SAPHYRE

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Overview of regulators' and operators' views on resource sharing (final)

D7.1b

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Abstract

This document contains the results of a questionnaire conducted amongst regulators to assess policy and regulatory trade-offs regarding resource sharing in mobile networks.

Keywords

3G, 4G, infrastructure, LTE, mobile networks, network sharing, questionnaire, RAN sharing, regulatory aspects, trade-off.

Contents

Abbreviations

3G/4G	3rd/4th Generation
BEREC	Body of European Regulators for Electronic Communications
CbC	Case-by-Case evaluation
ComReg	Commission for Communications Regulation
D#	SAPHYRE Deliverable (number)
EU	European Union
ICNIRP	International Commission on Non-Ionizing Radiation Protection
LTE(-A)	Long Term Evolution (Advanced)
MVNO	Mobile Virtual Network Operator
NRA	National Regulatory Authority
OFCOM	Independent regulator and competition authority for the UK communications industries
OPTA	Onafhankelijke Post en Telecommunicatie Autoriteit
QoS	Quality of Service
R#	Respondent (number)
RAN	Radio Access Network
RSPG	Radio Spectrum Policy Group
TFEU	Treaty on the Functioning of the European Union
TNO	Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek
UMTS	Universal Mobile Telecommunication Service
WHO	World Health Organization
WP#	SAPHYRE Work Package (number)

1 Executive summary

This document reports the outcome of a questionnaire, which has been sent out to regulators in 35 European states within the framework of the SAPHYRE project. The questionnaire was set up to validate trade-offs identified in WP5, which dealt with business and regulatory aspects regarding resource sharing. This report only contains the results of the questionnaire and is complementary to D7.1a [1], i.e. the initial version of this report. That document was published end 2011 and contained the results of interviews held among operators.

Due to the relatively small number of responses we received on the questionnaire the outcome merely gives an indication but should not be considered as representative. From the responses it seems that among the states different views exist regarding the allowance of resource sharing between operators. The dominant response appears to be that sharing arrangements must be assessed on a case-by-case basis, but there does not seem to be a strong a priori opposition against sharing in its various forms.

2 Introduction

SAPHYRE aims at demonstrating how further advances in infrastructure and spectrum sharing in wireless networks improve spectral efficiency, enhance coverage, increase user satisfaction, maintain QoS performance, lead to increased revenues for operators, and decrease capital and operating expenditures. Apart from the development of enabling technology for resource sharing, SAPHYRE is also investigating business and regulatory aspects of resource sharing.

Today, sharing of resources beyond site sharing, especially RAN sharing, is already an option for mobile operators in response to the need to reduce costs. However, the assessment of operator views on sharing which we conducted in 2011 taught us that many important aspects affect the identification of drivers, barriers and trade-off. Most of these aspects are the sharing category, the adopted strategy, the country, the type of sharing area (rural or urban), the type of sharing urban area (indoor or outdoor) if applicable, the demand expectations, the market phase, the market position, the time of sharing implementation and duration of sharing, the infrastructure provider/receiver, the regulatory framework and the technology options.

From the regulatory perspective, the allowance of resource sharing among operators is likewise not a simple yes or no. Many factors come into play which through national policy, have been given a priori a certain relative weight and which influence decisions about allowance of specific sharing arrangements. Figure 1 below illustrates the palette of factors, which a regulator typically takes into account.

This questionnaire has addressed the European regulatory community beyond the project's External Advisory Board. It aimed to complete our view on the regulator's perspective on resource sharing, including the technological advances we have been able to produce and to validate a number of observations and conclusions we gained in SAPHYRE. The anonymised collected results are included in this report, which complements D7.1a [1], which addresses the *operators'* perspective.
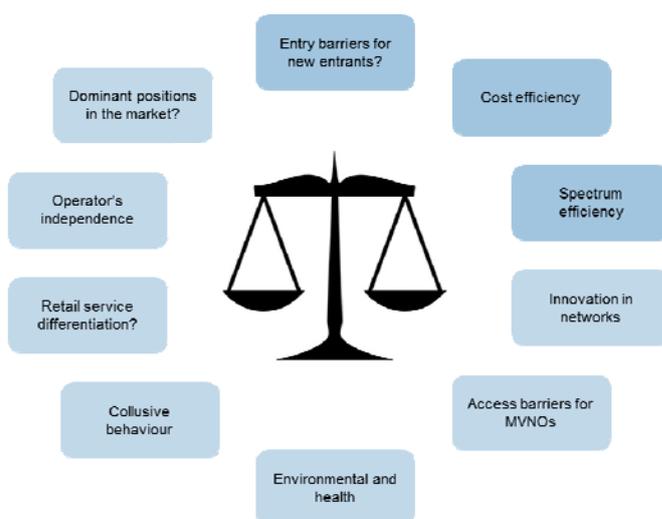

Figure 1: Relevant aspects to be considered in the regulatory context regarding sharing arrangements with mobile networks

3 Theoretical background

3.1 Regulatory aspects

In SAPHYRE WP5 we have studied the regulatory aspects regarding resource sharing in mobile networks [2]. This background section is directly derived from this work. In the conduct of that task, we looked at several sources. The EU framework directive [3] lists the objectives that National Regulatory Authorities (NRAs, such as OFCOM in the UK and OPTA in the Netherlands) have to take into account. As explained in more detail in [4], the following objectives are relevant to infrastructure and spectrum sharing:

- *"ensuring that there is no distortion or restriction of competition in the electronic communications sector, including the transmission of content"*

- *"encouraging efficient use and ensuring the effective management of radio frequencies and numbering resources"*

- *"safeguarding competition to the benefit of consumers and promoting, where appropriate, infrastructure-based competition"*

- *"promoting efficient investment and innovation in new/enhanced infrastructures"*.

The framework directive also mentions a set of other areas that are of interest. It stipulates that European Member States have to cooperate in many areas relating to the use of radio spectrum, taking into account the *"economic, safety, health, public interest, freedom of expression, cultural, scientific, social and technical aspects of EU policies as well as the various interests of radio spectrum user communities with the aim of optimising the use of radio spectrum and avoiding harmful interference"*. Among other things, this has led to the formulation of limits for the maximal electromagnetic field strengths. These limits need to be taken into account in the evaluation of infrastructure and spectrum sharing arrangements, as the sharing can have an effect on the radiated power and its geographical distribution.

In a joint study, BEREC and the RSPG have analysed the status of infrastructure and spectrum sharing in Europe in 2011 [5]. In addition, they analysed the considerations for NRAs in their evaluations of sharing arrangements. As expected, this analysis reflects the high-level policy objectives from the framework directive and further develops and applies them for the issues typically encountered in sharing. Apart from the sector-specific stipulations from the framework directive, BEREC and the RSPG also take into account the generic legal and economic criteria from Article 101 of the Treaty on the Functioning of the European Union (TFEU, [6]) that aim to protect the competition in the European internal market by prohibiting cartels and other forms of undesired coordination between market players that can disrupt competition.

Based on the BEREC/RSPG analysis and the policy objectives in the framework directive the following set of criteria has been identified with regards to the assessment of sharing arrangements[1]:

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[1] The model illustrated in Chapter 2 is a bit further articulated but comprises the same set of criteria.

- Dominant positions;

- Barriers to entry;

- Homogeneity of product offerings;

- Efficient use of spectrum;

- Cost efficiency;

- Innovation in radio networks;

- Emitted power level.

Each criterion is introduced and further developed in the next sections. The first three criteria play a role in the assessment of the impact of sharing arrangements on competition. The promotion of competition is the key ingredient of two of the policy objectives mentioned above (dominant positions and barriers to entry). The other criteria relate to the other policy objectives. In current practice, regulators will evaluate each individual sharing arrangement on its own merits by looking at the balance between the various criteria.

3.1.1 Dominant positions

In telecommunications, the number of competing network infrastructures is traditionally limited. In European countries, the number of mobile network operators is typically three or four. In larger countries, the leading operators typically have market shares of 30–50% [7]. This level of market share is seen as an indication for a dominant position. A market share above 50% is generally seen as proof for a dominant position for a single operator [4]. The key characteristic of an operator with a dominant position is that it has a market power large enough to operate largely independent of the other participants and the customers in the market. For example, a dominant operator is able to raise its prices to obtain a larger profit. Sharing arrangements between operators carry the risk of increasing the market power of the participants or the newly created combination of participants to the degree that dominant positions are created or reinforced.

The effects of a sharing agreement on the potential creation or strengthening of a dominant position are not only dependent on the market shares involved, but also on the specific arrangements in the agreement:

- Extent of sharing – What is the geographic coverage of the sharing arrangements? Are all sites of the operators covered by the agreement? Do the participating operators share all of their spectrum or only part of it?)

- Sharing terms and conditions – Is the sharing agreement open for further participation by other operators? Are there exclusivity clauses that govern sharing arrangements for other (future) radio technologies or spectrum?)

- Information exchange – To what degree will the information be exchanged between the partners necessary for the operation of the shared infrastructure and spectrum lead to undesired coordinated behaviour ("collusion") of the partners in the retail market for mobile services?

3.1.2   Barriers to entry

Barriers to entry refer to obstacles that make it harder for a new operator to enter the market for mobile services. Telecommunications markets traditionally have substantial barriers to entry as they require significant up front investments in network infrastructure and, for mobile networks, spectrum. Moreover, the investments are for a large part sunk as they cannot be easily recovered if an operator decides to leave the market [4]. A sharing arrangement is likely to affect these barriers, as it leads to increased economies of scale for the participating operators. As will be seen in the analysis, sharing can be beneficial but also detrimental for new entrants. This depends on the characteristics of sharing arrangements, such as:

- How large are the cost benefits obtained by sharing, and how are they distributed over the participating operators?

- Can new entrants enter an existing sharing coalition?

3.1.3   Service homogeneity

Service differentiation allows mobile network operators to gain a competitive advantage. They can distinguish their services from the services offered by their competitors in several aspects, such as price, quality and bundling with other services, e.g. in order to appeal to different market segments. Sharing agreements can reduce the freedom of the partners to differentiate their services relative to each other. The result would be a service market in which mobile operators compete on a narrower set of services or service features. Whether sharing indeed has this undesired effect depends on the (as of yet not fully known) technical and organisational characteristics of the sharing arrangements, such as:

- To what extent can sharing partners independently control the QoS delivered to their customers? Can the sharing partners independently choose the QoS classes they use for their services, or are they forced to cooperate and agree on the available classes?

- Can a request from a sharing partner for the installation of an additional base station to meet a specific coverage need be accommodated in the sharing, also when the other partner is not interested or willing to pay for it?

3.1.4   Efficient use of spectrum

Spectrum is a valuable, scarce resource and it should therefore be used efficiently. Infrastructure and spectrum sharing can contribute to the efficient use of spectrum, in various ways:

- Does the spectrum sharing lead to higher spectral efficiency, in terms of the number of Mbit/MHz per cell?

- Does the sharing arrangement lead to more extensive reuse of spectrum through the use of more (but smaller) cells to cover the same geographic area? This leads to a higher efficiency in terms of Mbit/MHz for the whole geographic area under consideration.

3.1.5   Cost efficiency

Cost savings and more efficient use of resources in general are the main drivers for mobile network operators to participate in sharing. Cost savings also contribute to the policy goal of efficient investment in infrastructures. Telecommunication infrastructure is seen as an important economic growth enabler.

3.1.6   Innovation in networks

Sharing arrangements also affect the environment in which operators introduce innovations in their networks. In this study, innovation in networks refers to larger upgrades and migrations of networks, such as the future introduction of LTE-Advanced in LTE networks. If the innovation roadmaps of the sharing partners are aligned, the sharing arrangement can promote the innovation as the corresponding costs and investment risks may be reduced. The uncertainties surrounding the investment strategy and business may also be reduced as the innovation roadmap of another operator in the same market is (at least partly) known. The latter effect, though, could also be seen as an undesired effect of the sharing. It increases the market power of the sharing operators compared to the other operators in the same market that do not have access to this information. An existing sharing agreement may also limit the speed of roll-out of new technology as it will have to be coordinated among partners and thus may be determined by the operator with the slowest pace.

Innovation in networks also has an important geographical dimension. Mobile network operators tend to introduce new generations of network technologies in urban areas first, as these areas offer the most attractive business cases: many potential customers can be reached by upgrading a relatively limited number of sites. A number of regulators have recognised this tendency and have concluded that they needed to take specific action, e.g. requirements in licences, to promote the innovation in networks in rural areas alongside the urban areas, e.g. the 800 MHz licenses auctioned in Germany in 2010 contained roll-out conditions that were targeted specifically at rural areas.

3.1.7   Emitted power levels

The emitted power levels in RANs must comply with the limits on maximal field strengths that are imposed by national authorities to limit the exposure of the public to electromagnetic fields. These limits also apply to shared RANs. Network and spectrum sharing can affect the emitted power levels because they are likely to introduce changes in the radio planning of operators. Obviously, sharing arrangements should not result in power levels that exceed the limits.

In addition to spectral efficiency and emitted power levels another important regulatory aspect is the energy efficiency.

3.2   SAPHYRE innovations

It was considered important to take into account the innovations in sharing concepts as they have been researched in SAPHYRE in order to enrich the perception of regulator's that sharing could take different and sometimes far reaching forms. The SAPHYRE

innovations, which are considered relevant in this specific context, have been summarised as follows:

- SAPHYRE has shown that the hardware technology and base station requirements in current LTE releases 10 and 11 supports spectrum sharing in general. In particular, both types of sharing – orthogonal and non-orthogonal – are supported. The required control overhead can be realised with current base station backhaul connections.

- For non-orthogonal spectrum sharing (operators using exactly the same frequency (sub-)channel in the same area at the same time), under perfect channel state information and in a two operator scenario with four antennas at the base station, under full load conditions, a SAPHYRE gain of the order of 100% could be realised in link-level simulations.

- For non-orthogonal spectrum sharing, three distributed algorithms for beamforming and power allocation are developed which achieve efficient operating points. By implementation on the hardware platform, the SAPHYRE gains were confirmed on measured channels and on real transceivers.

- For orthogonal spectrum sharing (operators using the channels in the frequency pool in a mutually exclusive way), under perfect channel state information and with maximum sum throughput scheduling a gain between 6% and 100% in terms of throughput could be realised depending on the traffic load of two operators. The more asymmetric the load is between the operators, the higher is the SAPHYRE gain.

- In a spectrum and relay-sharing scenario, it was shown, that the SAPHYRE gain by sharing the relay as well as the spectrum is about 100%, e.g. at 7 dB from 2.5 to 5 bit/s/Hz).

3.3 Questionnaire

Against this theoretical background a questionnaire has been composed which does not contain actual questions but rather a set of statements, which the respondent agrees or disagrees with. There is only one actual question, dealing with radiation limits.

3.3.1 Statements

The following 14 statements have been formulated.

1. Sharing is becoming increasingly accepted and used, moving from site sharing to more progressive types of infrastructure and spectrum sharing.

2. Spectrum sharing between operators can only be done, now and in the future, through the formation of a third company, i.e. more flexible forms of spectrum sharing without such an entity cannot be allowed.

3. Orthogonal and non-orthogonal spectrum sharing are equally treated by the regulator, i.e. the specific method of spectrum sharing is irrelevant.

4. The reported gains with spectrum sharing are likely to stimulate a review of the current approach to licensing spectrum to mobile operators.

5. Suppose that a spectrum sharing arrangement between two incumbents provides a spectral efficiency gain large enough to create room for a new entrant. This is an attractive proposition.

6. Relay sharing and full RAN sharing are equally treated by the regulator, i.e. the extent of RAN sharing is irrelevant.

7. Compared to the overall costs incurred by operators and the areas in which they compete, the effects of RAN sharing on costs and competition are small and therefore do not matter much from a regulatory perspective.

8. In sharing, there is a clear trade-off between the policy objective to promote competition and the policy objective to promote efficient investment in networks. Infrastructure competition in RANs comes at a price: higher average costs in the market. Which proposition best reflects your position:
   a) Having infrastructure competition in RANs is worth the higher average costs in the market.
   b) Lowering the average costs through sharing is more important than infrastructure competition in RANs.

9. As long as there is RAN infrastructure competition in urban areas, rural sharing is tolerable as the effects of urban competition, e.g. decent price level, spread out over the rural areas.

10. Suppose that an advanced form of sharing between two operators brings earlier and larger roll-outs of large network innovations, e.g. a step from 3G to 4G. This outweighs a reduction of the independence that individual operators have to introduce smaller network innovations, e.g. a bandwidth increase within a mobile network generation.

11. The options remaining for operators to differentiate their services at the retail level are more important than the level of concentration at the wholesale RAN level.

12. The organisational model for sharing, and in particular the information exchange between sharing partners and the resulting risk of collusion, is more important for its acceptability than the resulting wholesale RAN market shares.

13. Sharing arrangements that lead to a higher entry barrier for new mobile operators are not acceptable.

14. In Brussels, a limit of 3 V/m for the maximum electromagnetic field strength is used, compared to a 61 V/m limit for UMTS used in almost all other regions of Europe. Such a lower limit strongly affects the opportunities for site sharing. Do you expect the regulation on maximal field strengths to become substantially tighter in your country?

The addressees were invited to agree, partially agree or to (partially) disagree and were invited to motivate their choice.

3.3.2 Criteria priorities

The questionnaire contained a table in which respondents were asked to assign priorities to each of the identified criteria.

Table 1: Criteria priorities

Regulatory aspect	Your priority (1/2/3)*	Please explain your choice
Reinforcement of dominant positions in wholesale market		
Entry barriers for new operators		
Service homogeneity in retail market		
Efficient use of spectrum		
Cost efficiency		
Innovation in radio networks		
Environmental and health protection		
Operator's independence from competitors in general		
Access barriers for MVNOs		
Collusive behaviour because of information exchange in sharing		

*) Max. 3× Prio 1 (Top), 3× Prio 2 (High), 5× Prio 3 (Nominal). This is done in this way to challenge you to determine relative priorities.

3.3.3 Possible a priori positions with respect to sharing

Finally, the questionnaire contained a table in which respondents were asked to give their a priori position regarding various forms of sharing, where possible. Three possible a priori positions could be given for each form of sharing: accept, reject or case-by-case.

Table 2: Possible a priori positions with respect to sharing

Form of sharing	A priori position (accept/reject/CbC*)	Your elaboration
Site sharing		
Antenna sharing		
RAN sharing, excluding relays		
Relay sharing		
Preconfigured spectrum sharing (joint venture)		
Flexible spectrum sharing		
National roaming		
RAN sharing in rural areas		
RAN sharing in urban areas		

*) Case-by-case evaluation

4 Questionnaire results

4.1 Procedure

TNO approached the representative of the Irish regulator ComReg, member of the External Advisory Board, for assistance in finalising and distributing the questionnaire to the regulatory offices in the whole of Europe. This assistance was given generously which was highly appreciated.

Upon our request ComReg sent out the questionnaire to 48 officials from 35 countries on October 26th, 2012 with the invitation to answer the questionnaire and send responses back before November 12th. Beginning of November a kind reminder was sent. By mid November, TNO received six responses (in alphabetical order): Austria, the Czech Republic, Ireland, the Netherlands, Portugal and Turkey. The responses were gathered, briefly analysed and finally reported in this document.

Responses received do not reflect the official national position but reflects the personal view of the official. Although it is probably correct to say that officials' views on the matter will be strongly correlated with their own national policy, the results may not be interpreted as official statements.

In this report, the respondents have been anonymised by labelling them as R1, R2 … R6, so it is not clear which response came from which country representative. In case the country's identity was referenced in the respondent's text, such reference was removed.

4.2 Responses to the statements

The responses to our statements are listed in this section. For each item we have added a reflection based on the six responses.

Table 3: Statement 1

1.	*Sharing is becoming increasingly accepted and used, moving from site sharing to more progressive types of infrastructure and spectrum sharing.*
R1	I fully agree.
R2	I fully agree.
R3	I partly disagree, because, in our experience, operators have not been moving from a site-sharing to deeper types of sharing
R4	I fully agree.
R5	I fully agree. Yes, capabilities of advanced 4G technologies clearly show new ways of spectrum sharing.
R6	I agree, but the term "progressive types" leaves room for interpretation, not every type of infrastructure sharing is accepted from a legal/regulatory point of view.

Reflection on the responses

Among the respondents, there is general agreement that the statement is valid. The occurrence of more progressive types of sharing is indeed not yet widely observed.

Table 4: Statement 2

2.	*Spectrum sharing between operators can only be done, now and in the future, through the formation of a third company, i.e. more flexible forms of spectrum sharing without such an entity cannot be allowed.*
R1	I partly (dis)agree, because at present it may be difficult due to competition concerns, but in the future it is feasible that operators may be able to share spectrum through dynamic frequency sharing facilities or through licensed shared access.
R2	I partly (dis)agree, because it is only one of the viable options.
R3	I partly disagree, because there is nothing in the general provisions regarding the use of radio communications in our country that forces the creation of a third company in order to share spectrum. We would assess spectrum sharing on a case-by-case basis, and, should a third company be created, its impact on the market would be taken into account. In addition, we would assess the impact of spectrum sharing on the individual coverage obligations the operators possess.
R4	I partly (dis)agree, because some sort of sharing is realised through BTK, some not. It is hard to predict such a necessity now.
R5	I partly agree. We believe, that some forms of spectrum sparing can be negotiated directly between interested parties – e.g. the example of mobile 4G networks. However, some forms like Licensed Shared Access or dynamic access based on geolocation databases should be supported by third party services.
R6	As there is no legal/regulatory provision for spectrum sharing in our country, no comment can be made on compatible constructions.

Reflection on the responses

This statement leads to challenging responses from which we can conclude that respondents could imagine possibilities of spectrum sharing directly among operators without the need for a third company.

Table 5: Statement 3

3.	*Orthogonal and non-orthogonal spectrum sharing are equally treated by the regulator, i.e. the specific method of spectrum sharing is irrelevant.*
R1	I fully agree because at the moment the main concern is the impact of any sharing arrangements on competition.
R2	I partly agree, because it is true that each type of sharing is treated equally and has to respect a few basic principles. However, in certain scenario's it will be easier to fulfil these requirements than in others.
R3	I partly agree. It would depend on the specific terms underlying the agreement. Within the power it has by law, We would be, among other aspects, looking at the amount of information that would be shared among operators and how this exchanged information could impact the competition.
R4	Our national authority has no official regulation, board decision or any kind of legislation about this issue yet.
R5	We fully agree.
R6	As there is no legal/regulatory provision for spectrum sharing in our country, neither form (although distinction is unclear) is acceptable.

Reflection on the responses

This statement leads to quite different responses. R1 and R2 do not consider the distinction as relevant from a regulatory point of view. The comment made by R3 is interesting because it hits an important aspect, i.e. the level/amount of information sharing that is required. The response of R6 indicates that sharing is not generally allowed everywhere in Europe.

Table 6: Statement 4

4.	*The reported gains with spectrum sharing are likely to stimulate a review of the current approach to licensing spectrum to mobile operators.*
R1	I fully agree, because regulators will be obliged to consider demands from the industry to allow new approaches to spectrum sharing.
R2	I fully disagree, because sharing is already made possible if a few basic conditions are met. It is up to the operators to make decisions and arrangements on sharing.
R3	I partly disagree. It will depend on the specific bands and on the specific circumstances within the markets affected by the usage of those bands. We would assess the benefits of cost-saving sharing against possible negative consequences in terms of competition.
R4	I fully agree.
R5	I fully agree. It could support, inter alia, national views on efficiency of spectrum utilisation.
R6	I fully disagree, because no evidence of any gains of substance in real-live environment.

Reflection on the responses

Half of the respondents indeed consider a review of their current licensing approach as a possibility to accommodate this trend if it would be so rewarding in terms of efficiency gain. The other half is clearly in disagreement and indicates that it would not really change the current approach.

Table 7: Statement 5

5.	*Suppose that a spectrum sharing arrangement between two incumbents provides a spectral efficiency gain large enough to create room for a new entrant. This is an attractive proposition.*
R1	I partly (dis)agree, because although it is an attractive proposition the regulator would also be obliged to consider the impact on competition including barriers to entry.
R2	I fully disagree, because this will depend on the characteristics of the market and the market share of the combined incumbents …
R3	I partly agree, if there is market interest and especially if the benefits to the customers are high of having a new entrant, in respect to the costs of the two operators.
R4	I partly agree, because the information we have on this issue is not mature.
R5	I fully agree. We assume that the issue of spectrum sharing will dramatically change within next 20 years. More efficient (and flexible) ways of spectrum utilisation will probably attract newcomers in mobile and fixed bands.
R6	I fully disagree, because no evidence of any gains of substance in real-life environment, therefore no basis for such an assumption. Anyway, has to be evaluated on a case-by-case basis, false as a generic statement.

Reflection on the responses

The tendency here is to disagree on the statement, except for R5 who fully agrees. The core of the disagreements is the fact that the attractiveness depends on the market structure and conditions as a whole.

Table 8: Statement 6

6.	*Relay sharing and full RAN sharing are equally treated by the regulator, i.e. the extent of RAN sharing is irrelevant.*
R1	I partly (dis)agree, because it depends on the sharing arrangement and its impact on competition and barriers to entry.
R2	I fully agree. In both situation it are exactly the same that will have to be met.
R3	I partly agree. As stated beforehand, the agreement would have to be assessed on its own terms, assessing, among other aspects, the degree of information exchanged and the impact on the competition, as well as on the individual coverage obligations the operators are under.
R4	I fully agree.
R5	I fully agree.
R6	I fully disagree, because the term "relay sharing" is unclear.

Reflection on the responses

The tendency here is to agree with the statement. R3 basically recognised that the implications of full RAN sharing could be quite different from just relay sharing which would require a different treatment justify brings the level of information exchange as well the impacts upon individual is an additional aspect to be assessed.

Table 9: Statement 7

7.	*Compared to the overall costs incurred by operators and the areas in which they compete, the effects of RAN sharing on costs and competition are small and therefore do not matter much from a regulatory perspective.*
R1	I fully disagree, because although the effects of RAN sharing on costs may be beneficial to the operator the effect on competition may be detrimental, depending on the national market structure.
R2	I partly agree, because from a regulatory perspective sharing is allowed given that a few requirements are fulfilled. One of these is that it doesn't affect competition.
R3	I partly disagree, because RAN sharing costs depends on many factors, such as the area/ location (nearby urban/suburban area); target population and type of services available (impact on the network capacity); etc. Moreover, from the regulatory perspective, a RAN sharing has to comply with some aspects, mainly not to distort competition.
R4	I partly disagree, because the effects of RAN sharing on costs are very important for the operators.
R5	Probably yes, from the regulatory point of view. However, in the world of decreasing ARPU, increasing data consumption and new services introduction, the issue is very important for spectrum users (operators).

R6	I fully disagree, because • First, if impact on costs is low, then there is no case for sharing. • Second, cost and competition effects can not be traded off. If there is a significant detrimental effect on competition, then sharing is not acceptable from a regulatory point of view.

Reflection on the responses

In hindsight, the statement should not have been included in this questionnaire, because it raises a dispute at a point where it was not intended which is the relative importance and impact of sharing on overall costs and competition level. Respondents R4 and R6 are challenging this "factual" part of the statement or what it implies and they are right in doing so.

Table 10: Statement 8

8.	*In sharing, there is a clear trade-off between the policy objective to promote competition and the policy objective to promote efficient investment in networks. Infrastructure competition in RANs comes at a price: higher average costs in the market. Which proposition best reflects your position:*
	
	    a) Having infrastructure competition in RANs is worth the higher average costs in the market.
	
	    b) Lowering the average costs through sharing is more important than infrastructure competition in RANs.

R1	I partly (dis)agree, because the overriding issue is the level of competition in a market. For example, it may be more appropriate to encourage investment in competing networks if there is a lack of infrastructure. In a well developed market, on the other hand, lowering costs through RAN sharing may be a worthwhile objective.
R2	I fully disagree, because efficient investments as such are not a policy objective. However, there is a trade-off between efficient use of spectrum and competition. It is important to keep a certain level of competition.
R3	None of the propositions fully reflect our view on the issue. We have been incentivising infrastructure based competition by a variety of ways, as we believe this to be, under certain circumstances, desirable from the point of the view of the consumer welfare, via an increase in the depth of the competition between operators (resulting in better quality of service and in lower prices). Nevertheless, the merits of infrastructure based competition need to be assessed against the increase in costs and possible duplication for the industry considered as a whole. There is no definite view on RAN sharing in this regard.
R4	I fully agree with "Lowering the average costs through sharing is more important than infrastructure competition in RANs.".
R5	Cannot be generally concluded due to other relations (market analysis and their cross relations).
R6	I fully disagree, because if average costs can be lowered by the mean of infrastructure sharing it is acceptable. However, to the extend that infrastructure sharing has a detrimental impact on competition, infrastructure sharing can not be accepted from a regulatory point of view, because it has negative effects on prices, innovation, quality.

Reflection on the responses

This statement invites regulators to give their view on question to what extent competition is the preferred way to achieve low market prices if it also induces higher average costs due to infrastructure duplication. From the responses we derive that most respondents consider competition as important for the sake of consumer welfare. Therefore, sharing is only acceptable if/when it does not affect competition. R1 makes an interesting remark because we think it the opposite of the operator view. Operators would consider sharing as an interesting option in sparsely populated areas which show thin or no infrastructure deployment. Sharing here could improve the business case. In densely populated areas, the business case is generally good and any sharing incentive comes from scarcity of sites. See also the next statement.

Table 11: Statement 9

9.	*As long as there is RAN infrastructure competition in urban areas, rural sharing is tolerable as the effects of urban competition, e.g. decent price level, spread out over the rural areas.*
R1	I partly (dis)agree, because it depends on the level and nature of competition in the market.
R2	I partly agree, because sharing in a non attractive part of the country may be possible without hampering competition too much.
R3	See answer to statement 7.
R4	I fully agree.
R5	We partly agree. However in our country, there is not enough experiences.
R6	I fully disagree, because the economic potential for infrastructure sharing in rural areas is generally higher, but has to be evaluated on a case-by-case basis, false as a generic statement.

Reflection on the responses

The responses indicate some different views, including some inconclusive because it depends on various factors. It is fair to summarise the responses here that it needs to be assessed on a case-by-case basis.

Table 12: Statement 10

10.	*Suppose that an advanced form of sharing between two operators brings earlier and larger roll-outs of large network innovations, e.g. a step from 3G to 4G. This outweighs a reduction of the independence that individual operators have to introduce smaller network innovations, e.g. a bandwidth increase within a mobile network generation.*
R1	I partly (dis)agree, because it would depend on the impact on competition in the market.
R2	I partly agree, because it depends on the total setting of the market. One of the main goals for licensing are to have an efficient market with enough competition.
R3	I partly agree. We recognise there are benefits to sharing, as stated beforehand, but these would have to be assessed against the drawbacks, including in terms of smaller network innovations. Again, we would assess this on a case-by-case basis, taking also into account the relative size of the operators involved in the partnership (for instance, smaller operators, which tend to be more prone to innovation and differentiation, might be constrained by the partnership). Finally, we would assess whether this sharing would impact on the level of commitments which were inherent to the spectrum.

R4	I fully agree.
R5	We partly agree, because final situation depends on operators' decisions which is based on economic and strategy considerations and also on regulatory environment.
R6	I fully disagree, because competition is a key driver for innovation. Co-ordination in rollout usually causes delays. To the extend that infrastructure sharing has a detrimental impact on competition, innovation may suffer.

Reflection on the responses

Three respondents point out that whatever arrangement is considered, competition in the market is ultimately the key criterion. R6 makes the opposite argument, when stating that innovative but sharing partners could get delayed because of coordination, which will not be the case with small but innovative players.

Table 13: Statement 11

11.	*The options remaining for operators to differentiate their services at the retail level are more important than the level of concentration at the wholesale RAN level.*
R1	I partly (dis)agree, because differentiation of services at the retail level is very important but undue concentration at the wholesale level can be anti-competitive.
R2	I fully agree.
R3	As stated beforehand, we weight the benefits and costs involved in sharing, which include the impact on the competition at the retail level and the cost-saving at the wholesale level.
R4	I partly (dis)agree, because the options remaining for operators to differentiate their services at the retail level is important as well as level of concentration at the wholesale RAN level.
R5	I fully agree. Yes, the main goal is to support market competition in order to bring better retail prices.
R6	I fully disagree, because competition is needed on the whole value chain.

Reflection on the responses

The responses indicate that different opinions exist on this aspect, but four respondents make clear that concentration on the wholesale market is something to be considered in the assessment. The majority seems to be of the opinion that consideration of the retail market alone is not adequate.

Table 14: Statement 12

12.	*The organisational model for sharing, and in particular the information exchange between sharing partners and the resulting risk of collusion, is more important for its acceptability than the resulting wholesale RAN market shares.*
R1	I fully agree.
R2	I partly disagree, because it is important to retain efficient competition, which means that there is no tacit behaviour and also no (abuse of) dominant market power.
R3	See answer to statement 11.
R4	I fully agree.
R5	We fully agree.

R6	I fully disagree, because the statement is unclear. What is meant with "wholesale RAN market shares"? The effects on competition which includes the tendency towards collusion are key from a regulatory point of view.

Reflection on the responses

Responses at least indicate that information exchange between operators is considered an important evaluation aspect.

Table 15: Statement 13

13.	*Sharing arrangements that lead to a higher entry barrier for new mobile operators are not acceptable.*
R1	I fully agree.
R2	I partly (dis)agree, because I don't see how this would happen.
R3	Auctions and other licensing procedures are used to get a certain level of competition on infrastructure.
R4	Sharing should be done in such a way that the competition on the service level remains.
R5	I partly agree, but it would depend on the magnitude of the increase on the entry barriers, on one side, and on the benefits resulting from the sharing agreements, on the other.
R6	I fully agree.

Reflection on the responses

Half of the respondents agree. R2 did not recognise the effect which the statement suggests. Section 3.1.2 explains the rationale behind it.

Table 16: Statement 14

14.	*In Brussels, a limit of 3 V/m for the maximum electromagnetic field strength is used, compared to a 61 V/m limit for UMTS used in almost all other regions of Europe. Such a lower limit strongly affects the opportunities for site sharing. Do you expect the regulation on maximal field strengths to become substantially tighter in your country?*
R1	Cannot say with certainty, but no indications currently that it will be reduced.
R2	No, because we follow the international ICNIRP guidelines. For the time being, there is no reason to tighten the regulations.
R3	Our country has adopted the reference level of 61 V/m for the 2 GHz – 300 GHz frequency band.
R4	I partly agree, because site sharing will be decrease the electromagnetic field strength.
R5	Definitely no, because our country fully respects recommendations and guidelines of internationally recognised bodies, like e.g. ICNIRP and WHO.
R6	Can not answer this question as out of scope of regulator's responsibilities.

Reflection on the responses

Responses do not reveal any policy intentions comparable to the Brussels limit.

Table 17: Regulatory aspects related to sharing and principal regulators' position

Respondent Regulatory aspect	Respondents' priorities (1/2/3)*					
	R1	**R2**	**R3**	**R4**	**R5**	**R6**
Reinforcement of dominant positions in wholesale market	2	2	Void	Void	2	Void
Entry barriers for new operators	2	1	Void	Void	3	Void
Service homogeneity in retail market	3	1	Void	Void	1	Void
Efficient use of spectrum	1	3	Void	Void	2	Void
Cost efficiency	3	3	Void	Void	1	Void
Innovation in radio networks	3	3	Void	Void	2	Void
Environmental and health protection	1	2	Void	Void	1	Void
Operator's independence from competitors in general	3	3	Void	Void	2	Void
Access barriers for MVNOs	1	2	Void	Void	3	Void
Collusive behaviour because of information exchange in sharing	1	1	Void	Void	3	Void

*) Max. 3× Prio 1 (Top), 3× Prio 2 (High), 5× Prio 3 (Nominal). This was done in this way to challenge the respondents to determine relative priorities.

Reflection on the responses

Three of the six respondents provided input in this table. The table "forces" the respondents to prioritise the various aspects, which is obviously difficult without the specifics of a certain case. From the table it becomes clear that generally the respondents weigh the same aspects differently, except for the aspect listed first which deals with reinforcement of dominant positions in a wholesale market. However, based on the comments, which were additionally provided, we observed that these priorities were interpreted somewhat differently among the respondents. Hence any interpretation based on comparison of priorities would be invalid.

Table 18: Possible forms of sharing and principal regulators' position

Form of sharing Respondent	A priori position (accept/reject/CbC*)					
	R1	R2	R3	R4	R5	R6
Site sharing	Accept	Accept	Accept	Accept	Accept	Void
Antenna sharing	Accept	Accept	Accept	Accept	Accept	Void
RAN sharing, excluding relays	CbC	CbC	Accept	Accept	Accept	Void
Relay sharing	not determ.	CbC	Accept	Accept	Accept	Void
Preconfigured spectrum sharing (joint venture)	CbC	CbC	CbC	Reject	Accept	Void
Flexible spectrum sharing	CbC	CbC	CbC	Reject	Accept	Void
National roaming	Accept	CbC	Accept	Reject	Accept	Void
RAN sharing in rural areas	CbC	CbC	Accept	Accept	Accept	Void
RAN sharing in urban areas	CbC	CbC	Accept	Accept	Accept	Void

*) Case-by-case evaluation

Reflection on the responses

Only R6 refrained from providing input. The other responses confirm that there is no discussion about conventional forms of sharing, i.e. site and antenna sharing. We see that R1 and R2 prefer to determine their position only on the basis of actual cases, while R4 and R5 are quite predetermined. The response of R5 is remarkable as all forms are sharing appear to be a priori acceptable. The tendency from the responses is that there is no strong a priori opposition towards sharing in its various forms. This is an important observation although based on a small set of inputs.

5 "Conclusions" on the basis of the responses

From these responses, which are merely illustrative and cannot a priori be assumed to be representative for the whole of Europe, we have drawn the following "conclusions"[2]:

- The responses seem convincing in that impact of intended sharing on the level of competition in the market is the most important evaluation aspect.

- Given the specifics of the market, the players and their networks, the respondents often choose for case-by-case evaluations. A priori and specific policy guidelines clearly saying "what is and what is not allowed" are difficult if not impossible to imagine. The tendency is that there does not seem to be a strong a priori opposition against sharing in its various forms.

- The responses seem to indicate that in Europe there is not yet a great level of consensus among regulators regarding policies on sharing.

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[2] *Conclusions* is set between brackets because no real conclusions can be drawn from such a small set of responses.

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