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**Durango, USA, 12-16th August 2002**

**S1-021765**  
**Agenda Item: Netshare SWG**

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### **Presentation of Specification to TSG or WG**

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**Presentation to:** TSG SA Meeting #17

**Document for presentation:** TR 22.951, Version 1.0.0

**Presented for:** Information

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**Abstract of document:**

**Changes since last presentation to TSG-SA Meeting #13:**

None

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**Outstanding Issues:**

- **Treatment of international roaming subscriber in sharing network**
  - **Conclusion needs to be drafted**
  - **Requirements on name display when manual network selection is used is for further study**
  - **UE capabilities and requirements will be for further study**
  - **Charging and security requirements to be completed**
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**Contentious Issues:**

None identified.

# 3GPP TR 22.951 V1.0.0 (2002-09)

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*Technical Report*

## **3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service Aspects and Requirements for Network Sharing; (Release 6)**

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## Foreword

This Technical Report has been produced by the 3<sup>rd</sup> Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

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## Introduction

*This clause is optional. If it exists, it is always the second unnumbered clause.*

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# 1 Scope

In the current dynamic market place, as a result of partnerships, acquisitions, creative agreements among operators and so on, the need for tools that enable various degrees of network sharing is becoming more and more important.

When GSM and then UMTS were specified, the possibility of sharing part or all of the network by two or more separated commercial entities was not considered and as a result the standards lack some functionalities that enable the realisation of such commercial agreements.

GSM was designed under the principle "one operator, one radio access network". The GSM network has some possibilities of infrastructure sharing, but it does not support true radio access network sharing. The initial design of 3GPP system has followed the same principle.

This technical report is aimed to capture the service and user requirements that must be fulfilled by the 3GPP system in order to enable network sharing. Network sharing includes various scenarios e.g. common radio access network connected to multiple core networks or multiple radio access networks sharing one core network.

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# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TR 21 912 (V3.1.0): "Example 2, using fixed text".

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# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

**Core Network Operator:** Operator that offers core network services.

**Iu-flex:** Routing functionality for intra domain connection of RAN nodes to multiple CN nodes.

**Radio Access Network Operator:** Operator that offers radio access to one or more core network operators.

**RAN sharing:** Two or more CN operators share the same RAN, i.e. a RAN node (RNC or BSC) is connected to multiple CN nodes (SGSNs and MSC/VLRs) belonging to different CN operators.

**Roaming:** The ability for a user to function in a serving network different from the home network. The serving network could be a shared network operated by two or more network operator.

**Shared Network:** When two or more network operator sharing network elements.

## 3.2 Symbols

None

### 3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

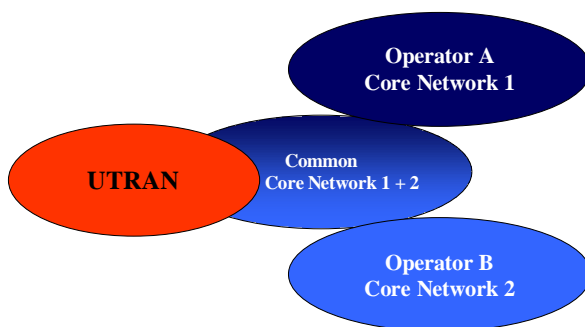
*Abbreviation format*

## 4 General Aspects

[Editor's note: This chapter gives an overview including existing requirements]

## 5 Network Sharing Scenarios

Sharing networks and network infrastructure has become a very important part of 3GPP systems. There are many network-sharing scenarios possible depending on different operator strategies but also on rules and legislation in different countries. 3GPP systems are originally not fully designed for network sharing between different operators however some limited support exists in the 3GPP Release 99. The equivalent PLMN feature in Release 99 allows operators to share a common UTRAN, with certain parts of the core networks also shared between the operators, see Figure 1.



**Figure 1: Two operators sharing the same UTRAN. To make this work, parts of the core network need to be shared as well.**

Important to note here is that this network-sharing scenario allows operators without a UMTS license to share the network and supply its customers with 3G services. For example, a 2G operator may supply its subscribers with 3G services using another operator's allocated spectrum. A geographically split network, i.e. a scenario in which cooperating operators cover different parts of a country, is also possible in Release 99. One operator's core network may also be connected to several UTRANs, see Figure 1.

[Editor's note: clarify the difference between the support of network sharing aspects in the R99/R4 compared to proposed the future network sharing supports]

Different kinds of evolution paths are essential for shared networks. For example, it is not only the sharing solution at a certain time that is important, but also how it is possible for the sharing partners to evolve either to a more dedicated network or to a more joint network. That is, the set of infrastructure sharing solutions and scenarios that is discussed in the industry cover alternatives that together include:

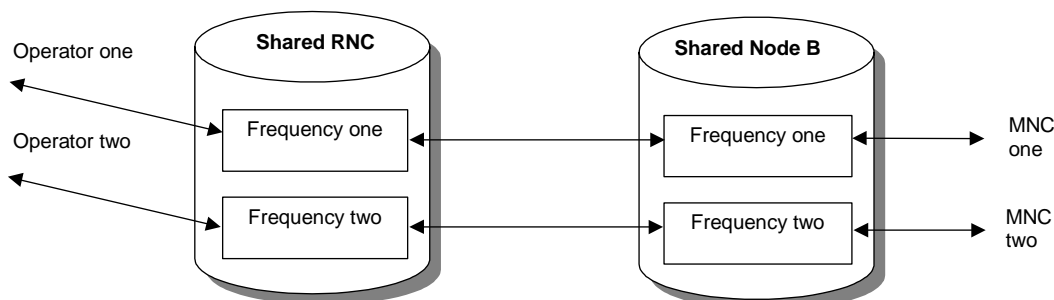
- solution alternatives targeting at dedicated networks in the near future,
- solutions for infrastructure sharing not targeting at immediate exit, but at exit when for example the network capacity demand so requires,
- infrastructure sharing targeting at long term sharing, which for example is the case when one of the operators lacks a frequency license.



Although these network-sharing scenarios are possible in Release 99 of 3GPP systems, the solutions are far from optimised. Identifying, changing, and adding appropriate functionality in the network will definitely lead to a better shared-network operation.

## 5.1 Scenario1: Multiple core networks sharing common radio access network in R99

For operators that have multiple frequency allocations it is possible to share the RAN elements, but *not* to share the radio frequencies. In this case the operators connect directly to their own dedicated carrier layer in the shared RNC in the shared RAN. This solution is possible with 3GPP Release 99 and is illustrated below in Figure 2 for the case when two operators have one license each.



**Figure 2: The figure illustrates how it is possible to within the 3GPP Release 99 framework have dedicated carrier layers in the RAN for multiple operator. The operators transmit their own mobile network code (MNC) on their dedicated carrier**

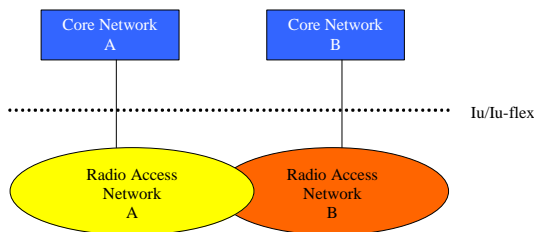
### 5.1.1 Limitations

## 5.2 Scenario 2: Geographically split networks sharing

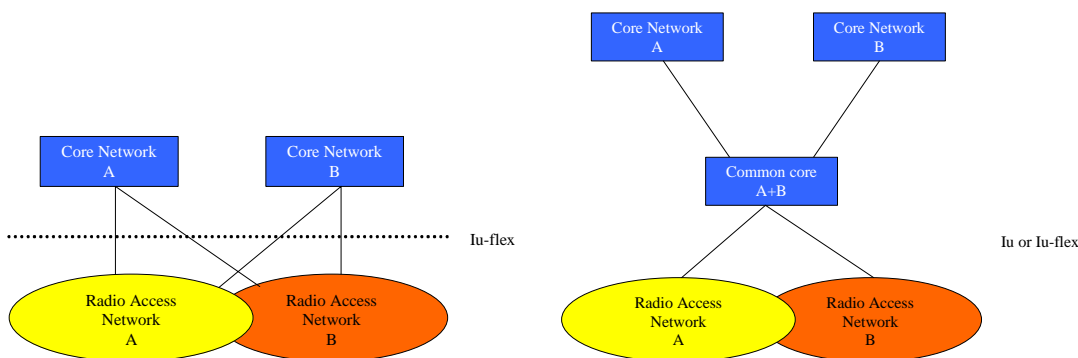
In this scenario, two (or more) operators with individual 3G licenses will cover different parts of a country but together provide coverage of the entire country.

This scenario can be divided into following cases:

- 1) When two (or more operators) employ national roaming for the users, which implies that only one core network will be associated with each radio access network. Care is obviously needed when coverage regions overlap, which makes this a valid shared-networks scenario. This case is shown in Figure 3.
- 2) The operators can have their individual core networks connected to both radio access networks throughout the entire coverage area, but utilizing the different operator's allocated spectrum in different parts of the coverage area. The connection of the core networks to the radio access networks can either be done utilizing Iu-flex or by sharing parts of the core network, e.g. SGSNs and/or MSCs. The work on shared networks in Rel-6 shall not make any of these possibilities mandatory – it shall be a choice for the operator to make based on, e.g. cost and necessity. It shall, however, be possible to introduce Iu-flex functionality between the common core network parts and the radio access network for purely load-sharing purposes.



**Figure 3: Geographically split network using national roaming between operators.**



**Figure 4: Geographically split shared-networks scenarios for Iu-flex and non-Iu-flex solutions**

The national roaming scenario and the non-Iu flex scenario in Figure 4 can be deployed already today using R99 functionality and are therefore important in the future work of 3GPP. The Iu-flex scenario in Figure 4 is an obvious way of evolving the non-Iu-flex scenario in case the operators wish to have completely separate core networks in the future. It also represent the evolution of the national roaming scenario if the operators decide they want more control of its own users and services in the shared network.

In areas where more than one of the operators provide coverage, users shall only be allowed to use the radio access network provided by their home operator.

### 5.3 Scenario 3: Common Network Sharing

In this scenario, one operator will deploy coverage in a specific geographical area, and other operators will be allowed to use this coverage for their subscribers. Outside this geographical area, coverage is provided by each of the operators.

For example, in the case of two operators, a third-party could provide UTRAN coverage to operators A and B' subscribers in areas with high population density. In less dense areas, GERAN coverage is provided by operator A and operator B and in these areas the subscribers shall connect to the access network of their operator.

### 5.4 Scenario 4: Common spectrum network sharing

Common spectrum network sharing is applicable when

- one operator has a 3G license and shares the allocated spectrum with other operators that do not have 3G licenses of their own.
- a number of operators decide to pool their allocated spectrums and share the total spectrum (operators without allocated spectrum may also share this pooled spectrum).

The scenario can be realized as follows.

1. Using Iu-flex results in a “clean” split between the core networks and the radio access network(s), see case 1 in Figure 5 below. This thus requires Rel-5 functionality.
2. Parts of the core networks can be shared and Iu-flex functionality is not needed, see case 2 in Figure 5 below.

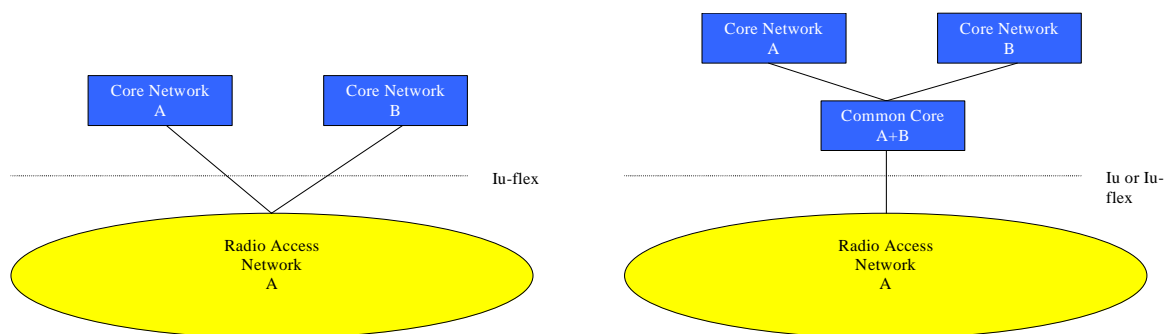


Figure 5: Two different cases of common spectrum network sharing

## 5.5 Scenario 5: Multiple radio access networks sharing common core network

[Editor's note: TBD]

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# 6 Network Identities and User Classification

[Editor's note: Handling of selection of CN nodes in RAN and in CN based on IMSI and roaming agreements]

To fully support for example handover, service differentiation and access rights in shared networks it is occasionally necessary to identify to which operator that a user belongs to and possibly group the users according to this information. To avoid complicated operation and maintenance procedures, such user classification should be general for all the functions in the shared network that needs information about the user identity.

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# 7 User Requirements

Network sharing is an agreement between network operators and shall be transparent to the user.

## 7.1 Network selection

When network sharing exists between different operators and a user roams into the shared network it shall be possible for that user to register with an operator (among the network sharing partners) that the user has subscription with or an operator (among the network sharing partners) that the user's home operator has roaming agreement with even if the operator is not offering radio coverage.

This network selection can either be done automatically by the UE or manually by the user.

[Editor's note: The case of subscribers whose home PLMN does not have roaming agreements with all the network sharing partners is covered by the above text but needs further study]

## 7.2 Network name display

The terminal shall always display the name of the operator the user has registered with.

[Editor's note: requirement on manual network selection by the user is FFS]

## 7.3 UE requirements

Shall support legacy (pre-Rel-6) UEs. This requirement is important since a Rel-6 network sharing solution may imply changes in the UEs.

[Editor's note: These capabilities and requirements will be identified at the later stage]

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# 8 Network requirements

The service capabilities and requirements should not be restricted by network sharing scenarios.

It shall be possible for a network operator to differentiate its service offering from other network operators within shared network.

---

# 9 Mobility Requirements

## 9.1 Service continuity

The mobility in a shared network, both when controlled by the UE and when controlled by the network shall not cause any undue interruption of service.

It shall be possible for a subscriber to roam between the different parts of a shared network without requiring the user intervention. The user experience while roaming in a shared network shall be no worse than the user experiences in a non-shared network.

NOTE: in some instances the user intervention may be required, for example it maybe required in cases where the change to a different part of the shared network causes a change in the service tariff.

## 9.2 Handover

Seamless handover shall be supported between a shared network and a non-shared network. The user should be able to receive the same service level during and after a handover between the networks.

The network shall be able to access the relevant subscriber information in order to determine the appropriate candidate for handover. Examples of information that may be required in order to take the decision on the candidate could include (non exhaustive list):

- type of subscription (e.g. prepay / postpay)
- home network of the subscriber (for roaming subscribers)
- service(s) to be handed over
- subscribed quality of service

## 9.3 Roaming

When the user is registered on a shared network, the control of the PLMN and radio access technology (e.g. UTRA, GERAN) employed within that shared network shall be under the sole control of the network operator. This shall not imply any limitation on the manual or automatic selection of a PLMN that does not belong to the shared network where the user is registered.

In case the mobility in the shared network is controlled by the UE (e.g. cell reselection) the operator shall be able to set parameters, other than radio parameters that determine the most appropriate candidate. Examples of these parameters are: subscription information, requested service, network load and so on.

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## 10 Security Requirements

The service capabilities and requirements should not be restricted by network sharing scenarios.

It shall be possible for a network operator to differentiate its service offering from other network operators within shared network.

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## 11 Charging Requirements

[Editor's note: It shall be possible to charge the user for the use of his resources of the shared network.]

Charging solutions shall support the shared network architecture so that both end users and network sharing partners can be correctly charged for their usage of the shared network.

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## 12 Conclusions

## Annex A (Informative): Examples of network sharing realisations

In this annex some examples of how network sharing can be realised in real situations is described. Often the realisation of a shared network will encompass more than one scenario described in section 5. These examples aim to demonstrate how the requirements identified in this technical report are applied.

### A.1 Advanced Geographical split with seamless national roaming

Operators A and B, both licensed to operate a GSM network and a 3G network have agreed to share the 3G portion of the radio access network in some areas of the country where the traffic is expected to be low (Low Traffic Areas, or LTA) while building separate 3G networks in the areas with higher traffic density (High Traffic Areas or HTA). The LTA is split in two parts, one built by Operator A, the other by Operator B.

Note that a HTA may correspond to a subset of a Location Area (e.g. motorway, railway, shopping centre, train station...)

Operators A and B will not share their respective GSM networks anywhere in the country and will not share the 3G network in the HTA, but want to achieve seamless service continuity for subscribers moving among permitted networks.

#### Mobility for a subscriber of operator A

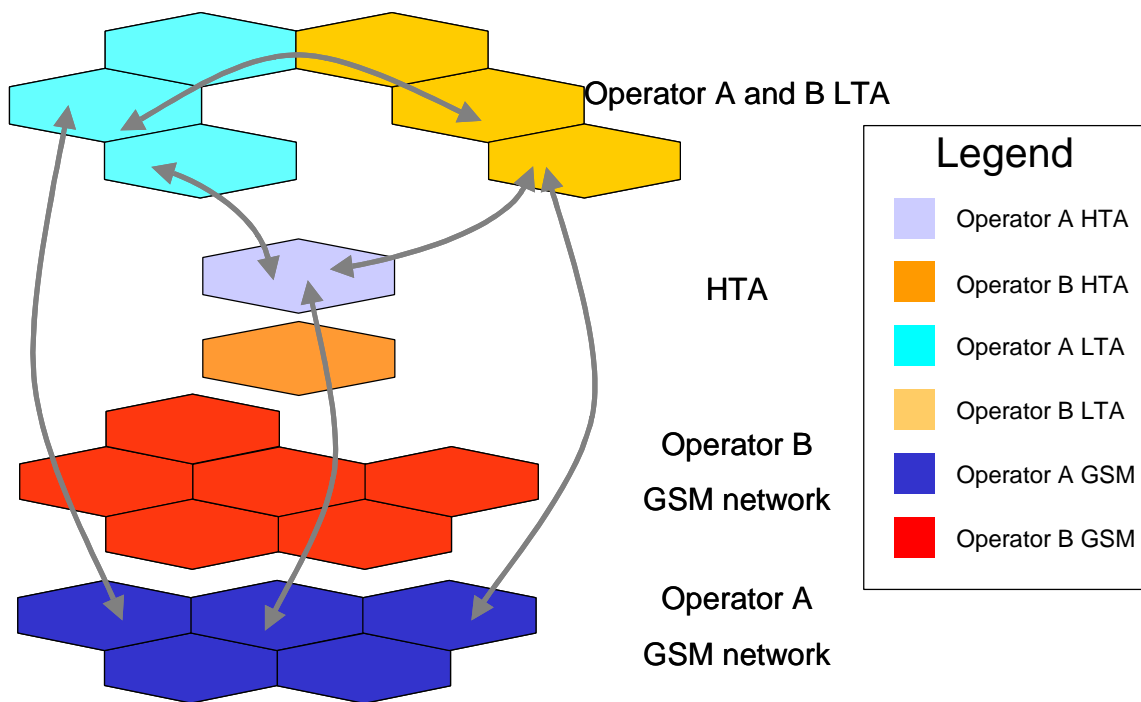


Figure A.1: mobility for a subscriber of operator A

Operator A and B aim to offer full mobility in the shared 3G network without loss of active services (both Circuit and Packet switched) when crossing the border between areas where coverage is provided by the other operator.

When the users exit the 3G coverage area, their UE are transferred to the 2G network of the home operator. Similarly, when the user enters an HTA coming from the home GSM network or from either of the LTA, the UE is transferred to the 3G network of the home operator.

Moreover, when the subscriber registered in the GSM network moves into the HTA it should be possible to move as soon as possible to the 3G network of the home PLMN. More generally the subscriber should move to a permitted 3G network as soon as it becomes available.

The network name displayed on the UE is that of the home operator regardless of the provider of the 3G coverage.

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## A.2 Requirements

The following requirements can be identified by analysing the above architecture and mobility rules for network sharing

- Both operators will want to be able to apply different mobility rules according to the identity of the subscriber (IMSI). Examples of subscribers categories are:
  - subscribers of operator A
  - subscribers of operator B
  - inbound international roaming subscribers  
The latter category could be further divided in sub-categories
- The differentiated mobility behaviour needs to be supported both for UE controlled mobility (e.g. cell reselection) and for Network controlled mobility (e.g. handover).  
The differentiated mobility behaviour needs to be supported both in the UTRAN and in the GERAN.
- Both operators will want the display of the operator name on the terminal to be independent of the provider of the radio coverage
- Both operators will want the facility to steer the traffic to the preferred network and preferred radio access technology according to the subscriber profile, network status, service used

[Editor's note: this bullet needs further clarification]

- Both operators will want to provide services to their subscribers from their respective core networks
- Both operators will want to have continuity for both Packet Switched and Circuit Switched services used while the subscriber roams from one part of the network to another.

## Annex B (Informative): Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2002-01					<i>First draft S1-020342, creation of version 0.0.0</i>	0.0.0	0.0.0
2002-02	SA1#15	S1-020450, S1-020383			<i>Included network sharing scenarios in chapter 5.</i>	0.0.0	0.1.0
2002-04	SWG meetings	S1-020771			<i>Included “user requirements” for network sharing in chapters 7, 9 and 10.</i>	0.1.0	0.2.0
2002-05	SA1#16	S1-020942			<i>Third draft (new scenario included in section 5). Output from Victoria 13-17 May.</i>	0.2.0	0.3.0
2002-07	SWG meetings	S1-021356, S1-021252, S1-021446			<i>Clarification of scenario 4 in chapter 5. More text added to chapters 8 and 9 due to contributions to TR. An informative annex added in the document.</i>	0.3.1	0.4.0
2002-08	SA1 #17				<i>Definitions to chapter 3.1. Clarifications and refinements of network sharing scenarios 2 and 4. Chapters 7 and 9 updated based on contributions and discussions. Preparation for submission for information to SA.</i>	0.4.0	0.5.0