|  |  |
| --- | --- |
| 3GPP TR 28.810 V1.0.0 (2020-06) | |
| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Services and System Aspects;  Study on concept, requirements and solutions for levels of autonomous network;  (Release 16 ) | |
|  | |
| *5G-logo_175px* | 3GPP-logo_web |
|  | |
| The present document has been developed within the 3rd Generation Partnership Project (3GPP TM) and may be further elaborated for the purposes of 3GPP. The present document has not been subject to any approval process by the 3GPPOrganizational Partners and shall not be implemented. This Specification is provided for future development work within 3GPPonly. The Organizational Partners accept no liability for any use of this Specification. Specifications and Reports for implementation of the 3GPP TM system should be obtained via the 3GPP Organizational Partners' Publications Offices. | |

|  |
| --- |
|  |
| ***3GPP***  Postal address  3GPP support office address  650 Route des Lucioles - Sophia Antipolis  Valbonne - FRANCE  Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16  Internet  http://www.3gpp.org |
| ***Copyright Notification***  No part may be reproduced except as authorized by written permission. The copyright and the foregoing restriction extend to reproduction in all media.  © 2020, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC).  All rights reserved.  UMTS™ is a Trade Mark of ETSI registered for the benefit of its members  3GPP™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners LTE™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners  GSM® and the GSM logo are registered and owned by the GSM Association |

Contents

Foreword 5

1 Scope 7

2 References 7

3 Definitions of terms, symbols and abbreviations 7

3.1 Terms 7

3.2 Symbols 7

3.3 Abbreviations 8

4 Background and concepts 8

4.1 Background 8

4.1.1 Overview 8

4.1.2 Relevant study in other SDOs or industry parties 8

4.1.2.1 Relevant study in automotive industry 8

4.1.2.2 Relevant study in GSMA 8

4.1.2.3 Relevant study in TMF 8

4.1.2.4 Relevant study in ITU 9

4.1.3 Benefits of having autonomous network level 9

4.2 Concept of network autonomy 9

4.3 Concept of network autonomy level 9

4.4 Potential dimensions for classification of network autonomy 10

4.4.1 Introduction 10

4.4.2 Workflow 10

4.4.3 Management scope 10

4.4.4 Scenarios 11

5 Use cases 11

5.1 Fault recovery use case example for network autonomy level 11

5.1.1 Introduction 11

5.1.2 Entire workflow 11

5.1.3 Potential classification of network autonomy for fault recovery 12

5.2 Network optimization use case example for classification of network autonomy 13

5.2.1 Coverage optimization use case example for classification of network autonomy 13

5.2.1.1 Introduction 13

5.2.1.2 Entire workflow 13

5.2.1.3 Potential classification of network autonomy for coverage optimization 14

5.2.2 Capacity optimization use case example for classification of network autonomy 15

5.2.2.1 Introduction 15

5.2.2.2 Entire workflow 15

5.2.2.3 Potential classification of network autonomy for capacity optimization 16

5.3 RAN NE provisioning use case example for classification of network autonomy 17

5.3.1 Introduction 17

5.3.2 Entire workflow 17

5.3.3 Potential classification of network autonomy for RAN NE provisioning 17

5.4 Multi-domain/layer/technology management service coordination automation use case example 19

6 Potential solutions 20

6.1 Potential solutions for network autonomy level 20

6.1.1 Introduction 20

6.1.2 Framework approach for classification of autonomous network level 20

6.2 Potential requirements for standardized features 21

6.2.1 Introduction 21

6.2.2 Potential relation with autonomous network related standardized features and interfaces 22

6.2.3 Potential solutions for autonomous network related standardized features 23

7 Conclusion and recommendation 23

Annex A: Change history 24

# Foreword

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

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

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

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

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

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

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

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

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

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

**can** indicates that something is possible

**cannot** indicates that something is impossible

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

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

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

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

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

In addition:

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

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

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

# 1 Scope

The present document describes the background, concept, definition and classification of network autonomy levels, typical scenarios for managing network and service which need autonomous support, the potential requirement and solutions and recommendation for the way forward in 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] SAE J3016\_201401: "Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems".

[3] GSMA: "AI & Automation: An Overview", <https://www.gsma.com/futurenetworks/wiki/ai-automation-an-overview/>.

[4] TMF: "A whitepaper of autonomous networks: empowering digital transformation for the telecoms industry", https://www.tmforum.org/wp-content/uploads/2019/05/22553-Autonomous-Networks-whitepaper.pdf.

[5] 3GPP TR 28.812: "Telecommunication management; Study on scenarios for Intent driven management services for mobile networks".

[6] 3GPP TS 28.313: "Self-Organizing Networks (SON) for 5G networks".

[7] 3GPP TR 28.809: "Study on enhancement of management data analytics".

[8] 3GPP TS 28.535: "Management services for communication service assurance; Requirements".

[9] ITU-T Y.3173: "Framework for evaluating intelligence levels of future networks including IMT-2020".

# 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].

**Intent**: See definition in TR 28.812[5].

## 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].

<ABBREVIATION> <Expansion>

# 4 Background and concepts

## 4.1 Background

### 4.1.1 Overview

Autonomous network is one of the important topics in 5G network. Complexity of 5G network increases with large number of devices and diversity of services. Different autonomous mechanisms are introduced by the industry to reduce the complexity of mobile network and service management. Different autonomous mechanisms in the networks may lead to different capabilities of autonomy and different performance on network and service management, which may lead to different autonomous networks levels.

### 4.1.2 Relevant study in other SDOs or industry parties

#### 4.1.2.1 Relevant study in automotive industry

In 2014, the Society of Automotive Engineers (SAE) proposed the automatic driving levels in [2], clarifying the 6-level automatic driving rating standard (L0～L5). The SAE J3016 scheme determines the automatic driving level by evaluating the participation degree of the driver and the automatic driving system from four evaluation dimensions: motion control (acceleration/deceleration/steering), driving environment monitoring, fallback performance of dynamic driving task, and system capability (driving modes). The SAE J3016 has been widely accepted by the automotive industry and applied to industry analysis, product planning, and been used for guiding the automotive industry to carry out five stages of work to achieving full automatic driving.

SAE J3016 provides a helpful reference to telecommunications industry for the study of autonomous networks levels. However, there are some fundamental differences between the automotive industry and telecommunication networks, thus the classification of network autonomy levels and automatic driving levels is different as well.

#### 4.1.2.2 Relevant study in GSMA

The transformation from “no intelligence” to “full intelligence” is considered to be a long term with a step-by-step process and introducing automation with AI abilities into network can bring value to operators. GSMA calls for a harmonized classification system and supporting definitions regarding intelligent network, see [3]. A harmonized classification system of intelligent network is considered to be helpful to define the concept, levels of intelligent network, describe categorical distinction and educate a broader community while a network automation system is engaged.

GSMA is interested on this topic and encourage relevant studies.

#### 4.1.2.3 Relevant study in TMF

Similar with [3], a harmonized classification system and supporting definitions for autonomous networks is delivered in [4]. The following factors of autonomous networks are introduced for evaluation of autonomous networks levels: execution, awareness, analysis, decision, intent/experience, applicability.

The following levels of autonomous networks are described as well: level 0 - manual management, level 1 - assisted management, level 2 - partial autonomous network, level 3 - conditional autonomous network, level 4 - high autonomous network, level 5 - full autonomous network.

#### 4.1.2.4 Relevant study in ITU

A framework for evaluating intelligence of future networks including IMT-2020 is specified in Recommendation ITU-T Y.3173 [9]. A method for evaluating intelligence level and an architecture view for evaluating network intelligence level are introduced. The following dimensions for evaluating network intelligence level are identified: demand mapping, data collection, analysis, decision, action implementation. The following network intelligence levels are specified:

- L0: Manual network operation

- L1: Assisted network operation

- L2: Preliminary intelligence

- L3: Intermediate intelligence

- L4: Advanced intelligence

- L5: Full intelligence

### 4.1.3 Benefits of having autonomous network level

As described in clause 4.1.2.1, the document of SAE J3016 [2] has been widely applied to automobile industry analysis, consulting of motor vehicle products planning, and also been used for guiding the automotive industry to carry out five stages of work to achieving full automatic driving.

Similar to what SAE J3016 means to the automotive industry, a common understanding of the levels of autonomous network will be helpful to the telecommunications industry. The operator’s operational and management efforts and dedicated relevant resources will vary according to different autonomous networks levels. It would be beneficial for operators to have clear view on the expectation of the level of their network (s) to indicate the maturity of the network autonomy, so that they could first focus on the important features which should be prioritized to achieve certain level of autonomy in their networks. This approach will help operators to smoothly migrate to a higher autonomy level and a better operational efficiency.

Having autonomous network level has the following benefits:

- Providing evaluation basis for measuring the level of an autonomous network along with its components and workflows.

- Providing reference for gaps and priorities analysis for standardization works on network autonomy.

- Providing guidance to operators, vendors and other participants of telecommunications industry for roadmap planning.

## 4.2 Concept of network autonomy

Network autonomy describes the telecom system (including management system and network) capability which is able to be governed by itself with minimal to no human intervention. Some features discussed in 3GPP are related to network autonomy. Following are some examples:

* Self-Organizing Network (SON)
* Management data analytics
* Intent driven management
* Close loop SLS assurance

## 4.3 Concept of network autonomy level

Network autonomy level describes the level of application of autonomy capabilities in the network management workflow. The participation of the human and telecom system in the network management workflow are important factors to evaluate the network autonomy level. For each network autonomy level, which tasks can be performed by telecom system, which tasks can be performed by human, and which tasks can be performed by cooperation of human and telecom system needs to be clarified. For example, in the highest autonomy level, all tasks are performed by telecom system.

## 4.4 Potential dimensions for classification of network autonomy

### 4.4.1 Introduction

This clause describes the potential dimensions for classification of network autonomy.

### 4.4.2 Workflow

Workflow is used to describe the necessary steps to fulfil certain management purposes. A workflow is composed of one or more management tasks. The autonomy capabilities of the tasks in the workflow may impact the network autonomy level.

Following are the potential categorization of the tasks in a workflow:

- **Intent translation:** The group of tasks which translate network or service intent from operator or customer into detailed management operations which may affect one or more of the following groups of tasks, i.e. awareness, analysis, decision, execution.

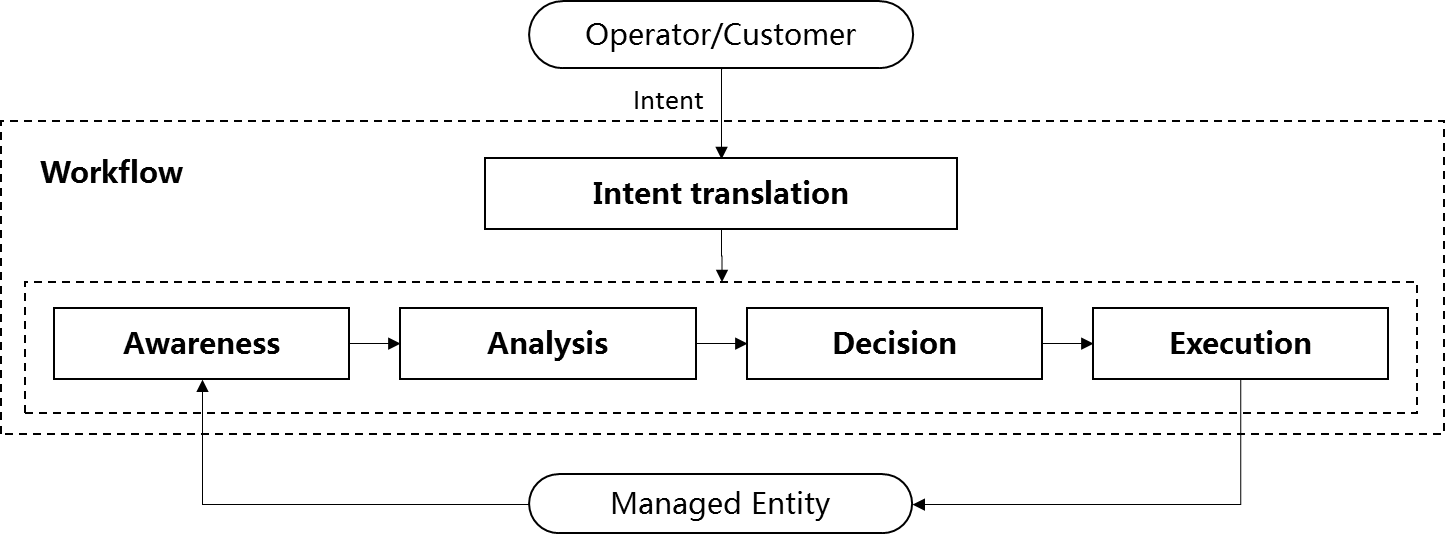
- **Awareness:** The group of tasks which monitor network by collecting network information.

- **Analysis:** The group of tasks which analyse the collected information (e.g. information about network status, network issues and so on) or based on the historical data to further predict the future change trend of the above network status, and make recommendation for decision.

- **Decision:** The group of tasks which decide the necessary management operation for execution, e.g. network configuration or adjustment.

- **Execution:** The group of tasks which execute the management operations.

Figure 4.4.2-1 illustrate the general workflow for network autonomy.

**Figure 4.4.2-1: General workflow for network autonomy**

### 4.4.3 Management scope

The network autonomy can be implemented in different management scopes, the complexity of network autonomy depends on the management scope. For example, it will be more challenge for the telecom system to achieve the network autonomy on cross domain layer than domain layer, because more autonomy mechanism needs to be introduced for the coordination between different domains.

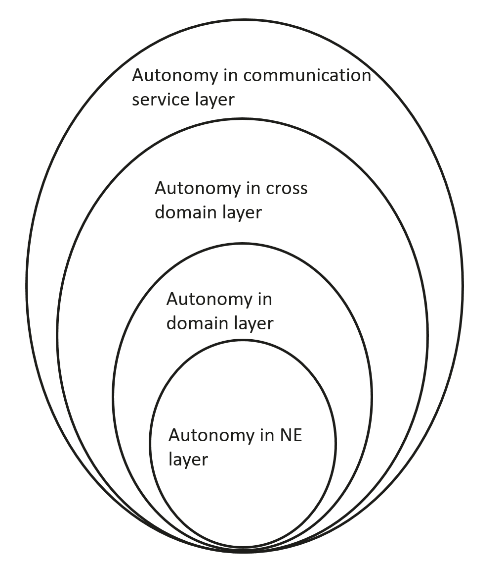
Following are potential scopes of network autonomy:

- Autonomy in NE layer, which means the autonomy mechanism is executed in the NE.

- Autonomy in domain layer, which means the autonomy mechanism is executed in the MnF(s) in domain.

- Autonomy in cross domain layer, which means the autonomy mechanism is executed in the MnF(s) in cross domain.

- Autonomy in communication service layer, how to execute the autonomy mechanism in communication service layer is FFS.



**Figure 4.4.3-1: Autonomy for different management scope**

### 4.4.4 Scenarios

The network autonomy can be implemented for different scenarios, the complexity of network autonomy depends on the detailed scenarios it applied. Also it will be more challenge for the telecom system to achieve the network autonomy for full scenarios than for certain scenarios. For example, autonomy applicability of network deployment will be more challenge for outdoor combine indoor scenario than only outdoor scenario.

# 5 Use cases

## 5.1 Fault recovery use case example for network autonomy level

### 5.1.1 Introduction

Fault recovery use case refers to the entire workflow of network fault management, full autonomy of fault recovery can help the network operator to reduce OPEX by reducing manual involvement in such tasks and to enhance user experience by reducing the time for network fault recovery. However, full autonomy of fault recovery 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 mechanism in corresponding steps.

### 5.1.2 Entire workflow

The entire workflow of fault recovery is as following:

- **Task A:** Fault recovery intent translation. The task which translate the fault recovery intent to the detailed fault management operations.

NOTE: The examples of fault recovery intent are alarm compression rate increasing, fault recovery response time reducing, etc.

- **Task B:** Fault related information collection. The task which collect the alarm information and other fault related information (e.g. performance information and configuration information etc.).

- **Task C:** Alarm filtering. The task which filter the alarms collected in Task B based on the filtering rules specified. A single network fault may generate a large number of correlative alarms over space and time, therefore it is considered advantageous to have methods filtering the redundant alarms. Reporting only effective alarms without redundant alarms would improve the efficiency of alarm management.

- **Task D:** Fault recognition. The task which recognize or predict the fault and its category based on the alarm information and other fault related information.

- **Task E:** Fault root cause analysis (RCA). The task which analyse the detailed root cause of the network fault.

- **Task F:** Fault recovery mechanism analysis. The task which analyse the possible fault recovery mechanisms and corresponding solutions for support of maintenance based on the fault root cause, thereby generate the feasible options (e.g. recovery procedures).

- **Task G:** Fault recovery action generation. The task which determine the fault recovery action.

- **Task H:** Fault recovery execution. The task which execute the fault recovery actions (e.g. reconfiguring the network), and other corresponding actions (e.g. clearing of alarms, storage and retrieval of alarms).

### 5.1.3 Potential classification of network autonomy for fault recovery

Each of the detailed task in clause 5.1.2 can be accomplished either manually by the operator or automatically by the telecom system. Following are the potential classifications of network autonomy for fault recovery based on the participation degree of the human operator and the telecom system:

Level 0:

- All the tasks in the fault recovery workflow in clause 5.1.2 are accomplished by human.

Level 1:

- Fault related information are collected (Task B) automatically by telecom system based on human predefined rules. Fault recovery actions (Task H) which can be executed without human intervention (e.g. system initialisations, activation of a backup or fall back software load) are triggered by human and executed by telecom system based on human defined execution rules.

- All the other tasks in the fault recovery workflow are accomplished by human.

Level 2:

- Compared to Level 1, telecom system additionally assist human operator to filter the alarms (Task C) based on the filtering rules predefined by human operator. Fault recovery execution (only for the actions that can be executed without human intervention) (Task H) are triggered by human and fully executed by telecom system based on human defined rules.

- All the other tasks (Task A, Task D, Task E, Task F and Task G) are accomplished by human.

Level 3:

- Compared to Level 2, telecom system can additionally identify the fault domain and type (Task D except for fault prediction) and analyse the root cause of the network fault (Task E). For certain network faults, telecom system can accomplish the fault recovery mechanism analysis (Task F) and action generation (Task G) based on the fault recovery policies pre-defined and specified by human.

- Fault recovery intent translation (Task A) is accomplished by human, and all the other tasks (Task F and Task G) are accomplished by human operator for most of the faults except several conventional ones.

Level 4:

- Compared to Level 3, the fault recovery mechanism analysis (Task F) and action generation (Task G) are accomplished automatically by telecom system without human intervention. Telecom system also can predict the fault based on service performance (e.g. QoE, call drop ratio, user experience). For certain scenario, telecom system additionally assist human operator to translate the fault recovery intent to the detailed fault recovery policies (Task A) based on human predefined policies.

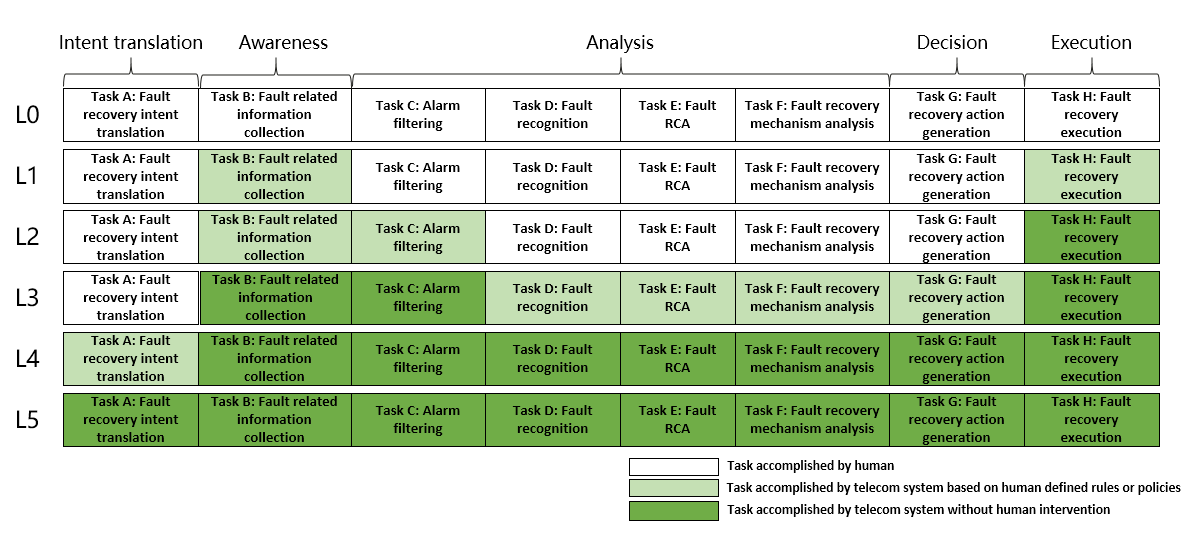
- Intent translation policies can be pre-defined and specified by human.

Level 5:

- The entire fault RCA and recovery workflow is accomplished automatically by telecom system without human intervention and human predefined rules or policies.

- Human can but not have to supervise the fault recovery decision generated by telecom system.

Figure 5.1.3-1 illustrate the classification of network autonomy for fault recovery.



**Figure 5.1.3-1: Classification of network autonomy for fault recovery**

## 5.2 Network optimization use case example for classification of network autonomy

### 5.2.1 Coverage optimization use case example for classification of network autonomy

#### 5.2.1.1 Introduction

Coverage is critical for good user experience, however, coverage optimization is complexity. Full autonomy of coverage optimization for whole network 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 mechanism in corresponding steps.

#### 5.2.1.2 Entire workflow

Following are the entire workflow for the radio network coverage optimization:

- **Task A**: Coverage requirements determination. The tasks of determining the coverage requirements (e.g. coverage area, weak coverage ratio) based on service assurance intent specified by customer.

- **Task B**: Coverage optimization policies determination. The tasks of determining the coverage optimization related policies (e.g., weak coverage analysis policies, weak coverage optimization policies).

- **Task C**: Coverage related information collection. The tasks of collecting coverage performance data (e.g. measurement data, MDT data).

- **Task D**: Coverage issues identification. The tasks of analysing the coverage performance and identifying the coverage issues (e.g. weak coverage).

- **Task E**: Coverage adjustment solution analysis and generation. The tasks of analysing the cause of the identified coverage issues and generating the coverage adjustment actions.

- **Task F**: Coverage adjustment actions determination. The tasks of deciding the coverage adjustment actions to be executed.

- **Task G**: Coverage adjustment actions execution (e.g. selection of coverageShape, digitalTilt and digitalAzimuth). The tasks of adjusting and configuring the coverage related parameters.

#### 5.2.1.3 Potential classification of network autonomy for coverage optimization

Level 0:

- All the tasks in the radio network coverage optimization workflow (Task A, Task B, Task C, Task D, Task E, Task F, Task G) are accomplished by human.

Level 1:

- Telecom system executes the tasks of adjusting and configuring coverage related parameters (e.g. coverageShape, digitalTilt and digitalAzimuth) based on coverage related parameters specified by human (Task G). Telecom system also can execute the tasks of collecting coverage related data (e.g. measurement data, MDT data and trace data) based on collection rule specified by human (Task C).

- All the other tasks in the radio network coverage optimization workflow (Task A, Task B, Task D, Task E, Task F) are accomplished by human.

Level 2:

- Compared to Level 1, telecom system can analyse the coverage performance and identify the coverage issue based on the coverage issue rule specified by human (Task D).

- All the other tasks in the radio network coverage optimization workflow (Task A, Task B, Task E, Task F) are accomplished by human.

Level 3:

- Compared to Level 2, telecom system additionally executes the tasks of analysing the coverage optimization solution (Task E) and determining the coverage adjustment actions (Task F) to be executed based on coverage requirements and/or optimization policies specified by human.

- All the other tasks in the radio network coverage optimization workflow (Task A, Task B) are accomplished by human.

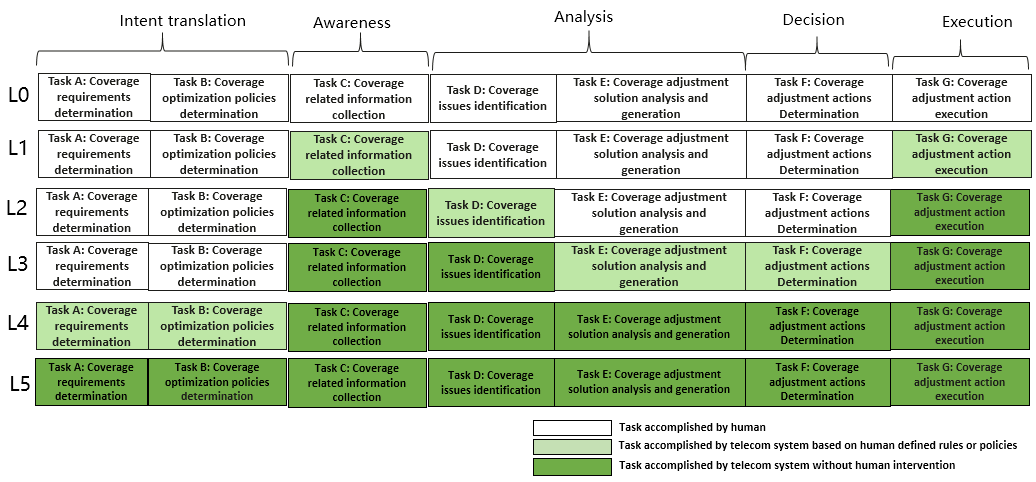
Level 4:

- Compared to Level 3, the telecom system additionally executes the tasks of determining coverage optimization policies (e.g., weak coverage cause analysis policies, weak coverage adjustment policies) (Task B). For certain scenarios, the telecom system can determines the coverage requirements (e.g. coverage area, weak coverage ratio) based on service assurance intent.

- The intent translation policies maybe pre-defined and specified by human to assist the telecom system.

Level 5:

- Telecom system can autonomously execute the entire workflow of radio network coverage optimization for all scenarios, which means the telecom system can achieve the full autonomy for radio network coverage optimization for full scenarios.



**Fgiure 5.2.1.3-1: Classification of network autonomy for radio network coverage optimization**

*Editor’s Note: The relation of above classification of network autonomy for radio network coverage optimization and Framework approach for classification of network autonomy level defined in Clause 6.1.2 is FFS.*

### 5.2.2 Capacity optimization use case example for classification of network autonomy

#### 5.2.2.1 Introduction

Network resources, especially radio resources are limited. In order to utilize radio resources in the most efficient way and improve user service experience, it is important to achieve higher system capacity by distributing user traffic across the system radio resources. Currently the flow of traffic simply follows the physical topology of the network or network slice, or static radio resource management policies, and resource usage may be unreasonable. Autonomous capacity optimization can help to improve resource usage efficiency greatly by taking into account the traffic steering when scheduling the network or network slice. For example, by creating a traffic prediction model, 3GPP management system can provide precise traffic prediction and the optimal network topology and traffic distribution.

#### 5.2.2.2 Entire workflow

The entire workflow of capacity optimization is as following:

- **Task A**: Capacity optimization intent translation. Translate the intent to the capacity optimization target information (e.g., capacity planning data, network topology, traffic model, etc.).

- **Task B**: Capacity information collection. Collect the current and historical performance data related to resource usage (e.g., PRB usage, RRC connection number, QoS flows, etc.) and network traffic (e.g., composite available capacity per cell (DL/UL), cell level load (DL/UL/SUL), TNL Load, etc.) for the network.

- **Task C**: Capacity data analysis. Analyse the current and historical performance data related to resource usage and network traffic for the network or network slices.

- **Task D**: Capacity issues identification and/or prediction. Identify the ongoing issues on resource utilization and predict the potential issues, and generate the capacity or resource utilization possible solutions (e.g., RRM policy adjustment, user migration, handover policy adjustment).

- **Task E**: Capacity optimization decision. Decide recommended solutions to optimize capacity and resource utilization.

- **Task F**: Capacity optimization execution. Apply capacity optimization solutions to telecom system (e.g., configuration of parameters and/or policies).

#### 5.2.2.3 Potential classification of network autonomy for capacity optimization

Each of the detailed tasks in clause 5.2.2.2 can be accomplished either manually by the operator or automatically by the telecom system. Following are the potential classifications of network autonomy for capacity optimization based on the participation degree of the human operator and the telecom system:

Level 0:

All the tasks in the capacity optimization workflow are accomplished by human.

Level 1:

- Capacity related information is collected (Task B) automatically by telecom system based on human predefined rules or configurations. Capacity optimization solutions can be triggered by human and executed by telecom system based on human-defined rules (Task F).

- All the other tasks in the capacity optimization workflow are accomplished by human.

Level 2:

- Compared to Level 1, telecom system additionally assists human to execute tasks of analysing the current and historical performance data (Task C) related to resource usage and network traffic for the network or network slices, and identifying the ongoing issues on resource utilization and predict the potential issues (Task D) based on human-defined rules. Capacity optimization solutions (Task F) are executed by telecom system without human intervention.

- Task A and Task E are accomplished by human.

Level 3:

- Compared to Level 2, the telecom system can automatically collect the current and historical performance data related to resource usage and network traffic (Task B). Telecom system could additionally assist human to review the capacity optimization solutions (Task E), which will finally be decided by human (operator).

- Task A is accomplished by human.

Level 4:

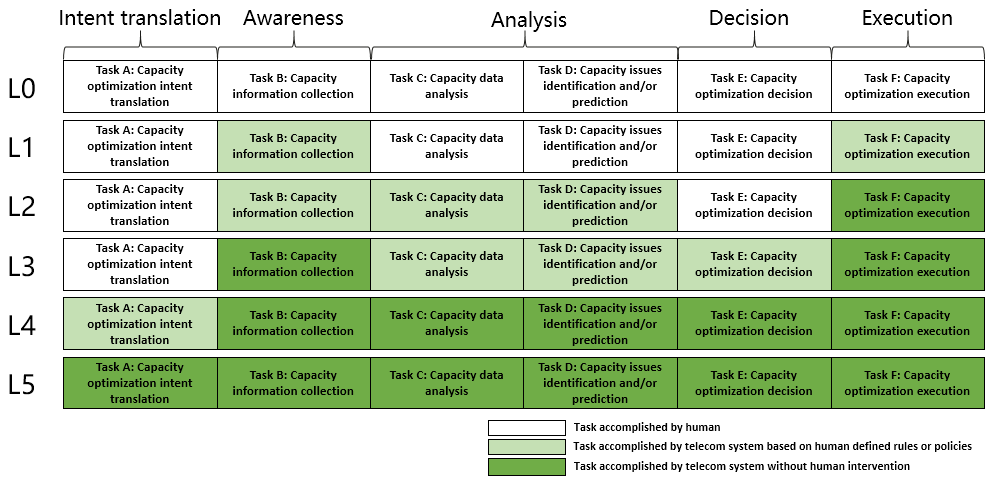
- Compared to Level 3, the capacity data analysis (Task C), capacity issues identification and/or prediction (Task D), and decision making (Task E) are accomplished automatically by telecom system without human intervention. Telecom system could additionally assist human to translate the intent to capacity optimization target information (Task A).

- The intent translation policies may be pre-defined and specified by human to assist the telecom system.

Level 5:

- The entire workflow of capacity optimization is accomplished automatically by telecom system without human intervention and human-defined rules.

Figure 5.2.2.3 -1 illustrate the classification of network autonomy for capacity optimization.



**Figure 5.2.2.3 -1: Classification of network autonomy for capacity optimization**

*Editor’s Note: The relation of above classification of network autonomy for radio network capacity optimization and framework approach for classification of network autonomy level defined in Clause 6.1.2 is FFS.*

## 5.3 RAN NE provisioning use case example for classification of network autonomy

### 5.3.1 Introduction

RAN NE provisioning use case refers to the entire workflow of deploying an RAN NE, full autonomy of RAN NE provisioning can help the network operator to reduce OPEX by reducing manual involvement in such tasks. However, full autonomy of RAN NE provisioning 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 mechanism in corresponding steps.

### 5.3.2 Entire workflow

Following are the entire workflow for RAN NE provisioning:

- **Task A**: RAN NE provisioning decision making.

- **Task B**: RAN NE planning data determination, the tasks of analysing and determining the network planning data (i.e. radio planning data, transport planning data) for the new RAN NE to be provisioned.

- **Task C**: RAN NE configuration data generation, the tasks of generating the network configuration data for the RAN NE based on the network planning data for the RAN NE and hardware information collected.

- **Task D**: RAN NE connection and hardware information collection, the tasks of connecting the RAN NE to the management system (including NE acquire its IP address and corresponding management system IP address) and collecting the RAN NE information (e.g. hardware information).

- **Task E**: RAN NE configuration data and software download and activation, the tasks of downloading and activating network configuration data and software in RAN NE.

- **Task F**: RAN NE verification, the tasks of performing the RAN NE verification (e.g. RAN NE test).

### 5.3.3 Potential classification of network autonomy for RAN NE provisioning

Following are the potential classification of network autonomy for RAN NE provisioning:

Level 0:

- All the tasks in the RAN NE provisioning workflow (Task A, Task B, Task C, Task D, Task E, Task F) are accomplished by human.

Level 1:

- Telecom system executes tasks of downloading and activating the available RAN NE network configuration data (i.e. transport and radio configuration data) and software prepared by human (Task E).

- Human makes the RAN NE provisioning decision and prepares the network configuration data for the RAN NE (Task A, Task B, Task C). Human connects the RAN NE to the management system and collects the RAN NE information (Task D). Human performs the RAN NE verification (Task F).

Level 2:

- Compared to Level 1, telecom system additionally executes the tasks of connecting RAN NE to the management system and collecting the RAN NE information (Task D).

- Human makes the RAN NE provisioning decision and prepares the network configuration data for the RAN NE (Task A, Task B, Task C). Human performs the RAN NE verification (Task F).

Level 3:

- Compared to Level 2, based on the network configuration data generation policies specified by human, the telecom system additionally executes tasks of analysing and determining the network configuration data for the RAN NE according to the network planning data specified by human (Task C). Telecom system also can executes tasks of performing the RAN NE verification (e.g. RAN NE test) (Task F) based on test policies specified by human.

- Human makes the RAN NE provisioning decision and prepares the network planning data (Task A and Task B). Human pre-defines the network configuration data generation policies.

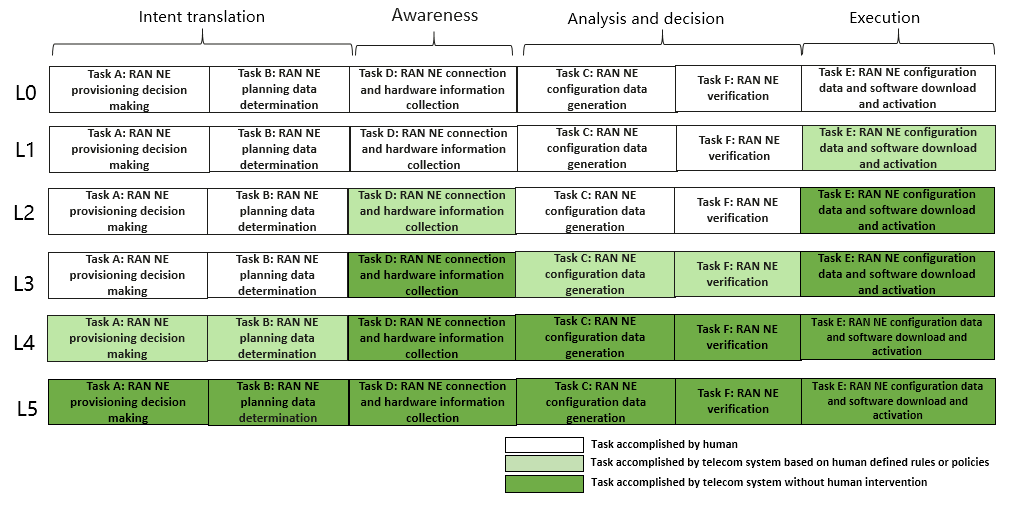
Level 4:

- Compared to Level 3, for certain scenarios, the telecom system additionally execute the task of making the RAN NE provisioning decision (Task A), analysing and determining network planning data (i.e. radio planning data, transport planning data) for the RAN NE to be provisioned (Task B) based on radio network deployment intent (e.g. provisioning radio network in certain area with network characteristics or SLA specified).

- The intent translation policies maybe pre-defined and specified by human.

Level 5:

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



**Figure 5.3.3-1: Classification of network autonomy for RAN NE provisioning**

*Editor’s Note:* *The relation of above classification of network autonomy for RAN NE provisioning and Framework approach for classification of network autonomy level defined in Clause 6.1.2 is FFS.*

## 5.4 Multi-domain/layer/technology management service coordination automation use case example

The goal of this use case is to enable automation of end-to-end joint coordination of management services across multiple domains (e.g. AN, CN), multi-layers (packet and optical transport), and multi-technology (wireless and wireline, x-haul, mobile core, data network, physical and virtual functions).

The following functions and services are assumed to be deployed and active:

- NG-RAN, 5GC, NSI(s).

- The performance assurance (PM), fault supervision (FM) and provisioning (CM) services are available across multi-domain, multi-layer, and multi-technology.

- The provider of multi-domain, multi-layer, and multi-technology coordination of management services.

The provisioning, assurance and supervision services provide information on the multi-domain, layer, and technology, the information characterized by:

- Status details on domain/layer/technology specific network resources, e.g. NG-RAN and 5GC, packet and transport networks, physical network resources and virtual resources

- Information from one or multiple network slices and slice subnets in relation with multi-domain, layer, and technology

- For each domain, layer, and technology, information on allocated resources and their utilization, event history (e.g. recent orchestration actions taken per domain, layer, and technology), history of actions taken (e.g. recent orchestration actions taken per domain, layer, and technology)

The provisioning, assurance and supervision services provide information on the multi-domain, layer, and technology, the information characterized by:

- Status details on domain/layer/technology specific network resources, e.g. NG-RAN and 5GC, packet and transport networks, physical network resources and virtual resources.

- Information from one or multiple network slices and slice subnets in relation with multi-domain, layer, and technology.

- For each domain, layer, and technology, information on allocated resources and their utilization, event history (e.g. recent orchestration actions taken per domain, layer, and technology), history of actions taken (e.g. recent orchestration actions taken per domain, layer, and technology).

The following scopes of network autonomy is applied to meet the objectives of automation of the multi-domain, layer, and technology coordination of management services:

- Network autonomy in NE layer

- Network autonomy in domain layer

- Network autonomy in cross domain layer

Based on the assumptions described above, the provider of multi-domain, multi-layer, and multi-technology coordination of management services is running jointly with individual coordination providers of domain, layer, and technology to automate end-to-end vertical and horizontal management coordination processes across multiple domain, layers, and technologies.

The provider of multi-domain, multi-layer, and multi-technology coordination of management services utilizes provisioning, assurance and supervision services to achieve optimal management coordination across multiple domains, layers, and technologies.

The provider of multi-domain, multi-layer, and multi-technology coordination of management services may utilize AI technologies (e.g. machine learning, deep learning algorithms, etc.) to achieve an optimal coordination.

The provider of multi-domain, multi-layer, and multi-technology coordination of management services offers management capabilities on the resource parameters configuration.

The coordination of management services consists of different levels of network autonomy as follows:

- Automation of coordination across multiple layer, technology, or domain individually.

- Automation of coordination across a combination of multiple-layer and technology, multiple-layer and domain, or multiple-technology and domain.

- Automation of coordination across multiple-layer, technology, and domain as a whole.

# 6 Potential solutions

## 6.1 Potential solutions for network autonomy level

### 6.1.1 Introduction

This clause describes the potential solutions for network autonomy level.

### 6.1.2 Framework approach for classification of autonomous network level

According to the potential categorization of the tasks in a general network autonomy workflow, a framework approach for classification of autonomous network level is introduced as following, which is used for evaluating the autonomy capability of telecom system.

**Table 6.1.2-1: Framework approach for classification of autonomous network level**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Network autonomy level | | Task categories | | | | |
| Execution | Awareness | Analysis | Decision | Intent translation |
| L0 | Manual operating network | Human | Human | Human | Human | Human |
| L1 | Assisted operating network | Human & Telecom system | Human & Telecom system | Human | Human | Human |
| L2 | Preliminary autonomous network | Telecom system | Human & Telecom system | Human & Telecom system | Human | Human |
| L3 | Intermediate autonomous network | Telecom system | Telecom system | Human & Telecom system | Human & Telecom system | Human |
| L4 | Advanced autonomous network | Telecom system | Telecom system | Telecom system | Telecom system | Human & Telecom system |
| L5 | Full autonomous network | Telecom system | Telecom system | Telecom system | Telecom system | Telecom system |
| Note 1: Human reviewed decision have the highest authority in each level if there is any confliction between human reviewed decision and telecom system generated decision.  Note 2: The present of above five task categories does not reflect the workflow sequence. | | | | | | |

**Level 0 manual operating network**: No categorization of the tasks is accomplished by telecom system itself.

**Level 1 assisted operating network**: A part of the execution and awareness tasks are accomplished automatically by telecom system itself based on human defined rules. At this level, telecom system can assist human to improve the execution and awareness efficiency.

**Level 2 preliminary autonomous network**: All the execution tasks are accomplished automatically by telecom system itself. A part of the awareness and analysis tasks are accomplished automatically by telecom system itself based on human defined policies. At this level, telecom system can assist human to achieve the close loop based on human defined policies.

**Level 3 intermediate autonomous network**: All the execution and awareness tasks are accomplished automatically by telecom system itself. A part of the analysis and decision tasks are accomplished automatically by telecom system itself based on human defined policies. At this level, the telecom system can achieve the close loop automation based on the human defined close loop automation policies.

**Level 4 advanced autonomous network**: All the execution, awareness, analysis and decision tasks are accomplished automatically by telecom system itself. And intent translation tasks can be partly accomplished automatically by telecom system itself based on human defined intent translation policies. At this level, telecom system can achieve the intent driven close loop automation based on human defined intent translation policies, which means the telecom system can translate the intent to the detailed close loop automation policies based on human defined intent translation policies.

**Level 5 fully autonomous network**: The entire network autonomy workflow is accomplished automatically by telecom system without human intervention. At this level, telecom system can achieve the whole network autonomy.

Note: Above framework approach for classification of autonomous network level are applicable for evaluating the autonomous network level from both management scope and scenario perspective. The overall autonomous network level of the whole telecom system is a comprehensive reflection of autonomous network level of the individual management scope and scenarios, which means in fully autonomous network level, the telecom system can achieve the whole network autonomy for all management scopes and scenarios.

## 6.2 Potential requirements for standardized features

### 6.2.1 Introduction

This clause describes the relation among the autonomous network levels and existing standardized features related to autonomous network and the potential requirements for autonomous network related standardized features to enable management use cases to support the expected autonomous network levels.

### 6.2.2 Potential relation with autonomous network related standardized features and interfaces

According to Clause 4.4.2 and Clause 6.1, a framework approach for classification of autonomous network level is based on the potential categorization of the tasks in a general network autonomy workflow, i.e. intent translation, awareness, analysis, decision and execution. According to Clause 4.4.3, the network autonomy can be implemented in different management scopes, i.e. NE layer, domain layer, cross domain layer and communication service layer.

Regarding this general network autonomy workflow and different management scopes, the relation among the autonomous network levels and autonomous network related standardized features is described as following:

- Standardized features in 3GPP SA WG5

- Work item 850030 SON\_5G “Self-Organizing Networks (SON) for 5G networks” specified the concepts, use cases, requirements, and procedures for the SON functions in 5GS. As described in Clause 4.1 in TS 28.313 [6], based on the location of the SON algorithm, SON is categorized into four different solutions, i.e. Cross Domain-Centralized SON, Domain-Centralized SON, Distributed SON and Hybrid SON. And the SON algorithm may consist of the functionalities including Monitoring, Analysis, Decision, Execution and Evaluation. The autonomy capabilities of various SON functions in 5GS may be different and therefore lead to different capabilities of autonomy on workflow and management scopes which may lead to different autonomous network levels. On the other hand, different autonomous network levels may lead to different requirements for the workflow and management scope capabilities of SON functions.

- Study item 850028 FS\_eMDAS “Study on enhancement of Management Data Analytics Service” studied concepts, process and role of MDAS, the use cases, potential requirements and possible solutions regarding the relation and interaction between MDAS and other NF functionalities are studied as well. It is described in Clause 5.1 in TR 28.809 [7] that the MDA plays the role of Analytics in the management loop and techniques such as AI and ML (e.g., ML model) may be utilized. The autonomy capabilities of various MDAS may be different and therefore lead to different capabilities of autonomy on analytics which may lead to different autonomous network levels. On the other hand, different autonomous network levels may lead to different requirements for the analysis capabilities of MDAS.

- Work item 850026 COSLA “Closed loop SLS Assurance” specified a closed loop assurance solution that helps an operator to continuously deliver the expected level of communication service quality. It is described in Clause 4.2 in TS 28.535 [8] that the management control loop for communication service assurance consists of Monitoring, Analysis, Decision and Execution, and in an open control loop, the human operator intervenes in one or more of the process steps of the loop while in a closed control loop, there is no direct involvement of a human operator or other operations system in the control loop. The process steps of the management control loop for communication service are covered by the general network autonomy workflow and the autonomy capabilities of the management control loop may be different and therefore lead to different capabilities of autonomy on awareness, analysis, decision and execution, which may lead to different autonomous network levels. On the other hand, different autonomous network levels may lead to different requirements for the management control loop for communication service.

- 5G MDT, Trace, PM, QoE related work items, such as work item 860021 5GMDT “Management of MDT in 5G”, work item 820036 TM\_SBMA “Trace Management in the context of Services Based Management Architecture”, work item 810031 5G\_SLICE\_ePA “Enhancement of performance assurance for 5G networks including network slicing”, work item 760058 QOED “Management of QoE measurement collection”, are relevant with the management of network and service data collection. The autonomy capabilities of these standardized features may be different and therefore lead to different capabilities of autonomy on awareness, which may lead to different autonomous network levels. On the other hand, different autonomous network levels may lead to different requirements for these features.

- Work item 820032 eNRM “NRM enhancements” specified the enhancement of NRM for SBA based 5G networks including NF Service Managed Object modelling, NF profile associated to a core control plane NF modelling, and NF & NF Service instance status and registration status modelling. They are relevant with the network and service configuration. The modelling of NRM and autonomy capabilities of the configuration may be different and therefore lead to different capabilities of autonomy on execution, which may lead to different autonomous network levels. On the other hand, different autonomous network levels may lead to different requirements for NRM normative work.

- Work item 810027 IDMS\_MN “Intent driven management services for mobile networks” studied intent driven management concept, scenarios and standard consideration for intent driven MnS. Intent translation is described in Clause 4.1.4 in TR 28.812 [5]. The Intent driven MnS producer is responsible for receiving intent and translate it to detailed requirements. The autonomy capabilities of various Intent driven MnS producers may be different and therefore lead to different capabilities of autonomy on intent translation, which may lead to different autonomous network levels. On the other hand, different autonomous network levels may lead to different requirements for the intent translation capabilities of Intent driven MnS producers.

- Standardized features in 3GPP SA WG2

- Work item 830047 eNA “Enablers for Network Automation for 5G” specified architecture enhancements for 5G System to support network data analytics service and framework to enable data collection and provide analytics to consumers. Extensions to NWDAF services to support the analytics that are required for e.g. QoS Profile Provisioning, Traffic Routing, Future Background Data Transfer and Slice SLA, etc. were defined as well. The autonomy capabilities of various NWDAF may be different and therefore lead to different capabilities of autonomy on data collection (i.e. awareness) and analysis which may lead to different autonomous network levels. On the other hand, different autonomous network levels may lead to different requirements for the data collection and analysis capabilities of NWDAF.

- Standardized features in 3GPP RAN

- Study item 801000 FS\_LTE\_NR\_data\_collect “Study on RAN-centric Data Collection and Utilization for LTE and NR” and work item 840091 “SON (Self-Organising Networks) and MDT (Minimization of Drive Tests) support for NR” specified the support of SON features, including MRO, MLB, and RACH optimization and MDT (Minimization of Drive Tests) features and L2 measurements as described in TR 37.816, TS 38.314, TS 37.320. TS 38.300, TS38.331, TS38.420, etc. These SON/MDT features are expected and specified to support network autonomy on network awareness (e.g. MDT features support automatic network data collection by measurements enhancement), decision and execution (e.g. MRO, MLB and RACH optimization support automatic UE reporting, inter-node information exchange, interface and network configuration enhancements). The autonomy capabilities of these SON/MDT features may be different and therefore lead to different capabilities of autonomy on awareness, decision and execution, which may lead to different autonomous network levels. On the other hand, different autonomous network levels may lead to different requirements for the SON/MDT features.

Different autonomous network levels may affect standardized interfaces (i.e. MnS) as well. The higher autonomous network level may request more sufficient network or service data to improve the capability on awareness and request faster configurations to improve the capability on execution, therefore lead to the enhancement of data collection and configuration related interfaces.

On the other hand, in a multi-vendor scenario, the higher autonomous network level may request simpler standardized interfaces (i.e. MnS) to reduce the interoperability complexity of 5G network management, and improve the network operating efficiency and automation performance.

### 6.2.3 Potential solutions for autonomous network related standardized features

*Editor's note: the potential requirements for autonomous network related standardized features to enable management use cases listed in Clause 5 to support the expected autonomous network levels may be added later.*

# 7 Conclusion and recommendation

*Editor's note: this clause will be used to document the conclusions and recommendation of the study.*

Annex A:  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2019-10 | SA5#127 | S5-196391 |  |  |  | Study on concept, requirements and solutions for levels of autonomous network | 0.0.0 |
| 2019-10 | SA5#127 | S5-196323  S5-196878  S5-196740 |  |  |  | 1. pCR 28.810 Add skeleton  2. pCR 28.810 Add background  3. pCR 28.810 Add scope | 0.1.0 |
| 2019-11 | SA5#128 | S5-197811  S5-197820  S5-197821  S5-197822  S5-197812  S5-197813  S5-197780  S5-197676  S5-197799  S5-197702 |  |  |  | 1. pCR 28.810 addition of multi-domain/layer/technology orchestration automation use case and requirement  2. pCR 28.810 Add concept of network autonomy  3. pCR 28.810 Add concept of network autonomy level  4. pCR 28.810 pCR 28.810 Add potential dimensions for classification of network autonomy level  5. pCR 28.810 Add coverage optimization scenario example for classification of network autonomy levels  6. pCR 28.810 Add NE deployment scenario example for classification of network autonomy levels  7. Add background of relevant study in other SDOs or industry parties  8. Add significance for levels of autonomous network  9. Add potential solution for network autonomy level  10. Add fault RCA and recovery scenario example for network autonomy level | 0.2.0 |
| 2020-03 | SA5#129e | S5-201324  S5-201493  S5-201494  S5-201495 |  |  |  | 1. pCR 28.810 Update Clause 4.4 Potential dimension for classification of network autonomy  2. pCR 28.810 Add capacity optimization scenario for classification of network autonomy level  3. Update NE deployment scenario example for classification of network autonomy level  4. pCR 28.810 Update Clause 5.1 Fault RCA and recovery scenario example for network autonomy level | 0.3.0 |
| 2020-04 | SA5#130e | S5-202390  S5-202391  S5-202392  S5-202393  S5-202394 |  |  |  | 1. pCR 28.810 Update capacity optimization scenario example for network autonomy level  2. pCR 28.810 Update Clause 5.3 NE deployment scenario example for classification of network autonomy levels  3. pCR 28.810 Update Clause 5.2 Coverage optimization scenario example for classification of network autonomy levels  4. pCR 28.810 Update Clause 4.4 Potential dimensions for classification of network autonomy  5. pCR 28.810 Update Clause 5.1 Fault RCA and recovery scenario example for classification of network autonomy | 0.4.0 |
| 2020-06 | SA5#131e | S5-203190  S5-203438  S5-203439 |  |  |  | 1. pCR 28.810 Clean-up  2. pCR 28.810 Update Clause 6.1.2 Framework approach for classification of autonomous  3. pCR 28.810 Add Clause 6.X Relation with existing standardized features  4. Implement Edithelp comments | 0.5.0 |
| 2020-06 | SA#88-e | SP-200480 |  |  |  | Presented for information | 1.0.0 |