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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
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Contents

Intellectual Property Rights	2
Legal Notice	2
Modal verbs terminology.....	2
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
6.1.2 Centralized SON.....	15
6.1.2.1 PCI configuration.....	15
6.1.2.2 Requirements for RAN NE plug and connect to management system.....	15
6.1.2.3 Requirements for self-configuration of a new RAN NE	15
6.2 Actor roles	15
6.3 Telecommunication resources	15
6.4 Use cases	16
6.4.1 Distributed SON management	16
6.4.1.1 RACH Optimization (Random Access Optimisation)	16
6.4.1.2 MRO (Mobility Robustness Optimisation)	17
6.4.1.3 ANR management.....	18
6.4.1.3.1 Starting the ANR function.....	18
6.4.1.3.2 Stopping the ANR function	18
6.4.1.3.3 Sending notification of added or deleted NCR.....	19
6.4.1.3.4 Handover Whitelisting.....	19

6.4.1.3.5	Handover Blacklisting	20
6.4.1.3.6	Prohibiting X2 or Xn connection to a peer node (X2/Xn blacklisting)	20
6.4.1.3.7	Prohibiting handover over X2 or Xn (X2/Xn handover blacklisting).....	21
6.4.1.4	PCI configuration.....	21
6.4.1.4.1	Initial PCI configuration.....	21
6.4.1.4.2	PCI re-configuration.....	22
6.4.2	Centralized SON.....	22
6.4.2.1	PCI configuration.....	22
6.4.2.1.1	Initial PCI configuration.....	22
6.4.2.1.2	PCI re-configuration.....	23
6.4.2.2	Use case for establishment of a new RAN NE in network.....	23
6.4.2.2.1	Use case for RAN NE plug and connect to management system.....	23
6.4.2.2.2	Use case for self-configuration of a new RAN NE.....	25
7	Management services for SON.....	27
7.1	Management services for D-SON management	27
7.1.1	RACH Optimization (Random Access Optimisation)	27
7.1.1.1	MnS component type A	27
7.1.2.1	MnS Component Type B definition	27
7.1.2.1.1	Targets information	27
7.1.2.1.2	Control information	27
7.1.2.1.3	Parameters to be updated.....	27
7.1.3.1	MnS Component Type C definition	28
7.1.3.1.1	Performance measurements.....	28
7.1.2	MRO (Mobility Robustness Optimisation).....	28
7.1.2.1	MnS component type A	28
7.1.2.2	MnS Component Type B definition	28
7.1.2.2.1	Targets information	28
7.1.2.2.2	Control information	28
7.1.2.2.3	Parameters to be updated.....	29
7.1.2.3	MnS Component Type C definition	29
7.1.2.3.1	Performance measurements.....	29
7.1.3	PCI configuration.....	30
7.1.3.1	MnS component type A	30
7.1.3.2	MnS Component Type B definition	30
7.1.3.2.1	Control information	30
7.1.3.2.2	Parameters to be updated.....	30
7.1.3.3	MnS Component Type C definition	31
7.1.3.3.1	Notification information.....	31
7.1.4	ANR management	31
7.2	Management services for C-SON.....	31
7.2.1	PCI configuration.....	31
7.2.1.1	MnS component type A	31
7.2.1.2	MnS Component Type B definition	32
7.2.1.2.1	Control information	32
7.2.1.2.2	Parameters to be updated.....	32
7.2.1.3	MnS Component Type C definition	32
7.2.1.3.1	Notifications information	32
7.2.1.3.2	Performance measurements.....	32
8	SON procedures	32
8.1	Introduction	32
8.2	Distributed SON management.....	33
8.2.1	RACH Optimization (Random Access Optimisation)	33
8.2.2	MRO (Mobility Robustness Optimisation).....	34
8.2.3	PCI configuration.....	35
8.2.3.1	Initial PCI configuration	35
8.2.3.2	PCI re-configuration.....	36
8.3	Centralized SON	37
8.3.1	PCI configuration.....	37
8.3.1.1	Initial PCI configuration	37
8.3.1.2	PCI re-configuration.....	37

8.3.2	Procedures for establishment of a new RAN NE in network.....	38
8.3.2.1	Procedures for RAN NE plug and connect to management system	38
8.3.2.2	Procedures for self-configuration management.....	39
Annex A (informative):	PlantUML source code	41
A.1	Procedures for establishment of a new RAN NE in network	41
A.1.1	Procedure for plug and connect to management system.....	41
A.1.2	Procedure for self-configuration management	41
Annex B (informative):	Change history	43
History		44

Foreword

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- 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

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.

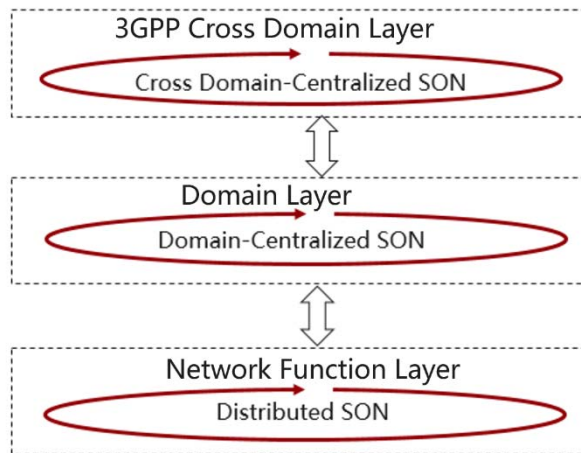


Figure 4.1.1-1: Overview of SON Framework

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.

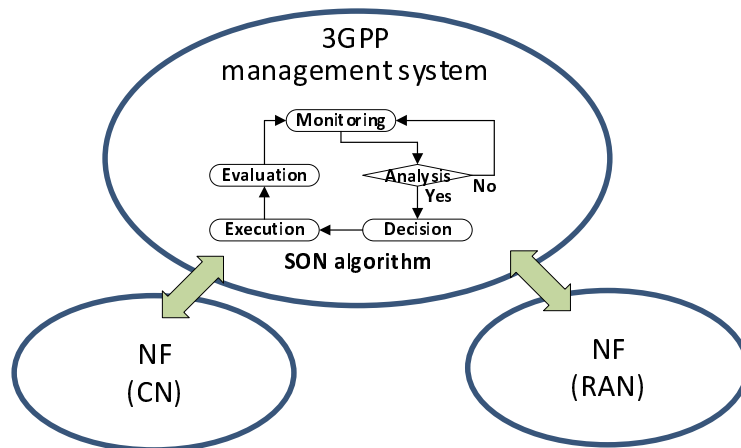


Figure 4.1.2.1-1: C-SON process

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.

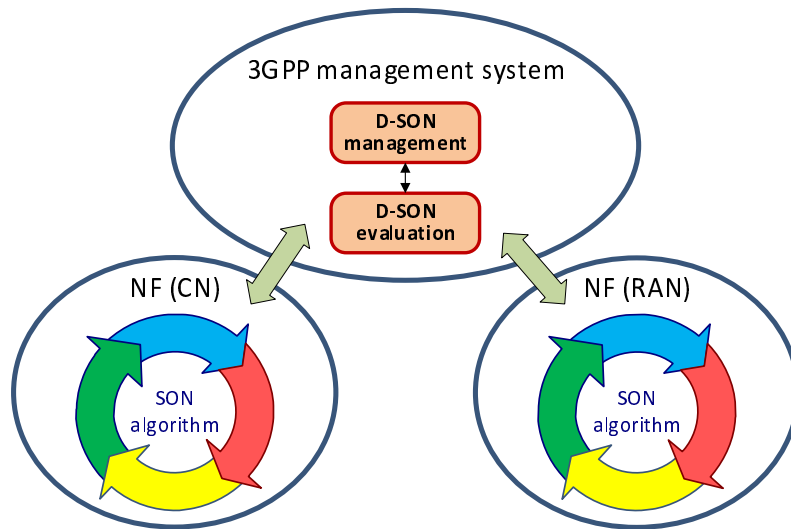


Figure 4.1.3-1: D-SON process

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.

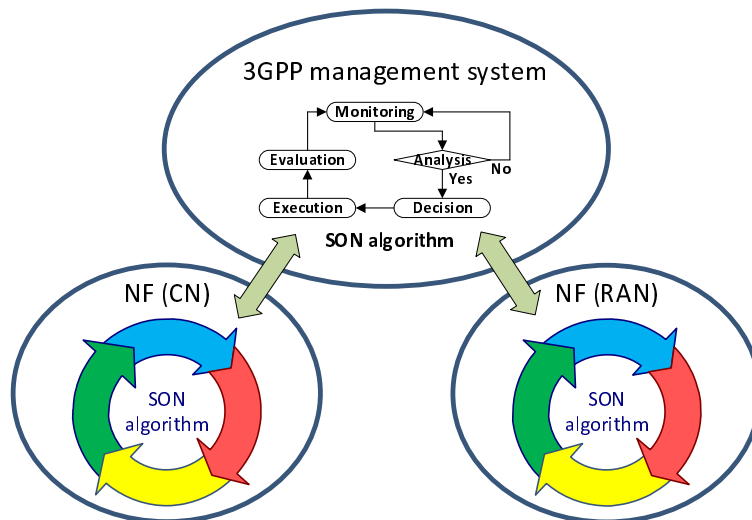


Figure 4.1.4-1: H-SON process

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 deployed NE to its management system providing support for self-configuration process as automatically as possible. The following functionality is included: initial IP Autoconfiguration service, Certificate enrolment, establish secure connection, establish connect to management system providing support for self-configuration process.

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 MnS producer should have a capability allowing the authorized consumer to set and update the targets for RACH optimization function.

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

REQ-RACH-FUN-3 MnS producer 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 MnS producer 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 MnS producer 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 MnS producer 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 fault supervision MnS should have a capability to notify the authorized consumer about the detection or 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.

6.1.2 Centralized SON

6.1.2.1 PCI configuration

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

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

REQ-CPCI-CONFIG-FUN-3 producer of fault supervision MnS should have a capability to notify the authorized consumer about the detection or resolution of PCI collision or PCI confusion problems for NR cells.

6.1.2.2 Requirements for RAN NE plug and connect to management system

REQ-PnC-CON-1 NE shall be able to get its own IP addresses and MnF IP address without manual configuration during plug and play for a NE connection to the network.

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.

6.2 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 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 or 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 Whitelisting

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 whitelist 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 Blacklisting

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 blacklist 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 PCIs for NR cells that have not been assigned with PCIs.	
Actors and Roles	D-SON management function to support initial PCI configuration.	
Telecom resources	- gNB; - The producer of provisioning MnS	
Assumptions	N/A	
Pre-conditions	- 5G NR cells are in operation. - No PCI values have been assigned to NR cells.	
Begins when	The D-SON management function decided to configure the PCI list for NR cell(s).	
Step 1 (M)	The D-SON management function requests the producer of provisioning MnS to configure the PCI list at 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)	The PCI configuration function selects PCI value(s) from the list of PCI values provided by the producer of provisioning MnS.	
Step 4 (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-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

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To automatically re-configure the PCIs of NR, due to the 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	- 5G NR cell(s) have being assigned with PCI value(s). - The PCI configuration function is in operation, and enabled.	
Begins when	PCI configuration function has detected the PCI problem of PCI collision or PCI confusion for NR cell(s).	
Step 1 (M)	The D-SON management function receives an alarm from the producer of fault supervision MnS indicating the 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 with the PCI value(s) being assigned for the NR cell(s).	
Step 5 (M)	The D-SON management function receives a clear alarm notification from the producer of fault supervision MnS.	
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	

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 has been in operation, and enabled.	
Begins when	The C-SON function requests the producer of provisioning MnS to collect the PCI related measurements reported by NG-RAN.	
Step 1 (M)	The C-SON function analyses the PCI related information and detects that NR cells have experienced PCI conflict or confusion issues.	
Step 2 (M)	The producer of fault supervision MnS notifies the C-SON function about the PCI collision or PCI confusion problems for NR cell(s).	
Step 3 (M)	The C-SON function determines the new PCI value(s), and requests the producer of provisioning MnS to re-configure the PCI value for the NR cell(s) 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 4 (M)	The producer of fault supervision MnS notifies the consumer-SON function about the resolution of PCI collision or PCI confusion problems for 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, REQ-CPCI-CONFIG-FUN-3	

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

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	After NE installation, connect the NE to its MnF providing support for self-configuration process, and to the External Network(s) as automatically as possible. 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 or other type of RAN NE (e.g. GNB-CU) is not addressed in this use case.	
Actors and Roles	NE	
Telecom resources	IP networks: Non-Secure Operator Network, External Network, and its elements like DHCP server optionally DNS, CA/RA servers, Security Gateway(s) (each protecting one or more Secure Operator Networks), Secure Operator Network(s) including MnF providing support for self-configuration process.	

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Assumptions	There is a functional power supply for the NE. There may be one or more IP Autoconfiguration Services like DHCP and Router Advertisements and zero or more DNS servers.	
Pre conditions	<p>The NE is installed.</p> <p>IP connectivity exists between the involved telecom resources. The involved telecom resources are functional. The relevant information is stored and available:</p> <ul style="list-style-type: none"> - Vendor Certificate at the NE - Operator Certificate at the CA/RA - For the External Network or Non-Secure Operator Network: <ul style="list-style-type: none"> - (Outer) IP autoconfiguration information at the IP Autoconfiguration Service - FQDN of the initial OAM SeGW at the NE and/or FQDN or IP address of the initial OAM SeGW at the IP Autoconfiguration Service - FQDN of the CA/RA servers at the NE and/or FQDN or IP address of the CA/RA servers at the IP Autoconfiguration Service - If FQDNs need to be resolved, corresponding IP address(es) at the DNS server(s) - For the Secure Operator Network: <ul style="list-style-type: none"> - (Inner) IP autoconfiguration information at the IP Autoconfiguration Service or at the initial OAM SeGW - FQDN or IP address of the initial MnF at the NE and/or DHCP Server of the Secure Operator Network. - If FQDNs need to be resolved, corresponding IP address(es) at the DNS server(s) - Configuration and software for the NE at the MnF(s) 	
Begins when	The NE is installed.	
Step 1 (M)	If a VLAN ID is available the NE uses it. Otherwise the NE uses the native VLAN where PnP traffic is sent and received untagged	
Step 2 (M)	The NE acquires its IP address through stateful or stateless IP autoconfiguration. This may provide 0 or more DNS server addresses.	
Step 3 (M)	The NE acquires the IP address of the CA/RA server. The FQDN of the CA/RA server may be pre-configured in the NE or the FQDN or IP address of the CA/RA server may be provided by the IP Autoconfiguration Service. FQDNs are resolved through the DNS if necessary. Information provided by the IP Autoconfiguration Services shall supersede those pre-configured at the NE.	
Step 4 (M)	The NE performs Certificate Enrolment.	
Step 5 (M)	The NE acquires the IP address of the OAM SeGW. The FQDN of the OAM SeGW may be pre-configured in the NE or the FQDN or the IP address of the OAM SeGW may be provided by the IP Autoconfiguration Service. FQDNs are resolved through the DNS if necessary.	
Step 6 (M)	<p>The NE establishes a secure connection (tunnel) to the Security Gateway given by Step 5.</p> <p>The NE receives its (inner) IP autoconfiguration information (which may be the same as the outer IP address obtained in step2) and optionally the address of one or more DNS servers within the Secure Operator Network from the Configuration Parameters of IKEv2 during tunnel establishment.</p>	
Step 7 (M)	The NE acquires the IP address of the correct MnF by either, issuing a DHCP request including the NE's vendor information, resolving FQDNs via DNS if necessary, or by having a pre-configured FQDN (including the NE's vendor information) resolved via DNS.	

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Step 8 (M)	The NE establishes a connection to the provided MnF and acquires its configuration and software if any. The configuration may contain an address to another MnF that this specific node shall use as MnF. The configuration may contain an address to another SeGW that should be used before connecting to the MnF. The MnF may then <ul style="list-style-type: none"> - release the connection to the current MnF and OAM SeGW and then restart (returning to step 1), - release the connection to the current MnF and OAM SeGW and then return to step 6, - release the connection to the current MnF and then repeat step 8, or - continue with step 9. 	
Step 9 (M)	The NE establishes a connection to the External Network(s) using the transport (VLAN ID, IP addresses) and security parameters provided in step 8.	
Ends when	Ends when all mandatory steps identified above are successfully completed or when an exception occurs.	
Exceptions	One of the steps identified above fails.	
Post Conditions	One or more secure connections exist between the NE and the MnF and the External Network(s). Via the connection to the MnF the NE can receive further instructions to become operational and carry user traffic, e.g. the administrativeState is set to "unlocked".	Clause 6.4.2.2.2 Use case for self-configuration of a new RAN NE
Traceability	All requirements of clause 6.1.2.2	

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.	

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Step 1 (*) (M O)	<p>The order of the bullet points in the list below does not imply any statements on the order of execution.</p> <ul style="list-style-type: none"> - 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. <p>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.</p> <ul style="list-style-type: none"> - 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	

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

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 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].

7.1.2.1 MnS Component Type B definition

7.1.2.1.1 Targets information

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

Table 7.1.2.1.1-1: RACH optimization targets

Targets	Definition	Legal Values
UE access delay probability per SSB	The probability distribution of UE access delay that is used to minimize the access delays for the UEs under the SSBs.	CDF of access delay
Number of preambles send per SSB probability	The probability of the number of preambles sent per SSB.	CDF of access delay

7.1.2.1.2 Control information

The parameter is used to control the RACH optimization function.

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

7.1.2.1.3 Parameters to be updated

Void.

7.1.3.1 MnS Component Type C definition

7.1.3.1.1 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

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].

7.1.2.2 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.

Control parameter	Definition	Legal Values
MRO function control	This attribute allows the operator to enable/disable the MRO functionality. See attribute <code>mroControl</code> 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 absolute deviation of the Handover Trigger, from the default point of operation (see TS 38.300 [7] and TS 38.423 [17]).	[-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 TS 38.300 [7]).	[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 TS 38.300 [7].	[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]).	

Performance measurements	Description	Related targets
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

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 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.

Control parameter	Definition	Legal Values
PCI configuration control	This attribute allows authorized consumer to enable/disable the D-SON PCI configuration functionality. See attribute <code>pciConfigurationControl</code> 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.

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 <code>pciList</code> 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.

Performance measurements	Description	Note
PCI collision notification	The collision notification is used to indicate two neighbouring cells of a serving cell 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.	

7.1.4 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.

7.2 Management services for C-SON

7.2.1 PCI configuration

7.2.1.1 MnS component 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 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].

7.2.1.2 MnS Component Type B definition

7.2.1.2.1 Control information

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

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.

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.

Performance measurements	Description	Note
PCI collision notification	The collision notification is used to indicate two neighbouring cells of a serving cell 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 cells	The measurement contains cumulative counter with subcounters that is identified by the PCI value(s) of the candidate cells, and is derived from <i>MeasResultListNR</i> (see clause 6.3.2 in TS 38.331 [9]) where it contains PCI in <i>PhysCellId</i> , and RSRP/RSRQ in <i>MeasQuantityResults</i> of candidate cells. It is generated when the RSRP received from the candidate cells exceeds certain thresholds.	

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 management

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.

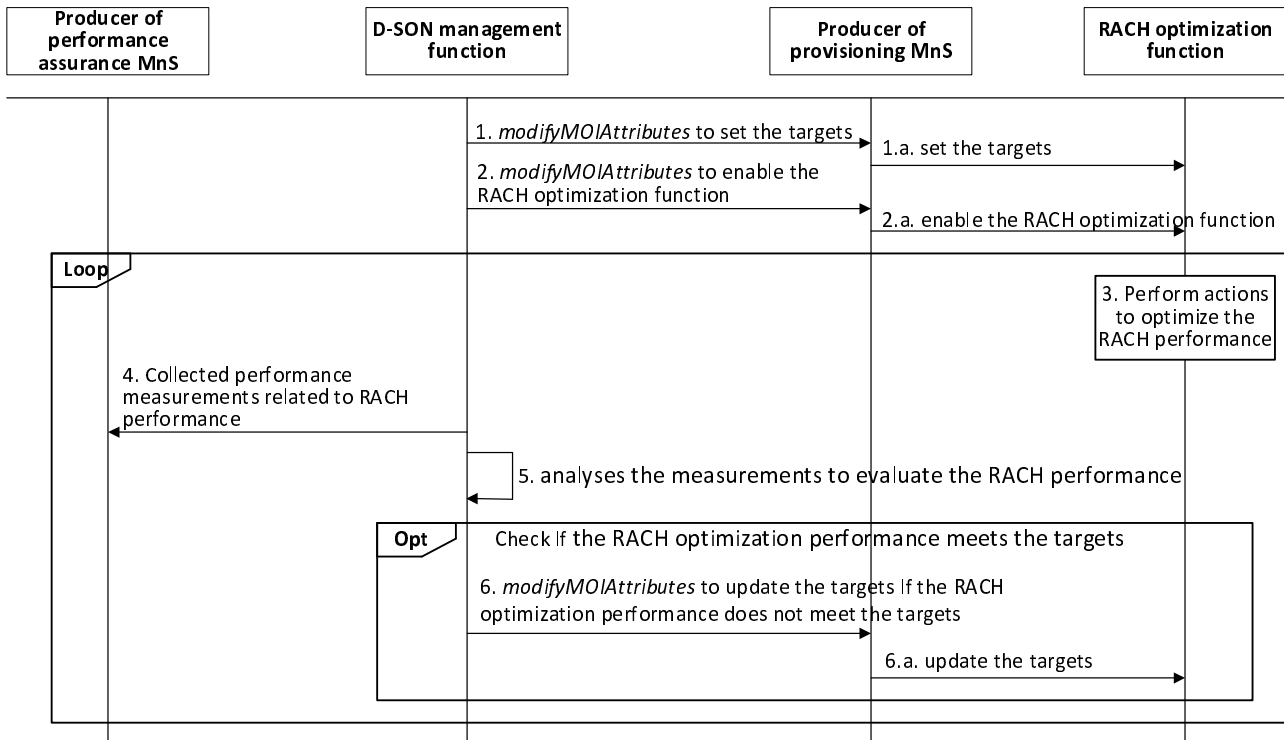


Figure 8.2.1-1: RACH Optimization procedure

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.

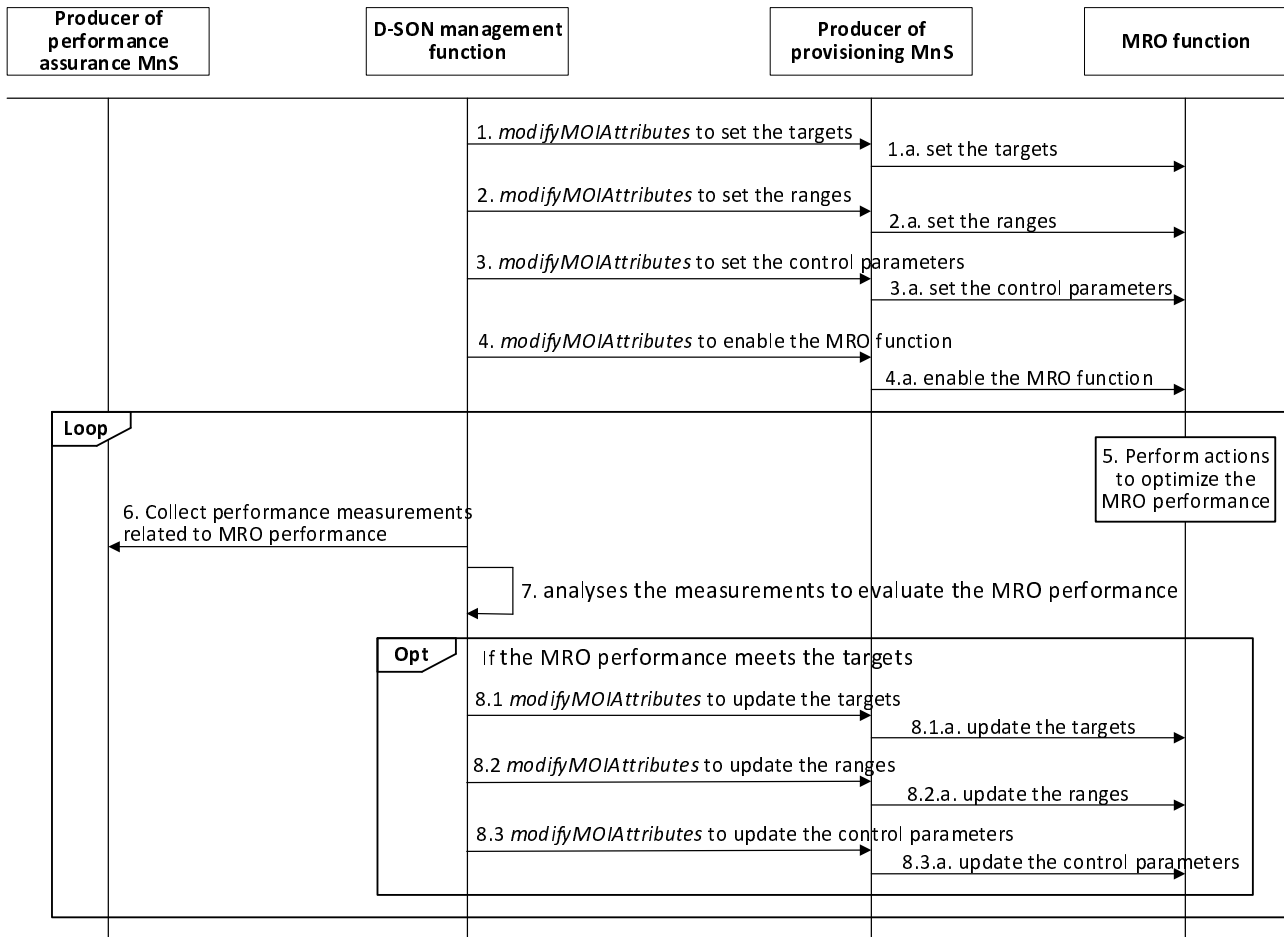


Figure 8.2.2-1: MRO procedure

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 MRO 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 MRO 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 PCI values to NR cells the first time.

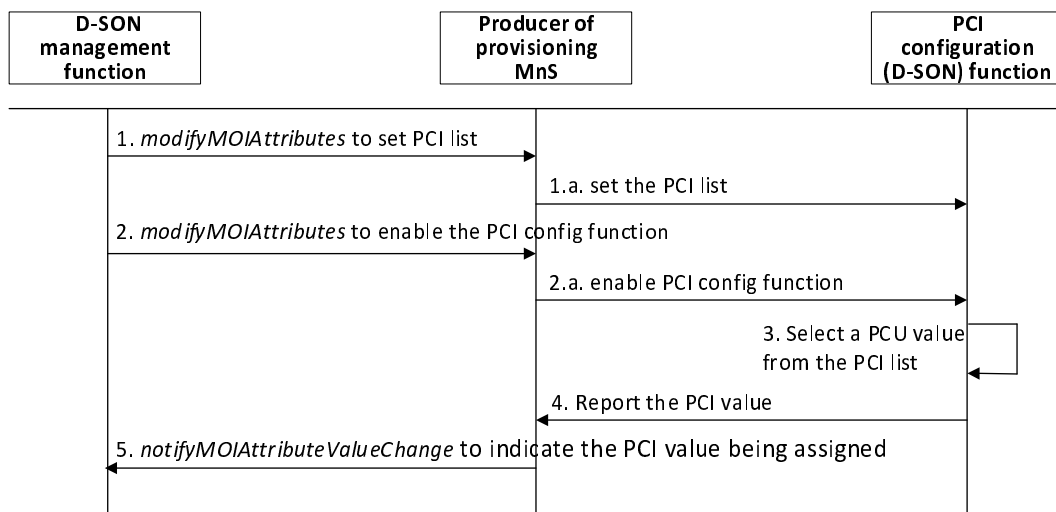


Figure 8.2.3.1-1: Initial PCI configuration procedure

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

Figure 8.2.3.2-1 depicts a procedure that describes how D-SON management function can re-configure the PCI list for NR cell(s) when PCI collision or PCI confusion issues were detected.

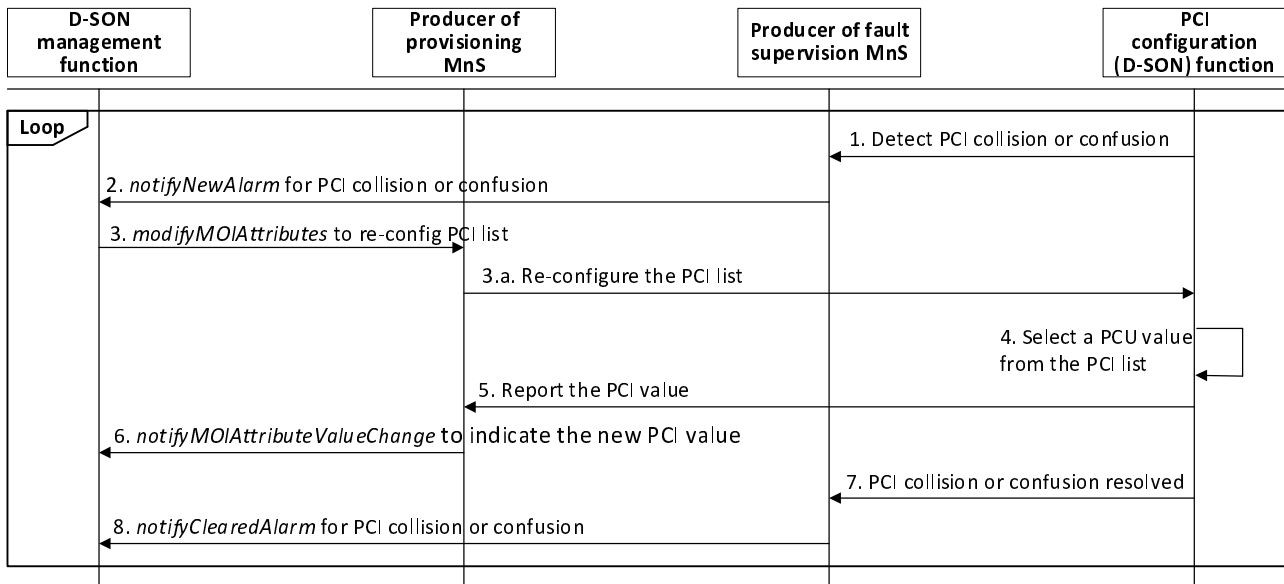


Figure 8.2.3.2-1: PCI re-configuration procedure

1. The PCI configuration (D-SON) function detects and reports the PCI collision or PCI confusion problems for NR cell(s) to MnS of fault supervision (NOTE).
2. The producer of fault supervision MnS sends a notification *notifyNewAlarm* to D-SON management function to report the PCI collision or PCI confusion problems detected on NR cell(s).
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) (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 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).
7. The PCI configuration (D-SON) function notifies MnS of fault supervision that the PCI collision or PCI confusion problems have been resolved (NOTE).
8. The producer of fault supervision MnS sends a notification *notifyClearedAlarm* to D-SON management function to report the PCI collision or PCI confusion problems being resolved.

NOTE: The interface between MnS of NF provisioning and PCI configuration (D-SON) 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.

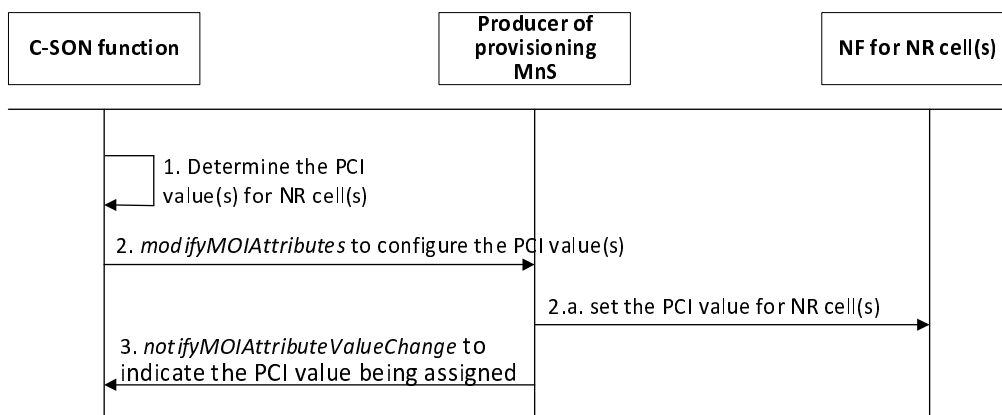


Figure 8.3.1.1-1: Initial PCI configuration procedure

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.

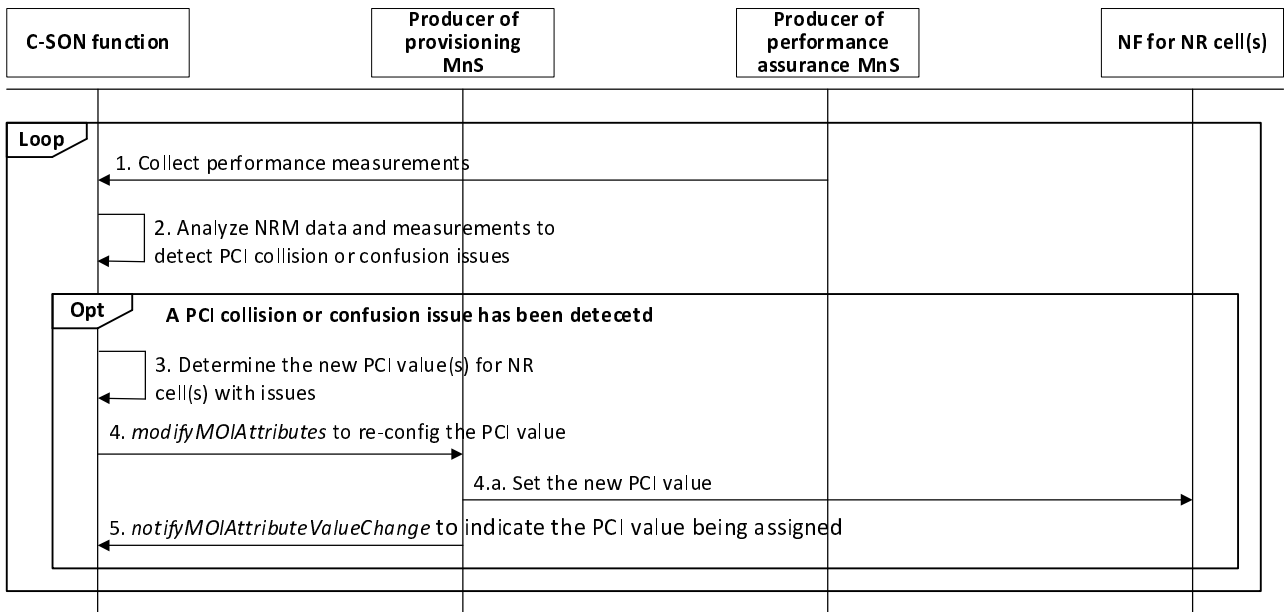


Figure 8.3.1.2-1: PCI re-configuration procedure

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 Figure 8.3.2.1-1 illustrates the procedure for 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.

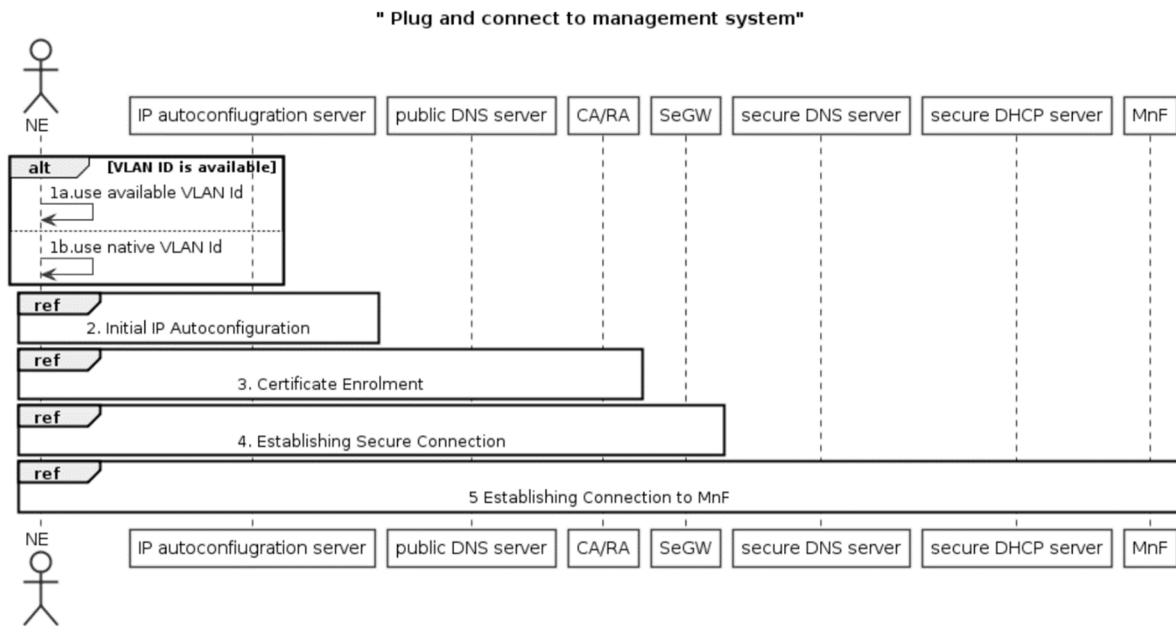


Figure 8.3.2.1-1: Procedures for plug and connect to management system

1, If a VLAN ID is available, the NE uses it. Otherwise the NE uses the native VLAN where PnP traffic is sent and received untagged.

2. NE invokes the "Initial IP Autoconfiguration" procedure and acquires its IP address through stateful or stateless IP Autoconfiguration. There may be additional information provided to the NE.

NOTE 2: The detailed "Initial IP Autoconfiguration" procedure refers to clause 5.2 of TS 32.508 [15].

3. NE invokes the "Certificate Enrolment" procedure.

NOTE 3: The detailed "Certificate Enrolment" procedure refers to clause 5.3 of TS 32.508 [15].

4. NE invokes the "Establishing Secure Connection" procedure and connects to the OAM SeGW.

NOTE 4: The detailed "Establishing Secure Connection" procedure refers to clause 5.4 of TS 32.508 [15].

5. NE invokes the "Establishing Connection to MnF" procedure.

NOTE 5: The detailed "Establishing Connection to MnF" procedure refers to clause 5.5 of TS 32.508 [15] and MnF act as the role of EM.

8.3.2.2 Procedures for self-configuration management

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

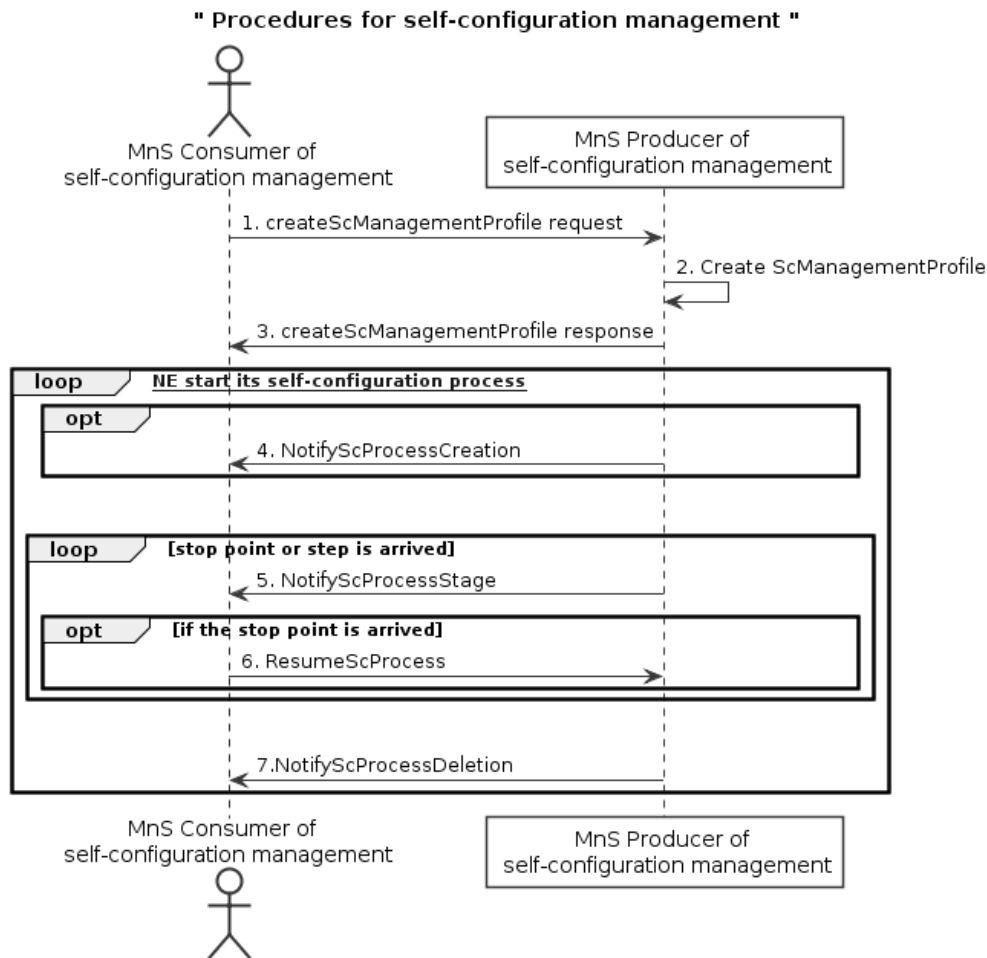


Figure 8.3.2.2-1: Procedures for plug and connect to management system

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.

Annex A (informative): PlantUML source code

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

A.1.1 Procedure for plug and connect to management system

The following PlantUML source code is used to describe the procedure for multi-vendor plug and connect to management system, as depicted by Figure 8.2.X.2-1:

```
@startuml
title " Plug and connect to management system"
actor NE
participant "IP autoconfiugration server" as IP_Server
participant "public DNS server" as P_DNS_Server
participant "CA/RA" as CA_RA
participant SeGW
participant "secure DNS server" as S_DNS_Server
participant "secure DHCP server" as S_DHCP_Server
participant MnF
alt VLAN ID is available
NE->NE: 1a.use available VLAN Id
Else
NE->NE: 1b.use native VLAN Id
End
Ref over NE, IP_Server: 2. Initial IP Autoconfiguration
Ref over NE, IP_Server,CA_RA: 3. Certificate Enrolment
Ref over NE, IP_Server,CA_RA,SeGW: 4. Establishing Secure Connection
Ref over NE, IP_Server,CA_RA,SeGW,MnF: 5 Establishing Connection to MnF

skinparam sequenceActorBackgroundColor #FFFFFF
skinparam sequenceParticipantBackgroundColor #FFFFFF
skinparam noteBackgroundColor #FFFFFF
autonumber "#'.'"
skinparam monochrome true
skinparam shadowing false
@enduml
```

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 8.2.X.3-1:

```
@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
2019-09						TS 28.313 Skeleton – before SA5#127	0.0.0
2019-10	SA5#127	S5-196672 S5-196674 S5-196675 S5-196696 S5-196697 S5-196698 S5-196857 S5-196747 S5-196858 S5-196802 S5-196860 S5-196861 S5-196862 S5-196863 S5-196864 S5-196865 S5-196865 S5-196803				Update according to the meeting agreement in SA5#127: S5-196672 pCR 28.313 skeleton S5-196674 pCR 28.313 introduction and scope S5-196675 Add SON Concept S5-196696 pCR 28.313 RACH optimization use case S5-196697 pCR 28.313 RACH optimization procedure S5-196698 pCR 28.313 RACH optimization information S5-196857 pCR 28.313 MRO use case S5-196747 pCR 28.313 MRO procedure S5-196858 pCR 28.313 MRO information S5-196802 pCr 28.313 ANR Business level requirements S5-196860 pCR 28.313 Add ANR Use Case: Start S5-196861 pCR 28.313 Add ANR Use Case: Stop S5-196862 pCR 28.313 Add ANR Use Case: Notification S5-196863 pCR 28.313 Add ANR Use Case: Handover whitelisting S5-196864 pCR 28.313 Add ANR Use Case: Handover blacklisting S5-196865 pCR 28.313 Add ANR Use Case: Prohibit X2/Xn S5-196865 pCR 28.313 Add ANR Use Case: Prohibit X2/Xn handover S5-196803 pCR 28.313 ANR Specification level requirements for NG-RAN	0.1.0
2019-11	SA5#128	S5-197790 S5-197791 S5-197792 S5-197793 S5-197835 S5-197836 S5-197551 S5-197586 S5-197818 S5-197819 S5-197796				Update according to the meeting agreement in SA5#128: S5-197790 pCR 28.313 D-SON PCI configuration use case S5-197791 pCR 28.313 C-SON PCI configuration use case S5-197792 pCR 28.313 D-SON PCI configuration procedure S5-197793 pCR 28.313 C-SON PCI configuration procedure S5-197835 pCR 28.313 D-SON PCI configuration information S5-197836 pCR 28.313 C-SON PCI configuration information S5-197551 Add usecase and requirements for establishment of new NE in network S5-197586 Add procedures for establishment of a new NE in network S5-197818 Update the requirements for ANR management in NG-RAN S5-197819 Add solutions for ANR management S5-197796 pCR 28.313 Add Concept for Establishment of new NE in network	0.2.0
2020-03	SA5#129e	S5-201583 S5-201584 S5-201376				Update according to the meeting agreement in SA5#129e: S5-201583 pCR 28.313 changes to MRO S5-201584 pCR 28.313 changes to RACH optimization S5-201376 pCR 28.313 Replace duplicated ANR management Stage 2 with reference	0.3.0
2020-05	SA5#130e	S5-202322 S5-202323 S5-202326 S5-202327 S5-202329 S5-202306				Update according to the meeting agreement in SA5#130e: S5-202322 pCR TS 28.313 clarification on RAN-related descriptions of SON management S5-202323 pCR clarification on the D-SON terminologies S5-202326 pCR 28.313 changes to RACH optimization S5-202327 pCR 28.313 changes to PCI configuration S5-202329 Update usecase and procedures for establishment of a new RAN NE in network S5-202306 pCR 28.313 revise MRO use case, requirements, information, and procedure	0.4.0
2020-06	SA5#131e	S5-203363 S5-202368				Update according to the meeting agreement in SA5#131e: S5-203363 pCR TS 28.313 MRO Function S5-203368 pCR 28.313 clean-up	0.5.0
2020-09	SA5#132e	S5-204450 S5-204451 S5-204452				Update according to the meeting agreement in SA5#132e: S5-204450 pCR TS 28.313 Corrections of Management service description S5-204451 pCR 28.313 add references for MRO measurements S5-204452 pCR TS 28.313 Corrections of D-SON Procedure	0.6.0
2020-09	SA#89e	SP-200758				Presented for approval	1.0.0
2020-09	SA#89e					Upgrade to change control version	16.0.0

History

Document history		
V16.0.0	October 2020	Publication