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Technical Report

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3GPP

Postal address

3GPP support office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet

http://www.3gpp.org

Foreword

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- x the first digit:
  - 1 presented to TSG for information;
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Introduction

Network sharing is emerging as a mechanism for operators to substantially and sustainable improve network costs and to efficiently utilize network capacity. The traditional model of single ownership of all network layers and elements is being challenged and more and more operators are adopting Network sharing as a means of cutting the heavy costs involved in initial roll-out, capital expenses (CapEx) and operating expenses (OpEx).

In general, increasing number of operators are sharing their mobile networks. Main arguments presented are:

- Increased rollout speed
- Quickly expand coverage to meet customer demand for wider coverage
- Sharing low traffic areas gains long term cost advantage
- Sharing high license burdens
- Cost efficiency CAPEX&OPEX
- Joined effort to offer availability of services at more affordable price.

Network Sharing has some major implications on the operations of the Network. Alignment on operational priorities, common network planning/evolution strategy, sharing end user data/subscriber data, sharing performance data, alarms etc in the shared network need to be considered carefully. Privacy, security and competitive information are also important for the operations of a shared network.

1 Scope

The present document is aimed at addressing the operational implications of Network Sharing.

There are a wide variety of deployment scenarios for Network Sharing.
Scenarios identified in TS 23.251 and TR 22.951 are taken into consideration to identify OAM impacts.

TS 23.251 "Network Sharing; Architecture and functional description" Specifies the stage 2 descriptions which are also considered to address OAM aspects.

NGCOR defined RAN sharing requirements are taken into account as input for this study.

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 22.951: "Service aspects and requirements for network sharing".

[3] 3GPP TS 23.251: "Network Sharing; Architecture and functional description".

[4] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

[5] 3GPP TS 32.101: "Telecommunication management; Principles and high level requirements".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1], TR 22.951[2], TS 23.251 [3] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1], TR 22.951 [2], TS 23.251 [3].

Organizational Roles:

Master Operator (MO): In RAN/Core Sharing scenarios, deployment and daily operation of shared network elements are entrusted to a single Actor, called the Master Operator. The Master Operator provides network and OA&M services to other Operators, called Sharing Operators. The Master Operator is the only one to have a direct OA&M connection from his DM to the shared network elements.

Sharing Operator (SO): Sharing Operators (SO) are service providers who share, alongside other Sharing Operators (SO), the network (RAN/Core network) facilities provided by the Master Operator. According to 3GPP TS 36.300[4] up to 6 operators can share a RAN.

NOTE: In a RAN/Core sharing scenario where Operator (service providers) A and B are Sharing Operators, Master Operator represents a role which can be played by either:

- Operator A or Operator B:

in that case, Operator A or Operator B plays both roles, i.e. is the Master Operator and one of the Sharing Operators at the same time,

or

- a joint-venture between Operator A and Operator B,

or

- third-party entity: In this context third party is referring to a wholesale mobile connectivity provider.

In the two latter cases, operators A and B rely on another company to play the role of Master Operator. This company cannot play the role of SO.

Resources in a Shared RAN/Core environment:

Master Operator Network Manager: Network Manager managing the shared RAN/Core.

Master Operator Shared Core DM: Domain Manager managing the S-CORE.

Master Operator Shared Ran DM: Domain Manager managing the S-RAN.

Shared Core: Core Network shared with other Sharing Operators. It may or may not include all core elements. For example the operators may share only the MME while having independent S/P GWs.

Sharing Operator Core DM: A Domain Manager enabling the Sharing Operator to manage its own core network (not shared).

Sharing Operator NM: Network Management System enabling the Sharing Operator to manage its own network and its portion of the shared network.

Sharing Operator RAN DM: A Domain Manager enabling the Sharing Operator to manage its own RAN (not shared).

Shared Ran: A set of Radio Access Network elements shared among Operators.

Sharing Operator CORE DM: A Domain Manager enabling the Sharing Operator to manage its own core network (not shared).

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1], TR 22.951 [2], TS 23.251 [3] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

MDT	Minimization of Drive Test
MO	Master Operator
MO-NM	Master Operator Network Manager
MO–SC-DM	Master Operator Shared Core Domain Manager
MO–SR-DM	Master Operator Shared RAN Domain Manager
NGCOR	Next Generation Converged Operations Requirements
OAM	Operations, Administration, and Maintenance
S-CORE	Shared Core
SO	Sharing Operator
SO-CORE-DM	Sharing Operator CORE Domain Manager
SO-NM	Sharing Operator Network Manager
SO-RAN-DM	Sharing Operator RAN Domain Manager
SON	Self Optimizing Networks
S-RAN	Shared Radio Access Network

4 Operational Scenarios for Network Sharing

Editor's Note: This section identifies the operational problems to be addressed including the impact on each of the OAM domains for network sharing deployment scenarios.

4.1 Scenario 1: Multiple Operators Core Network sharing common radio access network

4.1.1 General Description

The scenario described is for the RAN access Network that is shared by multiple operators with independent core network.

The RAN sharing can potentially be based on several factors like dedicated carriers, geographical area, shared resources, etc.

The chart below shows that a shared RAN network will be composed of not only the RAN nodes that are shared but also RAN nodes that are not shared by the operators.

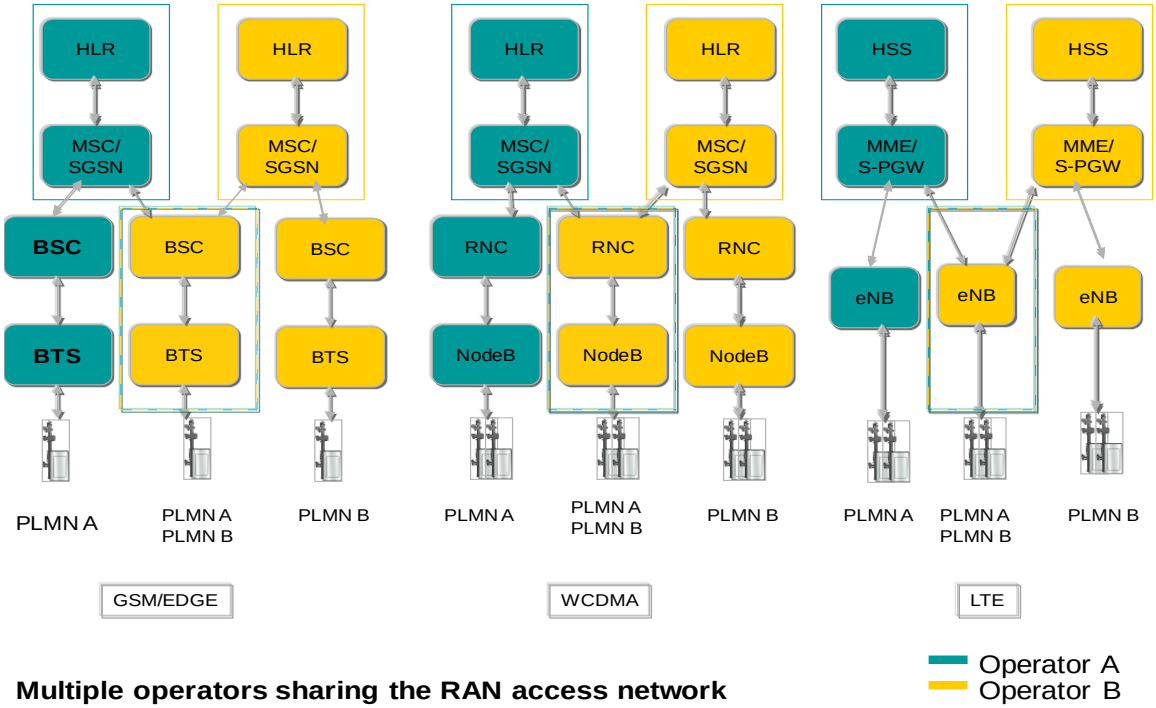

Figure 4.1.1.1

NOTE: An operator can also have multiple PLMNs. This is currently focused on all operations within the same country.

A RAN, even if shared between several operators, will always belong to a given operator. So there will always be a primary PLMN.

In all RAN sharing cases where multiple operators are involved the following impacts need to be analysed:

1. Handling of multiple PLMN IDs with the RAN. The MO's ability to filter/distinguish certain PLMN specific information based on PLMN is important for the operators sharing the RAN.

2. In addition, a single operator may have multiple PLMNs.

3. Ability to define policies that allow OAM to control actions per operator (and/or per PLMN) (example initiation of call trace etc.).

To address the above impact various OAM deployment scenarios for a RAN shared network needs to be analysed.

4.1.2 Use case description

For the RAN sharing scenarios there are several different OAM deployment options and such deployments are analysed below:

4.1.2.1 Scenario 1A: Shared node managed by Master Operator

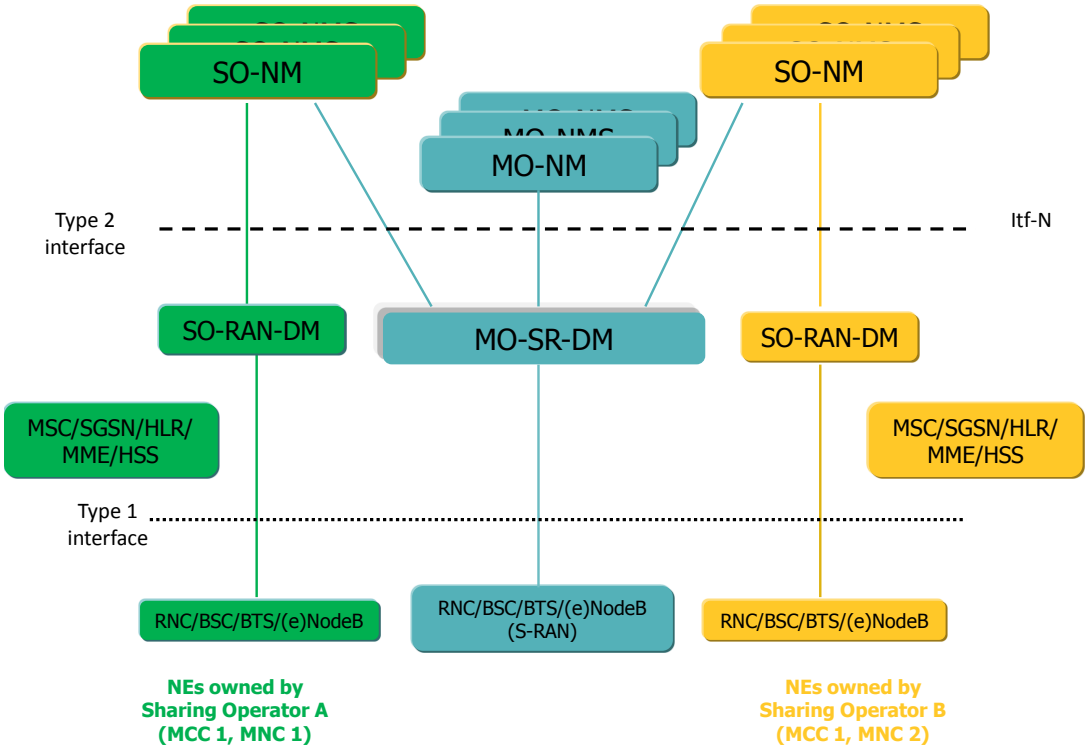

Figure 4.1.2.1.1:Scenario 1A

In this scenario the MO is responsible for managing the S-RAN. Each operator has his own NM.

According to the operators' sharing management agreement, the MO-SR-DM will make available relevant portion (of management data) to individual SO-NM.

This scenario aligns with the scenario defined in NGCOR document, business requirements defined in Reference [3]: Business Scenario 4, Section 3.4.2.

Editors Note: This is not aligned with the 3GPP TS 32.101 [5] reference architecture. There are use cases in the TR that are outside of the reference architecture. Need to determine if the reference architecture needs to be extended.

4.1.2.2 Scenario 1B: S-RAN managed by Master Operator (3GPP defined).

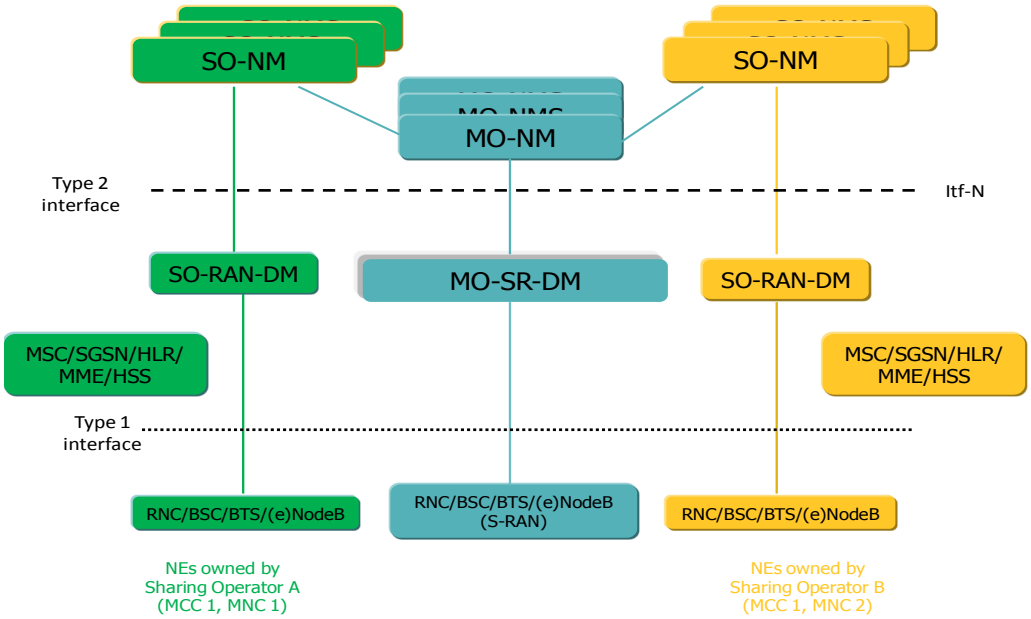

Figure 4.1.2.2.1: Scenario 1B

MO-SR-DM may need to forward management data (including the PLMN identification of the operators sharing the nodes) to the MO- NM. According to the operators' sharing management agreement, the MO-NM will send the relevant portion (of management data) to SO-NM.

This scenario aligns with the scenario defined in NGCOR document, business requirements defined in Reference [3]: Business Scenario 4, Section 3.4.2.

This scenario is compliant with the 3GPP reference management architecture.

4.1.2.3 Scenario 1C: Master Operator – Manages all RAN.

The management architecture of 1C is same as 1A and the RAN sharing management information is exchanged between MO-SR-DM and SO-NM.

A slight variation to scenario 1A can be as stated below. S-RAN is managed by MO which is a third party. In some cases if the operators do not want to deal with the day to day management of the nodes but still want just the high level view their network, the node level management may be out sourced to a different company (managed service provider).

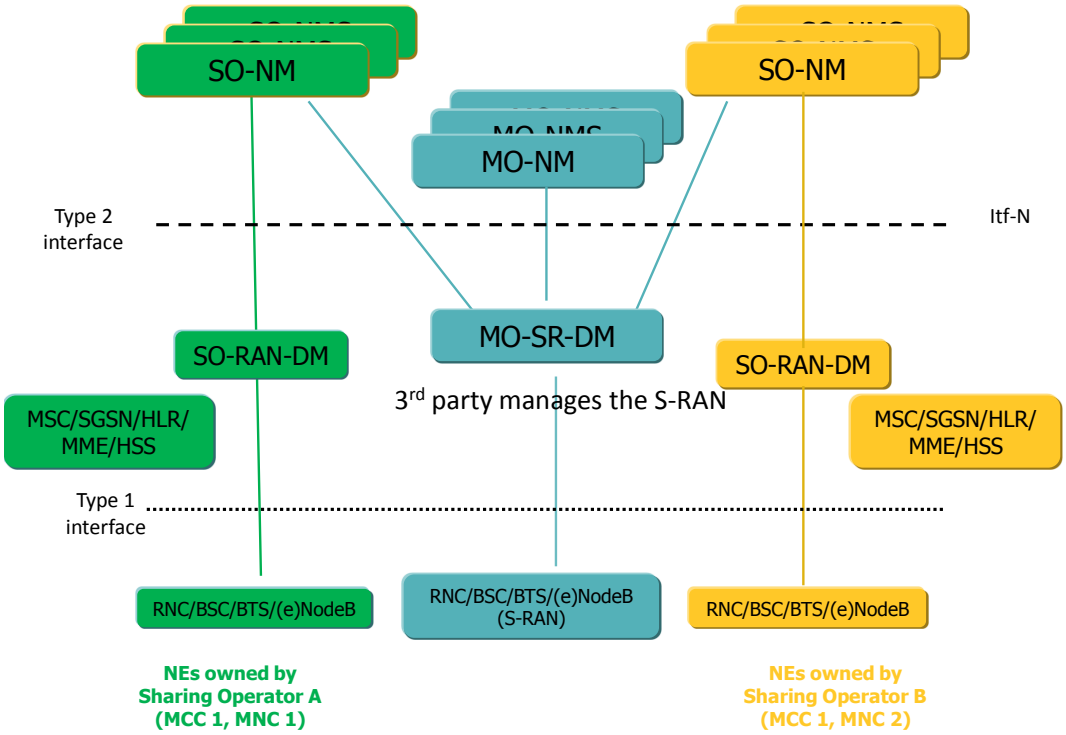

Figure 4.1.2.3.1: Scenario 1C

According to the operators' sharing management agreement, the third party MO will make available relevant portion (of management data) to SO-NM.

Editors Note: This is not aligned with the 3GPP TS 32.101[5] reference architecture.

4.1.2.4 Scenario 1D: Master Operator – Manages all RAN (3GPP defined).

The management architecture of 1D is same as 1B that the RAN sharing management information is exchanged between MO-NM and SO-NM.

A slight variation to scenario 1C can be as stated below. This scenario is compliant with the 3GPP reference architecture. Otherwise there is no difference between 1D and 1C. MO is a third party.

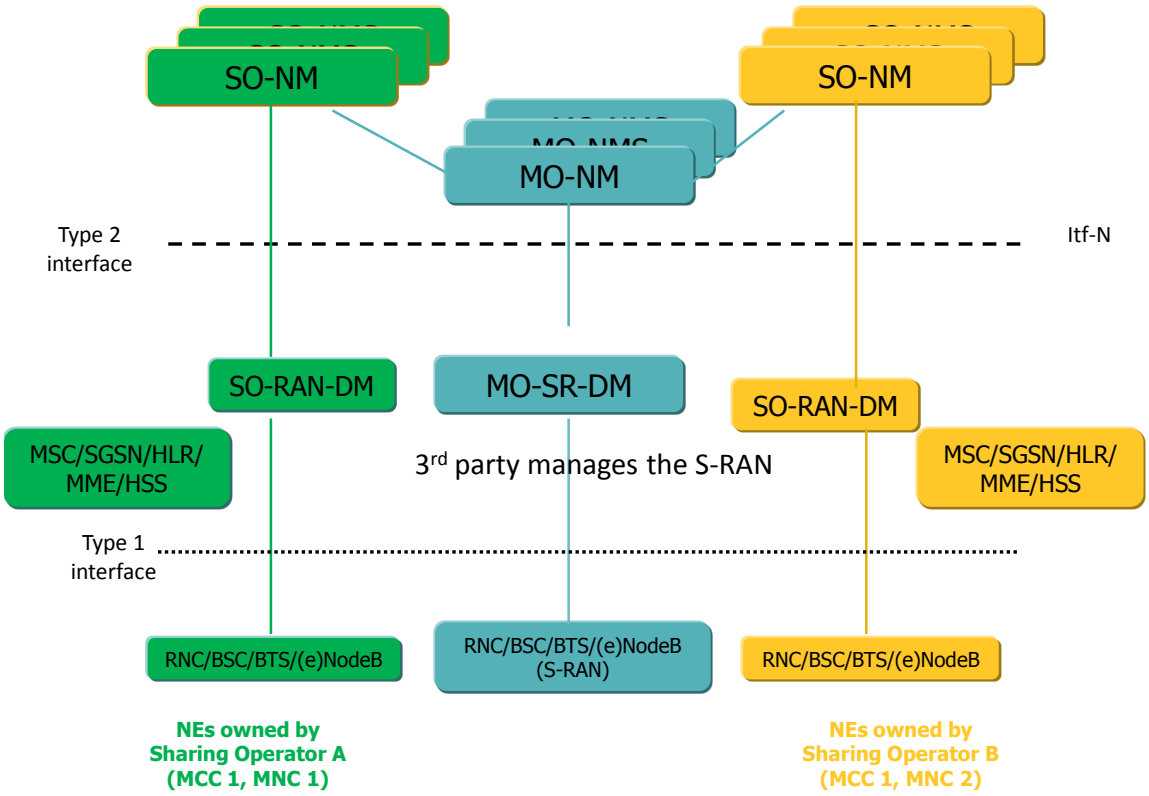

Figure 4.1.2.4.1:Scenario 1D

According to the operators' sharing management agreement, the MO-SR-DM will make available S-RAN datato MO-NM which in turn will provide the relevant portion (of the management data) to SO-NM.

This is a 3GPP defined shared scenario.

4.1.2.5 Scenario 1E: Network sharing between operators who own independent equipment and no DM/NM sharing

The management architecture of 1E is same as 1B that the RAN sharing management information is exchanged between MO-NM and SO-NM.

In this scenario the operator A owns his network completely and Operator B owns his network completely. The Operator A's subscribers with PLMN A can be serviced by Operator B's network as though it is an extension of the Operator A's network. The UE traversing to Operator B's Network will see Operator A's information and will appear to be in the same PLMN.

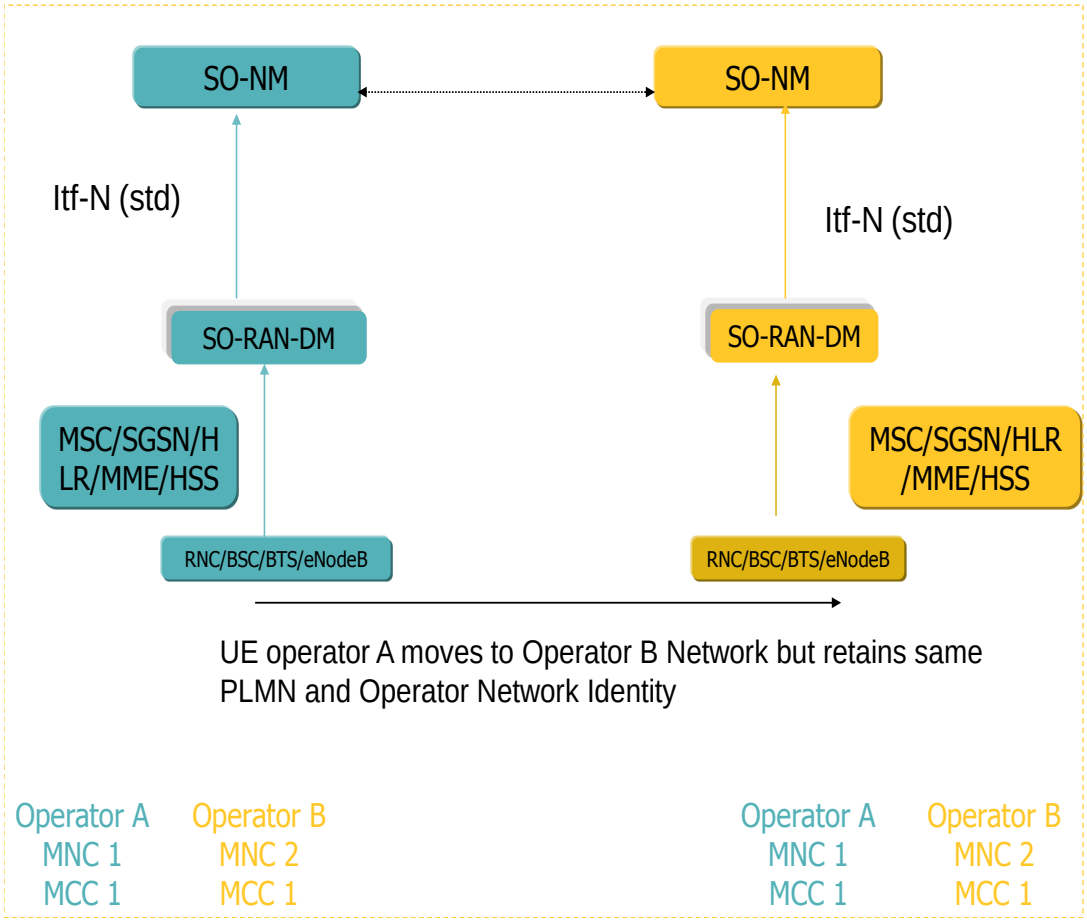

Figure 4.1.2.5.1:Scenario 1E

According to the operators' sharing management agreement, the SO-RAN-DM will make available relevant portion (of management data) to individual operator's SO-NM.

4.1.3 Fault Management impact

Alarms raised by the 3GPP nodes are generally associated with equipment, resources on the node etc and are alarms that all operators sharing the RAN resources would need to know.

However, there can be alarms raised when resources allocated on a PLMN basis or application that is PLMN specific needs attention. In those cases there may be need to filter alarms based on PLMN when delivered to the NM, particularly if the alarms are operator sensitive information.

EXAMPLE: CAC (Call Admission Control) failure alarm.

Several options for addressing the above are explored here.

Option 1: Introduce information in alarm (a new attribute) that identifies the PLMN. The parameter can be optional. This attribute will not be applicable to a large category of the alarms.

Option 2: Introduce the PLMN identification in the additional text or additionalInfo attributes in the alarm. This implies a vendor specific string.

Option 3: Change the NRM to introduce an <<InformationObjectClass>> or <<supportIOC>> for representing the PLMN. The alarm raised that is PLMN specific can be identified by the DN in the alarm. The exact modeling will be explored later.

Option 4: No changes. There is really no need to identify the alarm specific to a PLMN.

Option 5: Add an attribute to each monitored entity to identify the PLMN.

4.1.4 Performance Management impact

There are several categories of counters that characterize QoS and are split per operator. These need to be identified

Editor's Note: Identification of the PM counters which need to be per PLMN is TBD.

Option 1: Introduce the PLMN identification in an additional tag in the 3GPP PM file (a proprietary or standardized extension).

Option 2: Change the NRM to introduce an object class for representing the PLMN. The PM counters can be associated with the PLMN object.

Option 3: No changes needed. There is no need to separate these counter per PLMN.

4.1.5 Configuration Management impact

There will be NRM impacts as a result of supporting network sharing. Section 5 identifies the specifications that may have potential impacts. The exact changes will be identified in the WI phase.

4.1.6 Security Management impact

As a result of network sharing there is need to control access and visibility of certain operations and data. The ability to provide the access control on the NM will be supported by introducing and enhancing the information over Itf-N. Section 5 identifies the specifications that may have potential impacts. The exact changes will be identified in the WI phase.

4.1.7 MDT/Call Trace impact

4.1.7.1 UE Selection in Area based MDT

In area based MDT, whether a UE belonging to participating operator can be selected by other operators ' MDT job depends on the operators RAN sharing agreement.

For example, for scenarios 1A (figure 4.1.7.1), 1B, 1C, 1D and 1E listed in section 4.1.2 whether UE2 can be selected by operator A's MDT job as showing in the following diagram will depend on the network sharing agreement.

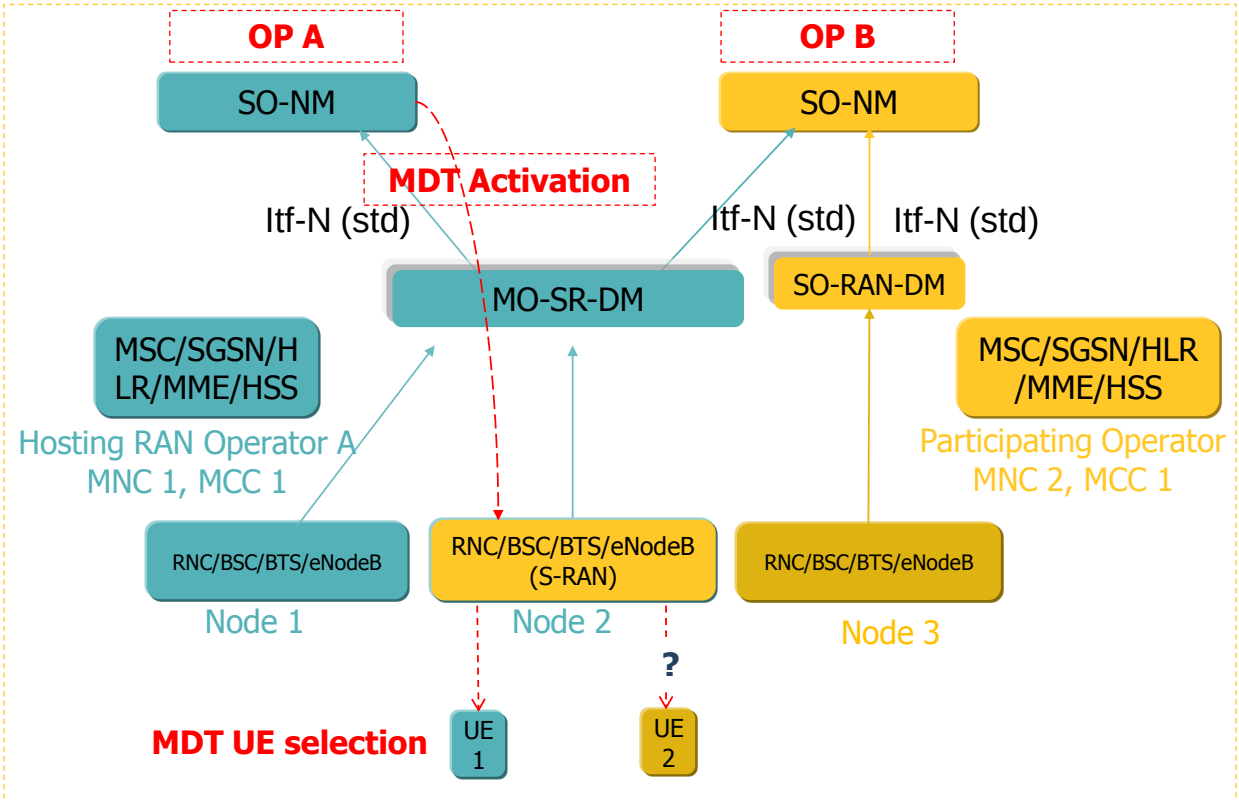

Figure 4.1.7.1

4.1.7.2 UE Selection and Data Retrieval in MDT

4.1.7.2.1 Criteria of analysis

The first and obvious criterion is availability of the user consent. Most of the RAN sharing scenarios listed in the 4.1.2 involve only two operators (operator A and operator B). However, there are certain scenarios where a 3rd operator may be involved – for simplicity, we'll just call it a third party. Here we list various possibilities for user consent availability.

1. User consent possibilities:

   1.1 User has not given his consent to any operators

   1.2 User has given his consent to all operators

   1.3 User has given his consent to operator A only

   1.4 User has given his consent to operator B only

   1.5 User has given his consent to operators A and B only (not to any 3rd parties)

Note that there is no existing solution addressing all these user consent possibilities.

The second criterion that is related to the SA3 requirement about data control "Consent to collect MDT data is given to specific data controllers". The data in MDT is stored at a TCE, so we list various possibilities for TCE ownership and control in a RAN sharing environment. In all these possibilities we assume that the TCE under question is directly "reachable" from the eNB that retrieved the UE data. Multiple "relay" scenarios are possible, but these add complexity and may be interpreted in a way that the first TCE in a "relay" chain has the full control over data and any forwarding decision is outside of MDT scope (e.g. similar to a case where operator "sells" the collected data to a third party). Here we list various possibilities for TCE ownership and control.

2. *TCE possibilities* (assuming that these are all directly reachable from the eNB):

   2.1 Both operators A and B have (and fully control) their own TCEs

2.2 Only operator A has his own TCE and fully controls it

2.3 Only operator B has his own TCE and fully controls it

2.4 Both operators A and B share the same TCE (share control and have access to all data)

2.5 Neither operator A nor B have their own TCEs and use a third party TCE

Note that the TCE possibilities are dependent on the network deployment.

Potentially there are multiple decision points in MDT that may be affected by the RAN sharing. Here we list the two critical ones: UE selection in management based MDT (whether a particular UE may be selected for a particular MDT session) and MDT data retrieval.

3. UE selection time decisions:

   3.1 UE selection for immediate MDT

   3.2 UE selection for logged MDT

The MDT data retrieval decision in immediate MDT cannot be logically separated from the UE selection decision (eNB configures a measurement in UE and receives the UE response in RRC message) therefore we don't list it below.

4. Data retrieval time decisions:

   4.1 Logged MDT data retrieval

4.1.7.2.2 Scenario analysis

In all scenarios documented in section 4.1.2 only Hosting RAN Operator (the operator that manages the shared node) is able to activate a management based MDT session on the Shared RAN Node. Two cases are possible: operator A activates MDT job on its own behalf and operator A activates MDT job on behalf of operator B. The path of activation forwarding may differ case by case (e.g. request of operator B received by SRDM directly from PONM, request of operator B received by SRDM via HRNM, etc.).

The important aspect of UE "belongs" relationship is where user has given his consent.

There is also potential difference between the five scenarios documented in section 4.1.2 in terms of TCE possibilities listed in clause 4.1.7.1.1, but currently it is not documented – therefore it is assumed, that all TCE possibilities are valid in all 5 scenarios.

Table 4.1.7.1.2.a: UE selection by shared Node for immediate MDT on behalf of the operator A

UE selection on behalf of operator A		TCE possibilities				
		2.1	2.2	2.3	2.4	2.5
Consent possibilities	1.1	NO	NO	NO	NO	NO
	1.2	YES	YES	YES	YES	YES
	1.3	YES	YES	NO	NO	NO
	1.4	NO	NO	NO	NO	NO
	1.5	YES	YES	YES	YES	NO

Table 4.1.7.1.2.b: UE selection by shared Node for immediate MDT on behalf of operator B:

UE selection on behalf of operator B		TCE possibilities				
		2.1	2.2	2.3	2.4	2.5
Consent possibilities	1.1	NO	NO	NO	NO	NO
	1.2	YES	YES	YES	YES	YES
	1.3	NO	NO	NO	NO	NO
	1.4	YES	NO	YES	NO	NO
	1.5	YES	YES	YES	YES	NO

The UE selection for logged MDT in general should follow the criteria used in UE selection for immediate MDT, but may potentially be relaxed depending on the area scope used for MDT job. For example, a UE may have the MDT job activated by shared Node and then continue while moving towards a non-shared Node (not shared nodes with potentially different available TCE connections).

In logged MDT data retrieval analysis, the table cells marked "N/A" indicate that this combination is not valid (e.g. if UE has not given consent to any operators there will be no logged MDT session on this UE and no logged data to be retrieved, or if UE has not given consent to a particular operator there will be no logged MDT session on this UE for that particular operator and no logged data to be retrieved, etc...).

Table 4.1.7.1.2.c: Logged MDT data retrieval by shared Node (MDT session "for" operator A)

Logged MDT data retrieval		TCE possibilities				
		2.1	**2.2**	**2.3**	**2.4**	**2.5**
Consent possibilities	1.1	N/A	N/A	N/A	N/A	N/A
	1.2	YES	YES	YES	YES	YES
	1.3	YES	YES	NO	NO	NO
	1.4	N/A	N/A	N/A	N/A	N/A
	1.5	YES	YES	YES	YES	NO

Table 4.1.7.1.2.d: Logged MDT data retrieval by shared Node (MDT session "for" operator B)

Logged MDT data retrieval		TCE possibilities				
		2.1	**2.2**	**2.3**	**2.4**	**2.5**
Consent possibilities	1.1	N/A	N/A	N/A	N/A	N/A
	1.2	YES	YES	YES	YES	YES
	1.3	N/A	N/A	N/A	N/A	N/A
	1.4	YES	NO	YES	NO	NO
	1.5	YES	YES	YES	YES	NO

The UE selection rules outlined in tables 4.1.7.1.2.a and 4.1.7.1.2.b and MDT data retrieval rules outlined in tables 4.1.7.1.2.c and 4.1.7.1.2.d apply to all scenarios listed in clause 4.1.2.

The rules tables 4.1.7.1.2.a and 4.1.7.1.2.b are symmetric – the important fact is on whose behalf the UE selection is performed, not which operator performs the selection.

There is no conceptual difference between scenario 1A (where operator A selects UEs behalf of operator B) and 1E (operator B selects UEs on behalf of operator A).

4.1.7.2.3 Conclusion

The important criteria for UE selection and data retrieval for MDT in RAN sharing environment are user consent availability (and specific operator details of user consent information) and control over the TCE(s) reachable from the shared node.

Different RAN sharing scenarios documented in clause 4.1.2 may potentially imply different TCE connectivity and availability.

UE selection for logged MDT on shared nodes may potentially use more relaxed rules than UE selection for immediate MDT.

4.1.7.3 Rel-11 solution

Background:

In Rel-10 there is a restriction that MDT is only allowed within one PLMN. This triggered SA to send a LS to SA5 saying that all functions should support network sharing. If that could not be fulfilled, it shouldexplicitly be mentioned.

The MDT function should have a basic support the use of shared networks in Rel-11. And as the trace function is used for MDT, all Subscriber and Equipment Trace functions should have the same support for shared network.

In Rel-11 some CRs have been agreed to allow MDT among the operators that are sharing a RAN. However, this has been done without considering the accessibility of MDT data by the different operators.

Conditions:

For the Rel-11 solution, the following conditions apply:

- Only RAN sharing is considered.
- The user consent remains unchanged (i.e. 1 bit).
- SA5 reference model remains unchanged, i.e. scenarios 1B, 1D and 1E.

Solution:

Management Based Activation:

The requirement that MDT should work for shared network is interpreted as any of the operators that are sharing a RAN should be able to access MDT data for its subscribers wherever they are in the shared RAN. That means that even if the RAN is owned by Operator A, the Operator B should be allowed to access MDT data for the shared RAN for its subscribersand vice versa.

Whether or not the Operator B is allowed to start Area Based MDT via a machine – machine interface is out of the scope for Rel-11. Rel-12 should study scenarios 1A and 1C etc. and what deployments of the domain managerfor shared networks should be supported by 3GPP and how these deployments are allowed to interact .

Signalling Based Activation:

As Signalling Based Activation is done in the core network, there is no issue for activation of Trace Sessions or Trace Recording Sessions.

Reporting of recorded data for Management Based Logged MDT and for Signalling Based MDT:

As only RAN sharing is supported. when a signalling based MDT recording is combined with Trace in a core network, all sharing operators should be allowed to start such recording and the recorded data from all parts of the own core network and the shared RAN should be sent to the operator that initiated the recording.
Also for Management Based Logged MDT, the UE can report the log to any eNB/RNC in the shared RAN and in the own RAN (if not the whole RAN is shared), even if they do not have knowledge about the Trace Session.
This means that the TCE IP addresses and the mapping of the TCE addresses should be coordinated between all operators that share a RAN. How that coordination is done is outside the scope of standardisation.

4.1.8 Impact on management of SON and related topics

Impact on SON uses cases as a result of Network Sharing is for futher study.

4.1.9 Architectural impact

There are two RAN sharing alternative management architectures are identified:

1. Management Architecture #1, in which the MO offer management capabilities to SOvia its Shared RAN Domain Manager (MO-SR-DM) as shown in Scenario 1A and 1C.
2. Management Architecture #2, in which the MO offer management capabilities to SOs via its Network Manager (MO-NM) as shown in Scenario 1B, 1D and 1E.

The scenarios 1A and 1C, in which the MO-SR-DMis connected directly to SO-NM are not supported by the existing 3GPP Management Reference Model (cf. [2]). The diagram below describes an extended 3GPP reference management architecture where the MO-SR-DMis connected directly to SO-NM via Type-7 interface.

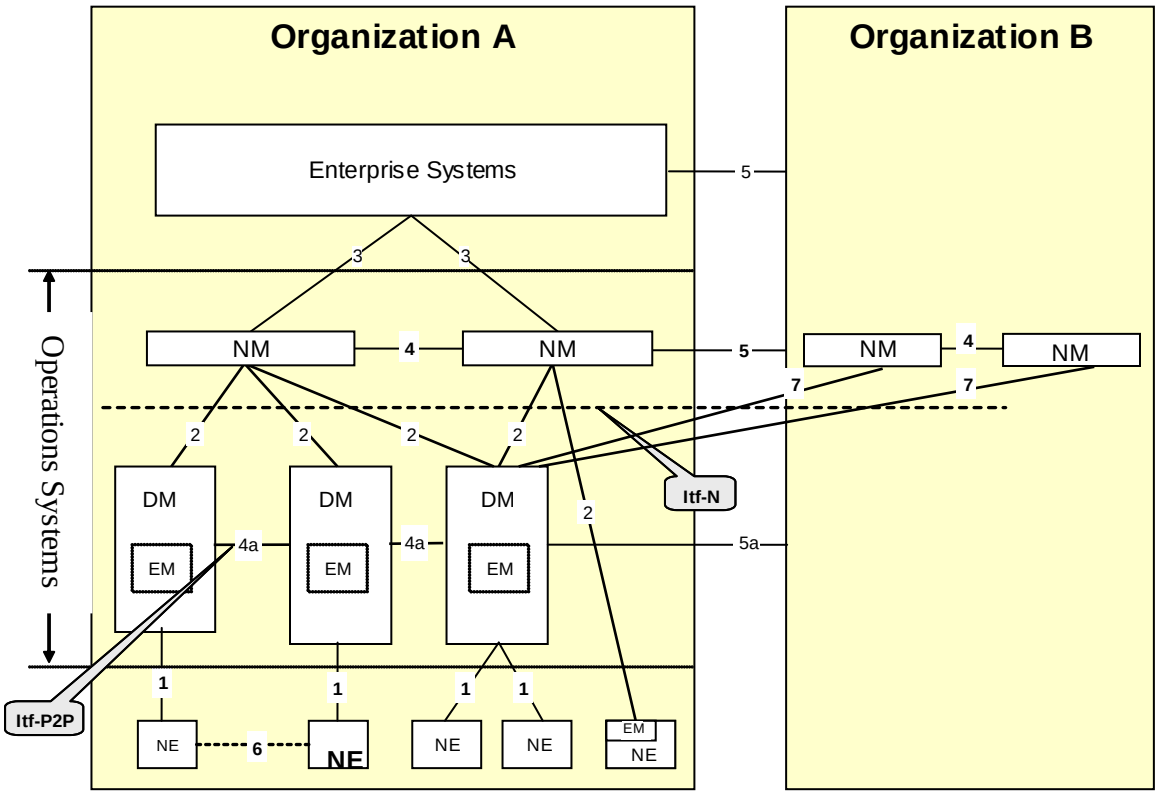

Figure 4.1.9.1

NOTE: The impacts of enabling a MO-SR-DM to be directly connected to SO-NMs need further investigation.

4.1.10 Other Impacts

Void

4.2 Scenario 2: Relay Node (RN) in a RAN sharing scenario

4.2.1 General Description

Even though operators may reach an agreement to share the DeNB in a RAN sharing scenario, it is possible that each operator would want to deploy RNs independently and for the exclusive use of their customers e.g. to address coverage issues raised by a customer. In this scenario it can happen that an operator wants a RN to select a different PLMN on the shared Cell of the DeNB than the primary PLMN of the cell. It should be possible to configure the RN to select the correct PLMN on a shared cell.

4.2.2 Use case description

The following describes this scenario in more details.

RN Pre-configuration (Phase 1)

Consider a scenario where a RN Connects to a RAN shared Cell on say PLMN A in phase 1 to obtain RN pre-configuration information. OAM would like to indicate that RN needs to connect to a PLMN B on shared cell for RN operation e.g. because only CN B has the MME RN or is for exclusive use by the operator B. Figure 1 illustrates the need for the DeNB Cell List information to be updated to include information about the PLMN which RN should connect to.

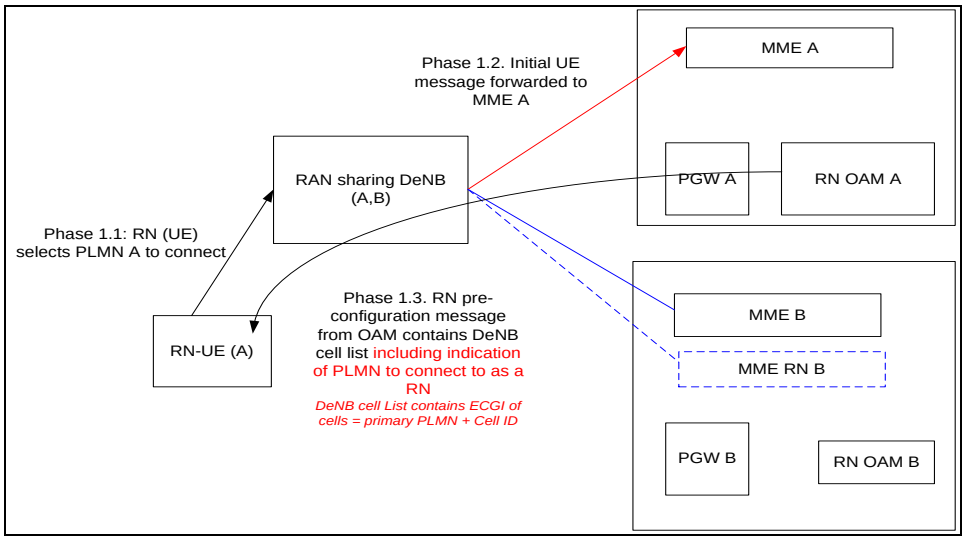

Figure 4.2.2.1: Illustration of scenario where RN connects to RN OAM via a PLMN A but is requested by OAM to connect as a RN on PLMN B.

4.2.3 Fault Management impact

No specific impact for this use case. This will be addressed by general changes related to RAN sharing and support for DeNB.

4.2.4 Performance Management impact

No specific impact for this use case. This will be addressed by general changes related to RAN sharing and support for DeNB.

4.2.5 Configuration Management impact

According to TS 32.766 [1], the DeNB cell list is a list of ECGIs as referenced below:

A.2.2.15 IOC RNFunction

Mapping from NRM IOC RNFunction attributes and associations to SS equivalent MOC RNFunction attributes

Attribute of IOC RNFunction in 3GPP TS 32.762 [4]	SS Attribute	SS Type	Support Qualifier	Read Qualifier	Write Qualifier
id	id	string	M	M	-
servingCell	servingCell	GenericNetworkResourcesIRPSystem::AttributeTypes::MOReference	M	M	M
candidateDeNBCells	candidateDeNBCells	genericEUTRANNRMAttributeTypes::EcgiListType	M	M	M

Editor's note: the need of attribute candidateDeNBCells is for FFS.

This definition of the DeNB cell list seems appropriate for the non-RAN sharing case where the eNB is broadcasting only the primary PLMN. However, if the RN OAM needs the RN to connect to PLMN B on the shared cell, there is no way to indicate this information in the DeNB cell list. The definition of DeNB cell list should be updated to support the RAN sharing case.

4.2.6 Security Management impact

No specific impact for this use case. This will be addressed by general changes related to RAN sharing and support for DeNB.

4.2.7 MDT/Call Trace impact

No specific impact for this use case. This will be addressed by general changes related to RAN sharing and support for DeNB.

4.2.8 Impact on management of SON and related topics

No specific impact for this use case. This will be addressed by general changes related to RAN sharing and support for DeNB.

4.2.9 Other Impacts

None.

4.3 Scenario 3: DM shared between Operator' affiliates

4.3.1 General Description

The scenario described here is for large service providers having footprints in many countries. Though, in some of these countries, they are incumbent, it also happens that, in some other countries, they are challengers, have limited footprints and have to lower their CAPEX and OPEX to be competitive. In some cases, they deploy a relatively limited number of network elements in each country and put in place a unique organization responsible for operating these domestic networks. The resulting 24/7 shared Network Operation Centre (NOC) uses a single DM for all the nation-wide networks it is in charge of. NOC staff is responsible of daily operation of the various networks. However, the local operation teams should have management capabilities for their respective network elements.

This scenario can apply to any 3GPP network entities.

4.3.2 Use case description

In this scenario, network elements are not shared between Operator's affiliates. However, they are managed from a common DM, which can be under the responsibility of one of the Operator's affiliates which have an agreement for sharing their DM (namely Affiliate A and Affiliate B in the example below) or under the responsibility of any other affiliate, based on Operator's policy.

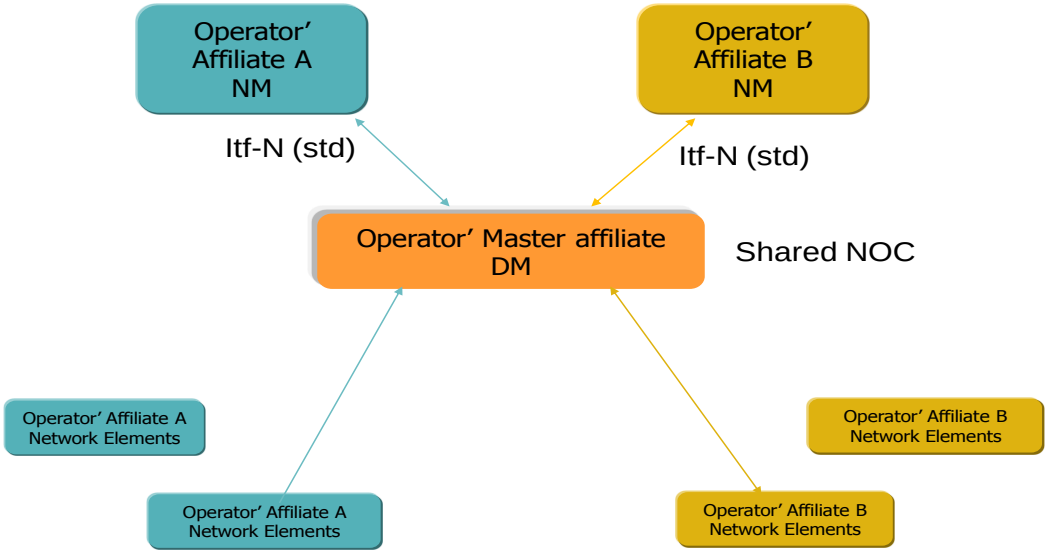

FIgure 4.3.2.1

This scenario aligns with the scenario defined in NGCOR document, business requirements defined in NGCOR Next Generation Converged Operations Requirements v1.2, Feb. 28th, 2012: Business Scenario 1, Section 3.4.1.1.

4.3.3 Fault Management impact

Since Operator's Affiliates do not share their nodes, it is expected that alarms raised by Operator's affiliate A network elements are not visible to other Operator's affiliates.

4.3.4 Performance Management impact

It should be possible that each Operator's affiliate configures its PM jobs from its NM, independently from each others.

It should be possible that performance counters and KPIs be split per Operator's affiliate.

4.3.5 Configuration Management impact

It should be possible that each Operator's affiliate configures its network elements from its NM, independently from each others.

4.3.6 Security Management impact

Mechanisms shouldexist so that Operator's affiliate A NM should not be able to retrieve or access information from other Operator's Affiliate network elements.

4.3.7 MDT/Call Trace impact

Impact on MDT/Call Trace as a result of Network Sharing is for futher study.

4.3.8 Impact on management of SON and related topics

Impact on SON uses cases as a result of Network Sharing is for futher study.

4.3.9 Other Impacts

Inventory Management: It should be possible that each Operator' affiliate inventories its network elements from its NM, independently from each others.

4.4 Scenario 4: Gateway Core Network (GWCN)

4.4.1 General Description

A network sharing architecture may allow operators to share all or part of the core in addition to sharing radio access network. This configuration is usually referred to as a Gateway Core Network (GWCN) configuration.

The architecture for GWCN is addressed in 3GPP TS 23.351 [3].

4.4.2 Use case description

4.4.2.1 Scenario 4.4a: Management Model for GWCN (Option #1)

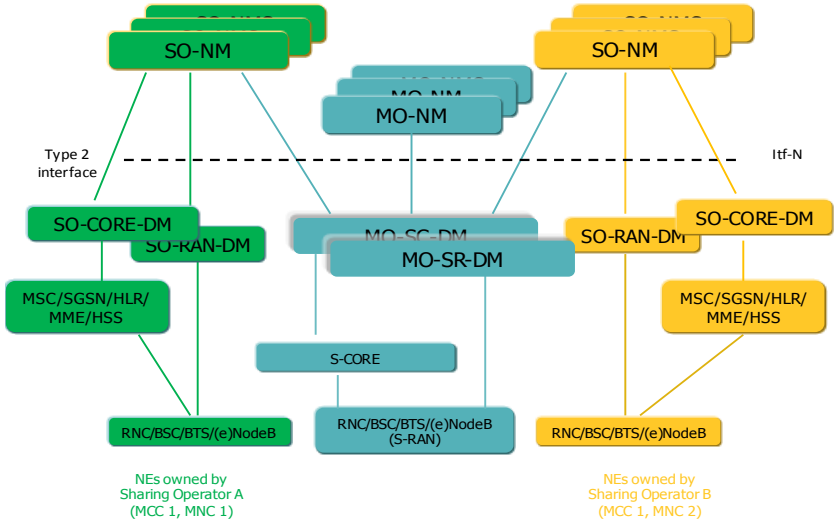

Figure 4.4.2.1.1

In this scenario both core network and RAN are shared and managed by MO.

4.4.2.2 Scenario 4.4b: Management Model for GWCN (Option #2, conformant with 3GPP current management architecture)

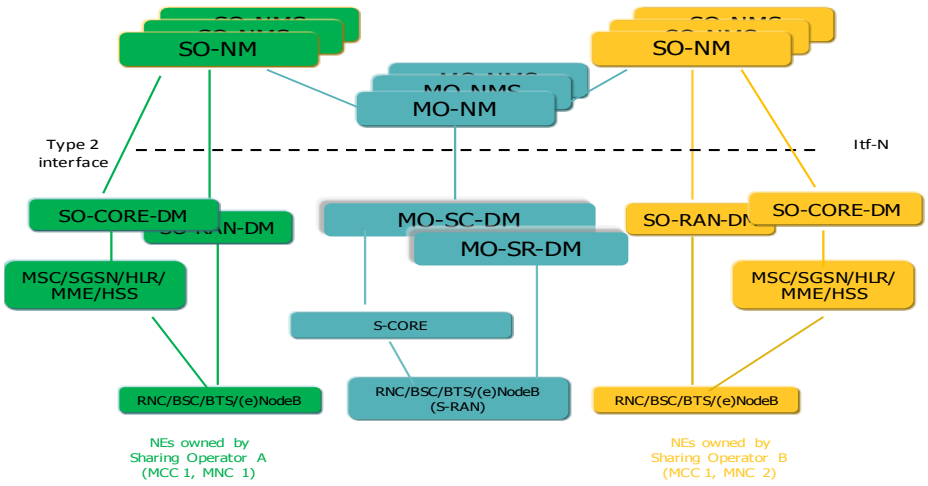

Figure 4.4.2.2.1

In this scenario both core network and RAN are shared and managed by MO.

4.4.3 Fault Management impact

Operators sharing the Core should be able to view alarms from the shared nodes. It may be necessary for certain alarms to be identified as pertaining to a particular PLMN or Operator.

The need or ability to view a subset of the alarms depending on the nature of the alarm is to be analysed further.

NOTE: The shared RAN part of the scenario is addressed in clause 4.1 and the analysis applies here for the shared RAN part.

4.4.4 Performance Management impact

Operators sharing the Core should be able to view performance counters from the shared nodes. It may be necessary for certain performance counters to be identified as releated to a particular PLMN or Operator.

The need or ability to view a subset of the performance counters depending on the type of the performance counter is to be analysed further.

Note: The shared RAN part of the scenario is addressed in Clause 4.1 and the analysis applies here for the shared RAN part.

4.4.5 Configuration Management impact

There will be NRM impacts as a result of supporting network sharing. Section 5 identifies the specifications that may have potential impacts. The exact changes will be identified in the WI phase.

4.4.6 Security Management impact

As a result of network sharing there is need to control access and visibility of certain operations and data. The ability to provide the access control on the NM will be supported by introducing and enhancing the information over Itf-N. Section 5 identifies the specifications that may have potential impacts. The exact changes will be identified in the WI phase.

4.4.7 MDT/Call Trace impact

Impact on MDT/Call Trace as a result of Network Sharing is for futher study.

4.4.8 Impact on management of SON and related topics

Impact on SON uses cases as a result of Network Sharing is for futher study.

4.4.9 Other Impacts

4.5 Scenario 5: Shared Core with independent RAN

4.5.1 General Description

A network sharing architecture may allow operators to share all or part of the core and have their own radio access network.

4.5.2 Use case description

In these scenarios, the management of the shared core network needs to be studied.

4.5.2.1 Scenario 4.5a: Shared Core with independent RANs (Option #1)

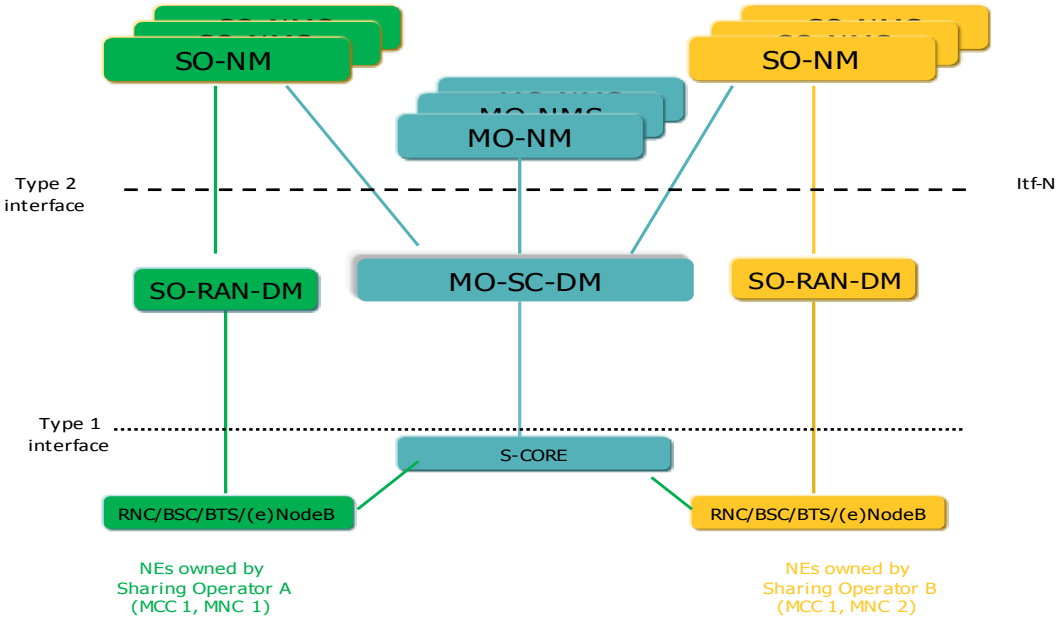

Figure 4.5.2.1.1

In this scenario the core is shared and managed by MO. MO-SC-DM manages the S-CORE and can be operated by a MO.

4.5.2.2 Scenario 4.5b: Shared Core with independent RANs (Option #2, conformant with 3GPP current management architecture)

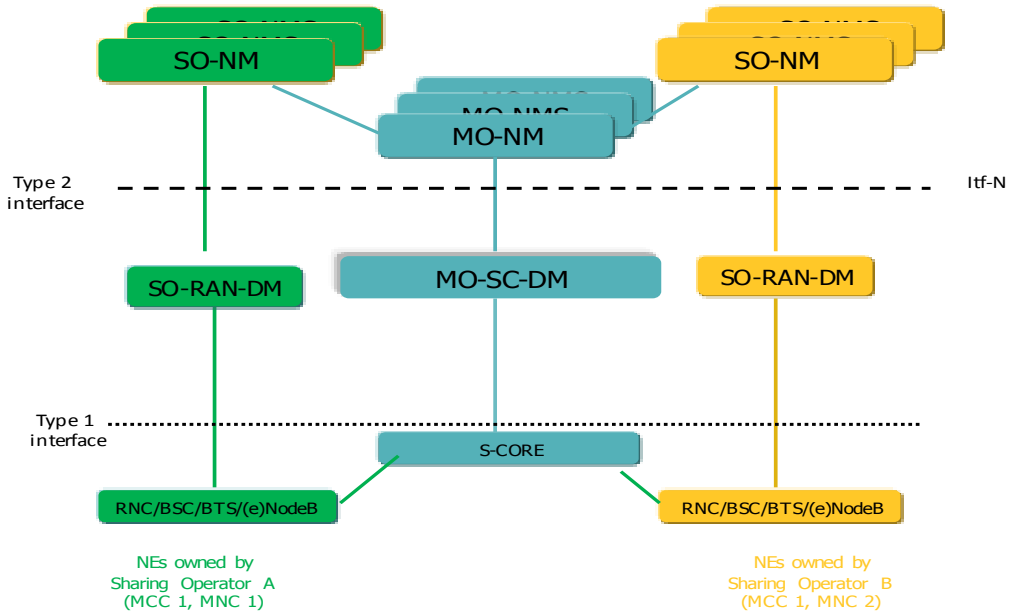

Figure 4.5.2.2.1

This is the same as Scenario 4.4a, except this scenario follows the current 3GPP management architecture.

4.5.3 Fault Management impact

The shared Core part of the scenario is addressed in Clause 4.4 and the analysis applies here for the shared Core part.

4.5.4 Performance Management impact

The shared Core part of the scenario is addressed in Clause 4.4 and the analysis applies here for the shared Core part.

4.5.5 Configuration Management impact

The shared Core part of the scenario is addressed in Clause 4.4 and the analysis applies here for the shared Core part.

4.5.6 Security Management impact

The shared Core part of the scenario is addressed in Clause 4.4 and the analysis applies here for the shared Core part.

4.5.7 MDT/Call Trace impact

Impact on MDT/Call Trace as a result of Network Sharing is for futher study.

4.5.8 Impact on management of SON and related topics

Impact on SON uses cases as a result of Core Sharing is for futher study.

4.5.9 Other Impacts

None.

5 Recommendation on OAM impacts for Network sharing

5.1 Summary and way forward

A LS was received from SA to all WG in Rel 10 to support Network Sharing. The main goal with the present document is to provide a response to the LS to study and understand what needs to be done to ensure existing functionality and new enhancement can support network sharing scenarios identified in the 3GPP SA5 specifications. In addition, the goal is to take into account NGCOR scenarios and requirements.

The analysis of use cases for Network Sharing resulted in 2 different management architectures as detailed in clause 4.1.9:

1. Management Architecture #1, in which the Master Operator offer management capabilities to Sharing Operators via its Shared RAN Domain Manager (also referred to as MO-SR-DM) as shown in Scenario 1A and 1C.

2. Management Architecture #2, in which the Master Operator offer management capabilities to Sharing Operators via its Network Manager (also referred to as MO-NM) as shown in Scenario 1B and 1D. Management Architecture #2 is consistent with the 3GPP reference management architecture.

While it is important to cover all aspects of Network Sharing, the recommendation and conclusion is to break up the work.

Based on the analysis the recommendations are provided below/

- A new Work Item will be opened to address the changes to the specification related to use cases analysed in the present document that align with Management Architecture #2.

- A new Study Item can be used to extend the analysis in the present document for additional scenarios of network sharing based on SA1 and NGCOR work that may require extending 3GPP reference management architecture.

5.2 Scenario 2 related changes

This definition of the DeNB cell list seems appropriate for the non-RAN sharing case where the eNB is broadcasting only the primary PLMN. However, if the RN OAM needs the RN to connect to PLMN B on the shared cell, there is no way to indicate this information in the DeNB cell list. The definition of DeNB cell list should be updated to support the RAN sharing case.

The recommendation is to provide changes in 28.658 to address this need.

5.3 Impact on existing specifications

Any resources identified by a <IOC> in the 3GPP specifications may support management of Network Sharing for the standardised operations, notifications, objects and attributes without modification to existing specifications (example: eNodeB level).

However, extensions may be needed to introduce new <IOC>s and/or modify existing <IOC>s and/or modify existing interface IRPs for certain scenarios (example: cell level) .

Note that vendor specific operations, notifications, objects and attributes, etc. are out of scope.

NOTE: Only Architecture #2 detailed in clause 4.1.9 is considered in the analysis.

The directive from SA came in at the beginning of Rel-11, The analysis has been done (2013-07) for specs in Rel-11 and existing Rel-12 specs.

The sharing has the following architecture:

RAN sharing can be made in two ways:

1. One cell is shared by several Sharing Operators
2. Each Sharing Operator has its own cell, even if the RAN node(s) are shared.

The Master Operator can access all data, regardless if it is shared or not. The division of data for Sharing Operators are made in the Master Operator's Network Manager.

Legend used in the table:

N/A – Not Applicable: The specification is not relevant to Network Sharing: example 32.581, 32.582. A note, "Network sharing is not applicable in this release", will be added in the Requirement TS in the scope section

NS - Not supported and no proposal to modify in the current Release: Needs modifications but may/will not be changed in current release. . A note, "Network sharing is not supported in this Release", will be added in the Requirement TS in the scope section of the identified specification of Release 12,

NR: Not required: The network sharing scenario is not specified in [3].

SWM: Supports with modification proposed in current release: Specification will be modified so it supports Network Sharing scenarios. The specification is marked SWM if ANY change is needed regardless of whether certain Network sharing scenarios are already supported with no change. A note (except for 32.101, 32.102, 32.155) will be added in the Requirement TS in the scope section explaining support of network sharing impact (e.g. changes needed in the TS).

NM: Supports with no modification: The specification supports Network Sharing scenarios with no modifications. Examples are generic NRM. Even though this NRM is needed for supporting configuration management for a shared node, there is no change needed to the specification. No note is needed to be added in the TS.

This Study uses the following Modes to further qualify the meaning of the word 'Support' in NM and SWM. These Modes are used in the Table below.

Mode 1: Support sharing in the sense that all resources (e.g. identified by the IOCs in the specifications excepting those imported) are shared with no differentiation between the Sharing Operators. Notifications of events, including alarms, of the shared resources are distributed to all Sharing Operators.

Mode 2: Support sharing in the sense that all resources (e.g. identified by the IOCs in the specifications excepting those imported) are shared based on some kind of rules, e.g. one Sharing Operator can only use 40% of the identified resource and the other Sharing Operator can only use 60% of the shared resource. Notifications of events, including alarms, about the Sharing Operator quota are distributed to that Sharing Operator only.

Table 5.3.1

3GPP specification Number	3GPP specification Title	Changes needed to support Network Sharing scenarios
TS 28.401	Performance Management (PM); Performance measurements for Core Network (CN) and non-3GPP access Interworking System	NM (Mode 1), SWM (Mode 2)
TS 28.402	Performance Management (PM); Performance measurements for Evolved Packet Core (EPC) and non-3GPP access Interworking System	NM
TS 28.601/602/606	Core Network (CN) and non-3GPP access Interworking System Network Resource Model (NRM); Integration Reference Point (IRP);	NR Current SA2 standard does not support WLAN from different operators be connected to the same CN nodes
TS 28.611/612/616	Evolved Packet Core (EPC) and non-3GPP access Interworking System Network Resource Model (NRM); Integration Reference Point (IRP);	NR Current SA2 standard does not support WLAN from different operators be connected to the same CN nodes
TS 28.620	Telecommunication management; Fixed Mobile Convergence (FMC) Federated Network Information Model (FNIM) Umbrella Information Model (UIM)	NM (Mode 1, Mode2)
TS 28.621/622/623	Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Requirements	SWM (Mode 1, Mode 2) Can SubNetwork be shared? Does the attribute setOfMcc need to indicate whether some MCCs belongs to the same operator or not?
TS 28.624/625/626	State management data definition Integration Reference Point (IRP)	NM (Mode 1, Mode 2)
TS 28.627/628/629	Self-Organizing Networks (SON) Policy Network Resource Model (NRM) Integration Reference Point (IRP);	N/A
TS 28.631/632/633	Inventory Management (IM) Network Resource Model (NRM) Integration Reference Point (IRP)	N/A
TS 28.651/652/653	Universal Terrestrial Radio Access Network (UTRAN) Network Resource Model (NRM) Integration Reference Point (IRP)	SWM (Mode 1, Mode 2)
TS 28.654/655/656	GSM/EDGE Radio Access Network (GERAN) Network Resource Model (NRM) Integration Reference Point (IRP);	SWM (Mode 1, Mode 2)
TS 28.657/658/659	Evolved Universal Terrestrial Radio Access Network (E-UTRAN) Network Resource Model (NRM) Integration Reference Point (IRP)	NM (Mode 1) Why? What needs to be changed (size of lists? COC?) SWM (Mode 2)
TS 28.661/662/663	Generic Radio Access Network (RAN) Network Resource Model (NRM) Integration Reference Point (IRP);	NM (Mode 1), SWM (Mode 2)
TS 28.671/672/673	Home Node B (HNB) Subsystem (HNS) Network Resource Model (NRM) Integration Reference Point (IRP)	N/A
TS 28.674/675/676	Home enhanced Node B (HeNB) Subsystem (HeNS) Network Resource Model (NRM) Integration Reference Point (IRP)	N/A
TS 28.701/702/703	Telecommunication management; Core Network (CN) Network Resource Model (NRM) Integration Reference Point (IRP)	See 32.631/2/6.

3GPP specification Number	3GPP specification Title	Changes needed to support Network Sharing scenarios
TS 28.704/705/706	Telecommunication management; IP Multimedia Subsystem (IMS) Network Resource Model (NRM) Integration Reference Point (IRP); Requirements	NR
TS 28.707708/709	Evolved Packet Core (EPC) Network Resource Model (NRM) Integration Reference Point (IRP)	NM
TS 28.731/732/733	Transport Network (TN) interface Network Resource Model (NRM) Integration Reference Point (IRP)	NM (Mode 1), SWM (Mode 2) NM? Are there any requirments to share transport network? Ask transport network expert if NS is possible/supported.
TS 28.734/735/736	Signalling Transport Network (STN) interface Network Resource Model (NRM) Integration Reference Point (IRP);	NM (Mode 1), SWM (Mode 2)?? Are there any requirments to share transport network? Ask STN expert if NS is possible/supported.
TS 28.751/752/753	Subscription Management (SuM) Network Resource Model (NRM) Integration Reference Point (IRP); Requirements	Out of the scope of this study Note:HLR/HSS cannot be shared between two operators
TS 32.101	Principles and high level requirements	SWM (Mode 1, Mode 2)
TS 32.102	Architecture	SWM (Mode 1, Mode 2)
TS 32.103	Integration Reference Point (IRP) overview and usage guide	NM
TS 32.107	Telecommunication management; Fixed Mobile Convergence (FMC) Federated Network Information Model (FNIM)	NM
TS 32.111-1/2/3/6.	Fault Management;: 3G fault management requirements	NM (Mode 1), SWM (Mode 2)
TS 32.121/122/126	Advanced Alarm Management (AAM) Integration Reference Point (IRP):	NM (Mode 1), SWM (Mode 2)
TS 32.140	Telecommunication management; Subscription Management (SuM) requirements	NM??Out of scope of this study
TS 32.141	Telecommunication management; Subscription Management (SuM) architecture	Out of scope of this study.
TS 32.150	Integration Reference Point (IRP) Concept and definitions	NM
TS 32.151	Integration Reference Point (IRP) Information Service (IS) template	NM
TS 32.152	Integration Reference Point (IRP) Information Service (IS) Unified Modelling Language (UML) repertoire	NM
TS 32.153	Integration Reference Point (IRP) technology specific templates, rules and guidelines	NM
TS 32.154	Backward and Forward Compatibility (BFC); Concept and definitions	N/A
TS 32.155	Requirements template	SWM (Mode 1, Mode 2) Place instruction to TS author: if SA5 members agreed to support NS, the TS captures it as a requirement. If SA5 members do not agree (e.g. after consultation with other groups that device signalling protocol cannot or do not support NS) to support, the TS does not need to mention it.
TS 32.156	Fixed Mobile Convergence (FMC) model repertoire	NM
TS 32.157	Telecommunication management; Integration Reference Point (IRP) Information Service (IS) template	NM
TS 32.171/172/176	Telecommunication management; Subscription Management (SuM) Network Resource Model (NRM) Integration Reference Point (IRP); Requirements	See TS 28.751/752/753
TS 32.181/182	Telecommunication management; User Data	??

3GPP specification Number	3GPP specification Title	Changes needed to support Network Sharing scenarios
	Convergence (UDC); Framework for Model Handling and Management	
TS 32.300	Configuration Management (CM); Name convention for Managed Objects	NM (Mode 1), SWM (Mode 2)
TS 32.301/302/306.	Configuration Management (CM); Notification Integration Reference Point (IRP)	NM (Mode 1), SWM (Mode 2)
TS 32.311/312/316.	Generic Integration Reference Point (IRP) management	NM (Mode 1), SWM (Mode 2)
TS 32.321/322/326	Test management Integration Reference Point (IRP);	NM (Mode 1), SWM (Mode 2)
TS 32.331/332/336	Notification Log (NL) Integration Reference Point (IRP)	NM (Mode 1), SWM (Mode 2)
TS 32.341/342/346 *Removed specs does not exist in Rel-11 or later.*	File Transfer (FT) Integration Reference Point (IRP)	NM (Mode 1), SWM (Mode 2)
TS 32.351/352/356	Communication Surveillance (CS) Integration Reference Point (IRP)	NM (Mode 1), SWM (Mode 2)
TS 32.361/362/366.	Entry Point (EP) Integration Reference Point (IRP); Requirements	NM (Mode 1), SWM (Mode 2)
TS 32.371/372/376	Telecommunication management; Security Management concept and requirements	NM
TS 32.381/382/386	Telecommunication management; Partial Suspension of Itf-N Integration Reference Point (IRP); Requirements	NM (Mode 1), SWM (Mode 2)
TS 32.391/392/396	Telecommunication management; Delta synchronization Integration Reference Point (IRP); Requirements	NM (Mode 1), SWM (Mode 2)
TS 32.401	Telecommunication management; Performance Management (PM); Concept and requirements	NM
TS 32.404	Telecommunication management; Performance Management (PM); Performance measurements; Definitions and template	NM
TS 32.405	Telecommunication management; Performance Management (PM); Performance measurements; Universal Terrestrial Radio Access Network (UTRAN)	NM (Mode 1), SWM (Mode 2)
TS 32.406	Telecommunication management; Performance Management (PM); Performance measurements; Core Network (CN) Packet Switched (PS) domain	NM (Mode 1), SWM (Mode 2)
TS 32.407	Telecommunication management; Performance Management (PM); Performance measurements; Core Network (CN) Circuit Switched (CS) domain; UMTS and combined UMTS/GSM	NM (Mode 1), SWM (Mode 2)
TS 32.408	Telecommunication management; Performance Management (PM); Performance measurements; Teleservice	NM (Mode 1), SWM (Mode 2)
TS 32.409	Telecommunication management; Performance Management (PM); Performance measurements; IP Multimedia Subsystem (IMS)	NM (Mode 1), SWM (Mode 2)
TS 32.410	Telecommunication management; Key Performance Indicators (KPI) for UMTS and GSM	NM, (Mode 1), SWM (Mode 2)
TS 32.411/412/416	Telecommunication management; Performance Management (PM) Integration Reference Point (IRP): Requirements	NM (Mode 1), SWM (Mode 2)
TS	Telecommunication management; Subscriber and	SWM (Mode 1, Mode 2)

3GPP specification Number	3GPP specification Title	Changes needed to support Network Sharing scenarios
32.421/422/423	equipment trace;	
TS 32.425	Telecommunication management; Performance Management (PM); Performance measurements Evolved Universal Terrestrial Radio Access Network (E-UTRAN)	NM (Mode 1), SWM (Mode 2)
TS 32.426	Telecommunication management; Performance Management (PM); Performance measurements Evolved Packet Core (EPC) network	NM (Mode 1), SWM (Mode 2)
TS 32.432	Telecommunication management; Performance measurement: File format definition	NM
TS 32.435	Telecommunication management; Performance measurement; eXtensible Markup Language (XML) file format definition	NM
TS 32.436	Telecommunication management; Performance measurement: Abstract Syntax Notation 1 (ASN.1) file format definition	NM
TS 32.441/442/446	Trace Management Integration Reference Point (IRP)	SWM (Mode 1, Mode 2)
TS 32.450	Key Performance Indicators (KPI) for Evolved Universal Terrestrial Radio Access Network (E-UTRAN): Definitions	NM, (Mode 1), SWM (Mode 2)
TS 32.451	Key Performance Indicators (KPI) for Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Requirements	NM, (Mode 1), SWM (Mode 2)

3GPP specification Number	3GPP specification Title	Changes needed to support Network Sharing scenarios
TS 32.452	Performance Management (PM); Performance measurements Home Node B (HNB) Subsystem (HNS)	N/A
TS 32.453	Performance Management (PM); Performance measurements Home enhanced Node B (HeNB) Subsystem (HeNS)	N/A
TS 32.454	Key Performance Indicators (KPI) for the IP Multimedia Subsystem (IMS); Definitions	NR
TS 32.455	Key Performance Indicators (KPI) for the Evolved Packet Core (EPC); Definitions	NM (Mode 1) SWM (Mode 2)
TS 32.500	Self-Organizing Networks (SON); Concepts and requirements	NM
TS 32.501/502/506	Self-configuration of network elements; Concepts and requirements	NM
TS 32.511	Automatic Neighbour Relation (ANR) management;	NM
TS 521/522/526	Self-Organizing Networks (SON) Policy Network Resource Model (NRM) Integration Reference Point (IRP);	N/A
TS 32.531/532/536.	Software management (SwM); Concepts and Integration Reference Point (IRP)	N/A
TS 32.541	Self-Organizing Networks (SON); Self-healing concepts and requirements	N/A
TS 32.551	Energy Saving Management (ESM); Concepts and requirements	N/A
TS 32.571/572	Home Node B (HNB) and Home eNode B (HeNB) management; Type 2 interface	N/A
TS 32.581/582/583/584	Home Node B (HNB) Operations, Administration, Maintenance and Provisioning (OAM&P): Type 1 interface	N/A
TS 32.591/582/593/594	Home enhanced Node B (HeNB) Operations, Administration, Maintenance and Provisioning (OAM&P): Type 1 Interface	N/A
TS 32.600/601/602/606	Configuration Management (CM)	NM
TS 32.611/612/616	Configuration Management (CM); Bulk CM Integration Reference Point (IRP)	NM
TS 32.621/622/626	Configuration Management (CM); Generic network resources Integration Reference Point (IRP)	SWM (Mode 1, Mode 2) Can SubNetwork be shared? Does the attribute setOfMcc need to indicate whether some MCCs belongs to the same operator or not?.
TS 32.631/632/636 *Removed specs does not exist in Rel-11 or later.*	Configuration Management (CM); Core network resources Integration Reference Point (IRP)	NM
TS 32.641/642/646	Configuration Management (CM); UTRAN network resources Integration Reference Point (IRP)	See 28.651/652/653
TS 32.651/652/656	Configuration Management (CM); GERAN network resources Integration Reference Point (IRP)	See 28.654/655/65
TS 32.661/662/666	Configuration Management (CM); Kernel CM	NM (Mode 1), SWM (Mode 2)
TS 32.671/672/676.	Configuration Management (CM); State Management Integration Reference Point (IRP)	N/A
TS 32.690	Telecommunication management; Inventory	N/A

3GPP specification Number	3GPP specification Title	Changes needed to support Network Sharing scenarios
	Management (IM); Requirements	
TS 32.691/692/696	Inventory Management (IM) Network Resource Model (NRM) Integration Reference Point (IRP)	N/A
TS 32.711/712/716	Transport Network (TN) interface Network Resource Model (NRM) Integration Reference Point (IRP)	NM (Mode 1), SWM (Mode 2) Ask transport expert if NS is possible/supported.
TS 32.721/722/726	Repeater Network Resource Model (NRM) Integration Reference Point (IRP);	??
TS 32.731/732/736	Telecommunication management; IP Multimedia Subsystem (IMS) Network Resource Model (NRM) Integration Reference Point (IRP); Requirements	??
TS 32.741/742/746	Signalling Transport Network (STN) interface Network Resource Model (NRM) Integration Reference Point (IRP);	NM (Mode 1), SWM (Mode 2) Are there any requirments to share transport network? Ask STN expert if NS is possible/supported.
TS 32.751/752/756	Evolved Packet Core (EPC) Network Resource Model (NRM) Integration Reference Point (IRP)	NM
TS 32.761/762/766	Evolved Universal Terrestrial Radio Access Network (E-UTRAN) Network Resource Model (NRM) Integration Reference Point (IRP)	NM (Mode 1), SWM (Mode 2) Why? What needs to be changed (size of lists? COC?)
TS 32.771/772/776	Home Node B (HNB) Subsystem (HNS) Network Resource Model (NRM) Integration Reference Point (IRP)	N/A
TS 32.781/782/786	Home enhanced Node B (HeNB) Subsystem (HeNS) Network Resource Model (NRM) Integration Reference Point (IRP)	N/A.
TS 32.791/792/796	Generic Radio Access Network (RAN) Network Resource Model (NRM) Integration Reference Point (IRP);	NM

5.4 Need for new specifications

A new TS 32.xxx will be created to capture stage 1 network sharing requirements, terminologies, OAM Reference architecture, scenarios and use cases. Materials will be mainly extracted from this TR.

We do not foresee any new Stage 2 or Stage 3 specification and existing TS will be modified as indicated in clause 5.3.

A TS supporting network sharing will have stated requirement statement(s) or have reference(s) to stated requirement statement(s) of another TS.

NOTE: The recommendations provided in clause 5.3 will be used as a starting point for the Work Item. However further analysis during the Work Item may be needed.

5.5 Need LS

In the case that network sharing solution for Mode 2 is desirable, SA5 will issue LS to the relevant group to confirm if their standard would support network sharing.

6 APPENDIX

6.1 System description (system roles)

This clause describes the system diagram and system-roles to explain the support of various network sharing scenarios documented.

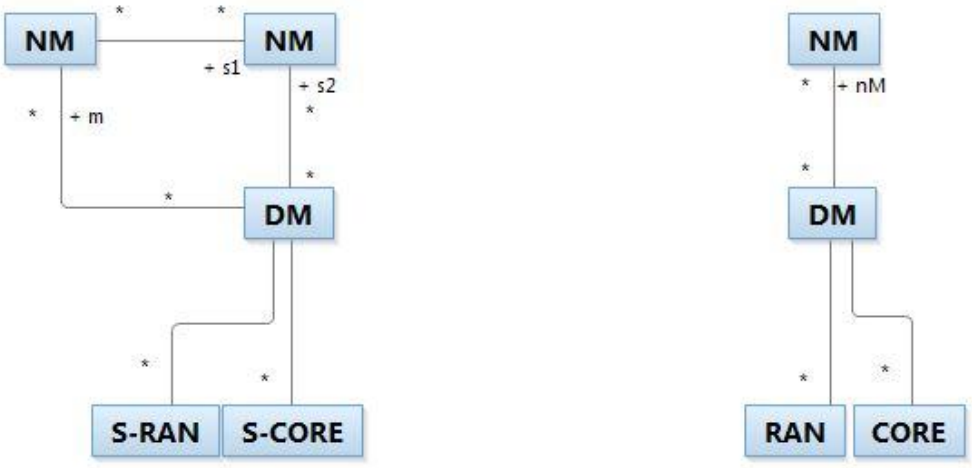

Figure 6.1.1: system diagram (for network and for non-network sharing scenarios) with system roles

The above left diagram is for network sharing scenarios. The right diagram is for the non-network sharing scenarios.

System Role:

nM: DM plays the role-nMS when interacting with NM in non-network-sharing scenario.

Other system roles (e.g. +m) are described after Figure 2 where organization roles are included.

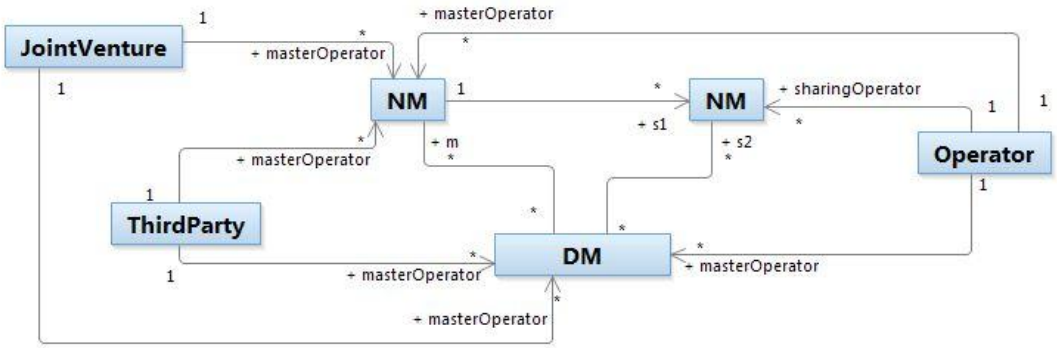

Figure 6.1.1.2: system diagram with organization roles and system roles (without non-network sharing)

Organization Roles:

masterOperator: See definition in clause 3. MO is its abbreviation.

sharingOperator: See definition in clause 2. SO is its abbreviation.

System Roles:

m: MO DM plays the role-m when interacting with MO NM.

s2: MO DM plays the role-s when interacting with SO NM.

s1: MO NM plays the role-s when interacting with SO NM.

The definitions of Organization Roles are defined in section 2. Only the system diagram supporting network sharing scenarios is shown in Figure 6.1.1.2. The system diagram not supporting network sharing scenario (i.e. the right side diagram of Figure 6.1.1.1) is not useful to illustrate Organization Roles (and does not appear in Figure 6.1.1.2).

There is no distinction made in this system diagram between Operator and Affiliate (where X number of Affiliates can be associated with one Operator and at most one Affiliate operates in one country).

Annex A:
Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2011-11					Added changes from TDoc S5-113818	0.0.1	0.1.0
2012-02					Agreed changes in S5-120307 and S5-120405 at SA5#81 included.	0.1.0	0.2.0
2012-03					Agreed changes in S5-120780, S5-120782 and S5-120783 at SA5#82 included.	0.2.0	0.3.0
2012-03					Editorial changes (removing revision marks)	0.3.0	0.3.1
2012-05					Agreed changes in S5-121356 and S5-121386 included	0.3.1	0.4.0
2012-10					Agreed changes in S5-122589 and S5-122591 included	0.4.0	0.5.0
2012-11					Agreed changes in, S5-123083, S5-123086, S5-123168, S5-123018,S5-123169	0.5.0	0.6.0
2013-04					Agreed changes in S5-130608 and S5-130746	0.6.0	0.7.0
2013-05					Agreed changes in S5-131028, S5-131029, S5-131051, S5-131052, S5-131088	0.7.0	0.8.0
2013-06	SA#60	SP-130281			Presented to SA Plenary for information	0.8.0	1.0.0
2013-08					Agreed changes in S5-131230, S5-131287, S5-131310, S5-131311	1.0.0	1.1.0
2013-09	SA#61	SP-130454			Presented to SA for approval	1.1.0	2.0.0