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**BACKGROUND PAPER ON INFRASTRUCTURE
SHARING**

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1 INTRODUCTION

The telecommunications infrastructure sector is traditionally characterized by huge fixed, sunk and irreversible investment, often making telecommunications infrastructure investment a high risk undertaking. This situation is often made more unpredictable by the rapid introduction of successive generations of new technology. Operators are occasionally faced with a situation where even before recouping their investments in existing infrastructure they embark on further investment in a new generation networks of networks. This phenomenon is common in the mobile sector, particularly in the context of 3G services, where the high cost of licensing and equipment have left operators vulnerable at the early stage of network deployment.

In response to this phenomenon, policy-makers, regulators and operators are increasingly placing more emphasis on alternatives to the traditional high-cost infrastructure model by considering measures such as infrastructure sharing, domestic roaming and MVNO agreements. These measures can help reduce the financial burden on operators, accelerate the introduction of new services and facilitate the deployment of new networks while lowering barriers to market entry.

2 WHAT IS INFRASTRUCTURE SHARING?

The term Infrastructure Sharing generally refers to the sharing of airtime and/or network facilities between one or more operators. The objective of Infrastructure Sharing is to maximize the use of existing network facilities which can include network capacity and capabilities, existing base station sites, backbone, radio links, and other resources to reduce infrastructure duplication and costs.

Infrastructure sharing can take a number of forms. In its simplest form it can involve the sharing of space on masts and associated buildings or sites. Alternatively, sharing can be more extensive such as in 3G infrastructure sharing arrangements that involve two or more operators coming together to share various parts of their network infrastructure for purposes of service provisioning.

Another variant can also take the form of national roaming where two or more operators reach an understanding that their respective subscribers can use each others' networks when outside the geographical coverage of their home network. Expanding the concept, Infrastructure Sharing can also extend to the co-location of network elements and the sharing of frequency spectrum for wireless-based telecom services.

3 WHY IS INFRASTRUCTURE SHARING IMPORTANT?

Infrastructure sharing is viewed largely as a measure to reduce costs. For example, experts at infrastructure manufacturers such as Ericsson and Siemens estimate that up to 40% of initial roll-out costs can be saved by sharing infrastructure in the case of 3G networks.

Together with savings on costs, Infrastructure Sharing can be used both in the start-up phase to build coverage quickly and in the longer term to build more cost-effective coverage in rural areas. Interest in infrastructure sharing can be expected to be at its peak in the start-up phase, when operators want to provide quick coverage in a large area while traffic demands are low and the costs for network deployment are relatively high. Infrastructure Sharing agreements, however, provide the highest savings in cases of low traffic demand where more efficiency is achieved by pooling resources. However, when network usage picks up, savings will decrease as each operator needs individual capacity.

Taking the sector as a whole, Infrastructure Sharing can also promote greater service-based competition and reduce infrastructure duplication through the more efficient use of existing network facilities.

It is important to note, however, that Infrastructure Sharing also has its limitations. Operators will necessarily cede some of their independence and their control over the network in exchange for cost savings. Networks will also become more complex and the ability of operators to compete on coverage will be curtailed.

4 INFRASTRUCTURE SHARING MODELS

As Infrastructure Sharing is particularly established in the mobile sector, the discussion of the different sharing models will use mobile networks as the context.

Mobile networks can be shared to different degrees. All parts of a mobile network can be shared between two or more network operators. This ranges from “passive” elements such as sites, towers, buildings and transmission links, through to radio transmission management, up to a common network infrastructure.

The most common and basic level of sharing occurs when two or more mobile operators share sites, with each putting up their own radio masts and installing their own equipment (site sharing). Usually, the space on masts and antennae are also shared. Partners that share sites may share all site related infrastructure which includes ownership rights or right to-use of the site, building or shelter, tower or mast, the power supply and battery backup, cabling and antennas and transmission equipment.

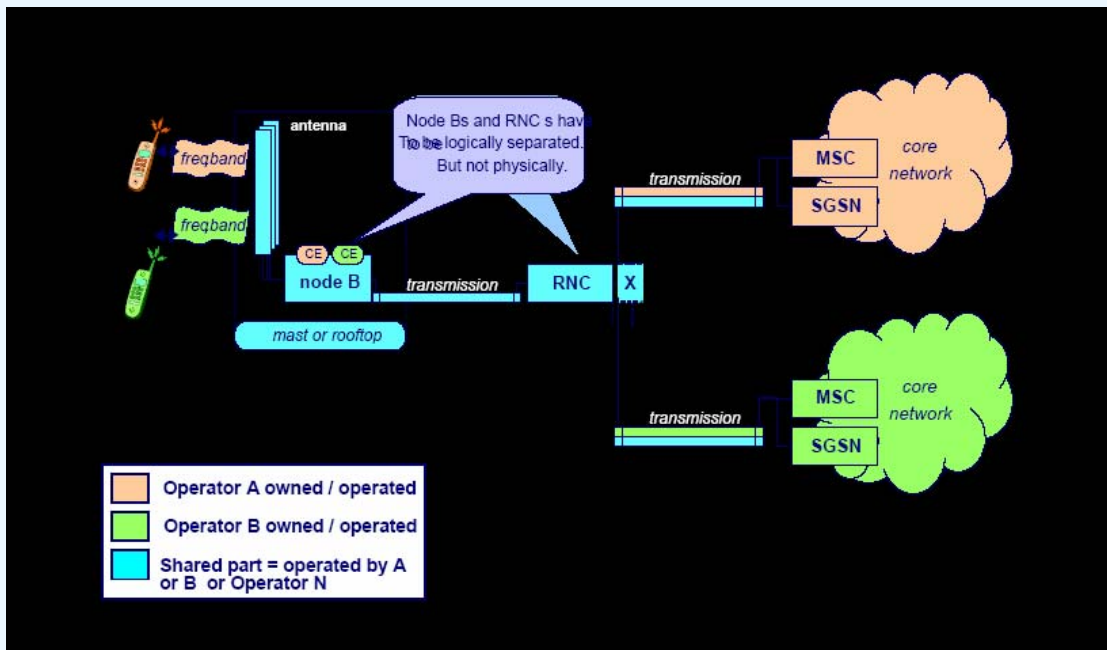
Site sharing is suitable for densely populated areas with limited availability and expensive sites, such as underground subway tunnels, as well as for rural areas with their associated high costs for transmission and power. Regulators often promote site sharing in order to allow new operators to build their networks more easily by re-using existing sites.

It is interesting to note that mast and antennae sharing have the backing of some environmental groups as it reduces the impact they have on views, particularly in rural areas.

Beyond the site sharing level, the base station equipment, which manages the transmission of signals over the mobile network, can also be shared. In such a scenario, each operator deploys its individual licensed frequency and deploys its individual cells, including individual control and network management, while sharing facilities such as the Radio Base Station (RBS), Radio Network Controller (RNC) and transmission.

In the case of 3G networks, for example, this level of sharing could include the sharing of the Node B and the Radio Network Controller (RNC) (see Figure 1).

Figure 1: Sharing of Node B and Radio Network Controller (RNC)

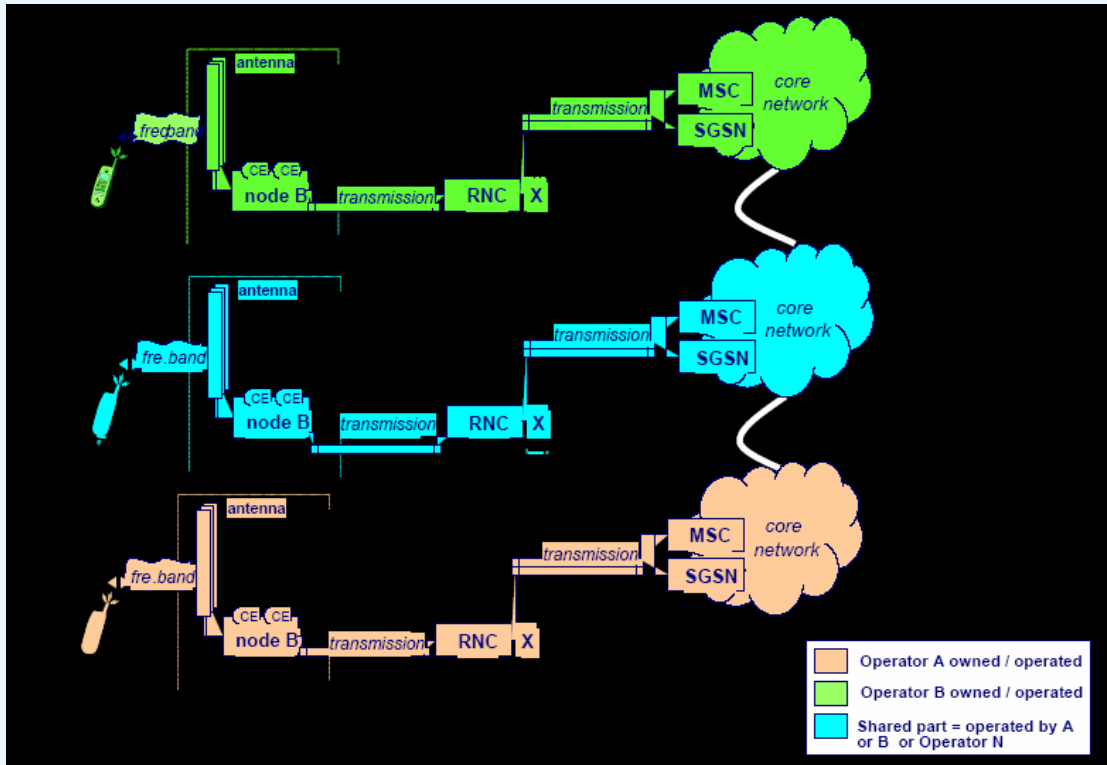


Source: Orange

The next level in Infrastructure Sharing involves the sharing of a common core network (network sharing). In this scenario, a common network – both circuit switched and packet oriented domain – is shared by at least two operators. In such a case, the operators typically share the RBS, RNC, Mobile Services Switching Center/Visiting Location Register (MSC/VLR) and Serving GPRS Support Node (SGSN). Each operator, however, has its own individual home network that contains the independent subscriber databases, services, subscriber billing and connection with external networks (see Figure 2).

The Common Shared Network is actually one network with additional capacity for the sharing operators' traffic demands. This Infrastructure Sharing arrangement can result in considerable savings for the network, but adds complexity to the planning and core network deployment because two or more operators have to be handled.

Figure 2: Sharing of a Common Network



Source: Orange

On top of this, there is also one further level to Infrastructure Sharing involving the sharing of all customer databases and billing information. This, however, normally takes place only in a close relationship, such as in a partnership with a mobile virtual network operator (MVNO) (see Box 1).

Box 1: Mobile Virtual Network Operator (MVNO)

The term "Mobile Virtual Network Operator" appears to be very popular, but rather vaguely defined. One element common to all of these definitions is the fact that the MVNO does not have a mobile license and uses either parts of or the entire infrastructure of another operator.

Essentially it involves an operator that does not own or control radio spectrum or associated radio infrastructure but does own and control its own subscriber base with the freedom to set tariffs and to provide enhanced value added services under its own brand.

Such arrangements can lead to increased service-based competition while also benefiting the operator that owns the infrastructure.

Source: ITU

4.1 National Roaming

Infrastructure Sharing can also take place on a geographical basis. Significant savings can be achieved if two or more operators build their networks in non-overlapping areas with mutually agreed access to each others' networks. In such an arrangement, the operators involved would cover different areas and, by allowing their subscribers to roam between their respective networks, the coverage area for services is expanded.

A number of variations can exist in such arrangements. For example, national roaming could be used by mobile operators when they divide their network build-outs into a regional split. National roaming also does not have to be allowed over the entire network of the co-operating operators. For example, it can be used by operators as a long term solution to achieve rural coverage. In densely populated areas, operators can build their individual networks, restricting the access of other operators' subscribers, while sharing access in rural areas where coverage costs are higher. National roaming agreements can also take the form of a mutual roaming agreement or a one-sided roaming agreement, where an operator with a large network provides additional coverage for an operator with limited coverage.

Regulators, however, may limit the nature of national roaming agreements or could couple them with minimum coverage conditions (e.g. no roaming until a certain percentage of population coverage is achieved) in order to further national objectives such as the promotion of facilities-based competition.

It is also important to note that although allowing national roaming between operators can cut infrastructure costs dramatically, it nevertheless has significant drawbacks if such network sharing arrangements end.

4.2 Network Ownership

Beyond the choice between the different models for Infrastructure Sharing, operators also have a variety of ownership models to choose from when distributing shared resources resulting from Infrastructure Sharing arrangements. These typically take the form of one of the following options:-

- *Master/slave(s)*: one operator owns the shared resources and leases its use to the other party or parties involved;
- *Joint ownership*: all parties have equal access to the shared resources, e.g. through the formation of a joint venture company, and
- *Third party ownership*: the build-out and ownership of shared resources is done through an independent network company (or *netco*), which is then used by two or more service companies (or *servco*).

5 INFRASTRUCTURE SHARING TECHNOLOGIES

Many new technologies that make sharing easier are emerging. Quintel, a joint-venture between QinetiQ and Rotch, the UK property group, has been set up specifically to capitalise on its mast-sharing technology. This enables five or six operators to share radio masts. Quintel's technology was originally developed by the UK-based Defense Evaluation and Research Agency (from which QinetiQ was spun out) for use in military situations where lots of antennae are crowded together, much as they are on battleships. The technology also enables the antennae to be tilted in the direction that best fills out each operator's network footprint. Antennae for different operators, which are in effect mounted on a single tower or positioned in a belfry window, can be tilted in different directions from each other.

New technology for sharing the electronics normally housed in a base station at the bottom of a mobile antenna is also emerging in the form of base-station (BTS) hotels. BTS hotels enable the electronics from a number of base stations to be grouped together as far as 10-15 miles away from the antennae they serve. This cuts down on the cost of maintaining the electronics and on services such as power and air-conditioning - and it also means engineers do not have to travel to so many remote sites. A BTS hotel could include five 3G base stations, four 2G base stations and a Tetra (Terrestrial Trunked Radio) base station. The base stations could be linked to 10 antennae and have shared access to the fixed network.

6 KEY ISSUES RELATED TO INFRASTRUCTURE SHARING

There are a number of important issues related to Infrastructure Sharing. These relate both to commercial as well as regulatory aspects of Infrastructure Sharing.

6.1 Commercial Considerations

Infrastructure Sharing should be a win-win situation for participating operators and it should also give them a competitive advantage over other operators in the market. As such, prospective sharing partners should look at their specific market situation, their rollout strategies and the benefits they seek to gain when considering an Infrastructure Sharing arrangement.

In general, a cost benefit analysis would have to be undertaken before entering into an infrastructure sharing arrangement, particularly when determining the extent of co-operation between the operators and the sharing model to implement (i.e. deciding what facilities or services should be shared). Depending on the sharing model selected, different levels of savings can arise, usually at the expense of freedom of control over network resources.

The freedom to plan and control network evolution, in particular, should be a key consideration when entering into an Infrastructure Sharing arrangement. Despite the positive effect Infrastructure Sharing would have on initial capital expenditure, infrastructure sharing would reduce the operators' ability to evolve their networks at a later stage.

In addition, considerations that must be taken into account by operators considering Infrastructure Sharing should also include the determination of a suitable ownership structure over shared facilities.

Given the fact that Infrastructure Sharing is typically entered into with a competitor, the protection of commercially sensitive data from the operators sharing the network will also have to be assured. More importantly, an exit strategy should be defined in case the market situation changes, or if traffic increases, making it more beneficial to deploy an independent network. A clear exit agreement allows operators a smooth migration to individual networks.

6.2 Competition and the Extent of Infrastructure Sharing

As noted above, Infrastructure Sharing arrangements have the potential to increase the level of competition in the marketplace by lowering infrastructure related barriers to market entry and by encouraging service-based competition. Nevertheless, a significant concern has been raised regarding the potential for Infrastructure Sharing to also lower the level of competition in the marketplace, depending on the extent of Infrastructure Sharing arrangements. Infrastructure Sharing arrangements may affect the competitive independence of operators in the market as a result of the network integration bred by such co-operation.

Different countries have adopted different approaches in order to safeguard the level of competitive independence between co-operating operators. Measures include mandating a distinct and differentiated cost base between operators; the development of different business plans, marketing and distribution strategies; and the independent development or acquisition of content and services. Requiring the independent control over the respective frequency resources of each operator is also an important competitive safeguard.

In the EU, for example, operators are allowed to share infrastructure as long as they maintain full operational control of their network. Sharing the radio access network is permitted, but sharing frequencies and the core network is not. In particular, the databases used to administer subscriber and interconnection information are required to be kept separate (see Box 2). Exemptions, however, are generally granted in special cases which advance the objectives of government policy and the economic benefits to the consumers of the services. It is important to note that any infrastructure sharing agreement could also be subject to review by the EC Commission under Article 81 of the EC Treaty and/or the EC Merger Regulation.

Box 2: Infrastructure Sharing and Competition Concerns in Germany and Sweden

In Germany, the main concern faced by the regulator involved a possible threat to the competitive independence of potential 3G operators that could result from a tight integration of the networks as a result of infrastructure sharing. Infrastructure Sharing is allowed only if the mobile systems can be independently operated, for example, if they can be shut down or maintained independently by software, and that no customer data is shared. In Germany, the sharing of antennae and sites is relatively common; however, the sharing of transmission management equipment and core networks is not commonly done.

In Sweden, the regulator has agreed to allow significant infrastructure sharing for 3G operators. Each operator only has to cover 30% of the population, while the remaining 70% can be shared. This is the approach is being taken by the European companies Vodafone, Hi3G and Orange, which jointly own 3G Infrastructure Services. However, with competition concerns, the regulator only allows radio components such as antennas, cables and base station electronics to be shared.

Source: APT Report on Study Question 1.1: Information Document on Sharing of Infrastructure in Asia Pacific

6.3 Should Infrastructure Sharing be mandated?

The level to which Infrastructure Sharing is mandated varies widely from country to country. Key considerations in deciding whether Infrastructure Sharing should be mandated include commercial implications - for example, whether such arrangements would benefit one operator over another -, the competitive model in the market in question - for example, whether service-based or facilities-based competition is encouraged (see Box 3) -, and the characteristics of the market - for example, rural versus urban markets. In an urban market, for example, the argument for mandatory Infrastructure Sharing may not be as strong as the need for capacity will be expected to grow. On the other hand, in rural areas, costs are expected to remain high while demand for capacity low.

In the EU, for example, a wide discretion has been given to National Regulatory Authorities (NRAs) to impose Infrastructure Sharing arrangements. The Interconnection Directive (Directive 97/33/EC) encourages the sharing of facilities and properties, although compliance with competition law is still required. The Directive grants NRAs the power to intervene and resolve disputes relating to agreements for co-location, or facility sharing. It also indicates that EU member states may impose facility and property sharing arrangements, including rules for apportioning the costs of sharing.

Box 3: Infrastructure Sharing and Facilities or Service-based competition

In the case of Singapore, the regulator's infrastructure sharing approach is guided by the primary policy goal of encouraging facilities-based competition. Under the current regulatory framework, licensees are generally not required to share any infrastructure that it controls with its competitors. Each licensee is expected to build or lease the use of the infrastructure it requires. Notwithstanding this however, infrastructure sharing is mandated in areas where there are clear space and operating constraints. For 2G and 3G licensees, such matters relate to infrastructure in the Mass Rapid Transit and underground road tunnels. The regulator has also allowed the co-location of base stations and sharing of transmission towers and masts to reduce the impact on the environment and to minimise the inconvenience to building owners and residents.

Taking a different approach, in Malaysia operators owning network facilities have been encouraged by the regulator to share infrastructure as a means of lowering costs and expanding coverage as well as to avoid a duplication of resources. To this effect, a Memorandum of Understanding to share infrastructure has been executed between the mobile operators.

To further catalyze infrastructure sharing, the concept of a third party provider of facilities is also being promoted in Malaysia. Under this concept of a third party will build the infrastructure and lease capacity or space to existing service providers. This concept, not only provides ready-made sites, but will also help reduce the numbers of telecommunication towers that have to be dealt with by local authorities.

Source: APT Report on Study Question 1.1: Information Document on Sharing of Infrastructure in Asia Pacific and ITU

7 ISSUES FOR DISCUSSION

1. To what extent should Infrastructure Sharing be encouraged by the regulator? Conversely, to what extent should Infrastructure Sharing be left up to operators to negotiate commercially? What are the factors the regulator should take into account when addressing this question?
2. What is the impact of Infrastructure Sharing on competition and on the viability of new market entrants?
3. In the event that the regulator seeks to promote Infrastructure Sharing, what are the options available to regulators?
4. What competition safeguards should a regulator establish when dealing with Infrastructure Sharing issues?
5. What models of Infrastructure Sharing should be mandated or prohibited (e.g. passive infrastructure, core network, national roaming, etc.)? And in what instances?
6. Should the same Infrastructure Sharing regulatory considerations apply to 2G mobile networks and 3G mobile networks?
7. What role should the private sector play in determining how and to what extent infrastructure should be shared?
8. What mechanisms are there available for operators to negotiate on equal footing with potential Infrastructure Sharing partners?
9. What should the role of the regulator be in the event that an Infrastructure Sharing seeker and a provider are not able to reach agreement?
10. Is a special dispute resolution mechanism necessary to resolve disputes over Infrastructure Sharing arrangements?

Appendix 1

Recommendations related to Infrastructure Sharing of the Working Group on Interconnection, Second ITU Forum of the Regional Working Group on Private Sector Issues of the Asia & Pacific Region, New-Delhi, 26-27 April 2004

Other Recommendations by the Working group on:

1.	Infrastructure Sharing	It should be encouraged by the Regulator / Licensor. Certain type of passive infrastructure needs to be necessarily shared, electronic infrastructure should be left to the mutual negotiations between both parties.
2.	Co-location of Equipment	Should be encouraged and should be on a reciprocal basis.

Appendix 2

Acronyms

BTS	Base Transceiver Station
GGSN	Gateway GPRS Support Node
GPRS	General Packet Radio Service
HLR	Home Location Register
IMSI	International Mobile Subscriber Identity
MNC	Mobile Network Code
MSC	Mobile Switching Center
MVNO	Mobile Virtual Network Operator
PLMN	Public Land Mobile Network
RNC	Radio Network Controller
RBS	Radio Base Station
SGSN	Supporting GPRS Support Node