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Broadband Networks and Open Access

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BROADBAND NETWORKS AND OPEN ACCESS

English - Or. English

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FOREWORD

The Working Party on Communication Infrastructures and Services Policy (CISP) discussed the paper in June 2012. It agreed to recommend the paper for declassification to the Committee for Information, Computer and Communications Policy (ICCP). The ICCP Committee agreed to its declassification in October 2012.

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BROADBAND NETWORKS AND OPEN ACCESS[1]

Main Points

This report examines "open access" policies and approaches in various contexts, including fixed and mobile access networks, backhaul and backbone networks, undersea cables and Internet exchange points (IXPs), bearing in mind that there is no single definition of "open access" in OECD countries. Nevertheless, open access arrangements share some common elements: they refer to wholesale access to network infrastructure or services that is provided effectively on fair and reasonable terms, for which there is some degree of transparency and non-discrimination.

For fixed networks, open access policies in the form of mandated regulated access, such as local loop unbundling or other wholesale access products, have undeniably played a leading role in the development of competition, in most OECD countries, as these markets were liberalised. A variety of wholesale access products enable different levels of investment and possibilities for technological independence for new entrants. While the price level of this regulated access has often been contested, many OECD countries have achieved a far higher degree of competition than would have been the case if they had not intervened to assist in the development of market access.

Open access arrangements will also play a major role in shaping the level of competition in next generation access (NGA) networks. Some of the access remedies that were available to regulators for traditional broadband may no longer be technically or economically viable for fibre networks. As it is unclear whether there will be sufficient infrastructure competition, especially outside very densely settled urban areas, the question of how to promote competition remains at the forefront.

The scope for wholesale open access in fixed networks does not only affect products and services such as access to the local loop or wholesale service at higher levels of the network (*e.g.* bitstream). Key access products, such as dark fibre services, access to ducts or, especially, access to in-building wiring, play a major role and need to be taken into account by policy makers and regulators as they may represent a major barrier for the entry of alternative operators.

In recent years, mobile networks have also experienced, to some extent, remedies such as obligations for mobile network operators (MNOs) to host mobile virtual network operators (MVNOs) as a means to improve competition. Under some conditions, these remedies could be termed as "open access". A number of policy makers and regulators in OECD countries fairly believe that entry of MVNOs, either through voluntary agreements with MNOs or by some type of mandated regime, has improved the level of domestic competition. Experience shows, however, that MVNOs have not been able to drive substantial

[1] The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

changes in some markets (*e.g.* international mobile roaming) where their influence is limited by a lack of access to competitive wholesale arrangements.

Open access arrangements have also been used at the backhaul and backbone network levels, for example by municipal backhaul networks, undersea cables or wholesale backbone networks. These initiatives are mostly the result of public intervention and are usually triggered by a mismatch between public policy objectives and the current outcomes of market forces.

Internet exchange points (IXPs) may be regarded as an example of open access arrangements, because an IXP typically allows its parties to exchange traffic based on agreed terms and conditions, and usually have a clear and transparent policy for members to adhere. They are usually run directly by industry participants, such as ISPs, that set their own policies and practices on a voluntary basis and under mutually beneficial terms and conditions that are open for others to join upon adherence to these rules.

Voluntary open access agreements remain relatively rare. Infrastructure sharing agreements are however fairly common, and some of these arrangements may have some degree of openness, but they are generally better categorised under the scope of purely commercial arrangements, and therefore the term "open access" may not be appropriate. The available evidence indicates that the incentive for commercial network providers to grant access to its infrastructure on open terms remains fairly low.

Many open access arrangements are a result of public funding of broadband networks. In these cases, there should be co-operation between the funding authority and the telecommunication regulator, to guarantee coherence between *ex-ante* regulation, competition law and public funding schemes for broadband networks. This would leverage the expertise of telecommunication regulators and ensure a consistent approach at all levels.

In sum, this report identifies several features that appear to be common in open access regimes in OECD countries:

- Access is provided at the wholesale level.
- Effective access is provided on fair and reasonable terms. Setting adequate price levels and avoiding non-price related discriminatory behaviours should play a major role in ensuring effectiveness.
- Access should be provided on transparent and non-discriminatory terms or, at a minimum, a clear policy should be established as to the conditions that apply to the arrangement. Transparency may also be implemented through a public reference offer.
- To date open access has rarely been provided voluntarily, and it is usually the result of direct or indirect public intervention.

Market failure has often been tackled through open access policies with relative success in a growing number of OECD countries. Moving forward, it is very likely that this will continue to be the trend and will not only be directed to fixed access networks only, but also to mobile, backhaul and backbone networks.

Introduction

The concept of "open access", for broadband networks, or "open broadband networks", can be referred to under a number of different scenarios, related to the establishment or treatment of these networks. These can range from commercial or voluntary arrangements, between communication operators and third-parties, through to regulatory intervention aimed at promoting certain policy objectives, such as expanding broadband availability, increasing competition, or promoting investment that may otherwise not be economic, such as in the case of enabling the establishment and treatment of shared facilities. The concept is different from "open Internet access", which tends to refer to the use of networks by end users or the relationship between end users and these service providers. "open Internet access" addresses a higher network level than broadband open access, which is generally used to only refer to the physical, data link and network layers only.

The use of an open access policy is often highlighted as a facilitator of objectives, such as promoting greater choice for consumers or addressing infrastructure bottlenecks, especially in the context of regulated access and, in that sense is generally taken to have positive connotations by users of the term. Telecommunication networks show large economies of scale and scope that could, in some cases, impede competition in the absence of open access policies. Nevertheless, open access policies that are the result of regulation, public investment or commercial outcomes, always need to be assessed against meeting overall policy objectives. Take, for example, the use of the term when it is applied to networks with structural separation between infrastructure and services. Such a network may well increase competition at the retail level but result in a virtual monopoly at the wholesale level. At the same time, what happens if a group of, otherwise competing, network and service providers jointly invest in a network said to be an open network? Regulators face the challenge of weighing up the use of shared facilities, where such investment may otherwise be judged as uneconomic, against what this may mean for further developments in areas ranging from promoting innovation or new competitive market entry.

There is not necessarily a uniform definition of the term "open broadband access" or "open networks", as the terms are used by different stakeholders in different contexts. The term may be applied to networks that are said to be open, for example, at different layers of networks (*e.g.* Layer 1 and 2). Nonetheless, it is widely believed that most stakeholders using these terms do refer to common features, such as transparency or non-discrimination, which involve at least a common starting point for understanding the use of the term "open access" and provides a starting point for considering what stakeholders mean by open access.

Following the liberalisation of telecommunication markets, authorities used open access as a tool to curtail bottlenecks. This was because they determined that sufficient competition would not otherwise have developed to meet their policy objectives. Across many countries, following a century of monopolies, regulators believed that some type of "open access", in the form of regulated access to some wholesale products, such as local loop unbundling, wholesale broadband access and line-sharing, was necessary to drive competition dynamics in these markets. Regulated access has usually included certain conditions that incumbent operators must meet, such as service level agreements, delivery times and, above all, price obligations.

The level of regulated prices, together with enforcement procedures, is arguably the most significant element of any "open access" obligation imposed by regulators. Many believe the price element, among others, has played a key role in opening markets to greater competition and providing the right incentives for investment and innovation. Some have called this choice "build or buy" and they argue it provides incentives for greater investment in telecommunication networks. Others argue that under certain

assumptions, low open access prices may discourage investment in new networks both by incumbent operators and new entrants.[1] Previous OECD work has examined the role of different market structures for the deployment of next generation access (NGA) networks in different countries (OECD, 2011).

Traditional fixed broadband networks have certain technological characteristics that enable them to implement open access policies at a number of levels (at open systems interconnection's -OSI- layer 1, layer 2, and so forth). Technical constraints such as the number of interconnection points or the possibility for service differentiation clearly have an influence on the economics of broadband service provision and the resulting competition dynamics. This report will briefly summarise these factors.

The introduction of next generation access (NGA) networks is based on changes to technologies and market demand. The different technologies being used to meet these demands have significant implications on the level of new investment required and whether there will be sufficient competition. This report examines these changes and what they may mean for different open access policies. These changes may, for example, have implications for the "ladder of investment" model that has been a cornerstone of regulatory approaches since telecommunication markets were liberalised.[2]

Open access obligations may be imposed by public authorities based on two other legal frameworks: that of public funding of broadband infrastructures and competition law, such as in antitrust and merger reviews. A growing number of countries have certain open access conditions that operators awarded public funding (*e.g.* preferential loans, subsidies), for broadband infrastructure deployment, need to comply with if they are to be recipients of that assistance. These obligations, widely used in regional and rural areas, are aimed at assisting third-party access to infrastructure supported by public funding. The rationale is to try to ensure that public funding, of broadband infrastructure, allows the emergence of some degree of competition in a given area.[3]

In some countries, such as in the Netherlands, regulators and competition authorities have imposed open access obligations in the context of mergers or acquisitions. These instances, among others, provide an option for imposing open access obligations, outside the regular legal resorts available to telecommunication regulatory authorities.

While most of the attention given to open access policies has focused on fixed broadband networks, the increasing relevance of mobile communications has triggered renewed interest in "wireless open access". There is a broad range of issues in mobile markets that can be considered under the umbrella of "open access" policies. The emergence of mobile virtual network operators (MVNOs) or wholesale arrangements may well be regarded as "open access". Arrangements such as those proposed by Lightsquared, in the United States, may well fall under the scope of open access for some stakeholders.

A further area that could be considered, under this category, could be the assignment of spectrum. Some regulatory authorities have held auctions, which specify some types of open access requirements on the successful participants. In addition, the trend toward the creation of secondary markets, which may promote the shared use of spectrum, (*e.g.* time of day) may also be considered by some as having elements of an open access policy. Finally, though perhaps not exhaustively, policies that enable unlicensed spectrum, such as that used by Wi-Fi access, could be considered as a form of open access.

While technology, policy objectives and the overall market dynamics may be very different for wireless networks, some common trends may be drawn on the basis of the understanding of open access policies for wireless networks. Moreover, this report discusses "open access" arrangements at the backbone and backhaul level, for example for submarine cables, Internet exchange points (IXPs) and backbone networks and attempts to derive some conclusions on the incentives, costs and benefits of these arrangements.

Most open access experience covered by this report involves some degree of public intervention. Nevertheless, this paper also shows some examples of "open access" arrangements between market players on a voluntary basis. For example, MVNO access agreements may be achieved with little or no regulatory intervention. To the extent that they also play a critical role in the exchange of IP traffic, under a broad consideration of open access, Internet exchange points are almost wholly driven by market players, with no regulatory intervention. IXPs can be managed by non-profit, semi-public or research organisations and therefore not directly managed by infrastructure providers or they can simply be a number of ISPs who band together to form an IXP with a certain set of policies and practices. Municipal broadband networks also offer some open access connectivity, although in that case, they are usually driven by public ownership of utilities or by other public initiatives at the local level.

For the purpose of this report, open access refers to some type of effective wholesale access to broadband services, with a certain degree of "openness" – such as transparency and non-discrimination - in the access policy established for these services, either on a voluntary basis or resulting from some obligations. The degree of effectiveness in that wholesale access may be determined by several criteria, such as pricing, availability and provision and enforcement procedures.

Different scenarios and scopes for open access

It could be argued that "open access" should be addressed from a technology-neutral perspective. This report aims to do so but, given that there are economic and technological constraints with any communication network, it also focuses on different perspectives or interpretations given to "open access" in different situations depending on the underlying technology. Historically, open access policies were initially directed to fixed networks where it was assessed that these facilities could not be economically replicated or, at least, not within a time that would meet policy objectives. The same reasoning has been applied to wireless networks. First, with respect to mandated roaming, where it takes time to roll out new networks. Second, in terms of the limitations on the number of new market entrants, due to constraints in the available spectrum, some regulators opened markets to mobile virtual network operators (MVNOs).

A wide range of scenarios has emerged where "open access" principles could be applied. In addition to the "traditional" meaning of the term for fixed networks, usually concerning access networks exclusively, similar concepts have emerged in the area of next generation zccess (NGA) networks, wireless networks and even domestic backbone infrastructure and undersea cables. Finally, "open access" IXPs provide an example of self-regulation where the actors using these facilities establish their own rules and practices.

Open access in traditional fixed broadband networks

Based on the OSI layer model, open access in fixed networks has been traditionally addressed using the following conceptual model (see Table 1), which covers access at three possible OSI network layers, either layer one, two or three, plus access at layer 0.[4] After the emergence of the Internet, it could be argued that a TCP/IP model could be used instead, as some access arrangements may be based on higher levels of the protocol stack (e.g. TCP/IP layer, application layer). Nevertheless, the OSI model provides a good comparison tool and is generally accepted as a good reference point by technical, economic and legal experts.

Using a relatively restrictive interpretation of the term, the following scenarios may be considered. Layer 0 access (conduits, ducts, collocation) is not a part of the network itself even though it corresponds to a significant share of the costs incurred in deploying fixed broadband networks. It may, therefore, also fall under the "open access" concept. Layer 1 comprises passive elements such as local loop unbundling or dark fibre, including the traditional copper loop and/or cable passive infrastructure. Layer 2 and 3 include

active equipment and provide for a variety of possibilities for implementation, which range from bitstream services at different levels of the network (e.g. national, regional, local interconnection at layer 2 or layer 3) or different technologies (*e.g.* IP-based, Ethernet-based, ATM) which allow for different technical implementations, different investment needs for alternative operators, as well as a different degree of freedom to offer differentiated services.

Table 1: Open access and OSI network layers

LAYER	WHOLESALE SERVICE PROVIDED
0	Conduit, collocation facilities, access to ducts
1 (physical layer unbundling)	Local loop unbundling, dark fibre leasing/optical layer unbundling in PONs
2 (data link layer unbundling)	Layer 2 bitstream access (e.g. Ethernet, ATM), dark fibre and link-layer electronics at each end
3 (network layer unbundling)	Basic network service provided, layer 3 bitstream (e.g. IP bitstream)

Source: OECD elaboration from Lehr *et al.* (2007)

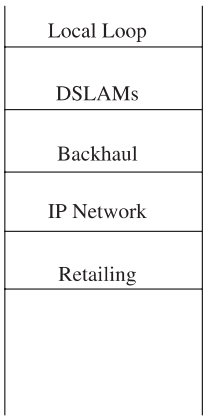
Traditionally, fixed broadband access has been provided over two main competing platforms: copper networks (DSL) and cable networks. As of June 2011, DSL and cable networks still represented 56.8% and 29.5% of the then total number of fixed wired broadband subscriptions in the OECD area (from a total of 309.4 million fixed wired broadband connections). These two technologies have different historical origins but now tend to provide very similar services: fixed voice telephony, television and/or video services and fixed broadband.

In most OECD countries, cable television networks have been upgraded from the mid-1990s onward in order to deliver bi-directional services, including broadband. Some OECD countries, such as the United States or Canada, started deploying cable television networks as early as in the 1940s. These networks have been and are being further upgraded for broadband service provision and in some cases have extensive - close to nationwide - coverage. In other countries, cable networks were developed much later and cover mainly urban areas. Unlike copper networks, open access regulation of broadband services provided over cable is relatively rare in OECD countries and, if it exists, it is implemented at a higher layer of the network. Unbundling the shared transmission channel (layer 1) is technically challenging for cable networks and is typically not mandated by regulators due to these difficulties. In addition, in many countries regulators have not considered imposing such obligations on cable operators due to their limited market share, *i.e.* it is not justified on the grounds of a dominant position held by those operators.

Wholesale broadband access over copper networks is or has been regulated to some extent in virtually every OECD country. Korea, Mexico, Chile, Israel and the United States do not mandate local loop unbundling and/or line-sharing today (in the United States copper loops are available at total element long run incremental cost prices, while line-sharing was gradually phased out during the 2000s). A more precise description of unbundling policies in these and other OECD countries will be provided below. Following telecommunications liberalisation, open access remedies such as wholesale broadband access or local loop unbundling proved necessary to introduce competition in voice telephony and broadband markets. The objective was to remove entry barriers and sunk costs that made the deployment of networks prohibitive by new entrants, especially for the local loop.

One rationale behind those obligations imposed on incumbent operators was to allow the replicability of broadband services by alternative - entrant - operators (CLEC in the United States terminology). This is illustrated by the "ladder of investment", which represents the necessary investment by entrants to replicate broadband services and therefore provide a credible competitive threat to the incumbent (see Figure 1). The higher the rungs of the ladder, the more investment is necessary and the higher the possible technology and service differentiation. The ultimate goal of many policy makers and regulators has been to achieve full infrastructure competition, including the local loop. However, service-based competition, that is, without entrants having their complete own infrastructure and thus leasing some facilities and services from incumbent operators, has been seen as an intermediate step towards infrastructure competition. For areas that may not attract investment by multiple operators, *e.g.* scarcely populated or remote areas, service-based competition may also be an efficient long-term market structure.

Figure 1. Ladder of replicability for broadband



Source: Cave (2006)

As work undertaken by BEREC, entitled "BEREC report on Open Access" highlighted, there is no legal definition of the term "open access", at least in the European Union, but regulators in European countries do have a common understanding of the term:

> "*The term 'open access' is used within Member States, although from an analysis of the responses to the questionnaire it was evident that no single definition exists. However, many countries have a similar understanding of the term in that it relates to transparent, non-discriminatory wholesale access to network infrastructure thereby enhancing competition*"[5]

BEREC further noted that:

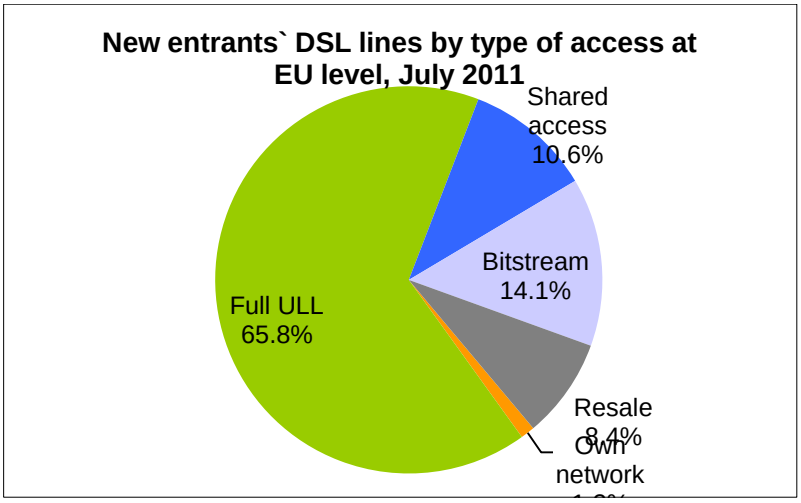
> *"There also was a strong view that the term should be used and understood in the context of the State Aid application process, some [Member States] suggested that it should be used exclusively in this context."*

Later, BEREC suggested replacing the term "open access" with the term "mandatory wholesale access" (BEREC, 2011a)

Local loop unbundling, however, is only one possible wholesale product that can be used by alternative DSL operators to reach the end-user premises. Other wholesale options exist, whether regulated or not, such as bitstream products, pure resale, sub-loop unbundling, unbundling at the concentration point or aggregation node, access to dark fibre or to in-building wiring and so forth.

Almost all OECD countries have used wholesale regulated access to some extent over a certain timeframe. To date, all European Union countries have made available local loop unbundling, shared access and bitstream products for alternative operators. In fact, some 75% of DSL subscriptions by entrants rely on either full local loop unbundling or on shared access (Figure 2). Alternative operators provide 46% of DSL subscription in the European Union in July 2011. The DSL market in the European Union relies heavily on the availability of wholesale products. These wholesale obligations are even more crucial in those areas where only one network infrastructure has been deployed, *e.g.* there is no cable coverage, as these areas would otherwise be confronted with a fixed network infrastructure monopoly.

Figure 2: New entrants' DSL lines by type of access at EU level, July 2011



Source: Digital Agenda Scoreboard 2011

Outside the European Union area, the situation is mixed. Some countries, such as Japan, have long had local loop unbundling obligations. Others only introduced unbundling requirements relatively recently: Switzerland (2007), New Zealand (2007). Chile only has a voluntary framework to which operators may adhere, but in practice local loop unbundling (LLU) is extremely rare in Chile.

Whether local loop unbundling and other wholesale products are available is not, of course, the only factor to be considered when assessing competition in broadband markets. Other key issues, such as the price of the copper loops and the procedure for alternative operators to request LLU provision, including service level agreements, and other such tools, can play an extremely important role in improving competition. Dysfunctional provision of LLU was among the reasons outlined in some countries that have introduced or have threatened to impose functional and/or structural separation on the incumbent operator (*e.g.* Australia, New Zealand, Sweden, United Kingdom).

Canada introduced unbundling obligations as early as 1997. However, these obligations had a five-year sunset clause commencing on 1 May 1997. The rationale behind this was to stimulate investment by new entrants to deploy their network facilities. On 11 July 2000, the CRTC initiated a public consultation on its preliminary view that the sunset clause should be extended beyond the five-year period.[6] In 2001 the sunset period was extended indefinitely. Despite this extension, entrants have not embraced the use of unbundled local loops to compete in the provision of broadband Internet services (OECD, 2003). Some ISPs rely on resale of bitstream products provided by both incumbent telecommunication and cable operators, although such products provide little technological independence. Platform-based competition between regional cable and telecommunication incumbents accounts for much of the broadband market. In

Canada, non-incumbent ISPs only represented 7% of residential fixed broadband revenues and 31% of business fixed broadband revenues in 2011 (CRTC, 2011).

In the United States, open access policies and, specifically, local loop unbundling played a major role in telecommunication policy debates in the 1990s and 2000s. Proponents of line sharing, and extensive obligations for carriers, pointed at beneficial effects on competition, while others felt that imposing open access obligations discouraged investments and led to inefficient business models and to a suboptimal service-based competition. In the United States, the Telecommunications Act of 1996 required LLU prices be set to (total element) long run incremental costs.

Following the implementation of the Telecommunications Act of 1996, various network sharing and unbundling requirements were enforced to boost "intra-modal" competition. Several court cases significantly undermined the Federal Communications Commission's (FCC) ability to implement the rules.[7] Cable operators usually provided Internet access through affiliated ISPs, which were largely unregulated. In 2005, the Supreme Court upheld the FCC's determination that cable modem services would be classified as an "information service", and thus not subject to mandatory common carrier regulation.[8] The FCC subsequently extended similar treatment to DSL.[9] Since then, broadband access markets are essentially free from unbundling requirements.[10] The FCC gradually eased the initial requirements through various new rules, such as those resulting from the Triennial Review Order, where it found that "excessive network unbundling requirements tend to undermine the incentives of both incumbent LECs and new entrants to invest in new facilities and deploy new technology".[11]

Empirical evidence on the effects of unbundling is mixed, though independent research has generally found it to be beneficial in the absence of other sources of competition. It has undoubtedly played a critical role in countries with little or no inter-modal competition and very few incumbent telecommunication operators had announced the introduction of DSL prior to regulatory authorities signalling their intention to apply unbundling policies. While the need for unbundling has been overtaken by development of effective competition in places such as Korea and Hong Kong, China, it still plays a critical role in many countries. Even then both countries, Korea and Hong Kong, China, have promoted open access to the inside wiring of apartment buildings, or other connection points for high-rise buildings, that facilitate infrastructure competition. By way of contrast, there has been little use of open access tools, such as unbundling, in some countries where there is insufficient broadband competition.

The unavailability of LLU in Mexico is partly due to the split of responsibility between several agencies in charge of declaring market players' dominance and of imposing asymmetric regulation. This institutional setting, known as "double window", derives in the broader inability of the regulator to impose asymmetrical obligations on the incumbent operator (OECD, 2012). By 1999, the Mexican regulator Cofetel made an attempt to impose obligations on the incumbent. After many years of litigations and injunctions filed by the fixed incumbent, these obligations have never been applied and were finally overturned in court. Starting in 2009, Cofetel is undertaking a new round of five market reviews, which could result in asymmetrical regulation imposed on the fixed and mobile incumbents. This new round is, for the time being, unlikely to address open access requirements.

Korea, Israel and Chile are the other three OECD countries were LLU is not available. It could be argued that LLU did not play a significant role in Korea being a global leader in the development of broadband services. Certainly, the demographics of the country and the early recognition of the importance of broadband by policy makers, were favourable or key factors. That being said, these factors also existed in several other countries. On the other hand, it can be noted that broadband competition started with the entry of Thrunet, which leased the cable plant from Kepco, a state-owned utility company (Kushida and Oh, 2006). The subsequent entry of Hanaro further enhanced this competition and triggered the virtuous circle of lower prices and increased penetration. While Korea now relies on facilities-based competition,

the availability of Kepco's infrastructure - a type of open access arrangement - played a crucial role in the development of competition. Today, as many countries seek to introduce greater competition there may be valuable lessons to be drawn from applying open access policies to infrastructure with public ownership or financed by utilities (*e.g.* backbone fibre associated with transport grids such as train lines) or in connection points to apartment buildings.

Another OECD country where unbundling has never been implemented is Israel. Open access - LLU and wholesale broadband access - is now being considered by the government. A public committee -"The Hayek Committee", named after its Chairman - submitted a report to the Minister of Communications recommending the adoption of a wholesale market.[12] The Ministry is now developing a set of wholesale products and tariffs for public consultation. In addition, the government is promoting the entry of the Israel Electric Company (IEC) into the market as a carriers' carrier, by setting up a subsidiary that will have access to IEC's infrastructure and will roll out an FTTH network with about 70% population coverage within seven years. The subsidiary will be majority owned by an investor who will be chosen by tender.[13]

Japan, one of the OECD frontrunners, in terms of fibre connectivity and broadband speeds, has historically relied on local loop unbundling to promote competition. The number of fibre subscribers overtook DSL subscribers in 2008. The market share of NTT West/East, the incumbent telecommunication network providers, in DSL broadband was only 35% by the close of 2009. It was as much as 74% for fibre broadband. The Japanese government is to date reluctant to remove unbundling obligations for fibre, which has existed since 2001, as they believe this would have a negative effect on competition itself. In fact, it is reducing the regulated priced for the unbundled fibre loop.[14] Japan is also considering functional separation to ensure that its open access policies are more effective.

Finally, Australia and New Zealand are following similar paths in changing broadband market structures. Both are structurally separating their incumbents and deploying nationwide fibre networks. Historically, New Zealand did not intervene to impose unbundling and did not enforce LLU until 2007. Since the adoption of this remedy, broadband penetration rates have significantly increased.[15] LLU has also been contentious in Australia, as Telstra brought a significant number of cases to court over a long period.[16] The system, largely based on arbitration by ACCC upon failed negotiations with Telstra, was not operational as many contentious issues remain, including pricing. This was undoubtedly a consideration in the Australian government's decision to deploy a national broadband network (NBN). This NBN will provide a wholesale only nationwide fibre access network aiming to reach 93% of the population. Additional wholesale facilities will be provided, to retail ISPs, through fixed wireless and satellites to service the remaining population.

Table 1. Mandatory LLU and cable open access - OECD countries

	Mandatory LLU unbundling	Mandatory cable unbundling
Australia	Yes	No
Austria	Yes	No
Belgium	Yes	No
Canada	Yes	Yes (bitstream)
Chile	No	No
Czech Republic	Yes	No
Denmark	Yes	Yes (bitstream)
Finland	Yes	No
France	Yes	No
Germany	Yes	No
Greece	Yes	No
Hungary	Yes	No
Iceland	Yes	No
Ireland	Yes	No
Israel	No (under review)	No
Italy	Yes	No
Japan	Yes	No
Korea	No	No
Luxembourg	Yes	No
Mexico	No	No
Netherlands	Yes	No
New Zealand	Yes	No
Norway	Yes	No
Poland	Yes	No
Portugal	Yes	No
Slovak Republic	Yes	No
Slovenia	Yes	No
Spain	Yes	No
Sweden	Yes	No
Switzerland	Yes	No
Turkey	Yes	No
United Kingdom	Yes	No
United States	Yes	No

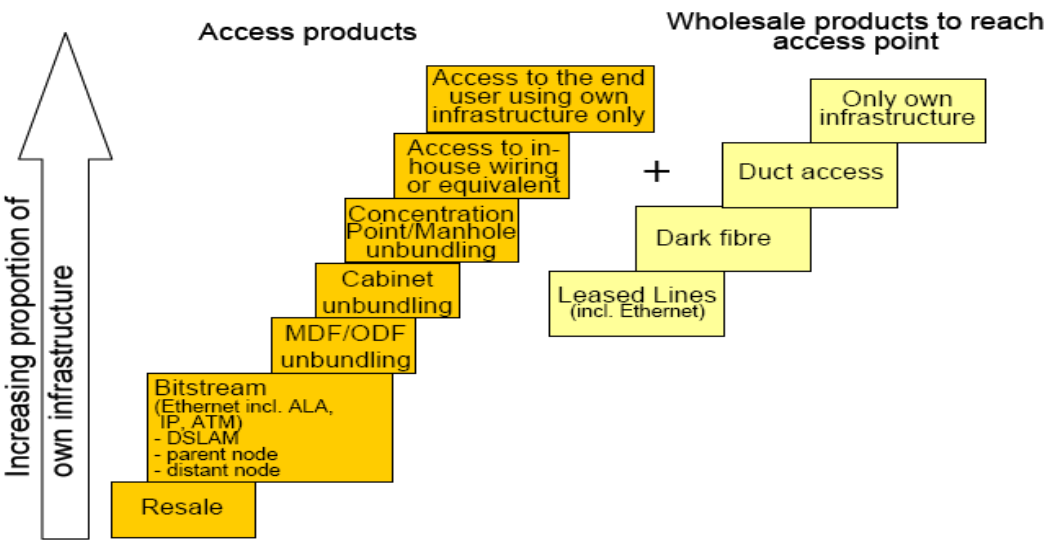
Open access in next generation access (NGA) networks

A key issue with new fibre networks is whether there will be sufficient infrastructure competition either from other fibre based networks or intermodal competition. While fibre based infrastructure competition has developed apace in some countries, such as Korea or Hong Kong, China, with open access applied only at places such as the basements of apartment buildings, it is less clear if this model can be replicated in countries with different demographics. In areas where there may only be one (virtual monopoly) or at best two (virtual duopoly) fixed network providers, the question of how to best ensure sufficient competition will be at the forefront. At the same time, to the extent that broadband wireless networks can provide a degree of this competition, they also need the use of fibre networks ever closer to their customers to efficiently offload traffic onto fixed networks. That is one reason why mobile providers have been active participants in proposals for open access networks in countries such as Italy.

As fibre networks play an increasing role in broadband service provision and fibre technology is deployed deeper in the network, moving closer to the premises (*i.e.* FTTH, FTTB, FTTC and so forth), new challenges arise as to the need and feasibility of implementing open access policies for NGA networks. These new networks have different technical and economic implications: wholesale access products are different for fibre technologies, network topologies may vary as well. In fact, new access products provide for a wide range of options available to entrants and may greatly differ from those available for copper networks. Those differences may be based, as mentioned, on technology, cost, network topology and service differentiation. In most cases, there no direct correspondence between fibre and copper wholesale access products, although some analogies may be drawn (see Figure 4).

As highlighted in previous OECD work, in an NGA environment LLU may no longer be feasible (OECD, 2010b). For point-to-point (P2P) topologies, unbundling could be feasible at the optical distribution frame (ODF), in a similar way to how unbundling was implemented in DSL networks, while for fibre, point-to-multipoint (P2MP) networks, this solution becomes more challenging.

Figure 3. NGA ladder of investment



Source: ERG (2009)

Although different unbundling options could exist for P2MP fibre networks, these might not be economically viable for entrants (*e.g.* subloop/splitter unbundling) or they are not yet technologically proven (WDM - wavelength division multiplexing). Therefore, it is likely that any form of wholesale access will have to be provided through indirect access obligations, as happens in cable networks. Some of these remedies may be based on "bitstream" or WDM. Nevertheless, regulators are strongly engaged with the industry in finding new, innovative wholesale products that may address some of the challenges highlighted. For example, a new bitstream access product has been required in the United Kingdom: virtual unbundled local access (VULA), which intends to provide a higher degree of independence than current bitstream products.

BEREC has discussed extensively wholesale products for NGA access and analysed the different possibilities and implications of these access products depicted above (BEREC, 2010). All the products may not be relevant in all cases, as some are specific to given roll-out scenarios (FTTH, FTTB, FTTC) and to topologies (point to point or point to multi-point: P2P and P2MP). This report does not intend to address these access products and scenarios in detail.

Unbundling at the "concentration point" - aggregation node - is relevant for some FTTH scenarios, being the concentration point located between the cabinet and the end-user or between the ODF and the cabinet. Depending on the location of the concentration point, alternative operators may be interested in unbundled access at this network level, even though some may prefer unbundled access at the cabinet or the ODF, depending on their network topology and associated economics.

Unbundling at the ODF (comparable to local loop unbundling for copper networks) may be done for P2P networks, and it does not pose any major challenges. Cabinet unbundling, whereby a lot more capital infrastructure - and therefore higher investments - is needed by the alternative operators, is mostly used for FTTC scenarios. Cabinet, concentration point and ODF unbundling are all Layer 1 products. Finally, bitstream products are possible for all topologies and fibre technologies and can be provided at Layer 2 (ATM, Ethernet) or Layer 3 (IP). As happened for cable networks, the higher the layer, the lower the technological independence for the alternative operator, which may have implications for competition in areas such as through innovation.

The deployment of NGA infrastructure has a fundamental difference with the regulation of copper: in most cases it is a newly built infrastructure and not a legacy network. Therefore, incentives for investment may play a more important role than they did for copper networks. When imposing access obligations on NGA infrastructure providers, regulators should take into consideration the balance between investment incentives and the promotion of competition. In that regard, they should consider appropriate costing methodologies, incentives that reward risk and/or uncertainty and investment recovery profiles.[17]

Even though this report does not attempt to address the issue of open access for NGAs in depth, it should note that some stakeholders, especially incumbent operators, argue that open access obligations would discourage investment in NGA infrastructures, whereas others, e.g. alternative operators, feel that lowering regulated prices for copper would provide an incentive for incumbents to deploy NGA networks.

In-building wiring regulations

Local loop unbundling and bitstream are key wholesale access products, but alternative operators typically need additional products or services in order to build their networks: collocation, access to ducts, dark fibre services and so forth. Specifically, some countries have identified the access to in-building wiring infrastructure as a key potential barrier preventing the deployment of broadband networks, especially NGA networks. These countries have developed regulations or best practice guidelines aimed at overcoming what may otherwise be a bottleneck to infrastructure competition.

While it could be argued that some of these initiatives have been put in place on the basis of national legislation, some regulatory frameworks for telecommunications already allow for such measures to be taken. Indeed, provisions concerning in-building wiring are usually targeted at all operators or, at a minimum, at those interested in deploying their networks in a given building. This is the reason why they are mostly imposed on a symmetrical basis, without having to declare market power exerted by one provider in the marketplace. For example, the European Union "Telecoms Package" reinforces the ability of regulators to impose the sharing of in-house wiring:

> *"…national regulatory authorities shall, taking full account of the principle of proportionality, be able to impose the sharing of such facilities or property, including buildings, entries to buildings, building wiring, masts, antennae, towers and other supporting constructions, ducts, conduits, manholes, cabinets."*[18]

Accordingly, regulators should consider promoting in-building infrastructure (and cost) sharing, namely to the fibre cabling towards individual apartments, and avoid exclusivity agreements. In this context, some European Union countries have imposed symmetrical obligations for the party deploying in-house wiring based on national law, namely Spain, Portugal and France (BEREC, 2011b). In Finland all in-house wiring belongs to the house owners and is therefore not included in the wholesale market definition. Such an arrangement also takes place in Sweden and Korea (Box 1) where, in addition, a very effective framework has been developed for labelling new buildings depending on their fibre connectivity. This framework has played a major role in transitioning to "fibre-ready" multi-dwelling buildings.

Box 1. In-building wiring in Korea

Korea is one of the leaders in the deployment and take-up of fibre optic networks in the OECD area. The percentage of fibre connections in total broadband subscriptions reached 57% in June 2011, close to Japan with 61%. This successful penetration of fibre networks is however underpinned by a decade-long effort to enhance the in-building wiring framework for multi-dwelling buildings in Korea, which was perceived as one of the main ways to facilitate greater competition in fibre infrastructure deployment.

The Building Certification Programme (BCP) certifies that an apartment building complex is equipped with suitable communication infrastructure for fibre-based broadband services. For instance, when every apartment building is connected to at least four optical cables (*i.e.* in-building facilities such as main telecommunication rooms, ducts, and wiring for FTTH services for residents), it qualifies for BCP's "supreme grade". BCP has two other grades, first and second, both of which should ensure FTTB connectivity. Unshielded twisted pair (UTP) cables are used for in-building wiring for first- and second-grade buildings and apartments. The programme can be applied to most of the apartments and major buildings in the country. If a building is compliant, the applicant is awarded a certificate and given permission to publish and advertise the award.

Korea's Building Certification Programme's certificates

Introduced in July 1999, BCP is now the *de facto* standard for in-building wiring, especially in multi-dwelling residential units. 28.8% of Korean households comply with BCP (13.2% with "supreme grade", 60.9% with "first grade", and 25.9% with the "second grade"). The most striking feature of BCP is that it is not based on the regulation of in-house wiring but on competition in the housing market. Current regulations for in-building wiring in Korea do not require facilities for FTTH nor FTTB. The Korean government, assisted by a growing housing market, succeeded in upgrading in-building wiring in most new apartments to the "superior" fibre-based system. Bearing in mind that 58.6% of Koreans live in apartment buildings, it can be noted that this programme has significantly increased competitive access to in-house facilities and prevented apartments being locked into a single provider, without much greater cost for residents to change operators.

Source: Information provided by the Korean government

Structural/functional separation and open access

Another option for regulators, having not achieved policy objectives using other remedies, is to implement structural or functional separation. In these cases the wholesale, or the tasks undertaken by the network provision branch of the incumbent operator, is separated in a way that non-discriminatory access is provided to its own retail division as well as to competing alternative retail operators. This has often been called "equivalence of input/EOI". This form of access - once the network/wholesale component has been separated - is often referred to as "open access", and it shares some of its widely accepted features (*e.g.* non-discrimination, transparency).

Australia's NBN is arguably the most ambitious broadband funding project undertaken by a government since the telecommunications industry's liberalisation. The project was designed in response to strong concerns about competition dynamics in the Australian telecommunication market, particularly lack of private sector investment in next generation broadband. While the NBN's access arrangements are based on the telecommunications access regime that is already in place, there are significant enhancements to it. The NBN legislation requires that services offered over the network must be provided on a wholesale-only basis, that is, there is no conflict of interest in NBN Co., the company operating the NBN, competing against its customers in downstream retail markets. Services are supplied on an open access and non-discriminatory basis with oversight from the Australian Competition and Consumer Commission (ACCC). NBN Co. must publish all its service offers.[19] The ACCC must be notified of any agreements that differ from the published offer. The only exception to the open access principle is when NBN Co. has reasonable grounds to believe that the other person would fail, to a material extent, to comply with the terms and conditions on which the service is supplied, for example, when there was evidence that the customer was not creditworthy or had repeatedly failed to comply with NBN Co.'s terms and conditions. NBN Co. is also subject to ACCC powers to make access determinations and binding rules. In November 2011, NBN Co. published its "Wholesale Broadband Agreement as its Standard Form of Access Agreement". [20]

The NBN Co Fibre Access Service is an Ethernet-based, layer 2 virtual connection on the NBN Co Fibre network that carries traffic between a User Network Interface (UNI), located at or near the premises, and the Network-to-network Interface (NNI) at the Point of Interconnect (POI) associated with the serving area in which those premises are located.

Australia's NBN open access arrangement shares most of the characteristics of a regulated, wholesale access FTTP network, including transparency, non-discrimination, a public reference offer, and so forth. Even though the motivation and history of the NBN makes the Australian case very specific, being a wholesale-only, publicly funded network, it can be regarded as a regulated open access scheme.

One factor, however, that may differentiate some open access networks is the extent to which they have a monopoly, or virtual monopoly, over the provision of wholesale infrastructure. It is not uncommon for some city-based "open access" networks to have a monopoly or virtual monopoly (e.g. Stokab, Stockholm's city-owned network of dark fibre). By way of contrast, some open access networks are subject to entry by other providers (e.g. commercial wholesale networks for undersea cables to local access). Monopoly power can arise from legal restrictions (e.g. limitations on access to or construction of ducts or poles) or simply because a virtual monopoly exists due to public funding making it uneconomic for competing private investment.

In New Zealand, a publicly-funded national broadband network is also being deployed by Crown Fibre Holdings. Regarding open access requirements, the arrangement is very similar to that of NBN Co., as Crown Fibre Holdings has also published a wholesale reference offer, and retail providers will serve final customers and businesses.[21] The reference offers contains bitstream layer 2 services, dark fibre rental and commercial backhaul services.

New Zealand's approach, however, has a number of differences. The government initially granted a ten-year forbearance from regulation to the successful bidders for the public-private partnership, which triggered concerns on the part of alternative operators and consumer associations.[22] In May 2011, the Minister announced that contractual arrangements would apply if the prices Crown Fibre Holdings establishes for its products were above prices regulated by the Commerce Commission.[23]

Australia's and New Zealand's approaches are therefore, to some extent, unique. While Australia's NBN fully falls into the system of ex-ante regulation, managed by the ACCC, in New Zealand this is less clear and this issue has been subject to public scrutiny and to a high degree of controversy.

Finally, it can be noted that some other countries have experienced measures aimed at functional separation of the incumbent telecommunication operators (*e.g.* Sweden, the United Kingdom) with the changes in Sweden being introduced prior to legislation and those in the United Kingdom following changes to that country's approach. In those cases, the incumbent operator remains fully subject to regulatory obligations such as the wholesale reference offer or price regulation. The aim of the measures towards functional separation, a fairly intrusive remedy, has been to enforce regulatory obligations effectively, achieve the EoI principle and overcome resistance from incumbents to accept *ex-ante* regulation. Under European Union law, it is a "last resort" remedy that is only applicable if other remedies have failed to achieve effective competition, and there is no or little prospect of infrastructure competition within a reasonable timeframe.[24]

While regulators have used functional separation for a number of years in relation to broadband networks, the use of structural separation for NGA networks is relatively recent. Outside the OECD area Singapore has adopted a structurally separated model for their national broadband network. Its regional neighbours Australia and New Zealand have also introduced structural separation for NGA deployments. While there are other examples of wholesale broadband networks resulting from commercial or government action (e.g. city based networks) the examples of Australia and New Zealand are most cited in OECD countries.

Regulated wholesale access for structurally and functionally separated networks shares some of the concerns and/or challenges of the regulation of a vertically incumbent operator but, theoretically, it should be easier to implement as some of the concerns regarding incentives to discriminate against third-party providers no longer exist. In any case, telecommunication regulators need have the resources and mandate to undertake this work especially if "open access" approaches result in monopoly power at the wholesale level.

Open access and public funding of broadband networks

A further distinction could be made when open access is provided to an infrastructure that has benefitted from some degree of public funding. In fact, "open access principles" usually appear in connection with some type of public funding of broadband networks. In the European Union, "open access" is used when referring to public funding frameworks (state-aid, see Box 2). Moreover, local and municipal broadband networks funded by public authorities in the United States and in the European Union usually adopt this concept, with slight variations, to highlight that wholesale access to broadband networks or services will be provided.

Box 2 Public funding of broadband networks in the European Union: the state-aid rules

According to BEREC, based on a questionnaire submitted to Member States, there is no legal definition for "open access" in the European Union. A possible exception is the public funding context (*Community Guidelines for the application of State aid rules in relation to rapid deployment of broadband networks*) –or 'state aid'- where it is somewhat defined:

> *"Accordingly, the recognition of an SGEI mission for broadband deployment should be based on the provision of a passive, neutral and open access infrastructure. Such a network should provide access seekers with all possible forms of network access and allow effective competition at the retail level, ensuring the provision of competitive and affordable service to end users."*
>
> *"'For example, an ADSL network should provide bitstream and full unbundling, whereas a NGA fibre-based network should provide at least access to dark fibre, bitstream, and if a FTTC network is being deployed, access to sub loop unbundling".*

Therefore, in the sense of the Guidelines, open access refers to mandated, transparent, non-discriminatory and effective wholesale access to broadband network(s) as a condition for being awarded subsidies. The term "open access" is used as a synonym of "effective wholesale access" and covers both passive and active access. The Guidelines also establish different conditions, depending on the type of subsidy granted, namely:

- Absence of state-aid:
  - Market Economy Investor Principle (MEIP): capital injection or equity participation on market terms (i.e. no "state aid" obligation applies).
  - Public service compensation in the form of Service of a General Economic Interest (SGEI) – but subsidy involved.
    - Meets Altmark criteria (see below).
    - Passive, neutral, open access, wholesale only, no special rights, subsidy only to non-profitable areas, provides "universal connectivity" in a given area.
- Presence of state-aid:
  - State aid for broadband: mandated, effective wholesale access for at least seven years.
  - State aid for NGA: they should observe the conditions for broadband, plus additional requirements that should be similar to those established by the National Regulatory Authority (e.g. passive and active access, conditions regarding migration to NGA). It should be noted that for white areas, both in terms of NGA access and basic broadband access, obligations concerning access to infrastructure, dark fibre and bitstream are required in any case.

When effective wholesale access is mandated, the Guidelines also establish that margin squeeze/predatory pricing situations should be avoided, by setting wholesale prices in line with (*ex-ante*) average regulated wholesale prices in competitive areas.

The Altmark criteria (based on case-law) are:

1) the beneficiary of a state funding mechanism must be formally entrusted with the provision and discharge of an SGEI, with its obligations clearly defined.
2) compensation parameters must be established beforehand in an objective and transparent manner.
3) the compensation cannot exceed what is necessary to cover all or part of the costs incurred in the discharge of the SGEI.
4) if there is no public procurement procedure, the compensation scheme must be determined based on the cost of a well run, typical undertaking.

Source: OECD elaboration from the "Community Guidelines for the application of State aid rules in relation to rapid deployment of broadband networks" (2009) and BEREC (2011)

It is remarkable that, as the BEREC report notes, there is no legal definition of the term "open access" in the whole European regulatory framework, but a general common understanding of the term by national legislators. Arguably, the notable exception to that are the Community Guidelines for public funding of broadband networks. These conditions are clearly prompted by the potential for public funds to be used to originate, or at a minimum perpetuate, situations of market power in a given area. The Guidelines only summarise the European Commission's case-law on broadband state-aid and are therefore not directly applicable. The European Commission reviews each submission and decides whether it complies with the Treaty, and under which conditions.

The rationale for providing effective wholesale access to publicly-funded, or at least publicly-operated infrastructure, is clearly not exclusive of the European Union. As discussed below, many public utilities providing broadband services also offer open access, and so do structurally or functionally separated networks that have received public funding, such as Australia's NBN and New Zealand's FTTC network. Effective wholesale access is seen as a means to improving retail competition or, at least, creating the conditions for a contestable market where incumbents refrain from taking advantage of market power. At the same time, if these schemes result in a monopoly, or a virtual monopoly, at the wholesale level they will definitely require regulatory oversight.

Local and municipal networks

Regional and local broadband networks have played an important role in broadband provision in many countries. Local utilities have a significant advantage to deploy broadband infrastructure, as they can rely on existing utility networks, such as water, sewage or electricity infrastructure. Most of these deployments have some degree of involvement of public authorities, which may own municipal utility companies or operate them indirectly under public service concessions. These publicly-operated networks usually grant access on open, non-discriminatory terms, which may be termed as "open access". It should be noted that the actual legal framework, under which these municipal networks operate, may take a wide variety of different forms including private-public partnership (PPP) arrangements.[25]

In Sweden, much of the public funding in broadband networks has direct or indirect local government involvement in deploying broadband networks (Forzati et al. 2010). An estimated 95% of municipality networks and 42% of housing companies' broadband networks in Sweden follow an open access model. TeliaSonera and Bredbandsbolaget are vertically integrated operators in that country. Most municipalities that owned a network also operated that network, as they found some difficulties in attracting ISPs. Swedish municipalities are often the only owners of the networks.

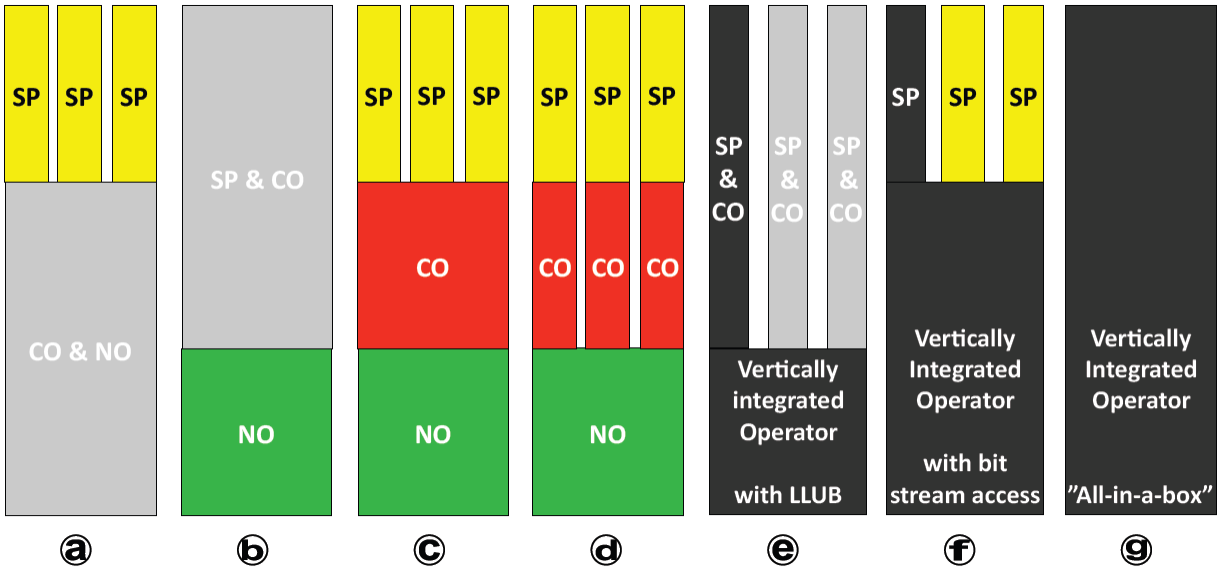
Stokab, owned by the city of Stockholm, runs a dark-fibre network and also acts as retail operator for the local government.[26] All operators are granted access to Stokab's network on equal terms. Sweden's largest housing company also belongs to the City of Stockholm and owns three companies: Svenska Bostäder, Stockholmshem and Familjebostäder.[27] The first relies on Stokab's network but provides, in addition, passive infrastructure within the multi-dwelling units, whereas the active equipment is provided by communication operators. Other housing companies have similar business models even though they seldom host more than one communication operator on their networks.

One example of an open access model, operated by Mälarenergi, is found in the city of Västeras.[28] In this case the company - a utility owned by the City of Västeras - acts both as communication operator and network owner. By way of contrast, in the Säffle municipality, there is a municipality network, which only runs the infrastructure and contracts the operation of the network. This case is notable as TeliaSonera, the incumbent operator, is now acting as the communication operator. In Sweden, municipalities play a central role in public administration, including telecommunications, which is reflected in the active role they are playing in deploying fibre broadband networks.

Danish municipalities are not permitted to provide broadband services directly. However, privately-owned utilities, primarily made up of former municipality-owned utilities, are allowed to provide access to broadband infrastructure. Privatised utilities have therefore mainly focused on deploying local/regional broadband infrastructure. In fact, Denmark is one of the leading European countries in FTTH uptake as a per cent, of all subscriptions, with 13%, just after the Slovak Republic (30%), Sweden (28%) and Norway (16%). The type of utility providing broadband services and the level of involvement of the private sector varies from country to country, but municipal broadband networks are especially important in the Netherlands and some Nordic countries.

One study found that out of the 74 municipal utility broadband networks surveyed in ten European countries, just 6% provided wholesale services only, while 44% provided only retail services and 50% provided both (Troulos and Maglaris, 2011). Clearly, the established relationship between the utility and its customers favours the retail provision of broadband services. Several different arrangements are thus possible for the provision of broadband network services (see Figure 4), from a fully integrated operator (case g) to various arrangements among the network owner, the communications operators and the service providers. Due to the involvement of public authorities, European municipal and regional networks have to comply with the European framework of public funding of broadband networks.

Figure 4. Access networks business models



Source: Forzati *et al.* (2007), SP: service provider, CO: communication operator, NO: network owner.

Xarxa Oberta is a backhaul network deployed by the Catalan regional government in Spain.[29] It merges existing municipal networks and is directed towards self-provision of communication services to the regional and local governments, and a wholesale, open access network, which provides spare capacity on an independent, non-discriminatory and transparent basis.

One study compiled some experiences of municipal broadband networks in the United States (Lehr et al. 2004). They concluded that technical, economic and regulatory constraints influenced to a great extent whether open access is offered and, if so, what type (layer 1, 2 or 3). The study concluded the targeted market segment (*e.g.* residential, business), the network's footprint, the type of services offered (voice, video and broadband access or any combination of them), and so forth, depended on factors such as the legacy infrastructure and regulatory framework.

This study found little evidence of open access being adopted voluntarily (i.e. around 10% of 250-300 communities surveyed). It noted that those that do offer open access have been heavily influenced by regulatory policy in making that choice. For example, local or state-laws prohibiting entry in retail communication services (e.g. in the states of Utah or Washington). The findings from the United States experience with broadband municipal networks is that the actual arrangement and services provided by a municipal network are highly dependent on local- and state-level factors, such as the history of the utility, its relationship with customers and the specific legal framework in place.

Not all municipal broadband networks, in the OECD area, provide open access. Some have chosen different operating models. More specifically, for the "Progetto banda larga" of the province of Brescia and the "Firenze Wireless" project, both in Italy, a PPP was established in order to deploy a network offering both e-government and commercial services. Even though the network is publicly owned, its operation was awarded, through open procurement procedures, to private companies. In this setting, only one operator provides retail services, rather than allowing third-party provision through open access. By way of contrast, "Terrecablate Siena" follows a pure public utility model, where the network is owned and operated by a municipal utility, which can provide wholesale access services to other operators, even though not subject to open access requirements (Nuciarelli et. al., 2010). Wien Energie, a municipal utility in Vienna, Austria, runs a fibre network and provides wholesale broadband service (Blizznet) for third-party providers, including A1 (Telekom Austria), until 31 August 2011. [30] This network hosts multiple service providers. The company says that it provides non-discriminatory access to content and service providers. Customers can also freely choose the services they will sign up for.[31] In Switzerland, Swisscom has developed interesting partnerships with the largest cities to deploy fibre networks (see Box 3).

Some companies like Axia (Canada) or Covage (France, participated in by Axia) have specialised in partnering with public authorities for developing PPPs for broadband infrastructure.[32] Axia has been the successful bidder for the FTTH projects in Alberta (Canada), Catalonia (Spain) and Singapore, among others. Covage also bids for public procurement contracts for building and operating fibre networks, by selling wholesale communications services to operators.

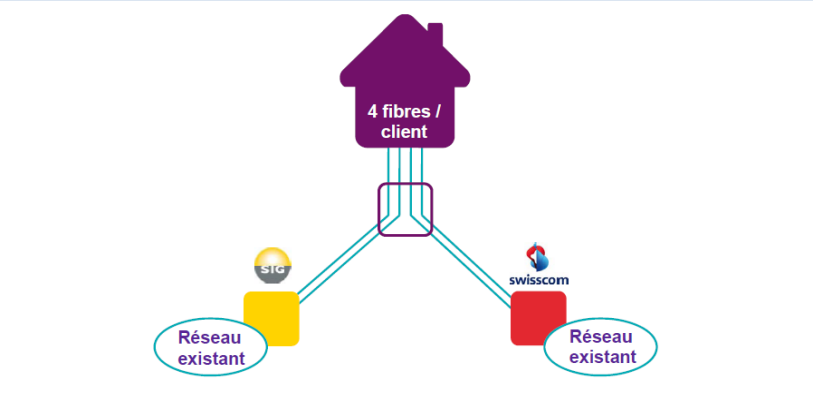
The Ons Net network, in the Nuenen municipality in the Netherlands, was successful in securing a municipal subsidy of USD 1 040 (EUR 800) per subscriber. This funding was transferred to the company responsible for deploying the networks (Sadowski et. al., 2009). The company was vertically integrated but open access was offered at Layer 3. Reggefiber became, in 2006, the majority shareholder of the operator. Despite being involved with public authorities in some projects, some of the networks deployed by Reggefiber did not involve public funding.

The available evidence on the business models for local broadband networks shows that open access conditions are provided by a large majority of the networks. They are rarely based, however, on voluntary arrangements, as they are influenced by local conditions, which may constrain the characteristics of the services they provide. Nor are they fully owned and operated by private players as most of them have a high degree of participation of public authorities in the form of various public-private partnership (PPP) arrangements. This is likely the result of the public ownership model used in some countries for municipal services such as water supply, sewage or electricity. These entities added broadband arguing they could do so at a lower incremental cost or provided a service not otherwise met by the market.

Box 3. The Swiss model for open access

Winterthur Utilities, in Switzerland, and the incumbent operator Swisscom have signed a partnership agreement to jointly expand the fibre network in the city. It aims at connecting 96% of households and businesses in Winterthur to a fibre (FTTH) network over the next few years. Swisscom will invest in the basic connection around 60% of the total cost (USD 77 million) and the city will cover the remaining 40%.

Swisscom has deployed a fibre network in the city since March 2010, and the already rolled-out cables will be incorporated into this partnership. Four fibres will be laid per household and business, and of these the two from Swisscom and the other two will be made available by Winterthur Utilities to other service providers, thereby enabling competition on an open infrastructure basis for the number of entrants that is technically feasible for this network. Swisscom has signed similar fibre roll-out partnership agreements with other municipal utilities, including Geneva, St. Gallen, Basel, Bern, and Luzern.



Source: www.swisscom.ch

Open access and general competition law

Beyond ongoing discussions on the role of *ex-ante* regulation and antitrust or merger reviews, these reviews undertaken by competition authorities in the course of an antitrust investigation, or a merger review, have the ability to frame markets and provide a level playing field for competition. As such, some antitrust and merger decisions have been crucial in implementing pro-competitive policies. Sometimes, they can make options available to enhance the ability of a regulator to impose conditions on market players, which otherwise may not be possible. This can be justified if there would otherwise be a diminution of competition resulting from a merger or acquisition between two firms.

In January 2000, American Online (AOL) and Time Warner announced a merger, which was subsequently submitted to the FCC and the Federal Trade Commission (FTC) for review in the United States. The merger was approved, under some conditions imposed by the FCC, a year later.[33] At that time, the 1996 Telecommunications Act had been passed and its implementation process was proving to be challenging, given various lawsuits questioning the FCC's authority to impose open access conditions, especially line-sharing and mandatory unbundling.

The conditions imposed on the merged entity can, therefore, be seen as an additional instrument used by authorities to impose undertakings to promote competition. In particular, the FCC ruled that AOL Time Warner should be prevented from constraining customer choice of ISP, over its cable network. The merged entity was also required to allow ISPs to control the first screen that consumers call up when they access

the Internet via a competing service, and to require it to give unaffiliated ISPs the same quality of service guaranteed to affiliated ISPs.

This decision should be considered, however, in the technological and market context of the time. Dial-up Internet access, via ISPs such as AOL, was still largely provided over networks owned by separate entities, such as via the public switched telecommunication network (PSTN). The operators of the PSTN were governed by rules that had been established to enable liberalisation of what were then broadly called value added services. The providers of these telecommunication networks could offer similar services to ISPs but had to create separate or stand-alone entities to do so. While dial-up services are still used by a very small number of Internet access subscribers this model was largely overtaken by changes to regulation and the development of commercial models that bundled broadband access and services. Nonetheless the intervention by the FCC and FTC provides an example of regulatory authorities using a merger to impose open access requirements.

The Netherlands provides a more recent example of open access conditions that have resulted from a merger review. In this case, the decision was issued in the context of NGA developments, and is aimed at ensuring long-term competition. The KPN-Reggefiber joint-venture was approved by the Dutch National Competition Authority (NCA), under certain conditions (Box 4).

Box 4. The KPN-Reggefiber joint venture and its attached open access obligations

The decision of the Dutch competition authority (NMa) on the KPN-Reggefiber remains one of the few competition cases in telecommunications where open access obligations have been imposed on the merged entity. It is also regarded as a good example of co-operation between a competition authority (NMa) and a telecommunications regulator OPTA.

Cable companies UPC and Ziggo have close to nation-wide coverage with non-overlapping footprints. These companies have developed over the years a significant competitive threat against the incumbent KPN. Reggefiber is a new entrant in the Dutch telecommunications market. It has deployed fibre broadband networks across the country and consolidated some of the existing local utility fibre networks. The joint-venture was formed to leverage KPN's customer base and marketing expertise and Reggefiber's network capabilities.

It was determined that the resulting entity would decrease competition both in the fibre and in the copper broadband market. Moreover, when the latter was replaced by fibre, there would only be two alternative networks in the country: fibre and cable (UPC's and Ziggo's cover different areas). These competition concerns were addressed by NMa by means of some undertakings, including open access requirements.

The merged entity had the following conditions imposed by authorities: *i*) to keep the joint-venture separate from its parent companies; *ii*) to provide information about the roll-out planning to (potential customers); *iii*) to grant access to third parties on specific terms; *iv*) transparency (including a reference offer) and non discrimination; and *v*) price caps, minimum quality of service and enforcement procedure.

The KPN-Reggefiber example highlights one of the challenges of converging antitrust and regulatory frameworks. The main concern, in this case and possibly others, was the potential conflict between the two sets of remedies. In a similar manner, the same problem could arise from obligations imposed in the context of public funding of broadband networks. These potential conflicts can be the result of various regulatory frameworks addressing a case from different perspectives. In the Dutch context, the competition authority NMa and the telecommunication regulator OPTA engaged in extensive discussions about how best to regulate the resulting entity and both authorities agreed a common response.

Merger review provides an opportunity for countries to impose certain conditions that cannot be based on general *ex-ante* regulation. This procedure should however remain extraordinary as it is case-specific by nature. If countries are aware that their telecommunication regulators lack the appropriate tools to ensure a level playing field and, if they wish to do so, impose open access obligations, they should consider developing the appropriate legal instruments and not rely on the opportunities offered by merger review.

Inter-agency conflicts arise in many OECD countries and should be considered based on different expertise, history and cultures of the two organisations. Ideally, public funding bodies, competition authorities and telecommunication regulators should engage in exchanging views and eventually agreeing on a common decision based on mutual understanding of the issues they are facing. At a minimum, these agencies should develop exchange protocols, or Memoranda of Understanding whereby they ensure the consistency of the conditions imposed on mergers or public funding with the telecommunications regulatory framework. Issues like wholesale pricing if "open access" agreements are imposed are crucial and the different agencies should convey a message of coherence, regulatory certainty and mutual co-operation.

Wireless open access

In recent years, wireless networks have become increasingly used in the delivery of traditional and some new communication services. Following increased transmission speeds and smartphone uptake, wireless broadband services are becoming more essential for the development of broadband networks. Some of the potential advantages of wireless networks include faster roll-out, potential wider subscribership, due to higher smartphone uptake, and a lower cost of deployment in rural and remote areas. In addition, of course, is the potential benefit of mobility for users. Nevertheless, wireless services are largely complimentary rather than competitive with fixed NGA networks.

The major limitation with wireless broadband is that spectrum is a scarce resource. OECD countries have only granted a limited number of Mobile Network Operator (MNO) licenses, typically between three and five. The bands assigned to operators need to be wide enough to allow for efficient spectrum use, avoid fragmentation and be capable of transmitting high-speed data. This is why the number of players and the available bandwidth play a key role in wireless markets and the degree of competition that exists.

In most countries with MVNOs, regulators have refrained from mandating that MNOs give MVNOs open access to their networks. According to some authors, the voluntary relationships or purely commercial agreements between MNOs and MVNOs emerge when they are mutually beneficial and there are no obstacles for these agreements to be reached (Dippon and Banerjee, 2006). These cases are, for instance, when the MVNO can add value to that relationship in ways such as expanding the MNO-served market and helping boost the combined profits of MNOs from retail and wholesale services beyond the likely profits from retail operations alone. For example, TracFone in the United States, which is the largest MVNO and larger than every facilities-based provider other than the four nationwide providers, offers prepaid mobile wireless services through commercial agreements with about ten wireless service providers in the United States, including AT&T and Verizon Wireless.[34] The largest facilities-based providers are arguably using strategic partnerships with TracFone in order to compete with each other for customers.[35]

In other cases regulated access to spectrum resources, such as through "open access" agreements, aims at achieving a greater level of competition in wireless markets by addressing spectrum limitations to the number of MNO licenses that can be issued. Experience has shown that, in a market where there is limited opportunity for market entry, MNOs have often shown little appetite to lease spectrum to potential competitors (i.e. mobile virtual network operators or MVNOs). For these arrangements to make commercial sense in terms of providing increased competition, MNOs must provide access to competitors at a price that cannot be higher than what MNOs could charge its own retail business. There might be other cases based on commercial agreements, however, where the MVNO may be able to provide a compelling value added service for users. To create a mutually beneficial situation, MVNOs would refrain from offering perfectly or even near substitutes for their host MNO's services, and try to develop retail services and market segments that MNOs largely ignore. This leads to situations where MVNOs provide value added services to niche customer segments (e.g. "greatcall" in the United States focusing on senior mobile users, Red Pocket Mobile in the United States providing multi-language customer support to foreign communities).

From a regulatory perspective the introduction of MVNOs has, of course, been to try to address the spectrum constraints that otherwise exist for market entry. Among them, we can mention "full MVNOs" who own and operate the core network elements, but do not have spectrum licenses. Instead, they can lease network infrastructure from MNOs or buy wholesale access or airtime from MNOs in order to provide services. Other MVNOs do not own all the core elements of the mobile network and this has proven to be a limitation to their ability to introduce competition in areas such as international mobile roaming.

Regulators need to balance open access policies against the incentives for different actors to invest in infrastructure and services. Too often this is presented as a trade off between increasing competition and a potential negative effect on investment. If open access policies can be introduced in a way that facilitates new investment, and drives incumbents to respond in kind, it is beneficial for the overall market. In France, for example, a new mobile market entrant came into the market at the beginning of 2012. Without an obligation for national roaming, on a pre-existing network, the new operator would have faced an almost impossible challenge, until it was able to roll out sufficient infrastructure to attract users. The regulator intervened in two ways. One was to compel existing operators to make available a commercially negotiated national roaming offer and the other, to specify the new entrant had certain targets it had to reach to initiate this offer (*i.e.* 27% of national coverage).

While existing operators, in any market, rarely welcome new entrants the existing incumbent offering roaming services to the new entrant has said it expects it could raise double the amount of revenue originally predicted (i.e. USD 2.6 billion instead of USD 1.3 billion).[36] These figures depend, however, on the pace at which the new entrant can roll out infrastructure where it currently uses the incumbent facilities. Clearly, it has an incentive to invest and thereby reduce payments to the incumbent for national roaming. Meanwhile the balance achieved by the regulator has brought considerable new competitive forces to the French market and new innovation. Such a balancing act can be more challenging with MVNOs.

Interventions giving entrants and competitors network access on a non-discriminatory basis and at cost-based prices might discourage investments to expand or upgrade their network infrastructure, as any competitive advantage arising from these investments would be available to hosted MVNOs while the associated risks would be borne by MNOs exclusively. Given the choice, open access that promotes and increases infrastructure competition, as is currently happening in France, may be preferable but cannot always be an option due to the availability of spectrum. That is why MVNOs play a very useful role but one that rarely transforms a market in the way a new entrant with their own infrastructure can achieve such a change.

The amount of innovation any market participants can generate is dependent on their own infrastructure, in the case of network facility providers, or the degree of open access provided for entities that resell services. In other words innovation can be closely tied to the network layer at which providers have control of their own services. To build on the example, in France, the new mobile entrant launched Extensible Authentication Protocol, or EAP, for its customers three months after joining the market. The service allows seamless authentication for its mobile users to its fixed network Wi-Fi service via xDSL or Fibre connections (see Box 5).

Open wireless network access is often discussed in the context of regulation that will require dominant operators (or operators with significant market power - SMP in the European Union terminology - to make their infrastructure available to other players. At the European Union level, the Access Directive stipulates that all public communications network operators shall have the right and obligation to negotiate interconnection with each other on non-discriminatory conditions, when requested by others.[37] Furthermore, operators who are declared as having market power may have obligations imposed on them "to meet reasonable request for access to, and use of, specific network elements and associated facilities" by national regulatory authorities. Thus, dominant players may sometimes, but not always, be required to observe open access network rules - *i.e.* provide access to networks or network facilities to all market participants on a fair and reasonable basis.

Box 5. Open access and home-based Wi-Fi networks

In 2012, a fourth facilities based network operator entered the mobile market in France (Iliad's Free Mobile). Initially, like many mobile operators that also own fixed local access networks (or install them at locations such as coffee shops and airports), Free enabled its mobile subscribers to access the facilities of its fixed network to take advantage of their Wi-Fi capabilities, if they were also fixed network subscribers. Mobile operators do this because it enables them to offload traffic from wireless to fixed networks, lower costs and improve services to customers.

Like a number of operators, Iliad has also provided the option for its fixed broadband subscribers to share their Wi-Fi with others on its network. In the case of Free Mobile this was available from day one of the service though customers had to sign on and authenticate their subscription to gain access. Soon thereafter, Free Mobile switched on the EAP-SIM protocol. This enabled Free Mobile subscribers to access Wi-Fi automatically via authentication using their SIM card. This included the advantage of more convenient access to potentially better network performance for those accessing services via Wi-Fi as well as freeing capacity for those still on the 3G network. In addition, data sent or received over Wi-Fi does not count towards a user's 3 GB monthly cap.

Free's business model has a number of features that have been derived from open access policies and practices. The company provides broadband, television and telephone services using local loop unbundling and its own infrastructure, and has persuaded its customers that they would benefit from sharing their Internet connections, as part of a bottom-up open access tool so as to expand its nationwide Wi-Fi network. Having achieved this, Free is now opening the free Wi-Fi to mobile customers, even those without fixed broadband subscriptions.

This provides further benefits. The company is not only able to offload traffic from mobile to fixed networks, but also to potentially reduce the amount of roaming payments to the incumbent operator. In that sense, it is using open access granted on a voluntary, though mutually beneficial, basis by its fixed network customers to substitute for the use of some regulated access imposed on an existing operator (*i.e.* while Free continues to roll out its own wireless coverage).

In its most recent update of the Recommendation on relevant markets (December 2007), the European Commission removed the mobile access and call origination market from the recommendation, suggesting that these markets were generally competitive in the European Union, unless national regulatory authorities considered otherwise. In this respect, various European countries have imposed obligations on the mobile access and call origination markets, aiming at facilitating entry and operation by MVNOs as well as better network utilisation if network capacity tends to be under used.

Indeed, MVNOs have flourished in some countries either by voluntary arrangements or due to some degree of regulatory action. In some countries like Denmark or Spain they have played a key role in market dynamics by increasing the number of players in those markets, by favouring players covering specific market niches (e.g. by adding specific value added services such as language support) and by promoting price-based competition

As opposed to that, the French regulator ARCEP found that, as of 2004, the mobile access and call origination market was not sufficiently competitive and that MNOs had a common interest in avoiding wholesale agreements with MVNOs. Thus, the regulator proposed new legislation mandating wholesale access as a way of stimulating competition. Since the proposal was made, however, French MNOs have voluntarily signed contracts with MVNOs for network access and, in view of these agreements, the regulator withdrew the proposal.

Despite this decision, renewed concerns have arisen in France regarding the competitive role of MVNOs.[38] In the recent frequency allocation in France, the condition of hosting MVNOs, upon a reasonable access request, was one of the tender criteria. The regulator conceived the issue as an important contribution to competition dynamics and placed particular value on the MVNO-related commitments. The spectrum assignment procedure was designed in a way that making a commitment to hosting of MVNOs was one of the selection criteria, in addition to any financial amount bid for the frequencies. Thus, successful bidders are forced to open up their network to MVNOs. A similar set of requirements was observed in the recent frequency allocation in 900 MHz in Japan.[39]

In Norway, the regulator NPT conducted the three criteria test for the access and call origination mobile market in 2010 and decided to extend *ex-ante* regulation.[40] Based on the NPT's market analysis and decision, Telenor was designated as an SMP operator, and must thus meet all reasonable requests for access and call origination on its mobile network regardless of the form of MVNO access, national roaming and collocation, on a non-discriminatory basis without undue delay.

If regulators find that markets are effectively competitive, no on-going ex-ante regulation is warranted. For example, Denmark used to impose on TDC an obligation in this market to provide wholesale access and national roaming for other service providers (including MVNOs) on objective, transparent and non-discriminatory terms. Thus, TDC was under general open access obligations where the company had to grant all reasonable requests for wholesale access. These rules were revoked after the 2007 Commission Recommendation came into force, as the Danish regulatory authority found that there was effective competition in the market and no need for *ex-ante* regulation that was previously imposed on TDC. [41] In the United Kingdom, OFCOM has stated "the mobile market continues to show signs of healthy competition and we do not currently see strong evidence of the type of market failure that drove our major intervention in the fixed sector". These countries would apply *ex-post* competition law rather than *ex-ante* regulatory obligations in order to address any emerging problems.

In other countries, open wireless network access is considered in the general context of network operator's obligations instead of operator-specific or case-specific requirements. In Japan, MNOs are, as fixed telecommunication carriers, required to provide access to any requesting carriers and subject to relevant interconnection obligations (e.g. fair, cost-based and non-discriminatory basis, making access charges and terms and conditions publicly available). To promote market entry by MVNOs, the Japanese government has been strongly involved in access policies for mobile markets and published some guidelines in 2010. Authorities were encouraged by the beneficial experience the country had achieved with unbundling policies for fixed networks.[42]

More generally, the adoption of NGNs drives these two sectors - i.e. fixed and mobile networks - towards convergence. The two networks will carry similar applications and share the same transmission protocol. The regulatory experiences in fixed NGN could be also applicable to mobile NGN. The growing take-up of mobile broadband services may increase the demand for network access from a variety of players in a more flexible manner, which could help develop more innovative services.

Hong Kong, China, also has general open access regulation in the mobile market.[43] Although limited to 3G network licenses, the regulation requires MNOs to open 30% of their 3G network capacity to non-affiliated service providers (e.g. non-affiliated MVNOs) on a non-discriminatory basis. The regulator OFTA has stated that the objective of this regulation is to promote competition for the provision of content and services over 3G networks, and to enable operators that do not have the resources to bid for, or who have failed to obtain 3G spectrum, an opportunity to participate in the 3G business. Thus, non-affiliated MVNOs may have access to the same network capabilities that the host MNO has made available to its own customers or affiliated service providers. Once an MNO has reached the open-network access threshold, it has no further obligation to provide additional capacity to non-affiliated MVNOs already connected.

Another approach is wholesale-only wireless broadband networks, purely commercially driven and not based on open access regulatory obligations. Lightsquared, in the United States, is attempting to implement a business model that would provide wholesale wireless network services, with national LTE coverage. This approach would focus on providing wireless access to market players which do not have their own wireless network or have limited spectrum resources. As of March 2012, the network deployment plan has been suspended, however, due to possible harmful interference with GPS services. The National Telecommunications and Information Administration (NTIA) of the United States concluded that there is no practical way to mitigate this interference from the company's planned terrestrial operations.[44] Lightsquared filed for bankruptcy protection in May 2012.

Infrastructure sharing could also be discussed in the context of open network access. In general, it is expected to avoid investment duplication or decommissioning of redundant sites and enable time-saving and efficient use of resources. It also has benefits for environmental and urban planning as it reduces the number of sites and space needed. Thus, infrastructure sharing is becoming an important means of promoting access to networks and offering affordable broadband services by reducing expenditures and ongoing expenses associated with the rollout and operation of networks.

There are generally two types of infrastructure sharing, either "passive" or "active". Passive network elements include cell towers, roof sites and power supply while active element sharing involves network controllers, switching and transmission systems. The latter might be more challenging due to a higher technical complexity, which may constrain the possible maximum speed provided. In recent years, there has been a trend towards infrastructure sharing in the mobile sector on an open access basis. For example, American Tower owns mobile tower sites all over the world and provides commercial access to towers for mobile operators.[45] GLT Infrastructure has a portfolio of over 30 000 mobile towers in India and sells shared passive infrastructure to mobile operators.[46]

Some countries have adopted policies to actively promote infrastructure sharing in the mobile sector. In Austria, under the Telecommunications Act, owners or other authorised users of a mast are required to permit joint use by public communications network operators if this use is technically feasible, in particular in terms of signal interference.[47] In Denmark, the Mast Act stipulates that masts owners for communication purposes have to meet requests from other parties for joint utilisation of the masts.[48] In other countries, the regulators rely on operators to engage in commercial negotiations for infrastructure sharing.

Given the increasing number of innovative services that have become available in mobile markets, some OECD countries are considering ensuring openness and flexibility of network intelligence functions. For example, VoIP are now directly available to consumers, provided by independent providers or smartphone applications, regardless of the operator that provides wireless connectivity.

In Japan, the government is now considering the inclusion of certain network intelligence elements under the scope of unbundling requirements. On the other hand, the United Kingdom acknowledges that network intelligence functions will be gradually replaced by "intelligent" software applications.[49] For instance, Google's "My location" collects data about user location by taking information from cell towers close to users to estimate their current location. Its capability of showing user location without accessing mobile operators' information database underlines this trend. Whether the role of network intelligence will increase or diminish is unclear, but it is important that policy makers and regulators monitor market developments carefully and take actions if needed.

Spectrum is one of the critical issues in view of the growing demand for connectivity. Many OECD countries are reconsidering their fundamental spectrum policies by finding alternatives to traditional approaches. More flexibility, to accommodate market changes quickly, may be needed. For example, one of the new options may be the various forms of "sharing", as spectrum may be shared in various ways based on time, space and geography. In the OECD area, one of the most common schemes for spectrum sharing is unlicensed spectrum. Here no single entity has an individual licence for that part of the spectrum and it is allocated for open use. There are, of course, rules, including technology restrictions and power level limitations, to avoid interference. A completely open system may, of course, have risks associated with a "tragedy of the commons". However, the recent outstanding success of Wifi and wireless LAN indicates that this approach has merit when considering efficient and flexible use of scarce resources and further technological developments may enhance the application of shared spectrum.

At the European Union level, there is an ongoing discussion on opening spectrum for wireless communications in the context of the "Digital Agenda for Europe". The original proposal of the European Union Parliament was in favour of an open access spectrum where appropriate, which would be harmonised at the European Union level. This included fostering shared and unlicensed spectrum use. As in other parts of the world the idea is to build on the success of open access Wifi. If spectrum can be used more flexibly on a shared and unlicensed basis depending on demand and technical feasibility, more affordable services may be possible. Innovative spectrum policies may also help expand wireless network coverage especially in less populated areas, which could assist in tackling that aspect of the "digital divide".

In other cases, unlicensed "open" access to spectrum has been discussed in the context of "white spaces". Spectrum allocated to television broadcasting generally has good propagation characteristics, which could promote innovative mobile devices and services. Wireless broadband providers are also expected to expand and improve service coverage especially in rural areas more easily with less expense. In the United States, the FCC allows unlicensed operation in the television bands at locations where frequencies are not in use by licensed services.[50] This has permitted both fixed and personal/portable unlicensed devices to operate in the television bands under certain technical conditions.

Open access obligations or policies are relatively new to the mobile communication industry, which, unlike fixed networks, has benefitted from arguably a greater degree of "end-to-end" competition. Across the OECD there is generally between three to five MNOs offering services in the same areas. By way of contrast, a user in a suburban street may only have one or two fixed network providers with their own facilities. For this reason there has generally been greater use of open access policies in fixed rather than mobile networks. On the other hand, spectrum constrains new market entry and joint ownership of fixed and mobile operators can also limit the pool for intermodal competition. This is why some countries have

encouraged or mandated open access schemes, which usually take the form of MVNO access. Where these developments have taken place, they can be considered to be relatively successful for domestic markets though they have had little influence on the price of international mobile roaming. This is because open access policies, imposed by national authorities, tend to be limited to domestic services.

Infrastructure sharing agreements are playing an increasingly important role in mobile markets, more markedly in the context of the deployment of LTE technology. Wholesale-only models have emerged at different levels of the network (*e.g.* Lightsquared, American Tower) and are usually based on purely commercial arrangements. The expected level of investments required for the deployment of LTE networks is clearly encouraging these agreements. The increasing focus on infrastructure sharing, or even mandated sharing, could however potentially reduce competitive investment incentives for network roll-outs. This means a likelihood of a virtual monopoly for some infrastructure with the intendant implications for required regulatory oversight.

A Russian mobile operator (Yota) reached an agreement, in March 2010, with four mobile operators in the country, to roll out one single wholesale LTE network that will be utilised by the four operators on a wholesale basis.[51] By 2014, the network is expected to cover 180 cities with more than 70 million inhabitants. The four operators also have had the option of a future stake of 20% in Yota. The agreement indicated an arrangement for the separation of network ownership and service provision. The stated aim is to avoid the cost of duplication of infrastructure investment and provide users with faster mobile access at lower prices.

In a similar development to Russia, and in the context of a single national open access LTE network, the Kenyan government has launched an initiative to roll out a wireless network. This will be funded and used by a single "consortium", including participation of the main telecommunication operators.[52] The ownership structure is based on a public and private partnership (PPP) where the government and telecommunication operators will own stakes equivalent to the capital they will invest in this joint venture. The government plans to issue a tender for a new company to build and operate the wholesale network, as opposed to auctioning the spectrum and awarding mobile licenses to individual operators.

These developments, in mobile networks, can be considered under the scope of infrastructure sharing agreements or, in the case of voluntary MVNO arrangements or other wholesale deals, under purely commercial schemes, unless some transparency and non-discrimination clauses are added to these agreements.

Internet exchange points, submarine cables and wholesale backbone networks

The exchange of traffic between different networks is fundamental for ensuring communication between users of different networks. With the expansion of the Internet, Internet exchange points (IXPs), where ISPs exchange Internet traffic among their networks, play a critical role in providing more efficient and cost-effective interconnection. The alternative is "transiting" the traffic through a third party to be exchanged and delivered back to the terminating network. In many countries, before the establishment of IXPs, traffic between two local networks would be exchanged outside the original country or region. This potentially had a negative impact on transit costs and network performance. The establishment of IXPs enabled these costs to be reduced, and network performance increased. Furthermore, by concentrating supply and demand they created a competitive marketplace for Internet transit around the IXP, which resulted in lower prices. In many OECD countries transit prices have dropped by a factor of 100 or more since 2000.

IXPs enable the efficient exchange of local traffic and therefore reduce the payments to upstream transit providers, traffic route distances, and latency issues experienced by end-users. Mexico is the only country in the OECD area without an IXP. Internet traffic originated in Mexico is exchanged on the east coast of the United States, in Latin American countries or European countries. In 2012, the OECD found that Mexico is among the most expensive countries in terms of IP transit charges.[53] Broadband prices paid by consumers and business necessarily reflect these IP transit charges and thus contribute to higher broadband prices. The insufficient use of IXPs, in a given country, is not in the interest of business and consumers. Generally, this points to a lack of competition in some aspect of the market. Concerns have been raised in Chile, for example, due to the common practice of exchanging traffic through the United States, despite having several IXPs in that country. If different actors do take this path it would tend to indicate either a problem with the local governance of an IXP (the best are self regulated and voluntary) or some other bottleneck that ISPs, using offshore facilities, are seeking to bypass.

IXPs in the OECD area are not regulated by government policy, and transactions within an exchange are left to market forces. Efficient IP-based interconnection can be achieved without the need for regulatory intervention. Because no entity is able to connect to the worldwide Internet on its own, a series of interconnection agreements and IP traffic exchanges constitute traffic routes which will reach its intended destination by means of "peering" or "transit" agreements.

Peering is a way to transport traffic between two networks, settlement-free in most but not all cases. By way of contrast, transit is used to transport the traffic via a paid agreement (e.g. from an ISP to an upstream service provider). These schemes rarely need regulatory oversight, since there is usually a fair range of peering and transit agreements to choose from. Two or more ISPs interconnected by the same public peering agreement are usually referred to as an "Internet Exchange Point".[54]

One way to ensure openness at the IXPs is called "mandatory multilateral peering" agreement where every connected party at an IXP must peer with every other party who is connected. Under this voluntary agreement, all connected parties agree to exchange traffic under the same conditions in the same agreement.

The downside of this type of agreement however might create a disincentive for large ISPs to interconnect. For example, the Western Australian Internet exchange (WAIX), requires a mandatory multilateral peering agreement among participants and, thus, every participant has to peer with every other participant.[55] This operational rule of WAIX influences the composition of participants. On the one hand, it has attracted many small and non-ISP participants; on the other hand, large ISPs such as Telstra and Optus are not parties to the agreement. These larger operators would prefer to sell transit to the smaller operators, which they say provides a return on their investment in the infrastructure for this traffic to be conveyed. This system works best if operators, small or large, have the freedom to choose their own arrangements for peering or transit.

The Kenyan IXP (KIXP) is run and operated by a non-profit organisation representing the ISPs and other telecommunication service providers in Kenya (the Telecommunication Service Providers Association of Kenya). It is a mandatory multilateral peering agreement, and each member must have a peering session with every other member through the KIXP route servers and router reflector.[56] The KIXP is a very unique case in that the regulator grants the license to the IXP operator (see Box 6).

Box 6: Government involvement in the Kenyan IXP

KIXP was launched initially in 2000 when the market was not yet fully liberalised. Following its launch, the incumbent telecom operator, Telkom Kenya (TK), filed a complaint before the national regulator and argued that the KIXP violated TK's exclusive monopoly on the carriage of international traffic. The regulator concluded that the KIXP be shut down as an illegal telecommunications facility. TK's opposition to KIXP was fierce because of the fear of losing a significant portion of its international leased line revenues.

Following discussions with the regulator, KIXP was granted a licence in November 2001. In 2002, the KIXP was re-launched having interconnected five Kenyan ISPs as the licence KIXP received stated that only licensed ISPs could participate in the exchange. Subsequently, the government has permitted KIXP to accommodate data providers that are not formally licensed ISPs with an interest in helping the exchange grow.

To date, there are 25 members already peering at the KIXP. Relative to major IXPs, the throughput of traffic exchanged is low, while it ranks among the top 15 IXPs in terms of growth, with 150% on an annual base.

Source: The World Bank (2011), Broadband Strategies Handbook

In Chile the regulator requires all IXPs in the country to be interconnected among themselves.[57] As the participation of large ISPs may have an influence on the success of IXPs, governments may consider facilitating the development of IXPs but as there have been questions about "tromboning" domestic Chilean traffic through third countries, it raises the issue as to whether such regulation is efficient. Some may ask about the effectiveness of such an obligation for openness to all participants, regardless of whether it is based on government involvement or industry voluntary agreements, since it might provide the wrong incentives, (e.g. ISPs may not expand their facilities to connect beyond a single exchange and hinder growth of the other IXPs).

The Neutrinx IXP in South Africa, which opened in September 2011, provides non-discriminatory, transparent interconnection among its parties.[58] This is an example of "open policies" for potential members to join the IXP. The Northwest access exchange (NWAX), established in Portland, Oregon, in the United States is another example of an Internet Exchange run by a neutral, non-profit organisation.[59] NWAX notes in its website that if a network service provider both operated the exchange and offered commercial network services, then other providers would be reluctant to join the exchange based on concerns of an uneven playing field.

In other cases, non-profit Internet-related institutions have undertaken major steps to improve broadband connectivity through IXP arrangements. For example, the Canadian Internet Registry Authority (CIRA) has undertaken an active programme to help qualified communities, independent ISPs, regional research and education networks and others to deploy IXPs in their community. CIRA's overall goal is to have local members build and operate the IXP, with CIRA bringing technical expertise, stability, back office functions, governance assistance, content providers and, if required, some financial and equipment support. Most significantly CIRA will help the IXP provide a variety of DNS hosting services (which can improve responsiveness and reliability for connected users) as well arranging CDN networks to collocate at the facility.[60]

Many IXPs are run by non-profit, neutral organisations of network operators, some with a small degree of government involvement, and have a clear, open policy for new members to adhere. The costs, usually shared among the parties, are sufficiently lower than those that would be incurred through multiple peering agreements or through transit to make these IXPs efficient. Therefore, it could be argued that IXPs provide an example of voluntary, open access arrangements, in that they enable efficient, non-discriminatory and cost-effective wholesale connectivity among ISPs. It should be noted, however, that

IXPs may rather be regarded as entities that facilitate interconnection between ISPs, rather than as arrangements providing access to infrastructure.

Wholesale open access: fibre backbone

The previous sections have largely dealt with wholesale open access for access and backhaul networks. This is linked to the location of the main economic bottlenecks in telecommunication networks: local access and backhaul tend to be more problematic in terms of effective competition as there is generally much more competition in national and international backbone networks. In some countries, however, wholesale backbone networks, may also involve economic bottlenecks in certain cases.

A lack of overseas connectivity through submarine cables has, in the past, been reported as a major hurdle for the development of international connectivity in some parts of Africa. Brazil has proposed the construction of a regional fibre backbone network to lower international connectivity costs in South America. In Europe, some routes have also suffered from insufficient competition, for example between the European mainland and some islands like the Spanish Canary Islands or some French DOM-TOM overseas territories, such as Mayotte, or some undersea cables between Europe and Africa (see Box 7).

Backbone fibre connectivity is perceived as a major problem by many governments. South American countries have long been aware of the problem, as wholesale backbone connectivity costs represent a higher share of the final retail costs than in most other regions at an estimated 30-40%.[61] Last March 2012, UNASUR Ministers met in Asunción, Paraguay, and agreed to a roadmap for a regional fibre backbone infrastructure.[62] The agreement lays down a three-year roadmap for UNASUR countries to develop a fibre ring including undersea cable connectivity. The first steps of the roadmap are planned to identify existing public and private backbone infrastructure and design an interconnection map.

Until recent years, Africa's Eastern Coast was an area without fibre-based international connectivity. This meant Internet users had to rely on more expensive satellite communication facilities for backbone carriage of traffic. Essay is a consortium that identified the need for connectivity in the region and deployed a 10 000 km submarine cable system linking South Africa with Sudan, including landing stations in Mozambique, Madagascar, the Comoros, Tanzania, Kenya, Somalia and Djibuti, with an estimated cost of USD 263 million.[63] It started operation in July 2010 and is run by a consortium of African telecommunication operators, through a public-private partnership WIOCC (West Indian Ocean Cable Company Limited), a special purpose vehicle (SPV) that benefitted from development funds. The consortium advertises "non-discriminatory open access" for small and medium telcos, ISPs and other organisations.[64]

Box 7. An alternative undersea cable to the Canary Islands

Given its geographical location, the Canary Islands in Spain have experienced competition concerns and deficient connectivity to Spain's mainland and to the rest of Europe. Telefónica was, up to 2008, the only provider of undersea cable connectivity between the Canary Islands and the Spanish mainland territory. Wholesale connectivity prices have been regulated since 2008. Canalink, a consortium of IT3, a publicly-owned telecommunications operator, and Islalink decided to invest in an alternative 2000 km-long undersea cable between the Canary Islands and the Spanish mainland.

This project is part of the broader initiative ALIX, which has been launched by the local authorities. ALIX aims at creating a Neutral Access Point (NAP) in Tenerife (Canary Islands) for Internet connectivity between Africa, Europe and America. As the project involves publicly-owned operators entering the market, the Spanish regulator (CMT) resolved that the new operators must observe the principles of neutrality, transparency and non-discrimination.

Source: NAP/WACI and www.d-alix.com

In its "*Rapport au Parlement et au Gouvernement relatif au secteur des communications électroniques outre-mer*" –on overseas French *départements*-, the French regulator ARCEP states that one of the reasons for the insufficient broadband development in DOM territories is the weak competition in undersea cables.[65] ARCEP recommends the purchase of long-term rights of use (so called indefeasible rights of use or IRUs) as opposed to leasing cable capacity to decrease the costs for operators and thus favouring the entry of alternative operators. A number of public initiatives for deploying alternative cables and granting access to alternative operators are taking place in the Antilles (Guadeloupe, Saint Martin and Saint Berthélemy) and Mayotte.

In some countries with more strict licensing regimes, the legal requirements for license holders may be a barrier to the development of "open access" wholesale backbone providers. For example, Chile recently modified its licensing regime to allow for wholesale-only providers. Previously, only those operators providing retail communications services could apply for a license, which virtually impeded wholesale-only business models for telecommunications.[66]

Open access policies for backbone connectivity, including undersea cables, have historically rarely been the outcome of purely private or public initiatives. In undersea cables, for example, while access for participation in IRUs might have been relatively open, in some cable systems, this did not mean much if

national regulation precluded competitive operators from taking advantage of connection to landing points for a specific country. At the same time, open access policies can be pro-competitive, irrespective of the nature of participants.

Common elements of open access policies

The previous sections provide an overview of the main elements of open access (or open access-related) policies and on the common elements present in these arrangements. The first conclusion, that may be drawn, is that there is no generally applicable legally-binding definition of "open access" in OECD countries. This term is widely used, sometimes with different implications, by a broad range of stakeholders, including public authorities. In its widest scope, "open access" is used to designate the use of a network by a third party other than the owner/operator of that network.

The second conclusion is that open access arrangements are applicable to access, backhaul and backbone networks and are therefore not dependent on the underlying technology or network level. Some of the common elements can be found at any of these levels. Accordingly, the use of the term "open access" for broadband networks can be linked to the following properties, or common characteristics, that are usually present in those arrangements.

Wholesale access

There is a widespread agreement among stakeholders and across all types of technologies that "open access" refers to wholesale access. Nonetheless, (*ex-ante*) regulated wholesale access is only one area where open (wholesale) access can take place, as open access may also happen as a result of a voluntary decision of a single network to provide it.

Effectiveness

Wholesale access branded as "open access" needs to be effective.[67] In the context of regulated open access, most of the concerns arise when an obligation for incumbent operators is not actually fulfilled, or it is not effectively enforced. Deficient quality of service, delays in the provision of wholesale products or discrimination against non-affiliated retail providers have often been alleged as being the reason why open access policies have not performed efficiently in some OECD countries. Countries that took the decision to implement functional or structural separation of the incumbent operator did so based on concerns about the actual enforcement of regulatory wholesale access obligations, known as "sabotage" in the economic literature. In conclusion, wholesale access has to be effectively provided if it is to be designated as open access.

Transparency

Transparency is another key feature of open access. The terms for any open access arrangement have to be transparent. If not publicly available, sufficient information about the terms of any open access arrangement must be made available to any interested parties, so that any access seeker may be aware of access terms and conditions.

Transparency may be implemented by means of a reference offer or by another mechanism that provides enough information to requesting parties. Transparency, where referring to NGA networks, may also be required for migration/transition plans from legacy networks to new fibre networks. The party leasing the copper has to make its migration plans public and advertise within a given delay that it intends to decommission its copper network.

Non-discrimination

Any open access arrangement has to be non-discriminatory. That is the reason why purely commercial negotiations, which do not apply the same access conditions to all interested players or, at least, do not have clearly established policies as to which conditions apply depending on potential access seekers, may not be classified as open access agreements. Non-discriminatory conditions should be considered as an integral part of every arrangement termed as "open access".

Clearly, non-discrimination may not be achieved solely relying upon the non-discriminatory behaviour of the incumbent operators. In the context of regulated wholesale access, where incumbent operator(s) have the incentive to discriminate against alternative operators, a whole set of enforcement, monitoring and control measures have been set by regulators.

An alternative to imposing fair and reasonable access conditions on the parties offering access is ensuring that the incentives for discrimination are not present. That is generally the case for IXPs, which, as noted above, are usually operated by non-for-profit organisations unrelated to any of the access seekers nor to the incumbent operators, with some exceptions.

Fairness/reasonableness and price control obligations

Finally, any non-discriminatory, transparent and effective wholesale access must have some degree of fairness and reasonableness. For example, fair and reasonable requests for access should be given due course. Typically, disputes over the fairness of requests relate to the prices charged or the requested and offered technical characteristics of access requests. Even though there is no widespread agreement about the implication of fairness/reasonableness, these terms frequently appear in the context of regulated wholesale access.[68] In this regard, debates about fair access can hardly be separated from the discussion of price control obligations. In fact, price control obligations in whatever form they may take - price caps, retail-minus, cost orientation - are pivotal to guaranteeing one of the properties that open access should comply with – that of "effectiveness".

As a necessary means to ensure effective open access, virtually every form of mandated open access entails some price-related obligations. As the resulting regulated price level is often subject to cost-orientation principles, gathering evidence about the costs incurred by the wholesale service providers is necessary. This usually involves a large degree of subject-matter knowledge and methodological challenges related to cost-accounting methodology, the willingness of operators to disclose accounting data and the cost-accounting models used to allocate costs. This work is usually undertaken by telecommunication regulators in most OECD countries and requires specialised staff and significant work in co-operation with operators.

Mandated vs. voluntary open access and private vs. public initiative

Voluntary open access in the context of access and backhaul networks remains relatively rare. Moreover, most of these cases are linked to the public ownership of the party offering open access, who aims at fulfilling public service obligation and public policy objectives. Purely private open access initiatives remain rare although some, wholesale-only proposed models, could be considered open access depending on the final conditions offered to requesting operators. They are, however, more likely to be classified as purely commercial agreements

The same considerations may well be derived for backbone infrastructure, including undersea cables. There may be little incentive to allow for open access when the infrastructure has been deployed by private market players, especially if they are backed by monopoly power in interconnecting networks. Most, if not all, of the initiatives which entail open access to undersea cables are consequences of the dominant position

of telecommunication operators running these cables, and thus a result of the lack of openness in accessing these infrastructures. That is the reason that public or semi-public initiatives were launched with open access policies in some regions.

Perhaps IXPs are one of the few exceptions to this pattern, in that they offer effective, transparent and non-discriminatory conditions for new members to adhere. It could be argued that IXPs are not purely private players, as most of them are non-for-profit organisations or are in a small number of cases associated with public authorities. It can also be argued that they do not provide open access, as they only provide interconnection among peers. On the other hand, it could be contended that an IXP is an infrastructure that any interested player may access on an open basis, and therefore it fully falls under the concept of open access.

Wired vs. wireless

Traditionally, the open access debate only concerned fixed networks. These networks suffered from economic bottlenecks, such as access to the local loop, which made the case for open access policies, in the form of regulated access, extremely compelling.

With the advent of mobile networks and, more markedly, after the increasing spectrum needs for wireless broadband networks, wireless networks have also been confronted with an economic bottleneck: limited spectrum resources. Lower costs of deployment for mobile networks may render wholesale-only models more feasible than they have been for fixed networks, although there is little evidence to date of wholesale-only mobile operators enjoying commercial success. Infrastructure sharing agreements appear to be gaining importance and this may be the trend in many countries for the deployment of LTE networks.

The role of open access in developing competition dynamics

The importance of open access policies, mostly in the form of regulated access should not be underestimated. The role of local loop unbundling in developing competition in numerous OECD countries has been significant. Success stories such as France or the United Kingdom in Europe or Japan and Korea in Asia are partly, if not mostly, the outcome of well implemented open access policies. While the debate over levels of investment, innovation, competition and so forth is an on-going one it is likely to become even more critical as NGAs are further developed.

The role of open access policies for undersea cables, publicly funded broadband networks and backbone networks also has to be recognised. Market failure has often been tackled through open access policies, usually in the form of mandated open access or private-public partnerships for investing in facilities where private initiative has not been found to be in line with public policy objectives.

Harmonising open access regimes

One of the challenges in dealing with open access policies from many different perspectives is the possible inconsistencies in implementation, regulatory uncertainty or incoherent obligations imposed by different regimes which may create methodological and/or practical differences in implementing open access policies or may even result in inconsistent obligations for telecommunication providers.

In this respect, formal and informal co-operation between the different authorities, *e.g.* competition authorities, telecommunication regulators, public funding agencies, should be strengthened. As *ex-ante* regulatory authorities usually have well-developed subject-matter expertise on wholesale regulation, cost-accounting methodologies and implementation/enforcement issues surrounding open access policies, these authorities should be involved by means of consultation in the process of laying down the conditions attached to open access broadband networks.

If a public authority grants some funds for the deployment of an open access broadband network, it would be highly advisable that it gathers advice from the telecommunication regulator and ensures that open access conditions are coherent with existing or future *ex-ante* obligations for this area or, at a minimum, some rationale is provided on the relationship between both sets of measures.

With respect to the coherence of open access conditions imposed by competition authorities, again they should observe the approach taken by national regulatory authorities and, if these measures are to be qualified as complementary - either by jurisdictional issues or by new findings - they should acknowledge and provide the rationale for such measures to be taken.

If enforcement measures relating to open access networks are not directly overseen by the regulatory authority, some co-operation mechanism must be implemented in order to guarantee that this implementation benefits from the subject-matter knowledge that the national regulatory authority has in dealing with mandated regulated access.

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ENDNOTES

1 Bourreau, M and Dogan, P. (2006) provides a model on why and how entrants make choices on infrastructure deployment depending on the regulated LLU price.

2 Cave (2006) proposed a model by which new entrants face increasing investment level ("the rungs of the ladder") when trying to replicate the incumbent's infrastructure. The higher the investment, the more independently they can provide the service and innovate.

3 BEREC has recently published a report on the regulation of co-investments in NGA networks, berec.europa.eu/files/document_register/2012/8/bor_12_41.pdf.

4 ISO/TC97/SC16, "Reference model of open systems interconnections", Doc. N227, June 1979.

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7 See for example, *United States Telecom Ass'n v. FCC*, 359 F.3d 554 (D.C. Cir. 2004), *available at* transition.fcc.gov/ogc/documents/opinions/2004/00-1012-030204.pdf

8 *National Cable & Telecomm Ass'n v. Brand X Internet*, 545 U.S. 967 (2005).

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12 The Committee to set and update "Bezeq" tariffs, and to set tariffs for wholesale services in fixed communications. www.moc.gov.il/sip_storage/FILES/8/2528.pdf

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17 For example, those included in the document "Costing methodologies and incentives to invest in fibre", prepared by Charles River Associates for the DG Information Society and Media of the European Commission, ec.europa.eu/information_society/policy/ecomm/doc/library/ext_studies/20120705_finalreport_costing_cra.pdf

18 Art. 12 of the Framework Directive (as per Directive 2009/140/EC of the European Parliament and of the Council of 25 November 2009).

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24 See Article 13a of Directive 2002/19/EC as amended by Directive 2009/140/EC.

25 PPPs are contractual agreements adopted in a variety of fields between a public and a private sector entity whereby the private party agrees to design, build and manage an asset (often an infrastructure asset) and to bear some of the risk associated to these activities. PPPs may thus take many different forms, associated to different degrees of involvement of public players. Some may have the form of DBO (Design-Build-Operate), BT (Build and Transfer), BOT (Build-Operate and Transfer), BRT (Build-Rent and Transfer) (Parcu et al., 2011)

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33 *Applications for Consent to the Transfer of Control of Licenses and Section 214 Authorizations by Time Warner Inc. and America Online, Inc., Transferors, to AOL Time Warner Inc., Transferee*, Memorandum Opinion and Order, CS Docket No. 00-30, 16 FCC Rcd 6547 (2001), *available at* transition.fcc.gov/Bureaus/Cable/Orders/2001/fcc01012.doc

34 hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-11-103A1.pdf

35 Many MVNOs do not publicly report subscriber data and it is a standard practice to include MVNO subscribers with the subscribers of the host facilities-based providers. During the second quarter of 2011, for instance, Verizon added 896 000 wholesale customers (out 1.4 million total net adds), and around 460 000 of those came from Straight Talk, one of TracFone's brands, www.fiercewireless.com/special-reports/whats-next-nations-roughly-four-dozen-mvnos.

36 www.totaltele.com/view.aspx?ID=472783

37 Directive 2002/19/EC, of the European Parliament and of the Council of 7 March 2002 on access to, and interconnection of, electronic communications networks and associated facilities (Access Directive).

38 *Avis n° 08-A-16 du 30 juillet 2008 relatif à la situation des opérateurs de réseaux mobiles virtuels (MVNO) sur le marché français de la téléphonie mobile,* www.autoritedelaconcurrence.fr/pdf/avis/08a16.pdf

ARCEP has included a number of MVNO-related criteria under the 4th 3G license tendering process, responding to the competition concerns in this market.

39 www.soumu.go.jp/menu_news/s-news/01kiban14_02000079.html

40 In order to identify markets that are susceptible to *ex ante* regulation, it is appropriate to apply the following cumulative criteria. The first criterion is the presence of high and non-transitory barriers to entry. These may be of a structural, legal or regulatory nature. However, given the dynamic character and functioning of electronic communications markets, possibilities to overcome barriers to entry within the relevant time horizon should also be taken into consideration when carrying out a prospective analysis to identify the relevant markets for possible *ex ante* regulation. Therefore the second criterion admits only those markets whose structure does not tend towards effective competition within the relevant time horizon. The application of this criterion involves examining the state of competition behind the barriers to entry. The third criterion is that application of competition law alone would not adequately address the market failure(s) concerned.

"*Commission Recommendation on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services"* (Second edition).

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43 "Open Network Access" for Third Generation (3G) Mobile Services, 29 May 2001, Office of the Telecommunication Authority, Hong Kong, China.

44 transition.fcc.gov/Daily_Releases/Daily_Business/2012/db0215/DA-12-214A1.pdf

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49 stakeholders.ofcom.org.uk/binaries/consultations/msa/summary/msa.pdf

50 hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-260A1.pdf

51 www.telecompaper.com/news/yota-to-build-wholesale-lte-network-for-russian-operators

52 www.balancingact-africa.com/news/en/issue-no-571/money/kenya-s-government-g/en

53 www.oecd.org/dataoecd/7/38/49536828.pdf

54 EURO-IX - Euro-IX has accepted the industry definition of an IXP as: "A physical network infrastructure operated by a single entity with the purpose to facilitate the exchange of Internet traffic between Autonomous Systems. The number of Autonomous Systems connected should at least be three and there must be a clear and open policy for others to join."

55 www.ausnog.net/files/ausnog-03/presentations/ausnog03-moyle-croft-peering.pdf, www.pipenetworks.com/docs/mlpa.pdf

56 www.tespok.co.ke/index.php/kixp

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67 Oxford dictionary, oxforddictionaries.com/definition/effective?q=effective: *adjective* successful in producing a desired or intended result: *effective solutions to environmental problems* (of a law, rule, or policy) operative: *the regulation will be* ***effective from*** *January.*

68 For example, in the context of the symmetrical obligation laid down by the French regulatory ARCEP, there is a requirement for the building operator to allow other operators to provide ultra-fast broadband services to the residents under fair and non-discriminatory conditions.