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Contents

Foreword

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

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

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

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

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

shall indicates a mandatory requirement to do something

shall not indicates an interdiction (prohibition) to do something

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

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

should indicates a recommendation to do something

should not indicates a recommendation not to do something

may indicates permission to do something

need not indicates permission not to do something

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

can indicates that something is possible

cannot indicates that something is impossible

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

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

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

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

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

In addition:

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

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

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

Introduction

The current 5G networks brings more operational complexities, and the telecom system need to be able to adapt their operation to the business objectives of the operator as well as expectations of customer, which is driving customer to shift the focus from "how" to "what". An intent driven system will be able to learn the behaviour of networks and services and allows a customer to provide the desired state, without detailed knowledge of how to get to the desired state. Thus, the intent driven management is introduced to reduce the complexity of management without getting into the intricate detail of the underlying network resources.

1 Scope

The present document specifies concept, use cases, requirements and solutions for the intent driven management for service or network management.

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 28.531: "Management and orchestration; Provisioning".

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

[4] 3GPP TS 28.530: "Management and orchestration; Concept, use cases and requirements".

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

[6] 3GPP TS 28.622: "Telecommunication management; Generic Network Resource Model (NRM); Integration Reference Point (IRP); Information Service (IS)".

[7] TM Forum IG1253A: "Intent Common Model v1.1.0".

[8] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception".

[9] 3GPP TS 28.538: "Management and orchestration; Edge Computing Management".

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: expectations including requirements, goals and constraints given to a 3GPP system, without specifying how to achieve them

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].

4 Concepts and Background

4.1 Intent concept

4.1.1 Introduction

An intent specifies the expectations including requirements, goals and constraints for a specific service or network management workflow. The intent may provide information on particular objective and possibly some related details. Following are some general concepts for intent:

- An intent is typically understandable by humans, and also needs to be interpreted by the machine without any ambiguity.
- An intent focuses more on describing the "What" needs to be achieved but less on "How" that outcomes should be achieved, The intent expresses the metrics that need to be achieved and not how to achieve them. This not only relieves the burden of the consumer knowing implementation details but also leaves room to allow the producer to explore alternative options and find optimal solutions. Intent describes the properties that allows a satisfactory outcome.
- The expectations expressed by an intent is agnostic to the underlying system implementation, technology and infrastructure. Area can be used as managed object in the expectations expressed by an intent to achieve system implementation, technology and infrastructure agnostic.

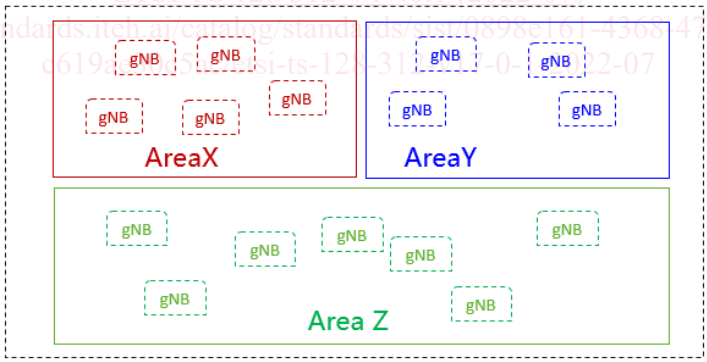

Figure 4.1.1-1

- An intent needs to be quantifiable from network data so that the fulfilment result can be measured and evaluated.

Intent can be categorized based on different user types or different management scenario types.

4.1.2 Intent categorizes based on user types

Based on roles related to 5G networks and network slicing management defined in clause 4.8 in 3GPP TS 28.530 [4], different kinds of intents are applicable for different kinds of standardized reference interfaces.

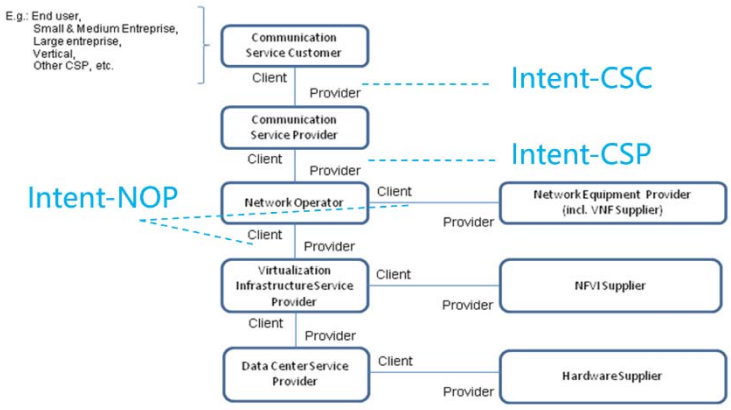

Figure 4.1.2-1: High-level model of different kind of intents expressed by different roles

- **Intent from Communication Service Customer (Intent-CSC):** Intent from Communication Service Customer enables Communication Service Customer (CSC) to express which properties of a communication service the CSC may request from CSP without knowing how to do the detailed management for communication service. For example, Intent-CSC can be 'Enable a V2X communication service for a group of vehicles in certain time'.

- **Intent from Communication Service Provider (Intent-CSP):** Intent from Communication Service Provider enables Communication Service Provider (CSP) to express an intent about what CSP would like to do for network without knowing how to do the detailed management for network. For example, Intent-CSP can be 'Provide a network service supporting V2X communications for highway-417 to support 500 vehicles simultaneously'.

- **Intent from Network Operator (Intent-NOP):** Intent from Network Operator enables Network Operator (NOP) to provide what NOP would like to do for group of network elements (i.e. subnetwork) management and control without knowing how to do the detailed management for the network elements. For example, Intent-NOP can be 'Provide a radio network service to satisfy the specified coverage requirements and UE throughput requirement in certain area'.

4.1.3 Intent expectations for different types of management needs

Intent expectations for different types of management needs:

- **Intent expectation for delivering network and service related object:** enables a consumer to express the intent expectation for the object (e.g. network, service, slice) to be delivered by the system. Examples of such intent expectations are:

  - "Delivering a radio network in the specified area with specified frequency information, transport information, and radio information (e.g. range of PCI, Cell Id), network capacity and performance information".

  - "Delivering a radio service in the specified area with certain service characteristics (e.g. SLS)".

- **Intent expectation for network and service related object performance:** enables a consumer to express the performance objectives of the object (e.g. network, service, slice) to be assured. Examples of such intent expectations are:

  - "Ensure the radio network in the specified area meets certain expected RAN UE throughput objectives (e.g. expected average RAN UE DL throughput, expected percentage of UE with the RAN UE DL throughout less than 5 Mbps)".

  - "Ensure the radio network in the specified area meets certain expected coverage objectives (e.g. expected coverage ratio, expected average RSRP)".

4.2 Intent driven management

4.2.1 Support for intent driven management

In Intent-driven management, the consumer provides its intent to the producer of a set of management services that would be consumed in a specific domain. For example, for the purpose of requesting a radio network with a new coverage, one possible solution (non-intent driven approach) is to use the set provisioning MnSs to decommission a cell and instantiate the cell to a new Node B for the new coverage. The alternative solution (intent driven approach) is to use management service produced by the domain is what may be referred to as the Intent-driven MnS by stating the intent for the radio network for the new coverage, based on the intent, system can trigger actions (e.g. decommission a cell and instantiate the cell to a new Node B) to satisfy received intent.

The producer of an Intent-driven MnS shall allow the consumer to manage the service and / or network resources through the use of intents. The producer shall support the capabilities for intent fulfilment, which include the following:

- The consumer states the intent to be fulfilled (which can be implemented by createMOI operation on the Intent IOC) and the producer receives and acknowledges the receipt of the intent.
- The producer validates the intent and then translates the intent to identify the required internal logic needed to fulfil the intent.
- The producer executes the compiled logic to fulfil the intent.
- The producer may report about the fulfilment result of the intent.

4.2.2 Intent driven MnS

Introduction of service-based architecture for 5G, in combination with functional model of business roles, exceeds the level of complexity for managing network in different scenarios (including scenarios for design/planning, deployment, maintenance and optimization) both in a single and multivendor network. New/simpler ways of managing are needed.

Actions of an intent driven MnS related to the fulfilment of intents may be categorized as intent deployment and intent assurance. Intent fulfilment refers to the steps taken to satisfy a newly received intent or an update to an existing intent. The goal of intent fulfilment is to bring the network or service's state to satisfy the new or updated intent. The fulfilment of some intents may end at the intent deployment, the case, if the intent's goal simply describes the availability or presence of a service. In other cases, the intent's goal describes the assurance requirements for a network or service (e.g. quality of service, end user experience, SLS, etc.) in addition to the need of existence of a service. Those intents have their fulfilment tied to the operation of the referred service or network function and may require frequent recurring actions to keep those assurance requirements achieved. This part of the intent fulfilment is referred to as intent assurance.

An Intent driven MnS allows its consumer to express intents for managing the network and services and obtain the feedback of intent evaluation result. The Intent-driven MnS producer have the following capabilities:

- Validate the intent.
- Translate the received intent to executable actions as follows:
  - Performing service or network management tasks.
  - Identifying, formulating and activating service or network management policies.
- Evaluate the result/information about the intent fulfilment (e.g. the intent is initially satisfied or not) and intent assurance (e.g. the intent is continuously satisfied).

Figure 4.2.2-1 shows the model of Intent-driven MnS.

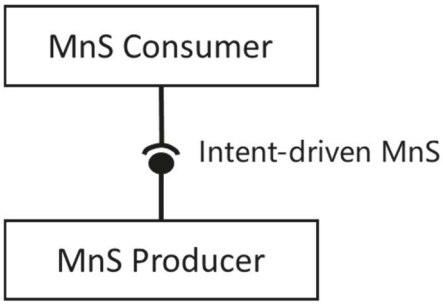

Figure 4.2.2-1: Intent-driven MnS

The intents may be fulfilled by utilizing multiple mechanisms including among others: Rule-based mechanisms, closed loop mechanisms and AI/ML based mechanisms. These mechanisms can be combined in solutions of various complexity, ranging from a simple approach rule-based mechanisms, to more elaborate solutions combining AI/ML, closed loop automation to ensure the fulfilment of intents.

When the intent is created on the MnS producer, the MnS producer may consume other management services (including non-intent driven MnS and intent driven MnS) to fulfil or satisfy the intent, e.g. creating new assurance closed control loop instance(s) or using assurance closed control loop instance (s) to satisfy the intent. The internal implementation of the intent fulfilment will however not be standardized.

An Intent driven MnS includes the following management capabilities to support intent lifecycle management:

- Create an intent, a MnS Consumer request to create a new intent on the MnS producer.
- Activate an intent, MnS Consumer request to activate an intent on the MnS producer when the intent is suspended.
- De-activate an intent, MnS consumer request to de-activate an intent on the MnS producer for a temporary suspension.
- Delete an intent, MnS Consumer request to remove an intent on the MnS producer.
- Modify an intent, MnS Consumer request to modify the content of the intent (e.g. expectation targets) on the MnS producer.
- Query an intent, MnS Consumer request to return the content and state (e.g. active, inactive) of the intent on the MnS producer.

4.2.3 Intent translation

The Intent driven MnS producer is the provider of Intent driven MnS and is responsible for deriving activities for networks and services or other intent(s).

The MnS consumer may consume Intent Driven MnS(s) provided by the Intent driven MnS producer(s) or may have the consumer role for non-intent MnS producers.

The conflict(s) including conflict between the intent and other intent(s) and/or Non-intent requirements needs to be detected and resolved during the intent translation. Figure 4.2.3-1 illustrate the potential way to satisfy intents originating from CSC:

- Intent-CSC MnS producer provides intent driven MnS for communication services. Intent-CSC MnS producers receive the expressed intent and translate it to Intent-CSP or network requirements, then may consume Intent-CSP MnS(s) or Non-Intent MnS(s) for network to fulfil the intent-CSC.
- Intent-CSP MnS producer provides intent driven MnS for network services. Intent-CSP MnS producers receive the intent and translate it to new Intents for NOP or network element requirements, then may consume Intent-NOP MnS(s) or Non-Intent MnS(s) for NE to fulfil the intent-CSP.
- Intent-NOP MnS producer provides intent driven MnS for network equipment. Intent-NOP MnS Producers receive the expressed intent, and translate it to detailed network element requirements, then takes some internal actions to fulfil the intent-NEP.

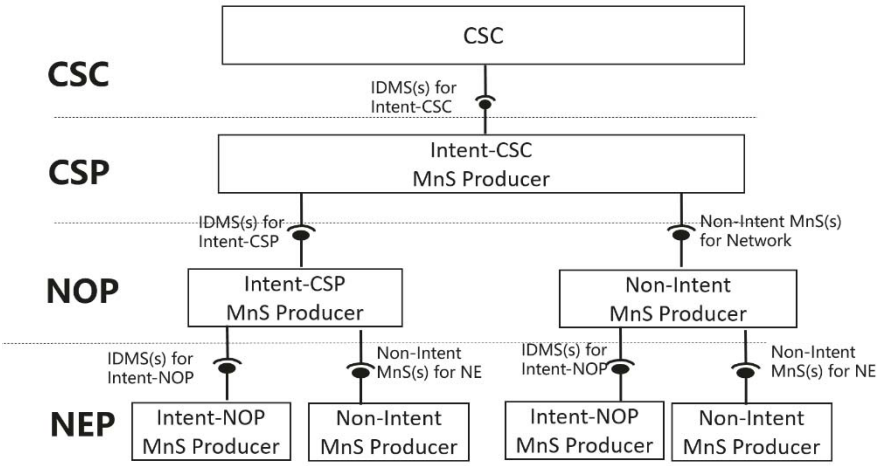

Figure 4.2.3-1: Potential way to satisfy intent-CSC originating from CSC

4.3 Intent driven closed-loop

Intent can be used for management and control of closed-loop automation (e.g. intent can be used to specify the goals for the closed-loop), which means the intent can be translated to policies and management tasks that the MnS producer needs to execute for the closed-loop automation. In the intent driven management approach, the mechanisms that the MnS producer using closed-loop automation mechanisms to satisfy the intent is the implementation of the MnS producer and shall not be standardized. The relation of the Intent driven MnS and the closed-loop automation with the Intent driven MnS producer is shown in the figure 4.3-1.

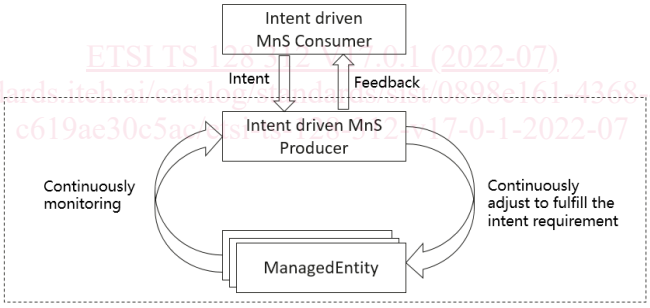

Figure 4.3-1: Intent driven closed-loop

4.4 Relation between rule, policy and intent

An intent specifies the expectations including requirements, goals, and constraints for a specific service or network management workflow, while a policy specifies the action(s) to be taken when given condition occurs and rules specifies the explicit or formula logics to be executed. For certain scenarios, policies can be used in conjunction with intents to achieve the autonomous purposes. Figure 4.4-1 describes the relation between rule, policy and intent in the "what-how" view. As it now stands, the telecom systems are mainly focused on "how" and "less what". The current 5G networks brings more operational complexities, and the telecom system need to be able to adapt their operation to the business objectives of the operator as well as expectations of customer, which is driving customer to shift the focus from "how" to "what". The first step towards that shift, has been shift from "Rule based management" to "Policy driven management", with more focus on "how" and less on "what" covering domain specific issues/aspects (an example for policy is when the average throughput is lower than certain threshold, take specified actions). As technologies are evolving and the level of complexity exceeds, the need for an abstraction level description (i.e. Intent) becomes more apparent (an example for intent is the target average throughput for certain area should be assured). An intent driven system will be able to learn the behaviour of networks and services and allows a customer to provide the desired state, without detailed knowledge of how to get to the desired state.

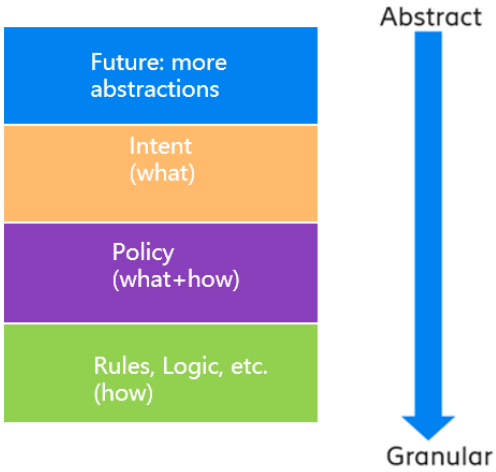

Figure 4.4-1: Relation between rule, policy and intent

4.5 General concept of Intent Content

4.5.1 Intent Expectation

In the most basic form, a consumer may use an intent to express to the producer the need for:

"an object O with characteristics S".

Where the characteristics S reflect the requirements, goals and contexts for an object.

The object may be a 3GPP managed object like a network slice, subnetwork (e.g. radio network) or other objects like a service. The consumer may desire the same requirements, goals and contexts for multiple objects with the same properties, in which case the intent may be stated for a list of objects as

"objects {O_1,O_2, …O_N} with characteristics S"

However, the consumer may wish to express different requirements, goals and contexts for objects with different properties. It is in that case necessary to distinguish the requirements, goals and contexts to be achieved for each set of objects with the same properties. Correspondingly, the combination of requirements, goals and contexts for each set of objects with the same properties is the Intent Expectation. Also the consumer may wish to distinguish the requirements, goals and contexts for different objects with the same properties, in this case, the combination of requirements, goals and contexts for each object instance may be contained in a separate Intent Expectation or requirements, goals and contexts for the multiple object instances may be combined in a single Intent Expectation.

4.5.2 Expectation Targets

For a given intent expectation, the desired characteristics of the object(s) are the expectation targets to be achieved. The expectation targets may include the metrics that characterize the performance of the object(s) or some abstract index that expresses the behavior of the object(s). A given intent expectation may include multiple expectation targets on the same object or on different objects with the same properties. A consumer may for example require for the Network Slice object(s) that User throughput > 5Mbps and latency < 1ms. The expectation targets may also be context specific, i.e. the intent may require a specific expectation targets given a specific target context. As such with the characteristics as a combination of expectation targets and target contexts, the intent expectation may be stated as:

```
"ensure that for
    Expectation Object O,
    Expectation Target_1 is T_1, Target Context_1 is C_1
     ….,
    Expectation Target_m is T_m, Target Context_k is C_k;
```

Each expectation target expresses an aspect of the characteristics of the object under consideration, i.e. it expresses a desired characteristics on a specific object. Each of the object characteristic may be desired to be equivalent to a specific value or constrained to a value or a range of values, e.g. as listed in Table 4.5.2-1. The combination of the name of characteristic (or simply the targetName), the condition constraining the characteristic and the value or value range for the characteristic is the target, i.e. the Expectation Target is the tuple:

Expectation Target = [targetName, condition, value range]

Table 4.5.2-1: Examples of Expectation Targets for different Objects

Example of Expectation Targets	ExpectationObject	targetName	Condition	Value range
example 1	Slice	Coverage area	Is at least	40 km radius
example 2	Communication Service	User throughput	Is greater than	2 Mbps

4.5.3 Expectation Objects

The object (s) for which a given expectation is addressed can be expressed with the object's identifier. This may, however, not always be adequate (e.g. if the consumer does not have or know the identifiers of the object) or may be cumbersome for some intents.

EXAMPLE 1: It may be easier to state "all slices in city ABC" as opposed to listing the individual slices. As such it may be easier to identify the objects by stating the object context information that filters and identifies the desired objects.

The objectContext is in form of a context list whose entries are each a tuple (attribute, condition, value range).

EXAMPLE 2: In the case of "all slices in a city" there is an object context, which is the tuple "location, =, city_ABC" and "objectType=slice".

4.5.4 Context

Each target may be constrained to only be achieved for a very specific set of constraints. For example, the consumer may state that: *"ensure that handoverFailureRate < 2 % if Load > 80 %"*, where the target *"HandoverFailureRate < 2 %"* is only to be achieved only in the context *"Load > 80 %"*.

Similar to the target, the context is also a tuple of < attribute, condition, value range > but where the values having a different semantics.

Although contexts and targets have the same structure, to distinguish between what needs to be achieved and the context which is only to be considered as required conditions, the Context has to be explicitly stated separate from the target. For example, if the consumer may wish that the Radio Link Failure rate (RLF) is less than 2 % when the load is more than 50 %. If the context (i.e. load > 50 %) is not explicitly stated/modelled as context, the producer could interpret the request to mean (RLF < 2 % and load > 50 %).

For a given expectation, the specific list of targets may be desired to be achieved for given combined contexts, i.e. besides the Target, an expectation may state a list of contexts which apply to all targets within the intent expectation. Similarly, there may be contexts that apply to all expectations within a given intent. Correspondingly, both Intent expectations and intents should be modelled to contain aggregate contexts that apply to all the contained sub elements.