Assessing network sharing agreements: why competition concerns are outweighed by efficiency benefits?

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ABSTRACT

In this paper I examine why network sharing agreements are prevalent in the mobile telecommunication industry, and specifically how they should be assessed from the competition point of view. For this, I briefly sum up the general features of the industry and identify the factors that incentivize operators to engage in network sharing agreements. Furthermore, I also discuss competition concerns and analyze the competition investigations from the UK, Germany, Denmark and Austria. I present, how competition policy can mitigate the possible problems even in case of an extended sharing agreement, thus ensuring the equal chances for deploying new networks. Although, competition policy was rather lenient towards sharing agreements, it also often use remedies in order to keep the wholesale market open, which can be regarded as unnecessary, if the general efficiency arguments are valid.

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INTRODUCTION

Network sharing agreements (NSA) in the mobile telecommunications are the co-operations between operators, where they agree to share certain parts or roll out their network infrastructure jointly. On a theoretical level NSA can have several levels: sharing only the passive elements of the network (e.g.: sites) or even using common radios, which is an active part of the network infrastructure. Or put it differently, an extreme case is when mobile operators merge. Compared to this outcome NSA can be regarded as a more competition constraining way of increasing efficiency. The general trends of this industry indicate that network sharing is becoming important, however, since they are horizontal agreements, competition concerns can be raised.

The first shock for the mobile industry for using NSAs was the appearance of 3G technology in the early 2000s, and now it faces several new problems, which makes NSAs a viable and wanted option. One important factor is that there is a technological change, namely 4G networks are to be rolled out in the following years. This will enable mobile operators to offer mobile broadband services that will be able to substitute for even fixed-line internet. On the other hand there is a severe profitability low point in the industry. Through liberalization and the increase of the number of operators, prices became very competitive, which reduced industry rents. This also means that there is a limited scope for investing in new technologies, since financial constraints are effective. The new and only way of increasing profitability is to have efficiency improvements. Here, the general logic of network industries have to be understood: when there are high fixed costs in an industry, there have to be some rents above marginal costs that assure the return on capital. Therefore, the pressure is two-fold. On the one hand, the return on 3G investments could only be realized if costs of the service – e.g. costs of the radio network – can be lowered. On the other hand, new investments for 4G networks will only be realized if operators can reduce investment costs. Hence if regulation wants to have a

rapid 4G network roll-out, a possible option is to be lenient with moves of network operators that enhance the efficient use of the radio network.

On the top of the above mentioned concerns, there is another factor affecting overall business conduct. The crises distracted demand hence returns on past investments and also affected the financing of new infrastructures. Also as return on investments became more unpredictable, financing new technologies has become more expensive, and it is also possible that financial constraints affect the distinct national markets differently, for example according to demand or geographic features.

Despite the explicit objective of formulating one single market, the European mobile telecommunication industry remained fragmented on a national level. Regulation is country specific, and spectrum allocation stays also within the country borders. Scarcity of frequency and high investment costs also lead to a limited number of competing firms at the national markets. Cross-border ownership of companies cannot solve the problem that markets are only country based either, hence the network effects cannot work properly. As the size of the network is a crucial factor affecting profitability, the basic solution would be to merge. However, sharing networks means that firm profitability can be rebuilt by cost reductions (Almunia, 2012). It is important to see that high investment requirements of rapid technological change would lead to consolidation and to avoid that, allowing network sharing can be an acceptable second-best solution.

These underlying features of the industry, that will be discussed in detail, have led to NSAs, and most probably the scope and depth of sharing will only increase in the future. As these agreements are horizontal co-operations between firms that otherwise compete on the retail market, concerns can be raised regarding effective competition. Hence the more or less open question is how detrimental these agreements are and whether the cost benefits can

outweigh the possible loss in competition, which would eventually make such agreements legitimate.

Up to now more or less partial analyses were made on the topic of NSAs, however, the literature from technical and operational feasibility until competition concerns were not aligned. There is a wide range of literature on mobile telecommunications regarding how competition works and what the determinants of industry performance are, as Gruber (2005); Gans, King and Wright (2005); Hausman (2002); Cave (2002). Also the question of network sharing feasibility was already addressed in Frisanco, Tafertshofer, Lurin and Ang (2008). Several studies investigate costs and the possible efficiency gains that can be reached through network rationalization. Hence the academic literature analyses the increasing return to scale or it addresses the problem of how many operators can compete on a market with given parameters of demand and costs with modelling techniques. Such questions are discussed for example in McKenzie and Small (1997), Beauvais (1999), Moral, Vergara, Pérez and Ovando (2010), Stephan, Neumann and Plückebaum (2012). The business literature also shows how much efficiency gains can be reached through joint network roll-out or even with greenfield or brownfield investments and network rationalization, such as GSMA (2010), Coleago (2009), Accenture (2011), Zehle and Friend (2010). National and international regulatory agencies also addressed the question of network sharing, hence comprehensive studies are made by for example BEREC/RSPG (2011) or BIPT (2012). From the competition policy point of view, the literature of production agreements is relevant – production joint ventures (JV) included – and also the competition investigations can serve as a baseline. For the former, general ideas are detailed in Motta (2004), Bishop and Walker (2010) or Mölleryd (2011). However, these mostly fragmented writings address only a few particular questions regarding network sharing. There is no coherent framework that enables the assessment of such agreements: what are the general

factors that need to be maintained in the mobile telecommunications market in order to have a viable competition with sufficient investments also.

The purpose of my thesis is to show how NSAs can raise competition concerns, and demonstrate why these concerns could be outweighed by the efficiency benefits of network sharing or why they may be not an issue at all. Firstly, an insight to the mobile telecommunications market will be given– main trends, the evolution of cost and market structure, and why efficiency improvements are crucial at the present stage of development. Furthermore, I connect the overall industry performance to the question of NSAs and the related competition concerns. For this, I will examine the competition inquiries made by the European Commission or by the concerning national competition authority. Three case from the UK market will be detailed, as they show illustratively how sharing agreements can be extended in a way that competition is not harmed. Also three examples from continental Europe will be analyzed from 2012: the brief discussion of the German case from 2003, the Austrian Hutchinson and Orange merger as an example for the extreme case and the case from Denmark which raised new kind of problems regarding competition. I will pinpoint the most important issues that were interpreted as key for maintaining effective competition, and also draw a conclusion on what factors have to be assessed properly, and how they can be helpful for countries that have not engaged yet in deep sharing agreements.

NSAs can also be assessed as an alternative way of industry consolidation. The overheated multi-operator model of mobile telecommunication services is not a sustainable one, therefore sharing can assessed as an alternative for mergers, but still maintaining a stronger competitive pressure as opposed to a more concentrated market structure. Hence, lenient competition policy should be maintained, bearing in mind what relevant competitive factors are.

The outline of the paper is the following. In Chapter 1 the technological and regulatory changes in mobile telecommunications will be summarized and the details of the economic factors that are explanatory for possible market structures are also detailed. In Chapter 2 the forms and advantages of different NSAs will be assessed. In Chapter 3 a brief summary on the conflicting policies, with an emphasis of competition policy will be given. Chapter 4 is the analysis of cases for network sharing and synthetizing the messages implied. After this I conclude the main policy relevant findings of the analysis.

1 CHAPTER: BRIEF HISTORY/DESCRIPTION OF THE INDUSTRY

In this chapter I briefly sum up the evolution of the mobile industry up to now. Attempts to communicate through wireless assets is not a new phenomenon, but the extensive public use of it is only a few decades old. Following Gruber (2005), two factors affected the development of this industry. Firstly, technological change made it possible that within a very short time period, mobile telephony has outrun fixed-line services, and also, it affected the possible market structure. The dynamic nature of technological change means that huge investment needs are prevalent in this industry, making for the case of NSAs. The other factor is regulation that had to be changed in order to establish the possibility of a multi-operator industry. Furthermore, this eventually increased the significance of competition policy. Nevertheless, these developments have to be assessed in a dynamic framework, where maintaining effective competition also have to regard technological issues and investment needs.

In order to discuss the relevance of NSAs, the specialties of the industry's cost structure will be also summarized, which is mostly affected by two features: scarcity of the spectrum and the network costs. These problems are further affected by external factors such as geography or features of demand, and costs shocks can alter usual industry conduct. These are the factors that can push towards NSAs. As a result of these issues I summarize the current stage of competition on mobile telecommunications market: what factors determine the strength of competition in a dynamic environment.

1.1 General advancement of the mobile telecommunications industry

1.1.1 Technological advancement

Following the partition of Gans et al. (2005), four periods of mobile telecommunications can be distinguished. In the beginning with analogue technology a mobile device used a whole frequency band exclusively, which meant that it was impossible to serve more than one mobile user at a particular area. In this setup congestion could occur easily, as one frequency could

only be used by one customer. However, the efficiency of using the same frequencies has increased with technology developments.

Here, I will follow Gruber (2005). One important step forward was the introduction of cellular technology: a larger geographic area was broken down to small cells, hence users located in different cells could use the same frequency. First this innovation was using analogue communication techniques (1G). It is also important to note that at that time, there was no standardization of communication technologies, hence there were many incompatibilities among and within countries. The next step was the introduction of digital communication (2G) in the 1980s. This was the time for Europe to apply a common standard, the Groupe Speciale Mobile: GSM (but only in the 1990s), which uses a 900 MHz frequency range and a standardized communication protocol between the handsets and the network. It was a really important step forward to mass usage, due to advancements of performance, capacity and quality of mobile telephony (Gruber, 2005). The next step was 3G technology, which increased the speed of communications, enabling more extended data traffic. This was the first key for extensive data transfers or mobile internet usage (Gans et al., 2005). The most recent technological shock that affects the mobile industry is the introduction of 4G services, which sets the stage for more extensive broadband services.

What is important to see is that the underlying difference is how these communication technologies use the spectrum at a particular location: for this, developing cells and the form of communication between the telephone network and the mobile device (the advancement of digitalizing), what matters. The importance of technology from the economics point of view is that through the easing of market entry conditions, it had an effect on the possible market structure that can be maintained in this industry, namely it opened the market for being a multi-player oligopoly.

1.1.2 Evolution of regulation

After the long regulatory history of the fixed-line telecommunications, it is not a surprise that mobile telephony also had to go along its own way. Following Gruber (2005), in the early years of mobile technology, it was not even decided whether it should be regarded as a luxury good or a basic service that should be enabled in a wider scale, which ultimately affects the regulatory attitude towards the industry. As in the case of natural monopolies, two types of conduct were in place: it remained either a highly regulated private monopoly such as in the US or the monopoly problem was 'solved' through state ownership (Gruber, 2005). However, regulation or state ownership can be moderately efficient. As reported in Hausman (2002), the US experience showed that in areas where regulation was in use, prices were significantly higher. That is why eventually a deregulation process could take place. The underlying question of whether mobile telecommunication has natural monopoly characteristics seemed to be resolved: apparently an oligopolistic structure proved to be the natural state of the industry.

Liberalization was rather asymmetric in the beginnings, as new entrants had to be strengthened. For example obligations of national roaming were often introduced in order to create effective third and fourth players on the national market, until new entrant could build own networks (Gruber, 2005). An additional feature of liberalization is that often a duopoly structure was implemented – through spectrum licenses it is rather easy to achieve – which was further widened with technological changes (for instance: in the UK). The longer term question is that whether sector specific regulation can be by-passed, to rely only on competition (Gruber, 2005).

It is important that due to the oligopolistic structure of the industry, ex ante regulation is rather important in order to have a viable competition. However, as more players could appear on the market, the emphasis from ex ante regulation shifted towards ex post intervention: competition policy (Gruber, 2005).

To sum up, not only the general considerations make industry regulation problematic, but technological change gives dynamic to the development of industry structure. Now, a more detailed overview of the industry specific problems relevant for network sharing will be overviewed.

1.2 Factors affecting costs and network roll-out feasibility

In this subchapter factors affecting the cost structure of the industry will be overviewed. Generally two problems push this industry to be a more concentrated one: spectrum scarcity and the cost features of the radio network deployment. Furthermore, I introduce the general consideration of network deployment feasibility, which ultimately determines the possible market structures and the affects competition.

1.2.1 Spectrum scarcity

The most obvious starting point when considering wireless communication is one of its very basic property: in order to have a product – for instance a one minute talk via wireless telephones – people need to use a scarce resource, a radio spectrum.[1] The amount of spectrum is given, and its efficient use also depends on how the state allocates it. As sending signals through given frequencies can interfere, regulation is needed: not only country level, but inter-country coordination is also crucial. The dimensions of regulation are the following: the frequency, geographic location, priority of the user in case of interference (Gans et al., 2005)

As spectrum allocation was always a government business, in the initial period of mobile telecommunication, frequencies were allocated also to state owned users. Only in the 1980s and 1990s came privatization in Europe, which also raised the question of proper frequency

[1] A minor technical detour based on Cave (2001): the product in case of mobile telecommunication needs to use the electromagnetic spectrum. The radio spectrum is usually defined between the range of 9 KHz to 3000 GHz. Two main characteristics can be mentioned, the spectrum's propagation feature and the amount of information that it can carry. The rule of thumb is that higher frequencies can forward more information, while propagation is weaker. Hence for example while at 300 MHz the TV broadcasting takes place, mobile communications with 2G (GSM) technology uses the 900 MHz frequency band.
Frequencies are further divided into frequency bands, like: very low frequency between 3-30 KHz (Gans et al., 2005). Hence GSM technology using frequencies from the 900 MHz band can mean that an operator has frequency rights for example between 915 and 930 MHz.

allocation. First, often only 'beauty contests' were used to decide on who can use a particular radio spectrum, which was based on business plans. It was used in a lot of cases, but this method is not the most efficient way of allocating property rights, as it does not reflect the parties' willingness to pay, which is the best proxy for the frequency's value. Using price mechanism is a more advanced way of allocating scarce resources, as under this allocation regime, spectrum goes to the user who values it the most. Hence using some kind of auction system was the next step in regulation towards more efficient frequency allocation (Gans et al., 2005). Also it became an important revenue source for the government.

A very important economic implication of the scarce nature of frequencies is that it automatically leads to the possibility of oligopoly rents (Gruber, 2005). As partly already covered before, historically regulation decided on how many operators can be on the market. Only a few licenses were awarded, which determined the number of players and the possible market outcomes. Firstly, spectrum rights below 1Gz were assigned, and latecomers could only get frequency bands in the 1800 MHz band, but there were 1900MHz or 2600 MHz frequency bands allocated as well. A relatively new phenomenon is that also lower MHz frequencies are allocated in the spectrum range of 790-862 MHz: the digital dividend. Hence the spectrum rent by the operators becomes diversified.

The natural features of spectrum such as diffusion characteristics and interference problems also have a significant effect on the investment needs of a network – as discussed in Lundborg, Reichl and Ruhle (2012). Lower frequencies have better propagation characteristics, but also fewer information can be transmitted through them. Therefore, bad frequency holdings can also push operators towards networks sharing in principle. As the already built network affects the value of new frequencies for an operator, it is rather important to have proper

allocation mechanism in use. Also, the valuation of a frequency also depends on the customer base, hence it greatly influences the return on investments.[2]

1.2.2 Increasing returns to scale

The initial market structure of mobile telephony was based on the idea of natural monopolies. However, this initial stance was overruled by digitalization as reported in Calhoun (1988). This shock affected the possible market base of the industry, which eventually made it possible for other operators to invest in separate new networks. However, the question is whether duplication of networks is welcome or not.

One could have an immediate inference that there are increasing returns to scale regarding the network infrastructure as it is usual in case of a network industry's cost structure (Gruber, 2005). However, there is only a moderate empirical literature on cost estimates of the network, and their results are also somewhat contradictory. One initial try showed for example, that there are decreasing returns to scale, but those estimations are based on only a few firms' observations and for an old technology (AMPS, which is a 1G technology (McKenzie and Small, 1997). In the study of Foreman and Beauvais (1999) they argue just the opposite. Using a more widespread panel dataset with denser observations, their estimations show that there are increasing economies to scale in mobile telecommunications. Constant returns to scale can be rejected for every investigated region, and larger markets (in terms of subscribers) show larger scale economies.

This is important from the regulatory point of view, because if there are scale economies, even if frequencies would not be a bottleneck for a competitive market structure, the network costs could push the market to a more concentrated one. Although the costs of technical assets are declining – somewhat similar to the semiconductor industry –, there are also cost elements

[2] Further, more technical details of spectrum related issues are discussed in Appendix A.

that are increasing: for example as spectrum allocation became auction based, its cost increased, and new investments are needed in every technological change.

Finally, the argument regarding cost efficiencies can be further elaborated. Although several operators could survive simultaneously on the market with own networks – for example due to certain demand features –, it will still lead to unnecessary duplications. To put it differently: the first-best solution for maintaining certain services would be to have one platform, still, a 'wasting' second-best solution can persist. That is why network sharing can be regarded as a tool for the industry to approximate the 'first-best' state.

1.2.3 Costs structure and demand factors: network feasibility

This subchapter sums up the cost related issues that affect the market structure, and also, grounds for the possible competition frameworks that have to be understood in order to have a valid picture of the industry conduct. NSAs can only be evaluated afterwards.

For assessing the general cost problems and the question of a viable business case, the considerations for national fiber access can also be used as a proxy for considerations regarding mobile network roll-outs, hence I will follow Stephan et al. (2012) to overview the general concerns. Their estimations capture factors that are very similar to the problems in most network industries, and also, the specific roll-out considerations specific to mobile telecommunications. First of all, external factors affect network build up costs, such as geographical endowment and structure of urban areas. Based on these features, different clusters can be made regarding costs. The second very important consideration is the estimation of penetration in the different clusters. Penetration is a crucial factor in making investments feasible, as due to high fixed costs for low penetration, the costs per user would be too high. Furthermore, the viability of an investment is highly dependent on the annual revenue per user (ARPU), which will be detailed later as well. It can be assessed jointly: there is a kind of trade-off between ARPU and penetration. If penetration is low, then higher revenues per user have to be maintained in order to break even. As penetration increases, the revenue per customer needed

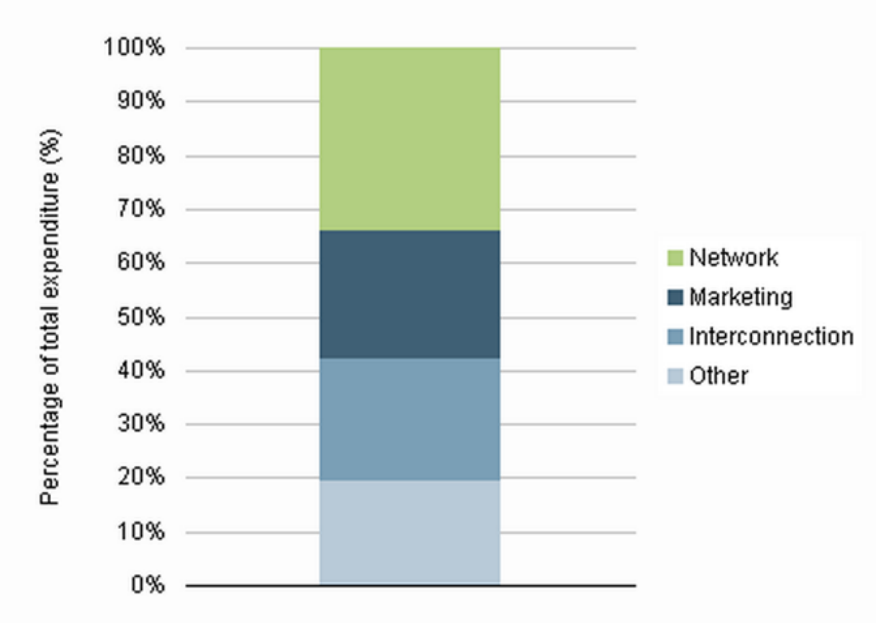
can approximate operational costs. The underlying result that is also meaningful for mobile network roll-out is that network roll-out costs are proportionately lower in 'good quality' (densely populated) clusters, and this is due to the high fixed-cost nature of network roll-out.

The early literature shows that from network costs specifically, the investments related to the base stations account for more than 50% of the total network costs. According to Blackstone and Ware (1978, cited in Gruber, 2005), the total costs of one cellular mobile telecommunication user is about $2400. ($1500 network costs and $900 is the handset). Network costs per customer were about €350 by 2000 (Dresdner Kleinwort Wasserstein cited in Gruber, 2005, p.51)

What is more important for network sharing is how network costs develop within total costs. According to recent estimates, those costs are approximately 30% of the total costs of an operator, as cited in Vornpuan (2010, p.3). Figure 1 gives a general idea about how other costs elements are distributed among the activities of a mobile operator, also showing that approximately one third of the costs are related to the access network. Hence this is the sum of costs that is targeted by NSAs (Analysys Mason, 2010).

Using other cost categorizations: network costs of the telecommunications industry are 20-30% of the OPEX, and 50-60% of CAPEX (Capital Expenditure) (Accenture, 2011, p. 1). These estimates are somewhat different in Chadbury and Terfloth (2007, p. 2): 60-80% CAPEX and 20% OPEX (Operating Expenditure). Nevertheless, the question is how these large cost elements can be reduced by network sharing – that will be discussed in the next chapter.

Figure 1: Percentage of total expenditures (%). Source: Analysys Mason (2010)



1.2.4 Cost problems: 'natural' determinants vs. technological cost shocks

Two general concerns can be identified. One is that the natural features of a given country can be extreme enough to influence network roll-out costs in a way, which indicate radically different business models for achieving certain coverage. The other problem is that in case of a cost shock – such as the need for new investments – the feasibility of a given network can be altered significantly.

An excellent example for the former is Australia – detailed in Islam et al (2008) –, where the population density makes it rather hard to do any business with high coverage needs, as it ranges from 145 people per square kilometers in the capital territory to 0.2 people per square kilometers in the Northern Territories (p. 2). This leads to a severe problem: rural areas cannot really have access to new technologies, coverage cannot be maintained profitably: low demand rural areas either cannot maintain any network at all, or cannot support duplication of network. Both ideas are important for understanding network sharing, and also for understanding why high coverage – including low demand areas – cannot usually be seen as an important competition factor on the long term. These issues regarding coverage can be also related to the

universal service obligations of fixed line telephony or postal services, where there is an explicit cross- subsidization of rural areas.

For an example of a cost shock, one can think of a radical technological change, which is actually already on its way in the form of 4G network roll-out, as it requires huge investments in the radio network assets. Here I follow Analysys Mason (2010). The increased investment needs induce industry consolidation or increased network sharing activity. The finest evidence for this is that rolling out 3G networks was the time when network sharing gained momentum. This increase in necessary investments is the same for 4G technology as well: both new equipment and extra spectrum are expensive. Furthermore, new technology take up rates are historically moderate, which means that returns are not immediate. The general cost problems with network infrastructure stem from the fact that multiple networks have to be maintained simultaneously and macro conditions make investments more expensive: funding of new technologies is difficult. However, investment in new technologies is crucial as due to the huge data increase expected, investing in capacities is inevitable.

According to the estimates used in Analysys Mason (2013) broadband coverage can be more cost effective by launching LTE networks – as there are significant spillovers of 3G networks for 4G upgrading. Nevertheless, capacity upgrading for LTE means 50% higher cost per customer.

After having a brief overview of the technological and regulatory issues of the mobile telecommunications industry, and the outline of the relevant cost problems, now I detail the current operation of the industry, also pinpointing the relevant factors explaining competition.

1.3 Evolution of market structures and competition

In this subchapter I will summarize the general market conduct, specifically how market structure evolved; how did it alter the nature of investments in this dynamically changing industry; what the underlying pricing and revenue problems are, which are crucial for survival. Furthermore I will shed light on the possible competition models capable of describing the

industry conduct, and how it affects wholesale level consolidation, which raises competition concerns. Hence this subchapter is the glue between the industry specific and competition specific issues.

As discussed above, the technological change made it possible that a multi-operator industry evolve. The question also addressed by Gruber (2005) whether other structural problems are pushing the industry in a monopoly state, seemed to be resolved as a 3-4 player industry emerged – through technology changes. But operator entry proved to be overheated (see Table 5 in Appendix C), as now consolidation takes place at least on the wholesale level. However, as a consequence, competition works well in mature markets.

Three types of effective constraints can decide on what type of a structure will be maintained in a specific market: the network costs (technology), demand factors and the spectrum scarcity. Spectrum scarcity problems have already been mitigated: spectrum efficiency has increased considerably (technology changes), and the auctioned spectrum is increasing also. The main problem is how network consolidation can take place if the model of having for example four simultaneous networks is not sustainable. Also when efficient competition is to be achieved, two further questions emerge: how many players are enough for competition, and what are the relevant market segments for competition (wholesale or retail).

One of the most relevant structural problem is regarding network investments. Based also on the cases discussed in Chapter 4, the network roll-out in a three or four operator setup is not feasible. There is a general informational problem: neither the costs of investments can be properly forecasted, nor the demand, thus return, can be well calculated in advance. As reported in Gruber (2005), 3G demand and investment needs (for example higher OPEX than for 2G) made operators postponing roll-out, and renegotiate coverage obligations. The dynamic nature of the industry – rapid technological change hence also gives incentives to postpone new investments. Regarding returns, the underlying problem is how pricing should reflect on the

fact that on the one hand it should be high enough to cover fixed costs, and on the other hand break even should come before new technology roll-out. Rapid changes also affect financing opportunities, as capital markets question the profitability of infrastructure investments, slowing down technology changes (Dunnewijk and Hultén, 2007).

Following the price problem, ARPU levels declined (Gruber, 2005), which stems from two sources. One is that with increased coverage the low demand areas are also connected, the second is that competition lowered prices. Now, revenue from data services are increasing, as this is the new segment where high-end consumers are. As this is the key for competitiveness, operators must invest in new broadband technologies if they want to stay in the market. These trends are illustrated in Figures 9-12 in Appendix C.

The only interesting question remaining is how one should think about competition: how markets should be defined with respect to different coexisting technologies, which is complicated by the emergence of 4G (it approaches broadband markets in general - substitution, hence market definition can be also challenged, see Figure 8 in Appendix C). A trivial idea that is also important for assessing competition issues is that coverage or the network itself is an important differentiating factor. However, according to for example Gruber (2005), coverage can be only a short-run differentiating factor. On the one hand, there are obligations for coverage, and also, important customers are rather concentrated, therefore high coverage is rather an additional 'feature' than a core part of the service. Consequently, there can be no significant competitive advantage achieved by having high coverage – only temporarily. According to the above mentioned cost structure, 60-70% of the costs are not network related, hence making other features able to achieve differentiation. Still, if coverage and the network are important, then what is crucial, is that the wholesale market have to be made available for entry. Problems can occur for example due to the scarcity of appropriate sites, or by maintaining enough frequencies to be able to access the market with new technologies. More importantly,

if firms compete not in coverage, they can compete in prices. For assessing the oligopolistic competition that can characterize this industry, one can think in the Cournot framework, where prices are above marginal costs and decreasing in the number of players, however, in the future, Bertrand (price) competition characterize better the competition (Gruber, 2005).

Another closely related argument discussed in Bohlin, Caves and Eisenach (2013). This comparative study shows that the US and the EU mobile telecommunications markets are significantly different. The first important aspect is that ARPU is higher in the US, but also there are a larger scope for letting economies of scale. Thus a more developed network can be seen there, and this gap between the US and European 4G network coverage is about to grow further – this is confirmed also by the wireless CAPEX trends, which is stagnating in the EU, while grew over 70% in the US (Bohlin et al., 2013, p. 17). As markets are fragmented in the EU, there is no possibilities to utilize economies of scale, and also, less concentrated market structures (see Figure 7 in Appendix C) can hinder investment incentives. However, as already discussed above, in a dynamically changing industry, consumer welfare is not necessarily hit by higher concentration levels.

As a conclusion one can infer that the original model of competing mobile network operators (MNO) is outdated (Frisanco et al., 2008), and consolidation should take place, which ultimately affects only a specific part of the vertical chain, that can serve only temporarily as a competitive factor. Therefore, the goal of competition policy is to maintain the possibility for new entry. Doing so means that competition policy also acknowledges that the classic form of industry consolidation is the merger of MNOs. If it can be replaced either by sharing agreements, or merging only after a vertical disintegration in the form of a JV, it may be a competition friendlier way of consolidation, as other parts of the service has still more players.

2 CHAPTER: NETWORK SHARING IN TELECOMMUNICATIONS

In this chapter I will sum up the possible forms of NSAs, and I also give a short introduction of the existing estimations on cost savings that are the main efficiency benefits for these initiatives. Informal NSAs were there for a while, which meant that mast sites were shared or rented by third parties (Accenture, 2011). Officially network sharing was allowed in 2001: after that, if certain conditions hold, and competition law is respected, network sharing is regarded as advantageous (IDC Network Cost Optimizations Strategies for Mobile Operators cited in Accenture, 2011). However, sharing has only become popular in recent years. An oversimplified history of sharing – following BEREC/RSPG (2011) – is that after the start of the 3G technology roll-out, due to for example coverage obligations, operators were induced to share part of their networks. The first infrastructure sharing agreements were introduced in Sweden in 2001. Initial forms were mostly only about to share passive elements of the network, and passive sharing has become very popular since then. A newer phenomenon is that operators also tend to share even active elements of their radio network (BEREC/RSPG, 2011).

As operators are just about to start the LTE network roll-out – or to put it in a wider perspective, mobile infrastructure that can provide broadband service is the next already ongoing development – it is probably a next push toward sharing agreements. LTE network building requires investments especially in the Radio Access Network (RAN) infrastructure (Zehle and Friend, 2010).

2.1 Types of sharing

Before going into the details of different possible NSAs, three types categorization have to be made clear. One is that sharing can be either passive or active: passive sharing means that no coordination is needed between the parties, while by active sharing, operators have a certain coordination in place. The second categorization is that three levels of the network can be differentiated from a horizontal perspective: core network, backhaul network and the radio access network (RAN). The former being the least, the latter is the most costly, hence incentives

for NSAs are set (Accenture, 2011). The third type of categorization is about the relative network endowment of the sharing parties.

2.1.1 Passive Sharing

Passive sharing is the most widely used form of sharing: operators share passive elements of their network, which means space or sites and physical supporting infrastructure. The main differentiating point compared to active sharing is that it does not require active coordination between operators. Several types of categorizations exist regarding passive sharing agreements. One distinction among passive sharing is site sharing and tower sharing (GSMA, 2010). However, instead of a simple site or tower sharing, many other facilities can be shared such as air conditioning, power supply, battery back-up or alarm installation as a passive sharing. As it is somewhat different from the core activity of a telecommunication network operator, in many countries it emerged to a separate industry, hence site sharing services and passive infrastructure maintenance is given by a third party (BIPT, 2012). Though initially it was only popular in established markets such as the US and UK, developing countries also tend to produce their own tower companies (Frisanco et al, 2008).

2.1.2 Active Sharing

Active sharing on the other hand requires more extended cooperation among parties. The basic form of active sharing (RAN sharing) is when antennas, feeder cables and transmission links are shared. For 2G technology, except transceivers every part of the network can be shared (at the site). According to BEREC/RSPG (2011), through different transceivers, operators can use different frequencies, which also means that radio optimizing can be done separately, thus leading to possible differences in the parties' coverage. Therefore, service differentiation is possible.

A more detailed resolution of active sharing is detailed in BIPT (2012). The depth order of the active types of sharing is: antennas, base station equipment, transmission, base station operations and maintenance, radio design and planning and radio spectrum. Furthermore, RAN

sharing is divided into three types. The 'basic' RAN sharing consists of antennas, feeder cable and transmission sharing. A step further is when also the radio network controller and parts of the Node B is shared. Several features are set jointly, but the control over consumer identification and synchronization of the consumer with the Node B (in case of 3G technology) remains independent. The main point is that it leaves service and coverage differentiation decisions by the operators. Of course when site sharing is also included, coverage differences will be small, competition will take place rather in pricing, customer service or quality. Such a setup exists in Australia and the UK and its name is Multi-operator RAN - MORAN. The third type of RAN sharing is when both RNC and Node B are shared and frequencies are pooled. However, this setup has been used rather rarely up to now – only in the latest Danish case included frequency sharing also. The name of this setup is Multi-operator core network – MOCN. Regarding LTE (4G) networks, where the RAN is simpler as the eNode B (the somewhat modified Node B) can be connected to more core networks at the same time, it is the flat RAN structure that enables sharing (BIPT, 2012).

The main technological issue that due to the possibilities of differentiation affects competition is that using the same equipment, different frequencies can be used by the operators. If site sharing is extended enough, there will be no significant coverage difference either, but the possibility is given and operators can compete in other market characteristics.

Conceptually, spectrum sharing can be defined as a separate category. Following BEREC/RSPG (2011), spectrum sharing is "the simultaneous usage of a specific radio frequency band in a specific geographical area by a number of independent entities, leverages through mechanisms other than traditional multiple- and random-access techniques" (p. 3). As reported in Herbert Smith (2012), up to now, there were no network sharing deal in Europe that would also include spectrum sharing – the first example is the Danish case discussed in Chapter

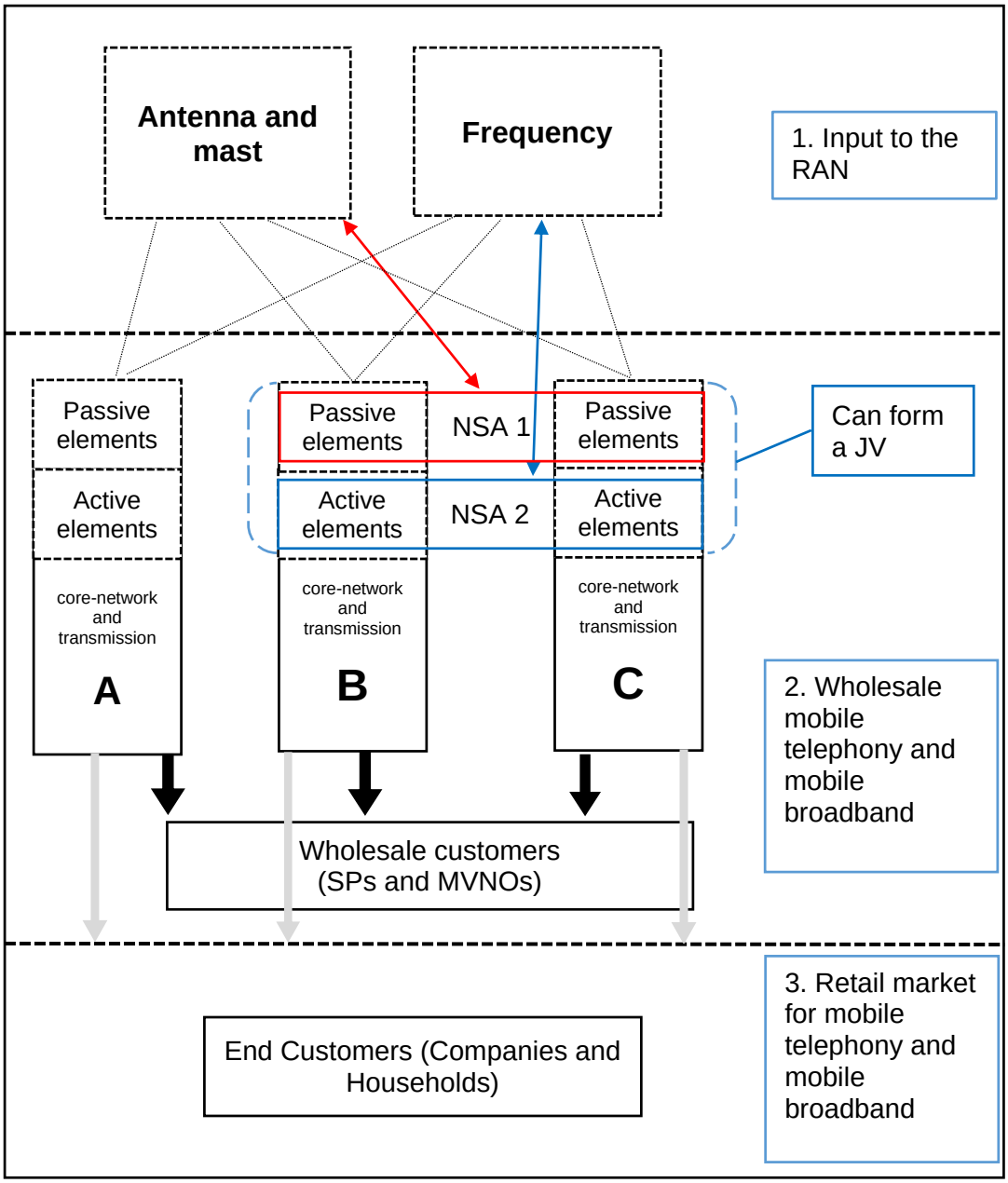
4. This could be a step forward in the depth of network sharing, considering that spectrum is also a scarce. However, for this to happen licenses have to be made tradable.

Although network roaming can be also assessed as a kind of sharing, there are no common elements used in this case (GSMA, 2010). It can rather be understood as a kind of leasing agreement, be it either national, international or inter-system. Obviously, in the case of roaming, there is no room for differentiating the network.

Based on GSMA (2010), core network sharing is when also the core transmission ring, the switching center (with home locations register), the billing platform, the logical entities (Value Added Systems) are shared. Furthermore, sharing of the core network can have two levels: transmission ring sharing or core network logical entities' sharing. If there are overcapacities in the core network, it is logical to lease some of the capacities for new entrants with financial constraints. When logical entities are also shared, it is a more extended form of sharing. Nevertheless, the advantages of such core element sharing is somewhat ambiguous. That is why sharing is more concentrated on the RAN.

Figure 2 below, shows a hypothetical mobile telecommunications market, with four options of the market players. In the baseline scenario, the operators can operate separately, by acquiring antenna, masts and frequency individually, which is indicated with the dotted black lines. Operator B and C can decide on acquiring masts and antennae elements, hence sharing passive elements, as indicated by the red arrow and rectangle. Furthermore, they can also bid jointly for frequencies and share active elements of their network – indicated by the blue arrow and rectangle. Vertical disintegration can also happen, when they outsource these activities to a JV – indicated by the blue dashed brackets. However, in every case, they can behave as separate wholesale and retail players.

Figure 2: The relevant markets. Based on DCCA, 2012b



SP: Service Provider
MVNO: Mobile Virtual Network Operator

2.1.3 Operational options for sharing

An often neglected part of the discussion of network sharing is what kind of operational options the operators have in the case of sharing. There are three ways of doing it as categorized in Frisanco et al. (2008). One is when operators do not have any network yet, and they roll-out the network together – this is called "greenfield". The other option is when there is a buy-in: an operator can purchase an existing network of another operator and then they operate jointly. If both players have an existing network, they can consolidate through a sharing strategy. Of course, as network sharing becomes more extensive, sacrificing the control also means less scope for strategic decisions. Therefore typically in rural areas where differentiation is a less important factor, the joint roll-out of the network is less problematic (Frisanco et al., 2008).

2.2 Cost advantages of network sharing

The main conceptual idea behind the different kinds of network sharing from a strict economics point of view is that sharing regarding the network assets tries to ease efficiency concerns of the physical network: the efficiency constraint stemming from the quasi natural monopoly nature of the industry can be eased this way. On the other hand, spectrum sharing or pooling tries to ease the second scarcity problem of the industry: the amount of spectrum is given, hence the efficient use of it can be mitigated through market mechanisms.

Based on the categorization of GSMA (2010), motivations for the use of NSAs can differ depending on the maturity of the market, the technology diffusion or according to a new entrant or an incumbent. In matured markets the goal is to reduce operating costs, in developing markets to have a more rapid network roll-out. Also, areas that are otherwise unprofitable can be reached through sharing, as CAPEX and OPEX optimization makes it a viable option.

What is important here from the economics point of view is that if competition concerns are to be resolved, efficiency gains should be assessed with respect to different kinds sharing

agreements. Here I will sum up the benefit side of sharing: a few estimations regarding cost reductions, which gives an overall picture of the possible gains of sharing.

Firstly, I will summarize the estimations reported in GSMA (2010). The advantages of site sharing can observed both in urban and rural areas. While in densely populated areas, it is the scarcity of the most efficient places for locating antennas that can support sharing agreements, in rural areas it is mostly capital saving that motivates agreements. Also, approving new sites is a cumbersome process, hence joining to existing ones can make more sense. In India, site and mast sharing caused a 30-50% saving in CAPEX and OPEX. As passive elements are 50% of the total network costs, this can save approximately 15% of the total costs. The possible drawback is that when an antenna is used jointly, then future investments at that given node is constrained. According to BEREC/RSPG (2011), passive sharing can have a 15-30% saving effect, based on several industry sources. Hence, passive sharing alone still has a significant effect which is more available compared to active sharing, where coordination is needed.

The dominant motivation behind RAN sharing is to cut back operational costs, which is important because of a downward pressure on prices due to lower ARPU levels. Hence, one trivial factor is that areas with low demand customers, or areas that have not been served before at all, RAN sharing is a viable option: in the latter case it also means plus revenue for the operators, as certain traffic could not be established (GSMA, 2010). Depending on the technology, estimates of Chadbury and Terfloth (2007) show that the cost reduction is about one-third for 3G and one-fourth for 2G technology. In their estimation using 60/40% CAPEX/OPEX ratio for 3G a 19% cost reduction, with 2G a 35% cost reduction can be reached.

Frisanco et al. (2008) used simulations in order to estimate the cost saving potential for different NSAs – both for different technologies (2G and 3G) and for different stances of roll-

out.[3] According to their financial model, there is a 20-40% saving potential both for OPEX and CAPEX – with site sharing being the least and full network sharing being the most extended form of sharing. [4]

A further summary of estimations regarding different cost savings of NSAs, including also backbone (backhaul) and core network sharing, is in Zahle and Friend (2010), which can be seen in Table 1 below.

Table 1: Cost saving estimations. Source: Zahle and Friend (2010)

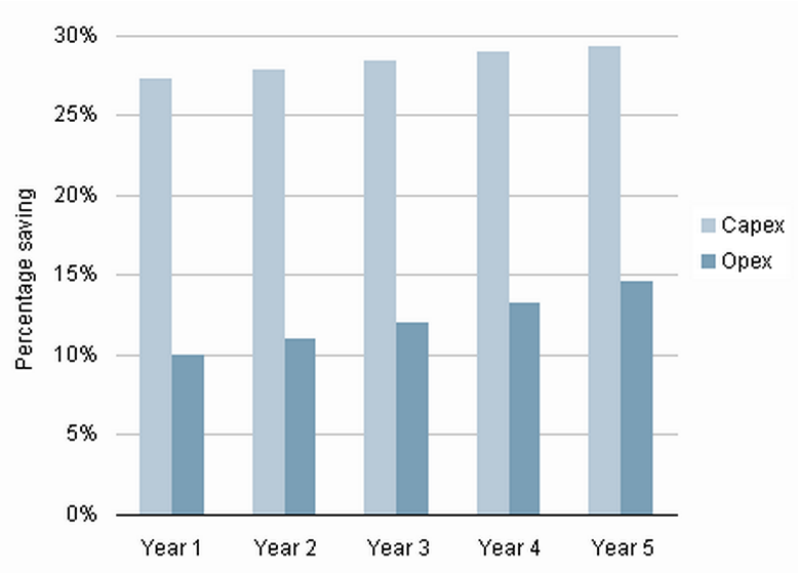
Sharing Model	Capital savings	Operations and Maintenance savings
Site/Mast Sharing	5-10%	5-10%
Transmissions Sharing (backhaul)	5-15%	5-15%
RAN Sharing: passive and active RAN, site rents, transmission capex and opex	20-25%	20-25%
Backbone Sharing – core network transmission	5-15%	5-15%
Core Network Sharing	15-25%	15-20%
Total	65% at max	65% at max

It is also important to note that the gains regarding sharing agreements also depend on whether it is a brownfield or a greenfield setting. In the case of a greenfield investment - that can be started for instance with the roll-out of 4G technology – the savings can be significantly higher (BEREC/RSPG, 2011). Cost savings were reported by Analysys Mason (2010a) as a year-to-year saving for a joint LTE network roll-out with RAN sharing – with 2500 sites shared in a developed economy. As Figure 2 shows, it can reach almost 30% CAPEX saving and 15% OPEX saving in a five year period.

[3] In the baseline model, there was that two operators Frisanco et al., 2008)

4 An important part of their modelling (Frisanco et al., 2008) is that they consider separately the option of outsourcing certain services (For instance: field services, maintenance, technical support, spares repair and logistics) while sharing parts of the network. As a conclusion they argue, that the additional OPEX benefit of outsourcing is rather significant, making it a viable option – as it somewhat also mitigates concerns about confidentiality of operators' data. CAPEX savings are similar in magnitude with the OPEX savings in case of outsourcing operations fully.

Figure 3: Joint LTE network roll-out savings for RAN sharing. Source: Analysys Masin (2010)



The importance of the above discussed cost efficiencies is that it demonstrates, that network sharing has large potentials for decreasing network costs. As will be discussed above, competition policy considers generally two argumentations regarding horizontal co-operations, out of which one is the efficiency gain. Therefore, if there is a spill-over effect to the consumers, these efficiency gains can legitimate NSAs

3 CHAPTER: THE CURRENT POLICY AND LEGAL CONTEXT OF MOBILE TELECOMMUNICATIONS

Network sharing in mobile telecommunications is in the midst of several conflicting policies. There are distinct national industry regulations, differing goals regarding spectrum auctions from country to country (even fiscal stance can be an issue here), while there is a general European policy for mobile broadband technology coverage and what is more important, there is competition policy affecting the possibilities. These policies sometimes agree, but are often conflicting also. Here I will briefly overview the regulatory environment and the conflicting policies regarding mobile telecommunications, and also discuss the main competition policy concerns.

3.1 Legal context

The general attitude toward sharing of mobile networks is rather positive. The first shock for network sharing was the introduction of 3G technology. The EU final position on the regulatory and competition issues regarding 3G technology was that easing of ex ante regulation for prices and a more lenient intervention threshold for regulation and higher reliance on competition policy was the plan for enhancing investments. Also, the first position on behalf of infrastructure sharing came up in this document (COM, 2001). Hence regulation acknowledges that this industry has large efficiency potentials through eliminating duplications, the efficient outcome indeed is that where necessary, the network should be used jointly. Furthermore, the financial difficulties were also considered. (COM, 2001)

A simple description of the regulatory changes can be found in Heimler and Anderson (2007), which will be detailed in the followings. The first radical change was in 1998, when the telecommunications sector was opened fully. However, for competition to work efficiently, other regulatory changes were to be implemented, thus in 2002 the EC approved six directives[5],

[5] These regulate access and interconnection of networks and facilities (Directive 2002/19/EC), authorization (Directive 2002/20/EC), give a common regulatory framework for telecommunications networks (Directive 2002/21/EC), universal service and users' rights (Directive 2002/22/EC), processing of personal data and protection of privacy (Directive 2002/58/EC). (Ofcom, n.d.)

aiming for a more competition-based regulatory assessment. The goal was to use market analysis before regulation is imposed at a given market. Furthermore, the Commission's recommendation is to use a three criteria test for identifying markets where ex ante regulation can be justified. These criteria are (i) high and non-transitory barrier to entry, (ii) the lasting nature of this entry barrier (as in this dynamic industry, these conditions can alter rapidly) and (iii) the inadequacy of competition policy to address these dominance problems properly (COM, 2007).

The latest European Framework for regulation explicitly says, that cooperative arrangements should be encouraged till competition is not damaged, as this is the efficient way of building new communications infrastructures (Council Directive, 2009/140/EC). Furthermore, there is an explicit recommendation in the Directive for facility sharing, as being a more efficient way of building new infrastructures and also as a supporting conduct for new entry in Recital 43 of the Directive.

The latest European Regulatory Framework regarding the spectrum was accepted in 2012. Regarding spectrum policy, there are three types of problems that needs to be regulated: allocation, usage and trading of spectrum. Allocating spectrum through auctions is already covered, hence will not be discussed here. Theoretically usage and trading is about to fine tune the outcome of allocation. The current EU regulation addresses these issues: it ensures service neutrality (if there is no interference problem), and the possibility of spectrum trading or spectrum sharing. (see RSPP, n.d.; Decision No 243/2012/EU)

Furthermore, there is a digital policy – Digital Agenda – with several goals for communication technology. One aim is for example a 50% adoption of 100 MBs broadband technology that is rather ambitious, and hence have a push toward solutions that increase coverage. Hence, as a matter of fact there is a pressure for sharing: for certain areas, LTE can be cheaper than fiber internet. (Marcus and Elixmann, 2012)

Furthermore, there is a general competition policy background that have to be assessed here is based on Article 101 TFEU, and the guidelines regarding horizontal mergers or co-operations (COM, 2011). The main concern is grounded in Article 101(1): agreements that distort competition and "limit or control production, markets, technical development and investment" should be prohibited. These issues will be discussed in detail in the next subchapter.

3.2 Competition Concerns

In case of NSAs the general ideas emphasized in the relevant competition guidelines can only serve as a starting point. Whether network sharing would harm competition depends on rather market specific nuanced issues, hence a general framework would be rather hard to be formulated. Therefore, it is important, that decisions should only take place on a case-by-case basis, only the drivers of competition can be highlighted ex ante. The main idea is that Article 101(1) and 101(3) have to be compared to each other: the potential restrictions of competition have to be compared to the other side, the pro-competitive effects of sharing agreements.

Although, here I will summarize the competition related issues on a theoretical level, it is important to note, that the question of how should one think about the competition authorities attitude towards network sharing can only implicitly revealed, as in all cases, network sharing investigation were cleared – what is more, mergers were cleared as well.

The general concerns will be summed up based on Bishop and Walker (2010). The problem with network sharing is its horizontal nature. Unlike in the case of vertical agreements, the parties have different relationship. While vertical agreements are often and more unambiguously efficiency enhancing changes, horizontal agreements ultimately affect the customers more directly. But, there are cases, when horizontal collaborations can have pro-competitive effects that also enable authorities to make exemptions. The basic concerns with horizontal collaborations is that it can make collusion easier and there is a non-coordinated effect through loss of rivalry. For example through balancing the cost structure and also the cost

differences, collusion is easier. However, the attitude toward horizontal agreements should be based on an analysis that considers the case that otherwise would have happened. Considering the extreme case of a horizontal merger, also efficiencies have to be assessed. It is not a new idea of proper competition policy, that better utilization of assets may be achieved through reallocation or joint usage. This can indeed have a downward pressure on prices, hence always the benefits and the probable upward pressure from potential loss of competition have to be compared. (Bishop and Walker, 2010)

This idea is explicit in the horizontal guidelines regarding 101: "determine the pro-competitive benefits produced by that agreement and to assess whether those pro-competitive effects outweigh the restrictive effects on competition" (COM, 2011, recital 20.). As NSAs are not restrictive on competition by object, the potential harms have to be show in on some parameters of competitive output, for example on price or quality.

And this is the argument that can be used in favor of network sharing: it lowers costs, shares the risks, new services can be launched more rapidly. (Mölleryd, 2011) The question is whether the benefits can be achieved without or with less strong agreements. If the efficiencies are high enough, and also, will have a positive spillover effect on consumers, it can be compatible with the competition framework.

Based on the EU guidelines the following criteria were summarized in the BEREC/RSPG (2011) report. The sharing agreement can be unilateral, bilateral or multilateral. The second is the geographic scope of the sharing agreement. The third is the impact on the competitive situation – whether the agreement affects coverage, prices or network quality. The fourth is whether the operators can maintain their independence in network planning. The fifth is whether the parties can have similar agreements with other operators or is this agreement exclusive. The sixth is how sensitive information can be exchanged: only sharing related information should be exchanged. In case of network sharing, implicit demand information and

capacity information can be exchanged, which can be detrimental to competition. But the general logic behind the exemption of information sharing is also a cost-benefit analysis: whether the efficiency gains are higher due to sharing certain information or not (see for example Vives, 2006) Furthermore, operators should be able to differentiate themselves in prices, quality and services and independent conduct should be maintained (collusion concern).

The more and more popular practical solution for carrying out a network sharing agreement is also characterized by vertical disintegration: operators delegate network maintenance to jointly owned JVs. This is basically a horizontal agreement between firms, otherwise competing at the final product level. According to Motta (2004) this kind of a collaboration is somewhere between cartels when the activity is research or production, hence should be treated accordingly by the law. The general idea is the same: the trade-off between efficiency and market power should be assessed.

The one sentence summary of the problem of competition policy on a broad level is whether it regards industry consolidation to be basically motivated by one of the natural constraints of the triumph of network-demand-spectrum, or should it be assessed as an anti-competitive attempt.

4 CHAPTER: CASES

In this chapter I will overview a few cases with a special emphasis on competition issues. Firstly, I review the market development in the UK through analyzing three competition investigations and hence the concentration of the wholesale market. Secondly, I also summarize cases from continental Europe: the German case that is similar to the first UK sharing agreement, the case of Denmark for having an extended sharing agreement, and an Austrian merger as an 'extreme' case for sharing. As a proof for the increasing importance of NSAs, Table 3 highlights sharing agreements from Europe.

Table 2: Network sharing agreement examples

Country	Year	Sharing
Austria		T-Mobile and Orange – RAN sharing in rural areas*
	2012	T-Mobile and 3 Austria**
Denmark	2012	Telenor and TeliaSonera**
Germany	2003	T-Mobile and O2 Germany*
Norway		Tele2 and Network Norway – JV for 2G and 3G*
Poland	2012	T-Mobile and Orange – JV: NetWorks, for LTE RAN sharing**
Russia	2012	MTS and Rostelecom
Sweden		TeliSonera and Tele2 – JV*
		Telenor and Hi3G – sharing outside mayor cities*
		Telenor and Tele2 – JV (NetMobility) for national 2G and 4G*
UK	2009	T-Mobile and Orange – Everything Everywhere*
		Vodafone and O2 – Cornerstone*
		T-Mobile and H3G – mast and 3G RAN sharing*

* Mölleryd (2011)
** Ernst&Young's: Inside Telecommunications (2012)

4.1 Cases from the UK

Analyzing the NSAs and their competition assessments in the UK gives a useful baseline for analyzing the problems: there are a lot of players, hence there is a real case for efficiency enhancing agreements.

The first step in the UK toward infrastructure sharing from the regulatory side was Ofcom's note in 2001, which set the stage for the first attempts for network sharing. It encouraged facility sharing, but also emphasized that competition cannot be harmed. It is also important to note that in that time, national roaming was still in place, but regulation wanted to phase out such agreements (GSMA, 2010). That is why network sharing could be seen more or

less as a substitute for roaming. Table 3 contains market information relevant for the three cases discussed below.

Table 3: Descriptive statistics for the UK mobile market

Mobile Operators / **Market characteristics**	**Vodafone**	**Orange (France Télécom)**	**T-Mobile UK Limited (Deutsche Telekom)**	**O2 UK limited (former: BT-Cellnet Limited and BT3G or MMO2)**	**H3G (3UK)**
market share by revenue for 2G (in 2003/2004 Q1)*	32.5%	25.7%	19,4%	22,4%	No data
retail revenues generated by mobile telephony in 2008 Q4 (Łm)**	954	795	647	1022	No data
market share (number of customerts) 2007***	20-30%	20-30%	10-20%	20-30%	5-10%
market share (number of customerts) 2009 1st half***	20-30%	10-20%	10-20%	20-30%	5-10%

*Oftel: Market Information, Mobile Update
** Ofcom: Telecommunications market data tables (May 2009)
*** Commission Decision (2003a) COMP Case/ 38.370

4.1.1 O2 UK Limited and T-Mobile UK Limited network sharing agreement

The first agreement was introduced between O2 UK (BT Cellnet and BT3G or MMO2) and T-Mobile UK (One2One) in 2002, when they notified the Commission on their proposed agreement consisting of network sharing and national roaming for 3G and 2G (GSM) technologies (Commission's Notice, 2002). These two companies have a very similar agreement also in Germany (discussed later) – hence these were the first trials on how much sharing can be allowed by the competition authorities (Gabathuler and Sauter, 2003). At that time, 3G networks were just about to roll-out, hence the pretext was given. The general attitude towards the agreement was positive as reported in the related press release also (Commission, 2002): a favorable view was in place, as the benefits of the sharing were assessed to be higher than the possible detrimental effects on network competition. In the followings the main

arguments of the case will be summed up, which led eventually to the clearance of this agreement.

Firstly, based on the information given in the Commission Decision (2003a), the general features of the deal will be introduced. The parties split the country into three regions according to demand specialties: initial build area (IBA) – the most densely populated area (30-50% of the UK population), with the majority of business demand -, divided area (DA) – second most densely populated areas (40-70% of population) -, remaining (rural) areas (RA)[6]. The scope of network sharing and the possible competition concerns arising are inversely related to the different population areas. The plan was to have a partial RAN sharing agreement (site sharing being the most important) at the IBA: cooperation in planning, acquiring, building and deploying sites for both technologies, and most of the elements are shared in the given site, except transmission and antennae (but no sharing of frequencies of core network elements). The parties also have priority for using a given site, and have a veto power against 3rd party usage. Also, some of the IBA would be covered by national roaming agreements as well. At the DA, parties have divided the areas into two parts, and they had to roll-out the networks separately and then national roaming would have been in place ensuring the mutual usage; but the parties could have extra investments on the other party's 'territory', also more confidential data are shared regarding coverage targets and roll-out plans.

For this to be cleared two types of arguments were presented by the parties. One is that it is not detrimental to competition, as at IBA areas there will be practically separate networks, and for the DA agreements, earlier coverage makes it easier to compete with other operators. But should there be any competition concerns, the second argument is that the efficiency gains due to faster delivery and lower prices more than offset any competitive harm (Commission's Notice, 2002).

[6] RA was not considered by the Commission.

The most relevant markets affected in this particular situation were the market for (i) sites and site infrastructure and the (ii) market for wholesale access to national roaming for 3G services, (iii) wholesale access to 3G and (iv) indirectly retail markets (Commission Decision, 2003a). [7]

Regarding site sharing agreements, there were three main concerns. One is that joint roll-out would abolish competition in coverage, which can be hardly true, as only DA areas are covered with a joint roll-out plan, hence on the country level the networks could be rather different. The second is that exclusive site usage agreements could have detrimental effects on 3rd party's chances to develop their own networks, but as there is no scarcity in proper sites available, this cannot be an issue. Thirdly, the split roll-out of the network in the DA could be seen as a market sharing, however, there are several exemption clauses that enable one party to deploy extra sites on the other's area, which resolve the concerns.

Although the commission decision (Commission Decision, 2003a) is explicit on the detrimental effect of national roaming on competition, namely no quality and coverage difference can be maintained, as it will be in place for only a short period of time, and the efficiency gain cannot be reached otherwise, it was enabled. The general reasoning is that it will force other players to have greater coverage the soonest possible, and to work on cost-saving solutions for the network roll-out. Competition can be increased this way, and what is more, this is an indispensable measure to have these cost efficiencies, and incentives for fast roll-out for other players as well.

To sum up, the decision is that site sharing and the related information exchange does not harm competition, as the network and services provided can be differentiated and exclusive site sharing does not harm other operators, hence it can be maintained. Furthermore, national

[7] The difference between access to national roaming and wholesale markets for network services and access is that by roaming, the operator can shape the range of services – hence services not available to the host operator's subscribers can be also provided –, with buying wholesale services, only those services can be provided that are also offered by the host operator. (Commission Decision, 2003a)

roaming was allowed till the end of 2007 in the IBA, while in the DA till 2008 (Gabathuler and Sauter, 2003).

4.1.2 3UK and T-Mobile – Mobile Broadband Network Limited

The sharing agreement between 3UK and T-Mobile and Orange is only important because it has a rather important role in the NSA between Orange and T-Mobile. 3UK was regarded to be a very important competitive force in the UK market, why its position was to be maintained. The two agreements was with T-Mobile on the 3G network, and with Orange on the 2G network. (Guitton et al., 2010)

4.1.3 Orange and T-Mobile Joint Venture

The third extensive sharing agreement was initiated in 2009, when Orange and T-Mobile (the 3rd and 4th players on the retail market) announced a 50-50% JV to be set up for maintaining network infrastructure (Guitton et al., 2010). This case is particularly interesting as both T-Mobile and Orange had an already existing agreement with UK3.

As summarized in Guitton et al. (2010), this investigation had four dimensions: (i) retail market effect, (ii) the wholesale market effects, (iii) the consideration of the effect on the already existing sharing agreement between 3UK and T-Mobile and (iv) the effects on the distribution of radio frequency holding. Furthermore, the main concerns were regarding the possible foreclosure of 3UK and due to the frequency pooling they would had been the only players capable of launching LTE services.

In the followings, I will use the Commission Decision (2010) for describing the situation. At this time, the UK telecommunications market is still a very competitive one, which is proven by the existence of 5 MNOs: O2, Vodafone, Orange, T-Mobile and 3UK. From Table 3, it is straightforward, that from based on the number of customers, Orange has a declining market share (between 2007 and 2009). Furthermore, there are around 25 MVNOs (Mobile Virtual Network Operator) selling telecommunications services. As a consequence, only the wholesale market was found to be problematic, as after the establishment of the JV, they had

the highest share on the wholesale level both with respect to revenues and subscribers. Four players would remain on the wholesale market, O2 and Vodafone being the effective competitive forces. The main question is whether disclosing capacities from retail players (MVNOs) is a probable strategy for the new JV. The Commission's view is that spare capacities would still be available, as rationalizing the joint network does not imply a decrease in capacities, on the contrary, demand for data transmission incentivize investments.

One of the biggest fears was that the new JV makes the 3G RAN sharing agreement between T-Mobile and 3UK instable, and as 3UK is a very important innovative player of the UK market, maintaining its role was crucial. The fear was that T-Mobile would not be incentivized to invest enough in assets that are shared with 3UK, hence affecting the quality of 3UK's 3G service. This could also mean that T-Mobile and Orange could get customers from 3UK in this way. The worst case scenario would be that with the foreclosure of 3UK, only three players would remain from five on the wholesale market. Therefore the following commitments were made: (i) a timing of the consolidation of the 3G RAN agreements between T-Mobile and 3UK, (ii) certain termination rights were cancelled, (iii) extended 2G agreement between Orange and UK, (iv) commitment to negotiate the network integration plan between 3UK and th JV, (v) fast dispute mechanism to resolve any related dispute between the parties (as summarized both in Guitton et al, 2010 and the Commission Decision, 2010).

The fourth type of problem was that due to the sharing the JV would get enough spectrum to launch 4G services – uniquely in the market. In order to be able to launch an LTE network, one needs to have 2*20 MHz contiguous spectrum. As jointly they would have had 2*60 MHz in the 1800 band, it would have meant that they were the only ones, who had the ability to launch LTE network on the short run. Although, an upcoming auction would have been held in the forthcoming years, selling 2*30 MHz at the 800 MHz spectrum and 2*70 MHz at the 2600 spectrum, these spectrums would be only available in the middle run. Hence if T-

Mobile and Orange would merge their spectrum, it would mean that their product would be much more advanced compared to the other MNOs' products. The remedies accepted by the parties regarding the spectrum problem is that they divest 2x10 MHz and 2x5 MHz at the 1800 MHz spectrum. Also, these spectrum rights have to be given to the same player in order to be able to launch an LTE service on these assets. As this is assured by the auction, the possible problems of spectrum concentrations are resolved.

The counterfactual case when operators bid for the new frequencies alone would let LTE networks to emerge at low frequencies at rural areas, while at high frequencies in urban areas. The point is that in the absence of the merger, more LTE networks could be built simultaneously.

4.1.4 Vodafone Limited/Telefónica UK Limited (O2)

The cooperation between Vodafone and O2 started in 2009, when team Cornerstone was established with the goal of sharing masts – hence it was only a passive sharing, without any tight organizational setup (MOA, 2013). In the following I briefly sum up the most important aspects of the companies' decision of forming Towerco in a JV for managing a single network of base stations based on the OFT's decision (2012) and Cummins (2013).

This is the most recent landmark case regarding any kind of NSA in the UK, assessed as a relevant merger situation.[8] The agreement had two parts: all passive network assets will be assigned to this new entity and the parties also agree on dividing the country into two parts and they will roll-out the RAN equipment accordingly. For this they will use multi-operator RAN equipment that can operate on multiple frequencies. However, intelligent or core parts of the network will not be shared, hence separate products and coverage can be maintained. As the RAN agreement is based on multi-operator radio equipment, the OFT did not consider it to be relevant.

[8] According to the British competition rules, a creation of a JV can be assessed as a relevant merger case. Also, the parties supply more than 25% of the services that is the limit for considering a merger case. (OFT 2012)

Hence only horizontal issues regarding passive site sharing were considered. It is important methodologically that the counterfactual during the analysis is the cooperation within the framework of Cornerstone. Regarding unilateral effects the OFT did not find any significant change in the competitive situation.

At that time there were only two other MNOs with demand for sites: Everything Everywhere and H3G. However, as their network is also a result of a cooperation and H3G has its own agreements as well, the demand for those sites integrated in Towerco are rather low. Hence there is an interaction between the different concentration initiatives of the operators: once two or three parties are allowed to share their network to form a JV, the demand for wholesale related products (for instance sites) is lowered, making further concentration among other parties less problematic.

Coordinated effects also remain probably moderate as core level competition will still exist: for instance switching centers or home locations will be maintained separately, which ensures the ability of differentiating in products, services, R&D both at wholesale and retail level. Problems with information sharing can be also considered to be less problematic compared to the former cases: the necessary information for passive sharing is not harmful for competition.

As intelligent parts of the network remain separate, competition can be preserved at the retail level. Hence there is no sign of prior collusion, and the information disclosed to Towerco is not significantly different in nature compared to the already existing cooperation. Greater symmetry regarding costs usually raises concerns of collusion, but in this case, it is not an issue either, as the passive infrastructure costs are not high enough within operational costs.

4.1.5 UK market conclusion

This extensive overview of the consolidation of the UK market gives a perfect example of how competition concerns can be raised over a lifetime of a given telecommunication technology. Here, a lot of MNOs were initially at the market with separate networks, and also,

there were a vivid retail market. At the end of the consolidation, there are only two organizations in the UK that plan and build network infrastructure, while at a retail level five firms are competing (MOA, 2013). Based on the investigations, the conclusion is that the main competition concerns were about to ensure the possibility of a new entry, hence remedies also aimed this goal.

4.2 Continental Europe

4.2.1 Germany

T-Mobile and MM02 had a very similar NSA in Germany as in the UK, hence only a short overview will be given based on Gabathuler and Sauter (2003) and the Commission Decision (2003b). Similarly to the UK case, extended site sharing, RAN sharing and also national roaming were part of the agreement. Two areas were defined: primary (50% of the population, where coverage have to be extended separately until the end of 2005) and secondary (less densely populated areas, with the other 50% of population). Extended site sharing and RAN sharing – with separate intelligent networks – and also national roaming on T-Mobile's network (but not on O2's network) would be maintained in the primary areas, while there would be reciprocal roaming in the secondary area.

The main conclusion for competition effects was rather similar to the UK case – based on Gabathuler and Sauter (2003). Site sharing was not found problematic, as core networks remain independent. Furthermore, RAN sharing was not investigated either, as it was still uncertain at that time. National roaming was found to be more problematic as there were also a restriction on capacity reselling to MVNOs, but based on the parties' arguments, this part of the agreement was also exempted for a 5 year period. Without this roaming restriction they would not have enough capacity for each other, hence they could not be efficient retail players.

4.2.2 Denmark – TeliaSonera and Telenor

This summary is based on the Executive Summary of the Danish Competition Authority's investigation (DCCA, 2012a) and on the investigation of the Danish Competition

Authority (DCCA, 2012b). This was one of the latest agreement on infrastructure sharing: TeliaSonera and Telenor agreed to build 2G, 3G and 4G technology networks jointly via a JV called Newco. The new feature of this agreement was that the parties also agreed to share frequencies, however, intelligent parts of the networks would not be shared in this case either, for instance consumer data or transmission capacities. They will remain independent both on decisions on the wholesale and retail market, hence the number of suppliers will not be lowered. This is an important step, as RAN sharing so far was only done in a MORAN setup, not in a MOCN. In Table 3 below, market shares based on turnovers and the existing spectrum holdings can be seen. Two important notes have to be made. One is that 3 is an important maverick player of the market, which is indicated for instance by the high share of mobile broadband share. Secondly, after the establishment of the JV, Telia and Telenor will hold a disproportionately large share of spectrum, which is also addressed by the investigation. Furthermore, Telenor is the second on the retail and first on the wholesale market, while Telia is the third on both markets (DCCA, 2012b).

Table 4: Market Shares (based on turnover) and Spectrum holdings. Source: DCCA (2012b)

Telecommunications Compatny	Mobiletelephony (market share)	Mobile Broadband (market share)	Spectrum holdings (total MHz)
Telia	20-30	0-10	2*70.4
Telenor	20-30	20-30	2*63.4
TDC	30-40	30-40	2*65.8
3	0-10	30-40	2*40
Other	0-10	0-10	

As can be seen in Figure 4, four markets can be affected: the market for antenna and master (position of antenna on the master), wholesale and retail markets for mobile telephony and mobile broadband and the market for spectrum. The competitive assessment of the case identified six types of problems, and the DCCA also set the remedies for problematic parts of the agreement. Now, I summarize these problems based on DCCA (2012a, 2012b).

The first concern was collusion at the wholesale level, which was solved by the obligation to accept 3rd party wholesale requests on customary terms. As wholesale market characteristics are such that the risk of cooperation is already high, this cooperation does not change the situation significantly. However, it is true that a new structural link will be established between the two players. The assessment looked at whether the parties have an incentive to foreclose wholesale customers: it would be only rational if they could recover the income decrease due to the foreclosure through retail expansion, which was found to be rather unlikely.[9]

The second concern was due to the way of cost recovery from the JV, which increases the variable costs, hence decreasing the incentives for attracting new consumers. The underlying problem is that common costs lessen the possibility of a cost competition, however there is no explicit limit for common costs in the case of production agreements. This problem was resolved by the obligation of accepting a tariff structure that reflects the cost structure of the RAN. As can be seen in Table 4, the spectrum allocation is also influenced – as Telia and Telenor would have approximately twice as much spectrum as the second largest company (TDC) –, and future auctions' outcome can be also affected. Therefore a commitment was made that only Newco will bid for new frequencies in the auctions.

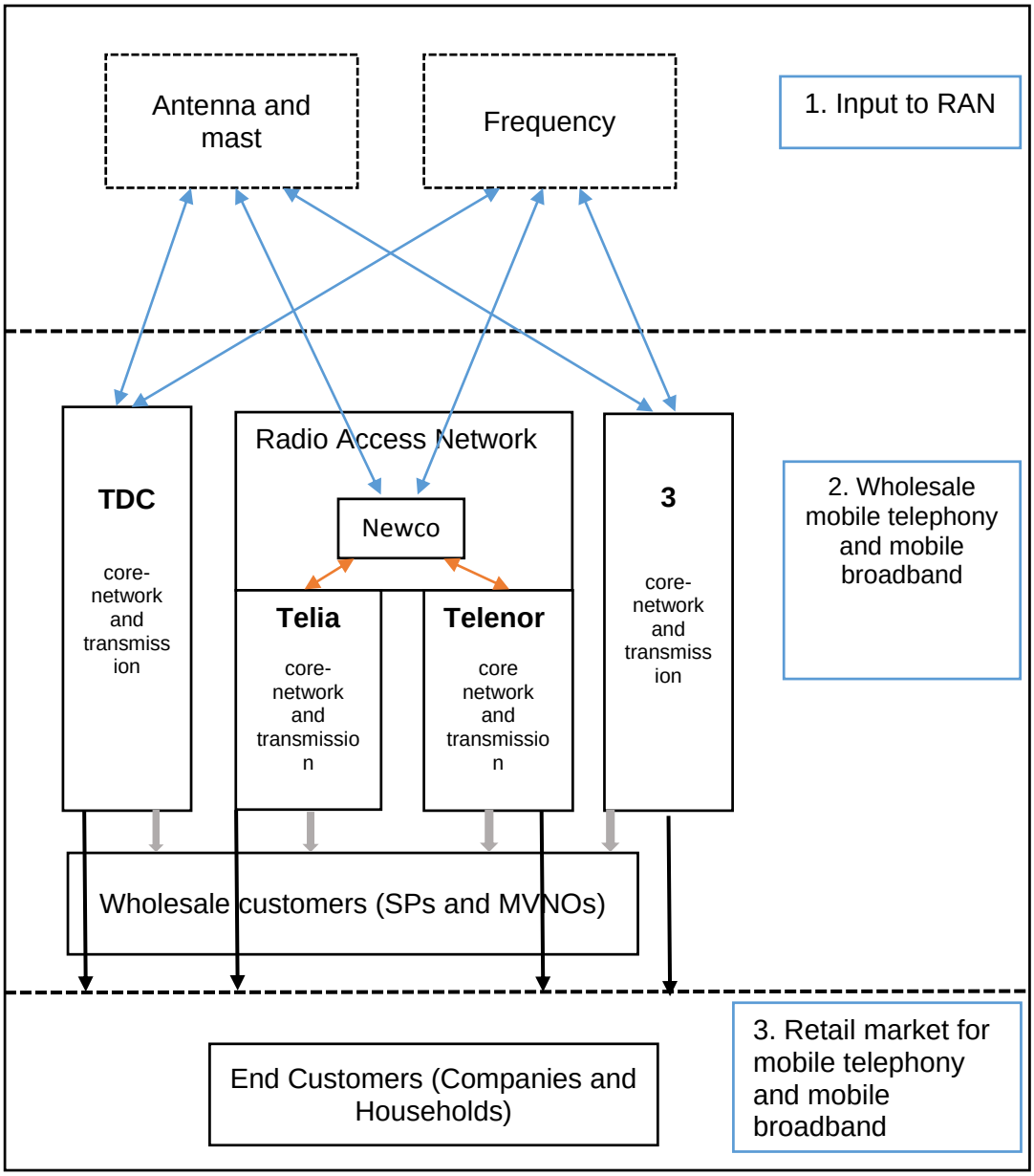
The fourth problem was that due to site rationalization, 3rd parties could lose coverage, therefore, unnecessary sites were to be sold to any third party. Regarding the problem of the higher chance of changing strategically important information, the parties adopted restrictions on the Board and Management of the JV, and the information that can be changed between the parties and the JV. The parties will disclose traffic forecasts only to Newco, and these forecasts will be sent separately, and no further information exchange can take place.

[9] As Telenor is the largest wholesale player, it is not likely, that his losses would be backed by retail expansion as the retail market is much more competitive. (DCA, 2012b)

Finally, it is also important to note that due to this agreement, the coverage of the parties will be identical. What is more: technological advancement will be also the same, which means, that two rather important competitive factors will be shut down. However, the investigation noted that there are large synergies in the joint maintenance of the network – also, the parties initial network endowment was different –, thus the unification of coverage and technology was cleared.

Figure 4: The relevant markets in the Telia/Telenor case. Source: DCA, 2012

Red arrows show the relationship between the parties and the JV. The blue arrows show the operators needs regarding antennas and masts, and frequencies The black arrows show the sales to retail customers. The gray arrows show sales to wholesale customers.



4.2.3 Austria

The merger case of H3G and Orange in 2012 from Austria is interesting mostly because it can be seen as an 'extreme' way of network consolidation. As the Commission Decision is not available yet. I will rely on the concerning press releases and the analyses of Bavasso and Long (2012, 2013). The clearance of the merger, which lessens the number of MNOs from 4 to 3, while remaining the smallest player based on market shares, was conditioned on commitments. The remaining players are the incumbent Telecom Austria and T-Mobile Austria. Similar to the above described cases, the main goal of the commitments was to enable new players to enter the market.

The assessment of this case was particularly interesting as although the joint market share was below the 25% limit, which is relevant for these situations, rather a more segmented market view was applied: "in private customer and data segments (…) the market power of the merging parties would have been higher than what their market shares suggested" (European Commission, 2012a). Further, based on the concerning press release (European Commission, 2012b), the new customers switching to smart phones chosen one of the merging parties with 50% probability.

Hence, three types of remedies were offered as summed up by Joaquín Almunia (European Commission, 2012a), with the goal rather similar the previously discussed NSA cases: the support of a new entrant, even if it is a MNO or a MVNO. Firstly, spectrum divestiture was mandated to the new entity, as this is necessary for a new operator to enter the market. Furthermore, in order to establish the possibility of a vivid retail market with the possibility of the new MVNO entry, Hutchison had to provide wholesale access for 10 years. Thirdly, the merger should not be completed until a wholesale access deal was not set with a MVNO.

Furthermore, the main point of analyzing this merger from the network sharing point of view is that the clearing decision did not acknowledge that the investment enhancing effects of

this merger would be grounded enough. More specifically, the hypothetical counterfactual was a NSA (European Commission, 2012a). This shows implicitly that competition assessment regards only NSAs as indispensable for efficiency gains – hence an alternative for industry consolidation. Also, as discussed in Bavasso and Long (2013), compared to the Vodafone and Telefónica JV in the UK discussed above, the Commission's decision was less interested in efficiency gains, which could also affect the national authorities.

4.3 Implications from the competition assessments

Several important inferences can be made based on the above analysis of the cases. One trivial but important statement is that competition policy was rather lenient towards sharing agreements. Not only cooperation on the passive level, but active sharing was permitted. Although there is no counterfactual case for assessing whether competition policy became increasingly permissive with time or not, it still worth to mention that the depth of sharing considered to be acceptable increased with great extent.

Depending on the current state of the industry, different types of competition considerations were emphatic. This means, that when there were a lot of operators at the market before a larger network roll-out, national roaming was considered to be a pro-competitive device that incentivize non-sharing operators to roll-out networks more rapidly – mostly in rural areas. However, this conduct was only allowed on the short run, to assure the possibility of a greater network differentiation in the future. Thus, it seems that the general competitive assessment considered rather short run effects of NSAs.

Furthermore, it is also evident, that there is an interaction between technological solutions and permissions competition policy: as more and more active elements could be used in a relatively separate manner – enabling a certain degree of differentiation – the depth of sharing increased accordingly. Thus it seems that there is a technological constraint for wholesale co-operation. However, coverage differentiation is becoming less important. In the Danish case, it

was not regarded as an important factor, and was accepted on efficiency grounds and by the making of viable competition for the incumbent company.

Another important problem regarding these horizontal agreements is that they increase the probability of information sharing. However, this seemed to be mitigated on the one hand by commitments of the parties regarding the shared information (only technical information are shared), and also the institutional form of such co-operations have changed: in the form of a JV, information flows could be adjusted in a way that it had no detrimental effect on competition.

Lastly, frequency holding was the also a crucial issue, which was resolved by divestiture remedies. For this problem also, the goal of competition policy was on one hand to exclude the possibility of a competition advantage for new technology roll-out, and on the other hand, to make new entry possible.

However, the whole argument can have somewhat altered flavor when it is assessed from a theoretical viewpoint that build on the two important features: the natural carrying capacity of a given market and the dynamic technological changes of the industry – which makes the return on high fixed costs more risky. Based on these features one could think that consolidation is a viable option. Nevertheless competition policy was about to either to ensure the possibility of new market entry as could be seen for instance in the Austrian case, or considering only 'pure' sharing cases for example the Orange and T-Mobile sharing case in the UK, the goal was to assure the position of 3UK as also underlined by Bohlin et al. (2013). Hence the attitude towards more concentration is at least questionable. Also, the emphasis on the efficiency gains remained rather moderate compared to competition concerns.

CONCLUSION AND POLICY IMPLICATIONS

In this paper I investigated NSAs in the mobile telecommunications industry, with a special aim to present that due to the efficiency gains and the general functioning of the market, competition issues can be outweighed. First of all, the introduction of the industry specific issues from the economics point of view proved that there are two types of scarcity problems in the industry: spectrum scarcity and network roll-out costs have increasing returns to scale. These generally push the industry towards a concentrated structure – even a natural monopoly can be the case, where demand factors are disadvantageous enough. Regulation on the other hand pushed the industry towards a multi-operator conduct, while high investment needs were prevalent, which made profitability rather hard to maintain. Consequently, an industry consolidation started to unfold: although effective mergers were rather rare, infrastructure sharing agreements became prevalent. As the 'supervision' of the market was increasingly based on competition policy – ex post – interventions, the question that has to be answered is how detrimental are these non-conventional consolidation initiatives.

Competition policy considers two questions regarding production agreements: whether they have detrimental effects on competition and whether they generate large enough efficiency gains that has spillover effects also to the consumers. The main message is that competition investigations ultimately acknowledged that NSAs – even extended ones – can have a legitimate role in industry consolidation, and although they re-structure the wholesale market, remedies can address the possible concerns properly. It is also interesting, that there was a relatively greater emphasis on anti-competitive effects compared to the acknowledgements of efficiency gains. Also, purely looking at the cases, a constant increase of leniency can be noticed, since the latest agreements supported wholesale consolidations leading to a two- or three-party market. The further question that remains is whether remedies making possible new entrance are necessary, however, based on the industry logic detailed above, it is rather superfluous.

There are two types of implications, one regarding the operators of the industry and another regarding competition policy conduct. From the overview of the general stance of the mobile telecommunications industry, it is straightforward, that in order to be able to roll-out new technologies, operators have to move towards a kind of consolidation. The efficient way of it is to introduce NSAs, hence EU countries not having such co-operations should incentivize them as a viable alternative of merging.

The implication for competition policy is twofold. One the one hand, the generally permissive competition policy is to be followed, and the most extensive sharing agreements can be allowed. Furthermore, competition policy should be more explicit about what kind of sharing agreements will be permitted and with what kind of remedies, hence lowering the uncertainty of such already risky initiatives.

On the other hand, as opposed to the competition policy conduct up to now, the considerations should be less about the creating the opportunities for new wholesale entrance, as the natural forces do not support new vertically integrated players. However, competition can still be ensured on other markets, where several players are prevalent.

BIBLIOGRAPHY

Analysys Mason (2010a): Wireless infrastructure sharing saves operators 30% in CAPEX and 15% in OPEX. Retrieved from: http://www.analysysmason.com/en-GB/About-Us/News/Insight/Wireless-infrastructure-sharing-saves-operators-capex-and-opex/#06%20May%202010

Analysys Mason (2010b): Deployment Models and Required Investments for Developing Rural Broadband Infrastructure in India. Retrieved from: http://www.analysysmason.com/About-Us/Offices/Asia-Pacific/New-Delhi/CII_broadband_report/#.Uau_atLDCSq

Analysys Mason – Ian Streule (2013): The cost of increasing broadband speed: who will decide – operators or regulators? Retrieved from: http://www.analysysmason.com/en-GB/About-Us/News/Newsletter/Broadband-speed-AMQ-Jan2013/#23%20January%202013

Article 101 TFEU (2008).Consolidated version of the Treaty on the Functioning of the European Union – part three: Union Policies and Internal Actions – Title VII: Common Rules on Competition, Taxation and Approximation of Laws. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:12008E101:EN:HTML

Bavasso, A. & Long, D. (2012): H3G/Orange Austria – Mobile Consolidation and Regulatory Reaction. Competition Policy International. Retrieved from: https://www.competitionpolicyinternational.com/h3g-orange-austria-mobile-consolidation-and-regulatory-reaction

Bavasso, A. & Long, D. (2013): The Application of Competition Law in the Communications and Media Sectors: A Survey of 2012 Cases. Journal of European Competition Law & Practice. 4(3). 264-276.

BEREC/RSPG (2011): Infrastructure and spectrum sharing in mobile/wireless networks. Joint BEREC/RSPG report. Retrieved from: http://rspg.ec.europa.eu/_documents/documents/meeting/rspg25/rspg11-374_final_joint_rspg_berec_report.pdf

Bishop, S., & Walker, M. (2010). *The economics of EC competition law: concepts, application and measurement*. Sweet & Maxwell.

BIPT – Belgian Institute for Postal Services and Telecommunication (2012): Communication of the BIPT of 17 January 2012 containing guidelines for infrastructure sharing.

Blackstone, E. & Ware, H. (1978). The cost of systems at 900 MHz. cited in Gruber (2005). *The economics of mobile telecommunications*. New York: Cambridge University Press.

Bohlin, E., Caves, W.K., Eisenach, J. (2013): Mobile Wireless Performance in the EU & the US. GSMA. Retrieved from: http://www.gsmamobilewirelessperformance.com/GSMA_Mobile_Wireless_Performance_May2013.pdf

Calhoun, G., 1988. Digital Cellular Radio. Cited in Gruber (2001), Competition and innovation: The diffusion of mobile telecommunications in Central and Eastern Europe. Information Economics and Policy, 13(1), 19-34.

Cave, M. (2002). Review of radio spectrum management. An independent review for Department of Trade and Industry and HM Treasury, 3.

Chadbury, R., & Terfloth, C. (2007). The Rise of Network Sharing: Risks and Rewards for Telecom Operators. Oliver Wyman. Retrieved from: http://www.oliverwyman.com/4-381.htm

Commission Decision (2003a): O2 UK Limited/T-Mobile UK Limited ('UK Network Sharing Agreement'). Decision 2003/570/EC. OJ L 200/59. Case COMP/38.370. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:200:0059:0084:EN:PDF

Commission Decision (2003b): T-Mobile Deutschland/ O2 UK Germany: Network Sharing. Decision 2004/207/CE. OJ L 75/32. Case COMP/38.369. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:075:0032:0058:EN:PDF

Commission Decision (2010): T-Mobile/Orange Merger Procedure. Case COMP/M.5650. Retrieved from: http://ec.europa.eu/competition/mergers/cases/decisions/M5650_20100301_20212_247214_EN.pdf

Commission's Notice (2002): BT Cellnet & BT3G/One2One Personal Communications. Case COMP/C1/N.38.370. 2002/C 214/08. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2002:214:0017:0021:EN:PDF

COM (2001). The Introduction of Third Generation Mobile Communications in the European Union: State of Play and the Way Forward. COM (2001)141 final. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2001:0141:FIN:EN:PDF

COM (2007). Commission Recommendation on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services. C(2007) 5406 rev 1. Retrieved from: http://ec.europa.eu/information_society/policy/ecomm/doc/library/proposals/rec_markets_en.pdf

COM (2011). Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements. OJ C 11/1. 2011/C 11/01.Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2011:011:0001:0072:EN:PDF

DIRECTIVE 2002/19/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on access to, and interconnection of, electronic communications networks and associated facilities (Access Directive). OJ L 108/7. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:108:0007:0007:EN:PDF

DIRECTIVE 2002/20/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the authorisation of electronic communications networks and services (Authorisation Directive). OJ L 108/21. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:108:0021:0021:EN:PDF

DIRECTIVE 2002/21/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on a common regulatory framework for electronic communications networks and services (Framework Directive). OJ L 108/33. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:108:0033:0033:EN:PDF

DIRECTIVE 2002/22/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on universal service and users' rights relating to electronic communications networks and services (Universal Service Directive). OJ L 108/51. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:108:0051:0051:EN:PDF

DIRECTIVE 2002/58/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications). OJ L 201. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2002L0058:20091219:EN:PDF

DIRECTIVE 2009/140/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL. OJ L 337/37. Retrieved from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:337:0037:0069:EN:PDF

Cummins, N. (2013): OFT clears Vodafone/Telefonica site sharing agreement. Retrieved from: http://www.twobirds.com/English/News/Articles/Pages/oft_clears_vodafone_telefonica_site_sharing_agreement0113.Aspx

DCCA (2012a): Radio Access Network sharing agreement between Telia Denmark A/S and Telenor A/S – Executive Summary. Retrieved from: http://www.kfst.dk/en/service-menu/press/presse-2012/radio-access-network-sharing-agreement-between-telia-denmark-as-and-telenor-as/radio-access-network-sharing-agreement-between-telia-denmark-as-and-telenor-as/

DCCA (2012b): Notification on the Network Sharing Agreement of Telia and Telenor. (Anmeldelse af Netdelingssamarbejde Mellem Telia og Telenor) Retrieved from: http://www.kfst.dk/konkurrenceomraadet/afgoerelser/afgoerelser-2012/

Dresdner Kleinwort Wasserstein (2002): European mobile operators: mixed signals. Cited in Gruber (2005), The economics of mobile telecommunications. New York: Cambridge University Press.

Dunnewijk, T., & Hultén, S. (2007). A brief history of mobile communication in Europe. Telematics and Informatics, 24(3), 164-179.

Earnst&Young's (2012): Inside Telecommunications. Quarterly Talking Points from Earnst&Young's Global Telecommunications Center. Issue 5. Q1 2012. Retrieved from:

http://www.ey.com/Publication/vwLUAssets/Inside_Telecommunications_1Q_2012/$FILE/Inside_TelecomsI5_final.pdf

European Commission (2002b). Commission intends to clear 3G network sharing agreements between T-Mobile and Orange in the UK and Germany. IP/02/1277. Press Release. Retrieved from: http://europa.eu/rapid/press-release_IP-02-1277_en.htm

European Commission (2002b): Comparative Assessment of the Licensing Regimes for 3G Mobile Communications in the European Union and their Impact on the Mobile Communications Sector. Annex to Final Report. Retrieved from: http://www.pedz.uni-mannheim.de/daten/edz-bo/gdi/02/annex_final_report.pdf

European Commission (2012a). Introductory remarks on Hutchison 3G Austria/Orange Austria merger decision. Joaquín Almunia. Speech/12/946. Retrieved from: http://europa.eu/rapid/press-release_SPEECH-12-946_en.htm

European Commission (2012b). Mergers: Commission clears acquisition of Austrian mobile phone operator Orange by H3G, subject to conditions. IP/12/1361. Press Release. Retrieved from: http://europa.eu/rapid/press-release_IP-12-1361_en.htm

Foreman, R. D., & Beauvais, E. (1999). Scale economies in cellular telephony: Size matters. Journal of Regulatory Economics, 16(3), 297-306.

Frisanco, T., Tafertshofer, P., Lurin, P., Ang, R. (2008, April). Infrastructure sharing and shared operations for mobile network operators From a deployment and operations view. In *Network Operations and Management Symposium, 2008. NOMS 2008. IEEE* (pp. 129-136). IEEE.

Gabathuler, D., & Sauter, W. (2003). Network sharing in 3rd generation mobile telecommunications systems: minding the coverage gap and complying with EC competition rules. Competition policy newsletter, (3), 43-46.

Gans, J. S., King, S. P., & Wright, J. (2007). Wireless Communications, Handbook of Telecommunications Economics. Vol. 2., 243-285

Gruber, H. (2005). *The economics of mobile telecommunications*. New York: Cambridge University Press.

GSMA (2010): Mobile Infrastructure Sharing. Retrieved from: http://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf

Guitton, J., Hristova, B., & Pozzato, V. (2010). Of spectrum and Radio Access Networks: the T-Mobile/Orange joint venture in the UK. *Competition policy newsletter*, (2), 28-34.

Hausman, J. (2002). Mobile telephone. Handbook of telecommunications economics, 1, 563-604.

Heimler, A., & Anderson, R. (2007). What has competition done for Europe? An inter-disciplinary answer. Aussenwirtschaft, (4).

Holma, H., Ahonpaa, T., & Prieur, E. (2007, April). UMTS900 co-existence with GSM900. In Vehicular Technology Conference, 2007. VTC2007-Spring. IEEE 65th (pp. 778-782). IEEE.

IDC Network Cost Optimizations Strategies for Mobile Operators (2009). Cited in Rouffaert, C., Tucker, W. & Bultema, P. (2011). Mobile Network Sharing – A strategy for success? Accenture. Retrieved from: http://www.accenture.com/Microsites/gcf-2011/Documents/Accenture_Mobile_Network_Sharing-A_strategy_for_success.pdf

Islam, A. R., Selvadurai, N., & Town, G. (2008). Wireless broadband technologies for regional and rural Australia: A last-mile perspective.*Telecommunications Journal of Australia*, *58*(2/3).

Lundborg, M., Reichl, W., & Ruhle, E. O. (2012). Spectrum allocation and its relevance for competition. *Telecommunications Policy*, *36*(8), 664-675.

Marcus, J. S., Elixmann, D. (2012). Re-thinking the Digital Agenda for Europe (DAE): A richer choice of technologies.

McKenzie, D. J., Small, J. P. (1997). Econometric cost structure estimates for cellular telephony in the United States. Journal of Regulatory Economics,12(2), 147-157.

MOA (2013): Network Sharing and Consolidation – Site Sharing and Radio Access Network (RAN) Sharing. Mobile Operators Association. Retrieved from: http://www.mobilemastinfo.com/network-sharing-and-consolidation/

Moral, A., Vergara, A., Pérez, J., & Ovando, C. (2010, December). Assessment of the benefits of introducing a HSDPA carrier at 900MHz. In GLOBECOM Workshops (GC Wkshps), 2010 IEEE (pp. 834-838). IEEE.

Motta, M. (2004). Competition Policy: Theory and Practice. Cambridge University Press.

Mölleryd, B. G. (2011). Network sharing and co-investments in NGN as a way to fulfill the goal with the digital agenda. ITS Conference Paper. Retrieved from: http://www.econstor.eu/bitstream/10419/52153/1/67254492X.pdf

OFT (2012): Anticipated Joint Venture between Vodafone Limited and Telefónica UK Limited. ME/5556/12. Retrieved from: http://www.oft.gov.uk/shared_oft/mergers_ea02/2012/vodafone.pdf

OFCOM (n.d.). New EC Regulatory Framework for the regulation of electronic communications
Retrieved from: http://www.ofcom.org.uk/static/archive/oftel/ind_info/eu_directives/

OFCOM (2001). 3G Mobile Infrastructure Sharing in the UK – Note for Information
Retrieved from:
http://www.ofcom.org.uk/static/archive/oftel/publications/mobile/infrashare0501.htm

OFCOM (2009): Telecommunications market data tables Q4 2008. Retrieved from: http://stakeholders.ofcom.org.uk/binaries/research/cmr/q4_2008.pdf

Oftel (2003). Market Information, Mobile Update. Office of Telecommunications. London. Retrieved from: http://www.ofcom.org.uk/static/archive/oftel/publications/market_info/2003/mobile/q5mobile1003.pdf

Rouffaert, C., Tucker, W. & Bultema, P. (2011). Mobile Network Sharing – A strategy for success? Accenture. Retrieved from: http://www.accenture.com/Microsites/gcf-2011/Documents/Accenture_Mobile_Network_Sharing-A_strategy_for_success.pdf

RSPP (n.d.): The Roadmap for a Wireless Europe. Retrieved from https://ec.europa.eu/digital-agenda/rspp-roadmap-wireless-europe#adoption-of-the-first-radio-spectrum-policy-progra.

Stephan, J. A. Y., NEUMANN, K. H., & PLÜCKEBAUM, T. (2012). The Cost of Nationwide Fibre Access in Germany. Communications & Strategies, 1(85), 169-188.

Vives, X. (2006). Information sharing: economics and antitrust. In Bergman, M. (ed.), The Pros and Cons of Information Sharing, (pp.83-100). Kalmar, Sweden; Konkurresnverket (Swedish Competition Authority)

Vornpuan, P. (2010): Infrastructure Sharing in Practice: Sharing Mobile Networks. Retrieved from: http://www.itu.int/ITU-D/asp/CMS/ASP-CoE/2010/InfraSharing/S12.pdf

Zehle, S. (2009): Growth in Mobile Broadband – Benchmarks and implications for operators. Coleago Consulting. Retrieved from: http://www.coleago.co.uk/uploads/tx_downloads/Growth_in_Mobile_Broadband_Coleago_V2.5_13_Jul_09.pdf

Zehle, S., Friend, G. (2010): Network Sharing business planning. Coleago consulting. Retrieved from: http://www.coleago.co.uk/fileadmin/user_upload/Downloads/Network%20Sharing%20Overview%20Coleago.pdf

APPENDIX A

Mobile spectrum and frequency - Frequencies and network roll-out costs

In the followings I will rely on Lundborg et al. (2012). Spectrum allocation is particularly important as due to diffusion characteristics it has an effect also on the radio network's costs: lower frequencies have lower propagation path loss, which affects the size of the cells that can be built upon them. Besides the direct impact on the base station structure, frequency allocation implicitly also affects the design of core network infrastructure. The basic idea is that frequencies near each other can be used on the same network, for instance operators acquiring 800 MHz bands can use them on their 'old' network using 900 MHz. Therefore, frequency bands can have very different value for a company, which also should be reflected by the prices. That is why it is important that the allocation mechanism should be able to reflect to the real value of the spectrum bands. It can hold for example in case of an auction, but other administrative methods can distort factor prices in a way that it will also affect competition. Another important aspect is that first mover advantage can also turn out to be a significant factor for spectrum bidding, hence also having an effect on competition. As having a broad consumer base influences the returns on investments.

As already been mentioned, there are huge differences between the diffusion properties of different frequencies. Following Lundborg et al. (2012) further, the general starting point for an economic assessment of the cost of network roll-out is to categorize the given area according to geotypes, for example urban or suburban. There are factors that affect the propagation features of different spectrums, hence the cell radii for dense urban areas are significantly smaller compared to rural areas. (As for example walls can block propagation of the sign.) Therefore, a few factors can be determined that affect the number of base stations needed: population of a given geographic area, the market share of the given operator, the data rate (maximum data transmission during the day). There are two factors affecting capacities, the

technology and the frequencies that can be used. As frequency auctions are rare events, an operator facing a demand shock can only accommodate by increasing the cell density.

As already mentioned above, the frequencies have significant impact on propagation and data transfer. Therefore, network costs can be modelled based on frequency allocation as well. Generally, lower frequencies can lead to lower network investments costs. As reported in Holma, Ahonpaa and Prieur (2007, p.779), a 60% decrease in the number of base stations can be achieved when 900 MHz frequency band is used instead of a 2100 MHz band in case of 3G networks.

In Moral, Vergara, Pérez and Ovando (2010) a model for using 900 MHz band instead of 2100 MHz band was analyzed. They argue that a base network with 900 MHz band is efficient also in urban areas, as propagation costs make this frequency band very advantageous – if no interference, but more noise (deep indoor situations) is prevalent in the area. Therefore, only very high demand areas should be served with higher frequencies and denser cells. Their model also distinguishes between geotypes and also low-, medium-, and high demand situations, and they show cost saving potentials are very similar to the ones mentioned above.

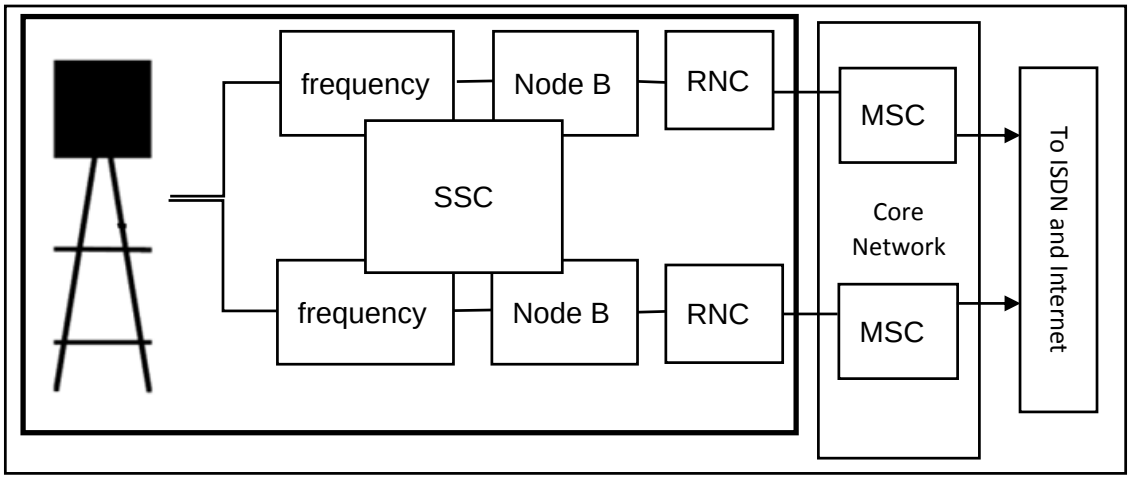
APPENDIX B

Setup of the mobile telecommunication network

There are a few important technical notion related to the network setup. Here I will follow the description of GSMA (2010). The infrastructure of mobile telecommunications can be partitioned into three big categories: access network, core network and the value added services. The access network consist of the handset, the mast (either purpose built or another appropriate structure), BTS (Base Transformer Station for GSM) or Node B (for 3G), that is a house with electronics for receiving and sending signals, BSC (Base Station Controller for 2G) and RNC (Radio Network Controller for 3G) are the elements that connect individual cabinets and send data to the core network. This setup can be seen in Figure 5 below.

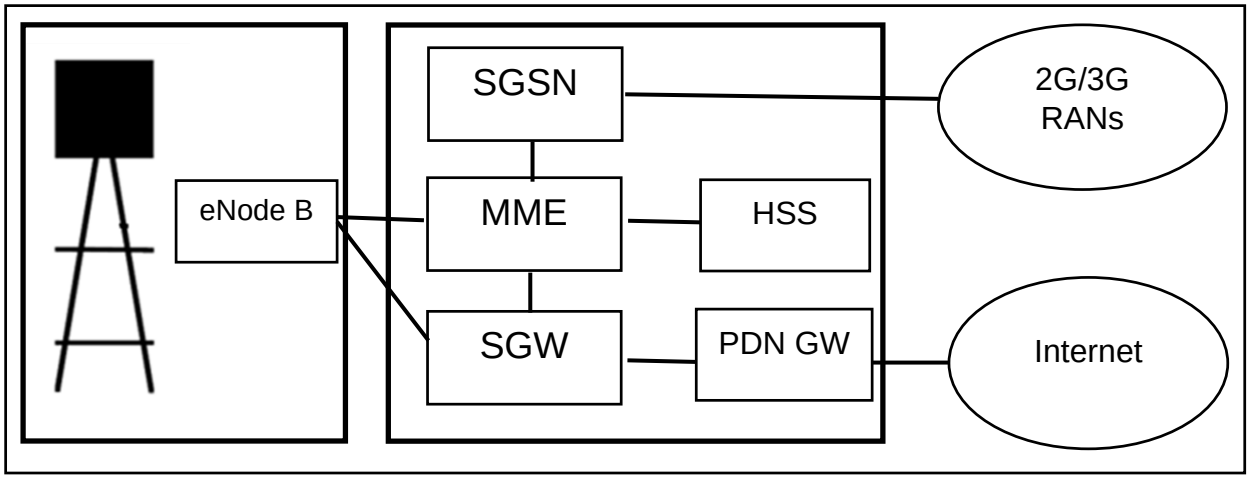
The core network has four key parts: MSC (Mobile Switching Centre) that switches data to and from other networks, HLR (Home Location Register) that stores consumer information, OMC (Operations and Maintenance Centre) that is liable for day-to-day operation, SGSN (Serving GPRS Service Node) and GGSN (Gateway GPRS Service Node).

Figure 5: Simplified UMTS network architecture. Source: Commission Decision (2003a)



Furthermore, as reported in BIPT (2012), for 4G networks – illustrated in Figure 5 below – network sharing is also possible, as the eNode B can be connected to core networks.

Figure 6: Simplified LTE network architecture. Source: BIPT (2012)
MME: mobility management entity – the main control node for LTE RAN, managing mobility between LTE and 2G/3G RANs
HSS: home subscriber server
SGW: serving gateway – routing and forwarding data packages between the LTE network and the Internet, and LTE and 2G/3G.
PDN GW: packet data network gateway – connection to external packet data networks (Internet)



APPENDIX C

Figure 7: Market Concentration – Herfindahl-Hirschman Index (HHI). Source: Bohlin et al., 2013, pp. 28

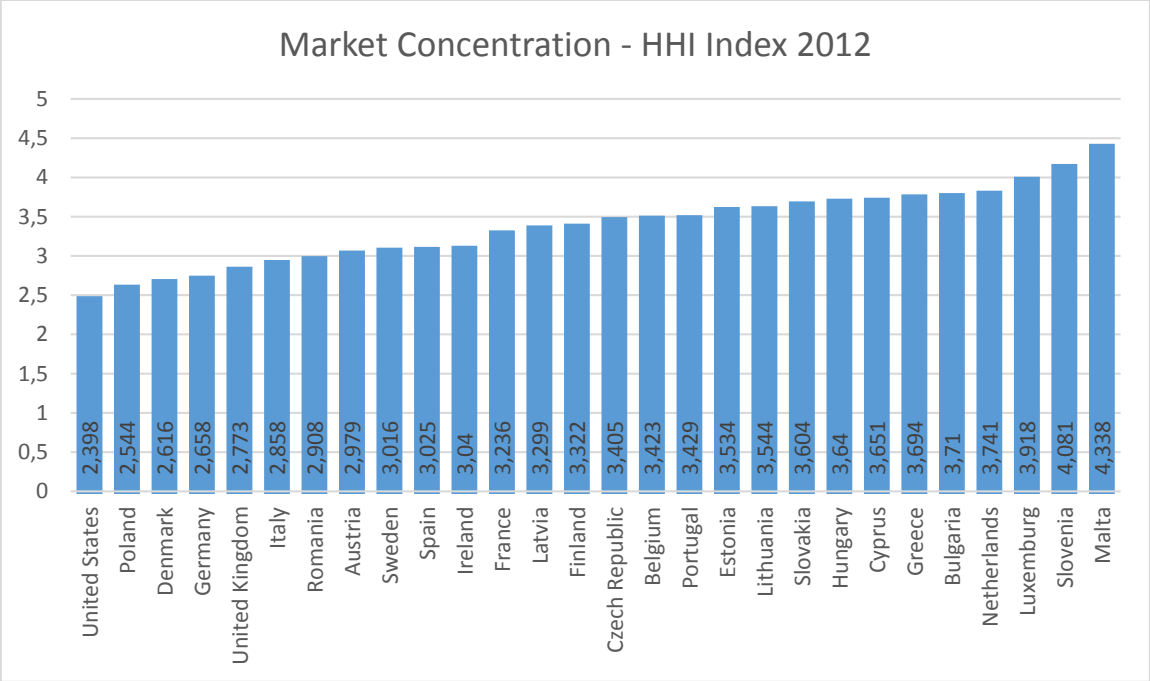


Table 5: 3 G licensing in Europe, Source: Comparative Assessment of the Licensing Regimes for 3G Mobile Communications in the European Union and their Impact on the Mobile Communications Sector (2002) (European Commission, 2002b)

Country	Number of licenses offered
Austria	4 to 6
Belgium	3 + 1
Denmark	4
Finland	4 nation wide, 4 regional
France	4
Germany	4 to 6
Greece	up to 4
Ireland	1 license for an MVNO and + 3 license
Italy	up to 5
Luxemburg	4
Netherlands	5
Portugal	4
Spain	3+1
Sweden	4
UK	4+1

Figure 8: Mobile Broadband Use in the UK – End 2008, Source: Zehle, 2009

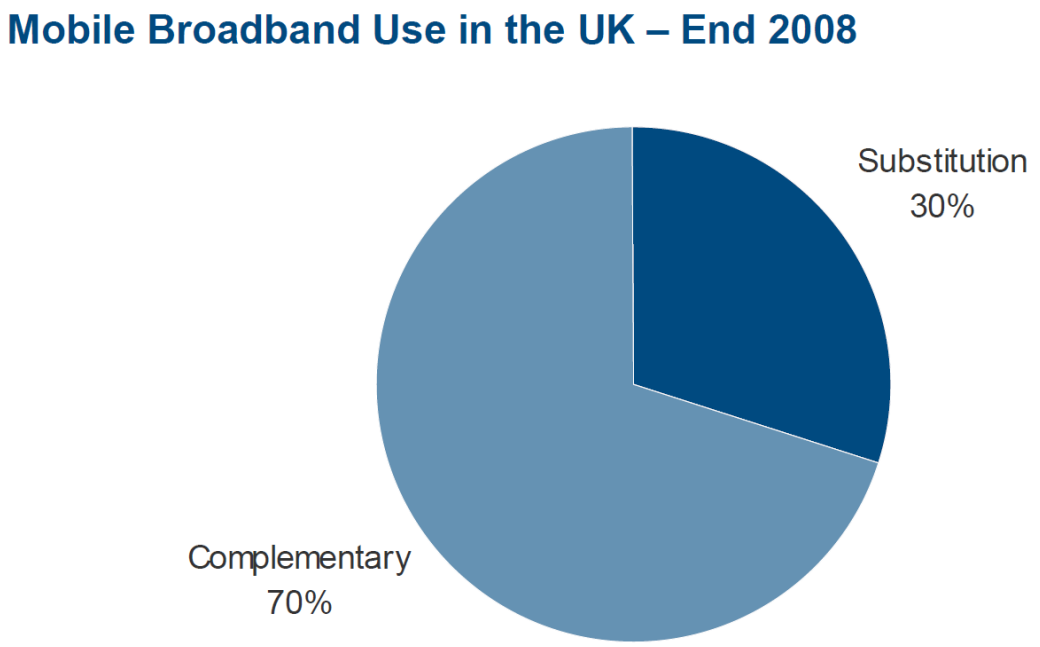


Figure 9: Telefonica O2 Europe – Non-SMS Data % of ARPU, Source: Zehle, 2009

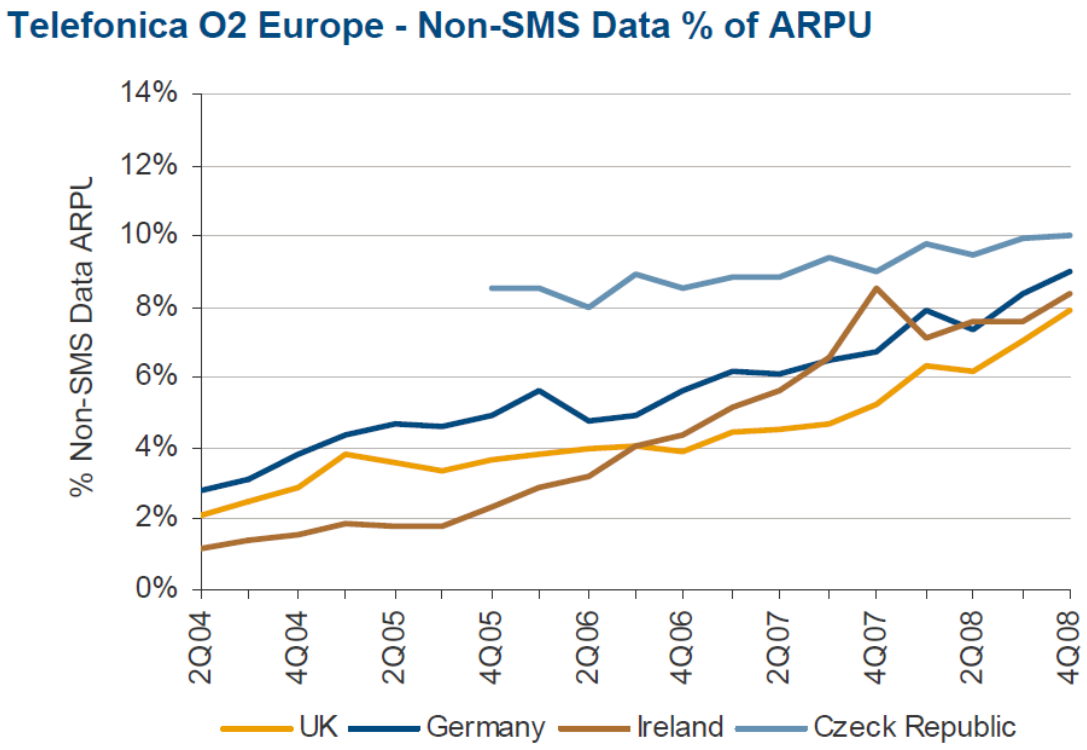


Figure 10: Vodafone - % of Service Revenue Non-Messaging Data, Source: Zehle, 2009

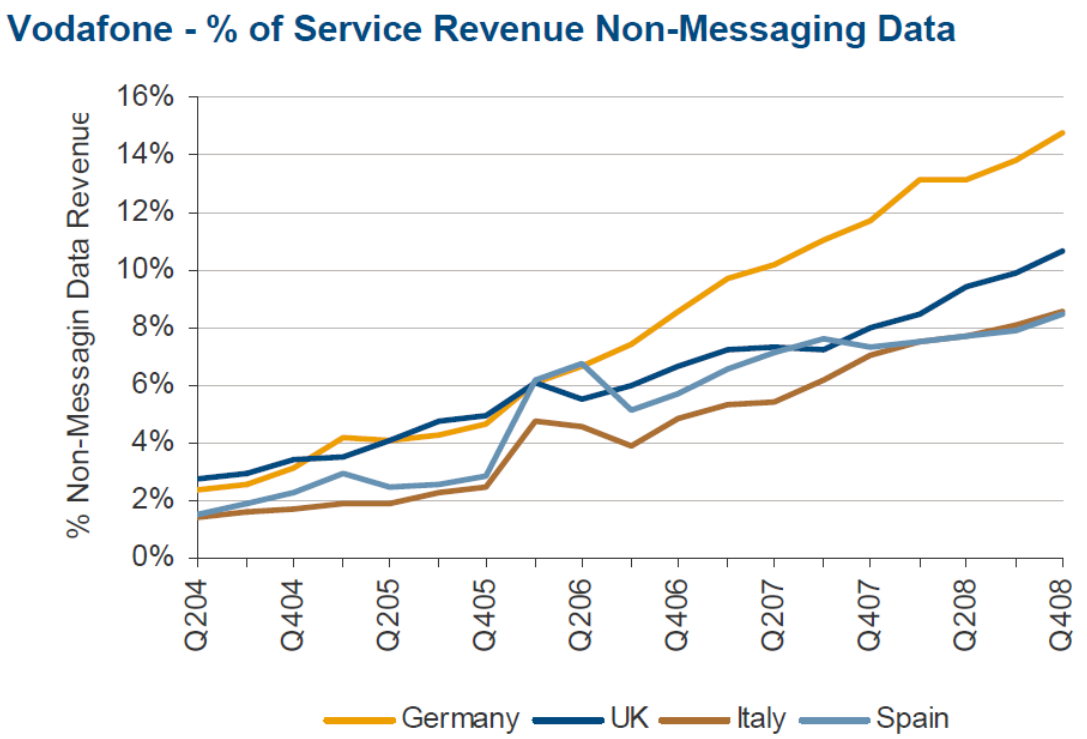


Figure 11: Vodafone Germany – Voice and Data ARPU, Source: Zehle, 2009

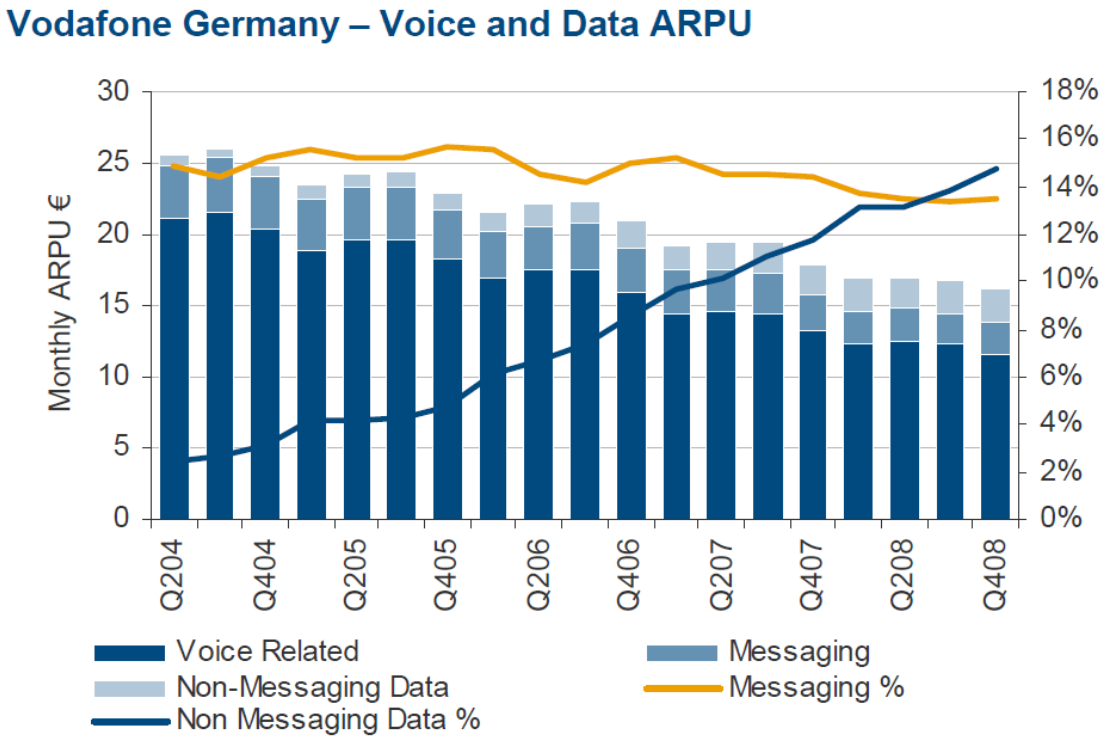


Figure 12: O2 Germany – Voice and Data ARPU, Source: Zehle, 2009

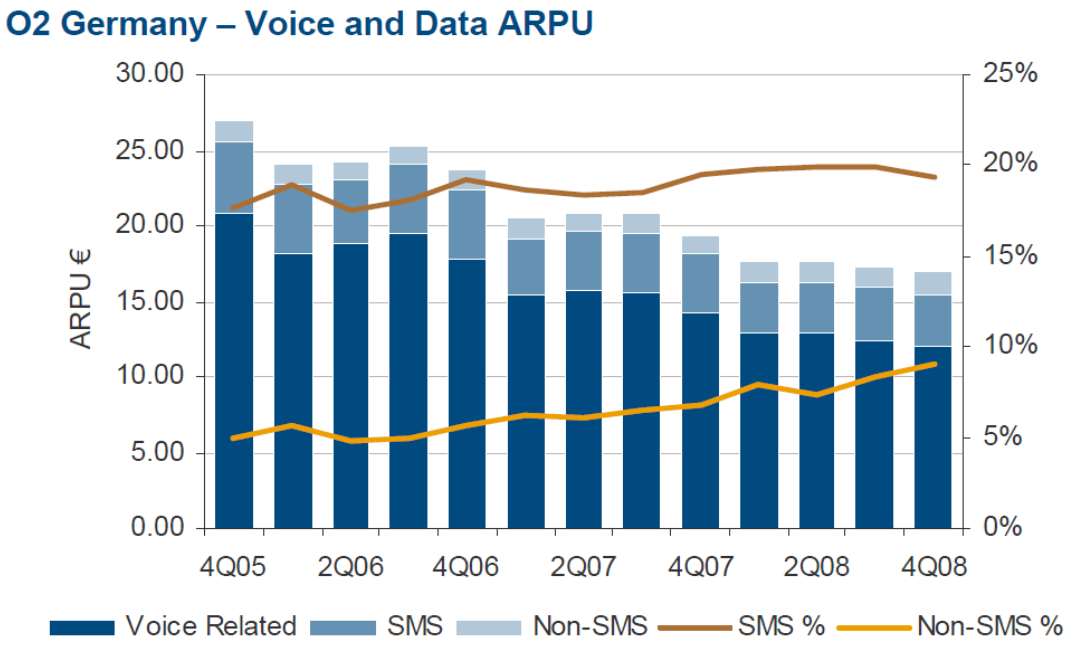


Figure 13: 3G coverage in 2009. Source: OECD, Indicators of broadband coverage.