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Economising on network provision while preserving competition: the challenges of 5G mobile network sharing

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Keywords: mobile markets, network sharing, competition, competitive assessment, 5G

This paper presents preliminary findings of an ongoing research project

Results may change

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1 Introduction

Sharing passive elements of the mobile network, like sites, towers and masts is everyday practice in the mobile industry. Beside the joint use of passive infrastructure, sharing active elements has also become increasingly widespread around the world. The main motive for such cooperation between competitors is to economise on network costs while delivering faster rollout of new technologies and/or providing more robust network coverage.

Both the passive and the active forms of sharing carry undeniable advantages to operators and consumers, but may also raise concerns: since the parties are direct competitors, these agreements could potentially lead to a restriction of competition. The potential anticompetitive effect of cooperation on an oligopolistic mobile market gets higher as the cooperation becomes deeper. While passive infrastructure sharing normally does not raise any competition concerns, the more active elements and functions of the network are shared, the more relevant the need for competition surveillance becomes. However, even many forms of active sharing can be approvable from a competition point of view, as they can provide enough benefits to consumers to counterbalance any potential loss of competition on the market. Furthermore, in many cases the cooperation can be designed and operated in a way that can provide a guarantee against potential anticompetitive concerns. Active network sharing is not a new phenomenon and a lot of knowledge and experience has been accumulated; and nothing seriously problematic has come to light regarding working agreements. Nevertheless, each new case must be judged on its own merits.

From each generation to the next, mobile networks have become more complex not only technically but also economically. Meanwhile the traditional mobile telecommunication services have become simple commodity products. The investment required for the roll-out and the cost of operation of a new network is high. Even if the efficiency of service provision increases significantly with a new technology generation, and there is increasing consumer

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interest in new services, it will pose a challenge to operators to achieve adequate returns on the required new investments. This is especially true with regard to 5G, which is arriving in markets now. Sharing some of these network building and operating costs between operators is a means to make 5G network deployments happen sooner and make the provision of 5G services more efficient. It is not 5G itself that is of particular societal interest, but that vast array of services which are to be built and provided on a stable, fast and reliable 5G connection.

The aim of the paper is to discuss the challenges in the competition assessment of 5G mobile network sharing which emerge in addition to those which were relevant under 4G networks (or below).

Chapter 2 of the paper briefly discusses the main types of mobile network sharing. Chapter 3 presents our analytical framework for the competition assessment of mobile network sharing agreements, built on the approach laid out in guidelines by the European Commission and European regulators, as well as competition cases in European jurisdictions. Throughout, we focus on radio access network (RAN) sharing. Chapter 4 brings 5G into the picture. Here we discuss five special 5G technology and service characteristics which pose new challenges to the competition assessment of 5G RAN sharing agreements and should be in the focus of future research.

2 What is mobile network sharing?

As a practical technical definition, we can say that mobile network sharing is a type of cooperation between competing mobile network operators to jointly use, manage and/or develop some of the network inputs required for their operations. The more network inputs are shared, the deeper the cooperation between the parties. Three main levels of sharing can be distinguished by depth according to the type of main network elements involved: sharing passive network elements, sharing the radio access network and core network sharing.⁵

- Passive network sharing means the common use of sites and masts, and sometimes antennae, to avoid the duplication of the passive infrastructure.
- Radio access network (RAN) sharing implies that in addition to the passive elements, antennae, radio equipment and controllers are also shared in some way. RAN sharing is a type of active sharing, since beside the passive elements, electronics are also involved. Two main types of RAN sharing are used in practice: MORAN (Multi-

⁵ We should note that in the regulatory practice national/internal roaming agreements are usually also classified as network sharing. Network sharing (be it passive or active) means providing the service by using some network elements and services jointly while each party still controls a significant part of the network and service parameters individually. In the case of national/internal roaming the roaming provider grants access to its network services to the roaming party. The roaming relationship between the parties is asymmetric: the network does not become common, and the resources are not used jointly. The roamer has no control over any parameters of the service. Even if it is a commercial agreement, roaming is an access type of service. Unfortunately, many national regulatory or competition authorities in Europe mistakenly do not make this distinction, which results in serious confusion in the competition and regulatory assessment of the network sharing agreements. See for example the draft BEREC Common position on mobile infrastructure sharing, BEREC (2018b).

Operator Radio Access Network) where only the radio equipment is used jointly, but each operator uses its own spectrum with a common RAN; and MOCN (Multi-Operator Core Network) when beside the common RAN some or all spectrum bands are also shared and used jointly by the parties.

- Under core network sharing some core elements and functions are shared by the parties. This option is rather theoretical, since currently, we know of no such network sharing agreements.

Each listed sharing option is deeper than the previous one, and the deeper level of sharing usually includes the one before.

The chance and seriousness of the competition concerns that arise depend on the depth of sharing

The deeper the cooperation, the larger the decrease in network independence. However, the decrease of independence is not linear from one level to the next. From the point of service independence, the core is the most important part of the network. While the core network is separate, the competitive independence of the parties does not diminish significantly compared to the standalone operation. It is also the case that the deeper the sharing, the larger the need for and frequency of coordination as well as information exchange between the parties. The deeper the cooperation, the higher the chance that competition concerns arise.

In practice, passive sharing is an everyday practice in the mobile industry all over the world, and normally does not pose any serious competition concerns.⁶ On the other end of the spectrum, core sharing might occur, but we do not know of any actual cases.⁷ There is a widely shared view that core sharing is highly problematic from a competition point of view. In the large middle ground stand various forms of RAN sharing that are widespread in its various forms. This is also the most interesting type, as it involves a less trivial competition assessment than the other two. Therefore, we focus on RAN sharing in this paper and how it could potentially change in the 5G era.

3 Competition assessment framework under the European competition regulation: our approach

In an earlier paper we presented a competitive assessment framework we found useful for the analysis of up to 4G mobile network sharing practices, based on the approach laid out in Article 101 of the European Treaty and the European Commission's Guidelines.⁸ Since the general European competition framework will not change due to the coming of 5G, it is a

⁶ In practice the opposite would be the case. Refusing a reasonable request by a competitor for access to the passive infrastructure in a location where duplication is not possible for some reasons, were harmful to competition. That is why in most countries there is regulation in place to circumvent this situation.

⁷ The mobile operator's industry organization, GSMA concludes in 2019, that „core networks sharing has not been popular and only few cases have been suspected to be so.“, 5G implementation Guidelines, GSMA, March 2019.

⁸ Papai, Z. – Csorba, G.- Nagy, P – McLean, A.: Competition policy issues in mobile network sharing: a European perspective, Institute of Economics - Centre for Economic and Regional Studies, Hungarian Academy of Sciences, Discussion Paper, MT-DP – 2018/28, 2018

very reasonable strategy to consider 5G network sharing in this setting. However, not only the technology, but also the affected markets, the business relations and economic characteristics of the industry may change with 5G, and the assessment of the issues could be different.

In the next sections we present the building blocks of our approach to competition assessment that we considered useful and valid for up to 4G mobile networks and markets, then discuss the changes that 5G brings, and attempt to assess their consequences.

In this chapter, we outline the main questions to consider in our conceptual framework to analyse a network sharing agreement. The principal question of an assessment is how the different aspects of the agreement will impact competition at the retail level of mobile telecommunication services.

3.1 The product and geographic market dimensions of mobile telecommunication services

Modern mobile networks provide many mobile services, such as voice, text messaging and data (internet) for personal communication, and data for machine-to-machine (M2M) communication. From a competition point of view, it is an important question whether certain types or segments of the mobile telecommunication services form distinct relevant product markets or not. In Europe, these questions have been raised during the assessment of several recent merger cases, and the final conclusion was always that the relevant product market was the retail market for mobile telecommunications services, or that the issue could be left open.⁹

Country-specific issues, the geographical and technological scope of the NSA, as well as the spectrum involved can influence the market definition. For example, if an active NSA covers only the spectrum and corresponding RAN used mostly for data services, then the market that needs to be assessed might be restricted to mobile data services. At the other extreme, if the NSA concerns all technologies and services, then all product segments need to be considered (separately or together).

Though quite a few market definition issues may arise in relation to network sharing agreements, fortunately in most cases it is not necessary to arrive at a definite conclusion regarding the boundaries of the relevant markets, as the competitive assessment would likely be similar given any reasonable market definition. Therefore, there is no significant risk to working with the loose definition of a unified market for mobile services at the retail level, without specifying whether it is sub-segmented into smaller relevant markets.

3.2 The vertical dimensions of the provision of mobile telecommunication services

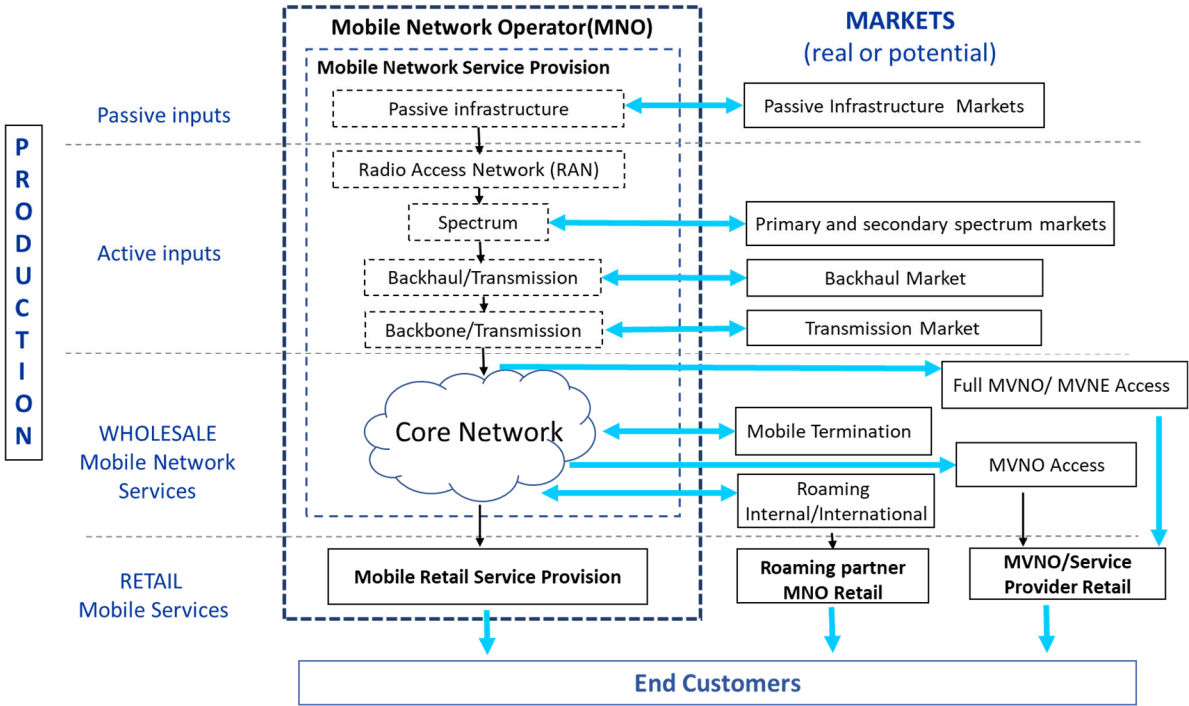
The mobile network and the relationship of the various infrastructure and service elements and markets is much more complex than in typical competition policy cases. The following

⁹ See for example T-Mobile/Orange UK COMP.M5650; Hutchison 3G Austria/Orange Austria COMP.M6497; Hutchison 3G UK/ Telefónica Ireland Comp/M.6992; Telefónica Deutschland/ E-PLUS Case M.7018; Hutchison 3G Italy/ WIND / JV Case M.7758.

figure presents our interpretation of the relevant vertical levels of the production of mobile network services and their connections in a general manner.

The black arrows show connections internal to the mobile network operator. The blue arrows show potential transactions with external (mobile operators or other) players. These connections mark the affected markets that are analysed later.

Figure 1. Markets related to the mobile telecommunications value chain



The vertical chain of providing mobile telecommunication services can be divided into three (not entirely distinct) levels. A classical integrated Mobile Network Operator (MNO) is active at all three levels.

1. "Production": Production of upstream mobile network services using various network inputs, equipment and services.
2. "Wholesale": Wholesale of different upstream mobile network services produced by the MNO to mobile service providers (MSPs). These MSPs can be other integrated MNOs (for example in the case of roaming services) or virtual mobile network operators (MVNOs). The wholesale transaction between the network and the retail service is implicit in the case of an integrated operator.
3. "Retail": Provision of retail mobile services to mobile end users, where the mobile retail service provider develops the retail service packages by using core capabilities, then sells them to the final customers, taking care of marketing, billing and customer relations. Core network functions play a very important role in retail service differentiation.

As seen on the graph, the "Production" level and the "Wholesale" level overlap to some extent: the core network is the part of either or rather both, as we discuss below. The production of upstream mobile network services can be further divided into several levels,

corresponding to different network elements (inputs). The boundaries between these elements are not always straightforward, but they are useful for analytic reasons. As we go down the "production line" dictated by technological sequencing, additional complementary network inputs and services are used. In the case of an integrated MNO, these complementary inputs / services typically arrive from within, but at some points the inputs can be bought from or sold outside. These real or possible transactions will define additional markets for the competitive assessment.

The main vertical elements of the production are the followings:

1. Passive infrastructure: these are sites, towers and antenna support structures on the roofs of buildings, including their maintenance and operation. In addition to the service provided within the integrated MNO, external transactions are common at this level.¹⁰
2. Radio access network (RAN): providing the radio access service requires additional network elements (antennae, radios and other instruments) and an active use of them with the specified spectrum. This is the level where the so-called active network begins. RAN services are typically supplied only internally, so there is no connecting market.
3. Radio spectrum: Wireless services use particular radio waves for signal transmission in the access network. Spectrum usage rights are typically acquired by the MNO at spectrum awarding procedures. However, in Europe and in several other regulatory environments it is also possible to trade spectrum on the secondary market.
4. Transmission network: this provides the connection between the RAN and the core of the mobile network. There is a usual separation between two depths of transmission (backhaul and backbone), although the boundaries between the two are not unambiguous.
5. Core network: this is the intelligent central part of the mobile network where the production of the (wholesale) mobile network service is completed using the above inputs, and where the differentiating features of the service are added.¹¹

3.3 Scope and characterisation of RAN sharing agreements

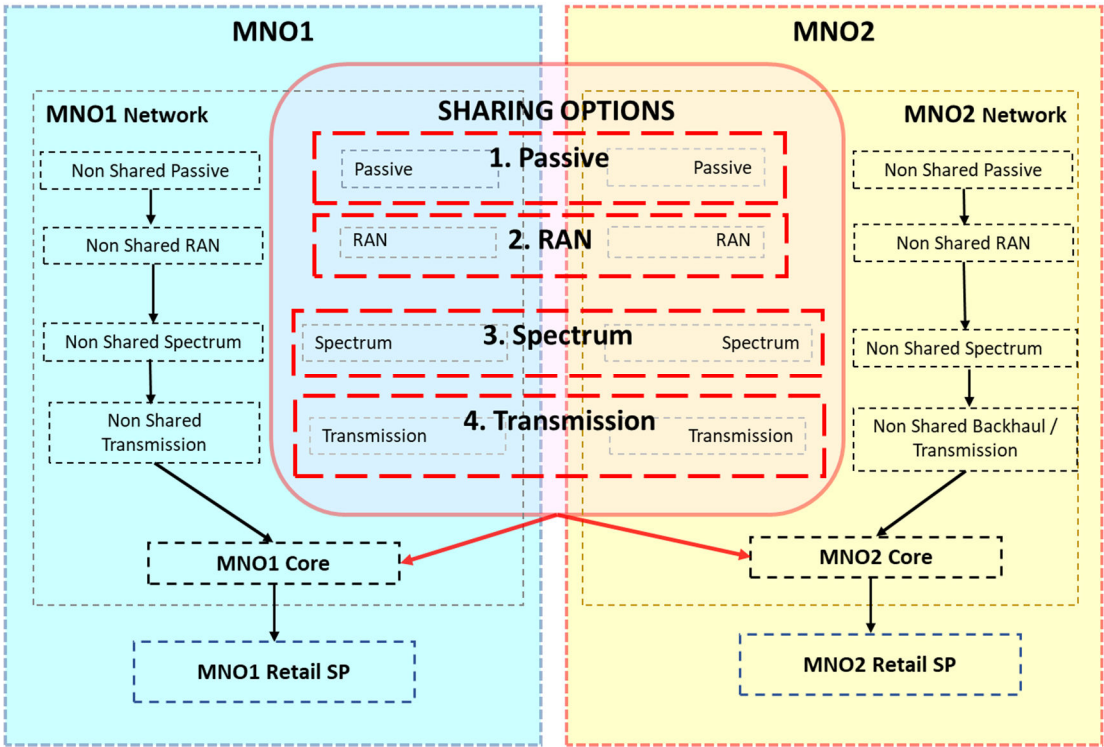
The next figure provides a general view of how the above framework can be used to illustrate network sharing between two MNOs. The advantage of this presentation is that it is capable of showing the potential complexity and depth of the cooperation between the parties. The figure below shows which production inputs could be shared in a concrete case: the passive network, RAN, spectrum and transmission. For the sake of generality, it is a situation when nothing is fully shared; each MNO uses both shared and non-shared elements to provide its services. If the passive elements and the RAN are shared, then we

¹⁰ It is standard market practice that mobile operators give each other access to their own passive infrastructure. In the EU and in many other countries existing regulations even require them to do so under certain conditions.

¹¹ There may exist so-called full MVNOs with their own core network who buy wholesale upstream mobile network services from an integrated MNO.

have MORAN sharing. If all the first three shared, then we have MOCN sharing. Sharing transmission is a typically rational addition to either of these.

Figure 2. A general view of network sharing between two MNOs



Sharing could also be partial or full in geographic scope (e.g. pertaining only to rural areas, covering the whole country, or somewhere in between, leaving large cities out of the sharing).

If the core is not involved, then no agreement, not even one with full passive and radio network sharing results in full-scale cooperation at the production level. That is why it is different to and raises much smaller competition concerns compared to a usual benchmark, an MNO merger.

3.4 The relevant competition policy framework in Europe

Since an NSA is an agreement between direct competitors, the natural starting point of any competition policy assessment in Europe is the framework established for horizontal agreements.¹²

According to the European legal framework, unless the NSA is characterised as a merger, the parties do not need to notify the agreement and can begin the implementation of the NSA without the approval of the competition authority. It is the competition authority's decision to start a formal investigation based on §101 of the European Treaty at any point if they

¹² If the network sharing agreement is in the form of a fully functional joint venture, then the NSA should be evaluated as a merger.

think the NSA in question might restrict competition. Actually, we know of several cases where an NSA was never investigated by the respective country's competition authority.

If the competition authority starts a formal investigation and then finds reasonable anticompetitive concerns with the agreement that the parties cannot rebut, then the NSA cannot be implemented (or cannot continue operating) in its original form. In this case, the parties should find and offer suitable commitments to remedy the situation, or the competition authority will conclude that the NSA is in breach of §101 and therefore should be terminated. All of the closed cases ended up with an approval or remedies offered by the parties, so there are no cases where the statements of a competition authority were tested at court.

The Horizontal Guidelines issued by the European Commission in 2010 presents the legal and economic arguments to be considered for the assessment of horizontal agreements; we follow its structure. The assessment consists of two successive steps:

1. First, one must assess whether the agreement may have any restrictive effects and thus breach Article 101(1) of the European Treaty. The burden of proof for establishing negative effects lies with the competition authority.
2. Secondly, if competitive concerns are substantiated in the first step, then the assessment of the efficiency benefits of the agreement becomes relevant. According to Article 101(3), should these positive effects outweigh the negative effects, then the agreement may be exempt. The burden of proof connected to efficiency benefits lies with the parties to the agreement.

3.5 Possible anticompetitive concerns

First, we make a few general observations regarding the process of evaluation:

- The principal question of the competitive assessment should be how the different aspects of the agreement will impact competition and customers below the last vertical level where the parties are still active. This means that we should always concentrate on how the NSA will impact the MNOs' final customers at the retail level of mobile telecommunication services.
- All concerns should be assessed separately in each affected product and geographic market. The methods used are very similar in each case, but the results could differ. It is therefore possible that a concern is substantiated only in one type of geographical area, or a specific segment of the product market.
- The market power of the parties to the NSA can substantially affect whether a concern arises, and thus their market power should be analysed thoroughly. As market power may differ at various vertical levels, it must be evaluated at the level appropriate to the specific competition concern.
- Since practically all national mobile telecommunications markets in Europe feature oligopolistic structures with 3 or 4 integrated competitors, seemingly small differences between countries can lead to different conclusions.
- A key expression in the case of all concerns is change: markets may be more or less competitive at the outset, but the assessment must concentrate on what the NSA

itself directly changes, compared to the appropriate counterfactual. Note that the counterfactual is not necessarily the current market situation, as telecommunication markets evolve quickly, but the expected future market outcome without the NSA in question.

As the focus of an NSA is the joint use of production assets, it can be characterised as a production agreement. Chapter 4 of the Horizontal Guidelines deals specifically with these types of agreements, so we discuss the potential concerns raised therein. The theories of harm can be grouped into three main categories:

1. The agreement could decrease each involved party's individual incentive to compete, and therefore could result in a loss of rivalry between the parties. Following the classical terminology used in merger cases, we refer to these concerns as unilateral (or non-coordinated) horizontal effects.¹³
2. The agreement could lead to a qualitative change on the market such that tacit collusion becomes easier, more stable or more effective on the market. Again, following merger terminology, we refer to these concerns as coordinative horizontal effects.¹⁴

We believe that the correct assessment of the coordinated effects of an NSA should analyse its impact on tacit collusion between all major operators, not just between the parties to the NSA.

3. The agreement could change the ability and / or the incentive of any party involved in the NSA to make access to an element of its mobile network infrastructure or service impossible or more expensive for competitors, which could indirectly have a harmful effect on the retail market. These exclusionary concerns will be referred to as vertical effects. These vertical effects typically arise due to the changed individual incentives of the parties regarding access.

Table 1 shows a list of competition concerns (theories of harm) that we discussed in detail in the next chapter. On top of the three main categories above, we also include one type that cannot be easily fit into the classic framework: the unfair competitive advantage.

¹³ Note that just because both parties' behaviour can change because of the agreement (and likely in the same direction), as long as the effect in question follows from changed individual incentives and not from any (tacit) collusion, it is a non-coordinated effect.

¹⁴ In our view, the Horizontal Guidelines uses slightly misleading language concerning the scope of collusion, as it usually refers only to collusion between the parties to the agreement. However, in other competition policy guidelines, especially concerning mergers where the theory of collusion is more firmly established, collusion is always discussed as taking place between all major market players in the relevant market. The economic theory of Industrial Organization that provides the conceptual framework of coordinated effects also deals predominantly with models of full collusion, as one major player not involved in the collusion would seriously jeopardise its effectivity.

Table 1. List of competition concerns

Horizontal unilateral effects	<i>Decrease in incentives to compete due to the decreased differentiation of services between parties</i> <i>Decrease in incentives to compete due to fixed costs becoming variable</i>
Horizontal coordinative effects	<i>Increased commonality of costs</i> <i>Information exchange</i>
Vertical effects	<i>Access to MNOs to passive infrastructure</i> <i>Wholesale access to MVNOs to the operators' network</i>
Unfair competitive advantage	<i>Potential exclusion of operators not party to the NSA</i> <i>Excessive concentration of spectrum</i>

We briefly discuss these theories of harm with regard to RAN sharing (we do not consider passive sharing, nor the sharing of the core).

3.6 Unilateral horizontal effects

3.6.1 *The decrease in differentiation*

One of the first potential concerns that can occur to competition authorities and regulators is that due to RAN sharing, certain aspects of the operators' services will become more similar to each other, their technical autonomy will decrease and the possibility (and/or incentive) to differentiate will also decrease. The loss of differentiation might imply a loss of competition.

This statement in itself is too general, and we need to specify what aspects of the services could be affected, and to what degree. Operators' services differ from each other in many ways like price, marketing strategies, range of services, data allowance, speed, quality, coverage. Some of these differences are related to the RAN, like coverage, some are dependent on the quality and quantity of spectrum used, some (most of them) are purely depending on the core and others do not relate to the network either.

We emphasise four general points that need to be considered when evaluating the potential change in differentiation:

1. We consider RAN sharing, maybe together with some transmission sharing, but no sharing of the core. This is important as the main differentiation of mobile services happens in the core network.
2. It is worth distinguishing between technical and commercial differentiation. Technical differentiation consists of setting and managing service parameters, service access and usage rights, authentication, and network resource allocation to the individual customers. Technical differentiation occurs mostly in the core, and many aspects of it are not visible to customers. Commercial differentiation is often – but not always – based on technical differentiation. However, many of the most important aspects of product differentiation are non-technical: they involve pricing, creating appealing bundles of products, and other elements of marketing strategies. RAN sharing

does not change the possibility and/or incentive of the operators to differentiate from a commercial perspective, nor a core-related technical perspective.

Therefore, non-core technical differentiation is the only area where the RAN sharing may have an impact.

3. RAN sharing typically affects coverage and other technical quality parameters attached to it in a positive way. An NSA usually result in greater similarity in coverage between the participating operators, but at a higher level than in the standalone scenario. The loss of differentiation might be well balanced by enhanced coverage. Moreover, coverage is less of an issue of differentiation when it is abundant. This argument can be made for other technical parameters, too.
4. The concern may be raised that RAN sharing also constrains the operators in their choice of technology, capacity enhancement and the introduction of technical innovations.¹⁵ This rests on the argument that in an NSA, future investments must be coordinated, and there is less freedom in introducing any innovation unilaterally. However, in the assessment of this issue the depth of the agreement is an important factor. In the case of MORAN, spectrum use, carrier aggregation, and the introduction of new technologies and switching off old ones could be easier. In the case of MOCN more coordination is needed. Furthermore, technical innovation itself is not predominantly driven by operators, but by equipment manufacturers, who then sell the new features and more advanced equipment to operators. Active equipment has a lifespan of a few years, and therefore innovations will be introduced within a relatively short time span irrespective of the NSA. Initially, the NSA may even speed up the adoption of new technologies as operators consolidate their networks.

It seems that the issue of lost differentiation will always be one of the main topics investigated in connection to NSAs. The burden of proof for substantiating whether there is a substantial decrease in differentiation compared to the counterfactual and that it is large enough to harm consumers is on the authority, and this task it is not at all easy from an analytical point of view.

3.6.2 The decrease in incentives to compete due to fixed costs becoming variable

One of the effects of a network sharing agreement is that some parts of the network costs become shared costs that need to be split between the operators in a way that they deem fair. The design of the system for sharing these costs may give rise to possible unilateral concerns, if the costs that were previously fixed may become variable (i.e. dependent on usage), which could decrease the operators' incentive to attract more consumers to exploit economies of scale, that is their incentives to compete might decrease.

This is a concern with an easy fix from a competition point of view: fixed costs must remain fixed, and shared according to some pre-agreed, non-variable system, instead of becoming usage-based; this way, the incentive to compete is preserved.

¹⁵ The innovation was not an issue in early network sharing cases. It appeared first in the press release of the European Commission on the opening formal investigation into mobile telephone network sharing in Czech Republic, in 2016. http://europa.eu/rapid/press-release_IP-16-3539_en.htm

3.7 Coordinated horizontal effects

Before going into the two, specific coordinative-type concerns that may arise when evaluating RAN sharing, we look at how coordinative effects are investigated in general. The central question when analysing coordinative effects is whether the parties and their competitors' ability and incentive to tacitly collude changes due to the agreement (in contrast to their individual ability and incentive to compete, as with unilateral effects). The usual argument would be that if parties become more similar to each other in certain key aspects of competition, then this could possibly lead to tacit cooperation between all market players to the detriment of consumers – for example, through increasing prices, delaying innovations, decreasing quality, etc.

As a first, but not conclusive step, coordinative effects are usually assessed based on the so-called Airtours criteria, originally developed for mergers, but now also referenced in the case of horizontal agreements: a sufficient level of market transparency, possible deterrence / punishment mechanisms and the lack of the disrupting presence of outsiders (mavericks). It also needs to be assessed whether the NSA itself changes the existing situation enough to enable coordination or make it more efficient. In our former paper, we gave detailed arguments for why this would be hard to substantiate.¹⁶

Overall, the mobile telecommunications market does not appear especially prone to coordination, but the specifics of both the market in question and the design of the NSA under investigation do matter.

We now look at the two specific coordinative concerns that RAN sharing may give rise to. These are mentioned as two general mechanisms in the Horizontal Guidelines where coordinated effects might arise, and both of these issues have actually appeared in the competition assessment of NSAs.

3.7.1 *The increase in cost commonality*

The Horizontal Guidelines specifically mention this possible concern with production agreements: if parties have market power, the parties' commonality of costs, that is, the proportion to variable costs which the parties have in common, may increase to a level which enables them to collude.

Even if the Horizontal Guidelines refer specifically to variable costs, as opposed to fixed costs, when discussing cost commonality, the concern cannot be dismissed simply with the argument that in mobile communications most of the costs are considered fixed. In a dynamic context, an industry has to recover fixed costs (and a return on them) in order to be sustainable and attract capital for financing the necessary future developments. If these short run quasi-fixed costs are also considered, this concern may appear more serious. Examples of costs that may become common include: costs relating to the passive infrastructure behind the parties' networks, costs relating to maintaining the parties'

¹⁶ Papai – Csorba - Nagy – McLean (2018).

networks, costs relating to spectrum. Large part of the variable costs of providing retail mobile services (marketing, sales, billing, etc) remain unaffected. As a result, if only network costs are affected, even full network consolidation would result in less than half of total mobile service production and provision costs becoming common. Unfortunately, no safe harbour is given: neither the guidelines, nor established case law give any threshold on cost commonality below which this specific coordinative concern cannot be raised.

Some increase in cost commonality is inevitable in all NSAs. The degree to which cost commonality increases essentially depends on two factors: (1) the scope of the agreement and (2) the cost sharing system.

Overall, the severity of this concern depends foremost on the chosen scope of the NSA, while the careful design of the parties' cost sharing system may mitigate it if the analysis focuses strictly on variable costs.

3.7.2 Information exchange

An NSA necessitates some degree of information exchange, both during its initial design phase and also later in its operation and decision-making regarding expansion and further developments. However, there is a potential competitive concern that sharing information between competitors can facilitate a collusive outcome, or make it more stable, especially by increasing market transparency. When evaluating the possible effects of information exchange in a production agreement such as an NSA, one must weigh this concern against the need for information sharing to make the NSA work efficiently.

A key principle in competition policy is that the amount and scope of information exchange should be kept at the lowest level necessary to the functioning of the agreement. It is only information exchanges between competitors of individualised data regarding intended future prices or quantities that is considered a restriction of competition by object; but no such data is needed to operate a shared network.

Information sharing might be a legitimate concern, but it does not prohibit the set-up of an NSAs completely. But to handle this issue, the scope of the information exchanged must be minimised, and the type of information shared must be restricted as well as the group of people with access to it.

3.7.3 Vertical effects

All vertical effects emerging in connection to NSAs are connected to access. Competitors usually seek access to the relevant upstream level in order to be able to provide their downstream services. The question is whether the NSA would have the effect of changing the ability and/or the incentive of any party involved in the NSA to make access to an element of its mobile network infrastructure or services impossible or more expensive for its competitors at the given vertical level (this is called foreclosure or raising rivals' costs). The levels in question define the concerns discussed. The two key issues are access to passive infrastructure, and MVNO access.

Vertical effects should be analysed in the framework of ability, incentive and effect to foreclose, developed originally in the framework for assessing non-horizontal mergers. In

general, any of these three conditions are hard to satisfy, and even more so cumulatively, though in some specific cases, these concerns may be valid. However, even if a competition authority can really substantiate a vertical theory of harm, usually the parties can easily offer commitments to alleviate these concerns.

3.7.4 Access to passive infrastructure

As NSA parties consolidate their networks, they may leave or demolish facilities that their competitors also use. The theoretical concern is that this could negatively affect competitors and through a possible (if temporary) adverse effect on their network coverage, also final consumers. The concern is potentially more relevant if the NSA results in a greater change (reduction) in the number and location of facilities.

On top of the general arguments raised on the ability-incentive-effect triad of foreclosure, some additional elements need to be considered. First, in terms of passive infrastructure there still remain alternative ways to get this type of access from players other than the MNOs, which would make the ability to foreclose less likely to prevail. Second, the cost of site rental alone is quite small compared to the whole cost of providing downstream service, which makes significant downstream effects unlikely.

Should this concern arise, a typical settlement would be to offer abandoned facilities to competitors to buy or rent, which may even coincide with their business interests.

3.7.5 Access to wholesale mobile services to MVNOs

The classic foreclosure argument is that the NSA may lead to the parties' increasing market power on the relevant upstream level, increasing their ability and incentive to foreclose MVNOs: refuse, limit or overprice their access to wholesale services.

Network access is of course a key input for all types of MVNOs, and the supply of possible providers is limited even without NSAs. This means that these concerns may seem more crucial than access to passive infrastructure. However, only some independence of the networks decreases as a result of the NSA, not the number of independent MNO access providers.

On top of the general arguments on ability, incentive and effect listed before, what is really important to consider is whether the incentives to provide MVNO access will be impacted by the NSA. If the sharing parties are not limited in using their dedicated network capacity, their ability and incentives will not change as a result of the NSA.

3.8 Unfair competitive advantage

Finally, we mention a type of concern that we believe is not a standard one in modern competition policy, based on the potential exclusionary effect of an NSA, either at the retail level or in connection to spectrum allocation.

The issue raised is that the parties to the NSA might gain a non-replicable cost and /or quality advantage, which may create a competitive advantage. According to the concern, the decreased relative competitiveness of other operators could lead to the competitors' exit or

serious weakening, thereby decreasing competition, and allowing the remaining players to abuse their increased market power.

3.8.1 Potential exclusion of operators not party to the NSA

This theory of harm can potentially be raised by operators who have been “left out” of the planned NSA in question: they could posit that their competitiveness on the retail market will suffer due to the NSA. This points to its essential weakness: since a competition authority should protect competition, not competitors, the fact that competitors may not be able to keep up with the NSA parties in some way is not in itself an argument against the NSA, as there is no consumer harm. If a competitor left the market, it may lead to consumer harm; but this seems highly unlikely on the current mobile markets and would be almost impossible to prove.¹⁷

3.8.2 Excessive concentration of spectrum

In the case of any RAN sharing involving spectrum pooling (MOCN or any deeper level of agreement) the parties to the NSA can use their spectrum more efficiently than in the standalone case. That is a key advantage and benefit of spectrum sharing.

A potential concern might be that the amount of available spectrum affects network capacity and speed, therefore if the parties to the NSA have a significantly larger amount of spectrum at their joint disposal than their competitors, the competitors may be unable to offer services of comparable quality.¹⁸ However, this concern can only be raised in case of an MOCN RAN sharing, and is not valid for MORAN. Second, the fact that competitors may not be able to keep up with the NSA parties’ superior offers due to the use of pooled spectrum is not in itself an argument against the NSA – consumer harm cannot be automatically assumed. Harm would only manifest if competitors were forced to leave the market or their ability to compete were significantly reduced due to the NSA, which hardly can be the case.

While the spectrum concern shares many features with the previously discussed exclusionary concern, the affected markets differ. Spectrum is allocated, and after a given number of years, re-allocated through various award mechanisms, such as auctions. The positions of the MNOs can therefore be much less stable in the long run with regard to spectrum endowment than on the retail market. The message is, that the root of the problem – and thus also its solution, lies in the design of the spectrum awarding procedures, and not the NSAs.

3.9 Efficiency benefits

If competitive concerns are substantiated in the case of an NSA, the next step is to assess the possible benefits, efficiencies resulting from it: the negative effects must be weighed against the positive ones. Although the efficiencies are crucial to the assessment of any NSA, they depend very much on the specific form it takes. The third paragraph of Article 101 lays out

¹⁷ Considering the extremely high burden of proof, it is not very likely that a competition authority could substantiate such a concern. We only know of one regulatory case (in the Czech Republic, see discussion later) when this concern was raised but then also dismissed later.

¹⁸ It has come up only in one case, in Denmark. Danish case 4/0120-0402-0057 between Telia/Telenor (decision taken in 2012).

the conditions under which the agreement may be exempt from the prohibitions in Article 101(1). These are the following:

1. The agreement must contribute to improving the production or distribution of goods or to promoting technical or economic progress.
2. Consumers must be allowed a fair share of the resulting benefit.
3. The agreement must be indispensable to achieve these efficiencies.
4. The agreement must not result in the possibility of eliminating competition in respect of a substantial part of the products (services) in question.

The burden of proof for showing that all four, cumulative conditions are met is on the NSA parties; while the competition authority must show harm, it is the parties who must demonstrate efficiencies.

It might seem that the central question, is whether the first two, interconnected conditions are met (efficiencies and resulting consumer benefits). However, the evaluation of the third condition can be tricky as well, since in order to show indispensability one needs to compare it with another rationally available option and argue that the second one does not produce a comparable level of efficiencies with less harm – this question can be crucial when designing the NSA. The fourth condition is usually simple to see: competition cannot be eliminated if at least one viable MNO is not part of the NSA.

Two main types of efficiencies may arise in NSAs:

1. Cost efficiencies: cost savings resulting from the agreement which translate into lower prices (or similar benefits) to consumers, which can and should be quantified. In order to judge the case, we need to know the pass-through rate, and a plausible mechanism for transferring the savings to the customers. This complex setting means that even for these more quantifiable efficiencies, the calculation is less than trivial.
2. Qualitative efficiencies: these can be the following: better indoor or outdoor coverage, better network quality, higher up- and download speed, higher throughput, faster network rollout, earlier availability of coverage and services on some locations, earlier fulfilment of coverage and quality commitments, etc. Some of these advantages are temporary, others are permanent by nature. These qualitative efficiencies also have to be assessed compared to the counterfactual and should be quantified as much as possible. This is especially important as these efficiencies taken together may be larger and more important than those passed through in the form of price decreases.

The judgement on whether the quantified and non-quantifiable efficiencies together can exceed and counterbalance the identified anticompetitive effects is at the discretion of the competition authority. Even if most of the efficiencies can be quantified, the concerns in general cannot. Some subjectivity cannot be eliminated from the process. As we noted above, an MNO merger sets a striking benchmark, and it is evident that RAN sharing raises much smaller competition concerns than a merger especially because it does not change the structure of the retail market.

4 Potential competition assessment issues under 5G RAN sharing

With the coming of 5G, it is safe to say that the economic incentives to cooperate in the provision of networks are even higher than before, in order to be able to compete viably and efficiently on the retail markets.¹⁹ This view is widely shared even by regulators.²⁰ What is more, the extreme point has also been raised that one 5G network is better and more efficient than separate MNO infrastructures.²¹ The full elimination of mobile network competition is not only a very radical but also a very ill-founded proposal. It is an exaggerated answer to the challenges of the deployment of a new critical communication infrastructure. But the challenge is present with 5G network investment – and network sharing can be a way to address it.²²

This means that while network sharing is expected to become more widespread with 5G, the related competition issues will concurrently become more complicated. Right now, nobody knows exactly what fully-fledged 5G will look like in reality and what services will be successful on the market. Initial network deployment has started before there is greater clarity. Currently, investors have to make their bets and regulators have to form their opinion on network sharing agreements under very high uncertainty. A regulatory gridlock holding up technology and market development would be harmful for European business and citizens. On the other hand, if network sharing led to competition issues, it would be better to address them as soon as possible. 5G network sharing issues and the markets potentially affected may be very different from the current ones, and the knowledge and experience accumulated till the present does not give enough guidance.

We can use the competition assessment framework we developed above, and see how 5G may change it. In what follows, we will overview some known or strongly expected characteristics of 5G relevant to network sharing and discuss how these may influence the assessment of certain theories of harm. We find that these characteristics mainly influence the assessment of the loss of differentiation, and the coordinative concerns, especially information exchange.

¹⁹ See for example Grijpink, F. – Ménard, A. - Sigurdsson, H. – Vucevic, N.: Network sharing and 5G: A turning point for lone riders, McKinsey, February 2018, <https://www.mckinsey.com/industries/telecommunications/our-insights/network-sharing-and-5g-a-turning-point-for-lone-riders>;

or Bernold, H. – Steiger, M. – Wilms, M. – Bock, W. – Schicht, R.: A Playbook for Accelerating 5G in Europe, September, 2018, http://image-src.bcg.com/Images/BCG-A-Playbook-for-Accelerating-5G-in-Europe-Sep-2018_tcm9-202394.pdf

²⁰ BEREC Report on infrastructure sharing, BoR (18) 116, BEREC, 2018

²¹ It was even raised in the US, see: Sullivan, M.: A Nationalized 5G Network Could Settle Network Neutrality For Good, FastCompany, 01.29.18, <https://www.fastcompany.com/40523621/a-nationalized-5g-network-could-settle-network-neutrality-for-good> . But other countries may also consider this option in their 5G strategy.

²² The telecom regulator of Singapore, IMDA put for consultation its principles for 5G introduction. In this document it signalled that it encourages network sharing amongst MNOs, but wants to have at least two separate networks in a currently four-player mobile market, Second Public Consultation on 5G Mobile Services and Networks, 7 May 2019, IMDA <https://www.imda.gov.sg/-/media/imda/files/regulation-licensing-and-consultations/consultations/consultation-papers/second-public-consultation-on-5g-mobile-services-and-networks/second-5g-public-consultation-7-may-2019-final.pdf?la=en>

4.1 Some key differentiating characteristics of 5G relevant to the competition assessment of network sharing agreements

4G is the modern general-purpose mobile network which supports voice and data services, and M2M communications. With the partial exception of narrowband IoT, the same general network is used for providing all the services. 5G is designed based on a different service philosophy. Special consumer needs can be supported with a flexible network, using Software Defined Network (SDN) and virtualisation (NFV) technologies to create virtually independent special-purpose networks, optimised for the critical requirements of the use cases.

The required technical capabilities of 5G have been widely discussed, so we do not repeat them here.²³ In general, three use case categories were defined, each of them with some critical technological requirements. These are the following:

- Enhanced Mobile Broadband (eMBB)
- Ultra-Reliable and Low Latency Communications (URLLC)
- Massive Machine-Type Communications (mMTC)

Of the three use case categories, only the enhanced mobile broadband function of 5G is clearly defined and actually under commercial implementation.

Each specific use requires new functions in the network. Therefore, it is important to know how the RAN and core network architecture and functions change in 5G compared to 4G, and what challenge these changes pose to the competition assessment.

4.1.1 Cloud RAN

Cloud RAN (C-RAN) is a centralised, cloud-based architecture for the radio access network. The 5G RAN requires a significant increase in the number of base stations compared to 4G, because it uses higher frequency bands and also because of the need to increase the local network capacity. In the current networks (4G and below) both the radio head (RRH) and the baseband unit (BBU) which generates and processes the signal are integrated and located at the base station. This requires space, power and cooling at the base station level. Network densification under 5G drives up the RAN cost significantly. An emerging solution to this challenge is the C-RAN architecture, which means that the baseband unit function is centralised, and one centrally located BBU can control several RRHs. The RRHs at the base stations are connected to the central BBU by fast fronthaul connections. This solution makes the new base stations simpler and consequently cheaper. The C-RAN makes mobility functions more efficient and also enhances the scalability of the network. But at a cost of deploying the required fast and large capacity fronthaul connections.²⁴

²³ See for example: Setting the Scene for 5G: Opportunities & Challenges, ITU, 2018 and for a more lively discussion see: Lehr, W: Future of Broadband Competition in a 5G World, 2018,

https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID3240191_code81468.pdf?abstractid=3240191&mirid=1

²⁴ See: Cloud RAN Architecture for 5G, A Telefónica White Paper Prepared in collaboration with Ericsson, 2016, http://www.tid.es/sites/526e527928a32d6a7400007f/content_entry5321ef0928a32d08900000ac/578f4eda1

By introducing the C-RAN, the RAN architecture changes. RAN sharing options become even more compelling because of the higher cost of the access network. MORAN or MOCN are both relevant possible forms of sharing. Regarding differentiation ability, the differences between the two remain roughly the same as with 4G. MOCN still results in higher coverage similarity than MORAN. But the increasing complexity of the RAN may affect both in comparison to the standalone Single RAN option. Since a more complex RAN enhances the options of differentiation compared to the current situation under 4G, the potential loss of differentiation will be higher compared to the standalone case. It does not follow directly that this would be a strong anticompetitive effect. And even if the concern were stronger than with a 4G MORAN/MOCN, it could still be counterbalanced by larger efficiencies. All in all, the differentiation issue is expected to be more relevant in the competition assessment of 5G RAN sharing.

4.1.2 Mobile Edge Computing

Mobile Edge Computing (MEC)²⁵ is a new development in 5G. It refers to placing core computing and processing functionalities right at the edge of the RAN, closer to the end user. It supports the ultra-reliable and low latency communications services. In 5G networks it may become rational to share these functions too. In this case not only the RAN but also some core functions would be shared, so the agreement would go beyond RAN sharing as we now know it. If the 5G core architecture is somewhat decentralised, the rationality of partial core sharing may emerge. The competition assessment framework presented above is appropriate for assessing these situations, but there is no precedence or benchmark: core sharing, even if only partial, has not been practiced before. It would definitely bring up a potentially significant issue about differentiation, and would also increase the need, the frequency and depth of technical coordination and exchange of information. Whether it is acceptable, supported or discouraged must be the result of a careful assessment of its effects on retail competition, and also the benefits expected from it.

4.1.3 Service innovations may depend critically on the implementation of new RAN features

The introduction of some new services depends on the implementation of both new core and new RAN settings. In a 5G network, as it is pictured now, this may be quite common when introducing new services or network-related service innovations. Therefore, it might constrain, at least temporarily, the ability of any of the parties to differentiate by being the first to innovate. Such issues could occur also in a 4G RAN sharing scenario, both under MORAN and MOCN, but could become more pronounced under 5G. This is because one main advantage of 5G is that it enhances the opportunities for service differentiation and service innovation. Under any type of RAN sharing such innovation requires increased coordination and information exchange between the parties regarding strategically

[146dde411001d0e/files/WhitePaper_C-RAN_for_5G_-_In_collab_with_Ericsson_SC_-_quotes_-_FINAL.PDF](https://www.gsacom.com/paper/multi-layer-cloud-ready-radio-evolution-towards-5g-nokia-white-paper/) ; Multi-Layer and Cloud-Ready Radio Evolution Towards 5G, Nokia, 2016, <https://gsacom.com/paper/multi-layer-cloud-ready-radio-evolution-towards-5g-nokia-white-paper/>

²⁵ See for short: What Is Edge Computing? <https://www.sdxcentral.com/edge/definitions/what-multi-access-edge-computing-mec/>, or MEC in 5G networks, ETSI White Paper No. 28, First edition – June 2018, https://www.etsi.org/images/files/ETSIWhitePapers/etsi_wp28_mec_in_5G_FINAL.pdf

sensitive topics of network development, as well as potentially decreasing their ability to differentiate. Therefore, both the differentiation and the information exchange concern would deserve more attention and scrutiny in the competition assessment than before. The parties to network sharing can attempt to address this challenge by drafting their agreement more carefully in advance, but even with this care concerns may remain.

4.1.4 Network Slicing

A “network slice is an independent end-to-end logical network that runs on a shared physical infrastructure, capable of providing an agreed service quality”.²⁶ Slicing is a critical differentiator of 5G compared to the current networks. It creates the new opportunity to define special-purpose networks, tailored to serve some special applications and /or user needs, as independent logical networks, above the common 5G physical network. This opens up markets for new services and use cases. Autonomous networks defined by slicing can support special IoT uses, or function as a drone management network, etc. It is not clear now how a RAN sharing agreement will handle the required flexibility, QoS and dedicated network capacity. It may be more of a problem under MOCN than MORAN. Slicing is such an important function of 5G that it must be regulated and managed well in the agreement. It requires more information exchange and coordination. The need for more intense coordination between the parties may increase the coordinative concern. Since slicing is a tool for service differentiation, that also can be a concern.

4.1.5 Verticals

As projected by 5G future service visionaries, new vertically related services (and markets) will be created and provided by using special 5G network services (maybe with slicing). The word verticals refer to new business models which will use a customised and optimised network hinged on the 5G network.²⁷ These special businesses can be logistics, electrical grids, robotics, telemedicine, agriculture, etc.

Traditional mobile services (voice, sms, data) are pure commodity inputs to the vertical services, so no special business relationship and interworking with these vertical players (banks, security service providers, etc.) was required. The projections about 5G verticals presuppose a quite different relationship and mutual dependence between the MNOs and these vertical market players. It is very likely that the number of potentially affected markets will be higher, and the competition assessment must consider these vertical markets as well. Another possible consequence can be that greater care and attention will have to be given in the agreements to handling the externalities caused by the vertical strategy of one party on the other, especially if their market strategy concerning verticals is very different. Again, as a result, we expect an increase in the complexity of the network sharing agreements, as well as in the assessment of them. From a competition point of view, it is very important that the cooperation at the RAN level do not constrain or affect downstream market behaviour.

²⁶ Network Slicing, GSMA, April 2018,

<https://www.gsma.com/futurenetworks/wp-content/uploads/2018/04/NS-Final.pdf>

²⁷ 5G empowering vertical industries, 5GPPP, 2016,

https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf

4.2 Summary

The table below summarise the three main types of concerns that would be especially relevant in relation to 5G: loss of differentiation, information exchange, and vertical concerns.

Table 2. The relevance of three highlighted network sharing competition concern types in relation to 5G's characteristic features

	Horizontal loss of differentiation	Coordinative information exchange	Vertical
C-RAN	<i>relevant</i>		
MEC	<i>possibly relevant</i>	<i>relevant</i>	
New RAN feature implementation	<i>relevant</i>	<i>relevant</i>	
Network Slicing	<i>possibly relevant</i>	<i>relevant</i>	<i>possibly relevant</i>
Verticals			<i>relevant</i>

Some mobile operators have already announced their intention to share their 5G networks²⁸ and more are expected. As more details on these cooperations become public, potential competition concerns will be better understood. The main challenge will be for both the sharing agreements and the European competition authorities' approach to adapt to the growing technical complexity of the mobile industry.

²⁸ Vodafone is the most active MNO in future 5G network sharing planning. In 3 out of the 4 announced 5G network sharing till 2019 May, Vodafone is a party: partnering with O2 in the UK, with Telecom Italia in Italy and with Orange in Spain. Vodafone is committed to the sharing as it emphasis in its 2019 annual report: https://www.vodafone.com/content/annualreport/annual_report19/downloads/Vodafone-strategic-report-2019.pdf.

The fourth known announcement was made by Tele2 and Telenor on securing new frequencies and consolidating joint plan for 5G network in Sweden, Dec 10, 2018 <https://www.tele2.com/media/press-releases/2018/tele2-and-telenor-secure-new-frequencies-and-consolidate-joint-plan-for-5g-network-in-sweden>

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