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Foreword

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

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

- shall** indicates a mandatory requirement to do something
- shall not** indicates an interdiction (prohibition) to do something

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

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

- should** indicates a recommendation to do something
- should not** indicates a recommendation not to do something
- may** indicates permission to do something
- need not** indicates permission not to do something

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

- can** indicates that something is possible
- cannot** indicates that something is impossible

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

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

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

In addition:

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

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

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

1 Scope

The present document studies on enhancement of autonomous network levels. It introduces the relevant study items and work items in 3GPP, identifies the additional generic MnS requirements of generic autonomous network level for the scenarios defined in Rel-17 and documents potential solutions for the identified generic MnS requirements. It also identifies the enhanced autonomy capabilities corresponding to different autonomous network levels for additional management use cases which is not defined in Rel-17 and documents potential solutions for the enhanced autonomy capabilities. Based on the investigation and studies, it provides recommendations for the further normative work.

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 28.310: "Management and orchestration; Energy efficiency of 5G".
- [3] 3GPP TR 28.813: "Management and orchestration; Study on new aspects of Energy Efficiency (EE) for 5G".
- [4] 3GPP TS 28.100: "Management and orchestration; Levels of autonomous network".
- [5] 3GPP TS 28.312: "Management and orchestration; Intent driven management services for mobile networks".
- [6] 3GPP TS 28.104: "Management and orchestration; Management Data Analytics".
- [7] 3GPP TS 28.532: "Management and orchestration; Generic management services".
- [8] 3GPP TS 28.541: "Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3".
- [9] 3GPP TS 28.622: "Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS)".
- [10] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".
- [11] 3GPP TS 32.422: "Telecommunication management; Subscriber and equipment trace; Trace control and configuration management".
- [12] 3GPP TS 28.313: "Management and orchestration; Self-Organizing Networks (SON) for 5G networks".
- [13] 3GPP TS 28.535: "Management and orchestration; Management services for communication service assurance; Requirements".
- [14] 3GPP TS 28.105: "Management and orchestration; Artificial Intelligence / Machine Learning (AI/ML) management".
- [15] 3GPP TS 28.554: "Management and orchestration; 5G end to end Key Performance Indicators (KPI)".
- [16] 3GPP TR 28.912: "Study on enhanced intent driven management services for mobile networks".

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].

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].

ANL	Autonomous Network Level
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4 Introduction on relevant specifications in 3GPP

In TS 28.100 [4], categorizations of the tasks in a workflow are specified in clause 4.3.4 including intent handling, awareness, analysis, decision and execution, and these task categories are used in the framework approach for evaluating autonomous network levels (ANL) in clause 5 of TS 28.100.

In clause 4.2.1 of TS 28.535 [13], management control loop including monitor, analytic, decision, execution is described. And in clause 6.1 of TS 28.104 [6], management loop including observation, analytics, decision, execution is specified as well. The management control loop and management loop defined in TS 28.535 [13] and TS 28.104 [6] are similar, and both of them have the similar consideration with the workflow specified in TS 28.100 [4], i.e. awareness, analysis, decision and execution. MDA role in the management loop is within the scope of analytics (see TS 28.100 [4]).

In addition to the above four items included in management control loop or management loop, intent handling is also introduced in TS 28.100 [4] which means certain autonomous network levels are required to support intent driven management control loop autonomously. And in clause 4.2.2 of TS 28.312 [5], intent driven MnS is defined with the capabilities including intent translation and intent fulfilment result/information evaluating, which are the main tasks included in the categorization of intent handling defined in clause 4.3.4 of TS 28.100 [4].

And if Artificial Intelligence/Machine Learning (AI/ML) technology is utilized in autonomous networks, AI/ML model training MnS specified in TS 28.105 [14], can be used to enable analytics or decision autonomy capabilities and thus to achieve certain autonomous network levels.

5 Issue investigations and potential solutions for scenarios listed in TS 28.100 [4]

5.1 Key Issue# 5.1: Enhancement of generic autonomous network level for network optimization

5.1.1 Description

5.1.1.1 Issue description

The generic autonomous network level for network optimization is defined in Clause 7.1 in TS 28.100 [4], which includes generic workflow, generic classification of autonomous network level, generic autonomy capability description for management system, generic MnS requirements and solutions for generic MnS requirements.

Based on current definition, the generic autonomy capability description for management system for level 4 is documented in clause 7.1.3 in TS 28.100 [4]. However, the additional MnS requirements for level 4 are not specified in clause 7.1.4 in TS 28.100 [4].

Regarding the solutions for MnS requirements for level 2, currently only solutions for the network issues which can be detected based on threshold is specified. The MDA feature specified in TS 28.104 [6] delivers the analytic capabilities for identifying more network issues (e.g. coverage issue, SLS issue, network slice throughput issue), so the MDA MnS can be used to support MnS requirements for level 2 which focus on the autonomous analytic capability. So it is necessary to analyse which concrete MnS requirements for level 2 are already supported by MDA MnS, and which MnS requirements can be supported by enhancement of MDA MnS.

5.1.1.2 Potential requirements

Following additional MnS requirements for level 4 needs to be specified to support generic autonomy capability description for management system for level 4.

REQ-ANL-NetOpt-Level_4-MnS-1 The 3GPP management system shall have the capability allowing its authorized consumer to specify the network optimization intent.

REQ-ANL-NetOpt-Level_4-MnS-2 The 3GPP management system shall have the capability allowing its authorized consumer to obtain the fulfilment information of the network optimization intent.

5.1.2 Potential solutions

Following solutions for MnS requirements for level 4 needs to be added in TS 28.100 [4] Table 7.1.5-1: Solutions for generic MnS requirements of autonomous network level for network optimization.

Table 5.1.2-1: Potential solutions for generic MnS requirements of autonomous network level 4 for generic network optimization

Level4	REQ-ANL-NetOpt-Level_4-MnS-1	This can be implemented by using generic provisioning MnS (e.g. createMOI) defined in TS 28.532 [4] to specify the network optimization intent defined in TS 28.312 [5].
	REQ-ANL-NetOpt-Level_4-MnS-2	This can be implemented by using generic provisioning MnS (e.g. getMOIAttributes) defined in TS 28.532 [7] to obtain network optimization fulfilment information defined in TS 28.312 [5].

Following are the additional solutions description for MnS requirements for level 2 to be added in TS 28.100 [4].

Regarding the **REQ-ANL-NetOpt-Level_2-MnS-2** and **REQ-ANL-NetOpt-Level_2-MnS-4**, the MDA MnS defined in TS 28.104 [6] can be used. The analytics output can represent network issue identification and network issue demarcation result. Which means MnS consumer can use the MDA MnS to obtain the network issue and corresponding demarcation result.

5.1a Key Issue# 5.1a: Enhancement of autonomous network level for radio network coverage optimization

5.1a.1 Description

The solution for MnS requirements for radio network coverage optimization is described in A.1.3, Based on current definition, following aspects needs to be further enhanced:

- The MnS component type A (operation and notification), MnS component type B (Information model) and MnS component type C (management data) to support the MnS requirements for radio network coverage optimization have not been explicitly described.

5.1a.2 Potential solutions

Based on the solutions for MnS requirements of autonomous network level for radio network coverage optimization defined in clause A.1.3 in TS 28.100 [2], following are the enhanced solutions description for generic MnS requirements of autonomous network level for radio network coverage optimization.

NOTE: The solutions below are not used to evaluate the autonomous network level, which are MnS solutions to support MnS requirements for 3gpp management system derived from autonomy capability of each level.

Table 5.1a.2-1: Solutions for generic MnS requirements of autonomous network level for radio network coverage optimization

ANL	Requirements	Corresponding solutions		
		MnS Component type A	MnS Component type B	MnS Component type C
Level 1	REQ-ANL-NetOpt-Level_1-MnS-1	createMOI of provisioning MnS defined in TS 28.532 [7]	CommonBeamformingFunction IOC in NR NRM defined in TS 28.541 [8]	Not applicable
	REQ-ANL-NetOpt-Level_1-MnS-2	createMOI of provisioning MnS defined in TS 28.532 [7]	PerfMetricJob IOC and TraceJob IOC defined in TS 28.622 [9]	Not applicable
	REQ-ANL-NetOpt-Level_1-MnS-3	operations of file data reporting MnS and streaming data report MnS defined in TS 28.532[7]	NR NRM (e.g. NRCellICU, Beam and NRCellRelation IOC) defined in TS 28.541 [8]	1. RSRP measurements (e.g. SS-RSRP), RSRQ measurements (e.g. SS-RSRQ) and SINR measurements (e.g. SS-SINR) defined in TS 28.552 [10]. 2. RSRPs of the serving cell and neighbour cells, and UE location in MDT reports [11]
Level 2	REQ-ANL-NetOpt-Level_2-MnS-1	createMOI of provisioning MnS defined in TS 28.532[7]	MDARequest IOC defined in MDA information model in TS 28.104 [6].	Not applicable
	REQ-ANL-NetOpt-Level_2-MnS-2	Operations of file data reporting MnS and streaming data report MnS defined in TS 28.532 [7]	MDARequest IOC defined in MDA information model in TS 28.104 [6]	"CoverageProblemId" of analytics output for coverage problem analysis in TS 28.104 [6].
	REQ-ANL-NetOpt-Level_2-MnS-3	createMOI of provisioning MnS defined in TS 28.532[7]	MDARequest IOC defined in MDA information model in TS 28.104 [6].	Not applicable

ANL	Requirements	Corresponding solutions		
		MnS Component type A	MnS Component type B	MnS Component type C
	REQ-ANL-NetOpt-Level_2-MnS-4	Operations of file data reporting MnS and streaming data report MnS defined in TS 28.532[7]	MDARequest IOC defined in MDA information model in TS 28.104 [6]	"CoverageProblemType" and "CoverageProblemAreas" of analytics output for coverage problem analysis in TS 28.104 [6].
	REQ-ANL-NetOpt-Level_2-MnS-5	createMOI of provisioning MnS defined in TS 28.532 [7]	MDARequest IOC defined in MDA information model in TS 28.104 [6]	Not applicable
Level3	REQ-ANL-NetOpt-Level_3-MnS-1	createMOI of provisioning MnS defined in TS 28.532 [7]	CCOFunction IOC defined in TS 28.541 [8] and TS 28.313 [12] as control information for CCO function.	Not applicable
	REQ-ANL-NetOpt-Level_3-MnS-2	createMOI of provisioning MnS defined in TS 28.532 [7]	CCOFunction IOC defined in TS 28.541 [8] and TS 28.313 [12] as control information for CCO function.	Not applicable
Level 4	REQ-ANL-NetOpt-Level_4-MnS-1	createMOI of provisioning MnS defined in TS 28.532 [7]	"weakRSRPRatioTarget" and "lowSINRRatioTarget" of RadioNetworkExpectation in intent information model in TS 28.312 [5] as expectation targets for radio network coverage assurance.	Not applicable
	REQ-ANL-NetOpt-Level_4-MnS-2	getMOIAttributes of provisioning MnS defined in TS 28.532 [7]	"targetfulfillmeInfo" for "weakRSRPRatioTarget" and "lowSINRRatioTarget" of RadioNetworkExpectation in intent information model in TS 28.312 [5].	Not applicable

5.1b Key Issue# 5.1b: Analysis on the solution for MnS requirements of autonomous network level for RAN UE throughput optimization

5.1b.1 Description

Autonomous network level for RAN UE throughput optimization is documented in clause A.2 in TS 28.100 [4]. In TS 28.100 [4], corresponding workflow and classification of autonomous network level for RAN UE throughput optimization is defined, however it is not clear whether the solution for generic MnS requirements of autonomous network level for RAN UE optimization is well defined. So it is necessary to analyse the solutions for corresponding MnS requirements.

5.1b.2 Potential solutions

Based on the existing generic MnS requirements of Level 1-Level 3 for the generic network optimization in TS 28.100 [4] and additional MnS requirements for Level 4 for the generic network optimization in clause 5.1, following are the solution descriptions to be added in TS 28.100 [4] which can be used to satisfy MnS requirements of autonomous network level for RAN UE throughput optimization.

- Regarding the **REQ-ANL-NetOpt-Level_1-MnS-1, 2, 3**, NR NRM (e.g. NRCellCU, NRCellRelation, NRCellDU) defined in TS 28.541 [8] are used to represent network adjustment solution. The UE throughput measurements (e.g. Average DL UE throughput in gNB, Distribution of DL UE throughput in gNB) defined in TS 28.552 [10] and RAN UE Throughput KPIs (e.g. DL RAN UE

throughput for a sub-network, DL RAN UE throughput for a NRCellDU) defined in TS 28.554 [15] are used to represent the network related information.

Regarding the **REQ-ANL-NetOpt-Level_4-MnS-1, 2**, the attribute "aveULRANUEThptTarget", "aveDLRANUEthptTarget", "lowULRANUEThptRatioTarget" and "lowDLRANUEThptRatioTarget" of RadioNetworkExpectation in intent information model in TS 28.312 [5] as expectation targets for RAN UE throughput assurance.

Following are the gap analysis for the solutions to Level 1-Level 4 MnS requirements for RAN UE throughput optimization:

- Gap: No existing solutions can be used to support additional MnS requirements to support autonomous network levels 2 and 3. The mechanism to allow MnS consumer to obtain the RAN UE throughput issue identification, demarcation and root cause analysis result is missing.
- Solution: MDA feature (TS 28.104 [6]) is developed to identify ongoing issues impacting the performance of the network and services, and help to identify in advance potential issues that may cause potential failure and/or performance degradation. Providing RAN UE throughput analytic output including information related to RAN UE throughput issue identification, demarcation and root cause analysis result is a potential enhancement to MDA. This capability can be used as potential reference solution for ANL.

5.2 Key Issue# 5.2: Enhancement of generic autonomous network level for RAN NE deployment

5.2.1 Description

5.2.1.1 Issue description

The generic autonomous network level for RAN NE deployment is defined in Clause 7.2 in TS 28.100 [4], which includes generic workflow, generic classification of autonomous network level, generic autonomy capability description for management system, generic MnS requirements and solutions for generic MnS requirements.

Based on current definition, the generic autonomy capability description for management system for level 4 is documented in clause 7.2.3 in TS 28.100 [4]. However, the additional MnS requirements for level 4 are not specified in clause 7.2.4 in TS 28.100 [4].

5.2.1.2 Potential requirements

Following additional MnS requirements for level 4 needs to be specified in TS 28.100 [4] to support generic autonomy capability description for management system for level 4.

REQ-ANL-RanNeDeploy-Level_4-MnS-1 The 3GPP management system shall have the capability allowing its authorized consumer to specify the intent for delivering RAN NE(s).

REQ-ANL-RanNeDeploy-Level_4-MnS-2 The 3GPP management system shall have the capability allowing its authorized consumer to obtain the fulfilment information of the intent for delivering RAN NE(s).

5.2.2 Potential solutions

Following are the solution for MnS requirements for level 4 for RAN NE deployment which needs to be added in TS 28.100 [4]. The RadioNetworkExpectation defined in TS 28.312 [5] can be used as the intent expectation for delivering RAN NE(s). A radio subnetwork can contain one or multiple RAN NE(s). The attribute "coverageTACContext", "pLMNContext", "nRFqBandContext" and "rATContext" in ObjectContext can be used as expected radio setting parameters for delivering RAN NE(s). The attribute "weakRSRPRatioTarget", "lowSINRRatioTarget", "aveULRANUEThptTarget" and "aveDLRANUEthptTarget" in ExpectationTarget can be used as expected network capacity and performance targets for delivering RAN NE(s). The expected transport setting parameters for delivering RAN NE(s) is missing in RadioNetworkExpectation in TS 28.312 [5] but it is investigated in TR 28.912 [16] and can be used.

5.3 Key Issue# 5.3: Enhancement of generic autonomous network level for fault management

5.3.1 Description

5.3.1.1 Issue description

The generic autonomous network level for fault management is defined in Clause 7.3 in TS 28.100 [4], which includes generic workflow, generic classification of autonomous network level, generic autonomy capability description for management system, generic MnS requirements and solutions for generic MnS requirements.

Based on current definition, the generic autonomy capability description for management system for level 4 is documented in clause 7.3.3 in TS 28.100 [4]. However, the corresponding MnS requirements for level 4 are not specified in clause 7.3.4 in TS 28.100 [4].

5.3.1.2 Potential requirements

Following additional MnS requirements for level 4 need to be specified in TS 28.100 [4] to support generic autonomy capability description for management system for level 4.

REQ-ANL-FM-Level_4-MnS-1 The 3GPP management system shall have the capability allowing its authorized consumer to specify the intent expectation for fault management.

REQ-ANL-FM-Level_4-MnS-2 The 3GPP management system shall have the capability allowing its authorized consumer to obtain the fulfilment information of the fault management related intent.

5.3.2 Potential solution

The intent driven MnS defined in TS 28.312 can be used to satisfy the **REQ-ANL-FM-Level_4-MnS-1** and **REQ-ANL-FM-Level_4-MnS-2** with following information specified:

concrete intent expectation and context for fault management (including the definition for intent expectation for fault management).

6 Issue investigations and potential solutions for new scenarios

6.1 Key Issue# 6-1: Autonomous network level for RAN energy saving use case

6.1.1 Description

6.1.1.1 Use case

The massive deployment of mobile network has brought about a rapid increase in energy consumption. The energy cost and carbon emission also become great challenges for the NOP. Operators are aiming at reducing power consumption in 5G networks to lower their OPEX with energy saving solutions. RAN energy saving represent the energy saving aspects (including capacity booster cell - gNB is fully or partially overlaid by the candidate cell(s) in TS 28.310 [2], area based energy saving in TR 28.813 [3], and other energy saving aspects) for RAN. So, introducing the autonomous network level for energy saving will benefit for operator to achieve the full autonomy goal step by step and have clear view on which typical issues can be addressed by telecom system in corresponding steps. The requirements for each autonomous level for energy saving are different. So it is important to introduce the autonomous network level definition for energy saving.

The concrete energy saving solutions should not be defined in the present document. This key issue only focus on autonomous network level defined for energy saving.

6.1.1.2 Workflow

Intent handling:

- **Task A:** RAN energy saving control information generation and determination. The tasks of generating and determining the RAN energy saving related control information (e.g. threshold value of high energy consumption issue analysis) and RAN energy saving actions generation) based on received RAN energy saving intent (e.g. expectation on energy saving targets in the specified areas with considering network performance (e.g. RAN UE throughput) assurance, as well as the frequencies and RATs to be considered).
- **Task B:** RAN energy saving intent fulfilment evaluation. The tasks of evaluating RAN energy saving intent fulfilment information (e.g. energy saving targets (e.g. target RAN energy consumption and RAN UE throughput in the specified area are satisfied or not).

Awareness:

- **Task C:** RAN energy saving related information collection. The tasks of collecting energy efficiency measurements (e.g. Data Volume measurement, PEE (Power, Energy and Environmental) measurements, network performance data (e.g. RAN UE throughput), network configuration data (e.g. energy saving state), environment data (e.g. electronic map, site location) and alarm data.

Analysis:

- **Task D:** RAN energy saving issues identification. The tasks of identifying energy saving issues (including energy efficiency issues (e.g. high energy consumption, low energy efficiency) as TS 28.104 [6] described and performance issue (e.g. low RAN UE throughput) which may be caused by energy saving actions.
- **Task E:** RAN traffic and performance prediction. The tasks of analysing current and historical RAN traffic load (e.g. PRB utilization rate, RRC connection number, etc.) and network performance (e.g. RAN UE throughput) to predict the traffic load trend and network performance trend over a period of time which could be used as references for energy saving solutions, analysis evaluation and determination.
- **Task F:** RAN energy saving issue demarcation. The tasks of analysing the RAN energy saving issues and determine the RAN energy efficiency issue categories (e.g. high energy consumption, low energy efficiency) and corresponding area (which can be identified by geographical area, RAN NEs or cells), as well as determining the performance issue is caused by energy saving actions.
- **Task G:** RAN energy saving issue root cause analysis. The tasks of analysing the root cause of the RAN energy saving issue, including RAN energy efficiency issues and performance issues caused by energy saving actions).
- **Task H:** RAN energy saving solutions analysis. The tasks of generating the recommended energy saving solution (e.g. activate or deactivate energy saving state for the energy saving objects, adjust the carrier configuration or transmit power, adjust the energy saving thresholds for different service types.) which can address the identified energy saving issues.

Decision:

- **Task I:** RAN energy saving solutions evaluation and determination. The tasks of evaluating the energy saving gains, as well as evaluating the RAN performance if such energy saving actions to be executed, and determining the optimal energy saving solutions (i.e. a set of energy saving actions) to be executed.

Execution:

- **Task J:** RAN energy saving solutions execution. The tasks of adjusting the RAN energy saving actions (e.g. activate or deactivate energy saving state for the energy saving objects, adjust the carrier configuration or transmit power, adjust the energy saving thresholds for different service types.) which can address the identified energy saving issues).

6.1.1.3 Classification of autonomous network level

Level 0:

- All the tasks in the RAN energy saving workflow (Task A, Task B, Task C, Task D, Task E, Task F, Task G, Task H, Task I, Task J) are accomplished by human.

Level 1:

- Telecom system executes the part of RAN energy saving solutions execution tasks (e.g. activate or deactivate energy saving state for the energy saving cell) based on the specified RAN energy saving solutions (Task J). Telecom system also can execute the tasks of collecting part of energy saving related information (including energy efficiency related information (including Data Volume measurement, PEE (Power, Energy and Environmental) measurements, etc.), network performance data, network configuration data and alarm data) based on the specified collection control information (Task C). At this level, telecom system can assist human to improve the execution and awareness efficiency for RAN energy saving.
- All the other tasks in the RAN energy saving workflow (Task A, Task B, Task D, Task E, Task F, Task G, Task H, Task I) are accomplished by human.

Level 2:

- Compared to Level 1, telecom system additionally executes the tasks of RAN energy saving issues identification, part of RAN energy saving demarcation and RAN energy saving issue root cause analysis for the energy efficiency issues based on the specified RAN energy saving issue analysis control information (Task D, Task F, Task G). In this level, telecom system also can execute the task of collecting RAN energy saving related information (including energy efficiency data, performance data, network configuration data, environment data, alarm data) based on the specified collection control information (Task C). The tasks of RAN energy saving solutions execution (Task J) are fully accomplished by telecom system. At this level, telecom system can assist human to achieve the closed loop for RAN energy saving based on human defined control information.
- All the other tasks in the RAN energy saving workflow (Task A, Task B, Task E, Task H, Task I) are accomplished by human.

Level 3:

- Compared to Level 2, telecom system additionally executes the tasks of RAN energy saving solutions analysis (Task H) and RAN energy saving solutions evaluation and determination (Task I) based on the specified RAN energy saving solution analysis and decision control information. In this level, telecom system also can execute the tasks of RAN traffic load and performance prediction (Task E) based on the specified RAN traffic load and performance prediction control information. The tasks of RAN energy saving related information collection (Task C), RAN energy saving issues identification (Task D) and RAN energy saving demarcation (including RAN energy efficiency issues demarcation and RAN performance issues caused by energy saving actions) (Task F) are fully accomplished by telecom system. At this level, the telecom system can achieve the closed loop automation for RAN energy saving based on the human defined control information.
- All the other tasks in the RAN energy saving workflow (Task A, Task B) are accomplished by human.

Level 4:

- Compared to Level 3, the telecom system additionally executes the tasks of RAN energy saving control information generation and determination (Task A), and RAN energy saving intent fulfilment evaluation (Task B) based on received RAN energy saving intent and intent handling control information. The tasks of RAN energy saving issue root cause analysis (including root cause analysis for energy efficiency issues and performance issues caused by energy saving actions) (Task G), RAN energy saving solutions analysis (Task H), RAN energy saving solutions evaluation and determination (Task I), and RAN traffic load and performance prediction (Task E) are fully accomplished by telecom system. At this level, telecom system can achieve the intent driven closed loop automation for RAN energy saving based on human defined intent handling control information.
- The intent handling control information maybe pre-defined and specified by human to assist the telecom system.

Level 5:

- Telecom system can autonomously execute the entire workflow of RAN energy saving for all scenarios, which means the telecom system can achieve the full autonomy for RAN energy saving for full scenarios.

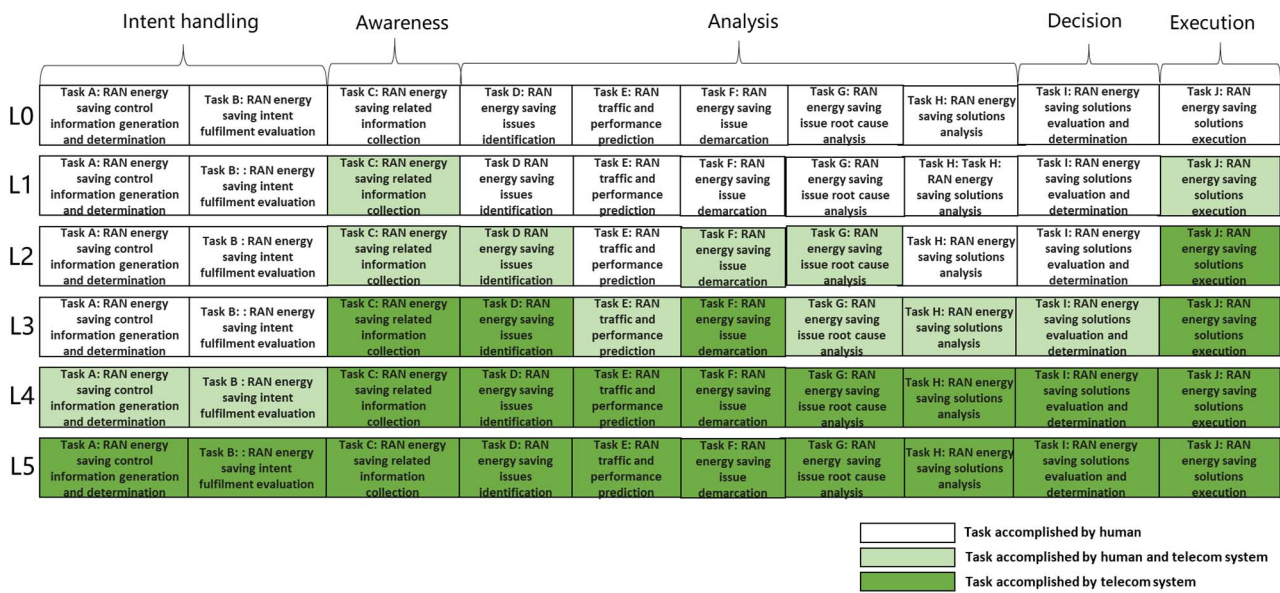


Figure 6.1.1.3-1: Autonomous network level for RAN energy saving scenario

6.1.1.4 Autonomy capability description for RAN energy saving

Level 1 for RAN energy saving: The 3GPP management system has the following autonomy capabilities:

- Adjust network based on the specified energy saving solution.
- Collect energy saving related information (including energy efficiency related information (including Data Volume measurement, PEE (Power, Energy and Environmental) measurements etc.), network performance data, network configuration data and alarm data).

Level 2 for RAN energy saving: The 3GPP management system has following autonomy capabilities:

- Identify the RAN energy saving issues based on the specified RAN energy saving issue demarcation control information.
- Demarcate the RAN energy saving issue (including the RAN energy efficiency issue categories (e.g. high energy consumption, low energy efficiency) and corresponding area) based on the specified RAN energy saving issue demarcation control information.
- Analyse the root cause of RAN energy saving issue (including RAN energy efficiency issues and performance issues caused by energy saving actions) based on the specified RAN energy saving issue analysis control information.

Level 3 for RAN energy saving: The 3GPP management system has the following autonomy capabilities:

- Generate the recommended energy saving solution based on specified RAN energy saving adjustment control information.
- Evaluate the recommended RAN energy saving solution and determine the optimal energy saving solutions to be executed based on specified RAN energy saving adjustment decision control information.
- Predict the traffic load trend and network performance trend.

Level 4 for RAN energy saving: The 3GPP management system has the following autonomy capabilities:

- Determine or update RAN energy saving control information according to RAN energy saving targets based on specified target translation control information.
- Evaluate RAN energy saving target fulfilment result based on specified target evaluation control information.

Level 5 for RAN energy saving: The 3GPP management system has the following autonomy capabilities:

- Generate the RAN energy saving target translation and evaluation control information.

6.1.1.5 Potential MnS requirements

REQ-ANL-RANES_1 The 3GPP management system shall have the capability allowing its authorized consumer to specify the RAN energy saving solutions and RAN energy saving related information collection control information.

REQ-ANL-RANES_2 The 3GPP management system shall have the capability allowing its authorized consumer to specify the control information of RAN energy saving issues identification, RAN energy saving issue demarcation, RAN energy saving issue root cause analysis and obtain the corresponding analysis result.

REQ-ANL-RANES_3 The 3GPP management system shall have the capability allowing its authorized consumer to specify the RAN energy saving solutions analysis control information and obtain the RAN energy saving solution to be executed.

6.1.2 Potential solutions

Based on the MnS requirements of autonomous network level for RAN energy saving defined for each level, following provide the guidelines for the potential MnS solutions used to support corresponding MnS requirements of autonomous network level for RAN energy saving.

Note: the solutions below are not used to evaluate the autonomous network level, which are MnS solutions to support MnS requirements for 3gpp management system derived from autonomy capability of each level.

Regarding the **REQ-ANL-RANES_1**, the NR NRM (e.g. NRCellCU, beam, and NRCellRelation, CESManagementFunction IOC) defined in TS 28.541 [8] are used to represent network adjustment solution. The RSRP measurements (e.g. SS-RSRP), RSRQ measurements (e.g. SS-RSRQ), SINR measurements (e.g. SS-SINR) defined in TS 28.552 [6], RSRPs of the serving cell and neighbour cells, and UE location in MDT reports, power, energy and environmental (PEE) measurements (e.g. PNF Energy consumption) and data volume measurements defined in TS 28.552 [10] and performance measurements for gNB (e.g. UE throughput) are used to represent the RAN energy saving related information.

Regarding the **REQ-ANL-RANES_2**, the MDA MnS defined in TS 28.104 [6] can be used. The analytics output can represent RAN energy saving issue identification and RAN energy saving issue demarcation result. The "EnergyEfficiencyProblematicObject " and "EnergyEfficiencyProblemType " of analytics output for energy saving analysis in TS 28.104 [6] can be used to obtain the RAN energy saving issue and corresponding demarcation result.

Regarding the **REQ-ANL-RANES_3**, following are two potential solution:

1. The CESManagementFunction IOC defined in TS 28.310 [2] can be used to specify the RAN energy saving solutions analysis control information , RAN energy saving solutions evaluation and determination control information.
2. The RadioNetworkExpectation defined in TS 28.312 [5] can be used as the targets for RAN energy saving. The attribute "targetCondition", " targetValueRange", " targetContexts " and "rATContext" in ObjectContext can be used as expected setting parameters. The attribute "weakRSRPRatioTarget", "lowSINRRatioTarget", "aveULRANUEThptTarget" and "aveDLRANUEthptTarget" in ExpectationTarget can be used as expected network capacity and performance targets. The "RanEnergyEfficiencyTarget " and "RanEnergyConsumptionTarget" in TR 28.912 [16] can be used as expected setting parameters for RAN energy saving.

6.2 Key Issue# 6-2: Autonomous network level for 5GC NF deployment

6.2.1 Description

6.2.1.1 Use case

5GC NF deployment use case refers to the entire workflow of deploying a 5GC NF, full autonomy of 5GC NF deployment can help the network operator to reduce OPEX by reducing manual involvement in such tasks. However, full autonomy of 5GC NF deployment is a long term goal, it will be beneficial for operator to achieve this goal step by step and have clear view on which typical issues can be addressed by utilizing network autonomy mechanisms in corresponding steps. The requirements for each autonomous level for 5GC NF deployment are different.

6.2.1.2 Workflow

Following are the entire workflow for 5GC NF deployment:

Intent handling:

- **Task A:** 5GC NF deployment policy generation based on received 5GC NF deployment intent (e.g. type of the 5GC NF, capability of the 5GC NF). The tasks of generating and determining the 5GC NF deployment related policies (e.g. 5GC NF configuration data generation policies, dialing test policies and 5GC NF virtualised resource feasibility polices).
- **Task B:** 5GC NF deployment intent evaluation, the tasks of evaluating 5GC NF deployment fulfilment information (e.g. satisfied or not).

Awareness:

- **Task C:** 5GC NF information collection, this task includes collecting the network environment data before deployment of 5GC NF information and collecting the 5GC NF and related network data when the 5GC NF is deployed (e.g. PM, FM and virtualised resource information).

Analysis:

- **Task D:** 5GC NF deployment data analysis, the tasks of analysing and generating the recommended configuration data and required virtualised resource information (e.g. VNFD, flavour ID) for deployment of the 5GC NF.
- **Task E:** 5GC NF virtualised resource feasibility check analysis, the tasks of analysing there is enough virtualised resource is available for deployment of the 5GC NF.

Task F: 5GC NF commissioning test and dialing test, the tasks of performing the 5GC NF commissioning test and dialing test before putting 5GC NF into service (e.g. ensure the configuration and network connection (including 5GC NF configuration and transport network configuration) is correct).

Decision:

- **Task G:** 5GC NF configuration data and virtualised resource information determination, the tasks of evaluating and determining the 5GC configuration data and virtualised resource information (e.g. VNF package) to be used for deploying the 5GC NF.

Execution:

- **Task H:** 5GC NF deployment, the tasks of deploying the 5GC NF based on determined VNF package, flavour ID and configuring the 5GC NF based on determined data.

6.2.1.3 Classification of autonomous network level

Level 0:

- All the tasks in the 5GC NF deployment workflow (Task A, Task B, Task C, Task D, Task E, Task F, Task G, Task H) are accomplished by human.

Level 1:

- Telecom system executes tasks of deploying the 5GC NF based on onboarded VNF package and activating configuration data prepared by human (Task H) and tasks of collecting part of 5GC NF information (including virtualised resource information) based on specified rules(Task C).
- All the other tasks in the 5GC NF deployment workflow (Task A, Task B, Task D, Task E, Task F, Task G) are accomplished by human.

Level 2:

- Compared to Level 1, telecom system additionally executes the tasks of collecting 5GC information (including virtualised resource information) (Task C). Telecom system also can execute the tasks of analysing the deployment data for the 5GC based on the network function generation rules (e.g. configuration template) specified by human (Task D). The tasks of 5GC NF deployment (Task H) are fully accomplished by telecom system.
- All the other tasks in the 5GC NF deployment workflow (Task A, Task B, Task E, Task F, Task G) are accomplished by human.

Level 3:

- Compared to Level 2, the telecom system additionally executes tasks of analysing and determining the deployment data for the 5GC NF based on the network configuration data generation policies specified by human (Task D). Telecom system also can execute tasks of performing 5GC virtualised resource feasibility check and commissioning/dialing test by human (Task E and Task F). The tasks of 5GC NF information collection (Task C) are fully accomplished by telecom system.
- All the other tasks in the 5GC deployment workflow (Task A, Task B) are accomplished by human.

Level 4:

- Compared to Level 3, the telecom system can additionally execute the tasks of 5GC NF deployment policy generation (Task A) and 5GC NF deployment intent evaluation (Task B) based on intent handling control information specified by human. The tasks of 5GC deployment data analysis (Task D), 5GC virtualised resource feasibility check (Task E), 5GC NF commissioning and dialing test (Task F), 5GC NF configuration data and virtualised resource information determination (Task G) are fully accomplished by telecom system.
- The intent handling control information maybe pre-defined and specified by human.

Level 5:

- Telecom system can autonomously execute the entire workflow of 5GC NF deployment for all scenarios.

	Intent handling		Awareness	Analysis			Decision	Execution
L0	Task A: 5GC NF deployment policies generation	Task B: 5GC NF deployment intent evaluation	Task C: 5GC NF information collection	Task D: 5GC deployment data analysis	Task E: 5GC NF virtualised resource feasibility check	Task F: 5GC NF commissioning and dialing test	Task G: 5GC NF configuration data and virtualised resource determination	Task H: 5GC NF deployment
L1	Task A: 5GC NF deployment policies generation	Task B: 5GC NF deployment intent evaluation	Task C: 5GC NF information collection	Task D: 5GC deployment data analysis	Task E: 5GC virtualised resource feasibility check	Task F: 5GC NF commissioning and dialing test	Task G: 5GC NF configuration data and virtualised resource determination	Task H: 5GC NF deployment
L2	Task A: 5GC NF deployment policies generation	Task B: 5GC NF deployment intent evaluation	Task C: 5GC NF information collection	Task D: 5GC deployment data analysis	Task E: 5GC virtualised resource feasibility check	Task F: 5GC NF commissioning and dialing test	Task G: 5GC NF configuration data and virtualised resource determination	Task H: 5GC NF deployment
L3	Task A: 5GC NF deployment policies generation	Task B: 5GC NF deployment intent evaluation	Task C: 5GC NF information collection	Task D: 5GC deployment data analysis	Task E: 5GC virtualised resource feasibility check	Task F: 5GC NF commissioning and dialing test	Task G: 5GC NF configuration data and virtualised resource determination	Task H: 5GC NF deployment
L4	Task A: 5GC NF deployment policies generation	Task B: 5GC NF deployment intent evaluation	Task C: 5GC NF information collection	Task D: 5GC deployment data analysis	Task E: 5GC virtualised resource feasibility check	Task F: 5GC NF commissioning and dialing test	Task G: 5GC NF configuration data and virtualised resource determination	Task H: 5GC NF deployment
L5	Task A: 5GC NF deployment policies generation	Task B: 5GC NF deployment intent evaluation	Task C: 5GC NF information collection	Task D: 5GC deployment data analysis	Task E: 5GC virtualised resource feasibility check	Task F: 5GC NF commissioning and dialing test	Task G: 5GC NF configuration data and virtualised resource determination	Task H: 5GC NF deployment

	Task accomplished by human
	Task accomplished by human and telecom system
	Task accomplished by telecom system

Figure 6.2.1.3-1: Classification of autonomous network level for 5GC NF deployment

6.2.1.4 Autonomy capability description for management system

Level_1 for 5GC NF deployment: The 3GPP management system has the following autonomy capabilities:

- Configure 5GC NF with the specified 5GC configuration data
- Request deploying 5GC NF based on the VNF package
- Collect 5GC NF information based on the specified 5GC information collection rule

Level_2 for 5GC NF deployment: The 3GPP management system has the following autonomy capabilities:

- Analyse the deployment data for the 5GC NF based on the specified network function generation rules

Level_3 for 5GC NF deployment: The 3GPP management system has the following autonomy capabilities:

- Analyse and determine the deployment data for the 5GC NF based on the specified network function generation policies.
- Perform the 5GC NF commissioning and dialing analysis based on specified control information.
- Perform the 5GC NF virtualised resource feasibility analysis based on specified virtualised resource feasibility analysis information.

Level_4 for 5GC NF deployment: The 3GPP management system has the following autonomy capabilities:

- Determine or update 5GC NF deployment policies according to 5GC NF deployment targets based on specified targets translation control information.
- Evaluate 5GC NF deployment targets fulfilment result based on specified targets evaluation control information.

Level_5 for 5GC NF deployment: The 3GPP management system has the following autonomy capabilities:

- Generate the 5GC NF deployment target translation and evaluation control information.

6.2.2 Potential solutions

Based on the MnS requirements of autonomous network level for 5GC NF deployment defined for each level, following provide the guidelines for the potential MnS solutions used to support corresponding MnS requirements of autonomous network level for 5GC NF deployment.

Note: the solutions below are not used to evaluate the autonomous network level, which are MnS solutions to support MnS requirements for 3gpp management system derived from autonomy capability of each level.

The NR NRM (e.g. `AMFFunction`, `SMFFunction`, and `UPFFunction` IOC) defined in TS 28.541 [8] are used to represent 5GC NF deployment solution. The performance measurements for AMF (e.g. registered subscribers measurement), performance for SMF (e.g. PDU session measurement), performance measurements for UPF (e.g. data packets measurement) and virtual resource usage related measurements defined in TS 28.552 [6] are used to represent the 5GC NF deployment related information.

The MDA MnS defined in TS 28.104 [6] can be used. The Analytics output can represent 5GC NF deployment issue identification and 5GC NF deployment virtualised resource usage feasibility result. The MDA assisted fault management and resource related analytics in TS 28.104 [6] can be used to obtain the 5GC NF deployment issue and virtualised resource usage analysis result.

6.3 Key Issue# 6-3: Management of Autonomous Network Level (ANL)

6.3.1 Description

6.3.1.1 Introduction

TS 28.100 [4] specifies the framework approach for evaluating autonomous network levels and concrete autonomous network level definition for network optimization, RAN NE deployment and fault management. Each autonomous network level definition includes workflow, classification of autonomous network level, autonomy capability description for management system, MnS requirements and solutions for generic MnS requirements. The autonomous network level definition in TS 28.100 [4] can be used to determine the ANL (L0-L5) for corresponding scenarios.

Autonomy functionalities such as SON functionalities, MDA functionalities, intent handling functionalities or combination of these management functionalities can be used to satisfy autonomy capabilities identified in different autonomous network level. For example, the CCO functionality can be used to satisfy the autonomy capabilities identified in level 3 for coverage optimization. So, from NOP view, if a NOP have a target to make its network to achieve certain autonomous network level specified by TS 28.100 [4], it is necessary to know which autonomy functionalities provided by corresponding NEP(s) can be used to satisfy the autonomy capabilities in corresponding autonomous network level.

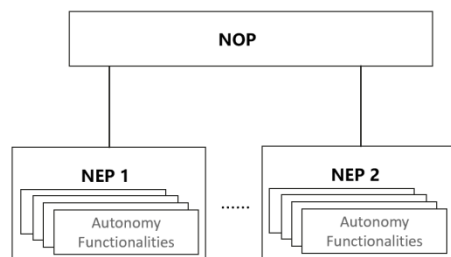


Figure 6.3.1.1-1: Autonomy functionalities provided by multiple NEPs

Correspondingly, the 3GPP management system should support these autonomy functionalities to realize autonomy capabilities to support certain autonomous network level.

6.3.1.2 Use case 1 Request autonomy functionalities for certain ANL

Different MnS Consumers (e.g. Operator) have different autonomy requirements (represented by ANL) for the same or different scenarios. Even same MnS consumer may have different autonomy requirements for different scenarios of same scenario type. For example, MnS consumer expect level 3 for the radio coverage optimization scenario, while expect level 2 for the RAN UE throughput optimization scenario. Several autonomy functionalities implemented by 3GPP management system, such as SON functionalities, MDA functionalities, intent handling functionalities or combination of these management functionalities can be used to satisfy different autonomy requirements. So, based on the expected ANL (e.g. level 3) for certain scenario (coverage optimization), 3GPP management system (as MnS producer) needs to:

- Identifies corresponding autonomy capabilities for the expected ANL based on the type of the required scenario (e.g. network optimization).
- Selects one or multiple autonomy functionalities (e.g. CCO Function) to satisfy the identified autonomy capabilities and manages their inter-related execution.
- Determine the MnS(s) which is necessary to support the autonomy functionalities (e.g. specify the control information for the autonomy functionalities).

MnS consumer needs to be aware of which autonomy functionalities can be used to satisfy its autonomy requirements and which MnS(s) can be consumed to support the performing of the functionalities. So, 3GPP management system also needs to send the identified autonomy functionalities and corresponding MnS(s) to MnS Consumer.

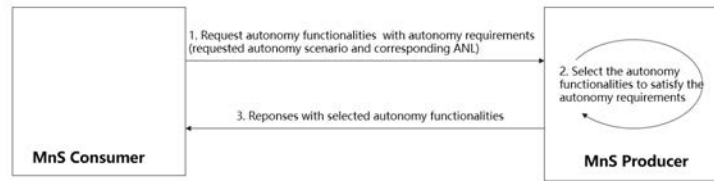


Figure 6.3.1.2-1: Request autonomy functionalities to satisfy autonomy requirements

6.3.1.3 Use case 2 Request to control and monitor autonomy functionalities for certain ANL

Based on the obtained autonomy functionalities and corresponding MnS(s) from MnS producer, MnS consumer will assess whether to use these autonomy functionalities to fulfil the expected ANL for the expected scenario. In case MnS consumer decide to use these autonomy functionalities, MnS consumer will request MnS producer to perform these autonomy functionalities and consumer corresponding supported MnS(s) to control and monitor these autonomy functionalities.

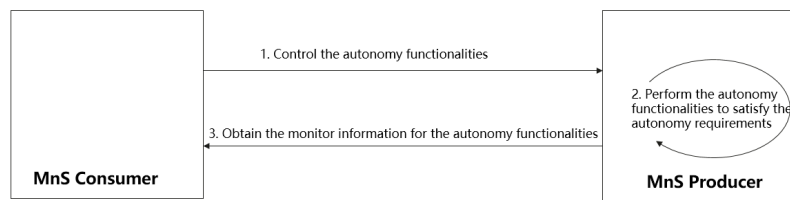


Figure 6.3.1.3-1: Request to control and monitor autonomy functionalities

6.3.2 Potential requirements

REQ-ANL_Mgmt_1: The 3GPP Management system should have the capability to allow an authorized consumer to request the autonomy functionalities with the specified autonomy requirements (including scenario and corresponding ANL).

REQ-ANL_Mgmt_2: The 3GPP Management system should have the capability to allow an authorized consumer to obtain the autonomy functionalities to satisfy the specified autonomy requirements.

REQ-ANL_Mgmt_3: The 3GPP Management system should have the capability to allow an authorized consumer to obtain the MnS(s) information to control and monitor the autonomy functionalities.

7 Conclusion and recommendation

7.1 Conclusion of key issue investigation

7.1.1 Key Issue# 5.1: generic autonomous network level for network optimization

Based on analysis and potential solutions described in clause 5.1.2, Regarding the REQ-ANL-NetOpt-Level_2-MnS-2 and REQ-ANL-NetOpt-Level_2-MnS-4 specified in TS 28.100 [4], the MDA MnS defined in TS 28.104 [6] can be used. The Analytics output can represent network issue identification and network issue demarcation result. Which means MnS consumer can use the MDA MnS to obtain the network issue and corresponding demarcation result.

7.1.2 Key Issue# 5.1a: autonomous network level for radio network coverage optimization

Based on analysis and potential solutions described in clause 5.1a.2, the enhanced solutions description for generic MnS requirements of autonomous network level for radio network coverage optimization is recommended.

7.1.3 Key Issue# 5.1b: autonomous network level for RAN UE throughput optimization

Based on analysis and potential solutions described in clause 5.1b.2, it is recommended to enhance MDA by adding new capability for RAN UE throughput problem analysis in TS 28.104 [6].

7.1.4 Key Issue# 5.2: autonomous network level for RAN NE deployment

Based on analysis and potential solutions described in clause 5.2.2, the `RadioNetworkExpectation` defined in TS 28.312 [5] can be used as the intent expectation for delivering RAN NE(s) for RAN NE deployment.

7.1.5 Key Issue# 5.3: autonomous network level for fault management

Based on analysis and potential solutions described in clause 5.3.2, the intent driven MnS defined in TS 28.312 can be used to satisfy the MnS requirements in clause 5.3.1.2 for fault management.

7.1.6 Key Issue# 6.1: autonomous network level for RAN energy saving

Based on analysis and potential solutions described in clause 5.3.3, the guidelines for the potential MnS solutions used to support corresponding MnS requirements of autonomous network level for RAN energy saving are identified. The NR NRM defined in TS 28.541 [8] can be used to represent network adjustment solution. The corresponding measurements defined in TS 28.552 [6], can be used to represent the RAN energy saving related information. And the analytics output can represent RAN energy saving issue identification and RAN energy saving issue demarcation result.

7.1.7 Key Issue# 6.2: autonomous network level for 5GC NF deployment

Based on analysis and potential solutions described in clause 6.2, the guidelines for the potential MnS solutions used to support corresponding MnS requirements of autonomous network level for 5GC NF deployment are identified. The NR NRM defined in TS 28.541 [8] can be used to represent 5GC NF deployment solution. The corresponding measurements defined in TS 28.552 [6], can be used to represent the 5GC NF deployment related information. And the analytics output can represent 5GC NF deployment issue identification and 5GC NF deployment virtualised resource usage feasibility result.

7.1.8 Key Issue# 6.3: management of autonomous network level

Management of autonomous network level is investigated in clause 6.3, which provides the capabilities for requesting autonomy functionalities and requesting to control and monitor autonomy functionalities for certain ANL. No normative work is recommended because it is depends on implementation.

7.2 Conclusion and recommendation in general

The study has identified additional generic MnS requirements and potential solutions of generic autonomous network level for the scenarios defined in Rel-17 including:

- Generic network optimization
- Radio network coverage optimization
- RAN UE throughput optimization
- RAN NE deployment, fault management

The study has also identified the generic MnS requirements and potential solutions of generic autonomous network level for additional management use cases which are not defined in Rel-17 including:

- RAN energy saving
- 5GC NF deployment
- Management of autonomous network level

Based on investigation of RAN UE throughput optimization, it is recommended to enhance MDA by adding new capability for RAN UE throughput problem analysis in TS 28.104 [6].

Based on investigation of other management use cases above, existing MnS, NR NRM and corresponding measurements described in clause 7.1 can be used as potential solutions for the identified MnS requirements. No normative work is recommended for those use cases in this study.

Annex A (informative): Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2022-04	SA5#142e	S5-222126	-	-	-	Initial skeleton	0.0.0
2022-04	SA5#142e	S5-222615 S5-222616 S5-222614	-	-	-	1. Add TR structure 2. Add scope 3. Add autonomous network level for RAN energy saving	0.1.0
2022-05	SA5#143e	S5-223565 S5-223566 S5-223567	-	-	-	1. Add key issue for enhancement of ANL for network optimization 2. Add key issue for autonomous network level for 5GC NF deployment 3. Update the key issue of autonomous network level for RAN energy saving scenario	0.2.0
2022-08	SA5#145e	S5-225679	-	-	-	1. Add introduction on relevant SI/WI in 3GPP. 2. Align TR front page title with SA WG5 official title.	0.3.0
2023-03	SA5#147	S5-232887	-	-	-	1. Update issue description and potential solution of Key Issue# 5.1. 2. Add Key Issue# 5.1b, #5.2 and #5.3.	0.4.0
2023-04	SA5#148e	S5-233411	-	-	-	Clean up some Editor's Notes and editorial issues	0.5.0
2023-08	SA5#150	S5-236003 S5-236004 S5-236005	-	-	-	1. Add gap analysis and recommendation for key issue#5.1b RAN UE throughput optimization. 2. Add use cases and requirements for management of ANL. 3. Add potential solutions for Key Issue #6-1: Autonomous network level for RAN energy saving use case.	0.6.0
2023-10	SA5#151	S5-236760 S5-237243 S5-237171	-	-	-	1. Rapporteur clean up 2. Add solution for 5GC NF deployment 3. Add conclusion and recommendation	0.7.0
2023-12	SA#102	SP-231518				Presented for information and approval	1.0.0
2023-12	SA#102					Upgrade to change control version	18.0.0
2025-09	SA#109	-	-	-	-	Update to Rel-19 version (MCC)	19.0.0

History

Document history		
V19.0.0	October 2025	Publication