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Please cite this paper as:

OECD (2014-11-06), "Wireless Market Structures and Network Sharing", *OECD Digital Economy Papers*, No. 243, OECD Publishing, Paris.
http://dx.doi.org/10.1787/5jxt46dzl9r2-en

OECD Digital Economy Papers No. 243

# Wireless Market Structures and Network Sharing

OECD

## FOREWORD

This report was presented to the Working Party on Communication, Infrastructures and Services Policy (CISP) in June 2014 and the CISP agreed to recommend it for declassification to the Committee on Digital Economy Policy (CDEP). The CDEP Committee approved the report in October 2014.

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*Note to Delegations:*
*This document is also available on OLIS under reference code DSTI/ICCP/CISP(2014)2/FINAL.*

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## MAIN POINTS

A key issue for policy makers and regulators, across the OECD area, is the market structures that will best deliver efficient and inclusive mobile communication services. This has led to two related issues addressed in this report, namely:

- the recent experience in selected countries, which have changed or held constant the number of facilities based operators,

- the initial experience and key questions that have arisen with wireless network sharing.

These questions are related because they converge around the issue of how many facilities based networks are optimal in providing competitive services in the same geographical location. In all OECD countries there are at least three mobile network operators (MNOs), which broadly compete on a national basis, with some countries having four or five facilities based networks operating nationally or in the same region. Historically, the coverage and capabilities of these networks have been important factors used by operators to differentiate their offers and attract customers. Nonetheless, sharing the expense of network facilities, between multiple MNOs, can significantly reduce costs, especially at a time when there are demands on operators to roll out new networks or extend coverage.

While it would be preferable for market forces to determine the number of MNOs, policy makers also have objectives that need to be met. These include ensuring sufficient competition and the wide geographical availability of service. If policy makers intervene in a way that increases or decreases the number of facilities based operators they may significantly affect the level of competition, at either the infrastructure or services level. Allowing or encouraging network sharing, for example, may limit facilities based competition but if subject to certain conditions may expand services competition. For example, it may result in more offers in any particular location that enable users to have more choices than would otherwise exist on a geographical or national basis and the players operate in distinctly independent fashion. In these instances, the coming together of MNOs, through network sharing arrangements may actually increase competitive choices for people in those locations. Nonetheless, there are many other issues that arise, such as whether the shared networks are available to all suppliers or in some way exclude facilities based entry by an otherwise leading player or a new entrant.

This report finds that in countries where there are a larger number of MNOs, there is a higher likelihood of more competitive and innovative services being introduced and maintained. Particularly, a larger number of MNOs is often the source for innovative offers that challenge existing market wisdom and practices and a driver for the entire market to become more competitive. As a result all operators, MNOs and MVNOs, are encouraged to improve their offers in terms of price, services offered and quality of the offer. If it is decided based on a market assessment that the current number of MNOs is not sustainable or that new facilities based entry is not likely, then it is worth considering to utilise voluntary network sharing agreements – either as an alternative to a merger or to allow a new player to enter a market. The potential savings from network sharing may represent a significant proportion of the savings that are used to justify a full merger, and in the case of network sharing without merger; the benefits of these savings are more likely to be passed on to consumers.

Accordingly, while there is a preference for maximising the number of facilities based MNOs, it is recommended that at least certain degrees of network sharing be allowed and encouraged if it leads to more players at both the wholesale and retail level as well as nationally or in specific regions. For example, in some rural areas in OECD countries there may be only one MNO present and, therefore, only a single

wholesaler. Network sharing may encourage other players to provide joint alternative infrastructure, in competition with that player, which they would not do alone. Finally, if mobile virtual network operators (MVNOs) are to provide meaningful choices for consumers as well as an additional constraint on potential anti-competitive conduct, they need to be able to operate technically and commercially independently from MNOs if they wish to do so. Even then, without sufficient wholesale competition, it is unlikely they will be able to substitute for the role played by a "challenger MNO".

A further new development in certain locations, in consideration of the number of licenced players, is the international competitiveness of a country's mobile sector in delivering services across borders. This report examines the introduction of innovative international roaming offers and offering Machine-2-Machine (M2M) services. Some operators in countries such as France, Luxembourg, the United Kingdom and the United States have begun to differentiate their offers by including off-net international roaming as part of the subscription (i.e. no additional charges are incurred when roaming on an independently owned operator in another country). In a similar manner, the Netherlands became the first country to reform regulation that now enables private networks to have access to IMSI-number ranges. A primary advantage, examined in this report and previous work, is to allow business to have more flexibility in choosing how to offer M2M services across borders. This is a significant development for policy makers to consider in all countries to ensure the competitiveness of their mobile communication sector and its ability to meet rapidly evolving demands in the M2M market.

# INTRODUCTION

Wireless networks and the mobile services they enable play a fundamental role in supporting economic and social development. Their contribution is critical in meeting a range of policy objectives, across the entire economy, something that has grown in recent years as the capabilities of these networks increased and competition drove innovation and inclusiveness. A key issue for policy makers and regulators, across the OECD area, are the most efficient market structures in their countries to build on these developments, promote investment and seize future opportunities. This has led to two related issues, addressed in this report, namely:

- Recent experiences in selected countries, which have changed or held constant the number of facilities based mobile operators,

- Initial experience and key questions that have arisen with wireless network sharing.

These questions are related because they converge around the issue of how many facilities based networks are optimal in providing competitive services in the same geographical location. In all OECD countries there are at least three mobile network operators (MNOs), which broadly compete on a national basis, with some countries having four or five facilities based networks operating nationally or in the same region (Annex 1). Historically, the coverage and capabilities of these networks have been important factors used by operators to differentiate their offers and attract customers. Nonetheless, sharing the cost of network facilities, between multiple MNOs, can significantly reduce costs, especially at a time when there are demands on operators to roll out new networks or extend coverage.

The mobile communication sector is characterised by a number of factors that significantly influence market structure. The most significant of these are constraints due to the limited amount of radio spectrum available and substantial economies of scale in building network facilities. Due to the requirements to manage spectrum as well as to ensure stable and continuous services, mobile markets are not an area typified by frequent market entry and exit.[1] As a result, policy makers have a number of factors they need to consider when asked to adjudicate on the implications of a merger that may limit competition, in introducing a new entrant to increase competition or in permitting network sharing.

Mobile network operators have turned to network sharing to reduce investment and operational costs. The practical and regulatory environment for network sharing is, therefore, examined in this report. In an increasing number of countries the sharing of infrastructure has proven to be an important tool for MNOs to curtail costs. In these instances, operators have created organisations that allow for the sharing of infrastructure between two or more MNOs. Some have specific arrangements that share infrastructure in locations such as highway tunnels, underground transport networks and shopping centres or in rural areas. In addition, a number of third party commercial firms -- that are not MNOs -- are delivering services to multiple mobile operators, such as infrastructure (e.g. antenna sites) or network management and billing systems. This report finds that it is preferable that policy makers and regulators allow elements of network sharing over a reduction in the number of operators should such a choice arise.[2]

In addition, in most countries mobile networks have opened their infrastructure to MVNOs, which operate without their own infrastructure. Instead, MVNOs use a spectrum license holder's network. Some regulators have seen these MVNOs as important tools in ensuring the competitiveness of a market and have imposed the requirement to host MVNOs as a commitment prior to approving mergers between mobile network operators. There is a wide range of MVNOs from sub-brands of Mobile Network Operators, through to resellers, that buy minutes and data wholesale, to full-MVNOs who manage

infrastructure, numbers, routing and marketing and sales independent of MNOs. In around half of OECD countries full-MVNOs are not present in the market, sometimes due to regulation that does not allow full independence. However, if MVNOs are to deliver on their promise to increase competition, as a remedy associated with allowing mergers, they need to be able to operate technically and commercially independently from MNOs if they wish to do so. Even then without sufficient wholesale competition it is unlikely they will be able to substitute for the role played by a "challenger MNO".

Recent experience following mergers, examined in this report, indicates the reduction in wholesale competition that follows the elimination of an MNO can curtail the competitiveness of MVNOs. This is most evident when there is a dramatic decrease in the amount of data included in MVNO bundles or in a lack of new MVNOs entering a market even where average retail rates are rising. As long as regulatory authorities ensure network sharing arrangements do not lead to less wholesale competition (e.g. MNOs remain independent wholesale providers over shared infrastructure) this need not be an issue. Rather, the concern arises where less of the benefits from network sharing in a three-player market are competed away, to the benefit of the consumer, than in a market with four or more national wholesale operators.

The report finds, as might be expected, that in countries where there are a larger number of MNOs, there is a higher likelihood of more competitive and innovative services being introduced. Particularly, a larger number of operators is often the source for innovative offers that challenge existing market wisdom and practices. As a result, some call these MNOs the "challengers". The effects on a market, of course, are not limited to actions by "challengers" as incumbent operators respond with their own offers and react on price, with the introduction of new services as well as quality. For example, international mobile roaming, which has long been a source of concern for regulators and consumers, has recently been addressed in an innovative way by challengers in some markets with at least four MNOs. This has included, for the first time, off-net roaming (i.e. on non-affiliated companies), in foreign markets as an inclusive part of a consumer's regular bundle (e.g. challenger MNOs in France, the United Kingdom and United States).

This does not mean that there is no innovation in markets with three operators, or that in such a market; one operator could not play the role of a challenger. In Portugal, for example, a premium offer, which includes 15 days of roaming to many European countries, has commenced in a market with three MNOs. It is after all the intensity of competition that is the key and there is no "golden number" that ensures effective competition. Nonetheless, experience has demonstrated that this is more likely in a market with at least four MNOs. Take the Netherlands, for example, where a new fourth MNO will launch a 4G network in 2014. It is notable, ahead of that launch, MVNOs offers are becoming more competitive and, in one case, included European wide roaming for consumers as part of a bundle.[3] Such a development depends on a competitive wholesale market.

At the same time, the prices of making international calls from mobile telephones, which have historically been far above fixed line rates, are increasingly treated as standard inclusions in low cost bundles where challenger MNOs have sought to win market share (e.g. France and Israel). In addition, there are indications that in markets where there is a mobile challenger, consumers have larger data bundles, larger plans of mobile minutes and will find more SIM-only plans on offer. Finally, the inclusion of new services or capabilities, some of which undercut traditional pricing models or were prohibited by some operators, have often been introduced first by challengers or in markets with at least four MNOs (e.g. mobile VoIP; tethering; seamless handover between mobile and fixed facilities using Extensible Authentication Protocol and so forth).

A further new development, in consideration of the number of licenced players, is the international competitiveness of a country's mobile sector in delivering services across borders. This report examines the recent licensing of an additional fourth MNO in Luxembourg whose business plan involves potentially attracting more customers located outside that country than domestic subscribers and offering M2M

services. This is the first time an MNO has been added to a market with such a business plan and can thereby qualify, as a spectrum holder, to take advantage of direct wholesale access in foreign markets in terms of international roaming. This business plan is uncertain, as it would depend on the use of international roaming or MVNO wholesale inputs to compete in other countries with national providers. In many OECD countries, these wholesale inputs are often not regulated, and where they are regulated (as is the case of the EU), the use of these wholesale services are restricted to roaming services. Though uncertain it is interesting that entrepreneurs see potential for such a business model. In a similar manner, the Netherlands became the first country to reform regulation that now enables private networks to have access to IMSI-number ranges. A primary advantage, examined in this report and previous work, is to allow business to have more flexibility in choosing how to offer M2M services across borders. This is an important development for policy makers to consider in all countries if they wish to ensure the competitiveness of their sector and its ability to meet rapidly evolving demands in the M2M market.

This report also finds that in markets introducing new players or maintaining at least four operators, investments in new network infrastructure increase and are pulled forward by existing operators, to defend against challengers. The report does not find extraordinary reductions in retail revenues for operators in most of these markets. Instead, it appears that mobile operator retail revenues have been remarkably stable over the last decade, though there are exceptions. While the average revenue per unit (ARPU), on a per SIM-card basis may have declined, this has to some extent been compensated by an increase in the number of revenue generating units. Competition, therefore, appears to often deliver more to consumers for similar revenue. This can be explained because, to a large extent, costs of mobile networks are defined by substantial upfront investments and stable operational expenditure. In turn, these costs are largely independent of the number of customers or more accurately subscriptions and only to some extent dependent on the peak traffic handled on a network.

Notwithstanding this, revenue declines can and do occur in some markets and for some operators. These changes can be due to longer-term shifts in consumer behaviour in areas such as substitution of one service for another or the effects of factors like the financial crisis experienced in recent years. The decline in voice and SMS revenue, for example, has not been wholly replaced by a shift to charging for data or other new services. It is also fair to say that mobile markets are more complex today than those in earlier years in a number of countries. Convergence means that policy makers and regulators will need to consider the competition issues associated with the entire electronic communication sector when considering mergers or enabling the introduction of new entrants. In addition, the interface between a mobile customer and their service provider has changed dramatically in the past few years.

Where once a mobile operator controlled the direct access to customers this is now shared with entities such as “app stores” and the services and products they supply. The emergence of this ecosystem has undoubtedly stimulated demand for the 3G and 4G services sold by operators but they are also no longer the sole arbiters on the introduction of new services, elements of their pricing and so forth in a way they were for 2G markets. This means an increase or decrease in the number of MNOs can have implications for this ecosystem in terms of the bargaining power of different players. Finally, revenue levels can be affected by the timing of changes in market structure given the high penetration rates that exist today compared to when the majority of operators entered the market. Today, new entrants need to offer compelling offers to entice consumers to change providers than for a ‘green field’ market with low penetration. The effects can therefore be magnified if that market has been less competitive than others. At the same time, the effects of a merger are likely to take some time to work their way through a market given the role contracts often play.

In addition, any focus on revenue trends needs to take into account the changes in wholesale market conditions in some countries that manifest themselves in revenue and cost reductions. For example, a reduction from high to low termination rates can be relatively neutral in terms of the bottom line, for some

MNOs, because while it reduces gross revenue it also reduces costs and may not have any significant effect on net revenue. If there are large imbalances in such payments it can, of course, act to reduce the amounts paid to some from other operators but should be relatively neutral for the net outcomes of the sector as a whole and will likely stimulate greater usage where savings are passed on to consumers.[4] Finally, close attention also needs to be paid to differences arising from changes in consumer preferences, in some countries, to SIM-only offers compared to models that incorporate the sale of handsets. Where this has occurred it can reduce total revenue but also involves a reduction in payments to manufacturers, which is an upfront cost.

Indeed, several OECD countries have recently witnessed an expansion in the number of operators from three to four or five, which demonstrates that some players, with the support of capital markets, are willing to step into mature markets where there will be four or more players. That being said, some OECD countries have also witnessed a decrease in the number of operators in recent years.

To address these issues this report discusses some of the experience several selected countries have had with changes in the number of MNOs and MVNOs, in areas such as innovation, pricing, investment and revenue as well as the approaches regulators have taken towards market design and mergers. It then summarises the experience from a number of brief country studies, followed by a more general assessment of the role of network sharing. Finally, it examines the role of MVNOs in markets, as they are important in merger conditions in some OECD countries.

## COMPETITION BETWEEN MOBILE NETWORKS IN THE OECD

When the United States Federal Communications Commission (FCC) was designing one of the first sales of licences to use spectrum, its then Chairman sought advice from Professor Michael Porter, on the optimal number of players.[5] Professor Porter reasoned that the authorities could not pick the equilibrium number of firms in advance. He advised the sale of more licenses than it was thought the market could bear and equilibrium would be found over time. In other words, mergers or market exits would continue until all firms were viable and with a commercial return. He suggested that, at some point, authorities might need to intervene to prevent further consolidation in order to ensure other policy objectives such as to ensure sufficient competition.

While it would be preferable for market forces to determine the number of MNOs, policy makers also have objectives that need to be met. These include aims such as ensuring sufficient competition and the wide geographical availability of service. Today, these issues are more complex than in earlier years because they may involve factors in some countries, such as the role of network sharing, changes to licences designed to seize benefits in cross-border service provision and the role MVNOs may play. Certainly, the natural inclination for a market -- necessarily structured around an oligopoly due to spectrum constraints -- is to reduce the number of players, even when equilibrium is reached. This is because, unlike other markets where there are more open entry conditions, wireless markets have considerable barriers to entry.

A decrease in the number of market participants can increase profitability for market players through cost savings and a decrease in competitive discipline. Most regulators agree that two MNOs are too few to ensure sufficient competition, but whether three, four or five is the optimal number is heavily debated. Unfortunately, there are high barriers to entry in the mobile market as a result of limits to spectrum allocation and high capital expenditure. If the market was more open to entry and exit there would be little need for considerations on the number of market players. Therefore, the design of a mobile market runs the risk of an inefficient propping up of otherwise unprofitable participants or conversely stopping the entry of more efficient players, to everyone's detriment. The efficiency of the number of players depends on the ability of players to respond to price or quality changes, that players are acting independently, managerial acumen, and all sorts of other factors that come up in, for example, merger analysis. In the following section the experience with the number of mobile operators will be reviewed including market design elements specific to mobile communication services. The document then reviews the differences in experience by consumers in markets with either three or more operators and closes with a review of the reactions by some regulators towards mergers.

### Designing mobile markets

In 1995, for the first time, the OECD considered developments in mobile market structure. This included the issue of initial liberalisation in some countries and further expanding the number of operators in markets that had introduced duopolies or third and fourth players. This work documented the benefits of increasing competition. It found that countries that had competition between more MNOs had more coverage and higher penetration rates than countries that only had one or two operators.[6]

While in 1995 only six OECD countries had three or more operators, the benefits for further liberalisation were increasingly evident. This was first accomplished by issuing a further one, two or three licenses as this became possible. Many countries standardised on GSM, but some used different technologies, such as CDMA and PCS. Following the turn of the century, the allocation of 3G spectrum was often used to add another MNO to the market, or to more evenly distribute the spectrum among all operators, so that first mover advantages were decreased to some extent. All those licenses, however, were distributed in markets where subscription growth was at the forefront. Generally, less than half of the population in OECD countries had a mobile telephone. This meant that new entrants could still find a "greenfield" for potential customers.

While most regulators aimed for four or five players in a 2G or 3G market this was not always realised. France, for example, had additional licences available at various stages of its market evolution but there was no new entrant between 1994 and 2012. The development of LTE (4G) presented a further opportunity to issue 3G or 4G licences. This was the case, for example, in Austria, Belgium, the Czech Republic, Israel, and the Netherlands. In these countries spectrum was specifically set-aside for new entrants and in other countries all potential players had the ability to seek market entry where spectrum availability permitted.

In recent years, Austria and the Czech Republic did not secure new market entrants following their auctions. In Belgium a joint venture of the two largest cable companies, "Telenet Tecteo Bidco" bought a 3G spectrum license, however to date it has not been used. It has indicated that it will remain operational as an MVNO on the network of one of its competitors. The Belgian regulator has indicated Telenet Tecteo Bidco is in breach of its license and has fined the company and given it until early 2014 to initiate rolling out a new network.[7] On 30th May 2014, Telenet Tecteo Bidco notified the Belgian government it would return its usage rights for the spectrum as of the1st June 2014. The Belgian regulator has started a procedure to formally approve this and expects this process to be finished by September 2014.[8] The Netherlands and Israel respectively secured one and two new entrants into their markets. The two new entrants in the market in Israel started operation in 2012. The new entrant in the Netherlands is expected to start operation in the first half of 2014.

The distribution of digital dividend spectrum for 4G spectrum also posed difficulties for authorities in how they allocated the blocks. In most European countries there was a total of 60 MHz available in the attractive 800 band. Because LTE requires paired spectrum, blocks would have to be 2x5 MHz or 2x10 MHz wide. Mobile network operators had a desire for 2x10MHz. This meant that there would only be three blocks available. On the other hand, it was also possible to auction six blocks of 2x5 MHz. However in many countries the government at the same time also auctioned blocks in other spectrum ranges, such as blocks in the 900MHz, 1800 MHz, 2000/2100 MHz and 2600 MHz. Therefore, the actual combinations were more complex. Regulators in some cases imposed caps on how much spectrum operators were able to acquire in particular in the lower and more attractive 800/900 MHz. For example, in Germany the holdings in the 900 MHz, which was not auctioned, were taken into account, so that operators which had more blocks of 900MHz spectrum were able to obtain less blocks of 800 MHz spectrum. One existing operator, E-Plus, chose not to purchase 800 MHz spectrum to save money and instead purchased more 2600 MHz spectrum.[9]

In Norway the design of the auction created an unexpected outcome; Tele2, one of the incumbent operators, not only failed to capture spectrum in the 800 MHz-band, but also lost its license for 900 MHz spectrum to a new entrant, Telco Data. This may have been contributed to by the auction design, which was of a sealed bid nature, where the highest bidder wins.[10] Tele2 now holds only 2100 MHz spectrum, which can be used for 3G. As a result it entered into a national roaming agreement with Telenor, where it can access Telenor's network throughout Norway, for all of its brands.[11] Telco Data is a sister company of ice.net, which currently manages a CDMA450 network in Norway, Sweden and Denmark.

As of the end of 2014, 17 OECD countries will have three national operators, 14 will have four national operators and three have five or more. In 2014, the Netherlands will see Tele2 become a mobile network operator, where it currently is a full-MVNO. In 2014, in Hungary, Digi, an existing fixed network broadband provider, purchased spectrum with the potential to introduce a fourth MNO in that country. The European Commission has reviewed two mergers, one in Ireland between Hutchison 3G and Telefonica and one in Germany, between Telefonica and e-Plus (KPN). These mergers were approved and will be concluded in 2014 or 2015, therefore these countries will see the number of operators reduced from four to three.

The integration of fixed and mobile communication offers has long been predicted. Nonetheless, in 2012 a report on fixed and mobile convergence found few examples of fixed-mobile integration at the network level.[12] More recently, work undertaken in 2014 found that there are a number of countries where bundled services, including mobile, are available as quadruple play offers. These offers had a discount for the total package but not a technical integration. That being said there are signals in the market that mobile networks are increasingly interested in leveraging fixed networks. By way of example, Vodafone recently acquired 'Kabel Deutschland' in Germany and Ono, a cable network in Spain. While Vodafone had previously offered fixed lines services, via wholesale access, these moves likely signal an increased commitment toward integration. At the same time, in France, one of the reasons given by the fourth entrant into the mobile market was that its leading competitors in fixed services offered quadruple play services. Following its entrance into the mobile market, it went a step further by becoming the first network to rely on its fixed line assets for Wi-Fi and 3G femtocells installed in its broadband set-top box for part of its service offer. That being said, to date, fixed-mobile convergence has not appeared to be a significant factor in the recent reviews of mergers of mobile operators.

**Regulators reaction to reduction in number of operators**

Setting aside spectrum for new entrants following a merger is one potential remedy, if it is otherwise judged that there may be insufficient competition as a result. Authorities generally consider a merger and acquisition of operators, when the number of networks is reduced. In most cases, both the sector regulator and the competition regulator are involved in determining whether a merger or acquisition can go through or whether there are specific conditions for a purchase or sale. In the European Union the European Commission also plays a role and can take the final decision if the merger is above a certain size and has implications for the internal market (Table 1). The evaluation of a merger is performed not just on the retail market implications, but also on wholesale markets for spectrum, roaming, termination rates, backhaul networks and handsets and devices.

Merger reviews in mobile telecommunication markets are necessary as the market is always moderately to highly concentrated as measured by the Herfindahl–Hirschman Index (HHI). The United States DOJ considers a market moderately concentrated with an HHI above 1500 and highly concentrated with an HHI of above 2500. Given that there are generally only four or five MNOs, the HHI will be at a minimum 2000 points with five operators and with four operators 2500 points.[13] In addition, the size of the mergers puts them across the threshold for merger review. In the actual review a larger number of factors play a role, such as the presence of mavericks, the possibility for disruption by other parties, ease of market entry as well as unilateral and co-ordinated effects.

**Table 1. Expected examination by public authorities on merger or acquisition of MNO, selected OECD countries**

| | Examinations by telecommunication authority | | Examination by competition authority | Others |
|---|---|---|---|---|
| | Authorisation on change of spectrum license holder | Others | | |
| Australia | | | Screening | |
| France | Required | | Required | European Commission |
| Japan | Required | | Screening | |
| Korea | Required | | Required | |
| Netherlands | Required | | Required | European Commission |
| Sweden | Required | | Required | European Commission |
| United States | Required | - Common carrier regulation<br>- Foreign ownership<br>- Competition | Required | Department of Justice, Committee on Foreign Investment |
| United Kingdom | | | Required | European Commission |

Notes: "Required'' means ex-ante authorisation is necessary in a normal case. "Screening" means ex-ante notification is necessary in a normal case but clearance is assumed if there is no opposition from the authority.

Country notes:
Australia: The competition authority can file application to the court for injunction, divestiture or penalty if it reaches a view that an acquisition is likely to have the effect of substantially lessening competition. The merger parties can seek the authority's view in advance to avoid those actions.
Japan: Notification to the competition authority for screening is mandatory if 1) the total domestic revenue of one of the merger parties exceeds JPY 20 billion and 2) the total domestic revenue of one of the other merger parties exceeds JPY 5 billion. The merger can take place after 30 days of the notification, if there is no further action taken by the authority, with possibility of shortening the length of days upon request.
Sweden: A concentration shall be notified to the Swedish competition authority if 1) the combined aggregate turnover in Sweden of the undertakings concerned in the preceding financial year exceeds SEK 1 billion and 2) at least two of the undertakings concerned had a turnover in Sweden the preceding financial year which exceeds SEK 200 million for each of the undertakings.

*Source*: OECD

One interpretation is that authorities were more "lenient" on mergers in earlier years but through time the conditions and demanded commitments for mergers have become more stringent and more mergers are being denied. Cases between 2005 and 2014 are displayed (Annex 2). The year of 2005 was chosen as in this year 21 out of the 30 OECD countries had over 90 subscriptions per 100 inhabitants, with 13 exceeding 100. All but three had over 70% penetration.[14] This meant, in terms of feature-phones, the penetration in the majority of countries might have been regarded as mature. Some of the experience with mergers is summarised for the Netherlands (Box 1) and for the United States in the country review in this document (e.g. AT&T and T-Mobile, T-Mobile and MetroPCS). From the Netherlands, the experience suggests that authorities need to take into account the potential risk of co-ordination between MNOs for competition and the effect a reduction of MNOs may have in this area.

**Box 1. The Netherlands experience with mergers and co-ordination**

The 2005, KPN acquisition of Telfort was approved by the Dutch regulator NMA without any obligations. The regulator concluded that competition would not be impaired between KPN and the three other operators, Vodafone, T-Mobile and Orange. Given that the last three were large international players, it was expected that they could compete strongly without KPN and would have similar or better economies of scale. In addition, these companies could attain benefits from handling international roaming traffic over the networks of their foreign affiliates. The regulator expected a strong role of MVNOs who had gained a foothold in the market already.[15]

In the evaluation of the merger between T-Mobile and Orange in the Netherlands, which would reduce the number of players from four to three, the European Commission was of the opinion that:

> "Pricing in this market does not present the characteristic of transparency which would be necessary to reach common understanding on terms of coordination. Each supplier elaborates and proposes several pricing tariffs, which vary on the basis of a great variety of elements: whether the customer is a prepaid or a postpaid one, whether it is classified as business or residential, hours of the day in which phone calls are made, called numbers (there might be preferential called numbers with lower tariffs) etc. In this respect, therefore, the Commission has not found any indications that the four MNOs could reach a common understanding to coordinate their behaviour. Lacking such condition, it is not necessary to investigate the possibility for the players to monitor deviations or to retaliate possible deviating behaviour. Furthermore the presence and the development of fringe competitors do not support the theory of existing coordination. It can be concluded that the market is not currently characterised by the presence of a collective dominant position."[16]

That the European Commission concluded that co-ordinated action was not possible, may not have been well founded as the Dutch competition authority had fined the five operators in 2002 for coordinating their behaviours. This decision was upheld in 2011. In addition in 2013 the Dutch Competition Authority found that it could not find illegal price agreements. However, it did find that through unilateral public statements in the press or at conferences there was a risk that operators coordinated their behaviour, for example over the re-introduction of a connection fee for new customers in 2008 and the lowering of subscriber acquisition costs and the introduction of inflation correction. In its analysis the regulator based itself on the OECD study 'Unilateral Disclosure of Information with Anticompetitive Effects'.[17] Operators committed to not making statements on pricing and strategy in the press.

The purchase of Tele.ring by T-Mobile, was the second acquisition in 2005, after The Netherlands. In this case the European Commission was more concerned about competition as at that time Hutchison 3G covered only 50% of Austria with its network and was dependent upon Mobilkom for roaming in the other parts of the country. It had only very limited access to 2100 MHz spectrum. The European Commission was therefore of the opinion that Austria effectively had 4.5 operators instead of 5 networks. The European Commission was, therefore, concerned that a reduction in the number of operators would lead to a reduction in competition in the market. T-Mobile committed to divesting a number of antenna sites and installations together with two blocks of 5 MHz UMTS spectrum, of which Hutchison 3G would purchase one. In their opinion this would make Hutchison 3G a viable competitor, which could compete with the other networks on equal footing.

In 2010, T-Mobile and Orange, merged to form EE and the number of MNOs fell from five to four. EE is now the largest MNO, with around a third of wholesale connections. A condition of the merger was that EE was required to divest some of its spectrum, and in autumn 2012 it sold 2x15 MHz of 1800 MHz spectrum to Three. In addition it committed to the completion of the build out of a network sharing agreement that existed between Three and T-Mobile. Therefore, although this divestment remedy did not result in a new entrant to the market, it was effective in strengthening the position of the fourth player in the market.[18]

In Austria, the acquisition of Orange by Hutchison marked the first time that the European Commission required an operator to divest a sub-brand and the associated customers. The European Commission found that there could be considerable non-coordinated effects potentially leading to a significant impediment to competition.[19] The merging parties had anticipated that the Commission would

have significant doubts and therefore had submitted a package of commitment to alleviate the concerns. These commitments were insufficient and had to be revised. The revised package however was approved. It contained a commitment to allow up to 16 MVNOs on the merged network and a commitment that only after the first MVNO agreement was signed the merger would proceed. Furthermore, the merged entity would divest spectrum if a new entrant would emerge in the 4G LTE auction. This new entrant however did not emerge in the subsequent auction.

Some discussions of mergers do not proceed as far as the need for regulatory intervention. In 2012, in Greece, Vodafone and Wind discussed a possible merger, however, reportedly terminated these talks over concerns that regulators would not support a reduction to two mobile operators in that country.[20] By way of further example, Softbank, the third largest MNO in Japan, purchased eAccess the fourth largest, but did not integrate it into its operation. As a result no merger review was necessary. However, to ease the concerns of authorities, Softbank had to relinquish two thirds of the voting shares to a consortium of 11 companies amongst which were Samsung and Nokia, while still controlling 98% of the shares in eAccess.[21] In 2014 however, Softbank sold eAccess to Yahoo Japan in which Softbank has a considerable interest, but is not a majority shareholder. The deal will be completed in June 2014.[22]

In 2013, there were two high profile acquisitions under consideration in Germany and Ireland. In Ireland, Telefonica proposed to sell its subsidiary O2 Ireland, to Hutchison 3-UK. This would quadruple the size of "3 Ireland" and reduce the number of players in the market to three. Telefonica Germany intended to purchase e-Plus from KPN. Prior to approving the European Commissioner in charge of mergers stated that such deals cannot come at the expense of higher prices for consumers. Both cases were determined in May and July 2014 and approved with conditions and a number of concessions from the operators.[23] In both cases the merged entity committed to setting capacity aside for MVNOs and new entrants. In August 2014, a possible merger between T-Mobile and Sprint in the United States was abandoned, reportedly because the players did not think they would receive regulatory approval.

Mergers between MNOs are not that common but can have substantial implications for competitive dynamics in any market. When they occur, they have faced increased scrutiny over the years. This appears to indicate that regulators are not convinced that a reduction from four to three operators is good for the functioning of the market. With operators now proposing to help to establish a new fourth operator as part of the commitments to allow for a merger, the rationale behind allowing mergers from four to three operators may be reduced. This may be even more palatable where the entrant has other characteristics such as an existing fixed network and customer recognition.

## IMPLICATIONS OF AN INCREASE OR DECREASE IN THE NUMBER OF MARKET PLAYERS

The approach taken in this document to assess the outcomes of changes in the number of MNOs is to look at case studies in different selected countries, which follows this section. Though many statements are generally made at the time of market entry or exit the outcomes are not always easy to attribute to a change. Some areas that are notable, in this respect, are set out below.

### Benefits to consumers

Competition in mobile markets benefits consumers by offering them better services, quality and price discipline. Particularly in countries with four or more mobile operators these benefits are visible through more competitive and more inclusive offers and services that are generally not available in countries with three mobile operators. When new entrants act as challengers they drive existing operators to improve their offers and performance. Generally, this leads existing operators to match the challenger operator, in other cases it leads to incumbents taking an additional step to get ahead. There is growing evidence for this in the case studies documented here in countries with at least four MNOs.

#### *Simplification of offers*

Take for example the benefits for consumers when mobile bundles are presented in a clear and understandable manner. The former Office of Fair Trading, in the United Kingdom, suggested that mobile telecommunication contracts are often cited as examples of a "Confusopoly"; a situation where firms make price structures or product attributes unnecessarily confusing, thereby making it difficult for consumers to evaluate rival offers.[24] It might be argued that more players would not make this less of a problem as they try to differentiate themselves in a positive way or more negatively to make it harder for consumers to compare offers. Recent offers that run against the negative aspect of this phenomenon, in France, Israel, the United Kingdom and the United States are documented in the following country sections and demonstrate that challenger brands realise that simplicity can also provide a competitive advantage.

Conversely, the reduction in the number of operators in the Austrian market has to date led to an increase in complexity for consumers. The largest mobile operator "A1" removed its pre-paid SIM-only offers from the market. As a result consumers have to compare offers not just on the basis of the bundle of minutes, SMS and data they receive, but also the type of phone and value of the phone that is part of the contract and the total cost of the bundle of the two over the lifetime of the contract. The ACCC in Australia has also commented on the complexity of mobile bundles following the reduction from four to three MNOs.

In the United States, with four national MNOs and smaller regional competitors, T-Mobile has aimed to simplify its plans for its customers as part of its "Uncarrier" strategy. It has introduced simplified unlimited voice and SMS plans, separated the telephone from the contract, removed the overage fees if customers go over their data bundle and has ceased using annual contracts.[25] The result has been a very positive reaction from subscribers as indicated by an increase in their number of subscriptions. In the United Kingdom, 3UK simplified its bundles to consumers by offering its subscribers access to unlimited data. 3UK introduced it and allowed consumers to use their phones for tethering laptops and tablets, which is often explicitly forbidden in some contracts. Some operators even require handset manufacturers to deactivate any tethering functionality on mobile phones. When 3UK introduced its 4G network all existing customers with 4G capable phones could make use of the network without additional surcharges. 3UK was also the only MNO in the United Kingdom committed to not increasing the prices of contracts, during the

contract period, which was common practice on other networks.[26] The striking attribute to these markets is that the parent companies of both T-Mobile in the United States and 3UK both have MNOs in Austria.

In France and Israel, as documented in the case studies, new market entry has also increased the simplicity of bundles. Traditional mobile offers, on the other hand, give consumers a choice from an array of options but they may not always be easy to understand or compare. By way of contrast, the new players in France and Israel introduced a very limited number of options that were either inclusive of services or had well defined allowances. In both countries the offers did not require customers to sign up for a fixed period and could therefore be cancelled or changed at any moment by a consumer. Neither offer from the new entrants came bundled with a mobile phone, though in Israel this is also due to a regulatory requirement. Rather in France it was a deliberate choice for the new player to distinguish itself from its competitors. By making handsets available on a 4, 12, 24 or 36 month payment schedule, customers were still able to get a device without meeting all the cost upfront, but were also made aware of the actual costs of such a telephone. The effect in France has been that now over 45% of consumers are not in a duration-constrained contract anymore and can switch mobile operators at any moment (Figure 4).[27]

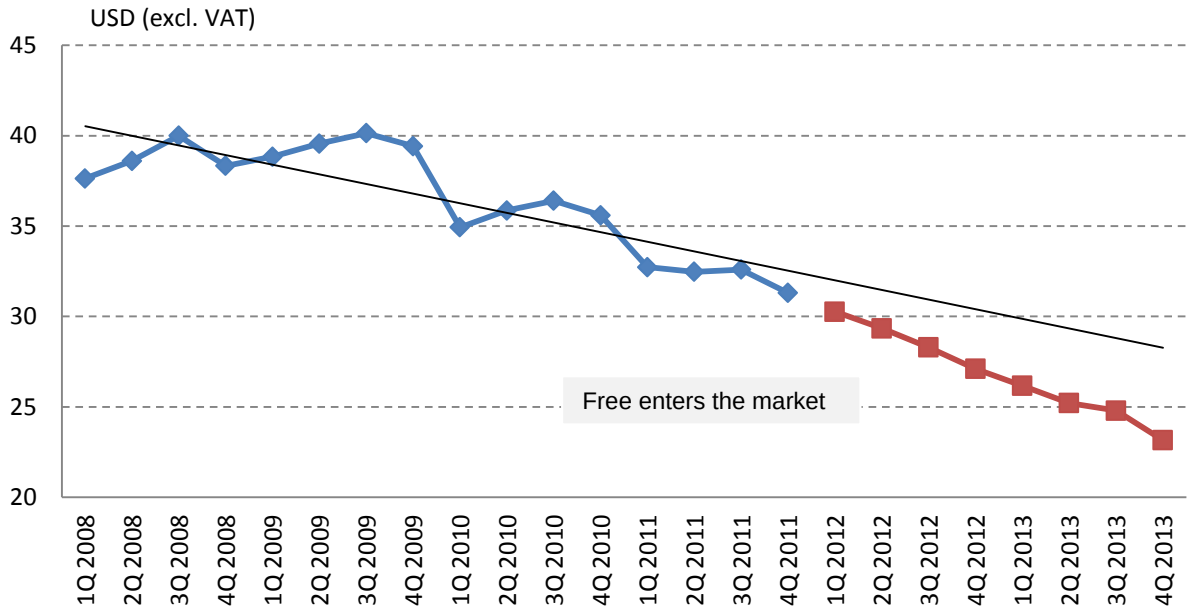
***Lower prices***

One of the effects that are to be expected from increased competition is a reduction in prices or an increase in the content of the offer. Both effects can be seen in Austria, France and Israel under four MNO markets. Unlimited offers did not really exist in France and Israel before the arrival of new entrants and those offers that approached unlimited were expensive. The introduction of unlimited offers as the base offer enabled consumers to achieve savings over their previous plans. The effect has been such that the index of telecom prices in France dropped by 11 points from 2011 to 2012 (Figure 3) In Austria a similar index dropped by 21.5 points from January 2011 to October 2013, only to go up 8.5 points at the end of 2013 (See section on Austria).

In Israel the entry offers of Golan Telecom and HOT Mobile were NIS 99 (USD 28.5) and NIS 89 (USD 25.6) respectively per month, for unlimited minutes and SMS, with 3GB of data. Furthermore, Golan Telecom included unlimited calls to fixed lines in 29 countries.[2829] A report, by "The Marker", showed that a package of approximately 400 minutes, 400 SMS and 1GB would previously have cost NIS 250 – 300 (USD 71 – USD 86) per month.[30] In order to win customers Golan and HOT have both decreased their prices even further as introductory offers for limited periods. Other operators have adjusted their pricing to compete with the new entrants. They propose unlimited bundles that are USD 18 for the first twelve months and cost subsequently USD 34.2.[31]

The French Consumer organisation UFC Que Choisir[32] has stated that the least expensive SIM-only offers in the French market, offered by the low-cost Internet brands of the incumbent operators, before Free Mobile entered the market, were between USD 46.6 and USD 54.7 per month (EUR 34 and EUR 39.90), with either 2 hours or unlimited calls and 1-2Gbyte of data. Following its entry into the market, Free Mobile offered unlimited calls and 3GByte of data for US 27.4 (EUR 19.99) per month. It should also be noted that these low-cost brands had started in anticipation of the arrival of Free. The section on France, in this document, contains further discussion, including references to the index of mobile subscription prices maintained by ARCEP and INSEE (Figure 3). Here it can be noted that the services and consumption volumes in 2013 had changed from earlier years and it is also useful to look at the calculations made by ARCEP to INSEE in this context. The latter two organisations found that mobile prices fell by 27.2%, on average, in 2013 after falling 11.4% in 2012.

**Figure 1. Average monthly mobile expenditure, France**




*Source*: UFC Que Choisir, based on ARCEP, trendline by OECD

UFC Que Choisir calculated based on data from the regulator that the average monthly payment for mobile services (on a per SIM-card basis, but excluding M2M) decreased from USD 33.10 to USD 23.20 after Free had entered the market. The trend line for the period before Free Mobile entered the market shows that though the average was declining somewhat, it went down more significantly in the period after Free Mobile entered the market.[33] The estimate of UFC Que Choisir is that the French consumer's purchasing power increased by USD 9.6 billion cumulative in the first two years of Free Mobile's entry into the market. Using OECD baskets it showed that France had become less expensive than a number of neighbouring countries.

The findings of UFC Que Choisir about the benefits to the consumer are however challenged by the Fédération Française des Télécoms (FFT), which represents all major fixed line and mobile operators, though not Iliad/Free. Having prices below the OECD average will lead in its opinion to an unsustainable situation. It stated in relation to the UFC study:

> "Beyond bias and methodological problems of this study, we cannot be satisfied with such a level of destruction of value in the market that is actually beneficial to people or for companies that must continue to invest and innovate, or to the State for its losses in tax revenue, or for consumers who, though satisfied by the fall in prices in the short term, will be penalised in the medium and long term through a loss of access to the most innovative services, or who will be harmed because of a degraded quality of service."[34]

The Austrian index (see section on Austria) provides some insight into what kind of offers were reduced in price in their market prior to a reduction in the number of players. It follows so-called: "low", "medium", "high" and "power-user" baskets. The index indicates that not all consumers are better off. Low-users witnessed a price increase. The reasons for this are unclear, though it does not have to be adverse for all consumers, as some consumers might be purchasing lower packages, because of the price difference, but might opt for packages with more minutes, SMS and data when these become more affordable. It appears likely that consumers migrate to more expensive medium use packages as these have

become less expensive in relative terms. As previously observed with services such as dial-up Internet, long distance calling and, where it existed, domestic mobile roaming, consumers sometimes have a preference for unlimited offers or offers that feel unlimited to them, even though on average it may be more economical for them to opt for an offer that included less and cost less.[35]

***Roaming***

International mobile roaming is another area where challenger brands are changing markets (Table 2). At the time of the OECD Recommendation on International Mobile Roaming, in February 2012, no mobile operator in an OECD country included this service as an integral part of their offer. In other words, consumers needed to purchase roaming services at an additional charge to the price of their regular bundle. While pricing international mobile services separately should be unproblematic, in practice this had led to unreasonable mark-ups compared to services purchased as part of a bundle. While some mobile operators had toyed with on-net roaming, in countries where they owned networks, as an integral part of their bundles this did not apply to off-net roaming. Indeed some of these offers had been withdrawn from the market or "grandfathered" for existing customers.

Since 2013, a growing number of offers from MNOs that include international mobile roaming, as an integral part of their bundles, have been made in countries with four or more operators. Such offers have largely not yet emerged in countries with three operators. While there had been offers where roaming was included, these were restricted to on-net roaming (i.e. roaming on networks with a current or past shared ownership, from operators in countries such as Denmark and Sweden). What is striking, post 2013, is the first off-net offers, for international mobile roaming, from operators based in France, Luxembourg, the United Kingdom and the United States with more than affiliated networks. These offers include "baseline plans" and no additional payments or action by customers. These offers include not only off-net international mobile roaming, but also roaming in some countries where these operators do not have a network with shared ownership. The networks that have launched off-net international mobile roaming are generally those with the smallest market shares. This suggests they view this as a strategy to gain customers. At the same time, some of these networks have parent or sibling companies in countries with three MNOs, but these companies have not launched similar offers in those countries.

The first country with a three MNO market with a larger player introducing an offer with some off-net roaming as part of a bundle was Portugal. Introduced in 2013, Vodafone, Portugal, has a premium offer ("Red Top" for USD 79 per month) for customers, which includes 15 days of international roaming per year, on Vodafone and partner networks, in a number of European countries.[36] Customers opting for its "Red" (USD 33) and "Red+" (USD 39) pay around USD 4 per day for roaming in these countries as do Red Top customers when they exceed 15 days.

While having four or more operators has not necessarily led to the integration of international mobile roaming in all countries, it has improved non-integral offers in countries with those numbers of players, such as Canada and Israel. Nonetheless, when the smallest players launch integral offers their larger rivals, as occurred in France, sometimes follow them. Almost all operators in France now have such an offer as part of their low cost brand and may include it in some form into the offers of the main brand.

While some of the companies offering international mobile offers operate in Australia and Austria, they have not yet offered the same inclusive offers for international mobile roaming, made available in markets where there are four operators.

A further question that can be posed when a country reduces the number of MNOs is the effect on the wholesale market for international mobile roaming. In Australia and Austria, the reduction of MNOs from four to three means that there is less potential competition to place discipline on wholesale rates.

Regulators do review this part of the market; however it appears to be of lesser significance compared to other elements of merger reviews.

**Table 2. Challenger brands influence in international mobile roaming**

| Challenger brands influence in international mobile roaming | MNOs* | International Roaming included in Bundle** | Challenger MNO offering services | Countries covered |
|---|---|---|---|---|
| Australia | 4 to 3 | No | | |
| Austria | 4 to 3 | No | | |
| Denmark[37] | 4 | Yes (May 2014) | Hi3G | Austria, Ireland, Italy, Sweden, United Kingdom & Hong Kong, China |
| France | 3 to 4 | Yes (Apr 2013) | Free Mobile*** | Austria, Germany, Israel, Netherlands, Poland, Portugal, French Overseas Territories, Czech Republic. |
| Israel | 4 to 5 | No | | |
| Japan | 4 | Yes (Sept 2014) | Softbank | United States (Only iPhone 6 users) |
| Luxembourg | 3 to 4 | Yes (Jan 2014) | Join Experience*** | |
| Sweden | 4 | Yes | Hi3G | Denmark |
| United Kingdom | 4 | Yes (Aug 2013) | 3-UK*** | Australia, Austria, Denmark Indonesia, Ireland, Italy, Sri Lanka. Sweden, United States & Macau, Hong Kong, China. |
| United States | 4 | Yes (Oct 2013) | T-Mobile US*** | SMS and data in more than 100 countries |

Notes: * Changes between 2012 - 2014. ** Roaming services included as part of a bundle for which no additional or metered charges are incurred. ***MNOs selected have the smallest market share in those countries. ***The companies have off-net international mobile roaming.

*Source*: OECD

### Implications for mobile network operators

A number of implications have been suggested for mobile network operators resulting from a merger or an increase in the number of market participants. These include:

- Contrary suggestions that a contraction or expansion, in the number of players in any particular market, is beneficial for investment in next generation networks.

- Some say that a decrease in the number of players will allow for cost-savings through synergies and economies of scale, which will result in more effective competition and lower prices for consumers.

- Some say that an increase in competition will result in a reduction in the number of jobs and the level of investment in new infrastructure. They take the position that a reduction of the number of market players would result in higher margins, which could support higher investment.

- Some industry analysts expect a decrease in sector-wide revenue from an increase in the number of market participants.

- Some MVNOs expect a decrease in the accessibility for them to enter and operate in a market when the number of MNOs is decreased.

***Revenue levels and market structure***

Some financial analysts, telecommunication consultants and mobile operators have contended that a reduction in industry revenues could lead to lower investment. For example HSBC has argued that mobile consolidation in Europe would be a win-win for operators and consumers alike, particularly a reduction from four to three networks.[38] It has stated that capital expenditure is the most powerful factor driving down unit prices (price of a minute/sms/MB). In its opinion consolidation would sustain higher infrastructure investment, because it would allow for increased margins. The firm has suggested network sharing is a complement and not an alternative to consolidation. This implies that the increased revenues obtained from consolidation by a consolidated entity would go to increased capital expenditure and not to higher dividends to shareholders. In addition, these higher margins would only be true for the merged entity and not for its two remaining competitors.

In Europe, Arthur D. Little and BNP Paribas expect a need for increased capital expenditure, particularly by smaller challenger MNOs, to more effectively compete with their larger and more established rivals. This could, they suggest, lead to either consolidation or network sharing. In their view: "Consolidation is an option but there are others too: network sharing is less risky and brings large savings as well." [39] They also expect that in countries where mobile and cable companies have combined or are likely to do so, a credible threat to incumbent mobile/DSL operators in the quadruple play market could be formed and that increased investment by these players would be necessary.

Across the OECD, investment in public telecommunications networks in fixed and mobile networks, excluding spectrum fees has remained rather stable between 1997 and 2011. Investment appears somewhat lumpy, but has generally remained between 14% and 16% across the OECD.[40] Mobile networks are evolving from being ones that primarily provided telephony services via hybrid-2G/3G voice data networks, to being "all-data" 4G+ networks. The change is being underpinned by authorities opening access to new spectrum, particularly in the 700 MHz, 800 MHz and 2.6 GHz bands, the result of the so-called digital dividend. This requires operators to upgrade existing base stations to new generations, involving a sizeable investment. Aside from the expense of acquiring spectrum, network operators will also have to purchase new base stations and backhaul capacity, particularly optical fibre networks as the capacity of LTE exceeds that of many wireless backhaul solutions.

There are also elements that point to incentives for this investment. For example, 4G networks are being introduced into markets that have a strong interest in mobile data and devices that support usage compared to the initial 3G deployments. In addition, 4G networks are IP-based and therefore are expected to have lower operating costs than traditional 2G/3G networks. The long term effect of LTE networks could therefore be a lowering of operational costs. Nokia Siemens Networks estimates that the capital and operational expenditure of a combined HSDPA/LTE network is between USD 5 and 10 per month over an 8 year depreciation period, if customers use 10 GB of data per month and average subscriber density is between 200 and 1000 customers per site. If customers use on average 1 GB per month, then the combined CAPEX/OPEX over 8 years would be between USD 2 and USD 8 per month per subscriber.[41]

It can be challenging to compare the performance of telecommunication companies because of the difference in accounting practices and the characteristics of specific markets. Whether total revenue, profit, EBITDA, average revenue per user (ARPU), average cost per unit or investment is used, each may be calculated in a substantially different way from one operator to another. As a result unless an analysis takes into careful consideration and names all the exceptions and differences and how these have changed over time, cross country analysis of mobile network financials can be unreliable. This is why the approach taken in this document is to look at what regulators have reported after taking into account market attributes and using a harmonised methodology for the countries concerned.

By way of example, total revenue, being the total amount of money received by a mobile operator, has a number of factors that make comparisons difficult. Retail revenue is received from subscribers of an operator through subscriptions and the purchase of goods, such as handsets. Wholesale revenue may also be included from attributes such as interconnection or roaming. Wholesale interconnection charges between mobile operators even out to a large extent. Nonetheless, the income received from inbound and outbound calls is both calculated under total revenue, though the revenue from the outgoing termination charge is a cost. This can lead to a "double counting" effect in company revenues, compared to the situation where only the difference between incoming and outgoing interconnection charges would be accounted. When a regulator reduces the mobile termination rate between operators, the revenue from both incoming as well as outgoing traffic is reduced. The operator still receives the same amount in subscriptions, from its customers, but it receives less from other networks and pays less to its competitors at the same time. This is particularly significant in markets that have substantially reduced termination rates and needs to be considered when looking at changes in market structure. If not revenue may appear to have declined but this may not be attributable to an increase or decrease in the number of players.[42] Additionally, even if overall, the revenues/payments cancelled each other out, the lowering of termination rates enhances the competitive conditions in the market.

Regulators often have periodical reports on the revenue of the mobile telecommunication sector. Generally, they report the differences between wholesale and retail revenue and these show this effect strongly. For example, a review of wholesale revenues for fixed networks in Austria showed a 20% drop in wholesale revenues between Q2 and Q3 2010. According to the regulator this was due to the integration between Mobilkom and Telekom Austria, which formed A1 Telekom Austria. Though it effectively was the same company, the revenue was no longer included.[43]

In Austria, in the mobile market at the same time, wholesale revenues decreased from their highest point at USD 1366 million (EUR 989 million) in 2005 to USD 596 million (EUR 432 million) in 2012. This was due to a reduction in roaming and termination rates. Wholesale revenues were 27% of revenues in 2005 to 15% of revenue in 2012. Over this period total revenue fell by 24%, but retail revenue fell 11% from USD 3688 million to USD 3248 million (EUR 2681 million to EUR 2361 million).[44] Given that competition was strong under a four-player market the decrease is understandable but much less than what might otherwise appear to be the case.

Cross-country comparisons of revenue are also fraught with challenges. What may not be clear, for example, is how the price of handsets is included in the revenue overviews. In Austria A1, the largest mobile operator removed its SIM-only offers from the market after the reduction from four to three MNOs. This is significant because SIM-only offers mean that customers will often buy a handset independently and this will not be recorded as revenue or the costs to the operator of what it passes on to the manufacturer, as a cost. There can also be quite large differences between countries in the size of the so-called handset subsidy, particularly for smartphones. In Israel such bundling of handsets and service are not allowed. Meanwhile, as noted, in France the use of SIM-only subscriptions is increasing. On the other hand, prior to the move by T-Mobile, and perhaps still the case for many consumers in the United States today, the dynamics were very different in that country. In the United States such a subsidy was generally

around USD 450 for a two-year contract and the phone would retail for USD 199. This meant there could be roughly a USD 650 difference per user recorded as revenue compared to a country where SIM-only offers are the norm. Most mobile networks in the United States are now changing their business models, to one where the device may be paid in instalments and are allowing their customers to bring their own devices, with a reduction in price for the monthly plan.[45] This will influence the comparability of revenues over time.

Some financial analysts point out that any total industry revenue decline could be a serious challenge for mobile operators, if it leads to a reduction in returns to investors. In 2013, a study by Credit Suisse showed that pricing of the least expensive offers in some European markets was close to what they believed to be the cost of delivering the service, particularly in Austria, Denmark, Finland and France and approaching this in Italy and the United Kingdom. They added the caveat that in Denmark and France it would still be some time before customers came out of existing contracts and could move to these offers. It expected that in those countries prices would cease to decline and even recover as the market stabilised. On the other hand it suggested further reductions might occur where they perceived prices to be well above their view of costs. In these cases, it advised its clients not to invest in mobile operators in these countries, until prices had reached the bottom. Nonetheless, it can be challenging to predict overall revenue trends because consumers may also shift to bundles with different levels of service (e.g. more data) with higher prices, even if less expensive offers exist for their previous consumption patterns.

It appears from the cases for revenue trends in Austria and the United Kingdom that fierce competition from four players, in a market, does not necessarily decrease overall revenues dramatically – at least for these countries. Instead, it appears that overall revenues remain rather stable. For example, once reduced termination rates are taken into account lower prices were largely offset by increased volume in France in 2012 (e.g. more subscriptions). Nonetheless, aside from the stimulus given to volumes in 2012, there has been a longer-term reduction in mobile revenues in France in recent years and this continued in 2013. Since reaching a peak, in 2008, mobile revenues have been reduced by around 16% by the close of 2013. There are a number of factors contributing to these reductions, discussed in the section of this document in France, some of which are net revenue neutral (e.g. relating to termination, handset acquisition models) but are primarily due to increased competition and changing consumer preferences.

Regulators should, therefore, keep a careful watch on the quality of services offered to ensure there is sufficient investment. The quality of mobile services is essential to the economy and adverse influences on quality could negatively affect other parts of the economy in unforeseen ways. For example, the initial phase of mobile communications was typified by competition through offering better coverage, but as this was improved and mobile communication established, coverage became a commodity. The smartphone era has brought the aspect back, and it is the combination of coverage and capacity in order to be able to use mobile data, and thereby potentially meet national broadband targets that has come to the forefront. Some regulators have used license conditions to impose coverage obligations as well as relied on competition to drive coverage expansion.

The experiences in countries such as Austria, France and the United Kingdom indicate that operators need a certain revenue to be operational, but adding an extra unit or an extra customer does not carry a significant marginal cost. When more customers sign up for services, prices can decline. Adding additional minutes or data does not carry a significant marginal cost and so operators will add more in a package in competitive situations. Though this may show up as decline in ARPU or a decline in revenue per minute, the effect on the bottom line of the operator may be much more modest than at first it appears.

Another factor that makes international comparisons of revenue between MNOs difficult to undertake, is the differences in how offers are divided between voice, SMS and data. Largely from 2007 onwards the use of smartphones rapidly changed usage behaviour, particularly with a move away from SMS to

Blackberry Messenger and WhatsApp, in countries such as Spain and the Netherlands. In France the uptake of WhatsApp was more muted as most offers include unlimited SMS.

Finally, many MNOs are part of a larger company that has fixed and mobile networks. A reduction in termination rates from fixed to mobile networks, which can be asymmetrical, may reduce the revenue of the mobile company, but at the same time is a cost saving on the side of the fixed network. The effect may therefore be revenue neutral over the group. Likewise, payments for fixed networks that connect the antennas to the core network and the core network to the world can be shown as a cost on the MNO side, but as revenue on the core network side of the company.

The direct implications for investment and employment, resulting from the number of MNOs, are even more challenging to ascertain. Where data are available they should be carefully assessed but generally describe a positive outcome. For example, in France the introduction of a fourth MNO has brought forward 4G investments. This should not be surprising as MNOs generally respond to increased competition with a move to improve their own market position to meet that competition. Nonetheless, the overall effects on employment and investment are also tied to changes in the sector as a whole. In other words, following the entry of a fourth operator, France had four players offering a full range of communication services with a rise in total investment and a recent reduction in employment, though with different effects on individual firms.

**Recent experience in OECD countries with mobile market participation**

This section briefly reviews recent developments in three different groups of countries. They are categorised by those that have recently reduced the number of MNOs from four to three (Australia and Austria), countries that have increased the number of MNOs from three to four or five (Brazil, Canada (through regional operators), Colombia, France, Israel, Luxembourg) or countries that have maintain four operators, although having reduced the number in earlier years from five to four MNOs (Sweden, the United Kingdom and United States). The aim is to have a wide range of experience on different aspects of changes in market structure including features such as the entities that conducted the reviews in the case of mergers, factors they took into account, potential conditions or remedies imposed and so forth. At the same time, attention is paid in some of the cases, to the experience with market characteristics following a change or maintenance in the number of players such as pricing, the introduction of new services, investment, revenue and so forth.

***Australia***

In 2003, Australia took advantage of 3G auctions to introduce a fourth MNO (Hutchinson-3) to compete with the existing players that had already entered the market -- Telstra (1987), Optus (1992) and Vodafone (1993). Until 2009, the country had four MNOs but the number was reduced following a merger between the two networks with the smallest market shares (Vodafone and Hutchinson-3 to form Vodafone Hutchison Australia (VHA)). In 2011, VHA announced it would cease marketing Hutchison-3's retail offers and the company shifted all remaining customers to the Vodafone network by August 2013. During that period, VHA and Telstra ended a 3G network sharing agreement that had existed between Hutchison-3 and Telstra. At the same time, VHA entered into a network sharing and roaming agreement with Optus that continues today.[46]

The merger between Vodafone and Hutchison-3 was permitted to proceed following a review by the Australian Competition and Consumer Commission (ACCC).[47] In May 2009, the ACCC said it would not oppose the merger saying it was of the view it would not be likely to have the effect of substantially lessening competition in any relevant market. It did so after finding that:

- The merger would lead to a significant increase in the level of concentration in the already highly concentrated Australian retail market.

- Hutchison-3 had played an important role in driving price competition and innovation in the retail market, often leading prices for postpaid mobile telephony plans where the monthly spend is USD 45 (AUD 49) or less and "priced aggressively" in prepaid and postpaid data services.

- Amongst competitors and within the industry more generally, Hutchison-3 was seen as an innovator. In Australia, Hutchison had been the first to market with cap plans, Skype on mobiles and prepaid mobile broadband, among other products and services.

While it was found that Hutchison-3 had been a vigorous and effective competitor, to that date, evidence analysed by the ACCC suggested to it that Hutchison-3 was likely to be a less competitive force in the retail market in the foreseeable future. There are, undoubtedly, challenges for any mobile carrier in covering such a large country with a small, often dispersed population outside major urban centres. The ACCC concluded that Hutchison-3 was unlikely to continue to be a vigorous and effective competitor in the broadband segment of the market. It was found that Hutchison-3 had network capacity constraints, and would need to undertake substantial investments in network facilities in order to continue to compete aggressively for mobile broadband customers. It noted that estimates for mobile growth suggested the number of mobile broadband subscriptions would substantially increase increasing mobile traffic. At the same time, it took into account Hutchison-3's financial performance during the start-up phase of the company's first five years, where it had not made a profit, suggesting it may not have the resources to compete effectively in the future.

The ACCC concluded that the merged entity would have an increased incentive to invest in its network given it would have the ability to spread its fixed costs over a larger subscriber base. Accordingly, the ACCC considered that the proposed merger might have a pro-competitive effect over the longer term.

*Outcomes*

The ACCC provides the Minister with an annual report on developments in the Australian telecommunication market.[48] This includes gathering evidence and providing commentary in areas such as competition and pricing. While this is not a specific assessment of the results of the merger, this report does provide some indications of outcomes -- taking into account the time it takes for contract periods to expire, existing offers to be replaced, planned investments modified and so forth.

Following the merger, the reports indicate that the downward trend in the pricing of traditional mobile services has tended to continue but that broadband data pricing has been more volatile and, in some cases, has increased when the amount of data included in bundles is considered. The change in direction is highlighted in the 2011 report as the effects of the structural change begin to be observed (Table 3).

**Table 3. ACCC price monitoring**

| ACCC Price Monitoring Date | Comment of Prices |
|---|---|
| 2010-2011 | *"The average real price for mobile services decreased by 4.6 per cent in 2010−11 compared to an increase of 1.8 per cent in the previous financial year. The average real price for post-paid 3G services declined by 2.7 per cent and 10.7 per cent for prepaid 3G services. This compares with declines over 2009−10 of 3.8 per cent for post-paid services and 0.3 per cent for prepaid services."* |
| 2011-2012 | *"The ACCC found that prices for wireless broadband services increased slightly in real terms in 2011−12.* ***This represents a clear departure from previous price trends where prices were falling by as much as 18.5 per cent (in 2008−09). Furthermore, for the first time in recent years, Telstra, Optus and VHA all decreased voice or data inclusions of some post-paid plans in 2011−12****. These changes to the value of plans may not be fully apparent to consumers because of the difficulty in comparing different plans."* |
| 2012-2013 | ***"Retail price competition was generally less vigorous this year than it has been in the past, particularly in the mobile sector. Mobile operators adjusted their pricing by keeping retail price points at about the same level but changing the included value components of some plans.*** *This can make it difficult for consumers to assess whether they are getting the same value or whether they would be better off with a different plan or service provider."* |

*Source*: OECD based on ACCC

While price is only one element in assessing the value provided to a customer, others being quality of service, coverage and so forth, the clear trend in Australia has been for consumers to receive less included data in their mobile bundles. This has been true not only in MNOs but notably with MVNOs following reduced wholesale competition. In October 2013, for example, TPG an MVNO on the Optus network reduced its included data allowance in its pre-paid offer from 1GB to 250 MB and subsequently 100 MB.[49] In February 2014, Boost Mobile, one of two resellers on Telstra's 3G network, reduced the data allowance in its bundle, with unlimited voice and text, from 3GB to 2GB for the same price. Earlier, in 2012, some analysts suggested the three remaining MNOs had reduced included data allowances by up to 40% compared to 2011 offers.[50]

Aside from indications on prices, it is not possible to assess the overall affects in the Australian market of the reduction from four MNOs to three from the available data. The ACCC make a number of positive statements in their reports on investment and all three MNOs have commenced 4G services in major cities. The question that can be asked, of course, is the extent to which this investment would have occurred irrespective of the merger proceeding, especially given an increasing use of network sharing. If meeting demand was the main driver of this investment the incentives were likely in place for all operators to increase investment in the most populated areas covered by all four MNOs due to competition. Outside these areas challenges remain.

The Australian Government's 2011-2012 Regional Telecommunications Review identified a lack of adequate mobile voice and broadband coverage as the issue of greatest concern to regional communities.[51] It found that while population coverage was claimed to be 99% there were large areas without coverage or with inadequate service, as well as persistent "black spots". It also found that many areas were only served by a single MNO.

This underlines the challenges for regulators that endeavour to predict market trends as the basis for assessing foreseeable outcomes from mergers. The ACCC correctly predicted an increase in demand for mobile broadband and a large increase in data traffic and said this would require increased investment. As it eventuated, demand even exceeded these predictions.

Recent ACCC reports and an improved understanding of how people make use of smart phones show that over 70% of average usage in many OECD countries is on fixed networks. In other words, authorities making decisions on market structures need to be cautious in using the demand for mobile broadband and traffic increases as the basis for considering the number of players in the MNO market. If, for example, players share mobile facilities and backhaul they reduce costs even at a time of overall increasing demand for investment and the services its supports but there has been a reduction in wholesale and retail competition.

A further outcome that does not necessarily seem to have come to fruition in Australia is that the merged operator would be a stronger competitor – at least in relative terms. VHA's combined market share (Vodafone had 16% and Hutchison 9% pre-merger) fell from 25% in 2010 to 20% in 2013 while Telstra, the largest player, increased its share from 40% to 43% over the same period.

Post-merger, VHA experienced a series of devastating network outages, which is one of the reasons its market share has suffered and Telstra's has improved. Telstra has been very successful in promoting its mobile network as 'the best and most reliable', whereas VHA has had to invest heavily in upgrading its network to address deficiencies in areas in which it provides coverage.

VHA and Optus entered into a network sharing and roaming agreement that has the advantage of reducing costs and potentially greater coverage to promote competitive choice. On the other hand, a question can be raised as to whether duopoly groups of infrastructure providers have the same incentives as where there is greater competition to expand services – an issue taken up in the sections of this document on network sharing. Moreover, could the same outcome have been achieved by opposing the merger given the incentives smaller players have to enter into network sharing but retaining greater retail and wholesale competition?

The reduction of MNOs in Australia has undoubtedly led to a less competitive and more concentrated mobile market. It is unclear from the available evidence, however, if this outcome led to greater benefits in other areas such as encouraging increased investment. A lesson that could be drawn for other countries considering mergers is that the combination of two smaller players does not necessarily lead to a stronger competitor for larger players. This can, of course, be viewed in relative terms with proponents of a merger saying that any achievements they have made have driven improvements from those larger players. Nonetheless, in Australia's experience the merged MNO has consistently lost market share, something that would not be expected if it were meeting customer requirements.

This leads to one of the largest questions for authorities considering a reduction in the number of operators. That is that it may be very challenging to reverse a decline in competition following a merger or to introduce a new MNO. In Australia's case a "digital dividend" auction in 2013 opened the possibility that a new player could enter the market. Indeed, TPG primarily an ISP offering fixed services and an MVNO, purchased a small amount of spectrum[52]. In the future, the company could potentially augment its mobile services to provide competition in some areas. TPG's spectrum holdings, however, are less than what was available to Hutchison-3 when the ACCC determined it was insufficient to be an effective competitor. That being said, Australia's programme for public investment in open access to shared network facilities may benefit smaller players.

To address the issue of inadequate coverage in some regions, the Australian government has committed to spend USD 93 million to improve mobile network coverage and competitive choice. It is also examining the role its public investment in the National Broadband Network (NBN) may play, particularly the USD 1 billion for fixed wireless. Telstra's competitors argue that they should have greater access to its network, that any public investment should come with a requirement for 'open access' and that the NBN's fixed wireless programme should be modified to provide facilities for mobile services.[53]

For its part, Telstra has invested a considerable amount in providing the widest coverage in Australia and views this as a matter that should be left to the market.[54] It strongly opposes any suggestion that it should be made to share existing facilities or that public investment should dictate open access policies. In respect to the first objection, this is a challenging area for regulators as an important consideration in many countries is whether facilities can be economically replicated. A decision in favour of a dominant player may assign consumers in those areas to a monopoly. On the other hand, mandating access may eliminate the incentive for further investment in competitive infrastructure. Nonetheless, most countries have taken the decision that any public investment should be associated with open access requirements rather than benefit a single provider.

***Austria***

Until 2013 the Austrian mobile telecommunication market consisted of four mobile operators. In 2013 two of the players, Hutchison-3G and Orange merged. The current market consists of:

- A1 Telekom Austria, part of the Telekom Austria Group, which has a 43.4% subscription share. It is the former state owned incumbent and today the government and America Movil are among its largest shareholders. The group has a number of mobile subsidiaries primarily in South-Eastern Europe.

- T-Mobile Austria, which has a 31% market share, was the second operator to join the Austrian market. In 2005 it acquired tele.ring, a competitive smaller player, pre-merger of H3G and Orange, known for its aggressive price policies.

- Hutchison 3G (or H3G), which has 25.6% market share. It commenced service in 2003 as a 3G only network. In 2013, Hutchison 3G merged with Orange. At the close of 2012, Hutchison had 11.1% market share and Orange had 18.6%. "yesss!" a sub-brand of Orange, which had a 6% market share was purchased by A1 Telekom Austria.

Austria has two operational MVNOs that are independent from the other mobile operators, Lycamobile and Vectone on A1's network. Having MVNOs on its network was a condition for the Hutchison-Orange merger, however, UPC, which has an MVNO agreement with H3G has not launched yet. There are a number of sub-brands that operators use, such as "bob", "tele.ring" and "yesss!" but these are all fully owned subsidiaries of an MNO. Overall the changes in the Austrian market have led to a significant increase in market concentration in an already concentrated market.

In December 2012, the European Commission approved acquisition of Orange's Austrian MNO by Hutchison-3G. This followed a review, which found that the Austrian mobile telecommunication market was already highly concentrated.[55] In addition, the economic analysis conducted by the Commission, showed that the market power of the merging parties would have been higher than what their market shares suggested. Added to this, the European Commission noted, that "…the market is characterised by high barriers to entry for competitors and consumers have little bargaining power when it comes to negotiating contracts with operators."[56]

The European Commission had concerns that a reduction in MNOs could lead to less competition and higher prices, to the detriment of consumers in Austria. To address these concerns, Hutchison-3G submitted remedies, offering in particular to divest spectrum and related rights and to provide wholesale access to its network. Based on these commitments, the European Commission concluded that the transaction would no longer raise competition concerns. Accordingly, the approval was conditional upon the implementation of commitments that would facilitate the entry of new players into the Austrian mobile telecommunications market.

Prime among these commitments was Hutchison-3G's undertaking to divest spectrum and additional rights to an interested new entrant in the Austrian mobile telephony market. It was envisaged that such a new entrant would not only have the right to acquire spectrum from Hutchison-3G but also additional spectrum at an auction planned in 2013 by Austria where spectrum would be reserved for this opportunity. Hutchison-3G also committed to provide, on agreed terms, wholesale access to its network for up to 30% of its capacity for up to 16 mobile MVNOs over the following decade (if no new MNO would enter the market), with all existing MVNO contracts to be honoured in case of a new MNO entering the market.

The reduction of MNOs in Austria was considered by a number of authorities. Austria's Bundeswettbewerbsbehörde (BWB), responsible for general competition, sought for the merger case to be referred to the Austrian authority. The European Commission intervened, however, and undertook the merger review working with the Austrian authorities. The sale of "yesss!" to A1 Telekom Austria, was reviewed by the BWB the additional sale of spectrum to A1 by BWB and TKK. The European Commission also sought for this to be referred to it, but BWB disagreed.

In its review the BWB found: "With the disappearance of yesss!'s aggressive pricing strategies, the only competitor of TA's [Telekom Austria] brand "bob" would fall away. The result feared by the BWB is an increase in pricing, since the competition in the Prepaid-Segment would cease to exist." In addition, it stated: "The merger of Telekom Austria and yesss! is closely related to the fusion of Hutchinson 3G and Orange that is currently being handled by the European Commission. In this case there are also many concerns to be found." [57] As a result the BWB appealed to the Austrian Cartel Court for an in-depth investigation.[58]

Court assigned an economic expert to give her opinion on the relevant economic and legal questions. Dismissing the BWB's and FCP's [Federal Cartel Prosecutor] findings the opinion held the merger of Telekom Austria and yesss! would not lead to the creation or strengthening of a dominant position on the market for mobile telecommunication services in Austria. The economic expert predicted price increases for customers in the pre- as well as in the post-paid segment. Nevertheless the expert expected that in the future new tariffs and brands will be placed on the market. The economic expert also discussed the aspect of coordinated effects and concluded that the incentive to coordinate will not increase due to the yesss! acquisition if the European Commission imposes a remedy within the Orange acquisition to allow Mobile Virtual Network Operators (MVNOs) access to the H3G network. The Cartel Court therefore cleared the yesss! acquisition without obligations/commitments end of November 2012."[59] The BWB concluded: "The BWB holds the Cartel Court's decision wrong mainly with regard to the facts it established."[60]

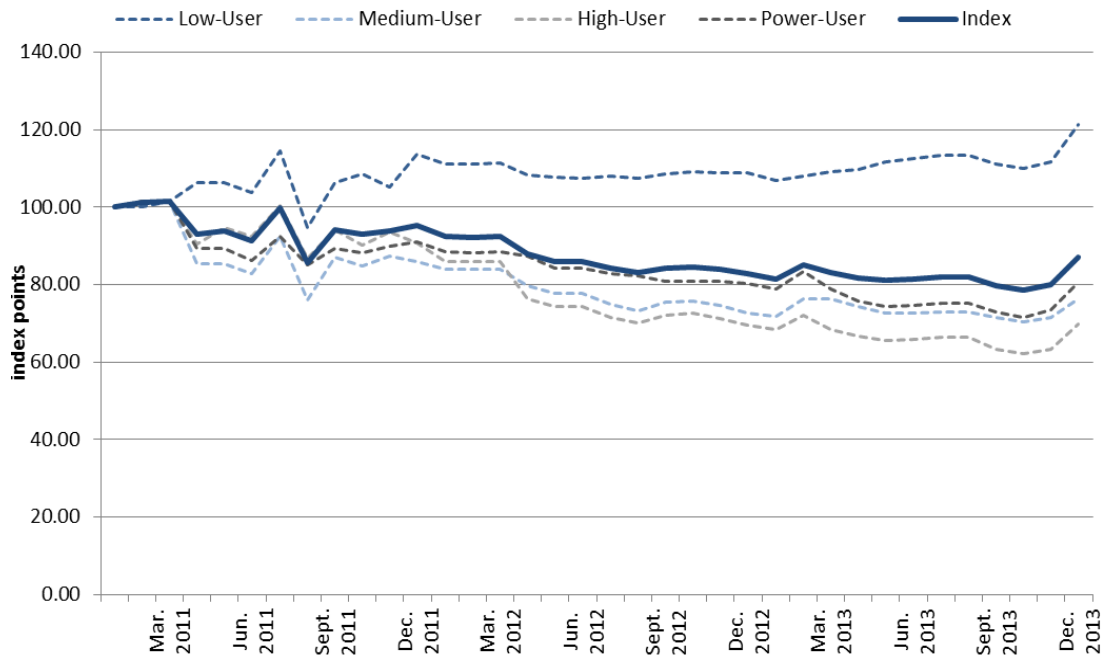
*Outcomes to date in the Austrian market*

Prior to the merger Austria had one of the least expensive markets for mobile communication services in the OECD. The OECD Communications Outlook 2013, for example, ranked Austria in the top four of the least expensive countries for each mobile broadband basket as measured in 2012. A further feature that characterised the Austrian market was the high degree of substitution between some fixed and mobile services. This was attributed to the prevalence of unlimited data bundles with pricing instead structured around download speeds. In addition, a typical SIM-only offer might include 1000 minutes, 1000 SMS's

and 1000 Mbyte for less than 10 Euro (USD13.89) per month. There are also some offers that contain a number of minutes to foreign countries and when roaming abroad. In short, the outcomes of the mobile market with four MNOs had been highly competitive and innovative.

In the period up to 2010 operators in Austria spoke of a "price war". Some estimated that the average revenue per user had consistently gone down, for most operators, except for a brief period in 2010.[61] The term "price war" is so widely used by the industry and the media, in association with price reductions, that it has lost much of its meaning. Nonetheless, immediately following that period, prices tended to continue to decline for users with larger consumption patterns and rise for those with lower usage. This is reflected in the Austrian regulators index of mobile prices between 2011 and 2013 (Figure 2). During the initial period covered by the available data the users that profited most from price reduction were the, so called, High (-38%) Medium (-30%) and Power(-29%). In contrast the prices for those with the lowest usage patterns increased by 10%. After the merger prices jumped from Q2 2012 to Q1 2013 with an 8 to 10 index points across the board, or a 12% increase for some offers.[62]

**Figure 2. Price index, Austrian mobile prices**




*Source*: RTR.

The Austrian Regulatory Authority (RTR) and TKK have monitored the affects the merger had on offers in the Austrian market. For example, all operators introduced new tariff packages, which were different from their previous bundles. All operators increased the prices of their most popular offers. Hutchison increased the prices of its least expensive offer. A1 took the decision to stop offering SIM-only post-paid tariffs. This does not mean that customers have to buy a handset with their subscription. Rather, it means that customers not buying a handset with their subscription still pay the same monthly fee as those who purchase a handset from A1.[63]

One of the merger conditions set by the European Commission was that Hutchison-3G had to open its network to MVNOs. To date, however, no new MVNOs have entered the market on its network. While Hutchison has a contract with UPC, the largest cable network, which may enter as an MVNO in end 2014,

this has yet to occur. A further condition in the reduction in the number of MNOs was that spectrum would be made available to a new entrant for the auction held in 2013. However, no fourth operator emerged in this auction.[64] The overall outcome in the market has, therefore, been greater concentration and fewer players to exercise price discipline.

While the three Austrian MNOs complained about what they said were prices that were too high for spectrum, it tends to indicate that they have placed a greater value on the expected returns from a market with three mobile infrastructure players instead of four. At the same time, America Movil's desire to increase its stake in Telekom Austria also indicates it expects attractive returns from the new market structure.

***Brazil***

Brazil, the largest economy in the LAC region (USD 2.25 trillion economy at current prices, 2012), has a dynamic mobile market that has been growing steadily reaching 275 million mobile subscriptions in June 2014. Fixed broadband has been also growing with 23 million subscriptions in Q2 2014 (just below 12 lines per 100 inhabitants).

Brazil has three leading telecommunication operators that provide both fixed and mobile services (voice, Internet access, pay-television): Vivo (Telefónica), Claro/NET Serviços/Embratel (owned by América Móvil) and Oi/Telemar (held by local investors and Portugal Telecom). These three groups jointly serve over 72% of the mobile market and 65% of the fixed broadband market (see Table 4). Even though they do not cover the totality of the vast Brazilian territory, all of them have national footprints and are reasonably widespread across the country. Therefore, all three operators could potentially offer converged fixed/mobile services.

**Table 4. Mobile market share in Brazil (%), June 2014**

| OPERATOR | REGION (1) | SUBSCRIPTIONS | MARKET SHARE % |
|---|---|---|---|
| Telefonica | I - II - III | 79 357 354 | 28.78 |
| TIM | I - II - III | 74 202 921 | 26.91 |
| Claro | I - II - III | 68 775 877 | 24.95 |
| Oi | I – II - III | 51 081 121 | 18.53 |
| Algar (CTBC) | I - II - III | 1 100 674 | 0.40 |
| Nextel | I - II - III | 1 024 289 | 0.37 |
| Portoseguro | I - II - III | 112 092 | 0.04 |
| Prefeitura de Londrina/COPEL | II | 52 585 | 0.02 |
| **TOTAL** | | **275 706 913** | **100** |

*Source*: Anatel
(1) Region I corresponds to RJ, ES, MG, BA, SE, PE, AL, PB, RN, CE, PI, MA, PA, AM, RR and AP; Region II to PR, SC, RS, DF, GO, TO, MT, MS, AC, RO; and Region II to SP.

In addition to these three converged players, there are two rapidly growing operators providing fixed (GVT) and mobile services (TIM). TIM (owned by Telecom Italia) is the second largest mobile operator in terms of subscribers but has only very minor fixed operations. TIM has a record of being commercially aggressive, thus triggering price reductions by other operators and adding new innovative features. GVT, in turn, is a rapidly growing fixed operator whose main shareholder is the media and telecommunication company Vivendi, headquartered in France. Currently holds some 12% of the fixed broadband market.

In Brazil, as in a number of OECD countries, some players would like to see a reduction in the number of MNOs. In 2010, Brazil's competition authority (CADE) ruled that TIM and Telefónica (Vivo) had to remain independent companies in Brazil and thus imposed an obligation in relation to Telefónica's minority share in Telecom Italia (owner of TIM through the holding company Telco). Indeed, in December 2013, CADE blocked Telefónica's increase in Telco's ownership, as it would have increased the links between TIM and Vivo. This could be viewed as an attempt to transition from four to three operators in the Brazilian market.

In August 2014, Telefónica and TIM made concurring bids to acquire GVT, which have not been yet examined by the authorities. Telefónica offered USD 8.95 billion for GVT, whereas Telecom Italia offered USD 9.3 billion, although the terms of the bids where different (the latter included a future stake at TIM for Vivendi).

While these two bids are being considered by the relevant operators in Brazil – and will likely be examined by competition authorities in that country – they reflect some trends also present in other countries. For example, operators with only fixed or mobile operations are keen to expand their offers lest competitors have an advantage through bundled services. Mergers are one way they might achieve this goal alongside any benefits they perceive in a reduction of mobile competition resulting from less MNOs.

***Canada***

Since 2008, Canada has had a policy of promoting competition in the wireless sector. In the 2008 spectrum auction for advanced wireless services (AWS) spectrum, measures were established to sustain and enhance competition. These included setting aside spectrum to facilitate new entry, as well as establishing new roaming and tower sharing policies.

Following the AWS auction, a number of new entrants secured spectrum licences and deployed wireless networks. New entrants included regional cable operator Videotron in Québec and parts of Ontario; wireless only MNOs Wind Mobile and Mobilicity in major urban markets in Ontario, Alberta and British Columbia; and wireless only MNO Public Mobile in parts of Québec and Ontario. In 2013, regional cable operator Eastlink launched its wireless network in Nova Scotia and Prince Edward Island.

Over the course of 2012, 2013, and 2014, further measures were taken to promote competition in the wireless sector. In 2012, the Canadian government reformed foreign investment restrictions for companies with less than a 10 percent national market share, and announced that its 700 MHz and 2500 MHz auctions would effectively reserve spectrum for a fourth provider in every region. In 2013, a policy framework on spectrum licence transfers was released, providing greater clarity on how spectrum licence transfer requests are reviewed. Under the framework, proposed transfers are reviewed on a case-by-case basis, and transfers that result in undue spectrum concentration are not permitted. In 2013, improvements were also announced to the existing tower sharing policy, as well as an extension and expansion of the existing roaming policy. In 2014, the Canadian government introduced interim legislation to cap domestic wholesale roaming costs and announced that its upcoming AWS-3 auction would include a large block of set-aside spectrum for operating new entrants.

According to a 2014 pricing study prepared by Wall Communications for Industry Canada and Canada's independent broadcasting and telecommunications regulator, the Canadian Radio-television and Telecommunications Commission (CRTC), average wireless prices in Canada have declined by 22 percent since 2008. Consistent with their "challenger" status, the pricing study also found that new entrant MNOs continue to offer prices that are substantially lower than incumbents, as much as 49 percent lower for smartphone wireless services.

*Mobile Network Sharing*

MNOs in Canada have entered into a range of network and spectrum sharing agreements to reduce costs, facilitate the roll out of next generation wireless networks, and provide access to leading wireless devices. In 2009, Bell and Telus completed a joint build-out of a national HSPA network, and also entered into a network sharing agreement with regional incumbent Sasktel in Saskatchewan. Importantly, Bell and Telus' national HSPA build ended Rogers' GSM monopoly in the country. Bell and Telus' network sharing agreement has since been updated to include LTE network infrastructure. In 2009, Rogers partnered with regional incumbent MTS to jointly deploy an HSPA+ network in Manitoba, and in 2013 it partnered with regional cable operator Videotron to build and share an LTE network in Québec and part of Ontario.

***Colombia***

In Colombia there are two MNOs that have existed since 1994, when the first mobile networks were deployed. Their nationwide coverage, however, is the result of mergers between regional operators. At the end of 2003 they were joined by a third nationwide MNO, which initiated their offer using PCS technology.

Between 2009 and 2010 three MVNOs started operations in Colombia. By 2012, one of the established MVNOs became a fourth MNO and launched the first 4G LTE network in the country. In the first half of 2013, the other two MVNOs entered the market. Following that, the administration started a process for a spectrum auction to deploy 4G networks. As a result of the auction in 2013 Colombia had six MNOs -- two of them as new entrants -- which had begun substantial 4G networks deployments. In 2014, there is a merger in progress, which will reduce the number of MNOs to five. This requires the merging entities to divest spectrum in order to fulfill spectrum caps.

*Network sharing in Colombia*

Colombia has a regulatory approach to network sharing, starting with mandatory conditions related to the sharing of towers, poles and ducts. There is also regulation related to the access, use and interconnection of telecommunication networks, especially in respect to essential facilities. It is focused on ensuring the capability of users to communicate with any other user in the country and the world, in relation to the independence of the service provider.

In addition, in the spectrum auction process for 4G networks, authorities defined national roaming obligations for incumbent operators, to facilitate new entrants, which will deploy 4G networks but do not have 2G or 3G networks. This is to ensure they will have a competitive offer in the market. There are also some RAN network sharing agreements between some MNOs that found in these agreements a way to deploy their 4G networks on a more efficient cost structure.

***France***

France has one of the most dynamic mobile markets in the OECD area with four MNOs and a number of MNVOs. Significantly, in considering developments in France, all these MNOs could be categorised as offering a full range of telecommunication services: mobile, fixed, Internet and IP television. The four MNOs, all of which have GSM, UMTS and LTE licenses, are:

- Orange, formerly France Telecom, is present in 30 countries, with a total customer base of more than 239 million in 2014, including 181 million mobile subscriptions and 15 million fixed broadband subscriptions. In France, it is the incumbent mobile telecommunication operator having

commenced its first service in 1985. As of March 2014, it had 25.5 million mobile subscriptions in that country. [65]

- In 1992, SFR entered the mobile market in France and by March 2014, it had 21.2 million mobile subscriptions. In 2014 Vivendi, its owner, was in talks with Altice/Numericable and Bouygues for the sale of all or part of SFR. In April 2014, Vivendi decided to accept the bid for SFR submitted by Altice/Numericable, the owner of the largest cable television network in France and the owner of HOT/HOT Mobile in Israel.

- Bouygues Telecom, a subsidiary of the Bouygues group of companies, entered the mobile market in France in 1994 as the third entrant. As of March 2014, it had 11.1 million mobile subscriptions as well as offering a full range of fixed services.

- Free Mobile is part of the Iliad group. It has the second largest number of fixed broadband subscriptions in France. Following an application in 2009, for the sole remaining 3G licenses, it obtained spectrum in 2011 and started operations in 2012. At March 2014, it had 8.6 million mobile subscriptions.

- In 2014, MVNOs held a market share of about 11.3% of SIM-cards in France according to ARCEP, the electronic communications regulator. This market share held steady despite the introduction of a fourth mobile operator.

In the years leading up to the fourth MNO the market in France was typified by a penetration rate that trailed the OECD average and there was relatively slow growth in the usage of mobile telephony, with an actual decline in voice minutes in 2009. This was widely attributed to relatively high prices and bundles that were typified by low usage caps for all services. In 2009, overall investment in the telecommunication market was at its lowest point since 2004. In addition, direct employment in the sector had continued its long-term decline reaching 124 thousand compared to 142 thousand in 2004.

Policy makers in France had long recognised the need to increase competition in the mobile market and had been prepared to do so from 2001 onwards. For a number of reasons, 2009 to 2011 can be considered as a turning point because it was the period during which the market prepared for the entrance of a fourth operator at the start of 2012. The outcomes following the launch can be considered as an achievement in terms of increasing mobile penetration and usage, bringing new innovation to the market that has often led the world and in driving investment in new wireless infrastructure.

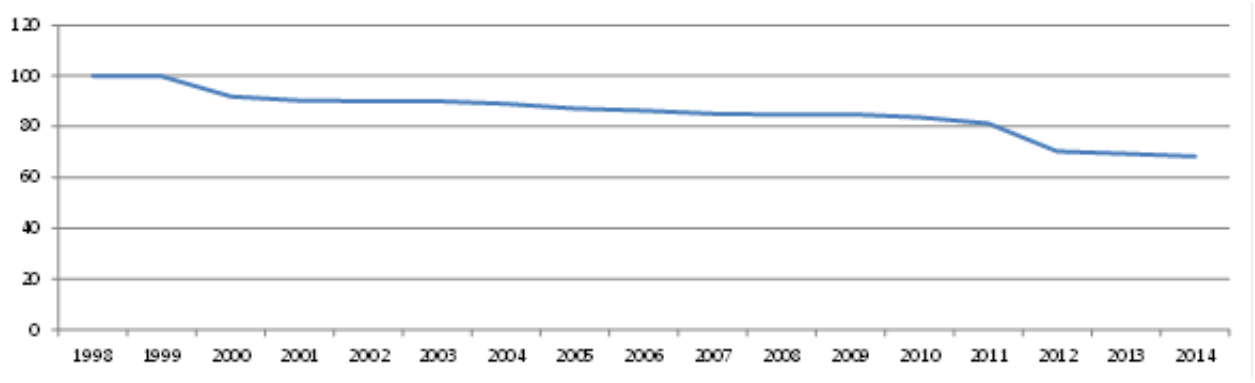
All these developments can be attributed to the substantial increase in competition brought to the market by a fourth MNO. Before reviewing the evidence it is worth noting some of the factors that make this change in market structure one of the more unique in recent years. One element, somewhat setting apart the arrival of a fourth MNO in France, is that the majority of non-incumbents entered markets with much lower penetration rates in the 1990s and early 2000s in OECD countries. Consider, for example, that the third operator in France had entered when the subscription rate was just 14 per 100 inhabitants, compared to 105 per 100 inhabitants for the fourth MNO entry.

While this presented more challenging circumstances, in many respects, for Free Mobile's entrance, the company benefitted from its extensive fixed network including, as a result, strong brand recognition in the market as an innovator and price leader. It also benefited from action by the regulator to ensure that one of the other MNOs was required to enter into a national roaming agreement, while Free Mobile rolled out its own network against specified coverage requirements. This created an incentive for one of the incumbent MNOs to reach a commercial agreement before their rivals from which they have benefited from the substantial interconnection revenue.

*Outcomes*

The available evidence demonstrates the benefits of introducing a fourth operator (Table 5). All metrics for access and usage of mobile and fixed networks have substantially grown between 2009 and 2013. The reduction in prices was captured in the index of telecommunication service in France with the greatest gain being made following the entry of the fourth operator (Figure 3).

**Figure 3. Index of French mobile telecom prices (1998-2014)**




*Source*: ARCEP, INSEE

The overall effects for employment, from the introduction of a fourth operator, are still being assessed in France, with increases and decreases for different operators. In 2013, the total employment levels declined to the level of 2009.[66] The mobile sectors total revenue declined in 2013, reflecting an increasing number of users coming out of contract and taking up offers, with their existing or other operators, at lower prices and changes to handset acquisition models (i.e. increased use of offers without joint purchase of a smartphone or other device).

An actual decline in mobile revenue in France in 2013 was in contrast to the first year of the entrance of a fourth operator which seemed to provide some stimulus from a longer term trend of decreasing total revenue. ARCEP attributed the trend over several years to factors such as an increase in VAT alongside changes to the use of services and how they are tariffed. It highlights the reduction in revenue attributed to voice and SMS, with greater use of unlimited offers for these services, alongside the take up of more data.[67]

During 2012, the first year of the fourth operator, the operator revenue for the mobile sector remained constant – actually increasing by 0.1%.[68] The difference can be attributed to the treatment of termination rates in the accounts of operators. Such data can be treated as revenue and cost, or more simply netted out, but in many ways can be close to neutral in terms of the bottom line. In other words, as termination charges are reduced, so too are revenue and costs. This is why ARCEP concluded after reviewing the 2012 data that the fall in prices was offset by the rise in demand (e.g. access and usage as well as new services). At the same time the consolidated EBITDA margins (earnings before interest, taxes, depreciation, and amortisation) for a full services company, such as Orange (France) are consistent with peers in countries with low termination fees. In 2012, for example, Orange had an EBITDA of 36.6% compared to Verizon's consolidated EBITDA margin of 34.9% in 2013.

**Table 4. Developments in the telecom market in France**

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|---|
| Mobile Subscriptions per 100 inhabitants | 71.3 | 76.4 | 81.5 | 86.8 | 90.4 | 95.4 | 100.3 | 105.2 | 112.1 | 117.1 |
| Mobile Voice Minute (millions) | 19,481 | 21,772 | 24,901 | 25,866 | 25,767 | 25,612 | 26,879 | 26,781 | 32,591 | 36,265 |
| SMS (millions) | 3,045 | 3,373 | 4,098 | 5,712 | 11,553 | 19,352 | 30,947 | 41,028 | 49,036 | 50,936 |
| Mobile Data (TB) | | | | | | | 9,429 | 16,725 | 28,469 | 47,548 |
| Total Revenue (EUR Millions) | 45,952 | 49,725 | 49,820 | 51,516 | 53,710 | 53,030 | 53,447 | 52,074 | 50,336 | 45,267 |
| Mobile Revenue (EUR Millions) | 14,868 | 16,199 | 24,185 | 25,066 | 26,572 | 25,965 | 26,209 | 25,525 | 23,658 | 19,630 |
| Investment total (excl. licences)* (EUR Millions) | 5,493 | 6,342 | 7,015 | 6,140 | 6,455 | 5,825 | 6,414 | 7,176 | 7,317 | 7,117 |
| Fixed investment | | 3,700 | 3,700 | 3,800 | 4,300 | 3,700 | 4,400 | 5,000 | 4,900 | .. |
| Mobile investment (excl. licences) | | 2,642 | 3,315 | 2,340 | 2,155 | 2,125 | 2,014 | 2,176 | 2,417 | |
| Employment | 142,137 | 140,410 | 133,114 | 129,894 | 126,298 | 124,232 | 126,557 | 128,820 | 129,167 | 124,935 |
| **Total broadband**** (thousands) | | | | | 17,819 | 19,831 | 21,328 | 22,737 | 23,975 | 24,905 |
| Normal speed broadband | | | | | 17,654 | 19,543 | 20,864 | 21,389 | 22,369 | 22,855 |
| Very high speed broadband | | | | | 165 | 288 | 464 | 1,348 | 1,606 | 2,050 |
| Very high speed broadband as a % of total broadband | | | | | 0.93 | 1.45 | 2.18 | 5.93 | 6.70 | 8.23 |
| Average monthly subscription fees (€) | | | | | | | | | | |
| Fixed line | | | | | 27.7 | 36.4 | 25.6 | 24.9 | 23.3 | 23 |
| Fixed broadband | | | | | 33.7 | 34.7 | 35.3 | 34.3 | 34.7 | 33.7 |

Notes: * Data for Investment (2013) are early estimates; ** Total broadband data are slightly different than the Broadband data published by the OECD. The breakdown : Broadband/Very high speed broadband is not used in OECD broadband data.

*Source*: ARCEP, INSIEE

It is critical to consider the effects on the market as a whole in France. That is because the arrival of a fourth mobile provider meant that each of the largest players could offer a full range of services. Prior to this only Orange, SFR and Bouygues Telecom could offer fixed and mobile services. While much of the attention has understandably been on the affects in the mobile market the result of having four full service providers has also driven competition in the fixed market. This may not have eventuated to the same extent had some players retained an advantage in the range of services they could offer. In other words the "incumbents", now competitively matched across all offers, have a greater incentive to improve fixed services as well as mobile.

Prior to its entry into the mobile market, Free had demonstrated a record as a challenger and innovator in the fixed broadband market. The company's initial EUR 29.99 triple play offer for fixed line broadband Internet, telephony to fixed lines in France and abroad and IP television, established a new benchmark for the market and was quickly replicated by other firms. The company's entry into the mobile market was expected to have a similar effect. Free Mobile's initial offer in January 2012 was either:

- EUR 19.99 per month with no contract term obligation, for unlimited calls to fixed and mobile networks in France, 3GB data and unlimited SMS/MMS in France. Customers of Free's fixed broadband service paid EUR 16.99.

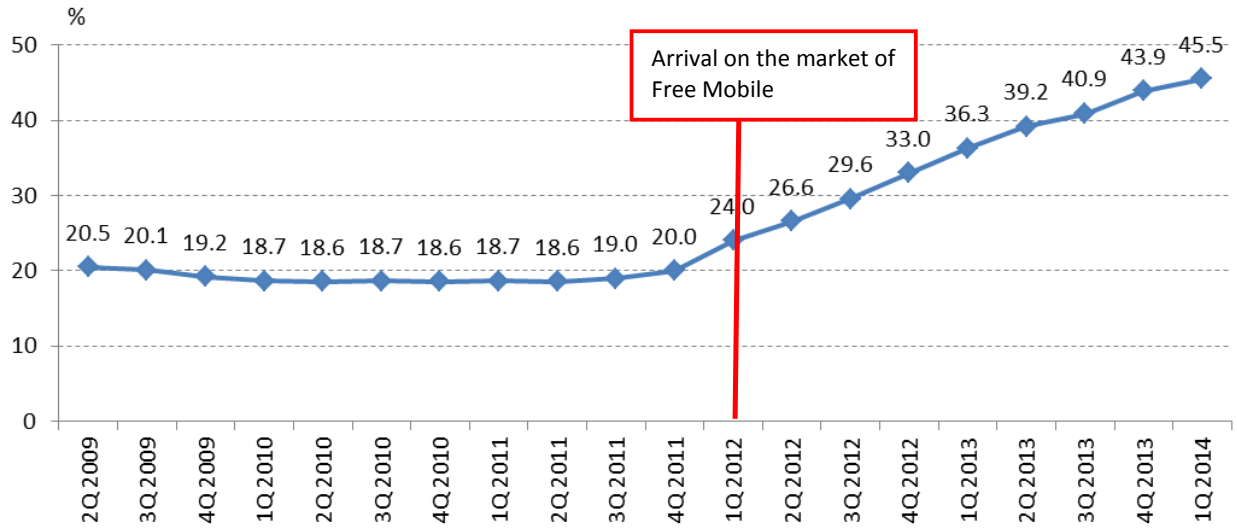
- EUR 2 per month with no contract obligation, for 60 minutes of calls to fixed and mobile networks and 60 SMSs. Customers of Free's fixed broadband service received the offer without charge.

The offers at launch were SIM-only without a commitment with customers welcome to bring their own devices. At the same time, if a customer wanted to purchase a mobile telephone from Free Mobile, these could be paid outright upfront or over four, twelve, twenty-four or thirty-six payments. Though Free has stores, its offers are purchased mostly via the Internet and via call-centers.

The response from consumers to Free Mobile's offers was very positive. In two years Free Mobile achieved a market share of 12%, which is significant for a new entrant especially given the large expansion in subscriptions stimulated by increased competition. These customers did not only come from the other existing operators. The changes generated new customers that previously did not have a mobile telephone service and others that took a second subscription. An important element was the offer at EUR 2 making mobile communications affordable for any consumer for which this had previously been a barrier. In addition, the offer at EUR 19.99 for people wishing to shift from a 'feature phone" range of services to those of a "smart phone" made this service far more affordable for many consumers. Finally the less expensive offers encourage existing customers or new customers to shift their mobile services to Free. All this pricing can be considered as elements of a strategy to enter a market with a subscription rate much higher than had been the case for the entry of the third operator and to take advantage of the company's widespread fixed line market share. Subsequently, Free included other improvements to its initial offers, including international calls and international roaming.

The existing MNOs response to the arrival of a fourth player included creating alternative SIM-only brands: Bouygues – B&You (launched July 2011), Orange – Sosh (October 2011), SFR – Joe and Red (October 2012), which offered their services only via the Internet and had similar bundles to Free Mobile.[69] In France, these offers were without commitment periods, such that today 45% of subscriptions are without commitment periods, meaning the consumer can switch to another operator at will (Figure 4). They also restructured and lowered the pricing of their "home brand" offers to meet the more competitive environment. In addition, consumers became more aware of the pricing of 'subsidised' handsets, compared to SIM-only offers, placing further competitive discipline on subscription prices. In response to Free these offers were subsequently improved with international calls and international roaming. Finally, the entrance of a fourth player in the mobile market has intensified competition across a full range of services where previously the three MNOs had an advantage if they chose to exercise it. This is exemplified by the development of offers from Bouygues Telecom.

**Figure 4. Percentage of customers using a subscription without commitment period**




*Source*: ARCEP

In 2009, Bouygues Telecom introduced the first quadruple play offer in France. The next year the company launched Bbox fibre, its very-high-speed broadband offer on the network of Numericable and began investing in Fibre-To-The-Home in high-density areas with Orange and SFR and in medium density areas with Orange. In 2012, the company launched 4G mobile services and, by 2014, said it had the widest coverage in France. These developments have made Bouygues Telecom a full service provider for business and consumers. By way of example, in April 2014, the company launched a fixed service plan for businesses with fewer than 10 staff costing EUR 44.90 over fibre or VDSL.[70]

Peak broadband speeds for the offer are 200 Mbps and there are two fixed lines with unlimited calls to fixed and mobile numbers in France, Europe and overseas French territories, Canada, China as well as the United States and to fixed numbers in 121 other destinations. The offer included a Bbox Pro Ultra dedicated gateway, Microsoft Office 365 for Business and other software (Norton Internet Security) as well as the ability to create a website with Microsoft SharePoint with an included .fr domain, have up to 50 GB of storage or their Exchange of e-mails, video conferencing and IM through Microsoft Lync. Finally, 2 GB a month of 4G mobile data was provided as a back-up in case of any landline downtime.

Other market parties reacted by pursuing a strategy of differentiation and quality for example, by bringing forward their 4G deployment plans. Free Mobile had not been successful in the 800 MHz LTE auction, which limits it to the 2.6 GHz band that has less coverage. In March 2012, Bouygues Telecom announced the roll out of 4G and SFR became the first with a commercial launch in November 2012.[71] Orange stated that it doubled its investments in 4G in 2013, compared to what it had initially planned.[72] By 2013, the three incumbents had all launched 4G coupled with new bundled and optional services to take advantage of the additional capacity but with a premium price based on their ability to differentiate their services and coverage. For its part, Free Mobile launched 4G in December 2013, but continued with its strategy of offering additional value and innovation without changing its pricing.[73]

In addition to stimulating new investment in mobile infrastructure the competitive market in France has encouraged some players to seek network-sharing agreements. In July 2013, SFR announced it had entered exclusive talks with Bouygues Telecom "to share parts of its mobile networks."[74] They cited the "profound changes" affecting the telecommunication market as the motive for the talks with commentators

noting any agreement could offer the two companies greater coverage and quality of service to offer their customers. The agreement, which was subsequently concluded in January 2014, is projected to save both companies USD 410 million per year from 2017-2018. This will be accomplished by sharing infrastructures outside dense urban areas.[75]

SFR and Bouygues Telecom will create a joint venture company to operate 11 500 mobile towers covering 57 per cent of the population, eliminating 7 000 towers between them. They plan to share cell sites and antennas but not spectrum or core elements of the network, which they say will allow them to offer differentiated services to consumers. The two companies said the new arrangements would require an initial increase in capital expenditure but substantial savings over time and improved performance for customers.

ARCEP welcomed the agreement between SFR and Bouygues Telecom, noting that mobile network sharing was encouraged, under certain conditions, in the terms of the 4G spectrum licenses that it established in 2011.[76] The regulator said that at a time when market competition was increasing and operators' expenditures continue to be high, especially for 4G network rollouts, resource pooling agreements could provide MNOs with a way to reduce their costs and increase the benefits passed onto users.

ARCEP said, however, it still needed to establish that certain conditions have been met. First, the two operators must remain independent from one another, in both their business strategies and sales. Second, they needed to ascertain that the agreement would not squeeze certain competitors out of the market. Finally, ARCEP said the agreement must result in better coverage and quality of service provided to end-users and that these improvements would need to be quantifiable and verifiable over time. Accordingly, ARCEP indicated that it would work with the Competition Authority to ensure these conditions would be met. One issue will be whether additional MNOs are able to join with Free Mobile subsequently requesting that it be able to do so.

***Israel***

In recent years, the Israeli mobile market has been transformed into being one of the most competitive in the OECD area. In 2014, there are five MNOs:

- Pelephone is part of the incumbent telecommunication operator Bezeq. In the 1980s it offered analogue services and later converted this to CDMA. It ceased CDMA services in 2009, when it launched a UMTS/HSDPA network in the 850 MHz and 2100 MHz. In May 2014, it was reported that Pelephone had finalised a network sharing agreement with Cellcom, which will be submitted to the Ministry of Communications and the Antitrust Authority.[77]

- Cellcom, the second market entrant, commenced services in 1994. It used a TDMA-850 network, but obtained a GSM-1800 license and later one for UMTS-2100. The TDMA network was decommissioned in 2011, with UMTS/HSDPA now deployed in the 850 MHz range. Golan Telecom roams on the networks of Cellcom. As noted above, in May 2014, it was reported that Cellcom had finalised a network sharing agreement with Pelephone, which will be submitted to the Ministry of Communications and the Antitrust Authority. It is also in talks with Golan Telecom on network sharing, no agreement has however been finalised at the time of writing.

- Orange/Partner, the third entrant, commenced service in 1998. It was the first network to use GSM in Israel. The initial owner was Hutchison Whampoa, which owned the Orange brand at that time, and licensed it to its Israeli subsidiary. Though Orange was sold to Mannesmann and then to France Telecom, the license remains for the Israeli company. Today Orange/Partner is majority

owned by Scailex Corporation. Orange SA of France is not a shareholder in the company, but continues to license the brand.

- Hot Mobile is a continuation of MIRS Communications and started public services in 2001. It used iDEN (Integrated Digital Enhanced Network) a proprietary technology of Motorola. iDEN was not compatible with more commonly used 2G/3G/4G mobile telephones. It was the smallest mobile operator but had exclusive contracts with several large customers. The cable company HOT, a subsidiary of Altice, the new owner Numericable in France, purchased MIRS in 2010. Subsequently, HOT activated a GSM network and obtained a 3G license in 2012. It has a roaming agreement with Pelephone until 2014. In 2013, it announced a network sharing agreement with Orange/Partner, which is subject to regulatory approval.

- Golan Telecom commenced operations in 2012. Initially it had lost its bid on a 3G license, but when other networks failed to meet the financial terms of the spectrum license, it was able to obtain that in 2011. The CEO of Golan Telecom, Michael Golan, is a former executive with Iliad/Free of France and Xavier Niel, the majority shareholder of Iliad, is said to be an investor in Golan Telecom. The offer with which Golan Telecom entered the market is very similar to that of Iliad/Free Mobile, with both networks being launched in the same year. Golan Telecom has a roaming agreement with Cellcom and is in talks with Cellcom about a network sharing agreement, which might also include Pelephone.

Until 2012, the mobile telecommunication market of Israel effectively consisted of Pelephone (29%), Cellcom (34%) and Orange/Partner (32%).[78] MIRS had 5% of the market but its use of a proprietary technology had been overtaken by market developments and limited it to a small share. More generally, retail and termination prices were relatively high, though penetration and domestic mobile telephony usage (as measured by minutes per user) were also high.

In 2012, the introduction of what were effectively two new MNOs had an immediate and significant effect on the market. Other critical reforms were the introduction of number portability and a lowering of termination charges. In addition, the Ministry amended the regulatory framework to allow provision of services by MVNO's and two of Israel's leading supermarket chains began offering services as MVNO's.

The most observable changes in the Israeli market have been the more competitive pricing following the entry of new operators. The OECD Communications Outlook (2011) ranked Israel among the most expensive countries in the OECD for high usage baskets. In the OECD Communications Outlook (2013) Israel was ranked among the least expensive countries for the mobile broadband baskets.

Both Golan Telecom and HOT Mobile entered the market with new offers that were significantly more attractive than those of the incumbents. They did, as with recent entry in France, of course need to attract customers away from existing players in a market where there was a high penetration rate. In Israel, however, there was an additional incentive to attract customers through both lowering prices and offering greater included value for which the market had demonstrated a preference (i.e. the first unlimited offers based on lower termination rates suited customers demonstrated demand for higher usage levels). The government had further stimulated the new entrants to do so by requiring them to make a deposit of approximately USD 100 million and USD 200 million of which they would get $1/7^{th}$ back for each percentage market share obtained over a two year period. If they achieved 7% market share the full amount would be returned, which was approximately 350 000 3G subscribers.[79] Both companies have had their deposits returned having successfully met these targets.

The entry offers of Golan Telecom and HOT Mobile were NIS 99 (USD 28.5) and NIS 89 (25.6) respectively per month, for unlimited minutes and SMS, with 3GB of data. Furthermore, Golan Telecom

included unlimited calls to fixed lines in 29 countries.[8081] A report, by "The Marker", showed that a package of approximately 400 minutes, 400 SMS and 1GB would previously have cost NIS 250 – 300 (USD 71 – 86) per month.[82] In the second quarter of 2014, both Golan and HOT Mobile offer NIS 59 (USD 16.99) introductory offers, which can last six to nine months. Golan Telecom even had an offer, which was NIS 35 (US 10). Other operators typically now offer subscription varying between NIS 89 and 129. The changes were best reflected in a statement by one of the incumbents. Cellcom, in an investor presentation, characterised it as a reduction from NIS 280 to between NIS 59 to 69 bundles.[83]

In France, rivals have generally concentrated on adding more value to packages but, more or less, maintained entry price levels. In Israel, there appears to be more emphasis on price competition especially for time limited or introductory prices. There is some differentiation in pricing strategies. Golan Telecom, for example, is the only MNO that includes international calls as part of its bundle. International calls from mobile telephones, which were once rare, are commonplace because of Golan's offer and reduced metered prices. HOT Mobile, on the other hand, has focused on integrating its fixed and mobile bundles as well as having low price offers. In some areas competitive affects are more uniform. The three incumbent operators, for example, all have more attractive international roaming deals than they previously offered. Like France there is significant innovation and new services include "virtual numbers" allowing for incoming calls from abroad on foreign numbers. Nonetheless, much of the current marketing strategy appears to be around pricing for SIM-only offers, where lower prices -- as opposed to primarily additional value being added -- are proving attractive for customers. This may be an outcome of five rather than four MNOs.

To reduce costs and facilitate the roll out of 4G networks, all mobile operators have announced network-sharing agreements. In November 2013, the first such announcement was made between HOT Mobile and Orange/Partner for their 4G infrastructure. This was perhaps somewhat unexpected given that HOT Mobile currently uses the Pelephone network but reflects the high degree of competition, including in finding partners. A month later, Cellcom, Golan Telecom and Pelephone announced a network sharing agreement for their 4G-network infrastructure. In May 2014 it was reported that Cellcom and Pelephone had submitted a proposal for network sharing to the Ministry of Communication and the Antitrust Authority for approval. Talks with Golan were still on-going.[84]

At the time of writing, all the proposed network sharing agreements are under consideration by authorities to determine if they are consistent with policy objectives, such as ensuring sufficient competition. However, the Israeli media reports that the agreement between HOT Mobile and Orange/Partner will likely be approved, with some stringent conditions. The agreement between Cellcom, Golan Telecom and Pelephone may, however, not be approved, because authorities do not want a tie up between two of the largest networks in the country. This might leave Pelephone alone.[85] At the same time, the media reports on prospective mergers that, at the time of writing, are denied by the various players involved.

The entry of new operators has been positive for investment. In 2013, for example, Orange/Partner, reported that investment was NIS 475 million, slightly down from NIS 492 in 2012, but up from NIS 471 in 2011 and substantially up from NIS 395 in 2010. In 2013, the company's free cash flow was roughly at the same level as in in 2011. For its part, in 2013, Cellcom stated that its free cash flow continued to increase despite competition and that it had reduced its debt significantly in that year. Its parent company, Bezeq too reported an increase in free cash flow, though this was across all business units, not just mobile.

All incumbent operators have reported declines in total revenue since the entry of new MNOs. In Israel, however, the regulator sets the mobile and fixed termination rates. In 2011, the mobile termination rate was lowered from 0.27 NIS to 0.073 NIS. Further, in 2013, the fixed termination rate was lowered from about 0.03 NIS to 0.01 NIS. These changes need to be considered in any comparison of revenue, before and after the arrival of new MNOs. This is because reductions in termination rates affect both revenue and costs.

Fixed broadband is still a duopoly, in Israel, though speeds are increasing (17 Mbps average purchased speed). A European-style wholesale market is being prepared for consultation, which should increase competition in this sector as well as enabling MNOs without fixed partners to offer bundles in a more competitive environment.

***Luxembourg***

The Luxembourg market has four licenced spectrum holders offering mobile services. These are:

- POST Luxembourg, a wholly state-owned public company since 1992, which began offering cellular services in 1985. It is the largest player in the market with our 250 000 subscriptions.

- Tango Services, a Luxembourgian subsidiary of Belgacom began offering service in 1998 and is the second largest player in the market. The company reported 280 000 mobile customers in 2013.[86]

- Orange Luxembourg, is a 100% subsidiary of Mobistar, whose major Shareholder is Orange, France.[87] It has been operating in the Luxembourgish telecommunication market since May 2004. At the end of December 2013, Orange Communications Luxembourg had a total of 102 000 active mobile telephony customers aiming for a 90% population coverage by beginning 2015.

- JOIN Experience is a 50/50 joint venture between JOIN Wireless and POST Luxembourg.[88] JOIN Wireless commenced 4G services in 2014 following the reception of a license in 2013.[89]

By 1998, in the then European Union area, all Member States had at least three or more mobile operators, except Luxembourg. Those countries with duopolies, prior to that time, complied with legislation dealing with further mobile licensing under the 1996 Article 90 Directive by licensing an additional operator using the DCS 1800 standard.[90] As Luxembourg had a monopoly it complied by licensing a second operator using this standard, hence the entry into the market of Tango.

In 2002, following a "beauty contest", UMTS (3G) spectrum was awarded to three applicants (Post, Tango and Orange) with there being no bidder for a fourth license. In its assessment of market conditions, at the time, the European Commission concluded that, on average, 3G licensing allowed for one additional mobile operator per market in Europe, a key area of regulatory focus.[91]

A characteristic of the market in Luxembourg is the high penetration rate for mobile subscriptions. In recent years, the country has averaged around 1.5 subscriptions for every inhabitant. This is the fourth highest in the OECD. A major contributing factor, in this outcome, is believed to have been the purchase of subscriptions by users residing in neighboring countries but travelling frequently to Luxembourg. At the time of its market entry, Orange stated the roaming traffic was a major attraction to enter the market.[92]

While always challenging to assign causation, it can be observed that the third and fourth largest operators have led to increased competition and innovation in the Luxembourg market. International roaming is a good case in point. On 28th August 2013, Orange Luxembourg announced:

> "Exclusively for Luxembourg and only to be offered with Orange, roaming Europe (all communications within Europe) is included in all Hello Europe schemes, without additional cost. Clients travelling abroad, for a day or longer, can call and send SMS within Europe, as if they were in Luxembourg. These calls and SMS will be accounted from their allowance, without further billing (within the contractual limits). This advantage is granted automatically to all existing Hello Europe subscriptions. Clients may also continue to use their included allowances for calls and SMS to Europe*, from Luxembourg."[93]

This tariff initiative by Orange, Luxembourg, was the first mobile operator to enable a European wide roaming offer within a customer's existing bundle. While France's Iliad Free had been the first company, with such an off-net offer, in April 2013, the offer was at that sage limited to Portugal. In addition, it was two days before "3UK" announced its similar offer for seven countries around the world on 30 August 2013. What set all these offers apart was that they included off-net (i.e. roaming on the networks of other unrelated companies) in an existing bundle.

The timing of Orange Luxembourg's offer followed the establishment of Join Wireless, after their successful application for a 4G license, in June 2013. While the move by Orange Luxembourg was ahead of Join's launch of service, in January 2014, it can be noted that the company did it in Luxembourg prior to other markets in which the company operates – including as the incumbent and largest player in France. In that country, Orange France introduced roaming as an included service within its post-paid bundles in January 2014, for European destinations, following the introduction of similar services by smaller rivals.

The entry of Join Wireless, as a fourth operator, is also related to changes in the European roaming market. While the incentive for the three incumbents is to change roaming offers to retain customers that are likely to give up one of their subscriptions, as roaming decreases or is eliminated in Europe, as a new entrant this is not the situation for Join Wireless. Join Wireless needs to attract new customers in a market with among the highest existing penetration. The company has been open with its business plan and objectives:

> "Launching in the Grand Duchy, the telecommunications provider hopes to expand to Belgium, Germany and France, with people living in the border region and often switching between networks a prime target market …. Over the next four years the 3.0 provider wants to attract around 200 000 customers in a region of around 10 million inhabitants."[94]

This development is a significant one in that it is likely that this is the first time, in an OECD country, that a mobile operator has been licensed with a business plan reliant on gaining a market share potentially larger in foreign countries rather than from a domestic market. The company's ambitions are also to offer machine-to-machine services to business customers as a significant part of its target market and to take advantage of cloud-based services and 4G technology. This business plan is uncertain, as it would depend on the use of international roaming or MVNO wholesale inputs to compete in other countries with national providers. In many OECD countries, these wholesale inputs are often not regulated, and where they are regulated (as it is the case of the EU), the use of these wholesale services are restricted to its use for roaming services. Though uncertain it is interesting that entrepreneurs see potential for such business model. While this strategy is reliant on being able to reach agreements with wholesale providers in other countries it has substantial potential benefits for Luxemburg through the introduction of a fourth operator focused on international markets. In that light it can be seen as similar to the pioneering move by the Netherlands in the reforms that they have made to the management of IMSI numbers that went in to force in March 2014.[95] In both cases the changes enable firms in these countries to have potential first mover advantages through expanding the number of licensed players in a particular segment (i.e. a fourth operator or greater flexibility for M2M users.

### *Sweden*

There are four MNOs in Sweden and they have some of the most active and long-standing arrangements for network sharing in the OECD area. These networks are TeliaSonera, Tele2, Telenor and Hi3G . The experience of Sweden can be valuable to policy makers considering the greater use of network sharing by MNOs, as an alternative to mergers as a means to reduce costs, particularly associated with expanding coverage, while ensuring robust competition.

In the 1970s, Sweden became one of the first countries in the world to introduce a second operator in mobile telecommunication services. At that time, Televerket, used the analogue Nordic Mobile Telecommunication System (NMT) while the competitior Comvik used a proprietary US based system. Following the process for licensing GSM, they were joined by a third MNO called Europolitan, which was also a new regulatory approach as two GSM licenses was the general case in most countries. In 1993, the incumbent (Televerket) was corporatised with the name Telia and today it has the largest market share. Comvik and Europolitan, through acquisitions and mergers became Tele2 and Telenor respectively, each of which is currently active in the market with the second and the third largest market shares.

In 2000, when 3G licenses were distributed, Telia had approximately a 50% market share. Nonetheless, the company was not successful in gaining a licence for 3G spectrum, in a comparative beauty selection process. Instead, Tele2 and Telenor were joined by Hi3G (owned by Hutchison (60%)-and Investor (40%) and Orange as the successful applicants (Table 6). This was said, at the time, to be the only example around the world of an incumbent not being awarded a 3G license either through a comparative selection or auction process. The implications for Telia were so substantial it became a major consideration in the company merging with Finland's incumbent (Sonera) to form a new enterprise TeliaSonera. Critically, for the development of network sharing, it also led the company to introduce a scheme that had not been used for the previous generations of technology in the country and to strike a deal with Tele2.

**Table 5. Competition, spectrum and network development in Sweden**

| | TeliaSonera | Tele2 | Telenor | Three |
|---|---|---|---|---|
| History | It was founded by a merger between Telia and Sonera in 2002, both of which were national dominant carriers in Sweden and in Finland respectively. | The company first started fixed telephony in 1993 and merged with a competitive mobile operator Comvik in 1997. | One of the first GSM operators in the country (Europolitan) was aquired by Vodafone and then purchased by Telenor in 2006. | It was established in 2000 by Hong Kong-based Hutchison Whampoa and Swedish Investor AB |
| Market shares in 2000 | 51% | 32% | 17% | - |
| *3G: Spectrum allocations and network developments* | | | | |
| Spectrum licensed in 2001 | - | 15 MHz in 1920-80 Mhz<br>15 MHz in 2110-70 MHz<br>5 MHz in 1900-20 MHz | 15 MHz in 1920-80 Mhz<br>15 MHz in 2110-70 MHz<br>5 MHz in 1900-20 MHz | 15 MHz in 1920-80 Mhz<br>15 MHz in 2110-70 MHz<br>5 MHz in 1900-20 MHz |
| **Network sharing JV** | **Svenska UMTS AB, 2001** | | **3G Infrastructure Services AB, 2001** | |
| Service launch | Mar 2004 | Jun 2004 | Feb 2004 | May 2003 |
| Coverage in January 2005 | 86% | 86% | 84% | 84% |
| Mobile voice and data: Market share in June 2008 | 43% | 32% | 18% | 6% |
| MBB: Market share in June 2008 | 40% | 22% | 15% | 21% |
| *LTE: Potentially available spectrum and network developments* | | | | |
| FDD 2600 MHz, May 2008 | 40 MHz | 40 MHz | 40 MHz | 20 MHz |
| TDD 2600 MHz, May 2008 | - | - | - | 50 MHz (purchased from Intel in Dec 2010) |
| FDD 800 MHz, Mar 2011 | 20 MHz | 20 MHz | | 20 MHz |
| FDD 900 MHz, May 2011 | 20 MHz | 15 MHz | 15 MHz | 10 MHz |
| FDD 1800 MHz, Oct 2011 | 70 MHz | 70 MHz | | - |
| **Network sharing JV** | **-** | **Net4Mobility, Nov 2011** | | **-** |
| Service launch | Dec 2009 | Nov 2011 | Nov 2011 | Dec 2011 |
| Time on LTE measured by OpenSignal, Feb 2014 | 57% | 93% | 85% | N/A |
| Mobile voice and data: Market share in June 2013 | 39% | 29% | 17% | 11% |
| MBB: market share in June 2013 | 34% | 25% | 23% | 15% |

*Source*: OECD

As a result, extensive network sharing has played a major role in the Swedish mobile telecommunication industry since the turn of the century – a development welcomed by all stakeholders. It is said, for example, to be one of the reasons behind the high coverage of advanced mobile networks, namely almost 100% of 3G services and 99.2% of LTE services by October 2013. It has also contributed to the rapid adoption of mobile broadband, with Sweden's penetration ranked third in the OECD in June 2013, not least because consumers have a greater range of MNOs with comparable network coverage from which to choose.

One characteristic of the Swedish market is that there is coverage in areas with lower population density by multiple providers. A major factor in this outcome has been the lower cost to deploy this infrastructure. In addition, the use of municipal fibre networks has played an important role in making essential infrastructure available. At the same time, investment by mobile operators guaranteed the needed revenues for extensions to the municipal networks that would support local connections as well as base stations. Local communities also often required mobile operators to co-operate in network development as

municipalities wanted to avoid duplication of facilities such as towers in their areas due to environmental concerns.

There are a number of initiatives for sharing 3G-network infrastructure and operation in Sweden. The first one is a joint venture UMTS-nät AB (Sunab) formed by TeliaSonera and Tele2 that followed Telia's unsuccessful application for a 3G spectrum license. This enabled Tele2 to take advantage of Telia's historically accumulated network assets, which proved beneficial for 3G-network deployment. By sharing 3G facilities newly built on those assets with a rival, Tele2 was able to significantly reduce the amount of investment and operational cost required for national 3G coverage. At the same time, network sharing was also beneficial for TeliaSonera, as it could provide 3G service without a spectrum license and without the substantial costs that would have been necessary if it had built the infrastructures itself. Under the arrangement, the Radio Access Network (RAN) including spectrum and backhaul are shared in addition to passive infrastructures. Given that the joint venture only involved one 3G licence there were no restrictions to establish a network with national coverage.

The second was a joint venture (3G Infrastructure Services - 3GIS) established between the other three successful applicants for a 3G licence: Vodafone (now Telenor), Hi3G and Orange. Orange withdrew its license and exited from the Swedish market in 2003 without commencing service. This was at a time when its parent company had taken on a large amount of debt, in the lead up to the bursting of the dot-com bubble, but the other two MNOs continued with the arrangement. Under the scheme, shared components of the resources range widely from passive infrastructures such as masts and sites to active ones such as backhaul and even spectrum resources allocated individually to each operator. It has been particularly beneficial for Hi3G as it was a completely new entrant, at the time of 3G licensing, and had to rely on existing networks to swiftly expand coverage. The license holders were obliged to establish their own networks so that they cover 30% of the population while the 3GIS network covers the remaining 70%, having implied that 3GIS' network covers smaller cities and rural areas.

Tele2 and Telenor developed a third network sharing arrangement for their investments in 4G (Net4Mobility). It went further than previous arrangements, because the two competitors bought 4G spectrum jointly and brought existing licenses in the 900 MHz, 1800 MHz and 2600 MHz into the venture. This network has, like predecessors, made extensive use of existing municipal networks to attain coverage objectives. In November 2010, the network entered service at a time when very few had commenced 4G networks in the world.

The take up of 4G services has proceeded apace in Sweden. Tele2 has indicated that LTE-enabled handsets accounted for 84 per cent of the sales of post-paid residential contracts in 2013. The amount of time spent on 4G networks is also high. OpenSignal, for example, collects actual data on mobile coverage and performance through monitoring a user's smartphones and the time they spend on LTE (i.e. the proportion of time a user has access to the LTE network). Its results for Sweden, are outstanding for Tele2 and Telenor, with a score of 94% and 85% respectively.

Despite a relatively wide range of shared network resources that might affect the incentives for different players to compete on the retail market the available evidence suggest the Swedish market has retained a healthy degree of competition. The OECD Communications Outlook 2013 recorded that consumers in Sweden can enjoy competitive prices across a range of baskets relative to peers in other countries. For example, with the consumption of 2GB per month by tablet, Sweden had the third least expensive offers in the OECD area. Smaller usage patterns are similarly placed and this has contributed to the high mobile broadband penetration rate.

PTS, the telecommunications regulator, has been positive towards network sharing as it has contributed to a better geographical coverage than might otherwise be expected, while retaining greater competition. PTS also believes the arrangements have other benefits. As the network sharing agreements are commonly very detailed and involve substantial financial commitments, they enable the regulator to have predictable conditions as well as a transparent regulatory framework and supervision. For these reasons, the PTS took into account the possibility for network sharing prior to the turn of the century, as a tool to realise almost 100% of population coverage as a condition to be imposed on 3G spectrum licenses based on offers from the operators at the beauty contest in 2000 as the selection mechanism for spectrum allocation. There was still limitation though, as until March 2011, no more than 70% of a network could be shared by a joint venture formed by multiple licensees, but the PTS subsequently made it more flexible by lifting that limit.

From the viewpoint of competition dynamics, it can be noted that Sweden has always ensured that there have been at least two networks co-existing. At the same time, it seems that operators have chosen to form joint ventures when partners are in almost equal position in terms of market power. For the sharing by Svenska UMTS, TeliaSonera had the drawback of not having a license and Tele2's market share was far smaller than TeliaSonera.

For the other sharing schemes, partners had almost the same amount of spectrum that can be used for the deployment of the service. In other words, there was little monopoly power raised by network sharing thanks to these factors.

These cases suggest that sufficient competition can be maintained with network sharing frameworks, even if they cover all geographical areas and share spectrum bandwidth that have been originally allocated to individual operators. One of the key points that may be applicable to other countries could be that these sharing agreements in Sweden were made before starting to build the network. They also went through careful examination by the Competition Authority and the regulator, including looking at the details of agreements. Undoubtedly, if Sweden had wanted to force certain existing network facilities to be shared between competitors then it would have faced much greater challenges than were actually experienced. The involvement of the authorities and the operators from the very first stage of network development was one of the main factors of the success of this model in Sweden.

***United Kingdom***

Since the 1990's the mobile market in the United Kingdom has benefitted from a significant level of competition with new entrants vying to gain market share from established providers. In 1993 and 1994 One2One (which later became T-Mobile, now part of Everything Everywhere - EE) and Orange (also now EE) entered the market, doubling the number of MNOs. In 1997, the early introduction of mobile number portability made it easier for consumers to switch between providers, further increasing competitive intensity. In 1999, Virgin Mobile, the world's first MVNO, launched services in the United Kingdom.

In 2000 five licences for 3G spectrum were auctioned. The licence, which provided the greatest amount of spectrum (2x15Mz of paired spectrum, plus 5 MHz of unpaired spectrum), was reserved for a new entrant, allowing Hutchison 3G to enter the market using the "Three" brand in 2003. In doing so it became the fifth MNO in the United Kingdom. Three used disruptive pricing to gain market share, and its entrance had a downward effect on prices from which consumers continue to benefit. It also introduced a number of new services to attract customers often being the first mobile operator globally to do so (Box 2).

The wholesale market in the United Kingdom also developed in a manner that favoured competitive dynamics. When BT, the incumbent fixed operator spun off its mobile network (O2 formerly BT Wireless) in 2001, it no longer had an incentive to favour any MNO.[96] Moreover, having five national MNOs not

only contributed to a vibrant retail market but also a highly competitive wholesale market. Since 2000, MVNOs such as Tesco Mobile, Lycamobile and Lebara have entered the market, and now account for around 15% of mobile connections. Some of them (e.g., Tesco Mobile) have started to offer 4G services.

In 2010, T-Mobile and Orange merged to form EE and the number of MNOs fell from five to four. EE is now the largest MNO, with around a third of wholesale connections. A condition of the merger was that EE was required to divest some of its spectrum, and in autumn 2012 it sold 2x15Mz of 1800 MHz spectrum to Three. Therefore, although this divestment remedy did not result in a new entrant to the market, it was effective in strengthening the position of the fourth player in the market.

In October 2012, EE was the first MNO in the United Kingdom to launch 4G services, using 1800 MHz spectrum. The other three mobile network operators all launched 4G services in 2013, and since the merger the market share of EE has fallen slightly. Following the merger there has also been a small increase in the retail market share of MVNOs/resellers. MNOs have also sought to reduce costs through network sharing agreements.

**Box 2. The role of a new entrant in driving competition**

Three (3UK) provides a useful case study of the role of a smaller disruptive operator in driving competition in a mature market. Since launching in 2003, 3UK has been very significant in driving both innovation and price competition in the United Kingdom. Innovative products and tariffs which 3UK has launched and which have had a major influence on the UK market include:

- The X-series packages launched in 2006, which offered access to a number of Internet applications. As part of this it partnered with Skype and was the first United Kingdom operator to permit mobile VoIP services. This was followed, in 2007, by enabling customers to use a Slingbox.
- Mix & Match tariffs launched in 2007, offering consumers a new range of flexible tariffs at market-leading rates, whereby consumers could mix text messaging and voice minutes (1 minute = 1 text) and choose from a range of handsets (e.g. Nokia 6500 at no additional cost; Nokia N95 at an extra USD 15 (£9) per month).
- In 2007, 3UK was the first MNO to push mobile broadband services to non-business consumers. Initially this was through mobile broadband dongles, where it held more than 50% market share.
- In 2010, 3UK launched "The One Plan", a smartphone tariff which offered unlimited data for smartphone users. By 2011, 97% of the networks traffic was data and the company was said to carry 40% of all such traffic in the United Kingdom.[97] Average data use across Three's 8 million customers was an industry-leading 2GB per month in December 2013.
- In 2013, 3UK launched 4G services and was the only UK operator committing to not charging a premium for 4G over 3G.
- In 2013, 3UK launched "Feel at Home" which scrapped roaming charges in 11 countries such that customers could use their existing bundles.

3UK has also been innovative in terms of challenging the industry cost structures. This has resulted in 3UK having EBIDTA margins that are close to those of the other MNOs (22.0% in H2 2013) in the United Kingdom, despite being a third to a quarter the scale of its peers. Innovations include:

- In 2005, 3UK was the first MNO in the United Kingdom to outsource its network management, agreeing a deal with Ericsson.
- The network share agreement with T-Mobile announced in 2008 was the first in the United Kingdom.
- In 2013, 3UK pulled out of retailing its services through Carphone Warehouse (the United Kingdom's largest independent mobile phone retailer), having pulled out of Phones4U (the second largest) in 2012. By the end of 2013, over 95% of contract handset acquisition came from direct rather than indirect channels.

*Consumer Outcomes*

The evidence confirms that a mobile market with four MNOs continues to deliver choice and value to consumers in the United Kingdom. Despite dramatic increases in the capabilities and use of mobile devices, the prices for services have fallen significantly over a decade in which there were five and then four MNOs. For example, the price of a typical bundle of mobile services has more than halved over that period. Today, there is a wide range in the level of mobile services available to meet different patterns of consumer demand. Consumers can buy packages with 4G mobile data, unlimited consumption and bundled smartphones or package with allowances of 150 minutes, 5000 texts and 500Mb of data cost from USD 25 (£15).[98] Ofcom's analysis has found mobile prices favourably with those available in other major economies.[99] This analysis also indicates that mobile prices are continuing to fall, with the total weighted average price of all eight connections, tracked by Ofcom, having fallen by 23% in the United Kingdom in the year to July 2013.[100]

While prices have fallen, use has increased significantly. The volume of voice calls via mobile has more than doubled in the past ten years. The volume of SMS has increased from 24 billion to over 170 billion. Some 92% of adults now use a mobile phone and the proportion of mobile users who have smartphones has also increased, rising from 27% in Q1 2011 to 51% in Q1 2013. The total volume of mobile data uploaded and downloaded across United Kingdom mobile networks more than tripled between March 2011 and June 2013. While the average household expenditure fell between 2003 and 2012 the increased volume has resulted in increased revenue. At a time when, termination rates have substantially fallen total mobile revenue increased from USD 20.7 billion to USD 25 billion (Figure 5).

Investment in mobile infrastructure is continuing apace with all four operators set to have 98% 4G coverage by the end of 2015. All four MNOs have launched 4G services. The licence obligation associated with the spectrum acquired by O2 Telefonica requires it to provide 98% indoor coverage by 2017. However, coverage from all four operators is likely to exceed this requirement. EE has stated that it will achieve 98% coverage by the end of 2014, and the other three operators have all indicated that they will achieve 98% coverage by the end of 2015.

*Looking forward to increased competition*

The 2013 800 MHz and 2.GHz (4G) auctions were designed to maintain the benefits of a four-MNO market. Ahead of the auction, Ofcom conducted an extensive assessment of the implications it might have on mobile competition. As a result of this assessment, it concluded that consumers would be more likely to benefit from better services and lower prices if, following the auction, there continued to be at least four credible national wholesalers of mobile services.

Ofcom had also considered that competition might be weaker if one or more credible national wholesalers were at a disadvantage in competing for certain service and customer segments, as a result of certain limitations in their capabilities as compared with their competitors. As a consequence, Ofcom adopted the following key measures to promote competition:

- It reserved some of the available spectrum in the auction for a fourth national wholesaler, i.e. a bidder other than EE, O2 or Vodafone; and

- It imposed overall spectrum caps so that no operator could hold more than 210 MHz of all mobile spectrum or more than 55 MHz (2 x 27.5 MHz) of spectrum below 1 GHz.

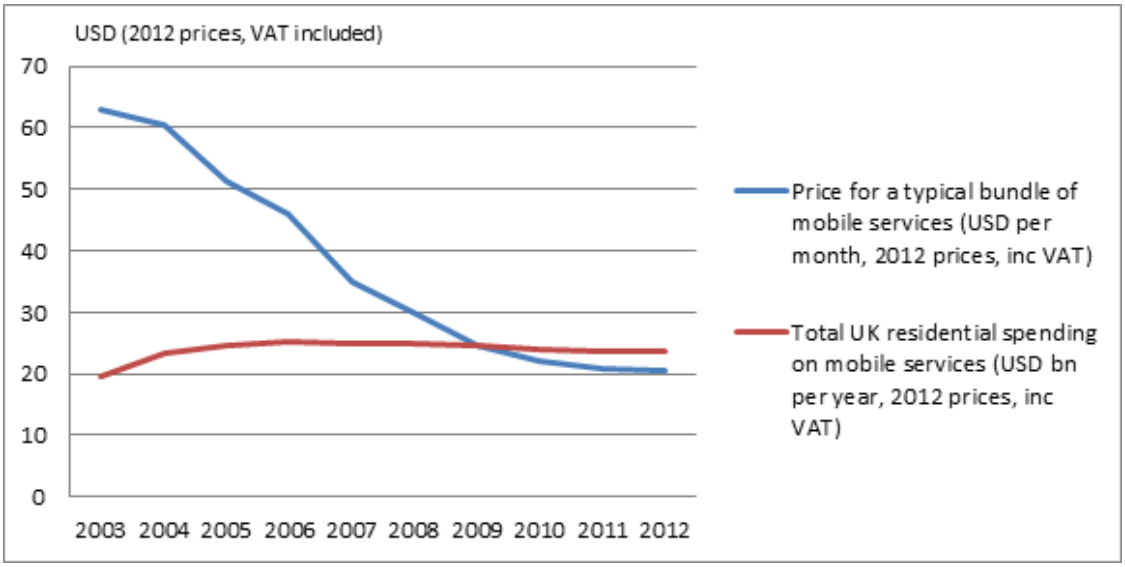
*All four current MNOs have launched 4G*

The outcome of the auction was an uneven distribution of spectrum, both in terms of overall spectrum bandwidth and also in terms of the holdings of spectrum in different bands. For example EE holds 36% of the total mobile spectrum bandwidth available, whereas O2 holds only 15% and 3UK only 12%. However EE holds only 10 MHz of sub 1 GHz spectrum (2x5 MHz of 800 MHz spectrum) whereas both Vodafone and O2 each hold nearly 55 MHz of sub 1 GHz spectrum (2x10 MHz of 800 MHz spectrum plus 2x17.4 MHz of 900 MHz spectrum). However, it is not clear that this asymmetry is contrary to effective competition.

All four of the main MNOs in the United Kingdom have sufficient spectrum in suitable bands to be able to compete effectively; for example, all four of the main MNOs hold spectrum suitable for the deployment of 4G LTE services. Indeed, a degree of asymmetry may actually be beneficial. The fact that some of them have more spectrum of one type and less of another, as compared with their competitors, may have the potential to increase competition, as it is likely to require the different MNOs to adopt different commercial strategies to compete in the market, creating the potential for greater innovation and differentiated competition (and perhaps reducing the risk of tacit collusion).

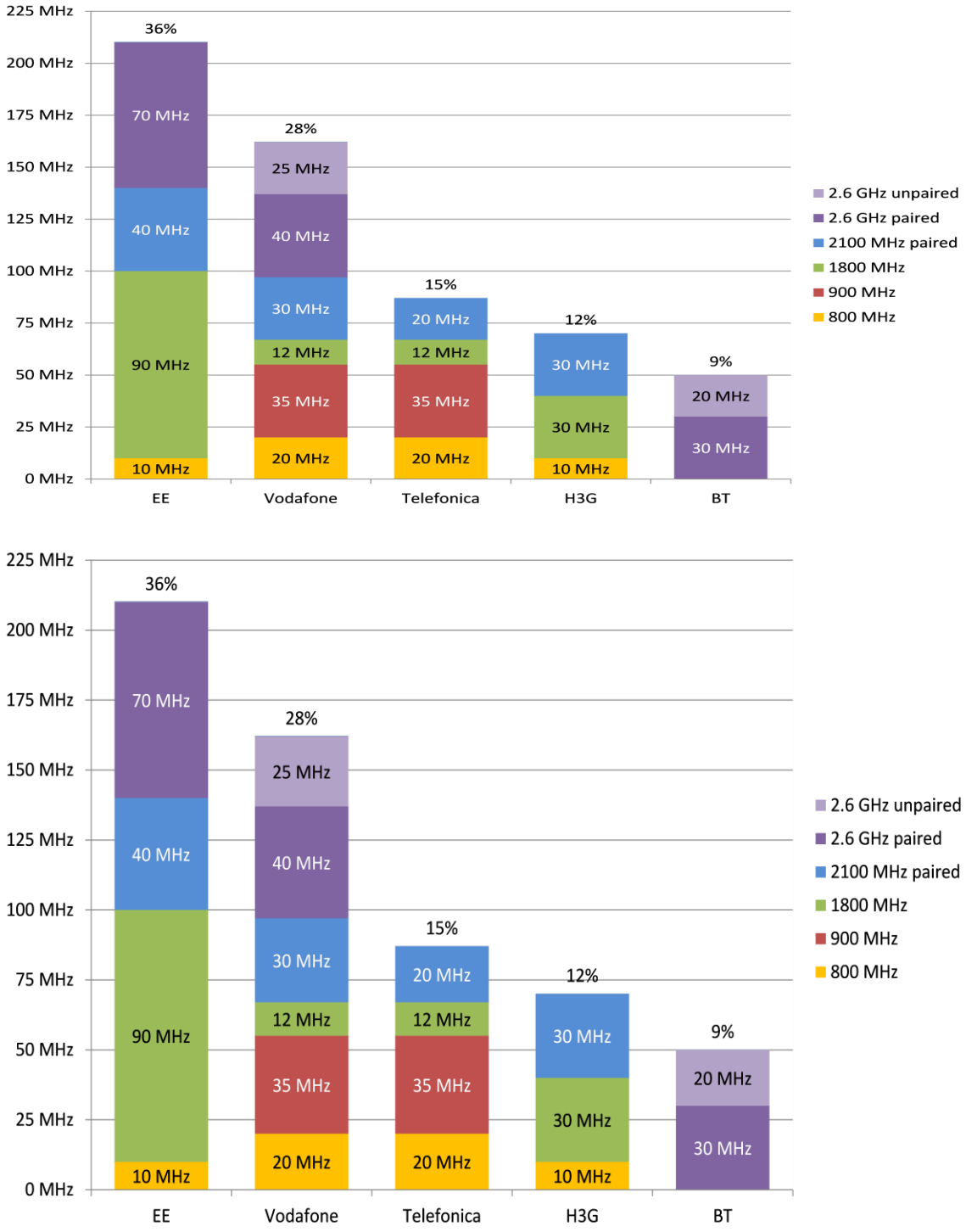
Finally, the 2013 UK auctions also resulted in the award of spectrum to a potential fifth operator – with BT acquiring spectrum at 2.6 MHz. However, it is not clear that this will result in the creation of a fifth national wholesaler providing comparable mass-market nationwide competitive pressure to that of the current four MNOs. While BT has not yet made a public statement of its plans it is likely that its mobile entry will be via a hybrid network deployment, relying for wide area mobile coverage on an MVNO deal, and supplementing this with use of its 2.6GHz spectrum and with its well established Wi-Fi network. The latter comprises over five million Wi-Fi hotspots. (Figure 6)

**Figure 5. Typical mobile prices and residential spending on mobile services**

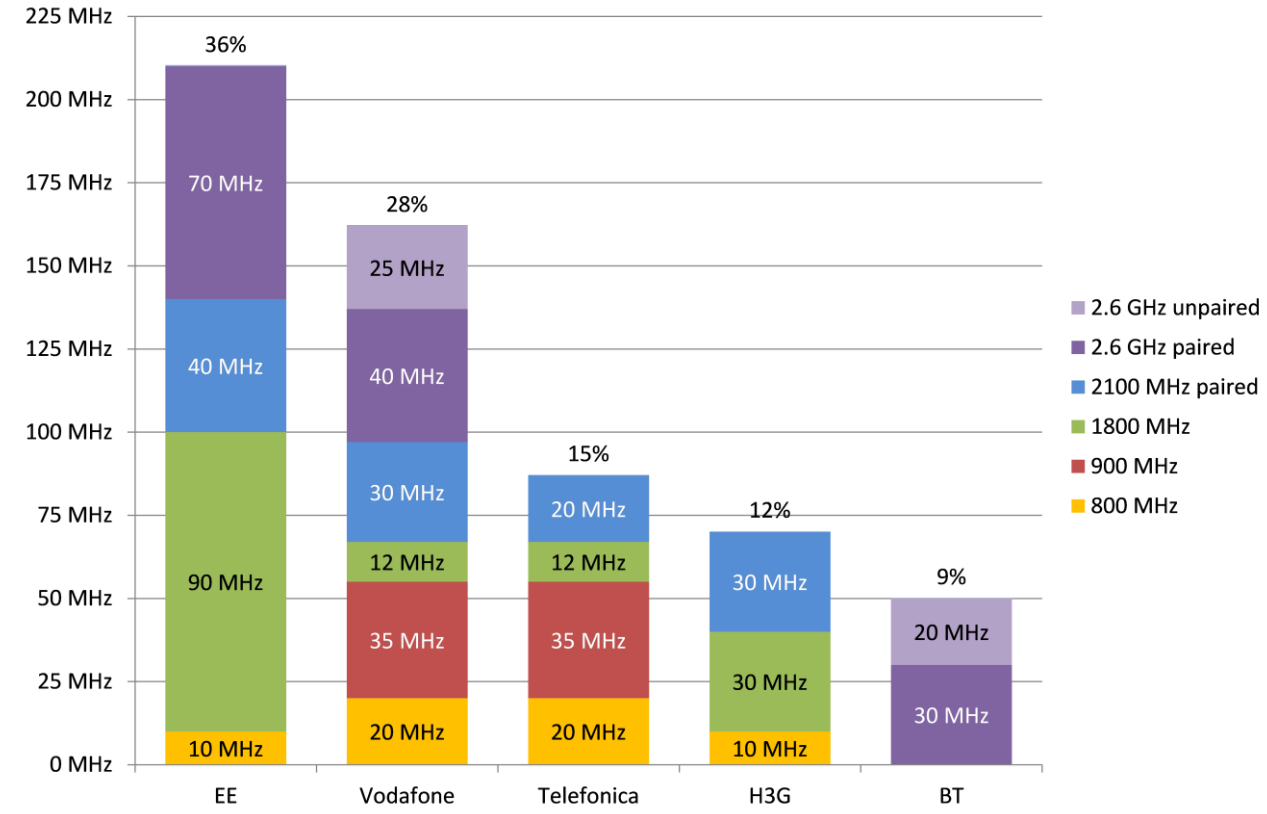



*Source*: Ofcom/Operators Source: Ofcom / operators. Notes: All stated in real terms. Includes estimates where Ofcom does not receive data from operators; adjusted to RPI 2012; includes VAT. The basket is based on average use of line rental and calls (local, national, international and calls to mobiles) in 2012. We calculate the cost of the basket over time by calculating an average cost per unit in each year and applying these to average use in 2012 to give an indication of what this use would have cost in each year.

**Figure 6. United Kingdom mobile spectrum holdings**




225 MHz
200 MHz
175 MHz
150 MHz
125 MHz
100 MHz
75 MHz
50 MHz
25 MHz
0 MHz
36%
70 MHz
40 MHz
90 MHz
10 MHz
28%
25 MHz
40 MHz
30 MHz
12 MHz
35 MHz
20 MHz
15%
20 MHz
12 MHz
35 MHz
20 MHz
12%
30 MHz
30 MHz
10 MHz
9%
20 MHz
30 MHz
EE
Vodafone
Telefonica
H3G
BT
2.6 GHz unpaired
2.6 GHz paired
2100 MHz paired
1800 MHz
900 MHz
800 MHz




*Source:* Ofcom.

### *United States*

The current structure and performance of the United States mobile telecommunication sector has been importantly shaped by two major policy areas: the approach to initial spectrum licensing and the approach to proposed mergers and acquisitions of mobile service operators.

*Initial Licensing*

The Federal Communications Commission (FCC), pursuant to the direction of the U.S. Congress set out in the Communications Act of 1934 (Act) as amended, carries out the initial licensing of spectrum, other than for federal government spectrum. Two aspects of initial licensing of mobile telephony spectrum are notable. First, licenses were generally not national in geographic scope, but rather local or regional. A major reason for this, once auctions became the mechanism by which initial license assignment was carried out, was the legal requirement that auctions be conducted so that a wide variety of bidders have an opportunity to win licenses.[101] Auctions, where only large or nationwide licenses were available, were viewed as not providing an adequate opportunity for bidders with lesser financial resources to bid successfully and participate in the provision of spectrum-based services. This approach meant that the identity of operators differed from one local area to another, and indeed that the number of launched operators often differed as well. Second, auctioning and licensing were structured so that there were a relatively large number of service providers in each local area. For example, by the early 2000s approximately 87% of people lived in counties where five or more mobile operators provided service. Roughly 76% of people lived in counties where six or more operators provided service, and roughly 30% of people lived in counties with at least seven providers.[102]

*Authority over Mobile Telecom Mergers*

Two United States agencies have concurrent jurisdiction over mergers and acquisitions in the mobile telephony sector: the Antitrust Division of the United States Department of Justice (DOJ), which applies the laws generally governing competition issues in the United States and the FCC, which applies relevant parts of the Act.

The DOJ is one of two primary competition policy agencies in the United States. When horizontal consolidations are at issue—proposed transactions that involve parties in the same market—the test the DOJ applies under its legal framework is whether the effect in some market "…may be substantially to lessen competition, or tend to create monopoly."[103] The DOJ essentially functions as a prosecutor. Parties must notify it of a planned transaction, but then the transaction may be consummated unless the DOJ challenges it in federal court, or a voluntary agreement is reached adopting certain remedies, such as divestitures, to ameliorate expected competitive harms.

The FCC's jurisdiction over mobile telecommunication transactions arises from the fact that spectrum licenses are changing hands. The legal test it applies is whether "…the public interest, convenience, and necessity will be served…" by the proposed transaction.[104] Its review embraces competitive issues, other public interest concerns, as well as issues such as the qualifications of the acquiring entity and whether any other parts of the Act or FCC regulations or policies would be violated.

In addition, it is notable that unlike the case with the DOJ, no mobile transaction can go forward until the FCC gives its affirmative approval. This effectively means that under its mobile sector merger review authority, the FCC preserves and promotes the public interest in two different ways. The first is in rejecting—or imposing remedial conditions on—deals that would in fact be harmful to competition and consumers.[105] The second is in promptly approving proposed transactions that would in fact be beneficial to consumers because they do not harm competition but rather allow cost reductions or other efficiencies to be realised. This second aspect of the FCC's mobile merger review was particularly important in the 1990s and early 2000s. Because, as noted above, initial licensing was largely carried out in a geographically fragmented fashion, there have been many proposed and approved transactions where efficiencies were available to be realised by the reorganisation of the sector's market structure. These mergers were typically between parties with little or no geographic overlap of licenses or networks. The FCC has found that these footprint-expanding deals are generally in the public interest. In addition, the DOJ typically has not challenged deals of this type.

Until 1st January 2003, the FCC had in place a spectrum cap rule that limited the amount of spectrum suitable for provision of mobile wireless services that one entity could acquire in any location. This rule functioned as a bright-line limit on mobile consolidation, because acquisition of spectrum was an important component of mobile operator consolidation. However, the FCC eliminated the rule in favour of reliance on case-by-case analysis, because it found the rule was too inflexible and blunt a tool, which might both allow some harmful transactions and block some beneficial ones.[106] In 2014, the FCC reaffirmed the use of case-by-case analysis in examining spectrum concentration issues, but singled out concentration of spectrum below 1 GHz as an area of particular concern.

*The Large Proposed Mobile Telecom Mergers*

By the end of 2003, the United States mobile telecom sector included six firms referred to as nationwide providers—although the coverage area of each fell short of complete national coverage—and a large number of regional and small providers. For example, another 13 operators had at least half a million subscribers each.[107]

With decisions in 2004 and 2005, the DOJ and FCC approved—with certain conditions—two large horizontal mergers, reducing the number of nationwide operators from six to four. In 2011, a proposed transaction that would have further reduced the number of nationwide providers to three was blocked. In the consideration of each of these proposed deals, the DOJ and FCC ended up reaching fundamentally similar judgments, although details and rationales were somewhat different.

The first of these three transactions was Cingular Wireless Corp.'s proposed acquisition of AT&T Wireless Services, Inc. DOJ focused on local geographic markets, saying that customers choose among the wireless providers that offer service in areas where they live and travel on a regular basis, and it considered both voice and broadband data product markets. Competitive factors DOJ evaluated included: the number of providers, their strengths and weaknesses including coverage and capacity, and their market shares; whether additional spectrum was likely soon to be available; whether potential expansion of providers was limited by insufficient spectrum or other factors; the market's population; and the market's concentration. DOJ found that unilateral competitive harm was likely to result from the proposed transaction in 13 local markets, and it reached an agreement with the applicants for appropriate divestitures to prevent those harms. A mix of operating units, minority interests, and spectrum assets were divested.[108]

In its review, the FCC also focused on local markets, and it found that it could analyse mobile voice and data services in a combined mobile telephony market. The FCC focused on the presence and capacity of other market participants, and like DOJ, considered the possibility of both unilateral harm and harm from coordinated interaction. It summed up by saying, "Competitive harm is unlikely in most mobile telephony markets, primarily because of the presence of multiple other carriers who have the capacity to add subscribers and the ability to supplement their current capacity as well. Thus, despite concentration that appears high in many markets, when measured based on firms' current shares of subscribers, other operators will nonetheless be an effective competitive constraint on the behaviour of the merged entity."[109] However, with regard to 22 local areas where the two firms' operating areas overlapped, the FCC analysis showed that competitive harm outweighing benefits was likely, and divestitures were ordered. The FCC also ordered divestitures of spectrum assets and minority interests.

The second of these three major transactions was the proposed merger of Nextel Communications and Sprint. DOJ closed its investigation without challenging this transaction. It found that merged company would not gain unilateral market power, and that there would be no harm from coordinated interaction. It stated "…other wireless carriers and new wireless technologies should continue to provide alternatives for customers of the merging parties, and these alternatives collectively should prevent the merging companies from harming competition."[110]

Similarly, the FCC order approving the merger found that no divestitures in any local market were necessary, because "…in the post-merger environment there will be a continuing presence of multiple other substantial carriers in each overlap market with the capacity to add subscribers and the ability to add capacity." It further explained that in the bulk of the local markets affected by the merger, there would still be four or more providers "…with thoroughly built-out networks, adequate bandwidth, and the ability to offer nationwide service plans." In addition it noted that there were no local markets where the number of providers would be reduced to two or one, a consequence it would have viewed as likely harming competition.[111]

The third major transaction was AT&T Inc.'s proposed acquisition of T-Mobile USA, Inc., announced in March 2011. If approved, it would have reduced the number of nationwide operators in the United States from four to three. In August 2011, the DOJ filed a lawsuit in federal court to block the transaction. In November, the FCC released a "Staff Analysis and Findings" report that recommended against approval and in December 2011, AT&T announced that it had abandoned its proposed acquisition.

In its "Complaint" filed with the court, the DOJ argued for the relevance of both local and national geographic markets, with the importance of a national market arising from the demand of enterprise and government customers for the services of a national network, and from the fact that rivalry among the four nationwide carriers (e.g., decisions on pricing, advertising, technology, and handsets) plays out on a nationwide level. DOJ also argued that non-nationwide carriers play a limited competitive role in constraining the possible market power of nationwide operators. It stated that the proposed transaction would increase concentration to high levels over much of the United States, for example, finding that the two firms' operations overlapped in 97 of the 100 largest local markets. DOJ also emphasized that T-Mobile had historically and currently "positioned itself as the value option for wireless services, focusing on aggressive pricing, value leadership, and innovation." Thus its loss as an independent provider would be particularly harmful to competition. Finally, DOJ found that neither entry by new mobile providers, nor merger-specific efficiencies, could be counted on to outweigh the transaction's anticompetitive effects.[112]

The FCC staff analysis was not an FCC decision, but essentially a recommendation to the commissioners. (Because the transaction was abandoned, no FCC decision was released.) And, as with the DOJ, the FCC staff saw the likely results of this transaction as very different from the prior two. First, also like DOJ, it expanded beyond an exclusive focus on local markets to consider nationwide issues and arguments. It found that across much of the nation the deal raised "…significant competitive concerns … due to the increased likelihood of unilateral and coordinated effects." It found problems with the economic and engineering evidence submitted to support the transaction. And it found generally that other claimed benefits of the transaction should not be recognised. It concluded that "substantial and material" questions of fact exist regarding the nature and extent of potential harms, and thus that the applicants had "…failed to carry their burden of proving that the proposed transaction, on balance, will serve the public interest."[113]

*Outcomes*

It is difficult to say with confidence exactly what the results of the consolidation from six to four nationwide providers have been, because no one can be certain how the sector would have evolved if the proposed consolidations had been resolved differently. In addition, the mobile sector performance observed today is not solely due to the decisions on these three proposed transactions. The DOJ and FCC have ruled on other, smaller horizontal mergers; the FCC has made other competition policy decisions; and, of course, there have been major changes in the mobile telecom business and technology since 2005. Nonetheless, it is possible to offer some comments and tentative judgments.

From 2005 to date, measures of the performance of the United States mobile sector have generally shown ongoing improvement. For example, available performance measures collected in the FCC's most recent Mobile Wireless Competition Report largely show positive, or at least non-negative, trends for the period 2005 through 2011. These measures include metrics such as total connections, voice and data usage, average price for voice and data, and profits.[114] In addition, quality improvements such as increased coverage and better handsets have continued, and significant innovation such as successive upgrades in air interface technology is ongoing. Thus, at a minimum we can say there has been no obvious harm to the performance of the mobile sector. While it's true that these trends might conceivably have been even better had there been no consolidation, at least in absolute terms key metrics such as trends in price and quality look positive. It does not appear to be the case that the benefits of competition and innovation that consumers had been enjoying were lost as a result of the Cingular – AT&T Wireless and Sprint – Nextel transactions. Further, there have been no serious post-transaction critiques of those two mergers that conclude they were harmful to competition.

In the aftermath of the rejection of the AT&T – T-Mobile consolidation, both firms have continued to engage in price and non-price rivalry, with each other and with Verizon Wireless, Sprint, and the smaller providers. Both firms have, for example, adopted new policies of paying the early termination fee a new

customer switching to it would otherwise owe to the provider it was leaving. In addition, among a number of recent initiatives, in October 2013 T-Mobile announced that it would no longer charge extra for certain international data roaming usage, but rather include such usage in the primary, domestic service bundles. Generally, T-Mobile appears to be continuing in the role DOJ and FCC had identified for it in their respective merger analyses of aggressive, maverick operator. This includes marketing itself as the "Uncarrier." In addition, during this period T-Mobile and Sprint discussed a combination of their two companies, another transaction that would also have represented a four-to-three consolidation, but in August 2014 they abandoned the idea citing opposition from the United States government.

*Network Sharing in the United States*

Network sharing has historically been less typical in the United States than in some other OECD countries. One type of sharing that is common, however, is passive sharing of masts, although the masts and sites are generally owned and managed by third parties rather than by the mobile operators themselves. In addition, the United States has had a large number of regional and local operators, who typically rely on roaming agreements with nationwide facilities-based providers to extend the geographic reach of their networks. Customers of the local, regional and national operators can then roam domestically on certain other networks to get more complete geographic coverage. Roaming agreements are primarily bilaterally negotiated between the operators, and typically the costs of wholesale roaming are not passed down directly to retail consumers in terms of a separate roaming charge, but rather are included in the on-network voice and/or data service bundle. In 2007, the FCC clarified that automatic voice roaming is a common carrier obligation, and must be provided to other carriers upon reasonable request, and on just, reasonable and non-discriminatory terms. In 2011, the FCC ruled that data roaming must be provided "on commercially reasonable terms and conditions".[115]

In 2013 the FCC approved with conditions a proposal by GCI Communication and ACS Wireless, the two major Alaskan-based mobile wireless providers, to transfer substantially all of their spectrum licenses to a jointly owned subsidiary as part of a transaction in which the subsidiary also would receive substantially all of the two companies' respective wireless infrastructures across the state of Alaska. The subsidiary would use these assets to provide wholesale wireless services to GCI and ACS Wireless, each of which would continue to provide retail services to Alaskan consumers. Given that the two companies were both major providers of mobile wireless service and given the geography and low population density of Alaska, there were some competitive concerns. Only AT&T also had a considerable position in the region. Verizon Wireless started building an LTE network in the region in 2013. The FCC approved the transfer of licenses and infrastructure to the jointly owned entity subject to certain conditions to protect competition and foster universal service, including a commitment by the parties to maintain and extend their network in Remote Alaska.[116]

## MOBILE NETWORK SHARING

In the previous sections this report has examined trends in the number of facilities based mobile network providers. The question this report now turns to is what implications network sharing may have for the future of mobile market structures and regulation. Does it, for example, enable governments to meet policy objectives such as greater geographical coverage with more choice for consumers? Does it provide authorities with further choices when considering the maintenance of sufficient competition in mobile markets or could it limit competitive dynamics? What implications does such a policy have for "open network" approaches that sometimes accompany the use of public funds such as in the provision of backhaul or to support universal service? Finally, should network sharing be considered as a preferable alternative to full mergers that reduce the number of players in a market?

Mobile network sharing is the generic term for when mobile network operators (MNOs) share part of their networks together. The term is generally used for when larger parts of the network, such as antenna-sites and backhaul are shared, but can mean different things to different people. Networks can share many different elements with different competitors, or purchase it from third parties as a service (outsourcing), which can have the same effect as sharing. Other than a spectrum license, which is assigned to a single party by governments, and an operator's brand identity there is little in a mobile networks operations that cannot be shared. In general terms, there are four forms of network sharing:

- Passive sharing, e.g. sharing of sites, masts and antennae;
- Active sharing, e.g. Radio Access Network (RAN) sharing
- Core network sharing
- Network roaming

Most network sharing agreements are voluntary between market parties. They may range in size from single sites to larger geographic areas or even joint ventures, where the participating companies jointly own the infrastructure. In some cases regulators may impose network sharing on operators. At the local level municipal governments may impose sharing for practical or environmental reasons. At the national level, some regulators, notably in Colombia, France and the United States, impose network sharing and/or roaming to allow new entrants to better enter the market and to increase coverage so that consumers have more choice.

### Sharing of passive network elements

*Site Sharing*

Finding good locations for antennas can be challenging, particularly in cities where there are few places to erect a high mast or where neighbouring buildings can create shadows in the signal. Planning procedures and site permits can create even more pressure to use the same locations. It is therefore common for antenna sites to be shared between multiple operators, because it may be easier to receive a permit for an existing site. At the site, the antenna's base transceiver station (BTS[117]), which is at the bottom of the mast and controls the functioning of the antenna, backhaul equipment and other equipment

are often owned by the respective networks or third party tower companies. Sites often have to be rented from third parties, such as building owners or farmers.

Some specialised companies such as Arqiva in the United Kingdom and Crown Castle in Australia and the United States, and Indus Towers in India, which states it is the largest of its kind in the world, with over 100,000 sites[118], focus only on contracting and managing site locations, including plots of land, and also places such as rooftops or church towers. These companies treat such locations as real estate that can be rented out to multiple mobile networks. These mobile networks then share the same site, though in most cases they still use their own equipment. Sometimes they buy or lease a portfolio of locations from MNOs, such as a recent tower lease by Crown Castle in the United States of 9700 sites from AT&T and 7200 from T-Mobile, at a cost of USD 0.5 and 0.33 million per site respectively, which were then leased back over a 28 year period, after which the sites can be bought for an additional payment of equal size to what was paid per site. For the MNO the result is cash in hand that can be invested today, with fixed costs over a long period.

*Mast sharing*

In the case of mast sharing, not only the site, but also the mast is shared between the operators. Each network typically brings its own BTS, backhaul equipment and other equipment. This may require some coordination between the MNOs, for example to guarantee the structural integrity of the mast and the location on the mast. As the MNOs typically use different antennas and determine the direction of the antenna, their coverage can also be different. The same companies that offer site sharing as a service to MNO's also offer mast sharing to MNOs.

*Fixed network sharing*

The transmission networks in the core and backhaul network are often shared with, or leased from other network operators. These other network operators can be other MNOs, but also fixed line operators. An example is Eurofiber in The Netherlands, which operates a dark fibre network. In that country, it is contracted by both T-Mobile and Vodafone to provide backhaul and core network fibre infrastructure. Mobile networks that were not part of the historical incumbent fixed network operator of a country or region frequently lease backhaul lines to their antenna sites. In rural areas it is often the only choice. The costs of rolling out to these sites is often prohibitive if it is only for an antenna site, whereas the incumbent fixed network operator generally has a network close to the antenna site and is often under legal obligation to provide access to this network.

In Sweden, an example of networks sharing for backhaul is the city of Stockholm's Stokab network. This network owned by the city of Stockholm provides dark fibre in an open network model, which means that any network can make use of it. One of the users is Net4Mobility, a joint-venture infrastructure company for the backhaul part of the LTE network of two mobile operators; Tele2 and Telenor. A long term commitment by Net4Mobility allowed Stokab to extend its network into new areas of the town and at the same time, Stokab's network and business model allowed Net4Mobility to deploy a network with a much higher cell site density than had been deployed previously for 3G.[119] Net4Mobility used this strategy of connecting through open municipal networks throughout Sweden.[120] It stated that sharing of infrastructure through municipal fibre networks allowed it to roll out much quicker than in regions where such shared infrastructure did not exist.

### Sharing of active network

*RAN-sharing*

The radio access network consists of the site, mast, antenna, BTS and backhaul. The company managing the site will lease the whole package to an MNO and carry the data to the core network of the MNO. It can use the same radio equipment to broadcast and receive traffic of multiple spectrum license holders. The MNO however has less influence over the orientation of the antennas and therefore the coverage of the network. Where and how traffic is broken out to the core networks of the various spectrum license holders is dependent upon the local situation.

In addition to RAN sharing, where a site and all equipment are shared, it is possible for arrangements to be entered into where a site is leased from one company and the antenna, BTS and equipment are leased from or shared with another company. One example of a company that offers such services is Ericsson which offers a turnkey solution to mobile networks, who can rent the antenna, mast and (satellite) backhaul from it. Japan provides a further example of a model for network sharing (Box 3).

### Core network sharing

Core mobile network systems are generally not shared between mobile operators. Examples of such systems are the network and switching subsystem (NSS), that carries out switching and mobility management, the High Speed Serial / Home Location Register (HSS/HLR) and systems for data communication (EPC) and for cost optimisation of traffic (UTRAN and GERAN). They are however often managed or provided as services by third party service providers, such as Ericsson, NSN, Acatel-Lucent and Huawei. The ownership and management has therefore been outsourced[121]. Cloud based solutions for core mobile network equipment, where multiple operators can share the same infrastructure, are currently being discussed and developed, but it is unclear in how far these systems have made significant inroads into the market.[122]

One market where the sharing of core mobile networks systems is already present is in the MVNO market segment, where mobile virtual network enablers (MVNE) provide core network systems for use by multiple MVNOs. In some cases MNOs make use of MVNEs for their own sub-brands as their own infrastructure is not flexible enough to host different sub-brands. An example is T-Mobile in the Netherlands, which uses “Aspider” for its sub-brands Ben and Simpel.[123] MVNOs are discussed in the final section of this document.

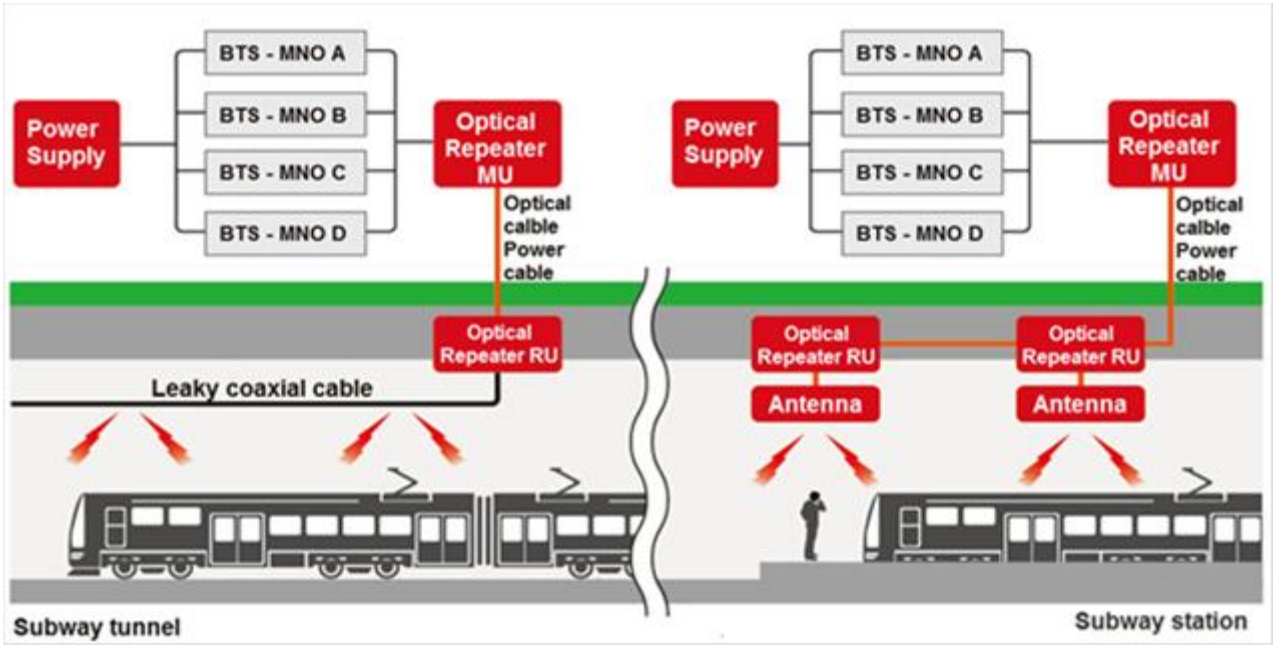
In the provision of Machine-to-Machine (M2M) services many MNOs would like to play a role. However, it requires them to have an M2M platform that gives customers with thousands or millions of devices in the field the required insight into their devices. Some networks have built their own M2M platforms with examples being T-Mobile and Vodafone. However, there are also service providers, such as Jasper Wireless, which provide their platform as a service to mobile operators. Jasper, for example, has contracts with AT&T, Telefonica, NTT Docomo, America Movil, KPN and Rogers. Telenor Connexion sold its M2M platform to Ericsson, which now sells it as a service to mobile networks.[124]

**Box 3. Japan: Tunnel association**

In a densely populated country, where infrastructure costs may be lower compared to expected returns, certain types of locations can still benefit from network sharing including active components. In Japan, for example, tunnels are used to overcome obstacles such as mountainous terrains or those commonly associated with urban areas and conurbations. The use of tunnels can still present challenges for MNOs. They may have, for example, a limited space to place cables and there is of course a cost to deploy infrastructure in a tunnel.

In 1994, the Japan Mobile Communications Infrastructure Association (JMCIA), a public entity, was established to provide a solution for active network sharing in tunnels.[125] Its membership includes all MNOs, major facility vendors and developers. It builds mobile infrastructure shared by those operators inside the tunnels of railways, roads and subways as well as underground shopping malls. The association provides transmission facilities from base transceiver stations (BTS) to antennas, including power supply, whereas BTS are separately operated by the MNOs (Figure 7). In the fiscal year ending in March 2014, the association had completed deployments and made mobile broadband services available at 473 points in subway tunnels with which all underground lines in Tokyo have been covered, 211 points in road tunnels, 82 points in railway tunnels and 765 points in subway stations.

**Figure 7. Shared facility operated by JMCIA in the subway**




*Source*: JMCIA Note: MU and RU stand for Master Unit and Remote Unit, respectively. BTS is operated by each MNO.

From a policy perspective, it can be noted that the efforts by the association are similar to other successful examples of network sharing, such as the practice in Sweden. It aims at developing new infrastructure by coordination through a joint entity, mainly financed by the operators. Government policy also supports this process. In some cases, the government subsidises the development of shared facilities in less populated areas although this is proportionally a very small part of the association's revenue (2.7% in FY2012). The association has also benefited from lower taxation requirements, as it is an authorised public interest entity.

*Outsourcing of core information systems*

Core information systems for sales, billing, customer relationship management, provisioning and other essential operations are often not shared between mobile operators. However, companies such as IBM, but also networking equipment vendors have made inroads in providing these systems as services to mobile operators. An example is Bharti Airtel in India, which outsourced the management of its network to Ericsson and of its core information systems to IBM.[126] This resulted in Bharti substantially reducing capital expenditures up front and allowed for pricing flexibility. Similar contracts were later made for other parts of Bharti's network in other countries. Other IT service companies are providing similar services and as with core network systems, this is an area where cloud solutions are becoming available.

*Spectrum Sharing*

BEREC defines spectrum sharing "as the simultaneous usage of a specific radio frequency band in a specific geographical area by a number of independent entities, leveraged through mechanisms other than traditional multiple- and random-access techniques, such as cognitive radio (use of white space). To put it simply, spectrum sharing consists in a common exploitation of frequencies among several operators: the end users of these operators can access the services of their respective MNO through all the frequencies that are shared in the access network. Active infrastructure sharing can actually include spectrum sharing."[127] When it recently reviewed this matter, Berec did not find any spectrum sharing agreements in Europe. In some respect the Swedish joint venture Net4Mobility is an advanced form of network and spectrum sharing. In August 2014, the Indian regulator TRAI allowed spectrum sharing between at most two mobile operators. One of the reasons given is that spectrum fragmentation is significant in many markets in India, with as many as a dozen MNOs per region, and more stringent power requirements (a tenth of the power of what is common in other countries. Spectrum sharing would allow operators in India to provide better coverage and better performance. The implementation does put a number of restrictions on how spectrum can be shared in order to keep competition in the market.[128]

*Small Cell and Indoor network sharing*

In some locations operators have found it difficult to roll out multiple competing infrastructures, for example in subways, shopping centres, airports and train stations. In Japan, operators have established the Japan Mobile Communications Infrastructure Association (JMCIA), a public entity, to provide a solution for active network sharing in tunnels and expanded its role to cover other locations such as shopping centres. Furthermore there is much discussion in trade magazines about the possibility of Wi-Fi offload for mobile devices. Already as much as 90% of a user's traffic will be handled by Wi-Fi at home and at work. Some operators, notably Free Mobile, are using EAP-SIM to seamless offload of some of their traffic to Wi-Fi. Other operators are offering their customers to Wi-Fi hotspots. The expectation of industry analysts is that this will continue and that at some point ISPs without a mobile network might offer access to the Wi-Fi access points available at their customers' home, to mobile networks.

**Roaming**

Roaming is the term applied when a mobile customer of a network other than that of the owner of the infrastructure makes use of the mobile infrastructure.[129] This can be a network from the same country or from another country. In practice from a technical perspective there is no fundamental difference between a terminal from the host network or from a visiting network. The procedures are in many ways the same:

- A device registers on the network and sends its International Mobile Subscriber Identity, IMSI number.
- The first six digits of the IMSI number (Mobile Country Code and Mobile Network Code) are verified as to whether they are on a list of approved networks, and if so,
- The request is forwarded to the Authentication Center (AuC), which then verifies the request with the Home Location Register of the network that the device belongs to. Each SIM-card is registered to only one HSS/HLR, with some operators having multiple HLRs. If the device is authorised,
- The authorisation will be registered in the Visitor Location Register (VLR), where the device will be assigned a Temporary Mobile Subscriber Identity.
- The device can then communicate.
- A customer of a domestic full MVNO that is hosted on the network is therefore, from the network's perspective, no different than a customer of a foreign MNO, roaming on the network.

At any given moment there may be hundreds of networks roaming on a particular radio network. It is important to recognise that from the perspective of the network that there is no functional difference between a roaming customer and a home network customer. From the perspective of marketing and sales of networks this may be different.

Roaming is necessary because no network has global coverage. At the same time, users wish to access services when they travel outside the areas covered by their direct supplier. Roaming is also used to fill in gaps in a national network or when new entrants are rolling out their facilities and as a way to share network investment costs. Some examples are:

- Iliad/Free Mobile in France, a new entrant, currently uses roaming to offer national coverage while it is rolling out its own network. The right to purchase roaming on one of the existing networks, under commercially agreed terms, was a part of the regulatory requirements that are in the mobile license for new entrants. In addition in the auction of 800 MHz spectrum one block carried the obligation to host a competing network if some conditions were met. This block was purchased by SFR and contains an obligation to host Iliad/Free Mobile. Tele2 in The Netherlands, will roam on T-Mobile's network for 2G and 3G coverage in the Netherlands. Tele2 is a new entrant that will start operations in 2014, it has only obtained 4G spectrum and, therefore, needs 2G/3G spectrum for backwards compatibility with existing handsets.
- Mexico is proposing a national wholesale network for mobile services. While there have been similar proposals in the past that have not gone ahead, such as Lightsquared in the United States, this model is being developed in some countries for rural areas.
- In Colombia, a new entrant has recently acquired 4G-LTE spectrum, and does not have any 2G/3G spectrum for IMT services. However, both general and particular rules defined by the Colombian regulator to access National Automatic Roaming, allow this operator to provide its users with data, SMS and voice services. During the first half of 2014, the regulator imposed particular obligations to existing Mobile Network Operators, for guaranteeing that the National Automatic Roaming provided to the new entrant could work properly, even though 4G spectrum for the deployment of their LTE network was the only spectrum assigned to this operator. As of June 2014, testing protocols are being carried out with existing Mobile Operators on the provision of National Automatic Roaming, with successful results so far.

In some countries, national roaming is a means to differentiate the retail products of mobile operators. In Colombia,[130] India, Russia and historically in China and the United States (before AT&T launched 'Digital One Rate" which was quickly adopted by other MNOs) customers pay - or once paid an additional fee, if they move outside their designated home area, which can be a city or region. In some ways roaming in Europe can be seen in a similar fashion as companies such as Vodafone, T-Mobile, Orange and Telefonica have networks in multiple countries, but differentiate the charges for accessing the network, based on whether the customer is on the "national" network or on the "international" network. Under the pressure of competition and regulation this is currently changing. In 2013 and 2014 a number of networks offered "roam like at home" packages.

As roaming mechanisms exist, spectrum license owners can more easily facilitate new business to make use of their spectrum licenses and commercialise these licenses in new ways. Without this flexibility, spectrum owners would need a license with each customer individually. With roaming they can aggregate these relationships.

**Regulatory treatment of network sharing agreements**

Sharing of passive infrastructure has existed since the early years of the mobile industry but until recently there were few examples of active network sharing agreements. Particularly in Europe, early attempts to share networks were restricted by regulators on competition grounds. In Colombia, France and the United States some forms of network sharing, through roaming have existed and were enforced by regulators.

A case in point is the agreement between T-Mobile and O2 to share network and roam on their respective 3G networks in Germany. T-Mobile was an incumbent in Germany with a far larger market share than the more recent entrant O2. The agreement was notified to the European Commission in 2002. The European Commission argued that national roaming, by definition, restricted mobile network-based competition with respect to the scope and speed of coverage, retail prices, network quality and transmission rates. These effects were found to be more serious in areas where there are good economic opportunities for the roll-out of parallel competitive networks, especially in urban areas. As a result the European Commission prohibited the national roaming arrangements but provided an exemption to allow market entry, with the exemption phased out in steps across specific cities and regions until the end of 2008.

In 2006, the European Commission's decision was overturned by the European Court of First Instance. Most notably, the Court considered that it cannot be ruled out that such a roaming agreement, rather than restricting competition between network operators, may actually be capable of increasing competition by enabling the smallest operator to compete with the major players in certain circumstances. In the context of the specific characteristics of the relevant emerging market, O2's competitive situation on the 3G market would probably not have been assured without the agreement, and might even have been put into jeopardy.

Network sharing is still subject to regulatory scrutiny but there are now many examples of network sharing arrangements. For example:

- In Sweden Net4Mobility is a joint venture between the mobile operators Telenor Sweden and Tele2 Sweden which owns and operates a 2G and 4G network with plans to cover 99 percent of the Swedish population.

- In Australia, Optus and Vodafone established a joint venture in 2004 to provide 3G coverage. This arrangement was expanded upon the merger of Vodafone Australia and Hutchison and

subsequently expanded to include both 3G and 4G. Agreements between the Australian mobile operators,

- Sharing infrastructure has been used or is being considered in several countries to provide coverage in rural areas; for instance Sweden, Mexico, and Colombia.

- In Colombia, there are also infrastructure sharing conditions imposed over incumbent MNOs in order to facilitate the new entrant's deployment."

Developing countries may have challenges in achieving better geographical coverage of mobile services due to the existence of other infrastructure issues such as the availability of electricity and roads, or even issues related with restrictions to infrastructure deployment. In this type of environment, network sharing could be a useful tool to enable governments to achieve the availability of other infrastructure into a region.

**Drivers for network sharing**

At the simplest level, the pursuit of lower costs, potentially faster roll-outs and efficiency lie at the heart of the drive towards greater network sharing. However, lower costs are not universal and there are other concerns that impact MNOs' decisions. In general, savings from active sharing are greater than for passive sharing as a higher proportion of costs are shared; however

- Physical capacity limits more typical of legacy 2G radio base stations limit the scope for savings from RAN-sharing in capacity driven areas. More recent technology has reduced this constraint, so active sharing benefits are increasingly possible also in urban areas.

- Savings from passive sharing are typically lower with rooftop sites than with tower sites, which require a significant tower investment. Moreover, site lease arrangements may not allow MNOs to save from sharing if lease arrangements do not result in lower total lease costs from sharing. Although this may be a transitory issue leaseholders can exert considerable holdout market power if MNOs have sunk investments in the site.

- The above may mean that savings are less in urban areas (more likely to be capacity driven, more likely to be rooftop, and more likely to have lease agreements with entities with market power).

- There are significant costs of migration to active sharing; which requires the consolidation of network to a single grid and parallel running while that consolidated grid is developed. Savings are likely to be far greater if sharing arrangements are put in place prior to rollout; which means the current focus on 4G is a significant driver of new sharing arrangements.

MNOs are concerned, however, about more than just the cost savings. In particular, in organisations which may historically have considered that network capabilities were a core competence and strategic asset, MNOs will also consider the effects of whether network capabilities can be maintained despite the sharing arrangements, and the implications for any loss of control over network strategy and loss of flexibility in spectrum auctions.

**Box 4. Network sharing in the United Kingdom**

***Network sharing in the United Kingdom***

The experience of the United Kingdom illustrates how network sharing can evolve over time and how different forms of sharing can co-exist. Site sharing, for example, has been present in the United Kindgom since the first mobile networks were launched in the 1980s. Coverage was seen as a competitive differentiator so MNOs were reluctant to make their sites, seen as strategic assets, available to competitors. However, in some cases sites were shared on a reciprocal basis: i.e. each operator provided access to sharing a small number of tis sites in return for access to the same number of competitor sites.

As the 3rd and 4th MNOs rolled out their networks in the United Kingdom, few sites were made available to them for sharing: the incumbents considered their coverage advantage to have too great a strategic value. However, as all of the networks matured, reciprocal arrangements became common across all MNOs. Prior to the award of 3G licences in the United Kingdom, the regulator secured a voluntary undertaking to provide national roaming to support the entry of a 5th MNO, and in 2003, Hutchison 3G UK ("Three") launched its 3G service, with its own network in urban areas underpinned by national roaming on Orange's 2G network. This national roaming arrangement has subsequently been renegotiated but remains in place today.

In 2007, Three and T-Mobile announced plans for "3G RAN" through a joint venture MBNL[131]. In the same year, Vodafone and Orange announced plans to RAN share both 2G and 3G[132]. Although Vodafone and Orange did not complete their agreement[133], together with the MBNL RAN sharing it did mark heightened interest among the MNOs for greater network sharing.

There are now two mobile network sharing arrangements in the UK: Cornerstone covering arrangements between Vodafone and Telefonica-O2 ("O2")[134], and MBNL covering arrangements between Everything Everywhere ("EE") and Hutchison 3G-UK ("Three").

The Cornerstone arrangement is comprised of two main elements:

- Radio access network ('RAN') sharing: sharing of active network components to establish a single RAN.
- Passive sharing: consolidation of the two operators' existing sites and passive infrastructure into a joint venture company.

The active sharing element of Cornerstone was announced in July 2012 and it represents an evolution of the two parties' previous passive sharing arrangements. Under Cornerstone the United Kingdom is divided into two geographic zones outside London (east and west) and separate treatment of north and south London. Within each territory, one operator is the 'host', owning and operating the single RAN that is used by both companies. The parties cooperate in each territory under the terms of a managed network services agreement. London is treated as a special case to be split only for 4G. The arrangements also establish a joint transmission network, consolidating traffic over a reduced number of sites to achieve economies of scale in backhaul capacity.

Passive assets (existing sites and passive infrastructure) are consolidated into a joint venture company that owns and manages all of the sites of both operators, nationally and in accordance with the single grid of base stations across the United Kingdom to serve the combined needs of both operators as efficiently as possible. This was essentially the extension of the existing Cornerstone agreement.

MBNL (EE/Three) was initially set up as a joint venture between T-Mobile and Three in October 2007. MBNL was responsible for consolidating two separate 3G RANs of T-Mobile and Three to deliver, and consequently manage, a combined 3G network for both operators. After the merger to form EE the merged company replaced T-Mobile in the MBNL joint venture and MBNL's role extended to consolidating Orange's 3G cells in the combined 3G RAN.

In contrast to the sharing agreement between O2 and Vodafone, Three and EE share nationally passive infrastructure, active 3G base station equipment ('NodeBs'), backhaul transmission and Radio Network Controllers ('RNCs'). Similarly however to Project Beacon, Three and EE maintain separate backbone and Core Network infrastructures, while each operator uses its own spectrum allocation. EE and Three have subsequently updated their arrangements for 4G to share sites masts and backhaul transmission but the two companies will not share active 4G equipment[135]. The two operators will maintain their separate Core Networks.

*Source* : OECD, Ofcom.

**Regulatory considerations**

There are potentially significant consumer benefits from active network (RAN) sharing from increased coverage, faster rollout and lower prices, these benefits are not certain and depend on local market conditions, including sufficient facilities based competition among MNOs:

- Increased coverage – sharing costs makes it more cost effective to extend coverage further. The total costs of providing additional coverage are largely independent of the number of sharing parties, so the costs for each sharing MNO will be lower than those of non-sharing MNOs. Absent any anti-competitive consequences, network sharing should therefore result in more coverage than would be the case without sharing;

- Faster rollout of new technology (of particular interest at present is 4G) as pooling of existing sites and resources reduces the need to acquire new sites and increase resources to meet the workload of a rollout programme;

- Lower prices - significant cost savings would be generated from RAN sharing and transmission sharing in particular and consumers would benefit if competition causes these savings to be passed on to consumers.[136] Whether competition does result in these savings being passed on to consumers will depend upon the state of competition between network providers and the extent to which the sharing arrangements change these competitive conditions. Particularly when joint ventures are formed between two networks, that sell access to a shared network to both operators, there may be conditions that the input costs for both operators are the same and, therefore, they will not compete significantly on price or services.[137]

- Decrease in environmental and aesthetic considerations, for example horizon pollution of wireless tower infrastructures and antennae on buildings and landmarks.

Regulatory scrutiny is, however, still necessary to ensure that these benefits do emerge and that sharing arrangements do not undermine competition and cause consumer harm. The regulatory process will depend upon the local legal environment, which may differ from country to country but the competition principles are likely to be similar. In particular, in relation to active network sharing, concern about potential:

- Unilateral effects;
- Potential coordination; and
- Information sharing

*Unilateral effects*

There are two concerns: the first one is when the network sharing arrangements provide the parties with the incentive and ability to raise prices or act in such a way as to reduce quality, customer choice or innovation. Such unilateral effects may have the indirect effect of benefiting other market participants but are not dependent on their co-operation. A second concern occurs when the arrangements result in less spare capacity being available as this could lead to a reduction in the incentives of each party to supply capacity to MVNOs and price aggressively at the retail level. The nature of cost sharing arrangements will play an important part in determining whether this is a risk as it is unlikely that the underlying cost of providing additional capacity will be any greater with network sharing than without.

If costs are shared in proportion to traffic, the incremental cost faced by each MNO for providing additional capacity is in effect the average cost of capacity, which is likely to be higher than the incremental cost of capacity absent the sharing arrangements, and as such the incentive to compete to provide that capacity to MVNOs is reduced. At the other extreme, if costs are shared in fixed pre-agreed proportions, then the cost to each MNO of additional capacity (for their own use or for sale to MVNOs) is less than the underlying cost of providing the capacity, which could lead to heightened incentives to compete to the extent that it damages the ability of the sharing MNOs to recover their costs, as each faces a low incremental cost of capacity but a large, and potentially increasing fixed cost (i.e. independent of the volume of own demand) of supporting the capacity demands of their sharing partner. This provides some insight into the tensions that underpin the cost sharing arrangements.

A pragmatic solution addressing both competition concerns and the return requirements of the MNOs could be for costs to be shared in pre-agreed proportions within a certain range (e.g. costs shared equally if traffic shares remain within the range of 40%-60%), but are shared in proportion to demand if traffic shares fall outside this range. Furthermore, safeguards can be provided to allow unilateral investment in capacity or coverage.

The arrangements could increase the barriers to potential network entrants who may wish to enter the market. A new entrant may wish to share network to reduce costs and facilitate entry into the market once they have acquired spectrum. Whilst it is always open to new entrants to construct their own network, the cumulative effect of sharing arrangements may make this prohibitive since all other parties would benefit from cost savings not available to the new entrant. Previously, it would have had a choice of gaining access to sharing with more networks, and could potentially play these options off against each other to get the best deal, but as sharing reduces the number of networks, the new entrant's ability to negotiate sharing would be reduced. The extent of this risk will depend upon the likelihood of any new entrant requiring such access, but if it did occur there would be a risk of significant harm to competition and consumers.

The parties will necessarily to some extent have to co-ordinate their network strategies, at least to the point of agreeing the coverage areas. The parties would also have strong incentives to have balanced spectrum holdings to avoid differing views on optimal network design. The effects of this desire to co-ordinate spectrum holdings would depend upon the spectrum allocation and spectrum trading arrangements in the country, but any issues that emerge could be addressed through licence conditions for future technologies and the design of the process for the award of spectrum.

A further risk to competition is any exclusionary effect caused by the creation of a dominant group of network sharers. If a smaller party does not have access to network sharing and as a result faces a cost disadvantage this may result in less of the network sharing cost savings being passed onto consumers, or worse, the exit of a player from the market and less competition in the long run. This risk would be dependent upon the structure of the market. In markets with potential symmetric groupings this is likely to be less of a concern, and to some extent and short-term asymmetry can be reduced in the long run by having greater symmetry in spectrum holdings between the groupings so that each group benefits from similar scale benefits.

A particular problem, however, occurs in three-player markets. The competitive conditions in a three-player market are likely to be such that less of the cost savings are competed away to the benefit of the consumer than in a market with four or more national wholesale operators, and seeking to create symmetry to offset the advantage of any two players sharing, e.g. by allowing the non-sharer a greater allocation of spectrum, may result in further concentration and less competition at the retail level.

*Potential coordination*

A risk in network sharing agreements is the potential for tacit collusion between the MNOs on the quality of, or access to, their networks and in doing so establish collective dominance. Three market conditions provide an indication of this risk:

- Do the members of the 'dominant 'oligopoly' have the ability to monitor the other members;
- Do suitable retaliation mechanisms exist should one of the oligopolists cheat; and
- Would the reaction of current and future competitors, as well as consumers, not destabilise the outcome of the common policy.

A market with four MNOs sharing two RANs with high barriers to entry would give rise to coordination concerns, as it is much easier to establish a focal point and to monitor and punish each other's behaviour, and there is limited outside pressure. A particular concern could be the extent and quality of coverage, which would be subject to competition between sharing entities rather than (the greater number of) MNOs. Coverage is easy to monitor and any investment to improve coverage could be punished by the competitors matching that investment to neutralise any advantage. This is a significant risk; however, ex post competition powers to intervene may be sufficient to address problems if and when they emerge.

There may also be an increased risk of industry-wide coordination to refuse to supply MVNOs. However, given that each MNO will still be an independent wholesaler, absent information spill-overs, and subject to the nature of the cost sharing arrangements as outlined above, there would be no change to either of the parties' incentives to accept MVNOs.

There is also a similar potential concern that such agreements could increase the risk of industry-wide co-ordination to deny access to sites or RAN to new entrants. The reduction in the number of RANs might make such coordination easier and if it did occur there would be a risk of significant harm to competition and for consumers. The likelihood of this issue arising is subject to the same drivers as of potential unilateral incentives to deny access.

*Information sharing*

In most sharing arrangements, the parties will exchange competitively sensitive information which, if not adequately restricted, could have a material effect on the degree of competition between the parties. Information flows between the parties could give rise to collusive outcomes in which competitors align their commercial strategies as a result of information to which they would otherwise not have access. This risk appears greater in the case of sharing of the active network, though it may also be present in the sharing of the passive network. In general this risk can be addressed through procedures and protocols that would be in place for the sharing of such information such as limiting those that have access to sensitive information and prevent marketing and commercial teams from learning of the strategies of their competitor.

*Network sharing and consolidation*

In general, competition between national wholesalers is likely to result in more enduring benefits to consumers than competition induced by MVNOs, who are reliant upon MNOs for supply, have control of a smaller share of the flow of funds than MNOs, and due to the structure of MVNO agreements who typically face less incentive to compete than MNOs.

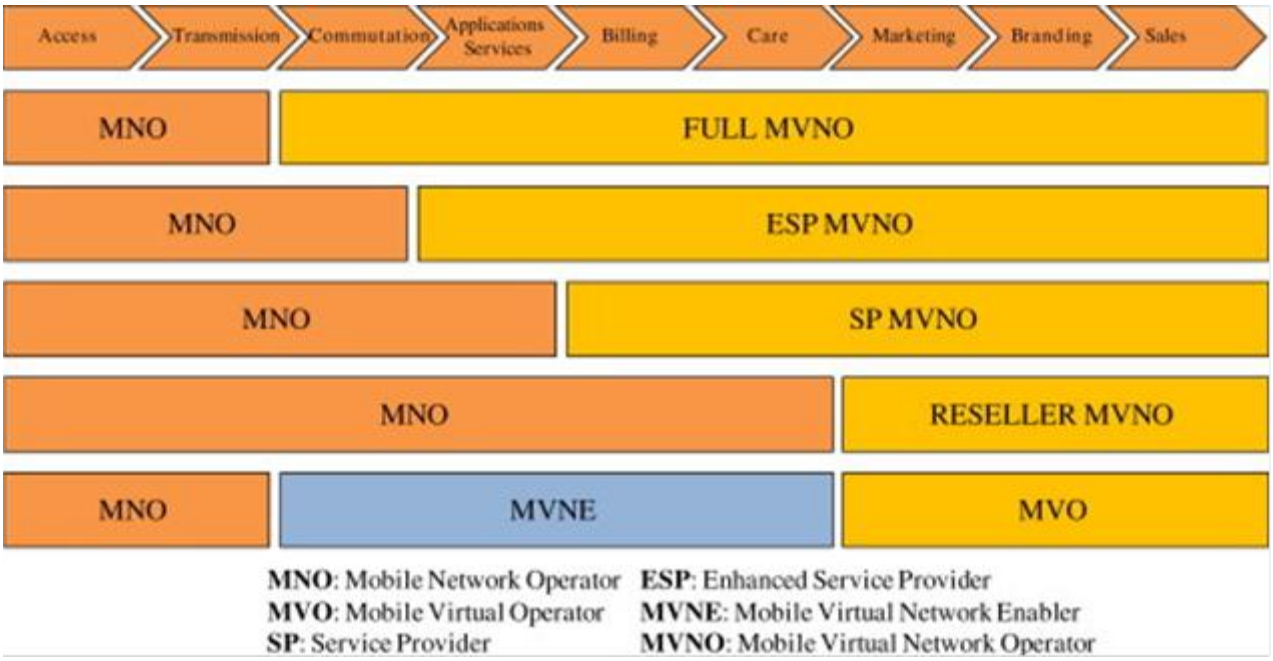
The fewer the number of national wholesalers the less the competition to supply MVNOs and the less likely it is that MVNOs have supply agreements that allow them to exert any competitive constraint on MNOs. Industry consolidation resulting from the full merger of MNOs could therefore have the impact of reducing competition to the detriment of the consumer; not only by reducing direct competition between MNOs in the retail market but also by reducing the competition to supply MVNOs which in turn reduces the ability of MVNOs to compete at the retail level.

Network sharing could be considered as an alternative to the concentration that would result from full mergers. The potential savings from network sharing may represent a significant proportion of the savings that are used to justify a full merger. In the case of network sharing where there is significant competition among MNOs and new facilities entry is unlikely, the benefits of these savings are more likely to be passed on to consumers. However, regulators will need to remain vigilant when overseeing network sharing agreements. Under some conditions network sharing agreements may lead to a decrease in competition similar to a potential diminution of competition experienced with a merger.

## MOBILE VIRTUAL NETWORK OPERATORS AND NETWORK SHARING

MVNOs also represent a type of network sharing though not in the same sense as that between MNOs. MVNOs are mobile network operators without a spectrum license. There are different types of MVNOs (Figure 8). At one extreme, reseller service providers are the most basic virtual operators. They purchase calling time from a network operator and sell it to customers, using their own brand name. The MNO provides billing and customer support. A further step is the Service Provider MVNO, they provide billing and customer support, without engaging in any network activity, such as call routing. A service provider is less dependent upon a mobile operator for creating its proposition in the market. One step up from this is the Enhanced Service Provider, which provides additional services such as call and data routing. This is a common type of MVNO because, as it can control the routing of calls and data, it can specialize in specific market segments, such as international calls. At the other extreme, full mobile virtual network operators are the most extensive type of virtual operators. Rather than just reselling calling time, full MVNOs hire network capacity, obtain an IMSI-range from the telecommunication regulator, issue their SIM-cards and maintain a home location register (HLR), containing data on their customers. Full MVNOs have a high level of freedom with regard to pricing in their domestic markets, service development and routing and work with higher margins than SP. Full MVNOs can also switch mobile networks without having to send their customers new SIM-cards.

**Figure 8. Types of MVNOs**




*Source*: Corrocher and Tasio[138]

If policy makers plan for MVNOs to play a significant role in adding to a market's competitiveness it is important that they can choose to be full MVNOs. A full MVNO rents access to the network of an MNO, but is in control of all technical and sales elements of its business. It can create its own price plans and marketing strategy. In addition they are in full control of the technical infrastructure, including numbers, routing and SIM-cards. Most important is that it would be able to switch mobile operators without significant changes to its infrastructure, nor by requiring its customers to change SIM-cards. Switching would give it bargaining power, necessary to secure favourable pricing. This does require that competing MNOs use the same networking technology and spectrum bands, otherwise it cannot exert the same competitive power on its suppliers negotiating with all MNOs in the country. From a technical network perspective, full MVNOs are no different from any other network roaming on a host network. It would therefore be expected that there are many full MVNOs on the market. Half of OECD countries do not, however, have full MVNOs in their market. Based on ITU data from 2013[139] these countries are: Canada, Czech Republic[140], Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, New Zealand, Slovakia, Slovenia and Turkey.

There are a number of reasons suggested as why full MVNOs are not more common:

- In some countries MNOs appear to be less willing to host full MVNOs on their networks than (E)SP MVNOs. This is likely to be because MVNOs can not be locked in to a single MNO (e.g. as appears to be the case in Ireland[141]).
- MVNOs do not have access to roaming agreements and have to rely on a host network for these agreements. According to the Roaming III regulation, full MVNO may now access roaming agreements in Europe, but in practice this is still rare. This appears to be due to them not being eligible for membership of the GSMA[142] and, therefore, not having access to STIRA agreements. There appears to be no technical reason for this distinction. An example was Tele2 in The Netherlands, which acted as a full MVNO with Dutch IMSI numbers, but switched to Swedish IMSI-numbers of its Swedish mother company when roaming.
- In some countries, such as Germany and Canada current regulations on IMSI-numbers limit access to mobile network codes to only spectrum holders. This prohibits the deployment of full MVNOs and locks them in to their initial host network.[143] The German regulator has started a public consultation on future regulation of IMSI numbers. The consultation requests input on opening access to IMSI-numbers for MVNOs and M2M-users.
- MNOs may restrict the type of service an MVNO can offer by withholding access to new technologies, such as 4G.

MVNOs are now present in all OECD countries, except Greece. The first MVNO in the world was brought to the market in Norway. It attempted to be a full MVNO, but failed to gain access to the market and eventually became only a service provider. This meant Virgin Mobile, in the United Kingdom, was the first operational MVNO. In some markets MVNOs developed naturally and in other markets regulatory pressure was brought to bear. In markets with more competitive MNOs, MVNOs were welcomed by MNOs because they allowed MNOs to get more customers on their networks, that otherwise might not have been addressed as a niche market. Regulatory tools that regulators in some countries have used to stimulate the introduction of MVNOs are:

- Conditions for mergers
- Specific requirements in spectrum licenses.
- Regulation of dominant players (Former Market 15 in the European Union).

The merger between Hutchison 3G and Orange in Austria came with the condition that the merged entity would provide, on agreed terms, wholesale access to its network for up to 30% of its capacity to up to 16 mobile virtual network operators (MVNOs) for the following decade.[144] An up-front commitment ensured that H3G would not complete the acquisition of Orange before it has entered into such a wholesale access agreement with an MVNO. The first to conclude such an agreement was UPC Austria.[145]

In some cases, the hosting of an MVNO is part of the spectrum license. The comparative selection for 3G networks in Ireland came with one block that carried an obligation to host MNVOs[146]. For the 4G auctions in France, the willingness to host an MVNO increased the chances of obtaining a license. In addition, to purely financial criteria, each operator's offer was increased by a multiplier if the candidate proposed to host full MVNOs on their network, and if the candidate proposed an enhanced rural build-out obligation, compared to the baseline criteria imposed by ARCEP.[147] All three winners of 4G licenses proposed to host full MVNOs on their networks. In Portugal, the three MNOs that participated in the multi-band auction, became subject to the obligation to allow access to their networks on non-discriminatory grounds in the 800 MHz and in the 900 MHz (attributed in the auction). This means the obligation to negotiate, upon request and in good faith, agreements aiming at allowing their networks to be used for MVNO operations.

In some countries regulators intervened to ensure markets were opened for MVNOs and in others this was the result of market forces. In Europe, intervention was possible under the European Union 2003 regulatory framework market 15 "Call access and origination in public mobile telephone networks". In 2006, for example, Spain found joint dominance of the three mobile operators in a market analysis.[148] Subsequently, the European Commission validated this finding. In France, ARCEP had found a similar joint dominance, but when it published this result, MNOs started to allow MVNO access to their networks and, as a result, the regulator suspended its decision.[149] In Ireland, the regulator found two operators had significant market power and the European Commission later endorsed this outcome. The decision was, however, annulled by the Irish Communications Appeals Panel. In the 2007 regulatory framework Market 15 was removed from the list of relevant markets. In principle, this still allows regulators to research the market, but it requires a higher burden of proof.

Some examples of successful MVNOs are:

- Virgin Mobile: The brand Virgin Mobile is used by MVNOs in eight countries. Each of these MVNOs is independent from the others, though they generally focus on younger people. In France, for example it was the first provider to offer unlimited SMS.

- Lycamobile offers less expensive calling to international numbers, focusing on immigrants. It is a full MVNO in at least nine countries.

MVNOs have focussed predominantly on those market segments that are underserved by MNOs. In a few countries, where the model had not been embraced, MVNOs were instrumental in promoting pre-paid mobile telephony. A further example is for those MVNOs that offers services to a certain diaspora or provide service support in specific languages. In addition, some entities have taken advantage of their other business attribute to enter this market such as supermarket chains (e.g. Tesco in the United Kingdom and Ireland, Aldi in Germany and Carrefour Mobile in France and Belgium). These supermarkets used their large retail networks to offer pre-paid plans.

MVNOs are not viewed as providing robust competition to MNOs in some countries. The structure and nature of MVNOs in the United States are such that, in all likelihood, although MVNOs do play a competitive role, they do not provide an effective competitive constraint on the four nationwide providers.

MVNOs in the United States marketplace generally serve niche consumers via pre-paid service offerings and therefore provide only very limited constraints on offerings to the post-paid subscriber segment.

Mobile roaming has also been an area in which MVNOs have entered the market though there are limitations in this area because they may not be able to directly negotiating roaming contracts with MNOs. Examples include 'Choozze', 'Truphone' and 'Transatel', which offer lower cost roaming plans for frequent travellers. An important development in this area has been the first moves towards liberalisation. Here private companies are permitted to become full Private Virtual Network Operators, particularly for use with Machine-to-Machine communication. This means they have access to Mobile Network Codes and HLRs. In March 2014, the Netherlands was the first country that enabled this form of roaming, by allowing private networks access to the necessary IMSI-number ranges.[150] The change in regulation means that private networks can:

- Now easily change mobile operators, without having to change SIM-cards,
- Buy access to multiple networks in a country at the same time (national roaming), reducing down time and single points of failure,
- Buy access internationally, without having to go through a "home" mobile network, reducing the costs of international roaming,
- Buy access to alternative wireless network infrastructures, such as Wi-Fi, through the use of technologies such as EAP-SIM.

This is likely to stimulate the use of M2M in the Netherlands and benefit the Dutch economy. In addition, Germany has started a consultation on whether it should allow MVNOs and M2M-users access to IMSI-numbers, in line with the initiative taken in the Netherlands.[151]

Based on this experience in Europe some have remarked that giving MVNOs and private an IMSI-number range does not necessarily mean that they will be able to buy international roaming access from MNOs. The obligations to provide wholesale roaming access are restricted to mobile providers, and a company using wholesale inputs for their own use not selling services to final customers does not qualify as mobile providers. An additional issue to be considered is resources and complexity implied in implementing STIRA agreements that would probably prevent most companies to contract their own roaming wholesale inputs. However, both these distinctions are artificially present in the market and not the result of technological or business considerations. A private network with thousands if not millions of SIM_cards, such as a major car company should be an attractive customer, particularly when all the host network needs to supply is roaming. Information the OECD obtained from a car manufacturer and some mobile operators indicates that many mobile operators do not consider the legal status of a private virtual network operator a significant problem. Similarly the complexity of the STIRA agreements is artificial. There is no fundamental reason why a company with a spectrum license in country A would be different from an MVNO from country A to a network in country B. One of the main reasons mentioned by players in the mobile industry is that there is no possibility for reciprocal agreements where the customers of either network can roam on each other's network. However, where network A might offer the best roaming offer to network C, the reverse might not be true, why then network A should not buy roaming from network B is unclear. From this perspective it is likely that liberalisation of the market to enable MVNOs and private virtual networks to buy roaming, could bring much needed rationalisation and competition to the market for roaming.

## ANNEX 1 NUMBER OF OPERATORS PER COUNTRY AND DATE OF LAST CHANGE

| August 2014 | Facility based competition | | | Network sharing | |
|---|---|---|---|---|---|
| **Country** | **Number of MNO** | **MNO: most recent change 2004 to 2014** | **Date of most recent change of MNO number** | **Status of network sharing between MNOs (RAN sharing)** | **Status of MVNO entry** |
| Australia | 3 (from 4) | Decrease | 2009 | Yes, between all three | Yes |
| Austria | 3 | Decrease | 2013 | Yes | Yes |
| Belgium | 3 | Unchanged | 1999 | Yes | yes |
| Canada | 26 (3 national) | Increase | 2009 | Yes, for example between Bell and Telus | 11 MVNOs |
| Chile | 7 | Increase | 2013 | Yes, mandated | 2 MVNOs |
| Czech Republic | 3 | Unchanged | | | Yes |
| Denmark | 4 | | 2003 | Yes | Yes |
| Estonia | 3 | | 2010 | No | Yes |
| Finland | 3 | Unchanged | | | Yes |
| France | 4 | Increase | 2012 | Yes | Yes |
| Germany | 4 (going to 3) | Unchanged | 2014/2015 | | 152 MVNOs |
| Greece | 3 | Decrease | 2007 | Yes | 1 MVNO |
| Hungary | 3 | Increase | 4th license in 2014 | | 7 MVNOs |
| Iceland | 4 | Decrease | 2006 | | 1 MVNOs |
| Ireland | 4(going to 3) | Unchanged | 2014/2015 | Yes | 5 MVNOs |
| Israel | 5 | Increase | 2012 | | 6 MVNOs |
| Italy | 4 | Unchanged | Stable since 1990s | | 27 MVNOs |
| Japan | 4 | Decrease | 2013 | Yes | 354 MVNOs with approx. 7.5% market share |

| | | | | | |
|---|---|---|---|---|---|
| Korea | 3 | Unchanged | 2000 | No | Yes. 4.6% market share |
| Luxembourg | 4 | Increase | | | 4 MVNOs |
| Mexico | 4 | | Current plans for new 4G wholesale network | | 2 MVNOs. There is no specific regulation for MVNOs |
| Netherlands | 3 (going to 4) | Increase | License obtained in 2013, roll out in 2014 | | Yes |
| New Zealand | 3 | Increase | 2009 | | Yes. 1.4% market share. |
| Norway | 3 | Unchanged | 2000 | Yes | 17 MVNOs for voice and 18 MVNOs for data. Market shares are 6.0% and 8.7% respectively. |
| Poland | 6 | Increase | 2009 | Yes | 19 MVNOs. 0.7% market share |
| Portugal | 3 | Unchanged | 1998 | No | 3 MVNOs. 1.6% market share |
| Slovak Republic | 3 | Increase | 2007 | | 11 MVNOs |
| Slovenia | 4 | Increase | 2008 | | 10 MVNOs |
| Spain | 4 | Increase | 2006 | Yes in rural area | Yes, 29 MVNOs with market shares of 9.6% (voice) or 8.7% (data) |
| Sweden | 4 | Unchanged | 2003 | Yes | 3 MVNOs |
| Switzerland | 3 | Unchanged | 1999 | | 1 MVNO |
| Turkey | 3 | Decrease | 2004 | | 42 MVNOs |
| United Kingdom | 4 (from 5) | Decrease | 2010 | Yes | 33 MVNOs |
| United States | 192 (4 national) | Decrease (in terms of national operators) | 2010 (in terms of national operators) | Yes | 147 MVNOs |
| | | | | | |
| Brazil | 4 | Unchanged | 2003 | Yes, need approval from the regulator (Anatel) | Yes, less than 0.1% |

| | | | | | |
|---|---|---|---|---|---|
| Colombia | 4 (going to 6) | Increasing | The number of MNOs will be six as of early 2014 but two plan to merge if they divest spectrum. | Yes (national roaming obligation imposed on some MNOs) | 6 MVNOs |
| Singapore | 3 | | | | |
| Egypt | 3 | Increased | 2006 | | No |
| Latvia | 4 | Increased | 2005 | | 2 MVNOs |

*Source:* OECD based on country data.

## ANNEX 2. MOBILE MERGERS IN OECD COUNTRIES

| Year | Country | Operators |
|---|---|---|
| 2005 | Netherlands | KPN purchased Telfort |
| 2005 | Austria | T-Mobile purchased tele.ring |
| 2005 | Chile | Telefonica Movistar purchased Bellsouth |
| 2007 | Netherlands | T-Mobile purchased Orange |
| 2009 | Australia | Vodafone purchased Hutchison-3 |
| 2010 | United Kingdom | Orange and T-Mobile merge to form EE. |
| 2010 | Switzerland | Orange intended to acquire Sunrise, but did not find regulatory approval. |
| 2011 | United States | AT&T intents to purchase T-Mobile, but does not find regulatory approval |
| 2012 | Austria | Hutchison 3G purchased Orange |
| 2012 | Japan | Softbank purchased eAccess |
| 2012 | Greece | Vodafone intended to purchase Wind Hellas reducing the number of operators to two, but regulators blocked the purchase |
| 2013 | United States | T-Mobile purchased MetroPCS<br>SoftBank purchased Sprint and Clearwire<br>AT&T purchased Allied Wireless |
| 2013 | Germany | Telefonica purchased E-Plus |
| 2013 | Ireland | Hutchison 3G UK purchased Telefonica Ireland |
| 2014 | Japan | Yahoo purchased eAccess from Softbank |
| 2014 | Colombia | Merger between Tigo (Mobile) and UNE (Fixed and mobile). Requires them to divest spectrum. |
| 2014 | United States | AT&T purchased Leap |

*Source:* OECD.

## NOTES AND REFERENCES

1 One of the higher barriers to entry is the access to spectrum due to availability of frequency bands and the speed at which administrations carry out assignment processes for the available spectrum. However, there currently are other options that could lower these barriers like implementing secondary markets of spectrum as described in OECD document "Secondary Markets for Spectrum: Policy Issues" (http://dx.doi.org/10.1787/232354100386) and "New Approaches to Spectrum Management" http://dx.doi.org/10.1787/5jz44fnq066c-en.

2 Some have pointed out that there may be conditions under which network sharing may not be preferable to a merger. Regulators will therefore have to investigate the conditions under which the network is shared to identify whether these conditions are met. See for example and upcoming study by Aguelakakis and Yankelevich, Collaborate or Consolidate; Assessing the Competitive Effects of Production Joint Ventures, Preliminary draft, 21 June 2014.

3 Choozze Bright costs EUR 35 per month for unlimited calls, SMS and data in the Netherlands and the rest of European Union. "Choozze launches freemium mobile offer in Netherlands", 19 August 2014. www.telecompaper.com/news/choozze-launches-freemium-mobile-offer-in-netherlands--1031861

4 In this regard, lowering termination rates allows a level playing field in the market. This is why in many countries smaller operators urge regulators to lower termination rates in order to reduce competitive distortions that frequently are also related with exploitation of tariff mediated network effects.

5 Spectrum Auctions : Promoting more mobile market competition… or less? http://newamerica.net/events/2013/spectrum_auctions an event of the New America Foundation held on November 21, 2013. Clip available at https://www.youtube.com/watch?v=n7NyruDI5sE from 25:00

6 Mobile Cellular Communications, Pricing Strategies and Competition, OECD, 1996, available at http://www.oecd.org/sti/ieconomy/1909817.pdf

7 Decision by the Belgian regulator to issue a fine on Telenet Tecteo Bidco http://www.bipt.be/public/files/nl/21013/besluit+inbreuk+BidCo+-+openbaar.pdf

8 Draft decision on the return of the 3G license of Telenet Tecteo BidCo, in French and Dutch available at http://www.bipt.be/en/operators/radio/rights-of-use/draft-decision-on-the-return-of-the-3g-license-of-telenet-tecteo-bidco

9 Regulatory Aspects for Preparing Spectrum Auctions, Dr Iris Henseler-Unger, Vice President BNetzA, European Workshop on Spectrum Auctions Mainz, 29 October 2010 http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Frequenzen/OffentlicheNetze/VergabeverfDrahtloserNetzzugang2010/Vortraege/2_VPraesHRegulatoryAspects.pdf?__blob=publicationFile&v=1

10 An upset in Norway following an auction of existing spectrum assets http://coleago.wordpress.com/2013/12/18/an-upset-in-norway-following-an-auction-of-existing-spectrum-assets/

11 Tele2 chooses Telenor, Press Releases: 30 April 2014, http://www.telenor.com/media/press-releases/2014/tele2-chooses-telenor/#

[12] OECD (2012), "Fixed and Mobile Networks: Substitution, Complementarity and Convergence", *OECD Digital Economy Papers*, No. 206, OECD Publishing.

[13] The term "HHI" means the Herfindahl–Hirschman Index, a commonly accepted measure of market concentration. The HHI is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers. For example, for a market consisting of four firms with shares of 30, 30, 20, and 20 percent, the HHI is 2,600 (302+ 302 + 202 + 202 = 2,600). http://www.justice.gov/atr/public/guidelines/hhi.html and the Horizontal Merger Guidelines http://www.justice.gov/atr/public/guidelines/hmg-2010.html

[14] OECD Communications Outlook 2007, Figure 4.7 http://dx.doi.org/10.1787/001065872504

[15] Besluit van de Raad van Bestuur van de Nederlandse Mededingingsautoriteit als bedoeld in artikel 37, eerste lid, van de Mededingingswet. Nummer 5104 /45 Betreft zaak: 5104/KPN – Telfort,

[16] Case No COMP/M.4748 - T-MOBILE / ORANGE NETHERLANDS, Date: 20/08/2007, http://ec.europa.eu/competition/mergers/cases/decisions/m4748_20070820_20310_en.pdf

[17] Terinzagelegging ontwerpbesluit toezeggingen Mobiele operators, 21-11-2013, https://www.acm.nl/nl/publicaties/publicatie/12312/Terinzagelegging-ontwerpbesluit-toezeggingen-Mobiele-operators/

[18] Case No COMP/M.5650 - T-MOBILE/ ORANGE http://ec.europa.eu/competition/mergers/cases/decisions/M5650_20100301_20212_247214_EN.pdf

[19] http://ec.europa.eu/competition/mergers/cases/decisions/m6497_20121212_20600_3210969_EN.pdf

[20] Vodafone set to halt Greek unit merger, February 5, 2012, Financial Times

[21] Softbank to sell stake in eAccess to Samsung, others: source http://www.reuters.com/article/2013/01/12/us-softbank-eaccess-sale-idUSBRE90B03K20130112

[22] Yahoo Japan to Buy eAccess From SoftBank, MARCH 27, 2014, New York Times http://dealbook.nytimes.com/2014/03/27/yahoo-japan-to-buy-eaccess-from-softbank/?_php=true&_type=blogs&_r=0

[23] "Mergers: Commission clears proposed merger between Hutchison 3G (H3G) and Telefónica Ireland (O2 Ireland) subject to conditions - frequently asked questions", http://europa.eu/rapid/press-release_MEMO-14-387_en.htm and "Mergers: Commission clears acquisition of E-Plus by Telefónica Deutschland, subject to conditions", http://europa.eu/rapid/press-release_IP-14-771_en.htm

[24] Confusopoly' is a situation where firms make price structures or product attributes unnecessarily confusing, thereby making it difficult for consumers to evaluate rival offers. As a result firms avoid having to compete hard on price. Mobile phone contracts, retail energy tariffs and bank accounts are frequently cited as examples of this. http://www.oft.gov.uk/OFTwork/public-markets/choice-and-competition/Confusopoly/#.U3FAWfmSwrV

[25] T-Mobile Makes Bold "Un-carrier" Moves, Mar. 26, 2013, http://newsroom.t-mobile.com/phoenix.zhtml?c=251624&p=irol-newsarticle&ID=1802239

[26] Protection for consumers against mid-contract price rises, Ofcom, http://consumers.ofcom.org.uk/2013/10/protection-for-consumers-against-mid-contract-price-rises/

[27] The Mobile services observatory for Q1 2014, Arcep,

[28] Calculate savings with Golan Telecom, HOT Mobile, Rami Levy, Home Cellular, No Fryers, 23 March 2012 http://nofryers.com/calculate-savings-with-golan-telecom-hot-mobile-rami-levy-home-cellular-in-israel/

[29] Israel restricts the sales of a bundle of mobile phone with a subscription. See table 2 OECD report "MOBILE HANDSET ACQUISITION MODELS" http://search.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP/CISP(2012)10/FINAL&docLanguage=En

[30] Article title and text in Hebrew http://www.themarker.com/technation/1.1709888

[31] See Cellcom SIM-unlimited http://www.cellcom.co.il/shop/join/pages/default.aspx?hp_001=sim_unlimited

[32] Concurrence dans la téléphonie mobile : Un bilan sans appel. La ligne consumériste ne doit pas être coupée, UFC Que Choisir. http://image.quechoisir.org/var/ezflow_site/storage/original/application/1be23ef5fc1ca2542bbb96692d1591ff.pdf

[33] This decline already started before Free entered the market as other operators took defensive measures such as starting low-cost sub-brands in the months prior to Free entering the market.

[34] Etude de l'UFC QUE CHOISIR sur la concurrence dans la téléphonie mobile : Position de la FFTélécoms, 5 May 2014, http://www.fftelecoms.org/articles/etude-de-l-ufc-que-choisir-sur-la-concurrence-dans-la-telephonie-mobile-position-de-la

[35] Internet pricing in light of the history of communications, A. Odlyzko, AT&T Labs, http://www.dtc.umn.edu/~odlyzko/doc/history.communications1.pdf goes into a number of examples in long distance calling, roaming, Internet dial-up and postal services.

[36] http://www.vodafone.pt/main/Particulares/tarifarios/red/

[37] Hi3G Denmark scraps roaming charges for several destinations http://www.telegeography.com/products/commsupdate/articles/2014/03/14/hi3g-access-denmark-scraps-roaming-charges-for-several-destinations/ and 3 Denmark customers get free 4G roaming in Sweden, 10 Jun 2013, Telegeography

[38] Supercollider, HSBC Global Research, February 2014

[39] Capex, the long march, Arthur D. Little and BNP Paribas, March 2014 http://www.adlittle.fr/uploads/tx_extthoughtleadership/ADL_Exane_2014-Capex_the_long_march-Exec_Sum.pdf

[40] Communications Outlook 2013, Figure 3.8 Public telecommunications investment by region, 1997 2011 excluding spectrum fees.

[41] Mobile broadband with HSPA and LTE – capacity and cost aspects, whitepaper by Nokia Siemens Networks from 2010, available at http://nsn.com/system/files/document/Mobile_broadband_A4_26041.pdf

[42] A further discussion of the impact of wholesale interconnection rates is available in "OECD (2012), "Developments in Mobile Termination", *OECD Digital Economy Papers*, No. 193, OECD Publishing. doi: 10.1787/5k9f97dxnd9r-en

[43] Communications Report 2012, RTR Austria, Figure 39.

[44] Communications Report 2012, RTR Austria, Figure 44

[45] Verizon was the final major operator to offer such plans in April 2014 http://www.cnet.com/news/verizon-bring-your-own-device-get-a-discount/

[46] Lucy Battersby, "Vodafone, Optus unveil mobile joint venture", 3 May 2012. www.theage.com.au/business/vodafone-optus-unveil-mobile-joint-venture-20120503-1y0nm.html

[47] ACCC, Vodafone Group plc and Hutchison 3G Australia Pty Limited - proposed merger of Australian mobile operations", 2009. http://registers.accc.gov.au/content/index.phtml/itemId/874445

[48] The reviews can be found at: http://www.accc.gov.au/publications/accc-telecommunications-report

[49] Farrha Khan, "TPG lowers mobile data allowance on its prepaid plan by 75%", October 4th 2013. www.techradar.com/us/news/phone-and-communications/mobile-phones/tpg-lowers-mobile-data-allowance-on-its-prepaid-plan-by-75--1186406

[50] Jenneth Orantia, "Consumers warned after telcos slash mobile data allowances", The Age, 6 November 2012. www.theage.com.au/national/consumers-warned-after-telcos-slash-mobile-data-allowances-20121105-28u3t.html

[51] Department of Communications, "Mobile Coverage Programme: Discussion Paper" 16 December 2013 www.communications.gov.au/__data/assets/pdf_file/0003/204069/Mobile_Coverage_Programme_-_Discussion_Paper.pdf

[52] James Hutchison, "TPG mobile spectrum buy questioned by analysts", 7 MAY 2013. www.afr.com/p/technology/tpg_mobile_spectrum_buy_questioned_1GHhr4IT8pCvjNJo4rv9XN

[53] David Ramli, Vodafone calls for NBN Co rural mobile network, The Sydney Morning Herald, 10 March 2014. http://www.smh.com.au/business/vodafone-calls-for-nbn-co-rural-mobile-network-20140309-34ff0.html#ixzz2yJD6mGh6

[54] Mitchell Bingemann, "Telco lashes rivals' push for more mobiles sector regulation", The Australian, 9 April, 2014. Htpp://www.theaustralian.com.au/business/in-depth/telco-lashes-rivals-push-for-more-mobiles-sector-regulation/story-e6frgaif-1226878238654

[55] European Commission, "Mergers: Commission clears acquisition of Austrian mobile phone operator Orange by H3G, subject to conditions", Brussels, 12 December 2012. europa.eu/rapid/press-release_IP-12-1361_en.htm

[56] Ibid

[57] BWB press release, 13 July 2012, http://www.en.bwb.gv.at/News/Archive2012/Seiten/NextRoundinMergerofTelekomAustriaandYesss!.aspx

[58] The Cartel Court, which is comprised of five panels that are each composed of two professional judges and two lay judges, is the decision making body in Austria. The Cartel Court employs seven professional judges who are partly involved in other matters and are supported by fifteen lay judges.

[59] BWB, "Annual Report on Competition Policy Development in Austria 2012 – 2013", www.bwb.gv.at/Fachinformationen/Bußgelder/Documents/Annual%20Report%202012_2013_Austria.pdf

60 Ibid

61 Presentation by IE market research. http://www.slideshare.net/nassanie/3-q11-austria-mobile-operator-forecast-executive-summary

62 Mobilfunkpreisentwicklung in Österreich Regulierungsdialog 21. Februar 2014, https://www.rtr.at/en/komp/RegDialog21022014/Mobilfunkindex.pdf

63 Gungl: Regulation is no aim in itself – the focus must be on customers Press release from: 21. 02. 2014 https://www.rtr.at/en/pr/PI21022014TK/Praesentation_21022014.pdf

64 "UPDATE 1-Austrian telecoms auction bids seen near 2 bln euros", 1 October 2013. http://uk.mobile.reuters.com/article/mergersNews/idUKL5N0HN31F20131001 and "Austrian 4G auction raises €2bn", 22 October 2013. www.globaltelecomsbusiness.com/article/3269476/Austrian-4G-auction-raises-2bn.html#.U1UX9F7KzS4

65 The sources for the number of subscriptions is based on the financial statements of operators and these data are not reported by ARCEP, which provides industry wide data. Generally operators focus on the number of SIM cards in operation, which includes uses such as M2M. In 2014, ARCEP reported 77.6 million SIM cards of which 7.3 million were M2M cards.

66 Mobile observatory ARCEP http://arcep.fr/index.php?id=36#c80239

67 Idem http://arcep.fr/index.php?id=36#c80239

68 ARCEP, "Press conference", 1 March 2013. arcep.fr/fileadmin/reprise/communiques/communiques/2013/press-conf_210313-slides_ENG.pdf

69 The increased competition also placed pressure on French MVNOs, such as La Poste and Virgin, which had been quite successful in the pre-paid and lower usage bundles in the subscription market. They too had to introduce offers that were similar to that of Free Mobile and the SIM-only sub-brands. Virgin, for example, introduced an offer that allowed users to use up to 1Gbyte/month while roaming. However this offer was limited in the number of subscribers able to take up the service with the handset that came supplied to enable experimentation with advertising and generating revenue from the usage of behavioral data. In addition, a number of services, such as tethering, were prohibited.

70 http://www.telecompaper.com/news/bouygues-offers-smes-200-mbps-fixed-web-lte-back-up--1005932

71 "Vivendi's SFR begins 4G battle in France" , 29 November 2012. www.reuters.com/article/2012/11/29/us-vivendi-4g-idUSBRE8AS0L920121129 and "Bouygues Telecom to roll out its 4G network and chooses Lyon as the pilot city", 22 March 2012. www.bouygues.com/wp-content/uploads/2012/03/12-0073-0322-cp-reseau-bouygues-telecom-gb.pdf

72 , "4G : Orange accélère pour couvrir 50% de la population en fin d'année" , 7 November 2013, La Tribune www.latribune.fr/technos-medias/20131107trib000794642/4g-orange-accelere-pour-couvrir-50-de-la-population-en-fin-d-annee.html

73 Steve Costello, "Free keeps up pressure with low-cost 4G launch", 3 December 2013

74 Valéry Marchive, "France's 4G rollouts to speed up after SFR, Bouygues start network-sharing talks", 23 July 2013. www.zdnet.com/frances-4g-rollouts-to-speed-up-after-sfr-bouygues-start-network-sharing-talks-7000018435/

[75] "SFR and Bouygues see network sharing savings by 2017-18", 3rd February 2014. www.reuters.com/article/2014/02/03/sfr-bouygues-idUSL5N0L81IP20140203

[76] ARCEP, "ARCEP welcomes the mobile network sharing agreement signed by SFR and Bouygues Telecom, and will perform a detailed analysis of it in the coming weeks", 31 January 2014.

[77] Cellcom Israel agrees network sharing with Pelephone, monday 19 May 2014 http://www.telecompaper.com/news/cellcom-israel-agrees-network-sharing-with-pelephone--1014399

[78] Cellcom financial presentation Q4 2011.

[79] Press release by the ministry, explaining the 7% rule http://moc.gov.il/sip_storage/FILES/3/3153.pdf

[80] Calculate savings with Golan Telecom, HOT Mobile, Rami Levy, Home Cellular, No Fryers, 23 March 2012 http://nofryers.com/calculate-savings-with-golan-telecom-hot-mobile-rami-levy-home-cellular-in-israel/

[81] Israel restricts the sales of a bundle of mobile phone with a subscription. See table 2 OECD report "MOBILE HANDSET ACQUISITION MODELS" http://search.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP/CISP(2012)10/FINAL&docLanguage=En

[82] Article in Hebrew http://www.themarker.com/technation/1.1709888

[83] Company presentation Cellcom Q4 2013 http://files.shareholder.com/downloads/CEL/3125431087x0x735578/16018bf4-4f04-4a62-a8e4-d4881c9a00ed/Company%20Presentation%20Q413.pdf

[84] Cellcom Israel agrees network sharing with Pelephone, monday 19 May 2014 http://www.telecompaper.com/news/cellcom-israel-agrees-network-sharing-with-pelephone--1014399

[85] Pelephone looks vulnerable, Gad Perez for Globes. http://www.globes.co.il/en/article-pelephone-looks-vulnerable-1000933981

[86] Press release Tnago http://www.tango.lu/documents/fck/file/08_Press%20release/141%20PR%20-%20Tango%20closes%20the%20year%20with%20two-digit%20growth.pdf

[87] Orange Luxembourg results 2013, https://www.orange.lu/static/pdf/news/Results-2013_Efin.pdf and Orange Hello Europe announcement https://www.orange.lu/static/pdf/news/HelloEurope_EN.pdf

[88] Join Experience http://joinexperience.com

[89] The process to award spectrum was opened in March 2014. http://www.ilr.public.lu/services_frequences/cons_publiques/conspub130313/Consultation_2600_MHz-2013.pdf

[90] CELLULAR MOBILE PRICING STRUCTURES AND TRENDS, OECD 1999, http://www.oecd.org/sti/2538118.pdf

[91] Comparative Assessment of the Licensing Regimes for 3G Mobile Communications in the European Union and their Impact on the Mobile Communications Sector, June 25 2002, EUROPEAN COMMISSION http://www.pedz.uni-mannheim.de/daten/edz-bo/gdi/02/annex_final_report.pdf

92 "Orange accepts Luxembourg UMTS licence"by Reuters staff, Tuesday 11 June 2002 http://www.totaltele.com/view.aspx?ID=404304

93 Orange Hello Europe http://www.orange.lu/static/pdf/news/HelloEurope_EN.pdf

94 Thierry Labro, "New mobile phone operator launches in Luxembourg", http://www.wort.lu/en/view/new-mobile-phone-operator-launches-in-luxembourg-52e13a6ee4b02ecc4ece2064

95 https://www.officielebekendmakingen.nl/stcrt-2014-6781.html

96 BBC, "BT approves mobiles spin-off", 23 October, 2001, http://news.bbc.co.uk/2/hi/business/1615100.stm

97 3-UK, "Data, data, everywhere", 21 November 2011. http://blog.three.co.uk/2011/11/21/data-data-everywhere/

98 Price information available on price comparison websites, January 2014.

99 Calculated using the lowest prices available to fulfil the requirement of each usage profiles using the tariffs offered by the United Kingdom's three largest mobile providers, weighted by their market shares. This analysis excludes services offered by smaller providers (including MVNOs) and new entrants, who as in other countries are frequently price leaders.

100 This analysis contrasts with the analysis in Figure2 (which shows flat UK mobile prices from 2010 to 2012). The analysis in Figure 4 is based on the eight mobile usage profiles shown, while the basket prices in Figure 2 are calculated using average per-unit prices across all mobile users; the analysis in Figure 4 better captures the effect of mobile data price changes on mobile prices.

101 See section 309(j)(3) and (4) of the Act, 47 U.S.C. § 309(j)(3),(4).

102 FCC, "Ninth Annual CMRS Competition Report," September 28, 2004, at para. 49 and Table 10, http://www.fcc.gov/reports/commercial-mobile-radio-services-cmrs-competition-report-9th-annual.

103 See Section 7 of the Clayton Act, 15 U.S.C. § 18.

104 See section 310(d) of the Act, 47 U.S.C. § 310(d).

105 More precisely, the Commission does not have the authority to simply reject a proposed transaction. Rather, it can order that the transaction be sent to an administrative law judge for a further, in-depth factual hearing. It is this outcome that may be considered equivalent in practice to a rejection.

106 FCC, "2000 Biennial Regulatory Review Spectrum Aggregation Limits For Commercial Mobile Radio Services, December 18, 2001, http://wireless.fcc.gov/spectrum/index.htm?job=spectrum_cap.

107 FCC, "Ninth Annual CMRS Competition Report," September 28, 2004, at Table 4, http://www.fcc.gov/reports/commercial-mobile-radio-services-cmrs-competition-report-9th-annual.

108 DOJ, "Competitive Impact Statement," October 29, 2004, http://www.justice.gov/atr/cases/f206000/206049.pdf.

109 FCC, Memorandum Opinion & Order (FCC 04-255), October 26, 2004, at para. 5, http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-255A1.pdf.

110 DOJ, "Statement of the Department of Justice Antitrust Division on the Closing of the Investigation of Sprint Corporation's Acquisition of Nextel Communications Inc., August 3, 2005, http://www.justice.gov/atr/public/press_releases/2005/210412.pdf.

111 FCC, Memorandum Opinion & Order (FCC 05-148), August 8, 2005, at para. 3, 119, http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-148A1.pdf.

112 DOJ, "Complaint," August 31, 2011, http://www.justice.gov/atr/cases/f274600/274613.pdf.

113 FCC, "Staff Analysis and Findings," Nov. 29, 2011, at paras. 5, 13, and 266, http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-11-1955A2.pdf.

114 FCC, "16th Annual Mobile Wireless Competition Report," March 21, 2013, http://www.fcc.gov/reports/mobile-wireless-competition-report-16th-annual.

115 See for example "Roaming for Mobile Wireless Services" on the FCC website: http://www.fcc.gov/rulemaking/05-265

116 FCC Approves GCI-ACS Transaction, FCC 13-96, July 12, 2013, http://www.fcc.gov/document/fcc-approves-gci-acs-transaction

117 http://en.wikipedia.org/wiki/Base_transceiver_station, "BTS is also referred to as the radio base station (RBS), node B (in 3G Networks) or, simply, the base station (BS). For discussion of the LTE standard the abbreviation eNB for evolved node B is widely used".

118 See the corporate website of Indus Towers http://www.industowers.com/

119 Stockholm's Stokab: A Blueprint for Ubiquitous Fiber Connectivity?, Benoît Felten, July 2012, Diffraction Analysis

120 Skånet 2011, The BAS network as the basis for the latest generation's mobile communication http://www.skanet.se/pics/1/13/%C5rsrapport%202011%20sk%E5net_eng_low.pdf

121 The exact construction of the arrangement can resemble business process outsourcing, financial lease, ownership and sub-contracting.

122 SK Telecom, NSN successfully complete Evolved Packet Core virtualization proof-of-concept, November 25 2013, http://fr.nsn.com/news-events/press-room/press-releases/sk-telecom-nsn-successfully-complete-evolved-packet-core-virtualization-proof-of-concept

123 Source: website Aspider, www.aspider.nl

124 Ericsson closes acquisition of M2M technology platform from Telenor Connexion, 24-08-2011, http://www.ericsson.com/news/1540712

125 Website of Japanese tunnel association http://www.jmcia.or.jp/

126 For Ericsson see http://www.ericsson.com/article/bharti_airtel_india_1595655422_c and for IBM see Bharti Airtel Case Study, IBM 2008 http://www-935.ibm.com/services/us/cio/ads/outsourcing/assets/pdf/bharti_airtel_case_study.pdf

127 Joint BEREC/RSPG Report on Infrastructure and spectrum sharing in mobile/wireless networks, 16 June 2011, http://rspg-spectrum.eu/_documents/documents/meeting/rspg25/rspg11-374_final_joint_rspg_berec_report.pdf

128 There are a number of caveats with the Indian spectrum sharing arrangement, these are explained in newspaper articles. A step forward in spectrum sharing, The Hindu, 11 August 2014, http://www.thehindubusinessline.com/opinion/a-step-forward-in-spectrum-sharing/article6305105.ece and TRAI allows spectrum sharing, The Telegraph Calcutta, 21 July, 2014, http://www.telegraphindia.com/1140722/jsp/business/story_18640049.jsp#.U-xydfmSySo Also see a press release of TRAI at http://www.trai.gov.in/WriteReadData/WhatsNew/Documents/Press%20Release21072014.pdf and the guidelines at http://trai.gov.in/WriteReadData/Recommendation/Documents/Guidelines%20on%20%20Spectrum%20Sharing.pdf.

129 There is the possibility that the owner of the spectrum license is a different entity than the owner of the network. However such leasing agreements are not very common outside of units, which are part of the same group.

130 National roaming charges were used in Colombia during the 90s due to the existence of regional licences. However, this situation changed at the end of that decade based on the mergers and acquisitions activity that took place during that period. From that moment on, MNOs have been operating on a national level, eliminating roaming rates among regions. However, in 2013 regulation regarding national roaming as an essential facility was issued, including the establishment of wholesale rates for voice, SMS and data. This decision has served as a means to reduce barriers to entry for new operators that entered the market in the auction that took place on June 2013. Operators are currently in the process of implementing roaming agreements for voice, SMS and data.

131 MBNL agreement announced in 2007. http://mbnl.co.uk/about-us/

132 Vodafone and Orange announce RAN share in the UK, 2007. http://www.theguardian.com/media/2007/feb/08/digitalmedia.mobilephones.

133 Vodafone announces agreement with Cornerstone in 2009. Press commentary noted that the prior agreement with Orange had not resulted in any significant sharing. http://www.mobiletoday.co.uk/news/industry/7317/New_network_sharing_deal_for_O2_and_Vodafone_sidelines_Orange.aspx

134 Vodafone has explained the sharing arrangements on its website. http://blog.vodafone.co.uk/2012/11/20/better-coverage-fewer-masts-your-complete-guide-to-our-network-joint-venture/

135 EE and Three announce 4G sharing arrangements. http://www.computerweekly.com/news/2240213694/EE-and-Three-sign-passive-network-share-deal-for-rural-UK

136 And not if the terms of sharing replicate the prices one would have if only facilities-based carriers competed where it was economic to do so.

137 See for example the aforementioned study by Aguelakakis and Yankelevich.

138 Figure used with permission from Nicoletta Corrocher, Laura Lasio Diversification strategies in network-based services: The case of mobile virtual network operators, Telecommunications Policy, Volume 37, Issue 11, December 2013, Pages 1110-1123, ISSN 0308-5961,

http://dx.doi.org/10.1016/j.telpol.2013.03.002 based on Ferdinand Jaspers , Willem Hulsink & Jules Theeuwes (2007) Entry and Innovation in Maturing Markets: Virtual Operators in Mobile Telecommunications, Technology Analysis & Strategic Management, 19:2, 205-225, DOI: 10.1080/09537320601168144

139 Mobile Network Codes (MNC) for the international identification plan for public networks and subscriptions (According to Recommendation ITU-T E.212 (05/2008)) (POSITION ON 1st JANUARY 2013) available at http://www.itu.int/dms_pub/itu-t/opb/sp/T-SP-E.212B-2013-PDF-E.pdf

140 In the Czech Republic there appears to be no legal reason why MVNOs cannot be full MVNO. However, the market for MVNOs is relatively new and full MVNOs appear not to have developed yet.

141 Ireland issued an MNC to a Clever Communications, however it was never able to secure a deal to access the market.

142 International Mobile Roaming Regulation, BEREC Report http://berec.europa.eu/files/news/bor_10_58.pdf page 44. The report mentions the GSMA researching the possibility for MVNOs to get access to STIRA agreements. In 2014 the GSMA does not mention such a possibility on its website.

143 For Germany, see Regeln für die Zuteilung von Internationalen Kennungen für Mobile Teilnehmer, veröffentlicht im Amtsblatt der Regulierungsbehörde für Telekommunikation und Post Nr. 23/2000 v.06.12.2000 geändert mit Vfg 11/2002 Amtsblatt 7/2002 und mit Vfg 55/2003 Amtsblatt 24/2003, Stand: 08.07.2011 The Canadian IMSI assignment guidelines require a spectrum license for the use of MNCs http://www.crtc.gc.ca/public/cisc/cn/CNODGL0004B.docx

144 Mergers: Commission clears acquisition of Austrian mobile phone operator Orange by H3G, subject to conditions, 12 December 2012 http://europa.eu/rapid/press-release_IP-12-1361_en.htm

145 EU, Hutchison showdown to take place today; Hutch unveils UPC as MVNO partner, 10 Oct 2012 http://www.telegeography.com/products/commsupdate/articles/2012/10/10/eu-hutchison-showdown-to-take-place-today-hutch-unveils-upc-as-mvno-partner/

146 Information Memorandum. Four licences to provide 3g services in Ireland, December 2001 http://www.comreg.ie/_fileupload/publications/odtr0196.pdf

147 French 4G Auction Results Announced, Winston Maxwell, Hogan Lovells, 23 December 2011 http://www.hlspectrumreview.com/2011/12/articles/auctions/french-4g-auction-results-announced/

148 EU / Spain: European Commission validates CMT proposal to impose MVNO access on mobile networks http://www.t-regs.com/index.php/2006/02/03/eu-spain-european-commission-validates-cmt-proposal-to-impose-mvno-access-on-mobile-networks-2/

149 EU assessment of significant market power, Thomson Reuters, http://uk.practicallaw.com/7-203-3689?service=competition#

150 Besluit van de Minister van Economische Zaken van 3 maart 2014, nr. ETM/TM/14024019, houdende wijziging van het Nummerplan voor identiteitsnummers ten behoeve van internationale mobiliteit (IMSI-nummers) in verband met het gebruik van IMSI-nummers door besloten netwerken https://zoek.officielebekendmakingen.nl/stcrt-2014-6781.html

151 Mitteilun 819, 2014 by the BundesNetzAgentur.
http://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Nummerierung/Technische%20Nummern/IMSI/Mitteilung819_2014.pdf?__blob=publicationFile&v=2