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## Regulations for and against cooperation in smallcells: How could regulations stimulate co-opetition by supporting sharing?

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## Regulations for and against Cooperation in smallcells

- How could regulations stimulate co-opetition by supporting sharing?

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### Abstract

Cooperation between Mobile Network Operators (MNO), as competing entities, has become a solution to overcome lack of revenue by reducing expenditures during recent years; where these cooperation patterns consist of horizontal and vertical models. As much as all these models apply in macrocell networks, they are all applicable in smallcell networks as well, but it is observed that smallcells are still deployed in single operator patterns.

On the other hand, telecom regulatory authorities are always concerned about cooperation between operators since they prefer fair distribution of market power among competing operators. The idea to stimulate competition, in order to bring maximum profit for end users, is an ultimate goal for regulators. At the same time, regulators are worried if a high level of collaboration between operators introduces new dilemmas such as creating “closed clubs” with significant market power.

In this paper we first discuss interpretations of national European telecom regulators from the *European electronic communications regulatory framework*, which is considered as a reference for all countries. Surprisingly, we see that European countries have different interpretations of the same European framework while transposing it into their regulations. Next, the effect of these regulations that are either pro or against cooperation in smallcell networks is investigated. We conclude by presenting the idea that European regulators may need to revise their legislations by considering regulation for promoting smallcell wholesale network sharing as the proper solution.

**Index Terms**– *Business model, Competition, Co-opetition, Femtocell, Indoor mobile deployment, Regulation, Sharing, Smallcell, Spectrum*

# 1 Introduction

Co-opetition or cooperation with competitors (Bengtsson & Kock, 2000) is not a new term for Mobile Network Operators (MNO) and has found its way into MNOs' terminology for a while. Many different reasons would lead MNOs to utilize collaboration with existing actors in the ecosystem. Motives such as cost reduction, faster network roll out, deficit of substantial assets and freeing up capital could be considered as major drivers. In order to satisfy such objectives, two main patterns are proposed: horizontal cooperation (i.e. outsourcing network operation and maintenance) and vertical cooperation (i.e. network sharing). A third pattern that is the combination of the above is also a viable; network sharing and outsourcing network Operation and Maintenance (O&M) simultaneously, where it targets almost all the drivers altogether.

MNOs generally acknowledge that their networks consist of outdoor and indoor locations with different requirements, but still they prefer to provision the network with one set of infrastructure (macrocells). During recent years indoor locations became the source of generating bigger portion of mobile data traffic. In order to satisfy this uprising demand, different indoor deployment solutions have been exploited that normally correspond to macrocell networks and the cooperation patterns adopted by them. Indoor deployment solutions consist of Distributed Antenna Systems<sup>1</sup> (DAS), Repeaters, small cells<sup>2</sup> and finally macrocells that can provide the coverage-capacity needs from outdoors. The aforementioned horizontal and/or vertical co-opetition patterns are widely applied in macrocells. Also regarding DAS and Repeaters, competing operators cooperate with each other and also with the facility owner and/or with companies using the indoor infrastructure. In this multi-operator settings the physical infrastructure i.e. the DAS network and the repeater equipment, is shared. However, the radio capacity (the base stations), the spectrum and the access control are managed by each operator (Markendahl & Ghanbari, 2013). As much as these co-opetition patterns are applied in macro cellular networks, DAS and Repeaters, they are properly applicable in smallcell networks as well but they are still not used in practice.

Besides horizontal cooperation, sharing as the most applied method of co-opetition mainly consists of three models: Roaming, Passive network sharing and active network sharing. *Roaming* is the solution within which an operator's subscribers are served by another operator's network where their respective operator has no network coverage. *Passive network sharing* is the case where different operators share passive network elements with each other (i.e. sites and masts). Active network sharing that is mainly known as Radio Access Network (RAN) sharing is the solution in which major network assets are also shared that are the electronic infrastructure. Since Spectrum and Core Network<sup>3</sup> (CN) elements are considered to be the major assets for MNOs, it is not common for MNOs to share them. The main rationale to avoid sharing these major assets is the unwillingness to lose control over own network as well as losing leverage over competitors.

Comparing indoor vs. outdoor network sharing, presence of different involved entities change the situations. Considering the Facility Owners as one of the major actors in indoor mobile network ecosystem, they only tend to use one set of Femtocell Access Points (FAP) and related infrastructure

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<sup>1</sup> The DAS definition is adopted from *The DAS Forum*. For more detailed description visit: <http://www.thedasforum.org/>

<sup>2</sup> The Small cell definition is adopted from *Small cell Forum*. Small cells are low-power wireless access points operating in licensed spectrum and are operator-managed and feature edge-based intelligence. For more detailed description visit: <http://www.smallcellforum.org/aboutsmallcells-small-cells-what-is-a-small-cell>

<sup>3</sup> A core network is the central part of a telecommunication network that provides various services to customers who are connected by the access network: [http://en.wikipedia.org/wiki/Core\\_network](http://en.wikipedia.org/wiki/Core_network)

within their premises, highlighting comprehensive network sharing in indoor Small cells. To enable RAN sharing in Small cells, network elements (e.g. FAPs and femtocell gateways) must be shared. More comprehensive solutions then infold sharing CN and Spectrum. The question that remains here is then whether it is permitted to share the aforementioned instances by the National Regulatory Authorities (NRA) within each European country or not. It should be added that since no instances of direct acts on small cell network sharing by European NRAs exist, these networks comply with the general telecom regulatory frameworks i.e. network sharing in macro cellular networks.

Taking into account the EU law as the reference for NRAs, RAN sharing is permitted under EU law but limited due to application of competition law principles (The European Parliament, 2009). Infrastructure sharing is also permitted and even encouraged under the EU electronic communications regulatory framework. But the Framework Directive emphasizes that the depth of co-operation between the sharing agreement parties must maintain a minimum degree of independence to allow independent control of networks and services by the respective parties. The unclarity in the degree of independence, discussed by EU Framework Directives, results in disparate interpretations by the NRAs when it comes to the most important assets; spectrum and core network.

At the same time while the major challenge for NRAs is enhancing competition and fairness in the market, it seems that regulations against sharing *spectrum* and *core network elements* are holding back this approach. The risk of creating local monopolies in the ecosystems could be one of the reasons that NRAs still are sensitive and do not tend to comprehensively liberalize their telecom industry. But at the same time this reasoning contradicts the situation that is already happening in the Wi-Fi ecosystem where local monopolies exist. Formation of “closed clubs” among actors who utilize high levels of cooperation with each other could also be considered as a major drawback.

## 1.1 Problem area and research questions

This paper gives a general overview on the European NRAs’ regulations for and against infrastructure, RAN, core network and spectrum sharing in mobile networks by directing the focus on indoor smallcell networks. The aim is to investigate the effect of promoting *sharing regulations* by European NRAs and the European Commission on the smallcell ecosystem. The goal is to discuss that, in contrary to some NRAs and the EU acquis, promoting comprehensive sharing in smallcells would stimulate competition instead of hindering it. Two main research questions are presented to resolve this issue:

1. *Does wholesale sharing<sup>4</sup> in smallcell networks comply with EU Electronic Communications Regulatory Framework?*
2. *What are the risks facing NRAs if they promote wholesale sharing as well as sharing spectrum and core networks in smallcells?*

## 1.2 Methodology

In this paper the focus is on analyzing the potential opportunities of wholesale network sharing for 3<sup>rd</sup> party actors, which would be enabled if regulations support comprehensive sharing in smallcells. The ideas regarding network sharing in this paper are originated from sharing in

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<sup>4</sup> Wholesale network sharing in this paper refers to the case that a viable 3<sup>rd</sup> party deploys the mobile network itself, offers capacity by utilizing a shared spectrum and operates the network on MNOs’ behalf.

macrocells. General regulations of network sharing as well as the guidelines for Spectrum sharing are explored by International Telecom Union (ITU, 2008). We have formulated the understanding on the EU regulations in this paper are based on the European Directives such as Framework Directive (The European Parliament, 2002), Access Directive (The European Parliament, 2002), Authorization Directive (The European Parliament, 2002), Radio Spectrum Decision (The European Parliament, 2002) and the related amendments (The European Parliament, 2009).

Different European NRAs' views on regulations for and against network sharing have been studied via reports by the Body of European Regulators for Electronic Communications (BEREC) and different NRAs' reports on telecom policies within their respective countries. In order to complement this study, three European countries are chosen as case studies: Sweden, Belgium and Romania. Different agendas in their telecom regulations are the main reason for choosing these case studies. In order to collect credible information regarding each of the above cases, a round of semi-structured interviews with representatives from each NRA has been conducted. The challenges facing regulators such as the impact of effective regulation on investment are discussed in the conclusion session and extended to cover regulations affecting sharing in small cells. Eventually, for analyzing the interaction between market actors, concepts and ideas from business network research are used (Håkansson & Snehota, 1989) (Mattsson & Johanson, 1992).

### **1.3 Related work and contribution**

Cooperation between different actors in form of sharing has been discussed for outdoor networks focusing on infrastructure sharing, resource sharing and site sharing (Mumtaz, et al., 2012); (Offergelt, et al., 2011); (Khan, et al., 2011). In indoor networks, arguments are most likely on DAS approaches where it has been discussed for a long time (Saleh, et al., 1987). Analysis of local Wi-Fi and private networks have also been investigated (Smura & Sorri, 2009); (Markendahl, 2011). On the other hand, ideas regarding sharing picocells as the indoor component of Heterogeneous Networks (HetNets) have been presented (Hua, et al., 2011) where the focus is mainly on cooperation between different network layers (Qingyang Hu, et al., 2011) and few discussions on how spectrum can be shared in the picocell layer (Capdevielle, et al., 2011) (Hua, et al., 2011).

Economic issues of outsourcing as the vertical cooperation pattern were considered mostly by (Frisanco, 2009). (Friedrich, et al., 2009) presented brief insights into the motivation for network outsourcing and the rationale behind vendor selection from the operator perspective. (Chaudhury & Terfloth, 2009) explained the risks and pitfalls that come with network outsourcing deals for network operators in their study, where they provide brief suggestions for the operators, in particular on what they can outsource and on what qualities in vendors that they need to look out for. Spectrum on the other hand and different alternatives to allocation of more licensed spectrum are currently discussed, examples are secondary spectrum access, licensed/ authorized shared access (LSA/ASA) (Forge, et al., 2012) (Parcu, et al., 2011) as well as secondary access and LSA and ASA concepts (Zander, et al., 2013).

Different regulatory enablers and economic benefits of telecom networks and infrastructure sharing have been studied by (Hasbani, et al., 2007). Regulations on network strategies focusing interoperability rather than infrastructure have been studied by (Rockstrom & Zdebel, 2002). Studies on a complete transition in order to bring the telecom regulation closer to the European Union rules has been done by (Verikoukis, et al., 2004). Eventually the gap in this regard seems to be studies on

the direct effect of regulations on stimulating competition. Since the Small cell ecosystem is considered to be only implemented in a cooperative manner, a study on the deterrent regulative issues on sharing and outsourcing network operation seem to be missing. To fill this gap, this paper surveys the existing EU regulations as a reference for European NRAs and discusses the deficits resulting to improper interpretations from EU legislations in this regards.

## 1.4 Paper outline

This paper is outlined as follows: section 2 discusses the European commission's general approach on Telecom resource sharing as the reference for NRAs. This discussion is followed by section 3 where we introduce European NRAs' viewpoint on network sharing in general while presenting valid samples of sharing agreements in some countries, indicating inconsistency between different countries. In section 4 we argue the effect of NRAs "interpretations" on adopting EU Framework Directives and applying them in their national regulations. Section 4 is followed by presenting three case studies; Sweden, Belgium and Romania. Eventually, section 5 answers proposed Research Questions as well as concluding the discussions.

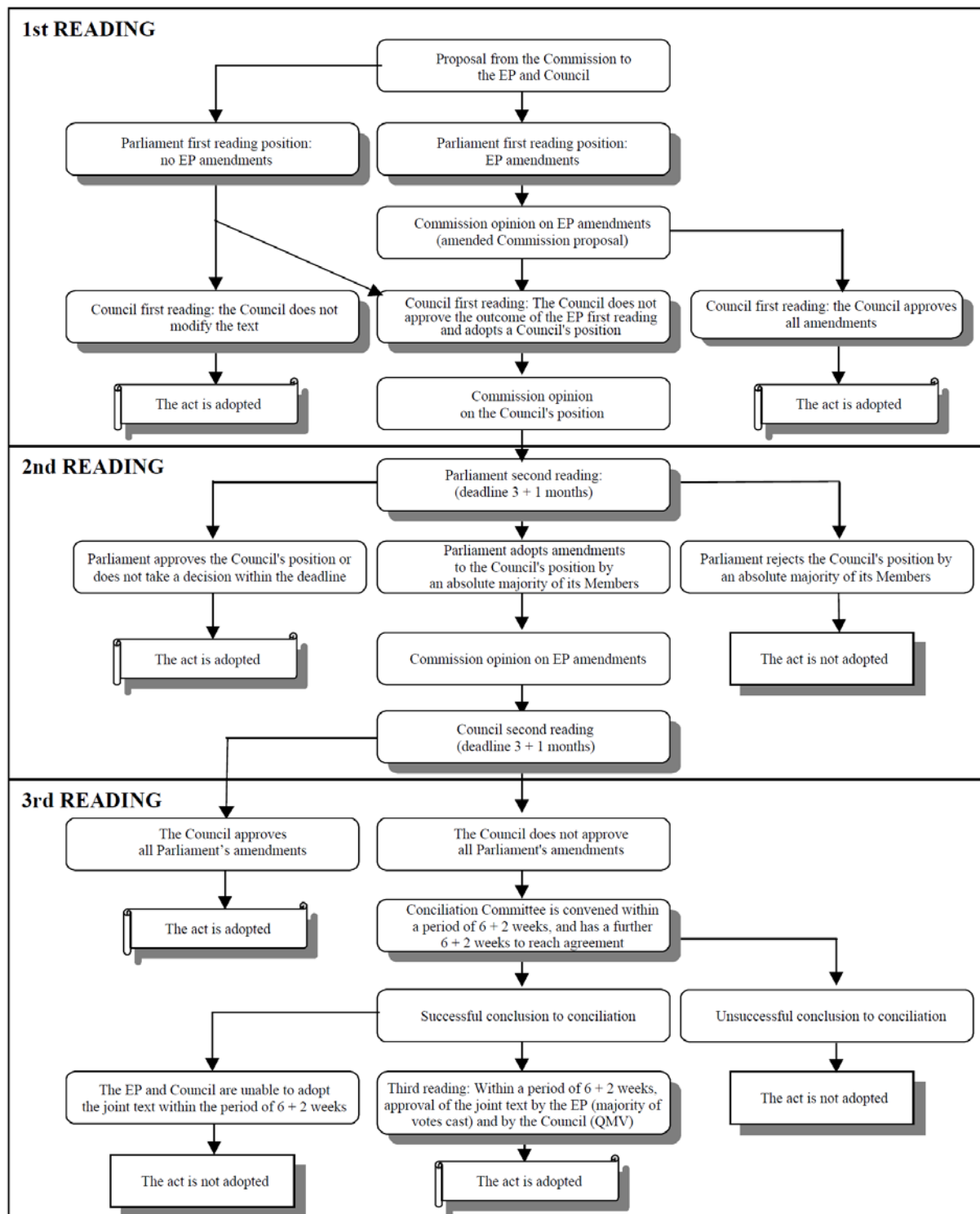
## 2 Telecom resource sharing under the EU regulatory framework

The EU electronic communications regulatory framework is considered to be the reference for national regulators. This regulatory framework, introduced by EU, is intended to be applied to all access and transmission networks for electronic communications where it includes telecommunications in specific. The results of decision making process within EU commission with regards to electronic communications leads to presenting legislations via following five Directives:

- the "Framework" directive (2002/21/EC);
- the "Access" directive (2002/19/EC);
- the "Authorization" directive (2002/20/EC);
- the "Universal Service" directive (2002/22/EC); and
- The "E-Privacy" directive (2002/58/EC).

The general decision making process consists of three reading stages (Figure 2-1) in order to assure consistency among all participants in the process. The intention is to standardize regulations across all member countries while competition is also subject to be increased by ensuring fairness in communication markets. Since all 27 European Member States are directly involved in the process, this decision making regime is supposed to guaranty the homology among internal regulations adopted from this process; which is not so.

Considering resource sharing as the most proper form and basis of cooperation by involved actors in the telecom ecosystem, the major resources that are subject to sharing are infrastructure, backhaul, core network and Spectrum. In order to limit duplication and utilize investments toward underserved areas, regulators have bound operators to contemplate resource sharing in macro cellular networks during recent years. As much as such sharing concepts are applied in macrocell networks, they are also applicable in smallcell networks as well, although it seems that neither regulators nor operators investigated smallcell network sharing specifically. Due to the homology between macro and smallcell networks, in this paper we adopt the smallcell sharing patterns majorly from macro cellular thinking.



**Figure 2-1 Presentation of the ordinary legislative procedure (Article 294 TFEU)**

The EU electronic communications regulatory framework permits infrastructure sharing that itself consists of Passive and Active infrastructure. Since smallcell networks do not require any specific passive infrastructure, the main concern is then the active infrastructure that mainly consists of femtocell access points (FAP) and femtocell gateways (FeGW). As a result of active infrastructure sharing, besides economies of scale, active network sharing would cause a great impact on product innovation and improved customer service in smallcells.



## LIMITATIONS

Focusing on active sharing, RAN sharing is permitted by EU law but at the same time, due to the principals of competition law registered by EU parliament, is *limited*. The article 8.5(d)<sup>5</sup> of the Framework Directive, directly encourages NRAs to promote “efficient investment and innovation in new and enhanced infrastructures, including by ensuring that any access obligation takes appropriate account of the risk-incurred by the investing undertakings and by permitting various cooperative arrangements between investors and parties seeking access to diversify the risk of investment, whilst ensuring that competition in the market and the principle of non-discrimination are preserved”. The Framework Directive in the Amended Article 12 also delegates the NRAs to impose sharing obligations under Ex-Ante regulations. The article specifically points at facilities (premises), which can be considered the case for indoor smallcells. In this regard, the article proposes sharing premises “including buildings, entries to buildings, building wiring, masts, antennae, towers and other supporting constructions, ducts conduits, manholes [and] cabinets”. Article 12 of the Access Directive, on the other hand, discusses Ex-Post obligations in order to equilibrate the market by restricting MNOs holding Significant Market Power (SMP). Sub section (1) (f) of the article requires such operators “to provide co-location or other forms of associated facilities sharing”.

As per European Commission (EC) perspective under the proposed legislator regime (EU electronic communications regulatory framework), disputes over refusals by involved actors could be referred to "competent national dispute settlement" bodies, which would rule on whether refusals are justified or whether any conditions imposed on access are reasonable. The European Commission has also laid out draft plans that would oblige network operators to provide "minimum information" about their physical infrastructure in order for communication providers to be able to assess "the potential for using existing infrastructure in a specific area as well as to reduce damages to any existing physical infrastructures". Disclosures would be made in line with principles on privacy and "business secrets", according to the draft Regulation (Pinsent Masons LLP, 2013).

The rationale behind EC's imposing limitation on RAN sharing becomes incommensurable while in the new Directive 2009/140/EC it is highlighted in particular that “improving facility sharing can significantly improve competition and lower the overall financial and environmental cost of deploying electronic communications infrastructure for undertakings, particularly of new access networks”<sup>6</sup>. The Framework Directive stresses even more concern while suggesting that sharing RAN must satisfy infrastructure based competition and frequency regulation. According to article 8.5 (c) operators should be able to voluntarily bind sharing agreements with each other though in order to sustain their competitive autonomy they are not allowed to start comprehensive sharing methods. The competitive autonomy (as a part of EU electronic communication framework) here refers to a minimum level of independence on controlling own network and specifically services.

It should be mentioned that since core network elements and spectrum are considered the main assets for any operator, then spectrum and core network elements must not be shared according to this limitation in order to prevent distortion and exploitation of competition for respective operators. At the same time, the Authorization Directive (article 5.6) and Framework Directive specifically emphasize on preventing spectrum hoarding by the SMP operators. This is then supposed to be done

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<sup>5</sup> Directive 2009/140/EC

<sup>6</sup> Recital (43) of Directive 2009/140/EC



via spectrum transfer as well as spectrum lease. Correspondingly, EU law insists on assessing each RAN sharing agreement separately in a way to ensure absence of competition distortion.

As a result of the imposed regulation by EU law (and specifically), considering both spectrum and infrastructure sharing in mobile networks within all EU-27 member states, sharing practices is now considered commonplace. Between the two, active network sharing is less common and is mainly in form of RAN sharing (BEREC- RSPG, 2011). An investigation by European Commission in 2003 found that site sharing does not raise any competition concerns but reserved its position with regard to RAN sharing, where active elements and network intelligence are not independently controlled by each MNO (Cullen International, 2013).

## 2.1 Spectrum Sharing as Solution for Wireless Crunch

The rapid exponential growth of mobile data users on one hand and the increasing importance of wireless connectivity on the other hand push the wireless ecosystem towards more efficient utilization of spectrum as the major capacitor. Spectrum scarcity also plays an important role in gearing sharing existing licenses, which is being pursued by operators in lack of such licenses. Regulators have also showed interest in spectrum sharing recently in order to equilibrate the market power as well as preventing spectrum hoarding. European Commission, in this regards, has argued the regulatory body in EU to support and enable legally binding spectrum sharing contracts between users to encourage wireless innovation in their internal market (Lunden, 2012). EC has initiated a proposal for spectrum sharing in European Union which is considered to be “an essential part of the solution to dealing with the wireless crunch... by using new technical possibilities to create a secondary market for spectrum rights”<sup>7</sup>. Since the initiative is still immature it does not propose any specific suggestions for how and when this model shall work but it outlines a right path. Recently in UK, operators and the regulator Ofcom are already well on their way to figuring out how to share spectrum, meaning the EU proposals may prove to be more essential for other countries in the Union, but not necessarily all (Lunden, 2012).

## 2.2 Factors adopted while evaluating network sharing

Considering the following objectives, there are several factors that should be adopted by NRAs in order to be able to evaluate resource sharing<sup>8</sup> in wireless networks in their respective countries, taking into consideration EU obligations<sup>9</sup>;

- *“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”,*

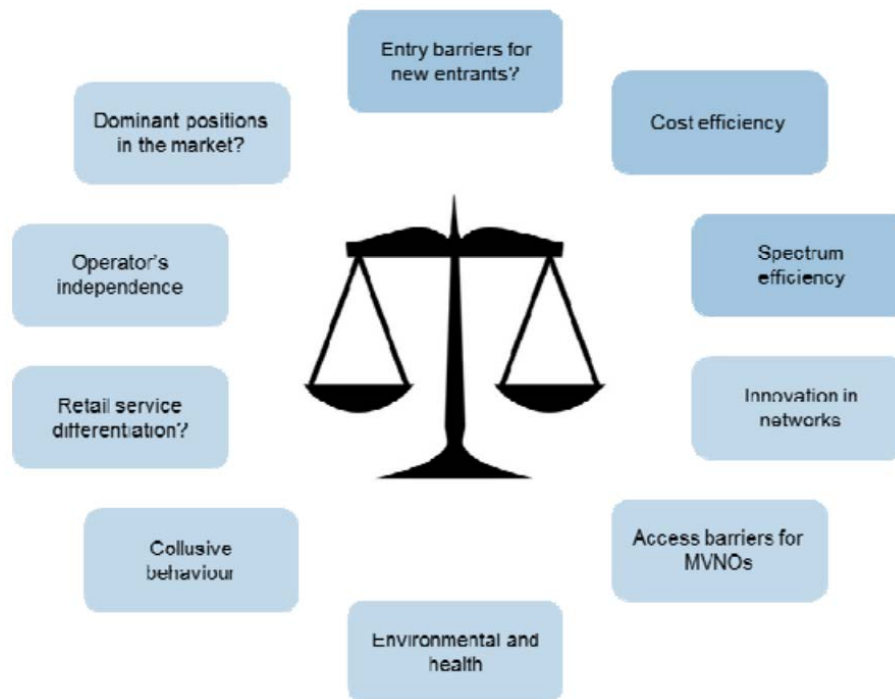
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<sup>7</sup> Neelie Kroes, former VP for the European Commission

<sup>8</sup> Regulation (EC) No 1211/2009 of the European Parliament and of the Council of 25 November 2009 establishing the Body of European Regulators for Electronic Communications (BEREC) and the Office. Directive 2009/136/EC of the European Parliament and of the Council of 25 November 2009 amending Directive 2002/22/EC on universal service and users’ rights relating to electronic communications networks and services

<sup>9</sup> Directive 2002/21/EC of the European Parliament and of the Council of 7 March 2002 on a common regulatory framework for electronic communications networks and services

Figure 2-2 illustrates the evaluation factors mentioned. These factors along with EU directives are normally considered by NRAs to formulate their national policies and decisions about the resource sharing arrangements. Figure 2-2 suggests that a balance among proposed factors should be considered unquestionably by the NRAs in order to ensure competition. More specifically the first three factors directly point at competition.



**Figure 2-2 Factors Affecting NRA Decision Regarding Sharing Arrangements (Van den Ende & Nooren, 2013)**

### **Dominant Position**

The mobile market in European countries could be described as an oligopoly typically with three or four players. A mobile operator is usually known as dominant player when has market shares of 30–50%, or more in way that it has a market power large enough to operate largely independent of the other players in the market. NRAs are normally worried about the dominant position in the market that could yield by certain resource sharing arrangement (Van den Ende & Nooren, 2013) (Nooren, et al., 2012). That why any aspects in the sharing agreement that may lead to undesired coordinated behavior (“collusion”) of the partners in the retail market for mobile services or any sort of anti-competition behavior shall be prevented as per NRA perspective.

### **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 for spectrum license fees and network infrastructure deployment. Sharing arrangements are likely to affect the entry barriers in the market, but is that a good or bad thing? That depends on the NRA assessment and measures to assure fair competition environment in the mobile market (Van den Ende & Nooren, 2013) (Nooren, et al., 2012).

### **Homogeneity of Product Offerings**

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. 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 technical and organizational characteristics of the sharing arrangements, such as (Nooren, et al., 2012):

- 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?

### **Efficient Use of Spectrum**

Spectrum is a valuable resource that is becoming scarce in some markets. Therefore it should be used efficiently. Infrastructure and spectrum sharing can contribute to the efficient use of spectrum (Nooren, et al., 2012). The network sharing models that utilize spectrum sharing besides better utilization of spectrum in RAN sharing models due to empowering higher spectral efficiency are the key ideas in this essence.

### **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 (Van den Ende & Nooren, 2013) (Nooren, et al., 2012).

### **Innovation in Radio Networks**

Sharing arrangements could affect the innovations in the mobile networks in many different ways (Van den Ende & Nooren, 2013) (Nooren, et al., 2012):

- The sharing arrangement can promote the deployment of new technologies as the corresponding costs and investment risks may be reduced.
- The market power of the sharing operators may be increased compared to the other operators in the same market that do not have access to new innovation.
- 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 recognized this tendency and have concluded that they needed to take specific action, e.g. requirements in licenses, 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.

### **Environmental and Health (Emitted power level)**

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 share 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 (Van den Ende & Nooren, 2013) (Nooren, et al., 2012).

### 3 NRAs and Resource Sharing in EU

Now that the EU regulatory framework's standpoint on resource sharing in wireless/mobile networks has been discussed, it is admissible to investigate which countries started initiating adapting to such cooperation patterns. It is worth mentioning that BEREC as the regulating agency of the telecommunication market in the European Union, consists of all 27 member states' NRAs as members and nine other countries as observers (Table 3-1), which are mainly countries assumed to join EU in the future. Since all the 27 EU members both join EU Parliament as well as BEREC, it is assumed that they all follow similar cooperation patterns when it comes to macrocell and smallcell networks. As a result, based on different interpretations and national policies, European NRAs allow and even promote, passive infrastructure sharing among mobile operators. Nowadays in all 27 EU member states there are agreements based on passive network sharing, that is, at least at the level of site sharing. However, the adopted regulations frameworks concerning the infrastructure sharing varies from country to country, especially when it comes to active sharing.

**Table 3-1 List of the Members and Observers of the BEREC Office**

Country	Name of Organization	Member or Observer
AUSTRIA	Austrian Regulatory Authority for Broadcasting and Telecommunications, RTR-GmbH	Member
BELGIUM	Institut Belge des Postes et Télécommunications, IBPT / BIPT	Member
BULGARIA	Communications Regulation Commission, CRC	Member
CROATIA	Croatian Post and Electronic Communications Agency, HAKOM	Observer
CYPRUS	Office of the Commissioner of Telecommunications and Postal Regulation, OCECPR	Member
CZECH REPUBLIC	Czech Telecommunication Office, CTU	Member
DENMARK	Danish Business Authority, DBA	Member
ESTONIA	Estonian Competition Authority, ECA	Member
FINLAND	Finnish Communications Regulatory Authority, FICORA	Member
FORMER YUGOSLAV REPUBLIC OF MACEDONIA	Agency for Electronic Communications, AEC	Observer
FRANCE	Autorité de Régulation des Communications électroniques et des Postes, ARCEP	Member
GERMANY	Federal Network Agency, BNetzA	Member
GREECE	Hellenic Telecommunications and Post Commission, EETT	Member
HUNGARY	National Media and Infocommunications Authority, NMHH	Member
ICELAND	Post and Telecom Administration, PTA	Observer
IRELAND	Commission for Communications Regulation, COMREG	Member

ITALY	Autorità per le Garanzie nelle Comunicazioni, AGCOM	Member
LATVIA	Public Utilities Commission, SPRK	Member
LIECHTENSTEIN	Office for Communications / Amt für Kommunikation, AK	Observer
LITHUANIA	Communications Regulatory Authority, RRT	Member
LUXEMBOURG	Institut Luxembourgeois de Régulation, ILR	Member
MALTA	Malta Communications Authority, MCA	Member
MONTENEGRO	Montenegro Agency for Electronic Communications and Postal Services, EKIP	Observer
NORWAY	Norwegian Post and Telecommunications Authority, NPT	Observer
POLAND	Office of Electronic Communications, UKE	Member
PORTUGAL	Autoridade Nacional de Comunicações, ANACOM	Member
ROMANIA	National Authority for Management and Regulation in Communications, ANCOM	Member
SERBIA	Republic Agency for Electronic Communications, RATEL	Observer
SLOVAK REPUBLIC	Telecommunications Regulatory Authority of the Slovak Republic, TU SR	Member
SLOVENIA	Post and Electronic Communications Agency, APEK	Member
SPAIN	Comisión del Mercado de las Telecomunicaciones, CMT	Member
SWEDEN	National Post & Telecommunications Agency, PTS	Member
SWITZERLAND	Federal Office of Communication, BAKOM	Observer
THE NETHERLANDS	Onafhankelijke Post en Telecommunicatie Autoriteit, OPTA	Member
TURKEY	Information and Communication Technologies Authority, ICTA	Observer
UNITED KINGDOM	Office of Communications ,OFCOM	Member

Table 3-2 summarizes wireless networks' resource sharing in 17 EU countries. Although all these countries participate in the legislative procedure of finalizing EU electronic communications regulatory framework as well as partnering in BEREC, still it can be seen that many inconsistencies exist in their national regulations. It is hard to believe that the main reason behind this issue may be different perceptions from the same EU law that they have approved all together.

**Table 3-2 Summary of the Infrastructure Sharing Policies in EU**

Country	Type of network sharing	Country	Type of network sharing
	Site and mast	RAN	RAN + core (separate or joint spectrum)
Austria	✓	✓ Antennae and repeaters in tunnels and metro	⊘

Belgium	✓	✓ Antennae and repeaters in tunnels and metro	⊘
Denmark	✓	✓ Incl. joint ownership of 800 MHz spectrum license (TT-Network JV)	✗
Finland	✓	✗	✗
France	✓	✓ (3G, only in rural areas)	✗
Germany	✓	✗	✗
Greece	✓	✗	✗
Ireland	✓	✓	✗
Italy	✓	✗	✗
Luxembourg	✓	✗	✗
Netherlands	✓	✗	⊘
Norway	✓	✗	✗
Portugal	✓	✗	⊘
Spain	✓	✓	⊘
Sweden	✓	✓ Incl. joint ownership of 2 GHz spectrum license	✓
Switzerland	✓	✗	⊘
United Kingdom	✓	✓	✓ Merging of RAN and core planned with joint ownership of spectrum.

✓ means that there are both regulations and commercial agreements

⊘ means that it is not regulated

✗ means that it is regulated but there are no commercial agreements

### 3.1 Development of Sharing Agreements between Mobile Operators under EC Directives

Many mobile operators in EU have entered agreements for passive and active sharing of 2G&3G mobile systems (BEREC- RSPG, 2011). The first sharing agreements are those signed in Sweden (Tele2 and Telia, H3G and Europolitan) in 2001, followed by similar agreements in UK and Germany (O2 and T-Mobile), where in each nation the operators agreed to jointly deploy a nationwide 3G network. In Sweden, the regulator has agreed to allow significant infrastructure sharing for 3G operators. Each operator only has to cover 30% of the population, while the remaining 70% can be

shared. Some other examples for passive sharing agreements sub-regional level is the signed agreement in 2006 between Orange and Vodafone, for sharing in Spain and UK; in addition to the deal between Telefonica and Vodafone in 2009 regarding the cross sharing of passive infrastructures in UK, Spain, Ireland and Germany (BEREC- RSPG, 2011).

The regulatory bodies in Europe govern sharing agreements in EU with a set of conditions, especially in active sharing cases, in order to protect the competition in the mobile operators markets. In 2003, the European Commission set the standard for what was permitted under EU regulatory law when it evaluated 3G network-sharing agreements between T-Mobile and O2 in Germany<sup>10</sup> and in the UK<sup>11</sup>. However, the European Commission's decision concerning national roaming arrangements in Germany was later successfully appealed before the European Court of First Instance (CFI). The whole story was started in 2002, when O2 and T-Mobile entered into network sharing agreements in Germany and the UK with a view to rolling out their respective 3G networks in these countries. Among other things, these agreements included provisions for national roaming arrangements between the two operators' networks. These agreements were notified to the European Commission (EC), which then assessed whether these agreements complied with the requirements of section 81 of the EC Treaty. In its decision, the EC found that the national roaming provisions contravened section 81(1) of the EC Treaty since these provisions were restrictive of competition<sup>12</sup>. However, the EC granted a temporary exemption for the national roaming arrangements in order to facilitate rapid roll-out of 3G networks and to make 3G services more widely available. The duration of this exemption varied, depending on the nature of the geographic market in question. O2 appealed the portion of the EC's decision concerning national roaming arrangements in Germany to the CFI. O2 argued that the national roaming agreements did not restrict competition within the meaning of section 81(1) of the EC Treaty. O2 further argued that the EC had erred in law by failing to consider what the conditions of competition would be in the absence of an agreement. O2 asserted that the EC concluded that national roaming agreements are inherently restrictive of competition without showing that this is the case or without engaging in the economic analysis required by section 81(1). The CFI agreed with O2 and struck down the EC's decision concerning national roaming agreements. The aforementioned decision of the European Court of First Instance in the T-Mobile and O2 cases seems to have curtailed European regulators' ability to impose restrictions on network-sharing agreements (BEREC- RSPG, 2011).

## 4 The effect of interpretations on regulations

So far we have illustrated that different EU member states apply different regulations regarding resource sharing in mobile networks. These regulations bear no distinct specification for smallcell networks and macro cellular networks at all. Looking at Table 3-2, NRAs' responses concerning the resource sharing across EU could be highlighted as:

- In countries like Italy, Portugal and Switzerland, infrastructure sharing is encouraged. Sharing is on a voluntary basis but core network elements as well as spectrum sharing is not allowed.

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<sup>10</sup> Commission Decision of 16 July 2003 relating to a proceeding under Article 81 of the EC Treaty and Article 53 of the EEA Agreement (Case COMP/38.369: T-Mobile Deutschland/O2 Germany: Network Sharing Rahmenvertrag), OJ 2004, L 75/32.

<sup>11</sup> Commission Decision of 30 April 2003 relating to a proceeding under Article 81 of the EC Treaty and Article 53 of the EEA Agreement (Case COMP/38.370: O2 UK Limited / T-Mobile UK Limited: Network Sharing Agreement), OJ 2003, L 200/59.

<sup>12</sup> With effect from 1 December 2009, Article 81 of the EC Treaty has become Article 101 of the Treaty on the Functioning of the European Union ("TFEU"). Article 101 aims 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.



- In some other countries, sharing is mandated. For instance, in France it is mandatory that MNOs share passive infrastructure while rolling out network. On the other hand, operators are obliged to share 3G networks in most rural areas. In Spain obligations exist when any specific operator does not have rights to access land. In the Netherlands sharing regulations are mandated for mast sharing and site sharing.
- Finland is the case for ex-post regulations. Mast and site sharing in Finland is considered a remedy for equilibrating market power. Any operator with SMP may face any such obligation.

As it was stated in Table 3-2, Sweden and UK are the only countries in which complete network sharing (that includes both RAN sharing, spectrum sharing and core network elements) is permitted by the NRA. The effect of such regulations can be easily observed in the market where there are commercial agreements bound between different actors benefiting from this situation. On the other hand, in countries like Belgium where core network and spectrum sharing is deregulated, MNOs try to overcome cost-related issues by alternative means. Studies show that this difference in regulations is due to different interpretations of NRAs from EU framework directive. For instance, the Belgian NRA claims that the EU framework, explicitly, emphasizes on deregulating such level of resource sharing while the Swedish NRA has the exact opposite idea.

#### 4.1.1 Case of Sweden

Sweden is one of the pioneers in telecom infrastructure sharing in the world. The Swedish operators first entered network sharing arrangements in 2001 in order to fulfill the 3G coverage obligations (Mölleryd & Markendahl, 2013). The most well-known patterns of resource sharing in Sweden are in form of Joint Ventures (JV) between operators. Svenska UMTS Nät (SUNAB) and 3GIS are the two JVs for rolling out 3G networks in Sweden where Net4Mobility is the sole JV for 4G networks. The other patterns of resource sharing such as Roaming (both national roaming and MVNOs) also exist in Sweden. The Swedish telecom market is considered as a liberalized market although some domestic experts may not agree with that<sup>13</sup>.

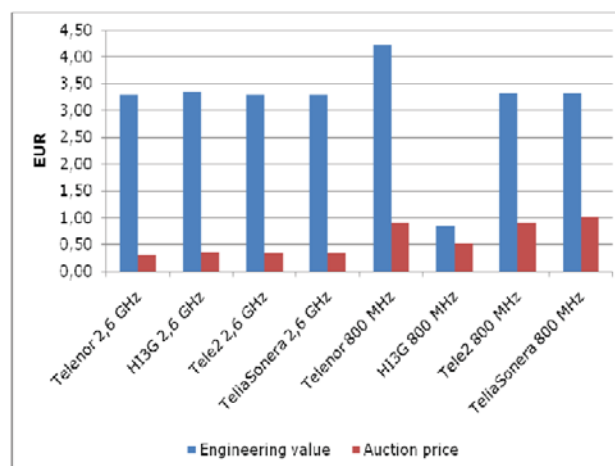


Figure 4-1 Comparing engineering value and auction price in Sweden Source: (Mölleryd & Markendahl, 2013)

The Swedish telecom regulator (PTS) obliges operators to share sites and masts (not RAN) whenever possible. In case an operator faces a case where a competitor refuses to share facilities, it

<sup>13</sup> Claes Beckman, Center Director for Wireless@KTH, Sweden

can request PTS to impose an obligation<sup>14</sup>. The JVs formed by operators, in order to prevent legal dilemmas and malpractices, hold their own spectrum licenses and not of any of their successors. As a result PTS has imposed the carriers to meet 30% coverage of population with their own infrastructure since SUNAB, 3GIS and Net4Mobility control their own spectrum. Based on comparing *Engineering Value* and the *actual price* of Spectrum in Sweden (Figure 4-1), the price being paid by license holders is presumed reasonable (while it may not be the case in every other country). This is then considered as one of the reasons that Swedish operators have not yet considered sharing spectrum while the upcoming capacity crunch may change such principals.

As it was stated earlier, Sweden (along with UK) is the rare case of sharing core network elements between operators as well. This practice is due to the regulation that allows core network sharing in case it is owned by a JV between operators. At the same time joint ownership of spectrum (in form of JVs) is also permitted by PTS resolving many capacity related issues in the networks. It should not be forgotten that rolling out networks in underserved areas (rural) has been also on PTS's agenda while regulating shared ownership of spectrum. Since smallcell networks are not yet deployed (or even been accepted) by Swedish operators, the regulations set forth by PTS towards macrocell networks are the only origin for possible smallcell deployments. For instance, in Sweden 5 MHz of spectrum in 1.8 GHz band (IMT) will become unlicensed by early 2014 (Figure 4-2) that is considered to be a viable option for rolling out smallcells (Awadelkarim Widaa Ahmed, et al., 2013).

800 MHz	900 MHz	1800 MHz	2.1 GHz
Licensed IMT/ IMT-A Bands (However some bands e.g. 5 MHz unlicensed block in 1.8 GHz in Sweden)			
2.3 GHz	2.4 GHz	2.6 GHz	3.6 GHz
LSA with in Military Band	Unlicensed Band (Wi-Fi)	Licensed IMT/ IMT-A Bands	
3.8 GHz		5 GHz	
LSA with in Satellite Bands		Unlicensed Band (Wi-Fi)	

Figure 4-2 Spectrum bands with different types of Access Rights Source: (Awadelkarim Widaa Ahmed, et al., 2013)

Although PTS is considered as one of the very few NRAs that supports full resource sharing, but still in densely populated areas such as Stockholm's downtown, there exist<sup>15</sup> roughly 50~130 base stations per km<sup>2</sup> that shows the high potential of resource sharing especially in indoor mobile deployments such as smallcells (Markendahl, 2011).

#### 4.1.2 Case of Belgium

The Belgian mobile market is known as a mature market with millions of customers loyal to loyal and trusted domestic brands; Proximus, BASE and Mobistar. As of year 2012, with issuing four 4G licenses among the existing operators and one newcomer, a large-scale deployment of 4G networks started. The shift that started in 2012 is supposed to uplift the limited growth in mobile market by diverting customers from low-value prepaid services to more expensive and premium postpaid services, using value packages with long term contracts and heavily-subsidised smartphones as an incentive to upgrade and increase profit per customer (Paydas, 2012).

Looking back at the origin of cooperation regulations, as of June 2005 resource sharing regulations and provisions of EU directive framework has been transposed into Belgium electronic communication law (article 25 to 27, section III of the Act). This Act "strongly" encourages operators

<sup>14</sup> Chapter 4, §14 of Swedish Electronic Communications Law (2003:389)

<sup>15</sup> The numbers are based on PTS's statistics from December 2009

to share sites, also burdens operators to inform competitors about installing new aerials in order to provide them the chance to consider sharing. The regulations only set forth for site sharing; where in case of smallcells infolds buildings where the Radio Access Network must be deployed. Belgian regulator (BIPT) does not impose any types of regulation (neither ex-Ante nor ex-Post) on RAN sharing, core network elements sharing and spectrum sharing in terms of pushing operators to share. On the other hand, the same act in Belgium law strongly emphasizes that spectrum sharing (in any way) plus sharing core network elements is against EU Framework Directive and it should not be practiced. Although frequency sharing/pooling between public mobile operators is currently not allowed, but the concept is however allowed and applied for Private Mobile Radios (PMR) and Short Range Devices.

To be more precise, according to BIPT (BIPT, 2012), The 3G Royal Decree<sup>16</sup> (article 2§1) lays down that *"The authorization covers the implementation of a land mobile telecommunications network of the third generation and the exploitation of the offered corresponding services, by the 3G operator, to the public through the intermediary of the network"*. In the same Royal Decree (article 1§7) a network is defined as the *"whole of selector switches, controllers and base stations necessary to offer a mobile telecommunication service"*. The 4G Royal Decree<sup>17</sup> sets forth that *"Usage rights cover the implementation of radio electric access systems over the entire national territory"*. Nothing in these provisions requires the holder of the authorization to be the exclusive owner of the network used to exploit the services or seems to prevent an operator to agree with another on the buy-back/rent/any other formula contemplating the shared use of antennas or other infrastructure elements. To conclude the Decree, radio access network sharing is permitted under Belgian law while BIPT "strongly" proposes that core network sharing as well as spectrum pooling is against EU framework directive therefore not allowed in Belgium.

#### 4.1.3 Case of Romania

In 2009, the telecom regulator initially established in 1991, was placed under the control of the Romanian Parliament and became reorganized under the name of "National Authority for Management and Regulation in Communications (ANCOM)". The decision making processes of ANCOM are supposed to be of an autonomous public authority. ANCOM, hand in hand with the Romanian Post National Company (CNPR) controls the telecom resources in the country. As the major asset for the 5 mobile operators in Romania there is no business case of spectrum sharing among operators, although it is neither regulated nor deregulated to do so. ANCOM has set an auction, last one in September 2012 resulting in a total of 682M€ for 485MHz (Figure 4-5), in order to optimize the distribution of spectrum licenses among viable actors. Figure 4-3 illustrates the spectrum allocation before the auction where the Ministry of National Defense (MApN) owned a considerable portion of the spectrum while Figure 4-4 illustrates the distribution of licenses after auction. This auction has been considered a major step toward equilibrating the market power by the national regulatory in Romania.

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<sup>16</sup> Royal decree dated 18 January 2001 setting forth the conditions and procedure for the grant of 3G mobile telecommunications authorizations.

<sup>17</sup> Royal decree dated 22 December 2010 related to the radio electric access in the 2500-2690 MHz band.

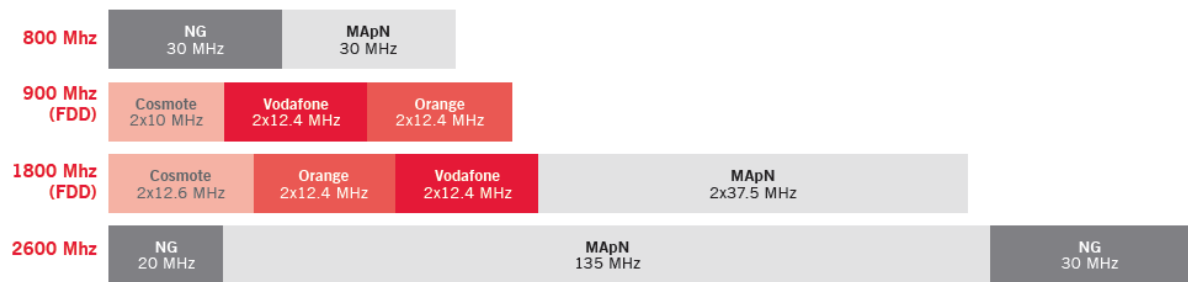


Figure 4-3 Allocation of the auctioned spectrum on bands and holders before the auction Source:ANCOM

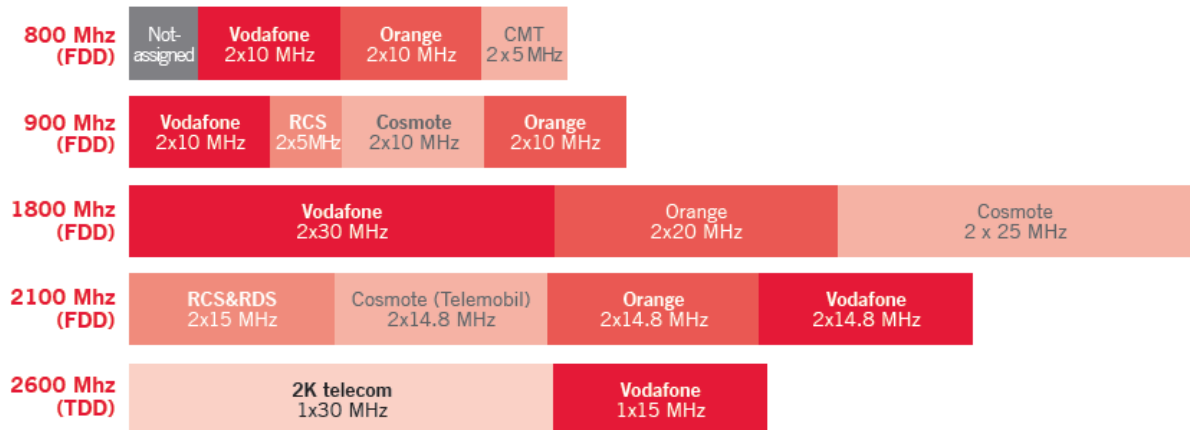


Figure 4-4 Allocation of the auctioned spectrum on bands and holders, post-auction Source:ANCOM

Categorie	Banda	Valabilitate	Cosmote RMT	Orange	RCS & RDS	Vodafone	2K Telecom
A	800 MHz	06.04.2014 – 05.04.2029	2 x 5 MHz	2 x 10 MHz		2 x 10 MHz	
B	900 MHz	01.01.2013 – 05.04.2014		2 x 12,5 MHz		2 x 12,5 MHz	
C	900 MHz	06.04.2014 – 05.04.2029	2 x 10 MHz	2 x 10 MHz	2 x 5 MHz	2 x 10 MHz	
D	1800 MHz	01.01.2013 – 05.04.2014		2 x 15 MHz		2 x 15 MHz	
E	1800 MHz	06.04.2014 – 05.04.2029	2 x 25 MHz	2 x 20 MHz		2 x 30 MHz	
F	2600 MHz	06.04.2014 – 05.04.2029	2 x 10 MHz	2 x 20 MHz			
G	2600 MHz	06.04.2014 – 05.04.2029				1 x 15 MHz	1 x 30 MHz
Preț de adjudecare (EURO)			179.880.000 €	227.135.002 €	40.000.000 €	228.520.034 €	6.601.000 €

Figure 4-5 Winners of the licences and license fees Source:ANCOM

Considering roaming (national roaming) as a viable sharing pattern, ANCOM has set forth for operators to offer national roaming for emergency calls (known as 112 calls in Romania). Operators are also obliged to offer national roaming to other operators who have minimum 30% national population coverage for a 3 years period. Considering MVNOs' business model based on sharing resources (roaming to MNOs' networks), the three minor mobile operators showed their willingness to accept MVNOs in their networks after ANCOM's encouragement. But until now there are no instances of MVNO in this country.

Romania's major carriers (Orange and Vodafone) have announced on 31th of July 2013, a new agreement for network sharing (Cazacu, 2013). This new agreement refers to only site sharing, each controlling and operating their networks independently. Each operator will operate as well by its spectrum independently. This settlement has been placed under the impression that ANCOM is encouraging infrastructure sharing in the country although there are not any instances of legislations on this matter. Focusing more on the smallcells specific needs, ANCOM has been obliging Facility Owners to open access to all operators, enabling them to deploy their cable networks. This decision had been made upon the impression that there is an urgent need for expanding the internet penetration but not specifically for any radio access network that may or may not use it as backhaul. On the other hand since there existed no regulation against putting up cables on poles and lamp posts, many operators decide upon rolling out their networks causing different dilemmas (Figure 4-6 shows an instance of lack of regulation in this sense). As a result of existing high Internet penetration in the country, the two big mobile operators have decided to operate smallcell networks. Orange has started its smallcell network roll out while Vodafone quite recently passed the technical departments' tests and now is on the marketing stage. Yet, ANCOM has not specified any special regulation regarding smallcells.



**Figure 4-6 Cable Jungle in Romania** Source: hotnews Romania

## **5 Discussion on necessity of resource sharing in Small cells**

Still it is negotiable that what the main benefits of sharing telecom resources specifically when it comes to small cell and indoor deployments could be. Positive effects of network sharing may be categorized into 2 general categories:

1. General benefits for the country and the economy:
  - Environmental issues,

- Better spectrum utilization and solving the spectrum scarcity problems,
  - Helping out the economy by spending less capital (big moneys in this case) on deploying network.
2. Direct advantages for consumers.
- Better pricing over services,
  - Better services such as coverage in underserved or un-served areas,
  - More options for consumers to choose.

These means that the Regulators could sometime review their legislations and jeopardize the competition in a sense that some more important benefits might be achieved. The important question still remains that is; why regulators hesitate to liberalize the markets entirely by forcing what they believe is true? The important fact is that there are lots of discussions about efficiency of competition and its positive outcomes for the end customers but it is not yet the solo outcome of pre-cautious regulation of collaboration.

As a result, accepting different perceptions by NRAs as the sole rationale behind making an important decision like whether major assets such as spectrum and core network elements could be shared among competitors or not is naïve. NRAs intentions on regulating their markets by regulating or deregulating collaboration processes are a proven fact that has been around since many years ago by the foundation of the very first regulatory authority. It can be deduced that NRAs not only interpret the framework based on the existing market statistics in their countries but also based on the situation that helps provisioning of a better fair distribution of power among MNOs. This way they guaranty pushing operators with SMP to share market and resources with other actors (especially new comers). The fact that a relatively big telecom market such as UK allows deeper levels of resource sharing but the Belgian NRA avoids regulating core network element sharing is a proof in this regard. Although it should not be forgotten that factors such as external pressure would also affect the regulation process.

In order to conclude this paper, it is needed to resolve two major issues prior to answering the proposed research questions:

### **Wholesale sharing; a step forward or abusing market power**

Operation and maintenance of smallcell networks is the primary model for outsourcing in small cells. By considering outsourcing as a horizontal collaboration pattern, network sharing then is considered a vertical model. The combination of the above models represents the third cooperation approach that is supposed to be *wholesale network sharing*. In this scheme, 3<sup>rd</sup> party local operators deploy the local network and lease capacity and coverage by demand to MNOs. In order to implement this model, the 3<sup>rd</sup> party should possess spectrum that are either licensed or unlicensed. Considering the recent allocation of the unlicensed 1800 MHz band for GSM and LTE opens up the discussion for a thorough outsourcing of the indoor network to 3<sup>rd</sup> parties in case regulators do not support utilizing share spectrum. The discussions on shared spectrum access are viable in some countries, as mentioned before, such as UK and Sweden, where the spectrum does not necessarily belong to involved parties of the collaboration scheme. It could be a joint venture by operators with an independent legal entity or a Local Network Operator.

The main concerns that arise after proposing wholesale sharing model by 3<sup>rd</sup> parties are the possible deficits of the regulations forced by the NRAs as well as National Competition Authorities

(NCA). The emergence of “closed clubs” with SMP in the smallcell ecosystem is one of the disadvantages of such models. As a result, a double effort both from NRA and NCA is required to avoid some such issues. The presence of existing network operation outsourcees as the most viable option for wholesalers (such as Ericsson, Huawei, Alcatel-Lucent and etc.) provokes the idea of abusing market power in tis regards.

#### **Enforcing competition, necessarily or not**

The answer can be NO. The incumbent operator or the one that is considered to have SMP, necessarily may not abuse power in order to expel the other operators or reject underserved consumers. On the other hand it should be considered that in some cases (mainly in developing countries) the incumbent can be the only entity that has the ability to enhance the technology and higher the level of services since it has enough capital and resources in order to do so. If the power is taken from such entity, then it should even try hard just to survive that leaves it with insufficient energy to open up the way. Another concern in front of sharing, for the NRAs, would be short term versus long term competition. An irrational enforcement of competition, where involved entities are forced to share assets with their competitors, may eventually jeopardize competition in the long run. This means that such entities become disinclined to invest in networks in the future since they are not willing to share their assets with rivals. So a question rises that is whether it is needed to burden competition on the market by any price?

## **6 Conclusion**

The research questions will be answered to conclude the paper:

#### ***Does wholesale sharing in smallcell networks comply with EU Electronic Communications Regulatory Framework?***

The fact that NRAs and NCAs do not differentiate between macrocell and smallcell networks makes the smallcell ecosystem abstruse. The main reason for this complexity is the difference in the impression of some parties on either of the networks’ ecosystem. Accordingly, the regulations for and against network resource sharing are tailored for macrocell networks and may not comply with smallcells. One the other hand, the whole sale sharing concept, even for macro networks, has not been considered in the EU Framework Directive which leads to absence of proper regulatory forces.

#### ***What are the risks facing NRAs if they promote wholesale sharing as well as sharing spectrum and core networks in smallcells?***

The most significant risk for NRAs would be shifting the SMP from MNOs to 3<sup>rd</sup> parties. Considering network vendors as a potential option in this case, the worriment is the unforeseen legislations for such actors. In case of wholesale sharing, the 3<sup>rd</sup> party is not considered to be titled a MNO. Therefore the telecom regulators’ legislations do not apply to them. On the other hand the Competition acts ruled by the NCA would not also be applicable in this case, causing chaos and possible unfair distribution of SMP.



## 7 Bibliography

Capdevielle, V., Feki, A. & Temer, E., 2011. *Enhanced Resource Sharing Strategies for LTE Picocells with Heterogeneous Traffic Loads*. s.l., IEEE 73rd Vehicular Technology Conference (VTC Spring).

Awadelkarim Widaa Ahmed, A., Markendahl, J. & Ghanbari, A., 2013. *Evaluation of Spectrum Access Options for Indoor Mobile Network Deployment*. London, 24th annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications - Workshop on Spectrum sharing strategies for wireless broadband services.

Bengtsson, M. & Kock, S., 2000. "Coopetition" in Business Networks—to Cooperate and Compete Simultaneously. *Industrial Marketing Management*, Volume 29, pp. 411-426.

BEREC- RSPG, 2011. *Report on infrastructure and spectrum sharing in mobile/wireless networks*, s.l.: BEREC.

BIPT, 2012. *Communication of the BIPT of 17 january 2012 containing guidelines for infrastructure sharing*, Brussels: Belgian Institute for Postal Services and Telecommunications.

Cazacu, A., 2013. *Finantistii*. [Online]

Available at: <http://www.finantistii.ro/telecom/vodafone-si-orange-s-au-inteles-pe-partajarea-infrastructurii-de-retea-79986>

[Accessed 3 September 2013].

Chaudhury, R. & Terfloth, C., 2009. The Lure of Network Outsourcing – Promise and Pitfalls for Telecom Operators. In: *Annual Review of Communications*. Chicago: International Engineering Consortium, pp. 67-74.

Cullen International, 2013. *Infrastructure and network sharing by mobile operators*, s.l.: Cullen International.

Forge, S., Horvitz, R. & Blackman, C., 2012. *Perspectives on the value of shared spectrum access, final report for the European Commission*. s.l.:SCF Associates.

Friedrich, R., Weichsel, P., Miles, J. & Rajvanshi, A., 2009. *Outsourcing Network Operations - Maximizing the Potential*, Germany: Booz&co. Business Report.

Frisanco, T., 2009. *Strategic and Economic Benefits of Regionalization, Centralization, and Outsourcing of Mobile Network Operations Processes*. s.l., Fifth International Conference on Wireless and Mobile Communications.

Hasbani, G., El-Darwiche, B., Mourad, M. & Abou Ch, L., 2007. *Telecom Infrastructure Sharing Regulatory Enablers and Economic Benefits*, New York: Booz & Company.

Hua, S., Liu, P. & Panwar, S. S., 2011. The urge to merge: When cellular service providers pool capacity. *arXiv preprint arXiv:1111.1964*.

Håkansson, H. & Snehota, I., 1989. No business is an island, the network concept of business strategy. *Scandinavian Journal of Management*, 5(3), pp. 187-200.

ITU, 2008. *Trends in Telecommunication -Six Degrees of Sharing*, Geneva: International Telecommunication Union.

Khan, A., Kellere, W., Kozu, K. & Yabusaki, M., 2011. Network sharing in the next mobile network: TCO reduction, management flexibility, and operational independence. *Communications Magazine, IEEE*, 49(10), pp. 134-142.

Lunden, I., 2012. *TheCrunch*. [Online]  
Available at: <http://techcrunch.com/2012/09/03/europe-lays-out-proposals-for-wireless-spectrum-sharing-amongst-fiercely-competitive-carriers/>  
[Accessed 9 September 2013].

Markendahl, J., 2011. *Mobile Network Operators and Cooperation - A Tele-economic study of infrastructure sharing and mobile payments services*. Stockholm: Ph.D dissertation, CoS, KTH.

Markendahl, J. I. & Ghanbari, A., 2013. *Shared smallcell networks - multi-operator or third party solutions?*. Tsukuba: to be published IOSC workshop.

Mattsson, L.-G. & Johanson, J., 1992. *Network Positions and Strategic Action: An Analytical Framework*. Uppsala: Företagsekonomiska institutionen.

Mumtaz, S., Monteiro, V., Rodriguez, J. & Politis, C., 2012. *Positioning for performance enhancement in shared LTE and HSPA networks*. Portugal, International Conference on Telecommunications and Multimedia (TEMU).

Mölleryd, B. G. & Markendahl, J., 2013. *Valuation of spectrum for mobile broadband services - The case of India and Sweden*. s.l., s.n.

Nooren, P., Berkers, F. & Janssen, T., 2012. *Business models, cost analysis and advises for spectrum policy - Project SAPHYRE*, Dresden: SAPHYRE Sharing Physical Resources – Mechanisms and Implementations for Wireless Networks.

Offergelt, F., Berkers, F. & Hendrix, G., 2011. *If you can't beat 'em, join 'em cooperative and non-cooperative games in network sharing*. s.l., 15th International Conference on Intelligence in Next Generation Networks.

Parcu, P. L. et al., 2011. *Authorised Shared Access (ASA): An Innovative Model of Pro-Competitive Spectrum Management*. [Online]  
Available at: <http://ssrn.com/abstract=2174518>  
[Accessed 3 June 2013].

Paydas, A., 2012. *Telecommunication Market in Belgium*, Brussels: FredJordaan.

Pinsent Masons LLP, 2013. *Out-Law*. [Online]  
Available at: <http://www.out-law.com/en/articles/2013/february/legal-action-threat-over-single-eu-telecoms-market-risks-overshadowing-infrastructure-sharing-initiatives-says-expert/>  
[Accessed 8 September 2013].

Qingyang Hu, R., Talwar, S. & Zong, P., 2011. *Cooperative, Green and Mobile Heterogeneous Wireless Networks*. San Francisco, s.n.

Rockstrom, A. & Zdebel, B., 2002. A network strategy for survival. *IEEE Communications Society*, 36(1), pp. 36-40.

Saleh, A. A. M., Rustako, A. J. & Roman, R. S., 1987. Distributed Antennas for Indoor Radio. *IEEE TRANSACTIONS ON COMMUNICATIONS*, COM-35(12), pp. 1245-1251.

Smura, T. & Sorri, A., 2009. *Future scenarios for future local area access: Industry structure and access fragmentation*. s.l., 8th Int Conf on Mobile Business.

The European Parliament, 2002. DECISION No 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community (Radio Spectrum Decision). *Official Journal of the European Communities*, 45(English edition), pp. L 108/1-6.

The European Parliament, 2002. DIRECTIVE 2002/19/EC of the European Parliament and of the Council of 7 March 2002 on access to, and interconnection of, electronic communications networks and associated facilities (Access Directive). *Official Journal of the European Communities*, 45(English edition), pp. L 108/7-20.

The European Parliament, 2002. Directive 2002/20/EC OF the European Parliament and of the Council of 7 March 2002 on the authorisation of electronic communications networks and services (Authorisation Directive). *Official Journal of the European Union*, 45(English edition), pp. 21-32.

The European Parliament, 2002. DIRECTIVE 2002/21/EC of the European Parliament and of the Council of 7 March 2002 on a common regulatory framework for electronic communications networks and services(Framework Directive). *Official Journal of the European Communities*, 45(English edition), pp. L 108/33-50.

The European Parliament, 2009. Directive 2009/140/Ec of The European Parliament and of The Council amending Directives 2002/21/EC, 2002/19/EC and 2002/20/EC (Text with EEA relevance). *Official Journal of the European Union*, 52(English edition), pp. 37-69.

Van den Ende, B. & Nooren, P., 2013. *Overview of regulators' and operators' views - project SAPHYRE*, Dresden: SAPHYRE Sharing Physical Resources – Mechanisms and Implementations for Wireless Networks.

Verikoukis, C., Mili, Z., Konstas, I. & Angelidis, P., 2004. *Overview on telecommunications regulation framework in Southeastern Europe*. Dubrovnik, Proceedings of the 12th IEEE Mediterranean Electrotechnical Conference, MELECON.

Zander, J. et al., 2013. On the Scalability of Cognitive Radio: Assessing the commercial viability of secondary spectrum access. *IEEE Wireless Communications*, 20(2), pp. 28-36.