Analysis of 3G Infrastructure Sharing

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1 EXECUTIVE SUMMARY

There is growing optimism among 3G license holders about the prospects of sharing 3G network infrastructure. The primary motivation for this sharing is to rapidly launch service and reduce the costs of deployment, thereby improving the overall financial health of the industry. The strategy to choose for network infrastructure sharing depends on the actual position an operator has in the market. For example, does the operator enter into a network sharing partnership with an existing network infrastructure and customer base (incumbent operator) or is the operator a new entrant to the market (Greenfield operator)?

The incumbent operator will focus on rationalisation of their investments into the network infrastructure and maximisation of site reuse. As there is already an existing customer base, the timely rollout has high priority in order to serve the actual customers needs. The highest economies of scale can be achieved by sharing network infrastructure with another incumbent operator. This scenario will improve the re-use of sites, as both partners will have nationwide coverage, and hereby hasten the rollout of network and services.

For Greenfield operators, the partnership with an incumbent operator seems to be attractive as it saves first and foremost precious time for the site acquisition. In this scenario, the Greenfield operator will probably start with their core network and build out into the incumbent operator’s existing access network. Both the Greenfield and incumbent operator will benefit from the split of site related costs in a shared network infrastructure partnership.

Nortel has already developed and will continue to add a range of solutions to enable network infrastructure sharing between license holders. The models being considered are the seamless national roaming model and radio access network models, which include site sharing, Node B sharing and RAN sharing in different variations. Analysis by Nortel has shown that sharing infrastructure will deliver healthy savings in capital expenditures (10% – 30%) and operational expenditures (20% - 40%) over a ten-year period. These important cost reductions will also lead to a reduction of business risk for the involved operators. Additionally, network infrastructure sharing will improve time-to-revenue by enabling the faster delivery of services to a greater number of subscribers.

![Figure 1: Subscriber growth with and without site sharing](image)

Adoption of network infrastructure sharing will pose challenges on multiple fronts: business, regulatory, technical, and political. However, Nortel endorses the idea of network infrastructure sharing because it benefits both the industry and the community by delivering 3G rapidly and cost-effectively.
2 INTRODUCTION

By having significantly invested in licence charges, Wireless Operators need to find smart and cost effective solutions for deployment of their 3G Network. The financing of this venture thus far has been conducted mainly through high levels of external funding, which has led to the downgrading of credit ratings of many of the current license holders. There has been concern about the viability of the overall business, particularly for the new entrants and their ability to deliver these 3G services rapidly.

Therefore, many in the industry are seeking solutions to reduce the overall business risk, improve time-to-revenue and most importantly reduce the amount of up-front network infrastructure build expenses. With global operators holding Pan-European and Asia-Pacific 3G licenses and thus bearing the burden of building networks, there is an immediate need to find solutions to lower the costs of building and operating these networks. Previous estimates (e.g. Financial Times) suggested that the cost of building 3G networks would be approximately US$ 5 billion\(^1\). One of the solutions being very carefully considered is the idea of sharing network infrastructure between license holders, while preserving both their independence and their ability to vigorously compete in the marketplace.

Analysis of a typical 3G Capital Expenditure (CapEX) model reveals that a majority of the upfront costs are related to establishing coverage (i.e. access related CapEx). As shown in Figure 2, approximately 70% of the CapEx involves acquiring the sites, access equipment, civil works (i.e. construction of the site, installation of the equipment) and laying the transmission network. With 3G, these fundamental implementation issues will be further complicated by the lack of sites, tighter environmental regulations, and health concerns regarding the hazards of radiation. In view of these challenges faced by 3G license holders, shared network infrastructure solutions need to be explored in order to reduce the financial risks facing the industry, establish faster universal coverage and thus improve time-to-revenue.

Figure 2: Split of Network Costs\(^2\)

\(^1\) http://www.ft.com
\(^2\) Nortel Shared Infrastructure Cost Analysis
Sharing of the network infrastructure will have a significant impact on time-to-revenue because acquisition of sites and deployment resources are scarce and are always on the critical launch path. But more importantly, sharing network infrastructure has long-term CapEx and Operational Expenditure (OpEx) savings, thus enabling 3G operators to focus on developing the applications and services demanded by the marketplace, which will ultimately drive usage, generate revenue, and sustain the overall business case for 3G.

3 SHARING MODELS BETWEEN LICENSE HOLDERS

One primary difference between the various network infrastructure sharing models is the treatment of the radio spectrum which each of the license holders brings into the partnership. Basically, there are two ways to use the licenses for spectrum sharing:

- The two license holders pool their spectrum.
  The operators manage a common pool of radio frequencies so that subscribers can equally use either carrier. Initially they could use one carrier from one of the operators and then gradually add more carriers taken from the common pool.

- The two license holders do not pool their spectrum.
  Two license holders do not pool their spectrum, so that each operator controls their own spectrum. 3G subscribers belong either to one or the other spectrum, and use their carrier accordingly.

4 NETWORK INFRASTRUCTURE SHARING STRATEGIES

As previously outlined, infrastructure sharing can deliver many benefits. However, the degree of infrastructure sharing can vary in each country depending on the regulatory and competitive climate. The two general infrastructure sharing models which will be explored in this paper are:

- Seamless National Roaming and
Each of these models is discussed below, outlining the savings operators can expect if they are implemented.

4.1 SEAMLESS NATIONAL ROAMING

In the seamless national roaming model, operator A and operator B build their network infrastructure in different regions of a country. Based on roaming agreements, each of the operators is allowed to use the shared areas of the other operator’s network infrastructure. There may also competitive areas (e.g. where both operators provide 3G coverage), where roaming is not allowed. The generalised model is shown in Fig 4.

Instead of two operators deploying their network infrastructure in the same geographical zone, each operator can concentrate on reaching fast coverage in their region. Competition is assured by the complete independence of the core networks and the applications/content domain.

National roaming exists already in GSM. Experience shows that national roaming improves the business case by establishing universal coverage and access to 3G services faster.

Although seamless national roaming is a very attractive solution for operators, there are still some challenges to master:

- Regulatory approval for geographical roaming will be required in most countries.
- The partitioning of the country into regions and the negotiation of roaming agreements may be difficult between the network operators.
- The timely and coordinated execution of independent network roll-outs is more complicated than with a network controlled by a single operator.
- Inter PLMN handovers between 3G and 2G, 2G and 3G and 3G and 3G networks reach a higher level of complexity than handovers for a single operator.
Nevertheless, the advantages of the seamless roaming model are notable. The business model is well understood, and the technical requirements for 3G seamless national roaming is an extension of roaming solutions in GSM/GPRS.

<table>
<thead>
<tr>
<th>Pros of Seamless Roaming</th>
<th>Cons of Seamless Roaming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved business case for operators</td>
<td>• Regulatory approval required</td>
</tr>
<tr>
<td>Clear ownership of equipment</td>
<td>• Interconnect agreements needed</td>
</tr>
<tr>
<td>Differentiation through Applications / Content</td>
<td>• Timely and coordinated execution of independent network builds critical</td>
</tr>
<tr>
<td>Easy migration to other shared solutions in network maturity</td>
<td>• Inter PLMN handovers have level of complexity higher than normal solutions</td>
</tr>
<tr>
<td>Low risk solution</td>
<td>• End to end inter PLMN QoS management challenging</td>
</tr>
</tbody>
</table>

Table 1: Pros/Cons of Seamless Roaming

### 4.2 RADIO ACCESS NETWORK SHARING

There are mainly three different models of access network infrastructure sharing, with some variations in each model. These models differ in their degree of sharing. This paper discusses the following models:

- Site sharing
- Node B sharing
- RAN sharing, including
  - Common Gateway (CGW)
  - 3GPP Release 6 Network Sharing, which includes two variations:
    - Multiple Operator Core Network (MOCN)
    - Gateway Core Network (GWCN)
  - UTRAN sharing

Operators may select for different shared network infrastructure models in different regions. The advantages of each model should be analyzed on a case-to-case basis.

### 4.2.1 SITE SHARING

Network elements that could be shared are illustrated in Figure 5.
Site sharing is the ability of two 3G license holders to acquire and rent a common site to host the Base Transceiver Station (BTS, a.k.a. Node B in the UMTS context) and transmission equipment. In addition, common equipment such as antenna systems, masts, cables, filters, outdoor shelter, etc. can also be shared.

A site support cabinet (SSC) which includes typically a number of rectifiers, DC distribution, and battery backup, etc could also be shared. Please note however that Nortel Node Bs, which come with an integrated site support solution from day one, do not require a SSC, thereby providing an associated footprint advantage.

Figure 6 illustrates the elements being shared in this model.
In the site sharing model a common site is acquired for the purpose of housing the operator’s individual Node B along with the use of common antennas and feeders, masts, and cables. Transmission equipment can be shared in some cases.

The main savings of this model are:

- **Capital Savings**: Shared costs of site acquisition, preparation, civil works and installation, power supply, and in some cases antennas and feeders.
- **Operational Savings**: Long term lease and maintenance costs of the sites, and transmission costs.
- **Other benefits** include reduced environmental impact, and no significant changes required in regulatory rules or license conditions.

Nortel has performed a sample business case study to quantify the potential site sharing CapEx and OpEx savings over a ten year period compared to a stand alone network build (i.e. no cooperation between 3G license holders).

The analysis was made with the following assumptions:

- A ten-year period was chosen for our analysis.
- The number of sites between the stand-alone model and the sharing model were equal.
- 60% of the sites were reused from the existing 2G network.
- Geographical coverage was considered.
- Two 3G license holders with 10 MHz each sharing sites.
- OpEx did not include marketing and handset costs.

Table 2 summarizes the results of the analysis:

<table>
<thead>
<tr>
<th>Investment Category</th>
<th>Savings Compared to Stand Alone Network Build (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpEx</td>
<td>20 – 30%</td>
</tr>
<tr>
<td>CapEx (non-3G related)</td>
<td>10 – 15%</td>
</tr>
<tr>
<td>CapEx (3G related)</td>
<td>-</td>
</tr>
</tbody>
</table>

OpEx savings are mainly derived through sharing of site lease costs between the two 3G license holders. CapEx savings are purely non-3G specific, such as civil works (site construction and site shelters), turnkey services (installation, site acquisition, site surveys) and power supply. There are no specific 3G related CapEx savings because each of the operators will have separate access networks and core networks in this model.

The site sharing model guarantees the separation of the operator’s networks and therefore the full differentiation and complete control of spectrum for each operator. Hence, there are no regulatory obstacles in most countries. Additionally, site sharing can lower the risk of site acquisition for both operators and hereby improve time-to-revenue for both parties.
Pros of Site Sharing

- Very important cost reductions in CapEx & OpEx
- Improved Time To Revenue
- Lowered risk of site acquisition
- Full differentiation and complete control of spectrum
- No regulatory obstacles in most countries
- Easy migration to other shared solutions in network maturity
- Environmental benefits

Cons of Site Sharing

- Available free space in existing sites
- Similar cell planning might be required
- Need for coordination and negotiation during radio planning, rollout and OAM
- No differentiation through radio coverage if antennas are shared

Table 3: Pros/Cons of Site Sharing

4.2.2 NODE B SHARING

In the Node B sharing model, two logically distinct Node Bs share one physical unit. The RNC and Core Network are not shared in this model, so that each operator can maintain control of their equipment and spectrum use. The separation of the Core Networks also allows each operator to offer differentiated services to their subscribers.

![NodeB Sharing Model]

Figure 7: NodeB Sharing Model

The potential of the Node B sharing model for savings in CapEx and OpEx are incremental to the site sharing or SSC sharing model. The combination of two logical Node Bs into one physical
Node B leads to the highest footprint reduction, but it also requires the same Node B supplier and will thereby limit the choice for partnerships with other operators.

Node B sharing will increase the complexity of the operational model for operators. Future hardware upgrades to add capacity or functionality may be difficult to negotiate, as the requirements of the operators may differ. The maintenance of common Node B elements like batteries or power supply needs to be negotiated. In cases where the partnership between the operators is terminated, it will be a complicated task to split the Node Bs into two physical Node Bs.

Node B sharing is the most complex technical solution, and it is based on the most complex business and operations models. Although the reduction of required footprint is an important benefit, the business case will not show significant improvements compared to the site sharing model.

<table>
<thead>
<tr>
<th>Pros of Node B Sharing</th>
<th>Cons of Node B Sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Limited CapEx savings over Site/SSC Sharing</td>
<td>• Regulatory approval needed</td>
</tr>
<tr>
<td>• OpEx savings from shared Installation &amp; Commissioning, radio optimization, and management costs</td>
<td>• Complex Business Model</td>
</tr>
<tr>
<td>• Different Radio Resource Management strategies can be applied</td>
<td>• Complex Operational Model</td>
</tr>
<tr>
<td>• Footprint reduction</td>
<td>• No significant cost savings over individual Node Bs for the same capacity</td>
</tr>
<tr>
<td></td>
<td>• Long term commitment between operators</td>
</tr>
<tr>
<td></td>
<td>• Same Node B supplier required</td>
</tr>
<tr>
<td></td>
<td>• Limited capacity</td>
</tr>
<tr>
<td></td>
<td>• No clear Exit strategy</td>
</tr>
</tbody>
</table>

Table 4: Pros/Cons of NodeB Sharing

**4.2.3 RAN SHARING**

RAN sharing involves sharing all the Radio access network elements including the NodeB, the RNC, the SAS (if any), and all the transmission in between. Different variations are then possible and are presented hereafter.

**4.2.3.1 COMMON GATEWAY (CGW)**

CGW is basically a RAN Sharing model where two license holders build a common radio access network infrastructure and use a common Gateway to access their own core network. They can incrementally combine their respective allocated spectrum such that their subscribers have access to the entire pool. For example, two 10 MHz UMTS license holders can build one common access network by pooling their spectrum. Typically they would deploy an initial network with a block of 5 MHz and gradually use their pooled 20 MHz as required by growth. (See figure 3.)
This model will require regulatory intervention in many of the countries that have allocated spectrum, and perhaps should be considered by regulators as a potential option in countries, which are still formulating license rules and conditions.

Although this model requires a strategic partnership between two 3G license holders and most likely will require regulatory approval, there are significant savings in CapEx and OpEx.

The main savings of this model are:

- **Capital Savings**: Shared costs of site acquisition, preparation of civil works, antennas, feeders, installation, and power supply, and UMTS specific equipment such as RNC and Node Bs.
- **Operational Savings**: Long term lease and maintenance costs of the sites and the network.
- **Other benefits** include the reduction of environmental impact.

Once again, Nortel has performed a sample business case study to quantify the potential CapEx and OpEx savings over a ten year period of access network infrastructure sharing compared to a stand alone network build (i.e., no co-operation between 3G license holders).

The analysis was made with the following assumptions:

- A ten year period was chosen for our analysis
- The number of sites between the stand alone model and the sharing model were equal
- 60% of the sites were reused from the 2G network
- National coverage considered
• Assumes two 3G license holders with 10 MHz each sharing sites
• Spectrum pooling

The following table summarizes the results:

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<td>25 – 30%</td>
</tr>
<tr>
<td>CapEx (3G related)</td>
<td>5 – 10%</td>
</tr>
</tbody>
</table>

Table 5: RAN Sharing Savings

Significant OpEx savings are derived through reduced cost of maintaining and managing one access network. Non-3G CapEx savings were achieved in areas such as civil works (e.g. site construction and site shelters), turnkey services (e.g. antennas, feeders, installation, site acquisition, site surveys, and power supply) and transmission equipment. 3G specific CapEx savings can be derived through common Node B and RNC equipment and reduction on the installation services for this common equipment. However, the Node B and RNC configurations in a shared model will be configured to deal with higher capacity elements from launch.

4.2.3.2 3GPP RELEASE 6 NETWORK SHARING

3GPP Release 6 has specified a Network Sharing architecture (ref: 23.251), which allows a singular physical UTRAN deployment to be shared between multiple CN operators, each with their own separate CN infrastructure deployments. Two architectural variations of Network Sharing are defined:

• **MOCN**: Multiple Operator Core Network
• **GWCN**: Gateway Core Network

This architecture applies to UTRAN only (i.e. not GERAN). While Release 6 UE devices are required to fully exploit this Release 6 network capability, pre-Release 6 UEs are also supported by this architecture.

4.2.3.2.1 MOCN

MOCN allows a single UTRAN to be directly connected to up to 5 separate CN operators, thereby offering the opportunity for a new CN Operator to avoid RAN deployment. A separate Iu interface (PS and CS) is deployed for each CN operator. This is shown in Figure.
MOCN ensures that call originations for subscribers for a given operator will be routed to the CN associated with that operator.

The UTRAN may be owned by one of the CN operators, or jointly owned.

In terms of business case, this solution is even more appealing than the CGW model, as no Common Gateway (MSC / SGSN) is required.

4.2.3.2.2 GWCN

GWCN also allows a single UTRAN to be used by multiple operators, as shown in Figure 0. However, in this case a common point of connection to the CN is used, which provides logical separate internally, and routing to the appropriate operator network elements.
This model provides savings which are similar in nature to the CGW model. However, contrary to CGW which can interwork with existing core networks, this model has an impact on the core network elements which must support some Release 6 functionality.

### 4.2.3.3 UTRAN SHARING

UTRAN sharing can be defined as a solution where two operators build one common radio access network without pooling their spectrum. This model is less critical from the regulator’s view. Technically, the complete separation of the spectrum is possible and allows hereby a wider differentiation, and therefore an additional opportunity for competition between the operators.

Frequencies are separated, each carrying a different MNC (Mobile Network Code). Therefore the mobile camps on the appropriate cell and displays the corresponding operator’s logo. This solution also allows the possible control of handovers to cells of the same operator (both 3G and 2G). Additionally, the RNC shall support multiple Iu interfaces. The routing to the proper MSC/SGSN shall be based on the cell (and therefore PLMN) in which the mobile involved is currently camping. No changes to the Release 99 specifications are required.

The RNC shall enable service differentiation by offering Radio Resource Management (RRM) or Quality of Services (QoS) functionalities, which can be optimized at the cell level, and are therefore specific to each operator. This is a particularly sensitive question for regulators who have allocated licenses to ensure free and fair competition. In any case, Nortel core network solution allows full differentiation through Applications and Services.
The potential OpEx savings of up to 40% over 10 years are attractive for operators. This is especially the case in rural areas, where UTRAN sharing will help operators to meet coverage obligations much faster, and with fewer expenses than other models.

<table>
<thead>
<tr>
<th>Pros of UTRAN Sharing</th>
<th>Cons of UTRAN Sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Important Savings in OpEx and CapEx</td>
<td>• Regulatory approval needed</td>
</tr>
<tr>
<td>• Trunking efficiency as all resources are pooled</td>
<td>High level integration to plan, manage and engineer the network,</td>
</tr>
<tr>
<td>• Investment focused on applications, services, and marketing</td>
<td>or a 3rd party</td>
</tr>
<tr>
<td>• Easy migration to other shared solutions in network maturity</td>
<td>Reduced chance to differentiate bearer services &amp; RRM/QoS</td>
</tr>
<tr>
<td>• Maximized solution for an operator shared model</td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Pros/Cons of UTRAN Sharing
5 CONCLUSION

3G operators are exploring network infrastructure sharing solutions in order to reduce the amount of upfront investment in building networks. Sharing network infrastructure will enable faster time-to-revenue, decrease the overall capital and operational expenditures. In addition, there are environmental benefits by reducing the number of radio sites required to deliver service.

The focus and the value of 3G networks is going to shift away from providing coverage to delivering innovative applications and services with quality, reliability, and ease of use. This fundamental shift will imply that differentiation and competition will be achieved through the core network and offering applications and services. Therefore, the shared infrastructure models highlighted in this paper will not hinder competition but rather enable operators to establish independent core networks so that innovative applications can be independently offered such that free and fair competition can prosper.

Nortel supports network infrastructure sharing and is enabling solutions to ensure operators can derive the obvious economic benefits of shared network infrastructure deployment. Our wide range of shared network infrastructure solutions will improve savings while providing differentiation to the partnering operators.

Site sharing will yield the best financial outcome in near to medium term with no major impact to network launches and without jeopardizing rollout schedules. Nortel believes that the introduction of shared Node B solutions would complicate network launches without bringing significant cost advantages. The near future will be dominated by site sharing, commercial network launches, full-scale integration and RF optimization in urban areas. After this phase, suburban and rural deployments are expected, where RAN sharing can be deployed after sufficient understanding of the regulatory climate.

Nortel is looking forward to enabling long term partnerships for shared network infrastructure between incumbent operators, incumbent operators and Greenfield operators and between the operators and their supplier.

Nortel strongly endorses any efforts to enable operators to improve the 3G business case by sharing network infrastructure. Nortel believes that sharing network infrastructure benefits everyone in the industry. Rapid deployment of 3G networks and accelerated launch of applications and services implies rapid take up and faster subscriber penetration.

The Nortel family of Base Stations (BTS) is capable of supporting 20 MHz in a single cabinet without requiring additional support equipment. This will enable two 10 MHz license holders to deploy service with minimum footprint. The advantages of this are reduced site construction and acquisition costs.

Nortel has also undertaken business planning activities to enable operators to quantify savings and to identify technical and business strategies to ensure infrastructure sharing can be successfully deployed.
6 ABBREVIATIONS

2G  2nd Generation mobile telecommunications system
3G  3rd Generation mobile telecommunications system
BTS Base Transceiver Station
CapEx Capital Expenditures
CCM Core Controller Module
CEM Channel Element Module
CN Core Network
DACS Direct Ambient Cooling System
GPRS General Packet Radio Service
GSM Global System for Mobile Communication
GWCN Gateway Core Network
IP Internet Protocol
MNC Mobile Network Code
MOCN Multi-Operator Core Network
MSC Mobile Switching Centre
MVNO Mobile Virtual Network Operator
OpEx Operational Expenditures
PA Power Amplifier
PLMN Public Land Mobile Network
QoS Quality of Service
RF Radio Frequency
RNC Radio Network Controller
RRM Radio Resource Management
SGSN Serving GPRS Support Node
SSC Site Support Cabinet
TRM Transmitter Receiver Module
UMTS Universal Mobile Telecommunication System
UTRAN UMTS Terrestrial Radio Access Network
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