition. Furthermore, CTU did not see a risk that the remaining competitor was pushed out of the market due to significant cost disadvantage. Based on the information CTU was given, CTU did not see a risk of tacit collusion. CTU did not see a risk on the wholesale market and the related investment in coverage. Furthermore, spectrum licence could require increased coverage. To sum up, competitive concerns were focused on the long-term effects on innovation and deployment of new technologies.

The European Commission has initiated proceedings and is in charge of an assessment based on competition law.

Denmark: Telenor and Telia

The Danish Competition Council (DCC) investigated the cooperation between Telenor and Telia ("TT-Netværket") in 2012. DCC found six different anticompetitive concerns with respect to Art. 101(1) TFEU. Five remedies were identified to address those concerns. A requirement to accommodate wholesale customers on customary and market conditions to address the risk of collusion on the wholesale market was imposed. An internal tariff structure reflecting underlying cost shall be used to avoid the conversion of fixed into variable costs. The parties may solely buy spectrum together in order to avoid the accumulation of excessive frequency resources. The parties must offer antenna sites to others that are to be dismantled due to the

[9] See https://www.rtr.at/de/tk/multibandauktion_NR (in German only)
[10] See https://www.ctu.cz/stanovisko-ceskeho-telekomunikacniho-uradu-ke-sdileni-siti-2g-3g-4g-pro-ucely-komplexniho

network consolidation. Requirements on the organization of the joint venture shall address and remove the risk of excess information exchange between the parties.

For the sixth anticompetitive concern – reduction of competition on significant parameters such as coverage and the development and spread of new technology – the parties provided sufficient proof that the criteria for individual exemption in TFEU Article 101(3) were met.

Besides the TT-Netvaerket, the Danish mobile market consists of two largely independent competitors: TDC and Hi3G Denmark. In 2015, Telenor and Telia proposed to merge, but withdrew their application when the European Commission required conditions that the merging parties did not accept.[11]

Finland: DNA / TeliaSonera Finland

DNA Oy and TeliaSonera Finland Oyj announced in August 2014 that they would form a joint venture ("Suomen Yhteisverkko Oy") in order to jointly provide coverage for Eastern and Northern Finland (50% of Finland´s total area and 15% of its population). The Finnish competition authority initiated proceedings based on competition law in November 2014.[12]

The Finnish competition authority expressed competitive concerns with respect to a potential harmonisation of mobile networks and thus a restriction on national network competition. Furthermore, operators might tacitly collude to the detriment of consumers. The importance of incentives to invest in new technology and high quality networks was stressed. As remedies to these concerns, the Finnish competition authority accepted obligatory MVNO access to the national network of the involved parties. Furthermore, the parties were required to rent out masts and sites to competitors. The information exchange between the parties is restricted, and the parties maintain the ability to bring their preferred network features or additional capacity to the joint network.[13]

FICORA changed the licence conditions to tackle competitive issues related to the joint venture: For 900/1800 MHz licences, coverage obligations of 99% of the population and the requirement to cover 80% of the population with an own network were introduced. If UMTS is used in 900 MHz, the carriers cannot be combined for a larger bandwidth (In other bands this is not restricted.).

France: Free Mobile / Orange

One of the two main network sharing agreements in France is the national roaming agreement between Free Mobile (4th mobile operator and last entrant) and Orange. It is a 2G/3G roaming agreement allowing Free Mobile's customers on Orange's network.

Since it was signed in 2012, this agreement is subject to intense debate in the sector. Designed to allow the entrance to the market of a new mobile operator, by providing access

[11] https://www.telenor.com/media/press-release/telenor-and-teliasonera-withdraw-from-merger-in-denmark/

[12] https://www.kkv.fi/en/current-issues/press-releases/2014/finnish-competition-and-consumer-authoritys-inspections-at-teliasonera-finland-oyj-dna-oy-and-suomen-yhteisverkko-oy/

[13] https://www.kkv.fi/en/current-issues/press-releases/2015/5.11.2015-fccas-decision-ensures-consumers-benefit-from-network-partnership-between-dna-and-sonera/

to an existing infrastructure, national roaming could have undermined investment incentive for the hosted operator if lasted excessively.

Following the adoption of national specific provisions in French law[14], Arcep adopted beginning of 2016 guidelines on mobile network sharing (that provides an analysis grid of what could be acceptable or not in terms of network sharing, with regard to its regulation objectives, including digital territory planning, infrastructure-based competition, etc.), and then invited the operators to modify, if necessary, the existing sharing agreements to comply with its guidelines.

As a result, Free Mobile and Orange agreed, in June 2016, on a roaming extinction trend, based on a progressive speed throttling for Free Mobile's roaming customers from January 2017 to end of 2020. After analysis, Arcep considered that these evolutions were in line with its guidelines and there was no need to use its new power to ask for modification of the roaming agreements granted by the adoption of national specific provisions in French law.

France: SFR / Bouygues Telecom

In addition to the roaming agreement between Free Mobile and Orange (described above), another important sharing agreement in France is the active sharing between Bouygues Telecom and SFR. It involves active sharing of their networks (in 2G/3G/4G) on 85% of the territory and 4G roaming of SFR's customers on part of Bouygues Telecom's network.

On 15th June 2016, following the adoption by Arcep of its guidelines, Bouygues Telecom and SFR transmitted to Arcep an amendment to their 2G/3G/4G network sharing, including the extinction of the 4G roaming of SFR on Bouygues Telecom network by the end of 2018.

In addition, the operators precisely documented the incremental deployment expected, induced by the sharing agreement, in comparison with a situation where the operators deploy standalone networks, leading to an increased 2G/3G coverage and accelerated 4G coverage. Finally, the operators committed to provide, on a semi-annual base, detailed information about the development of the program with regard to forecasts.

After analysis, Arcep considered that these evolutions were in line with its guidelines.

Greece: Vodafone Greece / WIND Hellas

Vodafone Greece and WIND Hellas formed a joint venture "Victus Networks" that shares the RAN for 2G and 3G. Currently, there is an application to share also 4G. EETT is the regulator and nationally has the sole responsibility for network sharing based on competition law, too. The Joint Venture was subject of an ex-ante assessment. EETT issued Decision 698/19/25-07-2013, allowing the infrastructure sharing agreement with the condition that free competition is preserved at all times and with the reservation to examine at any time, any anti-competition results that might arise for reasons attributable to the specific agreement entering into force. There is no further information with respect to the assessment of that agreement.

[14] National law (law n° 2015-990) empowered Arcep to request changes in the sharing agreements between mobile operators.

Hungary: Magyar Telekom / Telenor

Magyar Telekom and Telenor Magyarország notified NMHH about an agreement to mutually and partially share spectrum with each other in the 800 MHz band for LTE nationally with exception of the capital Budapest.[15] NMHH approved the lease as a secondary trading. NMHH stated that the agreement enabled both operators to offer a larger capacity and better technologies characteristics. Furthermore, NMHH examined whether the individual obligations that are linked to the individual licences are fulfilled. Since NMHH has no competence to examine the competition law aspects of the lease agreement, NMHH sent its decision to the Hungarian Competition Authority for information purposes after the decision was made.[16]

In February 2015, the Hungarian Competition authority initiated proceedings with respect to that agreement.[17] In January 2018, the Hungarian Competition authority held unannounced inspections at both parties of the cooperation in order to examine whether there was collusion during the tender in 2014.[18]

No further details on the assessment of the agreement are available.

Norway: Telia / ICE

The Norwegian Competition Authority imposed national roaming during a merger. Tele2 was sold to TeliaSonera. ICE, a new entrant, bought spectrum in the auction in 2013. The merger between TeliaSonera and Tele2 raised competitive concerns that solely two operators would be able to compete effectively. In order to maintain effective competition, several remedies were imposed on the merging parties: MVNO access, national roaming for ICE, selling of infrastructure to ICE, selling of the corporate customer base, the distribution network and frequencies and three Tele2 stores to ICE.[19]

Spain: Yoigo / Telefonica

In 2013, Yoigo and Telefonica agreed on a reciprocal national roaming. Yoigo provided Telefonica with national roaming services for 4G, whereas Yoigo received national roaming services in order to increase its coverage. The relevant background for Yoigo is that it only had spectrum in 1800 MHz bands and above and had problems in providing coverage nationally. The relevant background for Telefonica is that the reciprocal sharing agreement enabled Telefonica to delay its own 4G rollout.

[15] According to the answer to the questionnaire, the agreement also includes 3G. The assessment in the press release of NMHH (next footnote) is limited to the sharing of 4G spectrum.

[16] http://english.nmhh.hu/article/165939/NMHH_Approves_Interconnection_of_Magyar_Telekom_and_Telenor_Networks

[17] http://www.gvh.hu/en/press_room/press_releases/press_releases_2015/gvh_investigating_cooperation_between_telekom_and_.html

[18] http://www.gvh.hu/en/press_room/press_releases/press_releases_2018/the_gvh_held_unannounced_inspections_at_the_premis.html

[19] http://www.konkurransetilsynet.no/en/news/news-archive/20152/the-norwegian-competition-authority-clears-the-acquisition-of-tele2-by-teliasonera-subject-to-conditions/

In July 2015, CNMC declared so provisions of these agreements null and void and fined Telefonica €6 million and Yoigo €300,000. Especially the rollout delay of Telefonica and by compensation offering national roaming to Yoigo was found to be restrictive of competition. No efficiencies that would justify such a restriction were found.[20]

As indicated in Table 3, Yoigo plans to migrate its reliance on roaming from Telefonica's network into Orange's network from 2019.

Nevertheless, as further developed in section 4.3, despite this particular case where some risks were identified and addressed, the overall impact of infrastructure sharing agreements in Spain has been positive.

Sweden: Tele2/Telenor: Net4Mobility

PTS approved the transfer of 900 MHz and 2600 MHz from Tele2 and Telenor to N4M. A complaint was filed with respect to the deepened cooperation between Tele2 and Telenor restricting competition within the meaning of Article 101 TFEU and its national equivalent. The main argument was that a high concentration of spectrum would give Telenor and Tele2 the possibility to offer more advanced services (higher speed), and therefore a competitive advantage over other mobile operators. The Swedish Competition Authority did not undertake any action following the analysis of the complaint.

UK: Several agreements

OFCOM, as a competition authority, may open a competition investigation on an ex-ante basis. During the process, parties might offer some amendments to the initial agreements so that OFCOM does not need to open a formal competition investigation.

A range of possible competitive concerns was considered for different agreements (listed in Table 2). The agreement between EE and Three was originally between T-Mobile[21] and Three. For that agreement, the considered concerns related to information sharing and MVNO access (in particular, whether more efficient use of capacity would constrain supply to third parties and whether there were any 'veto rights' or other constraints on MVNOs as a result of the agreements). In relation to the sharing between Vodafone and O2, in 2009 OFCOM undertook a preliminary assessment and considered the plausibility of anti-competitive effects being realised as a result of factors such as information sharing, co-ordination, foreclosure of access to sites and the effect on coverage from consolidation of sites. In 2012, when Vodafone and O2 were negotiating to engage in more active sharing with Project Beacon, OFCOM considered, at a high level, whether the agreement was likely to raise concerns in relation to: any reduced incentive to supply MVNOs and/or price aggressively at retail level due to reduced spare capacity; the effect of the traffic balancing mechanism (in the agreement) on the unilateral incentive to expand; the ability for a potential new entrant to gain access to the RAN (rather than buying wholesale services); the ability and incentive to co-ordinate in order to reduce expenditure on network quality and investment, foreclose MVNOs and/or foreclose new network entrants; information sharing; and the impact on future spectrum auctions. The

[20] https://one.oecd.org/document/DAF/COMP/AR(2016)21/en/pdf, pp 12-14
[21] T-Mobile later merged with Orange in order to form EE.

parties proposed a number of amendments and so OFCOM did not open a Competition Act investigation.

Annex 2 – Full questionnaire

Infrastructure sharing questionnaire

Current sharing arrangements

1. What are the existing infrastructure sharing agreements in your country?

By passive sharing we mean sharing of the passive elements of network infrastructure (mast, sites, cabinet, power, and conditioning). By active sharing we mean sharing of active elements in the radio access network (e.g. antenna, radio network controller (RNC)). We consider national roaming a form of active sharing. If these definitions are not appropriate, please describe in detail which parts of the network are shared in the respective agreement.

If all MNOs lease passive infrastructure to each other, please state MNOs involved: "all"; passive sharing: "yes", agreement type: "lease".

	Agreement 1	Agreement 2	Agreement 3	Agreement 4
MNOs involved				
Passive sharing				
RAN sharing, separate spectrum				
RAN sharing, joint spectrum				
Core network sharing				
Geographic scope				
Time Frame				
Agreement type (Joint Venture, Lease, other)				
Technology covered (2G, 3G, 4G)				
Commercially driven or by regulatory intervention				
Further comments				

-

2. How are costs shared between the MNOs that are party to the sharing arrangements?

Current regulations and legal framework

3. Is there any (regulated) approach that network operators can inform each other about the sharing opportunities? If so, how does this happen (e.g. online platform)?

4. How does the telecom regulator get information on sharing agreements? Do mobile network operators have a duty to inform you about infrastructure sharing? Or does the telecom regulator get this information through other authorities, notably the competition authority or spectrum authority?

5. What are your regulatory powers and/or duties with respect to infrastructure sharing? Please describe them in detail, with reference to the applicable law[22]

6. Do you include any rules in your spectrum awards that foster, mandate or prohibit network sharing? If so, please describe these in detail.

[22] Telecommunication law, competition law or other.

7. Was your authority formally or informally involved in the evaluation of any infrastructure sharing agreement? If so, please briefly describe the competitive assessment, whether it was an ex-ante or an ex-post assessment, and any remedies/sanctions in detail (with reference to the agreements mentioned under question 1).

8. Please briefly describe the decisions and/or ongoing proceedings regarding infrastructure sharing and provide a link (if available) to any publicly available information on those decisions and/or ongoing proceedings. Preferably also describe the decision and proceedings based on competition law, differentiated between Art 101 (1) TFEU and/or Art 101 (3) TFEU.

9. Have you had any recent public consultations covering mobile/wireless infrastructure sharing in your country? If so, what were your proposals and the reactions from industry?

10. Do you or does another national authority provide any guidance or specific rules with respect to infrastructure sharing? If so, please describe them in detail and, for any specific rule or guidance please describe whether it is based on competition law or based on sector specific regulation (e.g. within the ancillary conditions of the spectrum award).

11. Do you expect that infrastructure sharing will become more important in the future? If so why? Is there any regulation in place or under consideration to i) mandate or ii) facilitate mobile/wireless infrastructure sharing? If so, what consumer outcomes are these regulations designed to achieve?

12. Do you have specific dispute settlement mechanisms in place or are disputes settled on a case by case basis within the existing judicial framework? Please kindly refer to the relevant law.

Benefits and challenges associated with sharing

13. What kind of benefits do you consider/expect from infrastructure sharing, for instance benefits for mobile network operators, end-users, in-door coverage, rural areas and/or other social benefits? Do you have any estimates about the cost savings achieved from the infrastructure sharing (including estimations in total % of opex and capex)?

14. Do you think there are any downsides associated with sharing (e.g. any negative impact on competition or coverage)? Does or did sharing for a specific technology or for a specific spectrum have an impact on competition in new technologies and/or spectrum purchases later on? Does or did sharing have an impact on MVNOs or non-participating MNOs?

15. What is your general experience with the sharing agreements in place in your country? Has infrastructure sharing impacted on the market to some extent (i.e. retail market competition, technological and service innovation)? If applicable, please differentiate between short-term and long-term effects.

16. Do you think there are any barriers to increase sharing in your country (e.g. co-ordination failures, landlord pricing, insufficient space on existing masts etc.)?

Future role of sharing in 2G, 3G and 4G networks

17. What further infrastructure sharing might be needed in 2G, 3G and 4G networks in future? What are the factors that you expect to influence such additional infrastructure sharing? Relevant factors could include (but are not limited to) mobile technology (2G/3G/4G), frequency band, geographic and/or demographic location (i.e. dense area), deep indoor coverage and types of infrastructure.

18. When do you expect that mobile network operators (MNO's) in your country to phase out legacy technology such as 2G and 3G? Do you expect the legacy technology would further

promote or limit infrastructure sharing, and why? Do you provide any guidance or rules for infrastructure sharing with respect to legacy technologies?

Future role of sharing in relation with 5G

19. What will the rollout of 5G mean for infrastructure requirements (macro sites, small cells etc.)?

20. What kind of changes in infrastructure sharing do you expect from 5G?

21. What regulatory changes might need to be made in order to support these changes, and how might they be made (e.g. would it require new legislation), including changes to the licensing regime and/or new ways of awarding spectrum? Do you know what the cost savings are to operators of this further sharing?

Annex 3 – Acronyms

Acronym	Definition
Arcep	Autorité de regulation des communications électroniques et des postes (France)
BCRD	Broadband Cost Reduction Directive
BEREC	Body of European Regulators for Electronic Communications
BIPT	Institut Belge des Postes et Télécommunications (Belgium)
BNetzA	Federal Network Agency (Germany)
CAPEX	Capital expenditure
CNMC	National Markets and Competition Commission (Spain)
CRC	Communications Regulation Commission (Bulgaria)
CTU	Czech Telecommunication Office
DCC	Danish Competition Council
EETT	Hellenic Telecommunications and Post Commission (Greece)
EMF	Electromagnetic Field
EMR	Electro Magnetic Radiation
ERP	Effective radiated power
EU	European Union
FICORA	Finnish Communications Regulatory Authority
GWCN	Gate Core Network
IRU	Indefeasible right of use
JV	Joint venture
LTE	Long-Term Evolution
MNO	Mobile Network Operator
MOCN	Multi-Operator Core Network
MVNO	Mobile Virtual Network Operator
NKOM	Norwegian Communications Authority
NMHH	Nemzeti Média és Hírközlési Hatóság (Hungary)
NCA	National competition authority
NRA	National regulatory authority
OFCOM	Office of Communications (UK)
OPEX	Operational expenditure
PTS	Swedish Post & Telecommunications Agency
QoS	Quality of service

Acronym	Definition
RAN	Radio Access Network
RNC	Radio Network Controller
RTR	Austrian Regulatory Authority for Broadcasting and Telecommunications
SIP	Single information point
SMP	Single market power
TFEU	Treaty on the functioning of the European Union
UK	United Kingdom
UMTS	Universal Mobile Telecommunications System