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Contents

Foreword

This Technical Specification has been produced by the 3rd 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:

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In the present document, modal verbs have the following meanings:

shall   indicates a mandatory requirement to do something

shall not   indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

should   indicates a recommendation to do something

should not   indicates a recommendation not to do something

may   indicates permission to do something

need not   indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

can   indicates that something is possible

cannot   indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

will   indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

will not   indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

might   indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

Introduction

The present document is part of a TS-family covering the 3rd Generation Partnership Project Technical Specification Group Services and System Aspects Management and orchestration of networks, as identified below:

TS 28.313: **Management and orchestration; Self-Organizing Networks (SON) for 5G networks.**

TS 28.552: Management and orchestration; 5G performance measurements.

TS 28.541: Management and orchestration; Self-Organizing Networks (SON) Network Resource Model (NRM) for 5G networks.

1 Scope

The present document specifies the concepts, use cases, requirements, and procedures for the SON functions in 5GS.

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 TS 32.500: "Telecommunication Management; Self-Organizing Networks (SON); Concepts and requirements".

[3]   3GPP TS 28.532: "Management and orchestration; Generic management services"

[4]   3GPP TS 38.321 "NR; Medium Access Control (MAC) protocol specification".

[5]   3GPP TS 28.552 "Management and orchestration; 5G performance measurements".

[6]   3GPP TS 32.511 " Telecommunication management; Automatic Neighbour Relation (ANR) management; Concepts and requirements".

[7]   3GPP TS 38.300 "NR; Overall description; Stage-2".

[8]   Void

[9]   3GPP TS 38.331: "NR; Radio Resource Control (RRC) protocol specification".

[10]   Void

[11]   3GPP TS 28.531 "Management and orchestration; Provisioning".

[12]   3GPP TS 28.550: "Management and orchestration; Performance assurance".

[13]   3GPP TS 28.541: "Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3".

[14]   Void

[15]   3GPP TS 32.508: "Telecommunication management; Procedure flows for multi-vendor plug-and-play eNodeB connection to the network".

[16]   3GPP TS 38.133: "NR; Requirements for support of radio resource management".

[17]   Void

[18]   3GPP TS 32.423: "Telecommunication management; Subscriber and equipment trace; Trace data definition and management".

[19]   3GPP TS 38.423: "NG-RAN; Xn Application Protocol (XnAP)".

[20]   3GPP TS 32.422: "Subscriber and equipment trace; Trace control and configuration management".

[21]   3GPP TS 28.315: "Management and orchestration; Plug and Connect; Procedure flows".

[22]   3GPP TS 28.314: " Management and orchestration; Plug and Connect; Concepts and requirements".

[23]   3GPP TS 28.317 " Management and orchestration; Self-configuration of Radio Access Network Entities (RAN NEs)".

3   Definitions of terms, symbols and abbreviations

3.1   Terms

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

Centralized SON (C-SON): SON solution where SON algorithms are executed in the 3GPP management system. Centralized SON has two variants:

- **Cross Domain-Centralized SON:** SON solution where SON algorithms are executed in the 3GPP Cross Domain layer.

- **Domain-Centralized SON:** SON solution where SON algorithms are executed in the Domain layer.

Distributed SON (D-SON): SON solution where SON algorithms are executed in the Network Function layer.

Hybrid SON: SON solution where SON algorithms are executed at two or more of the following layers: NF layer or Domain layer or 3GPP Cross Domain layer.

Searchlist: list of frequencies and supporting information to be used for neighbour cell measurements, which contains entries for NG-RAN and supported IRATs.

3.2   Symbols

Void.

3.3   Abbreviations

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

ANR	Automatic Neighbour Relation
CHO	Conditional Handover
DAPS	Dual Active Protocol Stack
NCR	Neighbour Cell Relation
NG-RAN	Next Generation Radio Access Network

4   Concepts and background

4.1   SON concepts

4.1.1   Overview

Based on the location of the SON algorithm, SON is categorized into four different solutions that are possible for implementing various SON use cases, the solution is selected depending on the needs of the SON use cases.

a) Centralized SON:

   1) Cross Domain-Centralized SON

   2) Domain-Centralized SON

b) Distributed SON

c) Hybrid SON.

The SON algorithm is not standardized by 3GPP.

The following figure illustrates the overview of SON Framework.
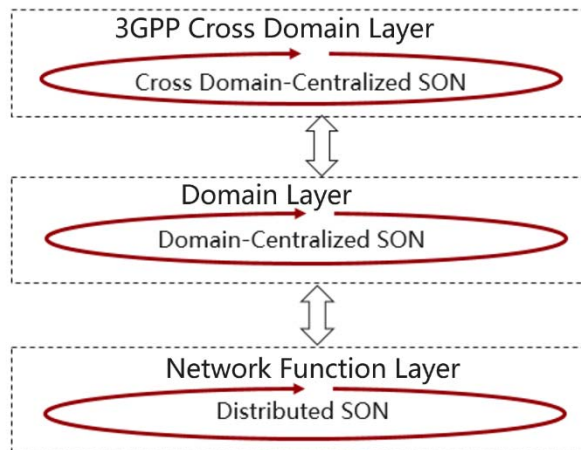
Figure 4.1.1-1: Overview of SON Framework

4.1.2   Centralized SON

4.1.2.1 Introduction

Centralized SON (C-SON) means that the SON algorithm executes in the 3GPP management system. The centralized SON concept has been defined for LTE in TS 32.500 [2].

Figure 4.1.2.1-1 shows a generic C-SON process, where the SON algorithms execute in the 3GPP management system interact with network functions in RAN and/or CN to implement SON functions. The SON algorithm may consist of the following functionalities:

- Monitoring: monitor the network(s) by collecting management data, including the data provided by MDAS.

- Analysis: analyse the management data to determine if there are issues in the network(s) that need to be resolved.

- Decision: makes the decision on the SON actions to resolve the issues.

- Execution: execute the SON actions.

- Evaluation: evaluate whether the issues have been solved by analysing the management data

NOTE: The management data as well as the exact algorithm may vary for different SON cases. For example, for automated creation of NSI, NSSI and/or NFs related cases, the management data may be SLA requirements received from service management layer; for automated optimization related cases, the management data may be performance measurements of the networks; for automated healing related cases, the management data may be alarm information of the networks. The management data and the algorithm are to be specified case by case.
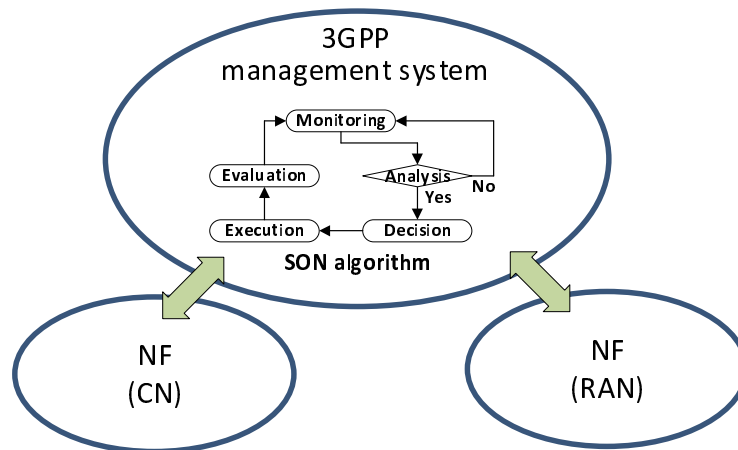
Figure 4.1.2.1-1: C-SON process

4.1.2.2   Cross Domain-Centralized SON

The Cross Domain-Centralized SON means that the SON algorithm executes in the 3GPP Cross Domain layer.

For Cross Domain-Centralized SON, the MnF(s) in 3GPP Cross Domain layer monitors the networks via management data, analyses the management data, makes decisions on the SON actions, and executes the SON actions.

4.1.2.3   Domain-Centralized SON

The Domain-Centralized SON means the SON algorithm executes in the Domain layer.

For Domain-Centralized SON, the MnF(s) in Domain layer monitors the networks via management data, analyses the management data, makes decisions on the SON actions, and executes the SON actions.

The MnF(s) in 3GPP Cross Domain is responsible for management and control of the Domain-Centralized SON function. The management and control may include switching on/off a Domain-Centralized SON function, making policies for a Domain-Centralized SON function, and/or evaluating the performance of a Domain-Centralized SON function.

4.1.3   Distributed SON

The distributed SON (D-SON) means that the SON algorithm is located in the NFs. The distributed SON concept has been defined for LTE in TS 32.500 [2].

For D-SON, the NFs monitors the network events, analyses the network data, makes decisions on the SON actions and executes the SON actions in the network nodes.

Figure 4.1.3-1 shows that the 3GPP management system (MnF in Domain or 3GPP Cross Domain) is responsible for the following functions:

   a) D-SON management function:

      1) Switch on/off a D-SON function,

      2) Provide policies, targets, and supplementary information (e.g., the range attributes) for a D-SON function.

   b) D-SON evaluation function: evaluate whether the issues have been resolved, and may apply D-SON management actions.
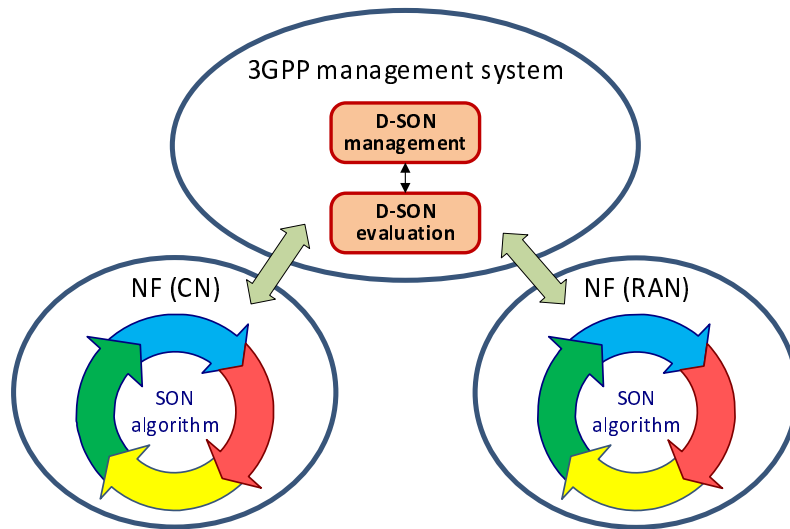
Figure 4.1.3-1: D-SON process

4.1.4   Hybrid SON

The hybrid SON (H-SON) means the SON algorithm are executed at two or more of the following levels: NF layer, Domain layer or 3GPP Cross Domain layer. The hybrid SON concept has been defined for LTE in TS 32.500 [2].

The 3GPP management system (i.e. MnF(s) in Domain or 3GPP Cross Domain) and NFs work together, in a coordinated manner, to build up a complete SON algorithm. The decisions on SON actions may be made by 3GPP management system and/or NFs, depending on the specific cases.

Figure 4.1.4-1 shows that the C-SON component is monitoring and executes SON actions.
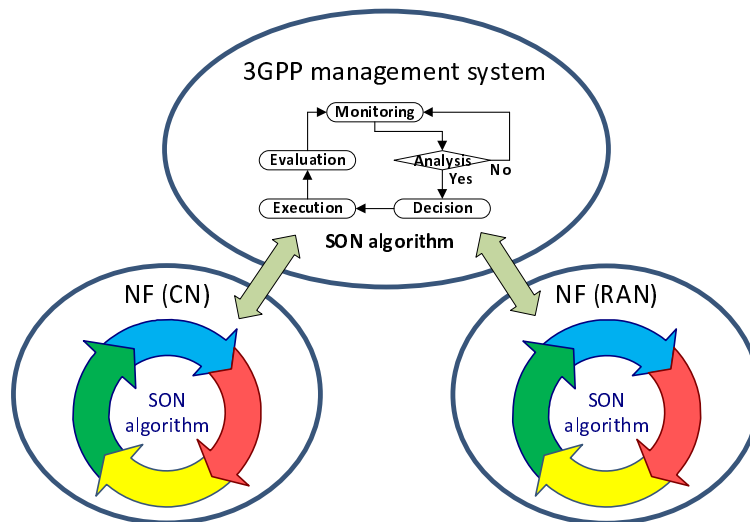
Figure 4.1.4-1: H-SON process

4.2 Self-establishment of new RAN NE in network

4.2.1   Introduction

Self-establishment of new RAN NE in network describes the procedure of a new NG-RAN NE can automatically establish when it is powered up and connect to the IP network in multi-vendor scenario, which includes:

-    Network Configuration data handling

- Plug and connect to management system

- Self-Configuration

4.2.2 Network configuration data handling

Network configuration data handling makes the network configuration data available to the management system support self-configuration process, which may include network configuration data preparation, network configuration data transfer and network configuration data validation. This happens except all of the network configuration data for NE can be generated by the management system supporting self-configuration process.

Network configuration data preparation: This makes the network configuration data ready in operator's network management system who provides the network configuration data. How to prepare the network configuration data in operator's network management system is out of scope of the present document.

Network configuration data transfer: This transfers the Network configuration data from network configuration data Provider to the network configuration data Consumer.

Network configuration data validation: This validates the syntax and semantics of network configuration data. It takes place in the network configuration data Consumer.

4.2.3 Plug and connect to management system

Plug and connect to management system connects the NE to its management system providing support for self-configuration process as automatically as possible. The concepts and requirements of plug and connect are specified in TS 28.314 [22].

4.2.4 Self-configuration

Self-configuration puts the NE into a state to be ready to carry traffic in an automated manner. The concepts of self-configuration are specified in TS 28.317 [23].

5 Business level requirements

5.1 Requirements

5.1.1 Distributed SON management

REQ-NR-ANR-CON-01 For NG-RAN ANR management, the initial status of a newly created NCR by the ANR function to a NG-RAN cell shall be such that HO is allowed, X2 or Xn connection setup is allowed, and the NCR is allowed to be removed by the ANR function in the gNB.

REQ-NR-ANR-CON-02 NG-RAN ANR management shall support NCRs from NG-RAN to NG-RAN and from NG-RAN to E-UTRAN.

REQ-NR-ANR-CON-03 For E-UTRAN ANR management, the initial status of a newly created NCR by ANR function to a NG-RAN cell shall be such that HO is allowed, X2 connection setup is allowed, and the NCR is allowed to be removed by the ANR function in the eNB.

REQ-NR-ANR-CON-04 E-UTRAN ANR management shall support NCRs from E-UTRAN to NG-RAN, in addition to support to other technologies, described in TS 32.511 [6] clause 5.1.

5.2 Actor roles

Not applicable

5.3 Telecommunication resources

Not applicable

6 Specification level requirements

6.1 Requirements

6.1.1 Distributed SON management

6.1.1.1 RACH Optimization (Random Access Optimisation)

REQ-RACH-FUN-1 The producer of provisioning MnS should have a capability allowing the authorized consumer to set and update the targets for RACH optimization function.

REQ-RACH-FUN-2 The producer of provisioning MnS should have a capability allowing an authorized consumer to enable or disable the RACH optimization function.

REQ-RACH-FUN-3 The producer of provisioning MnS should have a capability allowing the authorized consumer to collect performance measurements that are used to evaluate the RACH performance.

6.1.1.2 MRO (Mobility Robustness Optimisation)

REQ-MRO-FUN-1 The producer of provisioning MnS should have a capability allowing the MnS consumer to set the targets, HO offset ranges, and control parameters for MRO function.

REQ-MRO-FUN-2 The producer of provisioning MnS should have a capability allowing the MnS consumer to collect the handover related performance measurements that are used to evaluate the MRO performance.

REQ-MRO-FUN-3 The producer of provisioning MnS should have a capability allowing the MnS consumer to enable or disable the MRO function.

REQ-MRO-FUN-4 The producer of provisioning MnS should have a capability allowing the MnS consumer to update the targets, HO offset ranges, and control information for MRO function.

6.1.1.3 ANR management in NG-RAN

The business level requirements in clause 5.1.1 are decomposed into the following specification level requirements, applicable for NG-RAN:

REQ-NR-ANR-FUN-01   Producer of provisioning MnS shall support a capability allowing an authorized consumer to request establishment of an Xn connection to the neighbour gNB, or an Xn connection to the neighbour ng-eNB.

REQ-NR-ANR-FUN-02   Producer of provisioning MnS shall support a capability allowing an authorized consumer to request that an existing Xn connection to a neighbour gNB, or an Xn connection to a neighbour ng-eNB to be released, and that the establishment of such a connection is prohibited.

REQ-NR-ANR-FUN-03   Producer of provisioning MnS shall support a capability allowing an authorized consumer to request that an NCR is allowed to be removed.

REQ-NR-ANR-FUN-04   Producer of provisioning MnS shall support a capability allowing an authorized consumer to request that an NCR is not allowed to be removed.

REQ-NR-ANR-FUN-05   Producer of provisioning MnS shall support a capability allowing an authorized consumer to disable or enable the ANR function in one or more gNBs.

6.1.1.4 PCI configuration and re-configuration

REQ-DPCI-CONFIG-FUN-1 producer of provisioning MnS should have a capability allowing an authorized consumer to set or update the list(s) of PCI value(s) for NR cell(s).

REQ-DPCI-CONFIG-FUN-2 producer of provisioning MnS should have a capability allowing an authorized consumer to enable or disable the PCI configuration function.

REQ-DPCI-CONFIG-FUN-3 producer of provisioning MnS should have a capability to notify the authorized consumer with the PCI value(s) being selected for NR cell(s).

REQ-DPCI-CONFIG-FUN-4 producer of provisioning MnS should have a capability to notify the authorized consumer about the resolution of PCI collision or PCI confusion problems for NR cells.

REQ-DPCI-CONFIG-FUN-5 producer of provisioning MnS should have a capability allowing an authorized consumer to configure or re-configure the PCI list at the PCI configuration function.

REQ-DPCI-CONFIG-FUN-6 producer of fault supervision MnS should have a capability to generate or clear the alarm to PCI configuration function failure.

6.1.1.5 LBO (Load Balancing Optimisation)

REQ-DLBO-FUN-1 Provisioning MnS for D-LBO function should have a capability allowing an authorized consumer to set or update the ranges of HO and/or reselection parameters, and control parameters for LBO function.

REQ-DLBO-FUN-2 Performance assurance MnS for D-LBO function should have a capability allowing the authorized consumer to collect the LBO related performance measurements that are used to evaluate the LBO performance.

REQ-DLBO-FUN-3 Provisioning MnS for D-LBO function should have a capability to notify the authorized consumer about the LBO actions being performed.

6.1.1.6 CHO management

REQ-DCHO-FUN-1 The producer of NF provisioning MnS should have the capability allowing an authorized consumer to enable or disable Conditional Handover for a gNB.

REQ-DCHO-FUN-2 The producer of NF performance assurance MnS should have the capability to produce measurements related to CHO.

6.1.1.7 DAPS handover management

REQ-DDAPSHO-FUN-1 The producer of NF provisioning MnS should have the capability allowing an authorized consumer to enable or disable DAPS handover for a gNB.

REQ-DDAPSHO-FUN-2 The producer of NF performance assurance MnS should have the capability to produce measurements related to DAPS handover.

6.1.2 Centralized SON

6.1.2.1 PCI configuration

REQ- CPCI-CONFIG-FUN-1 The producer of provisioning MnS should have a capability allowing an authorized consumer to configure or re-configure the PCI value(s) for NR cell(s).

REQ- CPCI-CONFIG-FUN-2 The producer of provisioning MnS should have a capability to notify the authorized consumer with the PCI value(s) being assigned to NR cell(s).

REQ-CPCI-CONFIG-FUN-3 The producer of performance assurance MnS should have a capability allowing an authorized consumer to collect performance measurements about handover degradation which may be caused by PCI collision or PCI confusion problems for NR cells.

REQ-CPCI-CONFIG-FUN-4 The trace data producer MnS should have a capability to supply the authorized consumer with data allowing it to detect PCI collision or PCI confusion problems for NR cells.

REQ-CPCI-CONFIG-FUN-5 The producer of performance assurance MnS should have a capability to notify the authorized consumer about handover improvement which is the result of a resolved PCI collision or PCI confusion problem for NR cells.

6.1.2.2 LBO (Load Balancing Optimisation)

REQ-CLBO-FUN-1 Provisioning MnS for C-LBO function should have a capability allowing an authorized consumer to set or update the ranges of HO and/or reselection parameters for LBO function.

REQ-CLBO-FUN-2 Performance assurance MnS for C-LBO function should have a capability allowing the authorized consumer to collect the LBO load and LBO related performance measurements.

6.1.2.2 Requirements for RAN NE plug and connect to management system

The requirements for plug and connect an NE to management system are specified in TS 28.314 [22].

6.1.2.3 Requirements for self-configuration of a new RAN NE

The requirements for self-configuration management of a new RAN NE are specified in TS 28.317 [23].

6.1.2.4 RRM resources optimization for network slice instance(s)

REQ-RRM-FUN-1 producer of provisioning MnS should have a capability allowing authorized consumer(s) to update the RRM policies.

REQ-RRM-FUN-2 producer of performance assurance MnS should have a capability allowing authorized consumer(s) to collect the RRM related performance measurements on a per network slice instance basis.

6.1.2.5 Centralized Capacity and Coverage Optimization

REQ-CCO-FUN-1 producer of provisioning MnS should have a capability allowing authorized consumer(s) to update the CCO control parameters.

REQ-CCO-FUN-2 producer of performance assurance MnS should have a capability allowing authorized consumer(s) to collect the CCO related measurements, MDT, RLF and RCEF reports.

6.2 Actor roles

See use cases in clause 6.4.

6.3 Telecommunication resources

See use cases in clause 6.4.

6.4 Use cases

6.4.1 Distributed SON management

6.4.1.1 RACH Optimization (Random Access Optimisation)

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To automatically configure the RACH parameters in a cell in order to achieve the optimal network performance by reducing the network access time, and minimize the failures.	
Actors and Roles	D-SON management function to support RACH Optimization function.	
Telecom resources	- gNB; - The producer of provisioning MnS	
Assumptions	N/A	
Pre-conditions	- 5G NR cells are in operation. - RACH Optimization function is in operation.	
Begins when	The D-SON management function decides to enable the RACH Optimization function.	
Step 1 (M)	The D-SON management function requests the producer of provisioning MnS to set the targets for the RACH optimization function.	
Step 2 (M)	The D-SON management function requests the producer of provisioning MnS to enable the RACH optimization function.	
Step 3 (M)	The D-SON management function collects the RACH related measurements, and analyse them to evaluate the RACH performance.	
Step 4 (O)	If the D-SON management function determines that the RACH performance does not meet the target, it updates the targets for RACH optimization function;	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The RACH performance has been optimized.	
Traceability	**REQ-RACH-FUN-1, REQ-RACH-FUN-2, REQ-RACH-FUN-3**	

6.4.1.2 MRO (Mobility Robustness Optimisation)

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To automatically configure the handover parameters in cells or beams in order to improve the handover performance.	
Actors and Roles	D-SON management function to support MRO function.	
Telecom resources	- gNB; - The producer of provisioning MnS	
Assumptions	N/A	
Pre-conditions	- 5G NR cells are in operation. - MRO is in operation.	
Begins when	The D-SON management decides to enable MRO function.	
Step 1 (M)	The D-SON management function requests the producer of provisioning MnS to set the targets, HO offset ranges, and control information for the MRO function.	
Step 2 (M)	The D-SON management function requests the producer of provisioning MnS to enable the MRO function.	
Step 3 (M)	The MRO function detects handover issues (e.g. too late HO, too early HO and HO to a wrong cell) in intra-RAT or inter-RAT mobility by analysing reports from UEs and network side information, and acts to mitigate the HO issues by adjusting HO related parameters.	
Step 4 (M)	The D-SON management function collects MRO related measurements, and analyses them to evaluate the MRO performance.	
Step 5 (M)	The D-SON management function performs the following action, if the MRO performance does not meet the target: 1. Update the targets for MRO function. 2. Update the ranges for MRO function. 3. Update the control information for MRO function.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The MRO performance has been optimized.	
Traceability	**REQ-MRO-FUN-1, REQ- MR-FUN-2, REQ-MRO-FUN-3, REQ-MRO-FUN-4**	

6.4.1.3 ANR management

6.4.1.3.1 Starting the ANR function

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	The goal is to make the ANR function in the gNB is enabled.	
Actors and Roles	A MnS consumer of the MnS of D-SON management	
Telecom resources	The MnS producer of D-SON management gNB	
Assumptions		
Pre-conditions	The ANR function is not active. The gNB may have NCRs. The NCRs may be configured by a MnS consumer or may have been added by the ANR function if the ANR function has been active previously.	
Begins when	The Use Case begins when the MnS consumer decides to enable the ANR function in a gNB.	
Step 1 (M)	The MnS consumer enables the ANR function in the gNB.	
Ends when	Ends when all steps identified above are completed or when an exception occurs	
Exceptions	One of the steps identified above fails and retry is unsuccessful.	
Post Conditions	The ANR function in gNB is successfully enabled by the MnS consumer, or if unsuccessful, still disabled.	
Traceability	REQ-NR-ANR-FUN-0h	

6.4.1.3.2 Stopping the ANR function

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	The goal is to make the ANR function in the gNB is disabled.	
Actors and Roles	A MnS consumer of the MnS of D-SON management	
Telecom resources	The MnS producer of D-SON management gNB	
Assumptions		
Pre-conditions	The ANR function is active	
Begins when	The Use Case begins when the MnS consumer decides to disable the ANR function in a gNB.	
Step 1 (M)	The MnS consumer disables the ANR function in the gNB.	
Ends when	Ends when all steps identified above are completed or when an exception occurs.	
Exceptions	One of the steps identified above fails and retry is unsuccessful.	
Post Conditions	The ANR function in gNB is successfully disabled by the MnS consumer, or if unsuccessful, still enabled. All existing NCRs, whether created by ANR or otherwise are unaltered.	
Traceability	REQ-NR-ANR-FUN-0h	

6.4.1.3.3 Sending notification of added or deleted NCR

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	The goal is for the MnS producer to send a notification of added or deleted NCR to the MnS consumer.	
Actors and Roles	A MnS consumer of the MnS of D-SON management.	
Telecom resources	The MnS producer of D-SON management. gNB	
Assumptions		
Pre-conditions	The ANR function is active	
Begins when	An NCR is added or deleted. This could be the result of either the ANR function's action, or the creation of the deletion of an NCR by a MnS consumer.	
Step 1 (M)	The MnS producer sends a notification to the MnS consumer.	
Ends when	Ends when all steps identified above are completed or when an exception occurs.	
Exceptions	One of the steps identified above fails and retry is unsuccessful.	
Post Conditions	The MnS consumer is aware of the creation or deletion of the NCR.	
Traceability	REQ-NR-ANR-FUN-0m	

6.4.1.3.4 Handover Allowlisting

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	The goal is to make an NCR present in the NCRT, useful for handovers.	
Actors and Roles	A MnS consumer of the MnS of D-SON management	
Telecom resources	The MnS producer of D-SON management gNB	
Assumptions		
Pre-conditions	The ANR function is active.	
Begins when	The Use Case begins when the MnS consumer decides to allowlist an NCR.	
Step 1 (O)	The MnS consumer creates the NCR This step is executed if it the wanted NCR not already present in the NCRT.	
Step 2 (M)	The MnS consumer marks the NCR so that handovers are allowed, and so that the ANR function is not allowed to remove the NCR.	
Ends when	Ends when all steps identified above are completed or when an exception occurs.	
Exceptions	One of the steps identified above fails and retry is unsuccessful.	
Post Conditions	The wanted NCR is present in the NCRT. It is protected from being removed by the ANR function.	
Traceability	REQ-NR-ANR-FUN-0c, REQ-NR-ANR-FUN-0i	

6.4.1.3.5 Handover Blocklisting

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	The goal is to make an NCR is present in the NCRT and made unavailable for handovers.	
Actors and Roles	A MnS consumer of the MnS of D-SON management	
Telecom resources	The MnS producer of D-SON management gNB	
Assumptions		
Pre-conditions	The ANR function is active.	
Begins when	The Use Case begins when the MnS consumer decides to blocklist an NCR.	
Step 1 (O)	The MnS consumer creates the NCR. This step is executed if it the wanted NCR not already present in the NCRT.	
Step 2 (M)	The MnS consumer marks the NCR so that handovers are prohibited, and so that the ANR function is not allowed to remove the NCR.	
Ends when	Ends when all steps identified above are completed or when an exception occurs.	
Exceptions	One of the steps identified above fails and retry is unsuccessful.	
Post Conditions	The wanted NCR is present in the NCRT. It is protected from being removed by the ANR function.	
Traceability	REQ-NR-ANR-FUN-0d, REQ-NR-ANR-FUN-0i	

6.4.1.3.6 Prohibiting X2 or Xn connection to a peer node (X2/Xn blocklisting)

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	The goal is to prohibit a gNB from setting up an X2 or Xn connection to a peer gNB or eNB. If such a connection existed, it is brought down.	
Actors and Roles	A MnS consumer of the MnS of D-SON management	
Telecom resources	The MnS producer of D-SON management gNB	
Assumptions		
Pre-conditions	The ANR function is active.	
Begins when	The Use Case begins when the MnS consumer decides to prohibit the setting up of X2 or Xn connections to a peer node.	
Step 1 (M)	The MnS consumer configures the MnS producer with the peer node into the list of nodes for which X2 or Xn connections are prohibited.	
Ends when	Ends when all steps identified above are completed or when an exception occurs.	
Exceptions	One of the steps identified above fails and retry is unsuccessful.	
Post Conditions	The peer node is in the block-list. If an X2 or Xn connection was present to the peer node, it is brought down.	
Traceability	REQ-NR-ANR-FUN-0g	

6.4.1.3.7 Prohibiting handover over X2 or Xn (X2/Xn handover blocklisting)

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	The goal is to prohibit a gNB from using an X2 or Xn connection to a peer gNB or eNB for handover.	
Actors and Roles	A MnS consumer of the MnS of D-SON management.	
Telecom resources	The MnS producer of D-SON management gNB	
Assumptions		
Pre-conditions	The ANR function is active.	
Begins when	The Use Case begins when the MnS consumer decides to prohibit using the X2 or Xn connection to a peer node for handover.	
Step 1 (M)	The MnS consumer configures the MnS producer to mark the NCR to the peer node so that handovers over the X2 or Xn connection are prohibited.	
Ends when	Ends when all steps identified above are completed or when an exception occurs.	
Exceptions	One of the steps identified above fails and retry is unsuccessful.	
Post Conditions	The gNB is prohibited from using the using the X2 or Xn connection to the peer node for handovers.	
Traceability	REQ-NR-ANR-FUN-0o	

6.4.1.4 PCI configuration

6.4.1.4.1 Initial PCI configuration

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To automatically configure the initial PCI for a NR cell,from a list of PCIs .	
Actors and Roles	D-SON management function to support initial PCI list configuration.	
Telecom resources	- gNB; - The producer of provisioning MnS	
Assumptions	N/A	
Pre-conditions	- The NR cells is not yet in operation. - No PCI list has been assigned to the NR cell.	
Begins when	The D-SON management function decides to configure the PCI list for a NR cell.	
Step 1 (M)	The D-SON management function requests the producer of provisioning MnS to configure the PCI list for a cell to the PCI configuration function.	
Step 2 (M)	The D-SON management function requests the producer of provisioning MnS to enable the PCI configuration function at NR cell(s).	
Step 3 (M)	When the cell is about to start operating, the PCI configuration function selects a PCI value from the list of PCI values and provides that to the NR cell.	
Step 4 (M)	The producer of provisioning MnS notifies the consumer with the PCI value being assigned for the NR cell.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The PCI value of a NR cell has been configured.	
Traceability	**REQ-DPCI-CONFIG-FUN-1, REQ-DPCI-CONFIG-FUN-2, REQ-DPCI-CONFIG-FUN-3, REQ-DPCI-CONFIG-FUN-5**	

6.4.1.4.2 PCI re-configuration failure mitigation

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To automatically re-configure the PCI list of an NR cell, due to the failure of PCI configuration function to resolve PCI collision or PCI confusion problems.	
Actors and Roles	D-SON management function to support PCI re-configuration.	
Telecom resources	- gNB; - The producer of provisioning MnS - The producer of fault supervision MnS	
Assumptions	N/A	
Pre-conditions	- A NR cell has been assigned a PCI value. - The PCI configuration function is in operation and enabled.	
Begins when	The PCI configuration function has detected the PCI problem of a PCI collision or a PCI confusion for an NR cell.	
Step 1 (M)	The D-SON management function receives an alarm from the producer of fault supervision MnS indicating the PCI configuration function failed to resolve PCI collision or PCI confusion problems for an NR cell(s).	
Step 2 (M)	The D-SON management function requests the producer of provisioning MnS to re-configure the PCI list at the PCI configuration function.	
Step 3 (M)	The PCI configuration function selects PCI value(s) from the PCI list.	
Step 4 (M)	The producer of provisioning MnS notifies the consumer about the new PCI value of the NR cell.	
Step 5 (M)	The D-SON management function receives a clear alarm notification from the producer of fault supervision MnS indicating the PCI configuration function has resolved the PCI issues.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The PCI collision or PCI confusion have been resolved.	
Traceability	**REQ-DPCI-CONFIG-FUN-3, REQ-DPCI-CONFIG-FUN-4, REQ-DPCI-CONFIG-FUN-5, REQ-DPCI-CONFIG-FUN-6**	

6.4.1.4.3 PCI re-configuration

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To automatically re-configure the PCI of an NR cell, PCI collision or PCI confusion problems.	
Actors and Roles	D-SON management function to support PCI re-configuration.	
Telecom resources	- gNB; - The producer of provisioning MnS - The producer of fault supervision MnS	
Assumptions	N/A	
Pre-conditions	- A NR cell has been assigned a PCI value. - The PCI configuration function is in operation and enabled.	
Begins when	The PCI configuration function has detected a PCI collision or a PCI confusion for an NR cell.	
Step 1 (M)	The PCI configuration function selects a PCI values from the PCI list, and configures the cell with the new PCI value.	
Step 2 (M)	The producer of provisioning MnS notifies the consumer about the new PCI value of the NR cell.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The PCI collision or PCI confusion have been resolved.	
Traceability	**REQ-DPCI-CONFIG-FUN-3, REQ-DPCI-CONFIG-FUN-4**	

6.4.1.5 LBO (Load Balancing Optimisation)

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To automatically distribute user traffic among neighboring cells to ensure the radio resources are efficiently used, while providing quality end-user experience and performance.	
Actors and Roles	D-SON management function to support LBO function.	
Telecom resources	- The producer of provisioning MnS	
Assumptions	N/A	
Pre-conditions	- D-LBO is in operation.	
Begins when	The D-SON management function decides to enable D-LBO function.	
Step 1 (M)	The D-SON management function requests the producer of provisioning MnS to set the handover and/or reselection parameters ranges (see clause 15.5.1.4 in TS 38.300 [7]), and to enable the D-LBO function.	
Step 2 (M)	The D-LBO function perform load balancing as describe in clause 15.5 in TS 38.300 [7] and may notify D-LBO management function when the LBO action has been performed.	
Step 3 (M)	The D-SON management function collects LBO related measurements.	
Step 4 (M)	The D-SON management function analyses the measurements to evaluate the LBO performance and may request the producer of provisioning MnS to update the ranges for HO and/or reselection parameters.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The LBO performance has been optimized.	
Traceability	**REQ-DLBO-FUN-1, REQ-DLBO-FUN-2, REQ-DLBO-FUN-3**	

6.4.1.6 CHO (Conditional Handover)

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To enable CHO.	
Actors and Roles	D-SON management function to support the CHO function.	
Telecom resources	- gNB; - The producer of provisioning MnS.	
Assumptions	N/A	
Pre-conditions	- 5G NR cells are in operation. - CHO is not in operation for a gNB.	
Begins when	The D-SON management function intends to enable CHO for a gNB.	
Step 1 (M)	The D-SON management function requests the producer of provisioning MnS to enable CHO for a gNB.	
Step 2 (M)	The D-SON management function collects CHO related measurements and analyses them to evaluate the CHO performance.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	CHO is in operation from for a gNB.	
Traceability	**REQ-DCHO-FUN-1, REQ-DCHO-FUN-2**	

6.4.1.7 DAPS HO (Dual Active Protocol Stack Handover)

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To enable DAPS HO.	
Actors and Roles	D-SON management function to support the DAPS HO function.	
Telecom resources	- gNB; - The producer of provisioning MnS.	
Assumptions	N/A	
Pre-conditions	- 5G NR cells are in operation. - DAPS HO is not in operation for a gNB.	
Begins when	The D-SON management function intends to enable DAPS HO for a gNB.	
Step 1 (M)	The D-SON management function requests the producer of provisioning MnS to enable DAPS HO from a source cell to a target cell.	
Step 2 (M)	The D-SON management function collects DAPS HO related measurements and analyses them to evaluate the DAPS HO performance.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	DAPS HO is in operation for a gNB.	
Traceability	**REQ-DDAPSHO-FUN-1, REQ-DDAPSHO-FUN-2**	

6.4.2 Centralized SON

6.4.2.1 PCI configuration

6.4.2.1.1 Initial PCI configuration

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To automatically configure the PCIs of NR cell(s) that have not been assigned with PCI value(s).	
Actors and Roles	C-SON function to support PCI configuration.	
Telecom resources	- gNB; - The producer of provisioning MnS	
Assumptions	N/A	
Pre-conditions	- 5G NR cells have not been assigned with PCI values yet. - The C-SON has been enabled.	
Begins when	The C-SON function decides to configure PCI values for NR cell(s).	
Step 1 (M)	The C-SON function determines the PCI value(s) for the NR cell(s) that have no collision or confusion with its neighbours.	
Step 2 (M)	The C-SON function requests the producer of provisioning MnS to configure the PCI value(s) at the NR cell(s).	
Step 3 (M)	The producer of provisioning MnS notifies the consumer with the PCI value(s) being assigned for the NR cell(s).	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The PCI value of a NR cell has been selected.	
Traceability	**REQ-CPCI-CONFIG-FUN-1, REQ-CPCI-CONFIG-FUN-2**	

6.4.2.1.2   PCI re-configuration

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To automatically re-configure the PCIs of NR cells, due to the PCI collision or PCI confusion problems.	
Actors and Roles	C-SON to support PCI re-configuration.	
Telecom resources	- gNB; - The producer of provisioning MnS - The producer of fault supervision MnS	
Assumptions	N/A	
Pre-conditions	- 5G NR cells are in operation. - The C-SON function is in operation, and is enabled, and subscribed PM measurements are received.	
Begins when	The C-SON function requests the producer of performance assurance MnS to collect handover performance related measurements reported by NG-RAN. C-SON finds a potential PCI confusion and/or collision based on received PM data.	
Step 1 (M)	Based on the measurements above, the C-SON function requests the producer of trace MnS to collect Radio Link Failure traces from UEs in cells where PCI collision or PCI confusion is suspected.	
Step 2 (M)	The C-SON function analyses the PCI related information and detects if NR cells have experienced PCI conflict or confusion issues. If no PCI collision or confusion is found, go to step 5.	
Step 3 (M)	When the C-SON function detects PCI collision and/or confusion it determines the new PCI value(s), and requests the producer of provisioning MnS to re-configure the PCI value for the NR cell(s) which experienced PCI conflict or confusion issues.	
Step 4 (M)	The producer of provisioning MnS notifies the C-SON function about the resolution of PCI collision or PCI confusion problems for NR cell(s).	
Step 5 (M)	The C-SON function requests the producer of performance assurance MnS to collect handover performance related measurements reported by NG-RAN in order to assess whether the PCI collision or confusion was corrected. The C-SON function turns off the collection of RLF data.	
Ends when	All the steps identified above are successfully completed. Step 5 is done.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The PCI value of a NR cell has been selected.	
Traceability	**REQ-CPCI-CONFIG-FUN-1, REQ-CPCI-CONFIG-FUN-2, REQ-CPCI-CONFIG-FUN-3, REQ-CPCI-CONFIG-FUN-4, REQ-CPCI-CONFIG-FUN-5**	

6.4.2.2   Use case for establishment of a new RAN NE in network

6.4.2.2.1   Use case for RAN NE plug and connect to management system

The NE described in this use case can be gNB in non-split scenario and gNB-DU in split scenario.

Note: The NE within virtualization is not addressed.

The details of this use case are covered in plug and connect use case in TS 28.314 [22].

6.4.2.2.2   Use case for self-configuration of a new RAN NE

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal (*)	After installation, put in an automated manner the NE into a state to be ready to carry traffic.	
Actors and Roles (*)	MnF providing support for self-configuration process act as MnS Producer for Self-configuration management	
Telecom resources	NE MnS Consumer of Self-configuration management	
Assumptions	IP network connectivity exists between the NE and the MnF(s) providing support for the self-configuration process.	

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Pre conditions	The NE is installed and connected to an IP network.	Clause 6.4.2.2.1 Use case for Plug and connect to management system
Begins when	The field personnel start the self-configuration process. It is also possible that the process is triggered automatically after the completion of an NE self-test or receiving the self-configuration management profile creation request from MnS Consumer for self-configuration management.	
Step 1 (O)	MnF providing support for self-configuration process may notify MnS Consumer of self-configuration management about the start of the self configuration process.	
Step 1 (*) (M|O)	The order of the bullet points in the list below does not imply any statements on the order of execution. - An NE IP address is allocated to the new NE. - Basic information about the transport network (e. g. gateways) environment is provided to the NE. With this information the NE is able to exchange IP packets with other internet hosts. - The NE provides information about its type, hardware and other relevant data about itself to the MnF(s) providing support for the self-configuration process. - The address(es) of the MnF(s) providing support for the self-configuration process (e.g. MnF for software download, MnF for configuration data download) is provided to the NE. The address is equal to an IP address and a port number, or a DNS name and port number, or an URI. The address(es) of the MnF(s) providing support for normal OAM functions after completion of the self-configuration process are provided to the NE. The address is equal to an IP address and a port number, or a DNS name and port number, or an URI. - The NE connects to the MnF providing support for the software download. - The decision which software or software packages have to be downloaded to the NE is taken. - The software is downloaded into the NE. - The NE connects to the MnF providing support for the configuration data download. - The configuration data for the NE is made available by either preparing it or making prepared configuration data available. - The configuration data is downloaded into the NE. - Dependent External nodes are updated with new configuration data as well (if required). - The NE connects to the MnF providing support for normal OAM functions after completion of the self-configuration process. - The inventory system in the MnF is informed that a new NE is in the field. - The NE performs a self-test. Self-tests of different types can run at different places within the self-configuration procedure. - The operator is informed about the progress of the self-configuration process and important events occurring during the self-configuration process. - The network resource models are updated during and after the self-configuration process. - SW is installed, i.e. prepared in such a way, that the NE is ready to use it. NE is allowed to use the SW.	
Step 3 (O)	MnF providing support for self-configuration process may notify MnS Consumer of Self-configuration management about the progress of the self configuration during self-configuration process.	
Ends when (*)	Ends when all steps identified above are successfully completed or when an exception occurs.	
Exceptions		
Post Conditions	The NE is ready to carry traffic.	
Traceability (*)	All requirements of clause 6.1.2.3	

6.4.2.3 RRM resources optimization for network slice instance(s)

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To enable the optimization of the RRM resources allocated among network slice instance(s) to ensure the RRM resources are efficiently used, while providing quality end-user experience and performance.	
Actors and Roles	C-SON function to support RRM resource optimization for network slice instance(s).	
Telecom resources	- gNB; - The producer of provisioning MnS	
Assumptions	N/A	
Pre-conditions	- 5G NR cells are in operation. - An AI/ML model has been created based on the RRM related performance measurements received previously.	
Begins when	The C-SON function has been enabled.	
Step 1 (M)	The C-SON function collects RRM related measurements on a per network slice instance basis (e.g. mean DL/UL PRB used for data traffic, mean number of DRBs successfully setup, and mean number of PDU Sessions successfully setup, … etc.), by consuming the MnS of performance assurance.	
Step 2 (M)	The C-SON function analyzes the measurements to train the AI/ML model and determines the actions to optimize the RRM resources for network slice instance(s) that include consuming the MnS of provisioning to update the appropriate RRM policies.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The RRM resources for network slice instance(s) have been optimized.	
Traceability	**REQ-RRM-FUN-1, REQ-RRM-FUN-2**	

6.4.2.4 Centralized Capacity and Coverage Optimization (CCO)

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To optimize the capacity and coverage of NR cells to insure the efficient network resource usage, and optimal end-user experience and performance.	
Actors and Roles	C-SON function to support CCO.	
Telecom resources	- gNB; - The producer of provisioning MnS	
Assumptions	- PM job control and provisioning have been executed to allow C-SON function to receive performance measurements, MDT, RLF, and RCEF reports.	
Pre-conditions	- 5G NR cells are in operation.	
Begins when	The C-SON function has been configured with control information and enabled.	
Step 1 (M)	The C-SON function collects measurements (e.g. distribution of RSRP, RSRQ, …), MDT, RLF, and RCEF reports to monitor the issues (e.g. coverage holes, capacity deficiency, …) for NR cells or beams.	
Step 2 (M)	The C-SON function analyzes the measurements and MDT, RLF, RCEF reports to determine the actions if needed to optimize the NR cells or beams capacity and coverage according to the coverage optimization control policy i.e. adjusting the adjustable parameters within the specified ranges.	
Step 3 (O)	C-SON function consumes the provisioning MnS to re-configure the CCO control parameters.	
Step 4 (O)	The C-SON function collects measurements to evaluate whether the CCO actions have resolved the issues.	
Step 5 (O)	The C-SON function may re-configure or restore the CCO control parameters, if the issues have not been mitigated.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The capacity and coverage of NR cells have been optimized.	
Traceability	**REQ-CCO-FUN-1, REQ-CCO-FUN-2,**	

6.4.2.5　　LBO (Load Balancing Optimisation)

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To automatically distribute user traffic among neighboring cells to ensure the radio resources are efficiently used, while providing quality end-user experience and performance.	
Actors and Roles	C-LBO function to support LBO.	
Telecom resources	- The producer of provisioning MnS	
Assumptions	Both Domain Centralized SON and Cross-Domain Centralized SON are supported.	
Pre-conditions	- The C-LBO has been enabled.	
Begins when	The C-LBO function is enabled.	
Step 1 (M)	The C-LBOfunction collects LBO load measurements by consuming the MnS of performance assurance.	
Step 2 (M)	The C-LBOfunction analyses measurements to determine the actions to optimize the traffic load distributions among neighboring cells that include consuming the MnS of provisioning to update the ranges for handover parameters.	
Step 3 (M)	The C-LBOfunction collects LBO related measurements, and analyses them to evaluate the LBO performance, and may request the producer of provisioning MnS to update the ranges for HO and/or reselection parameters.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The LBO performance has been optimized.	
Traceability	**REQ-CLBO-FUN-1, REQ-CLBO-FUN-2**	

7　　Management services for SON

7.1　　Management services for D-SON management

7.1.1　　RACH Optimization (Random Access Optimisation)

7.1.1.1　　MnS component type A

Table 7.1.1.1-1: RACH optimization type A

MnS Component Type A	Note
Operations and notifications defined in clause 11.1.1of TS 28.532 [3]: - `createMOI` operation - `getMOIAttributes` operation - `modifyMOIAttributes` operation - `deleteMOI` operation - `notifyMOIAttributeValueChanges` operation - `notifyMOICreation` - `notifyMOIDeletion` - `notifyMOIChanges`	It is supported by Provisioning MnS for NF, as defined in 28.531 [11].
Operations defined in clause 11.3.1.1.1 in TS 28.532 [3] and clause 6.2.3 of TS 28.550 [12]: - `notifyFileReady` operation - `reportStreamData` operation	It is supported by Performance Assurance MnS for NFs, as defined in 28.550 [12].

7.1.1.2   MnS Component Type B definition

7.1.1.2.1   Targets information

The targets of RACH optimization are shown in Table 7.1.2.1.1-1.

Table 7.1.1.1.2-1: RACH optimization targets

Targets	Definition	Legal Values
UE access delay probability	The probability distribution of UE access delay per cell.	CDF of access delay
Number of preambles sent probability	The probability of the number of preambles sent per cell.	CDF of access probability

7.1.1.2.2   Control information

The parameter is used to control the RACH optimization function.

Table 7.1.1.2.2-1: RACH optimization control

Control parameter	Definition	Legal Values
RACH optimization control	This attribute allows authorized consumer to enable/disable the RACH optimization functionality. See attribute `drachOptimizationControl` in TS 28.541 [13].	Boolean On, off

7.1.1.2.3   Parameters to be updated

Void.

7.1.1.3   MnS Component Type C definition

7.1.1.3.1   Performance measurements

Performance measurements related to the RACH optimization are captured in Table 7.1.1.3.1-1:

Table 7.1.1.3.1-1: RACH optimization related performance measurements

Performance measurements	Description	Related targets
Distribution of RACH preambles sent	Distribution of the number of preambles UEs sent to achieve synchronization per SSB, where the number of preambles sent corresponds to PREAMBLE_TRANSMISSION_COUNTER (see clause 5.1.1 in TS 38.321 [4]) in UE.	UE access delay probability per SSB
Distribution of UEs access delay per SSB	Distribution of the time needed for UEs to successfully attach to the network per SSB.	Number of preambles send per SSB probability

7.1.2 MRO (Mobility Robustness Optimisation)

7.1.2.1 MnS component type A

Table 7.1.2.1-1: MRO type A

MnS Component Type A	Note
Operations and notifications defined in clause 11.1.1 of TS 28.532 [3]: `createMOI` operation - `getMOIAttributes` operation - `modifyMOIAttributes` operation - `deleteMOI` operation - `notifyMOIAttributeValueChanges` operation - `notifyMOICreation` - `notifyMOIDeletion` - `notifyMOIChanges`	It is supported by Provisioning MnS for NF, as defined in TS 28.531 [11].
Operations defined in clause 11.3.1.1.1 in TS 28.532 [3] and clause 6.2.3 of TS 28.550 [12]: - `notifyFileReady` operation - `reportStreamData` operation	It is supported by Performance Assurance MnS for NFs, as defined in TS 28.550 [12].

7.1.2.2 MnS Component Type B definition

7.1.2.2.1 Targets information

The targets of MRO are shown in the Table 7.1.2.2.1-1.

Table 7.1.2.2.1-1: MRO targets

Target Name	Definition	Legal Values
Total handover failure rate	(the number of failure events related to handover) / (the total number of handover events)	[0..100] in unit percentage
Total intra-RAT handover failure rate	(the number of failure events related to intra-RAT handover) / (the total number of handover events)	[0..100] in unit percentage
Total inter-RAT handover failure rate	(the number of failure events related to inter-RAT handover) / (the total number of handover events)	[0..100] in unit percentage

7.1.2.2.2 Control information

The parameter is used to control the MRO function.

Table 7.1.2.2.2-1: MRO control

Control parameter	Definition	Legal Values
MRO function control	This attribute allows the operator to enable/disable the MRO functionality. See attribute `dmroControl` in TS 28.541 [13].	Boolean On, off

7.1.2.2.3 Parameters to be updated

Table 7.1.2.2.3-1: Ranges of handover parameters

Control parameters	Definition	Legal Values
Maximum deviation of Handover Trigger	This parameter defines the maximum allowed deviation of the Handover Trigger from the default point of operation (see clause 15.5.2.5 in TS 38.300 [7] and clause 9.2.2.61 in TS 38.423 [17]). See attribute `maximumDeviationHoTrigger` in TS 28.541 [13]. The upper and lower bounds of this parameter are configured separately.	[-20..20] in unit 0.5 dB
Minimum time between Handover Trigger changes	This parameter defines the minimum allowed time interval between two Handover Trigger change performed by MRO. This is used to control the stability and convergence of the algorithm (see clause 15.5.2.5 in TS 38.300 [7]). See attribute `minimumTimeBetweenHoTriggerChange` in TS 28.541 [13].	[0.. 604800] in unit Seconds
Tstore_UE_cntxt	The timer used for detection of too early HO, too late HO and HO to wrong cell. Corresponds to Tstore_UE_cntxt timer described in clause 15.5.2.5 in TS 38.300 [7]. See attribute `tstoreUEcntxt` in TS 28.541 [13].	[0..1023] in unit 100 milliseconds

7.1.2.3 MnS Component Type C definition

7.1.2.3.1 Performance measurements

Performance measurements related MRO are captured in Table 7.1.2.3.1.-1:

Table 7.1.2.3.1-1. MRO related performance measurements

Performance measurements	Description	Related targets
Number of handover events	Includes all successful and unsuccessful handover events (see clause 5.1.1.6 in TS 28.552 [5]).	Total handover failure rate
Number of handover failures	Includes unsuccessful handover events with failure causes (see clause 5.1.1.6 in TS 28.552 [5]).	Total handover failure rate
Number of intra-RAT handover events	Includes all successful and unsuccessful intra-RAT handover events (see clauses 5.1.1.6.1 and 5.1.1.6.2 in TS 28.552 [5]).	Total intra-RAT handover failure rate
Number of intra-RAT handover failures	Includes unsuccessful intra-RAT handover events with failure causes (see clauses 5.1.1.6.1 and 5.1.1.6.2 in TS 28.552 [5]).	Total intra-RAT handover failure rate
Number of inter-RAT handover events	Includes all successful and unsuccessful inter-RAT handover events (see clause 5.1.1.6.3 in TS 28.552 [5]).	Total inter-RAT handover failure rate
Number of inter-RAT handover failures	Includes unsuccessful inter-RAT handover events with failure causes (see clause 5.1.1.6.3 in TS 28.552 [5]).	Total inter-RAT handover failure rate
Number of intra-system too late handover failures	Detected when an RLF occurs after the UE has stayed for a long period of time in the source cell; the UE attempts to re-establish the radio link connection in the target cell (see clause 5.1.1.25.1 in TS 28.552 [5]).	
Number of intra-system too early handover failures	Detected when an RLF occurs shortly after a successful handover from a source cell to a target cell or a handover failure occurs during the handover procedure; the UE attempts to re-establish the radio link connection in the source cell (see clause 5.1.1.25.1 in TS 28.552 [5]).	

Performance measurements	Description	Related targets
Number of intra-system handover failures to wrong cell	Detected when an RLF occurs shortly after a successful handover from a source cell to a target cell or a handover failure occurs during the handover procedure; the UE attempts to re-establish the radio link connection in a cell other than the source cell or the target cell (see clause 5.1.1.25.1 in TS 28.552 [5]).	
Number of intra-system too late handover failures per source beam	Detected when an RLF occurs after the UE has stayed for a long period of time in the source cell; the UE attempts to re-establish the radio link connection in the target cell (see clause 5.1.1.25.5 in TS 28.552 [5]).	
Number of intra-system too early handover failures per source beam	Detected when an RLF occurs shortly after a successful handover from a source cell to a target cell or a handover failure occurs during the handover procedure; the UE attempts to re-establish the radio link connection in the source cell (see clause 5.1.1.25.5 in TS 28.552 [5]).	
Number of intra-system handover failures to wrong cell per source beam	Detected when an RLF occurs shortly after a successful handover from a source cell to a target cell or a handover failure occurs during the handover procedure; the UE attempts to re-establish the radio link connection in a cell other than the source cell or the target cell (see clause 5.1.1.25.5 in TS 28.552 [5]).	
Number of inter-system too late handover failures	Detected when an RLF occurs after the UE has stayed in anNG-RAN cell for a long period of time; the UE attempts to reconnect to a cell belonging to an E-UTRAN node (see clause 5.1.1.25.2 in TS 28.552 [5]).	
Number of inter-system too early handover failures	Detected when an RLF occurs shortly after a successful handover from an E-UTRAN cell to a target cell in a NG-RAN node (see clause 5.1.1.25.2 in TS 28.552 [5]).	
Number of unnecessary handover for inter-system mobility	Detected when a UE is handed over from NG-RAN to other system (e.g. UTRAN) even though quality of the NG-RAN coverage was sufficient for the service used by the UE (see clause 5.1.1.25.3 in TS 28.552 [5]).	
Number of inter-system handover ping pong	Detected when an UE is handed over from a cell in a source system (e.g. NG-RAN) to a cell in a target system different from the source system (e.g. E-UTRAN), then within a predefined limited time the UE is handed over back to a cell in the source system, while the coverage of the source system was sufficient for the service used by the UE (see clause 5.1.1.25.4 in TS 28.552 [5]).	

7.1.3 PCI configuration

7.1.3.1 MnS component type A

Table 7.1.3.1-1: PCI type A

MnS Component Type A	Note
Operations and notifications defined in clause 11.1.1 of TS 28.532 [3]: - `createMOI` operation - `getMOIAttributes` operation - `modifyMOIAttributes` operation - `deleteMOI` operation - `notifyMOIAttributeValueChanges` operation - `notifyMOICreation` - `notifyMOIDeletion` - `notifyMOIChanges`	It is supported by Provisioning MnS for NF, as defined in 28.531 [11].

7.1.3.2 MnS Component Type B definition

7.1.3.2.1 Control information

The parameter is used to control the D-SON PCI configuration function.

Table 7.1.3.2.1-1: PCI contol

Control parameter	Definition	Legal Values
PCI configuration control	This attribute allows authorized consumer to enable/disable the D-SON PCI configuration functionality. See attribute `dPciConfigurationControl` in TS 28.541 [13].	enable, disable

7.1.3.2.2 Parameters to be updated

The table below lists the parameter related to the D-SON PCI configuration function.

Table 7.1.3.2.2-1: PCI update

Parameters	Definition	Legal Values
PCI list	The list of PCI values to be used by D-SON PCI configuration function to assign the PCI for NR cells. (See attribute `nRPciList` in TS 28.541 [13]).	List of integers

7.1.3.3 MnS Component Type C definition

7.1.3.3.1 Notification information

The table below lists the notifications related to D-SON PCI configuration.

Table 7.1.3.3-1: PCI notifications

Notifications	Description	Note
PCI change notification	When the PCI configuration function changes the PCI of a cell, this change is notified using a `notifyMOIAttributeValueChanges` notification. See attribute nRPCI in TS 28.541 [13].	

7.1.3.3.2 Alarm notification information

The table below lists the alarm notifications related to D-SON PCI configuration.

Table 7.1.3.3.2-1: PCI alarm notifications

Alarm notifications	Description	Note
PCI configuration function failure	This alarm notification indicates that the PCI configuration function has failed to resolve PCI collision or PCI confusion problems.	

7.1.4 ANR management

This management service is used for management of ANR, and ANR is specified in TS 38.300 [7], clauses 15.3.3.

Stage 2 for ANR management is located in TS 28.541 [13], clauses 4.3.2.2, 4.3.2.3, 4.3.32.2 and 4.3.32.3.

Stage 3 for ANR management is located in TS 28.541 [13], clauses C.4.3, D.4.3, and E.5.

7.1.5 LBO (Load Balancing Optimisation)

7.1.5.1 MnS component type A

Table 7.1.5.1-1: D-LBO type A

MnS Component Type A	Note
Operations and notifications defined in clause 5 of TS 28.532 [3]: - `createMOI` operation - `getMOIAttributes` operation - `modifyMOIAttributes` operation - `deleteMOI` operation - `notifyMOIAttributeValueChanges` - `notifyMOICreation` - `notifyMOIDeletion` - `notifyMOIChanges`	It is supported by Provisioning MnS for NF, as defined in TS 28.531 [11].
Operations defined in clause 11.3.1.1.1 in TS 28.532 [3] and clause 6.2.3 of TS 28.550 [12]: - `establishStreamingConnection` operation - `notifyFileReady` operation - `reportStreamData` operation	It is supported by Performance Assurance MnS for NFs, as defined in TS 28.550 [12].

7.1.5.2 MnS Component Type B definition

7.1.5.2.1 Control information

The parameter is used to control the LBO function.

Table 7.1.5.2.1-1: D-LBO control information

Control parameter	Definition	Legal Values
D-LBO function control	This attribute allows the operator to enable/disable the LBO functionality. See attribute `dlboControl` in TS 28.541 [13].	Boolean On, off

7.1.5.2.2 Parameters to be updated

Table 7.1.5.2.2-1: Ranges of HO and cell selection parameters

Control parameters	Definition	Legal Values
Maximum deviation of Handover Trigger	This parameter defines the maximum allowed absolute deviation of the Handover Trigger, from the default point of operation (see clause 15.5.1.4 in TS 38.300 [7] and clause 9.2.2.61 in TS 38.423 [17]). See attribute `maximumDeviationHoTrigger` in TS 28.541 [13].	[-20 .. 20] in unit 0.5 dB
Minimum time between Handover Trigger changes	This parameter defines the minimum allowed time interval between two Handover Trigger change performed by MRO. This is used to control the stability and convergence of the algorithm (see clause 15.5.1.4 in TS 38.300 [7]). See attribute `minimumTimeBetweenHoTriggerChange` in TS 28.541 [13].	[0 .. 604800] in unit Seconds

7.1.5.3 MnS Component Type C definition

7.1.5.3.1 Performance measurements

Performance measurements related LBO are captured in Table 7.1.5.3.1-1:

Table 7.1.5.3.1-1. D-LBO related performance measurements

Performance measurements	Description	Note
DL Total PRB Usage	This measurement provides the total usage (in percentage) of physical resource blocks (PRBs) on the downlink (see clause 5.1.1.2.1 in TS 28.552 [5]).	
UL Total PRB Usage	This measurement provides the total usage (in percentage) of physical resource blocks (PRBs) on the uplink (see clause 5.1.1.2.2 in TS 28.552 [5]).	
Distribution of DL Total PRB Usage	This distribution measurement is to monitor when a cell may experience overload situation in the downlink (see clause 5.1.1.2.3 in TS 28.552 [5]).	
Distribution of UL Total PRB Usage	This distribution measurement is to monitor when a cell may experience overload situation in the uplink (see clause 5.1.1.2.4 in TS 28.552 [5]).	
DL PRB used for data traffic	This measurement provides the number of physical resource blocks (PRBs) in average used in downlink for data traffic (see clause 5.1.1.2.5 in TS 28.552 [5]).	
UL PRB used for data traffic	This measurement provides the number of physical resource blocks (PRBs) in average used in uplink for data traffic (see clause 5.1.1.2.7 in TS 28.552 [5]).	

Performance measurements	Description	Note
Mean number of RRC Connections	This measurement provides the mean number of users in RRC connected mode during the granularity period (see clause 5.1.1.4.1 in TS 28.552 [5]).	
Max number of RRC Connections	This measurement provides the maximum number of users in RRC connected mode during the granularity period (see clause 5.1.1.4.2 in TS 28.552 [5]).	
Mean number of stored inactive RRC Connections	This measurement provides the mean number of users in RRC inactive mode during each granularity period (see clause 5.1.1.4.3 in TS 28.552 [5]).	
Max number of stored inactive RRC Connections	This measurement provides the maximum number of users in RRC inactive mode during each granularity period (see clause 5.1.1.4.3 in TS 28.552 [5]).	

7.1.6 MRO for Conditional Handover (CHO)

7.1.6.1 MnS component type A

MRO for CHO re-uses the component A for MRO, see clause 7.1.2.1.

7.1.6.2 MnS Component Type B definition

7.1.6.2.1 Control information

These parameters are used to control the CHO function.

Table 7.1.6.2.1-1: MRO fro CHO control

Control parameter	Definition	Legal Values
CHO function control	This attribute allows the operator to enable/disable the CHO functionality. See attribute `dCHOControl` in TS 28.541 [13].	Boolean On, off

7.1.6.2.2 Parameters to be updated

MRO for CHO re-uses the same parameters to be updated as MRO, see clause 7.1.2.2.3.

7.1.6.3 MnS Component Type C definition

7.1.6.3.1 Performance measurements

Performance measurements related to MRO for CHO are captured in Table 7.1.6.3.1.-1:

Table 7.1.6.3.1-1. MRO for CHO related performance measurements

Performance measurements	Description	Note
Number of requested conditional handover preparations	Counts the number of successful and unsuccessful inter-gNB conditional handover preparations sent (see TS 28.552 clause 5.1.1.6.6.1)	
Number of successful conditional handover preparations	Counts the number of unsuccessful inter-gNB conditional handover preparations sent (see TS 28.552 clause 5.1.1.6.6.2)	
Number of failed conditional handover preparations	Counts the number of unsuccessful inter-gNB conditional handover preparations sent (see TS 28.552 clause 5.1.1.6.6.3)	

Performance measurements	Description	Note
Number of requested conditional handover resource allocations	Counts the number of successful and unsuccessful inter-gNB conditional handover preparations (see TS 28.552 clause 5.1.1.6.6.4)	
Number of successful conditional handover resource allocations	Counts the number of successful inter-gNB conditional handover preparations (see TS 28.552 clause 5.1.1.6.6.5)	
Number of failed conditional handover resource allocations	Counts the number of unsuccessful inter-gNB conditional handover preparations (see TS 28.552 clause 5.1.1.6.6.6)	
Number of configured conditional handover candidates	Counts the number of outgoing inter-gNB conditional handover candidates requested (see TS 28.552 clause 5.1.1.6.6.7)	
Number of UEs configured with conditional handover.	Counts the number of UEs that has been configured with inter-gNB conditional handover (see TS 28.552 clause 5.1.1.6.6.8)	
Number of successful conditional handover executions	Counts the number of successful inter-gNB conditional handover executions received (see TS 28.552 clause 5.1.1.6.6.9)	
Mean Time of requested conditional handover executions	Counts the mean time of inter-gNB conditional handover executions (see TS 28.552 clause 5.1.1.6.6.11)	
Max Time of requested conditional handover executions	Counts the max time of inter-gNB conditional handover executions (see TS 28.552 clause 5.1.1.6.6.12)	
Number of configured conditional handover candidates	Counts the number of outgoing intra-gNB conditional handover candidates requested (see TS 28.552 clause 5.1.1.6.7.1	
Number of UEs configured with conditional handover	Countes the the number of UEs that has been configured with conditional handover (see TS 28.552 clause 5.1.1.6.7.2)	
Number of successful conditional handover executions	Counts the number of successful intra-gNB conditional handover executions received (see TS 28.552 clause 5.1.1.6.7.3)	
Number of requested conditional handover preparations	Counts the number of outgoing intra-gNB conditional handover preparations requested, for a split gNB deployment (see TS 28.552 clause 5.1.3.7.1.3)	
Number of successful conditional handover preparations	Countes the number of successful intra-gNB conditional handover preparations, for a split gNB deployment (see TS 28.552 clause 5.1.3.7.1.4)	

7.1.7 MRO for DAPS handover

7.1.7.1 MnS component type A

MRO for DAPS handover re-uses the component A for MRO, see clause 7.1.2.1.

7.1.7.2 MnS Component Type B definition

7.1.7.2.1 Control information

The parameter is used to control the DAPS handover function.

Table 7.1.7.2.1-1: MRO for DAPS handover control

Control parameter	Definition	Legal Values
DAPS HO function control	This attribute allows the operator to enable/disable the DAPS HO functionality. See attribute `dDAPSHOControl` in TS 28.541 [13].	Boolean On, off

7.1.7.2.2 Parameters to be updated

MRO for DAPS handover re-uses the same parameters to be updated as MRO, see clause 7.1.2.2.3.

7.1.7.3 MnS Component Type C definition

7.1.7.3.1 Performance measurements

Performance measurements related to MRO for DAPS handover are captured in Table 7.1.7.3.1.-1:

Table 7.1.7.3.1-1. MRO for DAPS handover related performance measurements

Performance measurements	Description	Note
Number of requested DAPS handover preparations	Counts the number of successful and unsuccessful inter-gNB DAPS handover preparations sent (see TS 28.552 clause 5.1.1.6.8.1)	
Number of successful DAPS handover preparations	Counts the number of unsuccessful inter-gNB DAPS handover preparations sent (see TS 28.552 clause 5.1.1.6.8.2)	
Number of failed DAPS handover preparations	Counts the number of unsuccessful inter-gNB DAPS handover preparations sent (see TS 28.552 clause 5.1.1.6.8.3)	
Number of requested DAPS handover resource allocations	Counts the number of successful and unsuccessful inter-gNB DAPS handover preparations (see TS 28.552 clause 5.1.1.6.8.4)	
Number of successful DAPS handover resource allocations	Counts the number of successful inter-gNB DAPS handover preparations (see TS 28.552 clause 5.1.1.6.8.5)	
Number of failed DAPS handover resource allocations	Counts the number of unsuccessful inter-gNB DAPS handover preparations (see TS 28.552 clause 5.1.1.6.8.6)	
Number of requested DAPS handover executions	Counts the number of outgoing inter-gNB DAPS handover candidates requested (see TS 28.552 clause 5.1.1.6.8.7)	
Number of successful DAPS handover executions	Counts the number of successful inter-gNB DAPS handover executions received (see TS 28.552 clause 5.1.1.6.8.8)	
Number of failed DAPS handover executions	Counts the the number of failed inter-gNB DAPS handover executions received (see TS 28.552 clause 5.1.1.6.8.9)	
Number of DAPS handover requested	Counts the number of outgoing intra-gNB DAPS handovers requested (see TS 28.552 clause 5.1.1.6.9.1)	
Number of successful DAPS handovers	Counts the number of successful intra-gNB DAPS handovers (see TS 28.552 clause 5.1.1.6.9.2)	
Number of requested DAPS handover preparations	Counts the number of outgoing intra-gNB DAPS handover preparations requested, for a split gNB deployment (see TS 28.552 clause 5.1.3.7.1.5)	
Number of successful DAPS handover preparations	Countes the number of successful intra-gNB DAPS handover preparations, for a split gNB deployment (see TS 28.552 clause 5.1.3.7.1.6)	

7.2 Management services for C-SON

7.2.1 PCI configuration

7.2.1.1 MnS component type A

Table 7.2.1.1-1: PCI type A

MnS Component Type A	Note
Operations and notifications defined in clause 11.1.1 of TS 28.532 [3]: - `createMOI` operation - `getMOIAttributes` operation -- `modifyMOIAttributes` operation - `deleteMOI` operation - `notifyMOIAttributeValueChanges` operation - `notifyMOICreation` - `notifyMOIDeletion` - `notifyMOIChanges`	It is supported by Provisioning MnS for NF, as defined in 28.531 [11].
Operations and notifications defined in clause 11.5.1 of TS 28.532 [3]: - `establishStreamingConnection` operation - `terminateStreamingConnection` operation - `reportStreamData` operation - `addStream` operation - `deleteStream` operation - `getConnectionInfo` operation - `getStreamInfo` operation	
Operations defined in clauses 11.3.1.1.1 and 11.6.1 in TS 28.532 [3] and clause 6.2.3 of TS 28.550 [12]: `notifyFileReady` operation - `reportStreamData` operation - `notifyFilePreparationError` notification - `subscribe` operation - `unsubscribe` operation - `istAvailableFiles` operation	It is supported by Performance Assurance MnS for NFs, as defined in 28.550 [12].

7.2.1.2 MnS Component Type B definition

7.2.1.2.1 Control information

The parameter is used to control the C-SON PCI configuration function.

Table 7.2.1.2.1-1: PCI control

Control parameter	Definition	Legal Values
PCI configuration control	This attribute allows authorized consumer to enable/disable the C-SON PCI configuration functionality. See attribute `cPciConfigurationControl` in TS 28.541 [13].	disable, enable
PCI list	The list of PCI values to be used by domain centralized SON PCI configuration function to assign the PCI for NR cells. (See attribute `cSonPciList` in TS 28.541 [13]).	Integer

7.2.1.2.2 Parameters to be updated

The table below lists the parameter related to the C-SON PCI configuration function.

Table 7.2.1.2.2-1: PCI update

Updated parameters	Definition	Legal Values
NR PCI	This parameter contains the PCI of the NR cell.	Integer

7.2.1.3 MnS Component Type C definition

7.2.1.3.1 Notifications information

The table below lists the notifications related to PCI configuration are generated from the NR cells.

Table 7.2.1.3.1-1: PCI notification

Notification information	Description	Note
PCI collision notification	The collision notification is used to indicate two neighbouring cells are using the same PCIs.	
PCI Confusion notification	The confusion notification is used to indicate that a serving cell has 2 neighbouring cells that are using the same PCI value.	

7.2.1.3.2 Performance measurements

Performance measurements related to the PCI configuration are collected from the NR cells.

Table 7.2.1.3.2-1. PCI related performance measurements

Performance measurements	Description	Note
PCI of candidate cellsExcessive Radio Link Failure	The measurement contains cumulative counter with subcounters that is identified by the PCI value(s) of the candidate cells, and is derived from *MeasResultListNR* (see clause 6.3.2 in TS 38.331 [9]) where it contains PCI in *PhysCellId*, and RSRP/RSRQ in *MeasQuantityResults* of candidate cells. It is generated when the RSRP received from the candidate cells exceeds certain thresholds. The measurements can be used to discover cells with excessive Radio Link Failures (see TS 28.552 [5] clauses 5.1.1.6.1.8, 5.1.1.6.1.9, 5.1.1.6.2.1 and 5.1.1.6.2.2)	

7.2.1.3.3 Trace Reporting

Trace information related to the PCI configuration are collected from NR cells.

Trace Report	Description	Note
RLF messages	Radio Link Failure messages are generated by UEs experiencing Radio Link Failures, which may be caused by a PCI collision or a PCI confusion (see TS 32.423 [18] clause 4.30 and TS 38.423 [19] clause 8.4.7)	

7.2.2 RRM resources optimization for network slice instance(s)

7.2.2.1 MnS component type A

Table 7.2.2.1-1: RRM resources optimization type A

MnS Component Type A	Note
Operations and notifications defined in clause 5 of TS 28.532 [3]: - `createMOI` operation - `getMOIAttributes` operation - `modifyMOIAttributes` operation - `deleteMOI` operation - `notifyMOIAttributeValueChanges` operation - `notifyMOICreation` - `notifyMOIDeletion` - `notifyMOIChanges`	It is supported by Provisioning MnS for NF, as defined in TS 28.531 [11].
Operations defined in clause 11.3.1.1.1 in TS 28.532 [3] and clause 6.2.3 of TS 28.550 [12]: - `notifyFileReady` operation - `reportStreamData` operation	It is supported by Performance Assurance MnS for NFs, as defined in TS 28.550 [12].

7.2.2.2 MnS Component Type B definition

7.2.2.2.1 Parameters to be updated

Table 7.2.2.2.1-1 defines the RRM related parameters to be updated by C-SON function.

Table 7.2.2.2.1-1: RRM related parameters

Control parameters	Definition	Legal Values
Maximum RRM policy ratio	This parameter specifies the maximum percentage of RRM resources used by the network slice instance(s). See attribute `rRMPolicyMaxRatio` in TS 28.541 [13].	0..100
Minimum RRM policy ratio	This parameter specifies the minimum percentage of RRM resources used by the network slice instance(s). See attribute `rRMPolicyMinRatio` in TS 28.541 [13].	0..100
Dedicated RRM policy ratio	This parameter specifies the maximum percentage of RRM resources that are dedicated to the network slice instance(s). See attribute `rRMPolicyDedicatedRatio` in TS 28.541 [13].	0..100

7.2.2.3 MnS Component Type C definition

7.2.2.3.1 Performance measurements

RRM related performance measurements are captured in Table 7.2.2.3.1-1:

Table 7.2.2.3.1-1. RRM related performance measurements

Performance measurements	Description	Note
Mean DL PRB used for data traffic	Provides the mean number of PRBs used in downlink for data traffic in the NRCellDU, with subcounters per sNSSAI (see clause 5.1.1.2.5 in TS 28.552 [5]).	
Peak DL PRB used for data traffic	Provides the peak number of PRBs used in downlink for data traffic in the NRCellDU, with subcounters per sNSSAI (see clause 5.1.1.2.9 in TS 28.552 [5])..	
Mean UL PRB used for data traffic	Provides the mean number of PRBs used in uplink for data traffic in the NRCellDU, with subcounters per sNSSAI (see clause 5.1.1.2.7 in TS 28.552 [5]).	
Peak UL PRB used for data traffic	Provides the peak number of PRBs used in uplink for data traffic in the NRCellDU, with subcounters per sNSSAI (see clause 5.1.1.2.10 in TS 28.552 [5])..	
Average DL UE throughput in gNB	Provides the average UE throughput in downlink in the NRCellDU, with subcounters per sNSSAI (see clause 5.1.1.3.1 in TS 28.552 [5]).	
Distribution of DL UE throughput in gNB	Provides the distribution of the UE throughput in downlink in the NRCellDU, with subcounters per sNSSAI (see clause 5.1.1.3.2 in TS 28.552 [5]).	
Average UL UE throughput in gNB	Provides the average UE throughput in uplink in the NRCellDU, with subcounters per sNSSAI (see clause 5.1.1.3.3 in TS 28.552 [5]).	
Distribution of UL UE throughput in gNB	Provides the average UE throughput in uplink in the NRCellDU, with subcounters per sNSSAI (see clause 5.1.1.3.4 in TS 28.552 [5]).	
Mean number of Active UEs in the DL per cell	Provides the mean number of active UEs in downlink in an NRCellDU, with subcounters per sNSSAI (see clause 5.1.1.23.1 in TS 28.552 [5]).	
Maximum number of Active UEs in the DL per cell	Provides the maximum number of active UEs in downlink in an NRCellDU, with subcounters per sNSSAI (see clause 5.1.1.23.2 in TS 28.552 [5]).	
Mean number of Active UEs in the UL per cell	Provides the mean number of active UEs in uplink in an NRCellDU, with subcounters per sNSSAI (see clause 5.1.1.23.3 in TS 28.552 [5]).	
Maximum number of Active UEs in the UL per cell	Provides the maximum number of active UEs in uplink in an NRCellDU, with subcounters per sNSSAI (see clause 5.1.1.23.4 in TS 28.552 [5]).	
Mean number of DRBs being allocated	Provides the mean number of DRBs being allocated in the PDU sessions in the NRCellCU, with subcounters per sNSSAI (see clause 5.1.1.10.9 in TS 28.552 [5]).	
Peak number of DRBs being allocated	Provides the peak number of DRBs being allocated in the PDU sessions in the NRCellCU, with subcounters per sNSSAI (see clause 5.1.1.10.10 in TS 28.552 [5])..	

Performance measurements	Description	Note
Peak number of PDU Sessions being allocated	Provides the peak number of PDU Sessions being allocated in the NRCellCU, with subcounters per sNSSAI (see clause 5.1.1.5.4 in TS 28.552 [5]).	
Peak number of PDU Sessions being allocated	Provides the peak number of PDU Sessions being allocated in the NRCellCU, with subcounters per sNSSAI(see clause 5.1.1.5.5 in TS 28.552 [5]).	
Mean number of RRC connections	Provides the mean number of RRC connections in the NRCellCU, with subcounters per sNSSAI (see clause 5.1.1.4.1 in TS 28.552 [5]).	
Maximum number of RRC connections	Provides the maximum number of RRC connections in the NRCellCU, with subcounters per sNSSAI (see clause 5.1.1.4.2 in TS 28.552 [5]).	

7.2.3 Centralized Capacity and Coverage Optimization

7.2.3.1 MnS component type A

Table 7.2.3.1-1: CCO type A

MnS Component Type A	Note
Operations and notifications defined in clause 5 of TS 28.532 [3]: - `createMOI` operation - `getMOIAttributes` operation - `modifyMOIAttributes` operation - `deleteMOI` operation - `notifyMOIAttributeValueChanges` operation - `notifyMOICreation` - `notifyMOIDeletion` - `notifyMOIChanges`	It is supported by Provisioning MnS for NF, as defined in TS 28.531 [11].
Operations defined in clause 11.3.1.1.1 in TS 28.532 [3] and clause 6.2.3 of TS 28.550 [12]: - `notifyFileReady` operation - `reportStreamData` operation	It is supported by Performance Assurance MnS for NFs, as defined in TS 28.550 [12].

7.2.3.2 MnS Component Type B definition

7.2.3.2.1 Parameters to be updated

Table 7.2.3.2.1-1 defines the CCO control parameters to be updated by C-SON function.

Table 7.2.3.2.1-1: CCO control parameters

Control parameters	Definition	Note
Configured max Tx power	Represents the maximum transmission power in milliwatts (mW) at the antenna port for all downlink channels, used simultaneously in a cell, added together. See attribute `configuredMaxTxPower` in TS 28.541 [13].	
Configured Max Tx EIRP	Represents the maximum emitted isotropic radiated power (EIRP) in dBm for all downlink channels, used simultaneously in a cell, added together. See attribute `configuredMaxTxEIRP` in TS 28.541 [13].	
Coverage shape	Identifies the sector carrier coverage shape described by the envelope of the contained SSB beams. See attribute `coverageShape` in TS 28.541 [13].	
Digital tilt	Represents the vertical pointing direction of the antenna relative to the antenna bore sight, representing the total non-mechanical vertical tilt of the selected `coverageShape`. See attribute `digitalTilt` in TS 28.541 [13].	
Digital azimuth	Represents the horizontal pointing direction of the antenna relative to the antenna bore sight, representing the total non-mechanical horizontal pan of the selected `coverageShape`. See attribute `digitalAzimuth` in TS 28.541 [13].	

7.2.3.2.2 Control information

The parameter is used to control the C-SON CCO function.

Table 7.2.3.2.2-1: CCO control

Control parameter	Definition	Note
CCO switch	This attribute allows authorized consumer to enable/disable the CCO functionality. See attribute `cCOControl` in TS 28.541 [13].	This parameter is used when domain centralized SON CCO is supported.
CCO policy	It indicates the range of the parameters which can be adjusted to optimize radio coverage. See attributes of the abstract class CCOParameters in TS 28.541 [13].	This parameter is used when domain centralized SON CCO is supported.

7.2.3.3 MnS Component Type C definition

7.2.3.3.1 Performance measurements

CCO related performance measurements are captured in Table 7.2.3.3.1-1:

Table 7.2.3.3.1-1. CCO related performance measurements

Performance measurements	Description	Note
Distribution of SS-RSRP per SSB	Provides the distribution of SS_RSRP per SSB (see clause 5.1.1.22.1 in TS 28.552 [5]).	
Distribution of SS-RSRQ	Provides the distribution of SS_RSRQ (see clause 5.1.1.31.1 in TS 28.552 [5]).	
Distribution of the number of active UE per SSB	Provides the distribution of the number of active UE per SSB.	
Number of requested handover executions	Provides the number of requested handover executions (see clause 5.1.1.6.1.7 in TS 28.552 [5]).	
Number of failed handover executions	Provides the number of failed handover executions (see clause 5.1.1.6.1.9 in TS 28.552 [5]).	

Performance measurements	Description	Note
Distribution of DL Total PRB Usage	Provides the distribution of samples with total usage (in percentage) of PRBs on the downlink in different ranges (see clause 5.1.1.2.3 in TS 28.552 [5]).	
Distribution of UL Total PRB Usage	Provides the distribution of samples with total usage (in percentage) of PRBs on the uplink in different ranges (see clause 5.1.1.2.4 in TS 28.552 [5]).	
DL PRB used for data traffic	Provides the number of PRBs in average used in downlink for data traffic (see clause 5.1.1.2.5 in TS 28.552 [5]).	
DL total available PRB	provides the total number of PRBs in average available downlink (see clause 5.1.1.2.6 in TS 28.552 [5]).	
UL PRB used for data traffic	Provides the number of PRBs in average used in uplink for data traffic (see clause 5.1.1.2.7 in TS 28.552 [5]).	
UL total available PRB	Provides the total number of PRBs in average available uplink (see clause 5.1.1.2.8 in TS 28.552 [5]).	
Average DL UE throughput in gNB	Provides the average UE throughput in downlink (see clause 5.1.1.3.1 in TS 28.552 [5]).	
Distribution of DL UE throughput in gNB	Provides the distribution of the UE throughput in downlink (see clause 5.1.1.3.1 in TS 28.552 [5]).	
Average UL UE throughput in gNB	Provides the average UE throughput in uplink (see clause 5.1.1.3.3 in TS 28.552 [5]).	
Distribution of UL UE throughput in gNB	Provides the distribution of the UE throughput in uplink (see clause 5.1.1.3.4 in TS 28.552 [5]).	
Mean number of RRC Connections	Provides the mean number of users in RRC connected mode (see clause 5.1.1.4.1 in TS 28.552 [5]).	
Max number of RRC Connections	Provides the maximum number of users in RRC connected mode (see clause 5.1.1.4.2 in TS 28.552 [5]).	
Number of PDU Sessions requested to setup	Provides the number of PDU Sessions by the gNB (see clause 5.1.1.5.1 in TS 28.552 [5]).	
Number of PDU Sessions successfully setup	Provides the number of PDU Sessions successfully setup by the gNB from AMF (see clause 5.1.1.5.2 in TS 28.552 [5]).	
Number of PDU Sessions failed to setup	Provides the number of PDU Sessions failed to setup by the gNB (see clause 5.1.1.5.3 in TS 28.552 [5]).	

7.2.3.3.2 MDT and Trace reports

CCO related MDT and trace reports are captured in Table 7.2.3.3.1-2:

Table 7.2.3.3.1-2. CCO related MDT and trace reports

Performance measurements	Description	Note
MDT reports	Provides RSRPs of the serving cell and neighbour cells, and UE location (see TS 32.422 [20]).	
RLF reports	Provides RSRPs of the of the last serving cell and neighbour cells, and UE location (see TS 32.422 [20]).	
RCEF reports	Provides RSRPs of the NR cell where the RRC connection establishment failed and neighbour cells, and UE location (see TS 32.422 [20]).	

7.2.4 LBO (Load Balancing Optimisation)

7.2.4.1 MnS component type A

Table 7.2.4.1-1: C-LBO type A

MnS Component Type A	Note
Operations and notifications defined in clause 11.1.1 of TS 28.532 [3]: - `createMOI` operation - `getMOIAttributes` operation - `modifyMOIAttributes` operation - `deleteMOI` operation - `notifyMOIAttributeValueChanges` - `notifyMOICreation` - `notifyMOIDeletion` - `notifyMOIChanges`	It is supported by Provisioning MnS for NF, as defined in 28.531 [11].
Operations defined in clause 11.3.1.1.1 in TS 28.532 [3] and clause 6.2.3 of TS 28.550 [12]: - `establishStreamingConnection` operation - `notifyFileReady` operation - `reportStreamData` operation	It is supported by Performance Assurance MnS for NFs, as defined in 28.550 [12].

7.2.4.2 MnS Component Type B definition

7.2.4.2.1 Parameters to be updated

Table 7.2.4.2.1-1: Ranges of HO and cell selection parameters

Control parameters	Definition	Legal Values
Maximum deviation of Handover Trigger	This parameter defines the maximum allowed absolute deviation of the Handover Trigger, from the default point of operation (see clause 15.5.2.5 in TS 38.300 [7] and clause 9.2.2.61 in TS 38.423 [17]). See attribute `maximumDeviationHoTrigger` in TS 28.541 [13].	[-20 .. 20] in unit 0.5 dB
Minimum time between Handover Trigger changes	This parameter defines the minimum allowed time interval between two Handover Trigger change performed by MRO. This is used to control the stability and convergence of the algorithm (see clause 15.5.2.5 in TS 38.300 [7]). See attribute `minimumTimeBetweenHoTriggerChange` in TS 28.541 [13].	[0 .. 604800] in unit Seconds

7.2.4.3 MnS Component Type C definition

7.2.4.3.1 Performance measurements

Table 7.2.4.3.1-1. lists the performance measurements that are used to monitor the load of NR cells (see clause 15.5.1.2 in TS 38.300 [7]).

Table 7.2.4.3.1-1. C-LBO load performance measurements

Performance measurements	Description	Note
DL Total PRB Usage	This measurement provides the total usage (in percentage) of physical resource blocks (PRBs) on the downlink (see clause 5.1.1.2.1 in TS 28.552 [5]).	
UL Total PRB Usage	This measurement provides the total usage (in percentage) of physical resource blocks (PRBs) on the uplink (see clause 5.1.1.2.2 in TS 28.552 [5]).	
Distribution of DL Total PRB Usage	This distribution measurement is to monitor when a cell may experience overload situation in the downlink (see clause 5.1.1.2.3 in TS 28.552 [5]).	
Distribution of UL Total PRB Usage	This distribution measurement is to monitor when a cell may experience overload situation in the uplink (see clause 5.1.1.2.4 in TS 28.552 [5]).	
DL PRB used for data traffic	This measurement provides the number of physical resource blocks (PRBs) in average used in downlink for data traffic (see clause 5.1.1.2.5 in TS 28.552 [5]).	
UL PRB used for data traffic	This measurement provides the number of physical resource blocks (PRBs) in average used in uplink for data traffic (see clause 5.1.1.2.7 in TS 28.552 [5]).	
Mean number of RRC Connections	This measurement provides the mean number of users in RRC connected mode during the granularity period (see clause 5.1.1.4.1 in TS 28.552 [5]).	
Max number of RRC Connections	This measurement provides the maximum number of users in RRC connected mode during the granularity period (see clause 5.1.1.4.2 in TS 28.552 [5]).	
Mean number of stored inactive RRC Connections	This measurement provides the mean number of users in RRC inactive mode during each granularity period (see clause 5.1.1.4.3 in TS 28.552 [5]).	
Max number of stored inactive RRC Connections	This measurement provides the maximum number of users in RRC inactive mode during each granularity period (see clause 5.1.1.4.4 in TS 28.552 [5]).	

Table 7.2.4.3.1-2 lists the performance measurements used to monitor the LBO performance:

Table 7.2.4.3.1-2. C-LBO related performance measurements

Performance measurements	Description	Note
Attempted RRC connection establishments	Includes the number of RRC connection establishment attempts (see clause 5.1.1.15.1 in TS 28.552 [5]).	
Successful RRC connection establishments	Includes the number of successful RRC establishments (see clause 5.1.1.15.2 in TS 28.552 [5]).	
Number of RRC connection re-establishment attempts	Includes the number of RRC connection re-establishment attempts (see clauses 5.1.1.17.1 in TS 28.552 [5]).	
Successful RRC connection re-establishment	Includes the number of successful RRC connection re-establishment (see clauses 5.1.1.17.2 and 5.1.1.17.3 in TS 28.552 [5]).	
Number of RRC connection resuming attempts	Includes Number of RRC connection resuming attempts (see clause 5.1.1.18.1 in TS 28.552 [5]).	
Successful RRC connection resuming	Includes the number of successful RRC connection resuming (see clause 5.1.1.18.2 in TS 28.552 [5]).	

8 SON procedures

8.1 Introduction

The procedures listed in clause 8 are some of all the possibilities, and are not exhaustive.

8.2 Distributed SON

8.2.1 RACH Optimization (Random Access Optimisation)

Figure 8.2.1-1 depicts a procedure that describes how D-SON management function can manage the RACH optimization (D-SON) function. It is assumed that the D-SON management function has consumed the performance assurance management service to collect RACH optimisation related measurements.
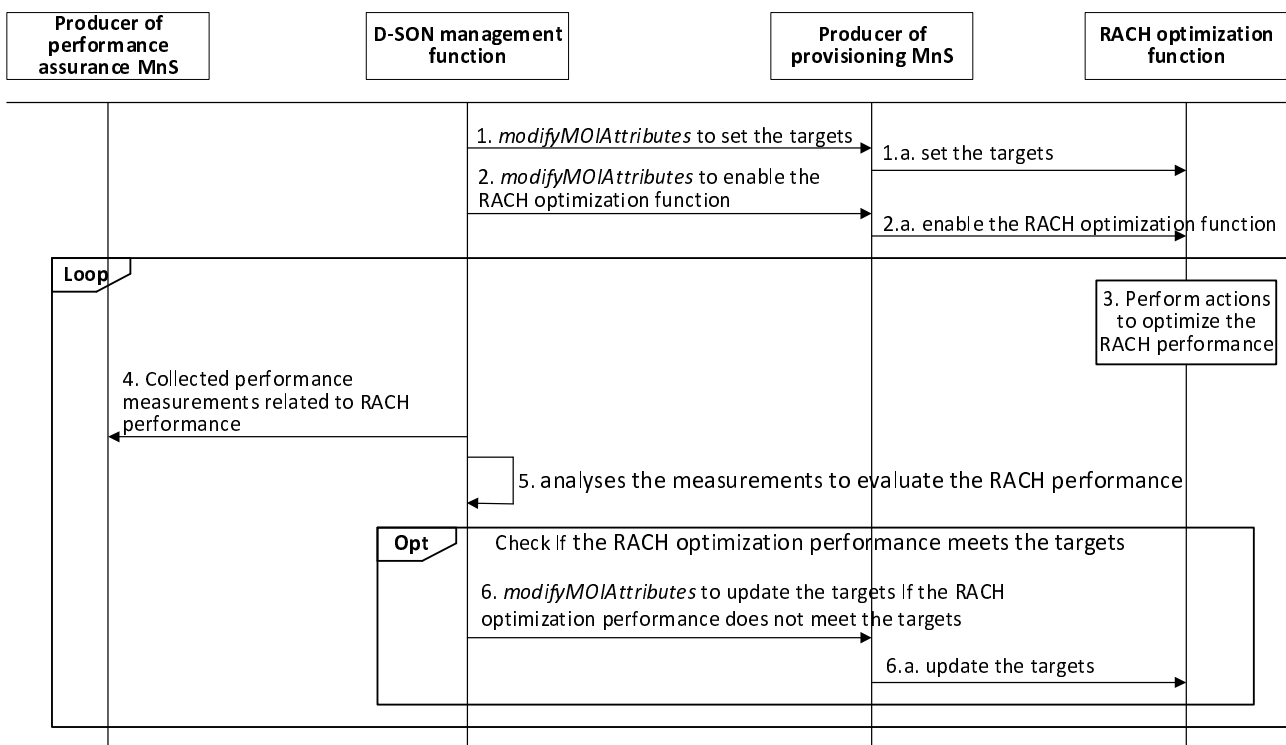

Figure 8.2.1-1: RACH Optimization procedure

1. The D-SON management function consumes the provisioning MnS with *modifyMOIAttributes* operation (see clause 5.1.3 in TS 28.532 [3]) to configure the targets for RACH optimization function.

    1.a The provisioning MnS sets the targets for RACH optimization (D-SON) function (NOTE).

2. The D-SON management function consumes the provisioning MnS with *modifyMOIAttributes* operation to enable the RACH optimization function for a given NR cell **if it is not enabled**.

    3.a The provisioning MnS enables the RACH optimization (D-SON) function (NOTE).

3. The RACH optimization (D-SON) function receives the RACH information report from UE(s), and analyses them to determine the actions to optimize the RACH performance if the performance does not meet the targets by updating the RACH parameters.

4. The D-SON management function collects the RACH related performance measurements.

5. The D-SON management function analyses the measurements to evaluate the RACH performance,

6. The D-SON management function consumes the provisioning MnS with *modifyMOIAttributes* operation to update the targets of the RACH optimization function, when the RACH optimization performance does not meet the targets:

6.a The provisioning MnS updates the targets for RACH optimization function (NOTE).

NOTE: The interface between provisioning MnS and RACH optimization is not subject to standardization.

8.2.2   MRO (Mobility Robustness Optimisation)

Figure 8.2.2-1 depicts a procedure that describes how D-SON management function can manage the MRO function. It is assumed that the D-SON management function has consumed the performance assurance MnS to create PM jobs to collect handover related measurements.
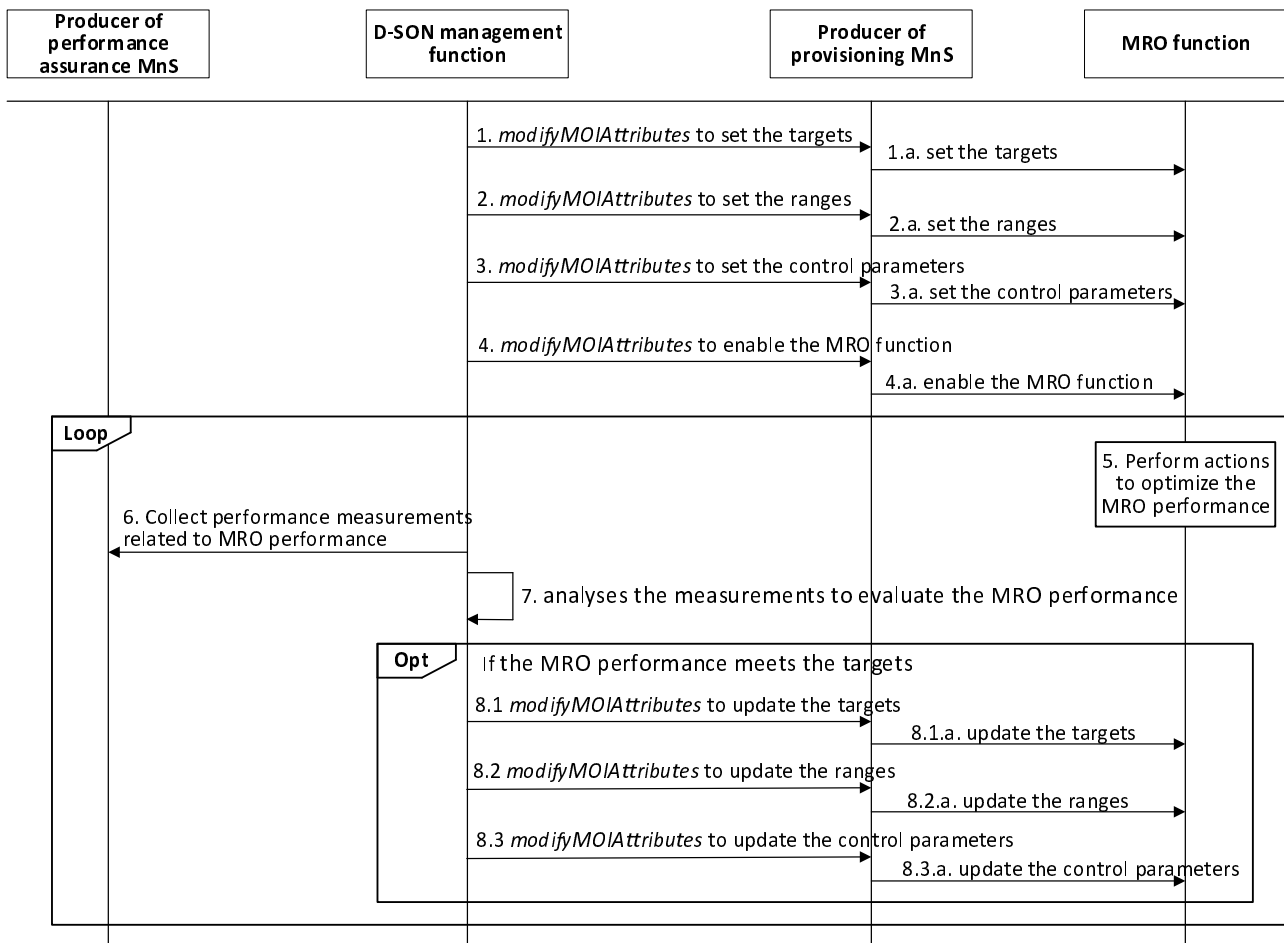

Figure 8.2.2-1: MRO procedure

1. The D-SON management function consumes the provisioning MnS with *modifyMOIAttributes* operation (see clause 5.1.3 in TS 28.532 [3]) to configure targets for the MRO function.

   1.a The provisioning MnS sets the targets for MRO function (NOTE).

2. The D-SON management function consumes the management service for NF provisioning with *modifyMOIAttributes* operation to configure the ranges of handover parameters.

   2.a The MnS of provisioning sets the ranges for MRO function (NOTE).

3. The D-SON management function consumes the management service for NF provisioning with *modifyMOIAttributes* operation to configure the MRO control parameters (e.g. Maximum deviation of Handover Trigger, Minimum time between Handover Trigger changes).

   3.a The MnS of provisioning sets the MRO control parameters for MRO function (NOTE).

4. The D-SON management function consumes the NF provisioning MnS with *modifyMOIAttributes* operation to enable the MRO function for a given NR cell if it is not enabled.

   4.a The provisioning MnS enables the MRO function (NOTE).

5. The MRO function receives MRO information reports from UE(s), and analyses them to determine the actions to optimize the MRO performance. If the performance does not meet the targets, it updates the handover parameters.

6. The D-SON management function collects MRO related performance measurements.

7. The D-SON management function analyses the measurements to evaluate the MRO performance,

8. The D-SON management function performs one of the following actions, when the MRO performance does not meet the targets:

   8.1. Consume the MnS of provisioning with *modifyMOIAttributes* operation to update the targets of the MRO function;

      8.1.a The MnS of provisioning updates the targets for MRO function (NOTE).

8.2. Consume the MnS of provisioning with *modifyMOIAttributes* operation to update the ranges of the handover parameters;

   8.2.a The MnS of provisioning updates the ranges of the handover parameters (NOTE).

8.3. Consume the MnS of provisioning with *modifyMOIAttributes* operation to update the control parameters;

   8.3.a The MnS of provisioning updates the control parameters (NOTE).

NOTE: The interface between provisioning MnS and MRO function is not subject to standardization.

8.2.3 PCI configuration

8.2.3.1 Initial PCI configuration

Figure 8.2.3.1-1 depicts a procedure that describes how D-SON management function can manage the PCI configuration (D-SON) function to assign the initial PCI values to an NR cell.
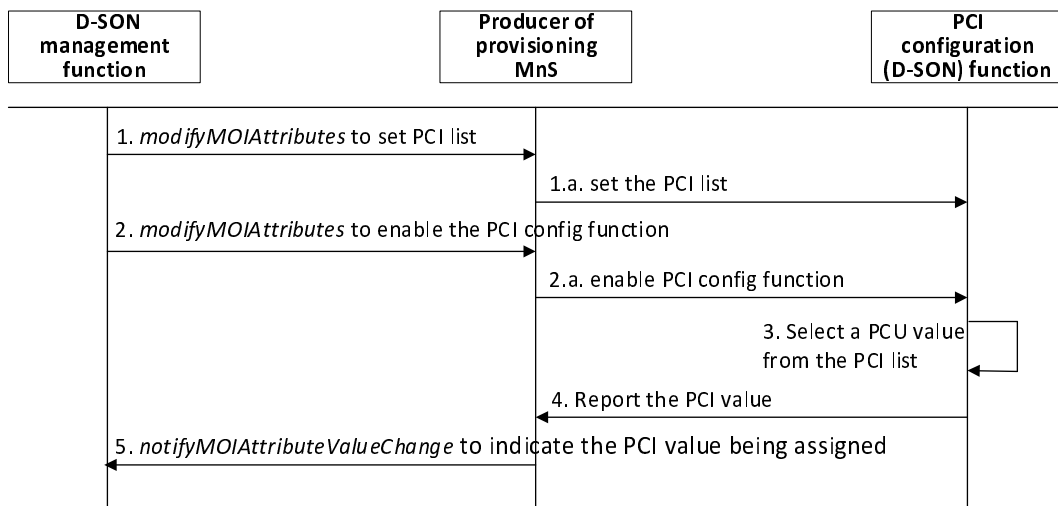

Figure 8.2.3.1-1: Initial PCI configuration procedure

1. The D-SON management function consumes the MnS of NF provisioning with *modifyMOIAttributes* operation to configure the PCI list for an NR cell.

   1.a The producer of provisioning MnS sets the PCI list at the PCI configuration (D-SON) function. (NOTE)

2. The D-SON management function consumes the MnS of NF provisioning with *modifyMOIAttributes* operation to enable the PCI configuration function for NR cell(s) **if it is not enabled**.

2.a The MnS of provisioning enables the PCI configuration (D-SON) function (NOTE).

3. The PCI configuration (D-SON) function selects PCI value(s) from the PCI list.

4. The PCI configuration (D-SON) function reports the PCI value(s) being assigned to the MnS of NF provisioning.

5. The MnS of NF provisioning sends a notification *notifyMOIAttributeValueChange* to D-SON management function with sourceIndicator = SON_operation, attributeValueChange = < nRPCI, new PCI value> (see clause 11.1.1.9.2 in TS 28.532 [3]) to indicate the PCI value(s) being assigned to NR cell(s).

NOTE: The interface between MnS of NF provisioning and PCI configuration (D-SON) function is not subject to standardization.

8.2.3.2   PCI re-configuration failure mitigation

Figure 8.2.3.2-1 depicts a procedure that describes how D-SON management function can re-configure the PCI lis for the NR cell, when the PCI configuration function is not able to mitigate a PCI collision or PCI confusion problemt.
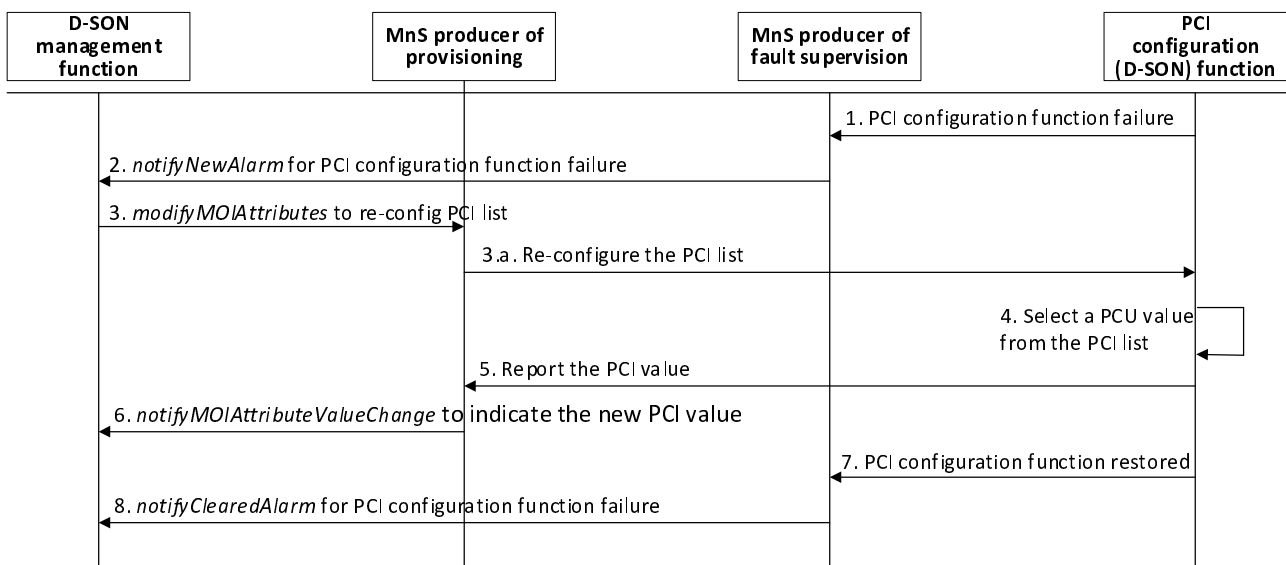

Figure 8.2.3.2-1: PCI re-configuration failure mitigation procedure

1. The PCI configuration (D-SON) function reports to the producer of fault supervision MnS that PCI configuration function failed to mitigate the PCI collision or PCI confusion problems (NOTE).

2. The producer of fault supervision MnS sends a notification *notifyNewAlarm* to D-SON management function to report the PCI configuration function failure.

3. The D-SON management function consumes the MnS of NF provisioning with *modifyMOIAttributes* operation to re-configure the PCI list for NR cell(s).

3.a The MnS of NF provisioning re-configures the PCI list for NR cell(s) (see NOTE).

4. The PCI configuration (D-SON) function selects PCI value(s) from the updated PCI list.

5. The PCI configuration (D-SON) function reports the PCI value(s) being assigned to the MnS of NF provisioning.

6. The Producer of provisioning MnS sends a notification *notifyMOIAttributeValueChange* to the D-SON management function with sourceIndicator = SON_operation, attributeValueChange = < nRPCI, new PCI value, old PCI value> (see clause 11.1.1.9.2 in TS 28.532 [3]) to indicate the new PCI value being assigned to NR cell.

7. The PCI configuration (D-SON) function notifies MnS of fault supervision that the PCI configuration function has been restored (see NOTE).

8. The producer of fault supervision MnS sends a notification *notifyClearedAlarm* to D-SON management function to report that the PCI configuration function has been restored.

NOTE: The interface betweenProducer of provisioning MnS and PCI configuration (D-SON) function is not subject to standardization.

8.2.3.3   PCI re-configuration

Figure 8.2.3.3-1 depicts a procedure that describes how the PCI configuration function, when detecting a PCI collision or confusion, re-configures the PCI of the cell based on the PCI list and notifies the D-SON management consumer.
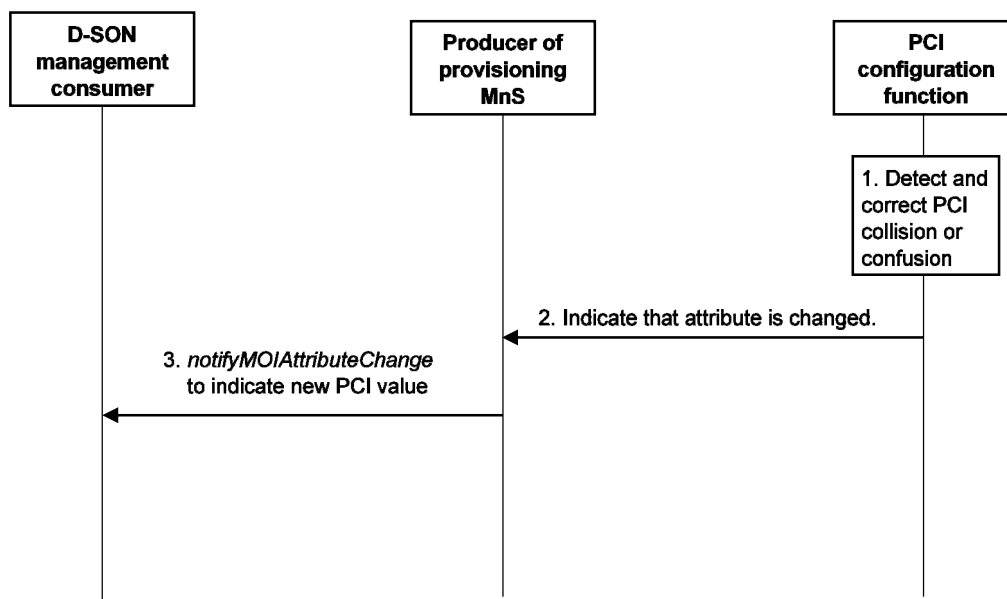

Figure 8.2.3.3-1: PCI re-configuration procedure

1. The PCI configuration (D-SON) function detects and corrects the PCI collision or PCI confusion problem for a NR cell.

2. The PCI configuration (D-SON) function indicates the attribute change to the Producer of provisioning MnS. (NOTE)

3. The Producer of provisioning MnS sends a notification *notifyMOIAttributeValueChange* to the D-SON management function with sourceIndicator = SON_operation, attributeValueChange = < nRPCI, new PCI value, old PCI value> (see clause 11.1.1.9.2 in TS 28.532 [3]) to indicate the new PCI value having been assigned to NR cell.

NOTE: The interface between Producer of provisioning MnS and PCI configuration (D-SON) function is not subject to standardization.

8.2.4   LBO (Load Balancing Optimisation)

Figure 8.2.4-1 depicts a procedure that describes how D-SON management function can manage the LBO function. It is assumed that the D-SON management function has consumed the performance assurance MnS to create PM jobs to collect handover related measurements.
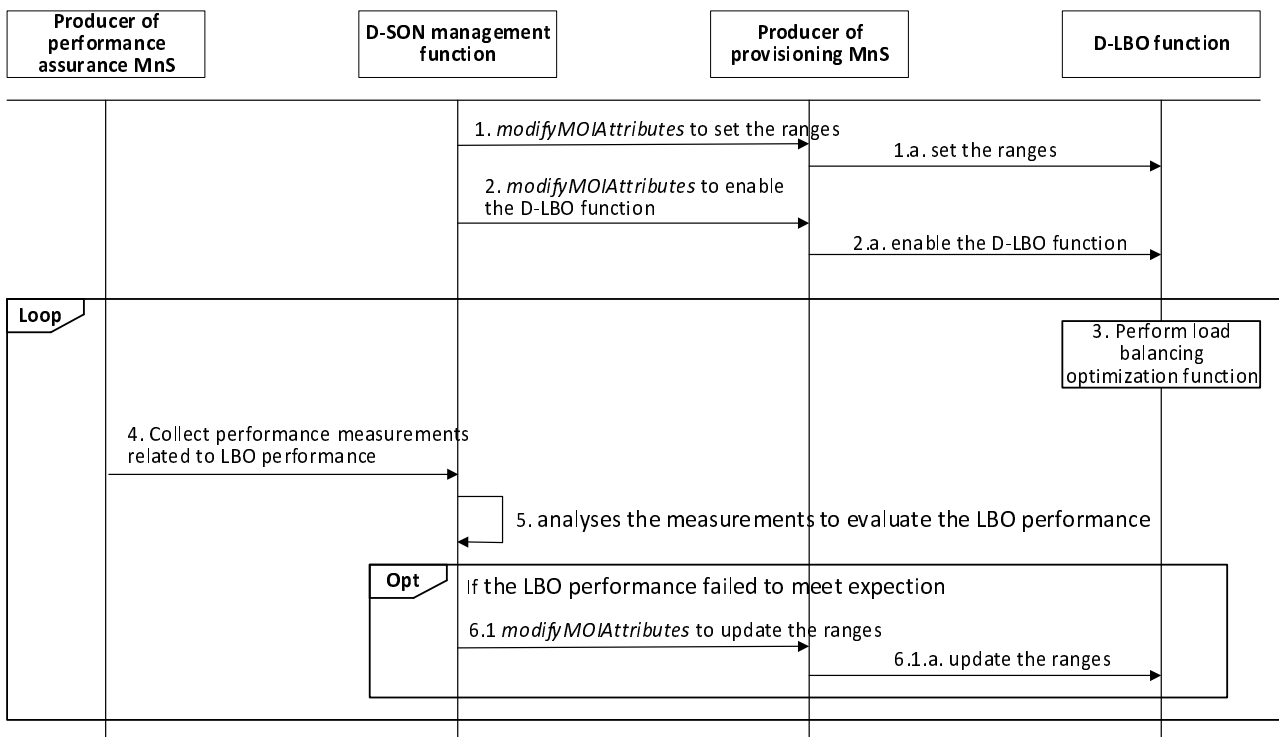
Figure 8.2.4-1: D-LBO procedure

1. The D-SON management function consumes the management service for NF provisioning with *modifyMOIAttributes* operation (see clause 5.1.3 in TS 28.532 [3]) to configure the ranges of HO and/or reselection parameters for the LBO function.

    1.a The MnS of provisioning sets the ranges for MRO function (NOTE).

2. The D-SON management function consumes the NF provisioning MnS with *modifyMOIAttributes* operation to enable the LBO function for a given NR cell if it is not enabled.

    2.a The provisioning MnS enables the LBO function (NOTE).

3. The LBO function <u>collects real-time load information to determine and </u>perform actions to balance the traffic loads among NR cells.

4. D-SON management function collects LBO related performance measurements.

5. The D-SON management function analyses the measurements to evaluate the LBO performance,

6. The D-SON management function consume the MnS of provisioning with *modifyMOIAttributes* operation to update the ranges of handover parameters if the LBO failed to meet expection,

    6.a. The MnS of provisioning updates the ranges of HO and/or reselection parameters (NOTE).

NOTE: The interface between provisioning MnS and D-LBO function is not subject to standardization.

8.3 Centralized SON

8.3.1 PCI configuration

8.3.1.1 Initial PCI configuration

Figure 8.3.1.1-1 depicts a procedure that describes how C-SON can assign the PCI values to NR cells the first time.
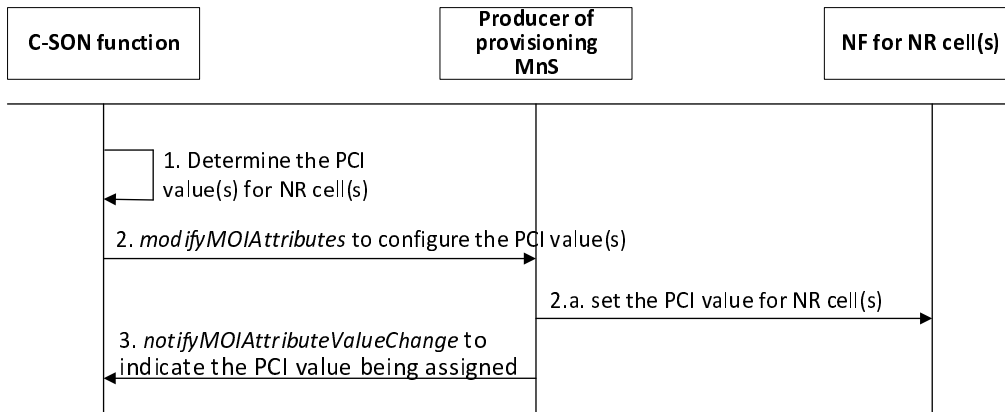

Figure 8.3.1.1-1: Initial PCI configuration procedure

1. The C-SON determines the PCI value(s) for NR cell(s).

2. The C-SON consumes the MnS of NF provisioning with *modifyMOIAttributes* operation to configure the PCI value(s) for NR cell(s).

2.a The MnS of provisioning sets the PCI value(s) for NR cell(s) (NOTE)

3. The producer of provisioning MnS sends a notification *notifyMOIAttributeValueChange* to C-SON function with sourceIndicator = SON_operation, attributeValueChange = < nRPCI, new PCI value> (see clause 11.1.1.9.2 in TS 28.532 [3]) to indicate the PCI value(s) being assigned to NR cell(s).

NOTE: The interface between MnS of provisioning and PCI configuration (D-SON) function is not subject to standardization.

8.3.1.2 PCI re-configuration

Figure 8.3.1.2-1 depicts a procedure that describes how C-SON function can re-configure the PCI list for NR cell(s) when PCI collision or PCI confusion issues were detected. It is assumed that the C-SON function has consumed the MnS of performance assurance to create PM jobs to collect PCI related measurements.
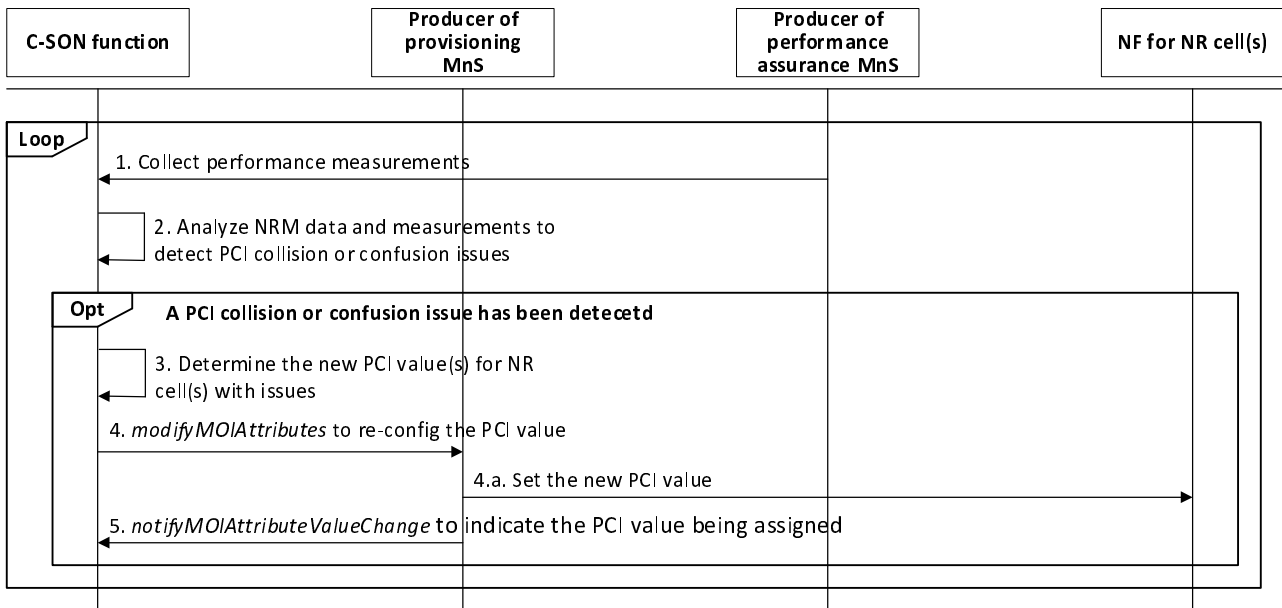
Figure 8.3.1.2-1: PCI re-configuration procedure

1. The C-SON function collects PCI related performance measurements that are derived from *MeasResultListNR* (see clause 6.3.2 in TS 38.331 [9]) from producer of performance assurance MnS.

2. The C-SON function analyses the NRM data and PCI related measurements to detect the PCI collision or PCI confusion problems for NR cell(s).

3. The C-SON function determines the new PCI value(s) for NR cell(s).

4. The C-SON function consumes the MnS of NF provisioning with *modifyMOIAttributes* operation to re-configure the PCI values for NR cell(s).

4.a The MnS of NF provisioning set the PCI value(s) for NR cell(s).

5. The producer of provisioning MnS sends a notification *notifyMOIAttributeValueChange* to C-SON function with sourceIndicator = SON_operation, attributeValueChange = < nRPCI, new PCI value, old PCI value> (see clause 11.1.1.9.2 in TS 28.532 [3]) to indicate the PCI value(s) being assigned to NR cell(s).

8.3.2   Procedures for establishment of a new RAN NE in network

8.3.2.1   Procedures for RAN NE plug and connect to management system

The NE described in this procedure can be gNB in non-split scenario and gNB-DU in split scenario.

NOTE 1: The NE within virtualization is not addressed.

The details of procedure flow and descriptions are covered in TS 28.315 [21].

NOTE 2: Void

NOTE 3: Void

NOTE 4: Void.

NOTE 5: Void.

8.3.2.2 Procedures for self-configuration management

The NE described in this procedure can be gNB in non-split scenario and gNB-DU in split scenario.

NOTE 1: The NE within virtualization is not addressed.

The details of procedure flow and descriptions are covered in TS 28.317 [23].

8.3.3 RRM resources optimization for network slice instance(s)

Figure 8.3.3-1 depicts an example of network slice instances that are created to support various services, such as URLLC, eMBB, or mMTC with different RRM resources requirements, where network slice instances sNSSAI #2-1 and sNSSAI #2-2 support a kind of RRM requirements, while network slice instances sNSSAI #1 supports different RRM requirements. It shows that the RRM resources provided by network functions of DU, CUUP, and CUCP are characterized by *RRMPolicyRatio* IOC with `rRMPolicyMaxRatio`, `rRMPolicyMinRatio`, and `rRMPolicyDedicatedRatio` attributes to define the shared resources, prioritized resources, and dedicated resources for network slice instance(s) (see clause 4.3.36.1 in TS 28.541 [13]).

The *RRMPolicyRatio* IOC has a base class *RRMPolicy* IOC that contains `resourceType` (i.e. PRB for DU, DRB for CUUP, and RRC connected user for CUCP) and `rRMPolicyMemberList` that contains the network slice instance(s) subject to this policy (see clause 4.3.43 in TS 28.541 [13]). A network function may have one or more *RRMPolicyRatio* MOI(s) where each *RRMPolicyRatio* MOI is associated with network slice instance(s) that share the same RRM resource requirements.
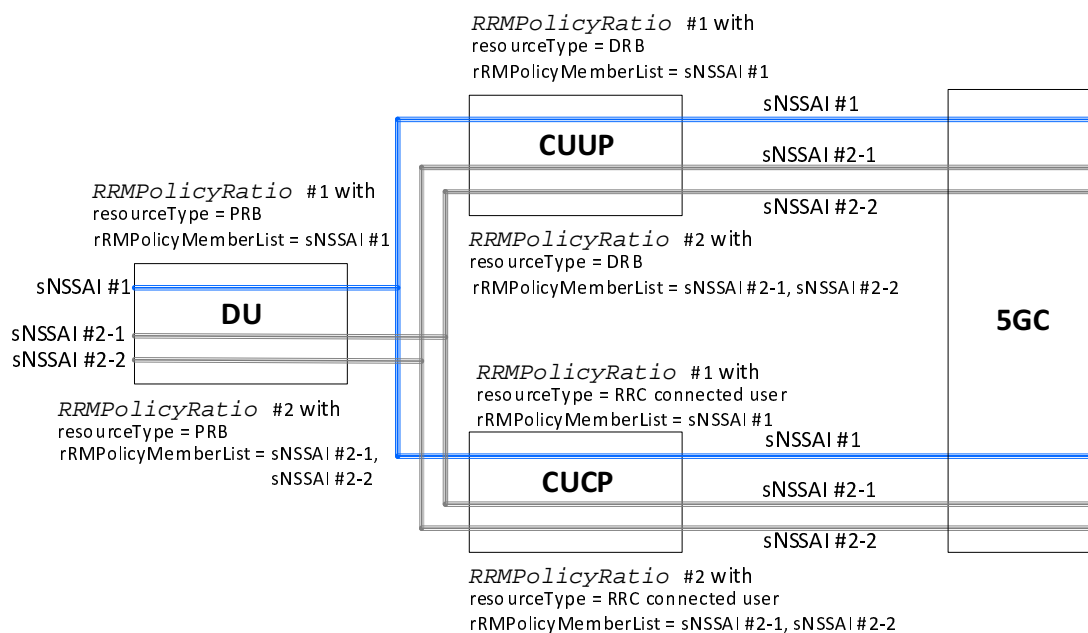

Figure 8.3.3-1: RRM policies for multiple network slice instances

It is assumed that the C-SON function has consumed the MnS of performance assurance to create PM jobs to collect RRM related measurements from RAN nodes, such as DU, CUCP, and CUUP where the network slice instances are created, and an AI/ML model has been created based on the use plane and control plane information (e.g. traffic loads and patterns) that are collected from the RRM related performance measurements received previously.
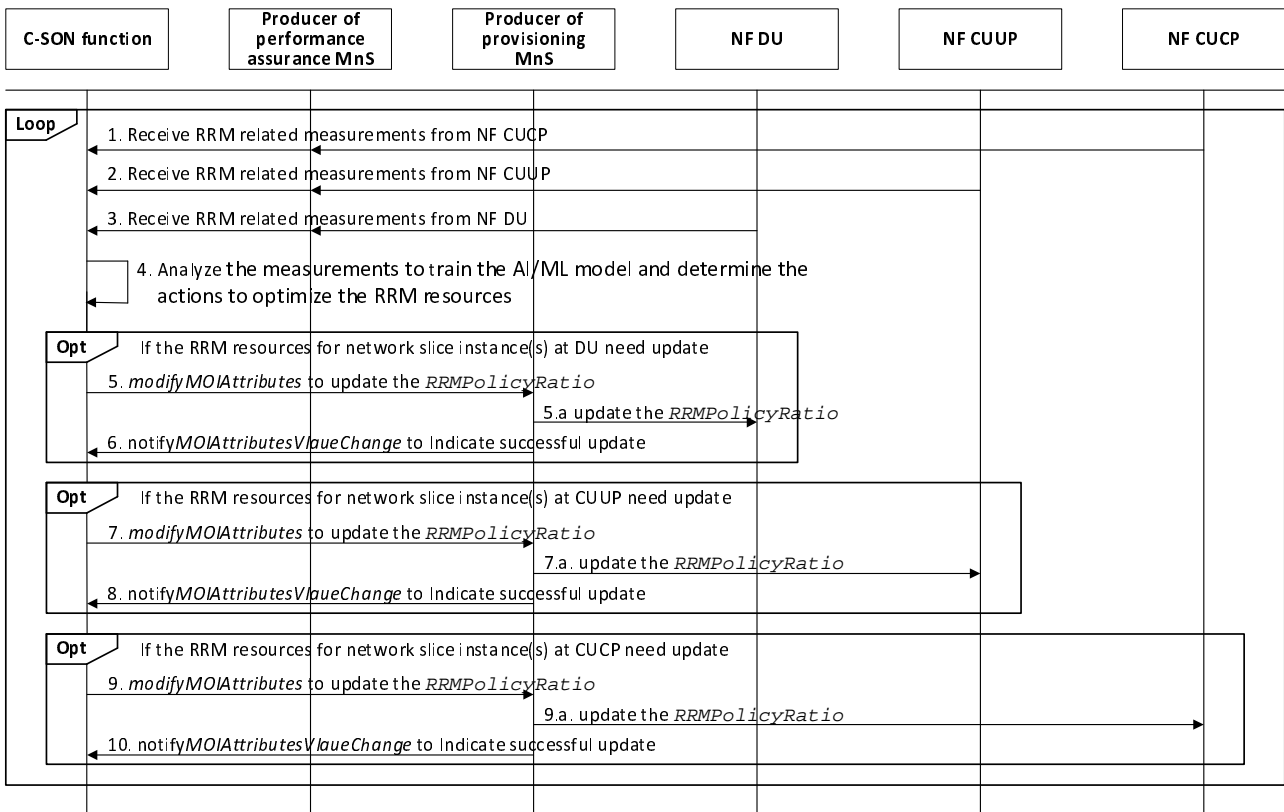
Figure 8.3.3-2: RRM resources optimization procedure

1. The C-SON function consumes the performance assurance MnS to receive the measurements (e.g. mean and peak numbers of PRB usage on DL / UL, average DL / UL UE throughput in gNB, distribution of DL / UL UE throughput in gNB) from NF DU to monitor the performance of network slice instances identified by sNSSAI #1 and sNSSAI #2.

2. The C-SON function consumes the performance assurance MnS to receive the measurements (e.g. such as mean and peak numbers of DRBs successfully setup) from NF CUUP to monitor the performance of network slice instances identified by sNSSAI #1 and sNSSAI #2.

3. The C-SON function consumes the performance assurance MnS to receive the measurements (e.g. mean numbers of PDU Sessions requested to setup, mean numbers of PDU Sessions successfully setup) from NF CUCP to monitor the performance of network slice instances identified by sNSSAI #1 and sNSSAI #2.

4. The C-SON function analyzes the measurements to train the AI/ML model and determines the actions if needed to optimize the RRM resources for network slice instance(s) that include consuming the MnS of provisioning to update the $RRMPolicyRatio$ corresponding to the specific network slice instance(s).

If the RRM resources for network slice instances at DU need update, then the following steps are executed:

5. The C-SON function consumes the MnS of NF provisioning with *modifyMOIAttributes* operation to re-configure the $RRMPolicyRatio$ for the NF DU.

   5.a The MnS of NF provisioning updates $RRMPolicyRatio$ at the NF DU.

6. The producer of provisioning MnS sends a notification *notifyMOIAttributeValueChange* to C-SON function with sourceIndicator = SON_operation, attributeValueChange = < RRMPolicyRatio, new value, old value> to indicate the successful $RRMPolicyRatio$ update.

If the RRM resources for network slice instances at CUUP need update, then the following steps are executed:

7. The C-SON function consumes the MnS of NF provisioning with *modifyMOIAttributes* operation to re-configure the $RRMPolicyRatio$ for the NF CUUP.

   7.a The MnS of NF provisioning updates $RRMPolicyRatio$ at the NF CUUP.

8. The producer of provisioning MnS sends a notification *notifyMOIAttributeValueChange* to C-SON function with sourceIndicator = SON_operation, attributeValueChange = < RRMPolicyRatio, new value, old value> to indicate the successful `RRMPolicyRatio` update.

If the RRM resources for network slice instances at CUCP need update, then the following steps are executed:

9. The C-SON function consumes the MnS of NF provisioning with *modifyMOIAttributes* operation to re-configure the `RRMPolicyRatio` for the NF CUCP.

9.a The MnS of NF provisioning updates `RRMPolicyRatio` at the NF CUCP.

10. The producer of provisioning MnS sends a notification *notifyMOIAttributeValueChange* to C-SON function to indicate the successful `RRMPolicyRatio` update.

NOTE: The interface between producer of provisioning MnS and NFs is not subject to standardization.

8.3.4 Centralized Capacity and Coverage Optimization (CCO)

Figure 8.3.4-1 depicts the procedure of centralized capacity and coverage optimization. It is assumed that PM job control and provisioning have been executed to allow C-SON function to receive performance measurements, MDT, RLF, and RCEF reports.
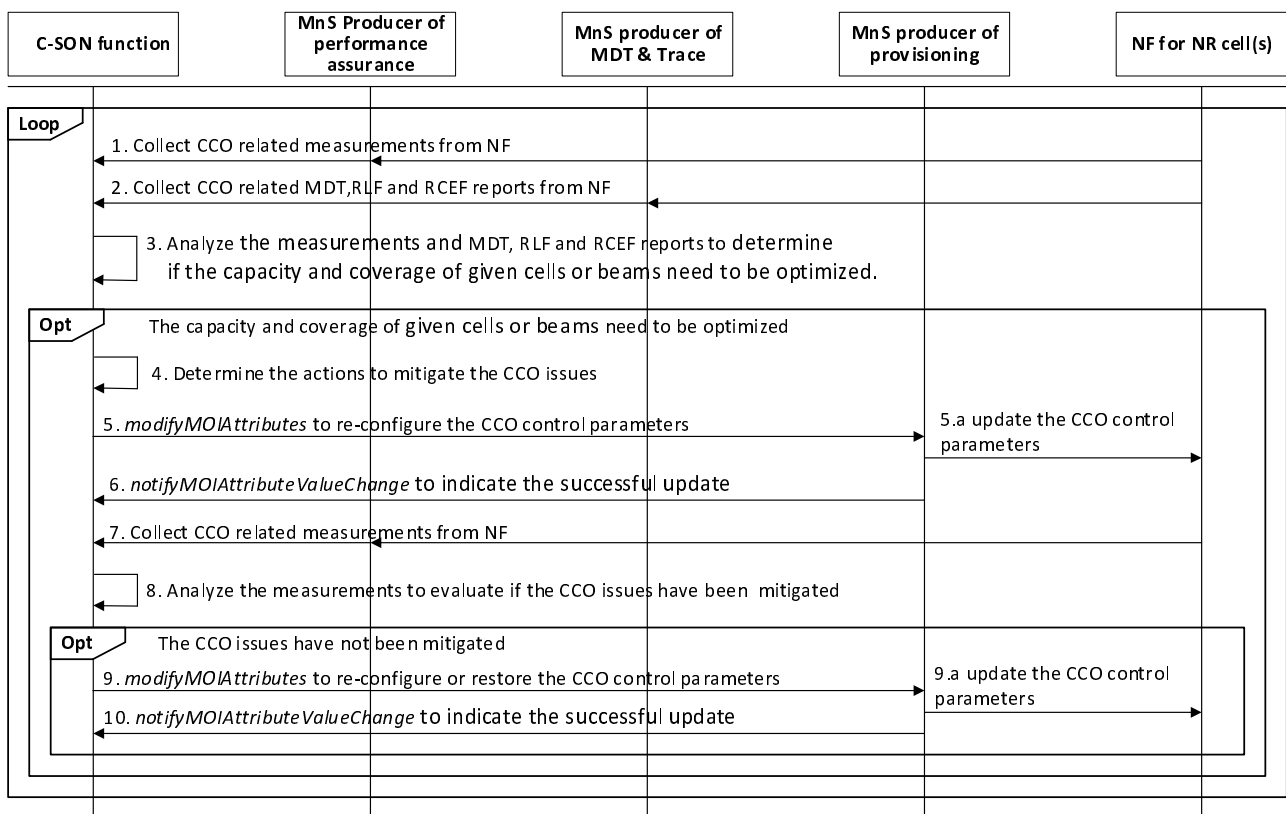
Figure 8.3.4-1: Capacity and coverage optimization procedure

1. The C-SON function receives the measurements, as listed in clause 7.2.3.3.1, which are used to detect the capacity and coverage issues in NR cells.

2. The C-SON function receives MDT, RLF, and RCEF reports, as listed in clause 7.2.3.3.2, which are used to detect the capacity and coverage issues in NR cells.

3. The C-SON function analyzes the measurements, MDT, RLF, and RCEF reports to determine whether the capacity and coverage of given cells or beams need to be optimized.

If the capacity and coverage of given cells or beams need to be optimized, then the following steps are executed:

4. The C-SON function determine the actions to mitigate the CCO issues.

5. The C-SON function consumes the MnS of NF provisioning with *modifyMOIAttributes* operation to re-configure the CCO control parameters, as listed in clause 7.2.3.2.1.

   5.a The MnS of NF provisioning updates the CCO control parameters at the NF for NR cells (NOTE).

6. The producer of provisioning MnS sends a notification *notifyMOIAttributeValueChange* to C-SON function with sourceIndicator = SON_operation, attributeValueChange = < attributes being changed> to indicate the CCO control parameters have been updated successfully.

7. The C-SON function collects the measurements.

8. The C-SON function analyzes the measurements to evaluate if the COO issues have been mitigated.

If the the CCO issues have not been mitigated, then the following steps are executed:

9. The C-SON function consumes the MnS of NF provisioning with *modifyMOIAttributes* operation to re-configure the CCO control parameters, as listed in clause 7.2.3.2.1.

   9.a The MnS of NF provisioning updates the CCO control parameters at the NF for NR cells (NOTE).

10. The producer of provisioning MnS sends a notification *notifyMOIAttributeValueChange* to C-SON function with sourceIndicator = SON_operation, attributeValueChange = < attributes being changed> to indicate the CCO control parameters have been updated successfully.

NOTE: The interface between producer of provisioning MnS and NFs is not subject to standardization.

Annex A (informative): PlantUML source code

A.1 Void

Annex B (informative):
Change history

						Change history	
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2020-09	SA#89e					Upgrade to change control version	16.0.0
2020-12	SA#90e	SP-201045	0001	-	F	Add subclause reference for ranges of handover parameters	16.1.0
2020-12	SA#90e	SP-201045	0002	-	F	Corrections on notification information of PCI configuration	16.1.0
2020-12	SA#90e	SP-201045	0004	1	F	Address the issues discovered by Edithelp	16.1.0
2020-12	SA#90e	SP-201045	0005	-	F	Fix the wrong references	16.1.0
2020-12	SA#90e	SP-201045	0006	-	F	Change RACH control attributes from beam to cell	16.1.0
2020-12	SA#90e	SP-201066	0007	2	B	Correct Distributed PCI optimization	17.0.0
2021-06	SA#92e	SP-210467	0018	3	F	Fix non-inclusive languages	17.1.0
2021-06	SA#92e	SP-210414	0019	-	F	Editorial changes to D-MRO	17.1.0
2021-06	SA#92e	SP-210414	0020	-	B	RRM resources optimization for network slice instance(s)	17.1.0
2021-09	SA#93e	SP-210874	0017	2	B	Requirements, use cases and services for C-PCI	17.2.0
2021-09	SA#93e	SP-210874	0026	1	B	Add RRM related measurements info	17.2.0
2021-09	SA#93e	SP-210874	0027	1	B	Add CCO use cases, requirements, information, and procedure	17.2.0
2021-09	SA#93e	SP-210874	0028	1	D	Editorial changes	17.2.0
2021-12	SA#94e	SP-211461	0029	2	B	Update procedures for plug and connect to management system	17.3.0
2021-12	SA#94e	SP-211462	0032	-	A	Correction of Figure 8.3.2.2-1 title for self-configuration	17.3.0
2021-12	SA#94e	SP-211452	0033	1	B	Add RRM related measurements information	17.3.0
2021-12	SA#94e	SP-211452	0035	1	B	Add notifications to D-SON functions of PCI re-configuration	17.3.0
2021-12	SA#94e	SP-211452	0037	1	B	Add LBO use cases, requirements, and procedure	17.3.0
2021-12	SA#94e	SP-211452	0040	1	B	Add C-SON CCO control information	17.3.0
2021-12	SA#94e	SP-211452	0041	1	F	Clause number correction	17.3.0
2021-12	SA#94e	SP-211452	0043	1	C	Correct handover trigger	17.3.0
2021-12	SA#94e	SP-211452	0044	-	B	Add beam specific handover counters to MRO	17.3.0
2022-03	SA#95e	SP-220182	0045	1	B	Add information in the PCI configuration notification	17.4.0
2022-03	SA#95e	SP-220182	0046	1	B	Add information in the C-SON notification	17.4.0
2022-03	SA#95e	SP-220172	0047	-	C	MRO additions for CHO and DAPS handover	17.4.0
2022-06	SA#96	SP-220593	0048	-	F	Correct non-inclusive language	17.5.0
2022-09	SA#97e	SP-220853	0050	1	A	Correction of intra-RAT and inter-RAT too early and too late handover failures description	17.6.0
2022-09	SA#97e	SP-220854	0052	1	F	Align the discription between TS 28.541 for CSON PCI configuration	17.6.0
2022-12	SA#98e	SP-221167	0053	-	F	Fixing incorrect references to IOCs of 28.541	17.7.0
2023-03	SA#99	SP-230203	0054	-	A	Align the attribute name of SON case with TS 28.541	17.8.0
2023-12	SA#102	SP-231487	0059	-	A	Correction of performance measurements for MRO	17.9.0
2023-12	SA#102	SP-231490	0061	1	F	Correction performance measurements for CHO and DAPS MRO	17.9.0
2024-03	SA#103	SP-240181	0062	-	F	Rel-18 CR TS28.313 Update concept ,requirements and procedure for Self-configuration to refer to TS 28.317	18.0.0

History

Document history		
V18.0.0	May 2024	Publication