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| Technical Specification | |
| 3rd Generation Partnership Project;  Technical Specification Group Services and System Aspects;  Management and orchestration;  Self-Organizing Networks (SON) for 5G networks  (Release 17) | |
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Contents

Foreword 6

Introduction 7

1 Scope 8

2 References 8

3 Definitions of terms, symbols and abbreviations 9

3.1 Terms 9

3.2 Symbols 9

3.3 Abbreviations 9

4 Concepts and background 9

4.1 SON concepts 9

4.1.1 Overview 9

4.1.2 Centralized SON 10

4.1.2.1 Introduction 10

4.1.2.2 Cross Domain-Centralized SON 11

4.1.2.3 Domain-Centralized SON 11

4.1.3 Distributed SON 11

4.1.4 Hybrid SON 12

4.2 Self-establishment of new RAN NE in network 12

4.2.1 Introduction 12

4.2.2 Network configuration data handling 13

4.2.3 Plug and connect to management system 13

4.2.4 Self-configuration 13

5 Business level requirements 13

5.1 Requirements 13

5.1.1 Distributed SON management 13

5.2 Actor roles 13

5.3 Telecommunication resources 14

6 Specification level requirements 14

6.1 Requirements 14

6.1.1 Distributed SON management 14

6.1.1.1 RACH Optimization (Random Access Optimisation) 14

6.1.1.2 MRO (Mobility Robustness Optimisation) 14

6.1.1.3 ANR management in NG-RAN 14

6.1.1.4 PCI configuration and re-configuration 15

6.1.1.2 LBO (Load Balancing Optimisation) 15

6.1.2 Centralized SON 15

6.1.2.1 PCI configuration 15

6.1.2.2 LBO (Load Balancing Optimisation) 15

6.1.2.2 Requirements for RAN NE plug and connect to management system 16

6.1.2.3 Requirements for self-configuration of a new RAN NE 16

6.1.2.4 RRM resources optimization for network slice instance(s) 16

6.1.2.5 Centralized Capacity and Coverage Optimization 16

6.2 Actor roles 16

6.3 Telecommunication resources 16

6.4 Use cases 17

6.4.1 Distributed SON management 17

6.4.1.1 RACH Optimization (Random Access Optimisation) 17

6.4.1.2 MRO (Mobility Robustness Optimisation) 18

6.4.1.3 ANR management 19

6.4.1.3.1 Starting the ANR function 19

6.4.1.3.2 Stopping the ANR function 19

6.4.1.3.3 Sending notification of added or deleted NCR 20

6.4.1.3.4 Handover Allowlisting 20

6.4.1.3.5 Handover Blocklisting 21

6.4.1.3.6 Prohibiting X2 or Xn connection to a peer node (X2/Xn blacklisting) 21

6.4.1.3.7 Prohibiting handover over X2 or Xn (X2/Xn handover blacklisting) 22

6.4.1.4 PCI configuration 22

6.4.1.4.1 Initial PCI configuration 22

6.4.1.4.2 PCI re-configuration failure mitigation 23

6.4.1.4.3 PCI re-configuration 23

6.4.1.5 LBO (Load Balancing Optimisation) 24

6.4.2 Centralized SON 24

6.4.2.1 PCI configuration 24

6.4.2.1.1 Initial PCI configuration 24

6.4.2.1.2 PCI re-configuration 25

6.4.2.2 Use case for establishment of a new RAN NE in network 25

6.4.2.2.1 Use case for RAN NE plug and connect to management system 25

6.4.2.2.2 Use case for self-configuration of a new RAN NE 25

6.4.2.3 RRM resources optimization for network slice instance(s) 27

6.4.2.4 Centralized Capacity and Coverage Optimization (CCO) 27

6.4.2.5 LBO (Load Balancing Optimisation) 28

7 Management services for SON 28

7.1 Management services for D-SON management 28

7.1.1 RACH Optimization (Random Access Optimisation) 28

7.1.1.1 MnS component type A 28

7.1.1.2 MnS Component Type B definition 29

7.1.1.2.1 Targets information 29

7.1.1.2.2 Control information 29

7.1.1.2.3 Parameters to be updated 29

7.1.1.3 MnS Component Type C definition 29

7.1.1.3.1 Performance measurements 29

7.1.2 MRO (Mobility Robustness Optimisation) 30

7.1.2.1 MnS component type A 30

7.1.2.2 MnS Component Type B definition 30

7.1.2.2.1 Targets information 30

7.1.2.2.2 Control information 30

7.1.2.2.3 Parameters to be updated 31

7.1.2.3 MnS Component Type C definition 31

7.1.2.3.1 Performance measurements 31

7.1.3 PCI configuration 32

7.1.3.1 MnS component type A 32

7.1.3.2 MnS Component Type B definition 32

7.1.3.2.1 Control information 32

7.1.3.2.2 Parameters to be updated 33

7.1.3.3 MnS Component Type C definition 33

7.1.3.3.1 Notification information 33

7.1.3.3.2 Alarm notification information 33

7.1.4 ANR management 33

7.1.5 LBO (Load Balancing Optimisation) 34

7.1.5.1 MnS component type A 34

7.1.5.2 MnS Component Type B definition 34

7.1.5.2.1 Control information 34

7.1.5.2.2 Parameters to be updated 34

7.1.5.3 MnS Component Type C definition 35

7.1.5.3.1 Performance measurements 35

7.2 Management services for C-SON 36

7.2.1 PCI configuration 36

7.2.1.1 MnS component type A 36

7.2.1.2 MnS Component Type B definition 36

7.2.1.2.1 Control information 36

7.2.1.2.2 Parameters to be updated 37

7.2.1.3 MnS Component Type C definition 37

7.2.1.3.1 Notifications information 37

7.2.1.3.2 Performance measurements 37

7.2.1.3.3 Trace Reporting 37

7.2.2 RRM resources optimization for network slice instance(s) 38

7.2.2.1 MnS component type A 38

7.2.2.2 MnS Component Type B definition 38

7.2.2.2.1 Parameters to be updated 38

7.2.2.3 MnS Component Type C definition 38

7.2.2.3.1 Performance measurements 38

7.2.3 Centralized Capacity and Coverage Optimization 40

7.2.3.1 MnS component type A 40

7.2.3.2 MnS Component Type B definition 40

7.2.3.2.1 Parameters to be updated 40

7.2.3.2.2 Control information 40

7.2.3.3 MnS Component Type C definition 41

7.2.3.3.1 Performance measurements 41

7.2.3.3.2 MDT and Trace reports 42

7.2.4 LBO (Load Balancing Optimisation) 42

7.2.4.1 MnS component type A 42

7.2.4.2 MnS Component Type B definition 43

7.2.4.2.1 Parameters to be updated 43

7.2.4.3 MnS Component Type C definition 43

7.2.4.3.1 Performance measurements 43

8 SON procedures 44

8.1 Introduction 44

8.2 Distributed SON 44

8.2.1 RACH Optimization (Random Access Optimisation) 44

8.2.2 MRO (Mobility Robustness Optimisation) 45

8.2.3 PCI configuration 47

8.2.3.1 Initial PCI configuration 47

8.2.3.2 PCI re-configuration failure mitigationn 48

8.2.3.3 PCI re-configuration 48

8.2.4 LBO (Load Balancing Optimisation) 49

8.3 Centralized SON 51

8.3.1 PCI configuration 51

8.3.1.1 Initial PCI configuration 51

8.3.1.2 PCI re-configuration 51

8.3.2 Procedures for establishment of a new RAN NE in network 52

8.3.2.1 Procedures for RAN NE plug and connect to management system 52

8.3.2.2 Procedures for self-configuration management 53

8.3.3 RRM resources optimization for network slice instance(s) 54

8.3.4 Centralized Capacity and Coverage Optimization (CCO) 56

Annex A (informative): PlantUML source code 58

A.1 Procedures for establishment of a new RAN NE in network 58

A.1.1 Void 58

A.1.2 Procedure for self-configuration management 58

Annex B (informative): Change history 59

# 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:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

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”.

# 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

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.

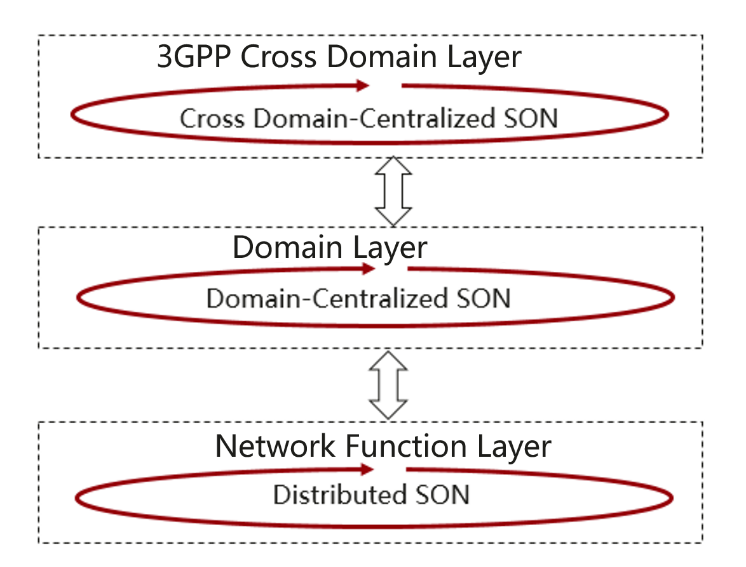


Figure 4.1.1-1: Overview of SON Framework

### 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. Self-configuration includes following functionality: create self-configuration task, monitor self-configuration process, generate configuration data if needed, download and activate software, download and active configuration data, perform self-test and update network resource model, etc.

# 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.

#### 6.1.1.2 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.

### 6.1.2 Centralized SON

#### 6.1.2.1 PCI configuration

**REQ- CPCI-CONFIG-FUN-1** Theproducer 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** Theproducer 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** Theproducer 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

**REQ-SCM-CON-1** The MnS for self-configuration management shall have the capability allowing MnS consumer request MnS producer to create, query and delete Self-configuration management profile.

**REQ-SCM-CON-2** The MnS for Self-configuration management shall have the capability allowing MnS consumer obtain the progress of self-configuration process form MnS producer.

#### 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 blacklisting)

|  |  |  |
| --- | --- | --- |
| 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 black-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 blacklisting)

|  |  |  |
| --- | --- | --- |
| **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** |  |

### 6.4.2 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. |  |
| 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 rachOptimizationControl 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 mroControl 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-RAT too early handover failures | Detected when an RLF occurs after the UE has stayed for a long period of time in the cell (see clause 5.1.1.25.1 in TS 28.552 [5]). |  |
| Number of intra-RAT too late 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 (see clause 5.1.1.25.1 in TS 28.552 [5]). |  |
| Number of intra-RAT 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 (see clause 5.1.1.25.1 in TS 28.552 [5]). |  |
| Number of intra-RAT too early handover failures per source beam | Detected when an RLF occurs after the UE has stayed for a long period of time in the cell (see clause 5.1.1.25.5 in TS 28.552 [5]). |  |
| Number of intra-RAT too late 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 (see clause 5.1.1.25.5 in TS 28.552 [5]). |  |
| Number of intra-RAT 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 (see clause 5.1.1.25.5 in TS 28.552 [5]). |  |
| Number of intra-RAT too early handover failures per source beam | Detected when an RLF occurs after the UE has stayed for a long period of time in the cell (see clause 5.1.1.25.5 in TS 28.552 [5]). |  |
| Number of inter-RAT too early handover failures | Detected when an RLF occurs after the UE has stayed in an E-UTRAN cell which connects with 5GC for a long period of time (see clause 5.1.1.25.2 in TS 28.552 [5]). |  |
| Number of inter-RAT too late handover failures | Detected when an RLF occurs shortly after a successful handover from an E-UTRAN cell which connects with EPC to a target cell in a E-UTRAN cell which connects with 5GC (see clause 5.1.1.25.2 in TS 28.552 [5]). |  |
| Number of unnecessary handover to another RAT | 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-RAT 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 pciConfigurationControl 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 pciList 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. | 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.x.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]). |  |
| 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]). |  |

## 7.2 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. | disable, enable |

##### 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.x.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]).. |  |
| 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.x.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 isotroptic radiated power (EIRP) in dBm for all downlink channels, used simultaneously in a cell, added together. See attribute configuredMaxTxEIRP in TS 28.541 [13]. |  |
| Coversage shape | Identifies the sector carrier coverage shape described by the envelope of the contained SSB beams. See attribute coverageShapen 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 CCOSwitch 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 attribute CCOPolicy 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.x.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]). |  |
| 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 5.1.1.4.3 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 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 mitigationn

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 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 collects real-time load information to determine and 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 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 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: Voiud

Note 3: Void

Note 4: Void.

Note 5: Void.

#### 8.3.2.2 Procedures for self-configuration management

The Figure 8.3.2.2-1 illustrates the procedure for start self-configuration management.

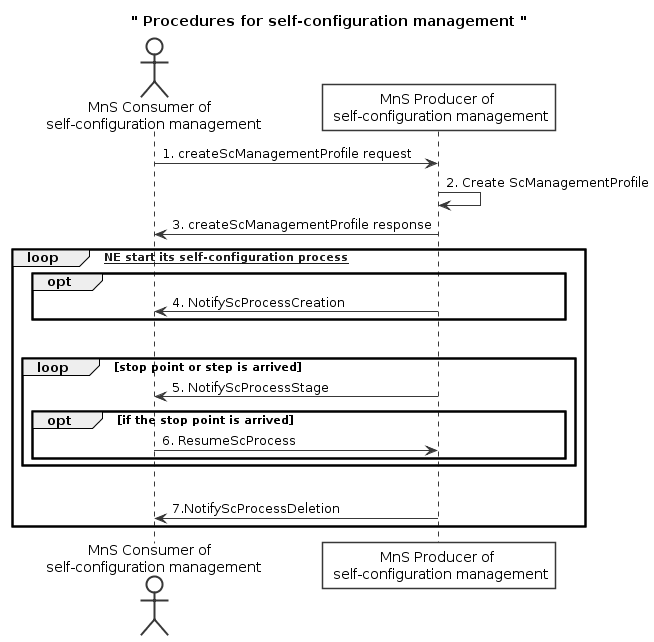


Figure 8.3.2.2-1: Procedures for self-configuration management

1. MnS consumer of self-configuration management sends createScManagementProfile request for NE(s) of a certain type to MnS producer of self-configuration management. NE information, stop point information and step information may be included in the request.

2. MnS producer of self-configuration management creates ScManagementProfile instance for NE(s) specified in the received request.

3. MnS producer of self-configuration management sends the create ScManagementProfile response to MnS producer of self-configuration management.

4. For each NE (specified in the created ScManagementProfile) starting its self-configuration process, MnS producer of self-configuration management sends NotifyScProcessCreation notification to MnS consumer of self-configuration management.

5. When arrival at a stop point (e.g. stop point waiting for the network configuration data) or step described in corresponding ScManagementProfile, MnS producer of self-configuration management sends NotifyProcessStage notification to MnS consumer of self-configuration management.

6. If arrival at a stop point in step 5), MnS consumer of self-configuration management sends ResumeScProcess request to MnS producer of self-configuration management. If the self-configuration process is suspended at a stop point and is waiting for the network configuration data, the request include network configuration data or information indicating location of network configuration data.

7. When the self-configuration process is terminated, the MnS producer of self-configuration management sends NotifyScProcessDeletion notification to MnS consumer of self-configuration management.

### 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 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 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 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 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 Procedures for establishment of a new RAN NE in network

## A.1.1 Void

## A.1.2 Procedure for self-configuration management

The following PlantUML source code is used to describe the procedure for self-configuration management, as depicted by Figure 8.3.2.2-1:

@startuml

title " Procedures for self-configuration management "

actor "MnS Consumer of \n self-configuration management" as SC

participant "MnS Producer of \n self-configuration management" as SP

SC -> SP: 1. createScManagementProfile request

SP -> SP: 2. Create ScManagementProfile

SP -> SC: 3. createScManagementProfile response

loop [Corresponding NE start its self-configuration process]

opt

SP -> SC: 4. NotifyScProcessCreation

end

|||

loop stop point or step is arrived

SP -> SC: 5. NotifyScProcessStage

opt if the stop point is arrived

SC -> SP: 6. ResumeScProcess

end

end

|||

SP->SC: 7.NotifyScProcessDeletion

end

skinparam sequenceActorBackgroundColor #FFFFFF

skinparam sequenceParticipantBackgroundColor #FFFFFF

skinparam noteBackgroundColor #FFFFFF

autonumber "#'.'"

skinparam monochrome true

skinparam shadowing false

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 |