



**5G;
Study on intent driven management service
for mobile network phase 3
(3GPP TR 28.914 version 19.0.0 Release 19)**



Reference

DTR/TSGS-0528914vj00

Keywords

5G

ETSI

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 - 3 or greater indicates TSG approved document under change control.
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- z the third digit is incremented when editorial only changes have been incorporated in the document.

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

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

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

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- 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 investigates new areas for enhancing the intent driven management services for mobile networks.

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 28.312: "Management and orchestration; Intent driven management services for mobile networks".
- [3] 3GPP TS 28.541: "Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3".
- [4] 3GPP TS 28.622: "Telecommunication management; Generic Network Resource Model (NRM); Integration Reference Point (IRP); Information Service (IS)".
- [5] TM Forum IG1253: "Intent in Autonomous Networks v1.2.0".
- [6] ETSI GR ZSM 011: "Zero-touch network and Service Management (ZSM); Intent-driven autonomous networks; Generic aspects".
- [7] 3GPP TR 28.912: "Study on enhanced intent driven management services for mobile networks".
- [8] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".
- [9] 3GPP TR 22.843: "Study on on Additional capabilities of mobile networks for drone operations and managements".
- [10] 3GPP TS 22.125: " Uncrewed Aerial System (UAS) support in 3GPP".
- [11] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".
- [12] 3GPP TS 28.554: "Management and orchestration; 5G end to end Key Performance Indicators (KPI)".
- [13] TM Forum TR291I: "Utility - Intent Extension Model v3.5.0".
- [14] TM Forum TR292H: "Mathematical Functions Definition and Collection v3.4.0".
- [15] TM Forum TR292C: "Function Definition Ontology v3.4.0".
- [16] 3GPP TR 28.836: "Study on intent-driven management for network slicing".

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].

example: text used to clarify abstract rules by applying them literally

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].

IDMS	Intent Driven Management Service
------	----------------------------------

4 Concept and background

4.1 Intent negotiation functionalities

4.1.1 Overview

An important aspect of intent-driven systems is their support of automation of intent-driven MnS consumer-intent driven MnS producer interactions. Introducing intent negotiation functionalities will be beneficial for the MnS producer and the MnS consumer to engage in a collaborative way. The intent negotiation can occur in the following two phases:

- Intent pre-evaluation, before the MnS consumer expresses the intent expectation to be fulfilled.
- Intent fulfilment, after the MnS consumer had expressed the intent expectation to be fulfilled.

4.1.2 Intent negotiation functionalities in Intent pre-evaluation phase

The intent negotiation functionalities for Intent pre-evaluation can be used to assist the MnS consumer to generate suitable intent information for the MnS producer. The network (including NEs) will not be changed during the intent pre-evaluation phase. The Intent negotiation functionalities in the intent pre-evaluation phase includes:

- Intent Feasibility check, the management capability to enable the MnS consumer to check if the proposed intent can be supported by the MnS producer.
- Intent Exploration, the management capability to enable the MnS consumer and the MnS producer to find the intent for fulfilment that is best aligned with MnS producer's capabilities.

4.1.3 Intent negotiation functionalities in Intent fulfilment phase

The intent negotiation functionalities for intent fulfilment can be used to enable the MnS producer and the MnS consumer to agree on the best way to fulfil an intent.

5 Use cases

5.1 Use case #1: Enhance the radio service delivering use case

5.1.1 Description

In 3GPP TS 28.312 [2], the existing use case and requirements for intent containing an expectation for delivering a radio service is described in clause 5.1.2 and includes the MnS consumer's expectations for delivering and assurance of a radio service (radio network as a service) in the specified area. However, following information is missing in Radio Service Expectation:

- Service capacity information (e.g. maximum number of UEs).
- PLMN information. The PLMN information (including PLMNId) is important to describe the radio service is specific for which PLMN.

In addition, MnS consumer may expect the radio service to be delivered and assured at a scheduled time instead of all the time.

Before MnS consumer expresses the expectations for delivering a radio service, the MnS consumer may want to check whether the MnS producer can guarantee fulfillment of the specified intent, but the way and handling of the related resource reservation is MnS producer's internal behaviour.

5.1.2 Potential requirements

REQ-Intent_RadioService-1: The intent driven MnS producer for radio service should have a capability enabling MnS consumer to request to deliver a radio service in a scheduled time.

The generic feasibility check requirements described in clause 5.14.2 are applied for the feasibility of an expected radio service before requesting to deliver a radio service.

5.1.3 Potential solutions

5.1.3.1 Potential solution #1

This solution proposes to reuse and enhance the existing RadioServiceExpectation defined in 3GPP TS 28.312 [2].

Enhancement Aspect1: Add following attributes in the existing RadioServiceExpectation:

- Add PLMNInfoContext as ObjectContext for Radio Service Expectation. The concrete definition for PLMNInfo see 3GPP TS 28.541 [3].
- Update the existing definition for `maxNumberOfUESTarget` in 3GPP TS 28.312 [2] more generic which can be applied for both EdgeServiceSupportExpectation and RadioServiceExpectation and reuse the `maxNumberOfUESTarget` as ExpectationTarget for Radio Service Expectation.
- Add SchedulingTimeContext as ExpectationContext for Radio Service Expectation. The datatype for SchedulingTime <<choice>> is defined in 3GPP TS 28.622 [4] which can support one-time interval, daily periodicity, weekly periodicity or monthly periodicity.

5.1.4 Evaluation of potential solutions

Only one potential solution has been identified, which is feasible.

5.2 Use case #2: Enhancement of radio network expectation

5.2.1 Description

5.2.1.1 Scenario 1: RAN energy saving

The following aspect is proposed to enhance the radio network expectation defined in 3GPP TS 28.312 [2] to support RAN energy saving.

The RAN energy saving target and service experience target in the existing object context are applied for all selected frequencies (represented by `dlFrequencyContext` and `ulFrequencyContext` in the `ExpctationObject`) and RAT (represented by `rATContext` in the `ExpctationObject`). However, in some scenarios, MnS consumer may want to assure different RAN UE throughput performance for different Frequencies or RATs in the same area when perform energy saving activities (same RAN energy saving targets). It is important to allow the MnS consumer to express different RAN UE throughput targets for different Frequencies or RATs in the specified area in the same intent and receive the target fulfilment result for different RAN UE throughput targets for different Frequencies or RATs.

5.2.1.2 Scenario 2: Radio network traffic assurance for scheduled events

The following is proposed to enhance the radio network expectation defined in 3GPP TS 28.312 [2] to support radio network traffic assurance for scheduled events.

The existing radio network expectation (e.g. existing `aveULRANUEThptTarget` and `aveDLRANUEthptTarget`) can be used to support MnS consumer to express radio network expectations on radio network traffic assurance in the specified areas for the scheduled events (such as a sports event or concert). However, the solution for user numbers requirement is missing. Besides, the radio network expectation also needs to be enhanced to support schedule times which can be one-time interval, daily periodicity, weekly periodicity or monthly periodicity and coverage area which can be represented by polygon area or a list of Cell (e.g. CGI) to satisfy the radio network traffic assurance scenario.

5.2.1.3 Scenario 3: Radio Network support for UAV pre-flight preparation

The following is proposed to enhance the radio network expectation defined in 3GPP TS 28.312 [2] to support UAV pre-flight preparation.

According to 3GPP TS 22.125 [10], in the control mode "Automatic flight by UTM (Uncrewed Aerial System Traffic Management)", the control message contains a pre-scheduled flight plan, e.g. array of 4D polygons, sent from the UTM to the UAV. The array of 4D polygons, which represents pre-scheduled flight plan, contains not only the location, but also the corresponding time. Besides, for requirements CPR 6.1-001 and CPR 6.1-002 in 3GPP TR 22.843 [9], clause 6.1, the 5G system should be able to monitor, predict the network condition and report the geographic areas where network requirements could or could not be met.

An Intent driven MnS, which allows its consumer to express intents for managing the network and services and obtain the feedback of intent evaluation results, would be suitable to support network management for UAV pre-flight preparation:

- For network condition assurance, corresponding network condition can be assured by expressing intent containing an expectation for providing necessary network conditions (e.g. network coverage) in the specific aerial flight zones composed of a list of `GeoArea` and `TimeWindow` pairs, i.e. a list of `<GeoArea, TimeWindow>`, to ensure the fulfilment of the targets when the UAVs need to be served by the managed entities in the specified aerial flight zone.

NOTE: `GeoArea` and `TimeWindow` are defined in 3GPP TS 28.622 [4].

- For pre-flight network status evaluation, intent fulfilment feasibility check could be performed before flight to determine whether the network requirements can be satisfied. If the feasibility check result is 'infeasible' or the intent cannot be fulfilled, MnS Producer should notify MnS Consumer about the problematic geographic areas.

5.2.1.4 Scenario 4: Radio Network support MOCN undifferentiated radio service in a specified area

Following aspects are proposed to enhance the radio network expectation defined in 3GPP TS 28.312 [2] to enhance support for MOCN.

The radio network for MOCN needs to carry the service traffic of MOP and POP, which may provide undifferentiated radio service for MOP and POP. However, it is inevitable that there will be differentiated radio service caused by a variety of factors, which will affect the user experience, especially the impact on the POP's users. The differentiated radio service may cause poorer service quality for POP and results in POP's user dissatisfaction.

Undifferentiated radio service requires that the wireless parameters of MOP and POP configuration are consistent, and the performance difference for MOP and POP should be within a certain range. MnS consumer expresses its intent expectation for ensuring a radio network for MOCN to MnS producer, which may include equal network performance information for MOP and POP. In this scenario, MnS consumer expresses its intent expectation for ensuring undifferentiated radio network performance in specified areas for MOP and POPs to MnS producer, which may include coverage area information, radio setting parameter sets, expected average experience requirements (e.g. RAN UE throughput), coverage requirements (e.g. weak coverage ratio) and, available resource related performance (e.g. available PRB) and handover requirements (e.g. 5GS to EPS handover success rate). MnS producer (e.g. RAN management system) accurately prepares network resources (e.g. PRB resources) and configure RF coverage related parameters in advance based on the requirements expressed by operator to ensure radio network for MOCN with undifferentiated radio service for MOP and POP.

5.2.2 Potential solutions

Following are the proposed solutions to support above enhancements based on existing RadioNetworkExpectation and TargetFulfilmentResult in 3GPP TS 28.312 [2].

Enhancement Aspects to support scenario 1:

- **Enhancement Aspect 1.1:** Update existing aveULRANUEThptTarget defined in 3GPP TS 28.312 [2] by adding "ulFrequencyContext" and "rATContext" as targetContext, and update existing aveDLRANUEThptTarget defined in 3GPP TS 28.312 [2] by adding "dlFrequencyContext" and "rATContext" as targetContext.
- **Enhancement Aspect 1.2:** Update existing TargetFulfilmentResult<<dataType>> by adding attribute "targetContext". The "targetContext" can be "ulFrequencyContext", "dlFrequencyContext" or "rATContext", which depends on the concrete target specified in the Intent.

Enhancement Aspects to support scenario 2:

- **Enhancement Aspect 2.1:** Add ActiveUEsTarget as ExpectationTarget, it describes the number of Active UEs for the specified areas. This target is related to Mean number of Active UEs in the DL per cell and Mean number of Active UEs in the UL per cell defined in 3GPP TS 28.552 [8].
- **Enhancement Aspect 2.2:** Replace the targetAssuranceTimeContext with the SchedulingTimeContext. The datatype for SchedulingTime <<choice>> is defined in 3GPP TS 28.622 [4] which can support one-time interval, daily periodicity, weekly periodicity or monthly periodicity.
- **Enhancement Aspect 2.3:** Add attribute "cellContext" as ObjectContext for RadioNetworkExpectation to describe the coverage areas which represented by a list of cells. The contextValueRange for cellContext can be a list of CGIs (NCGI in case of NR cells and ECGI in case of E-UTRAN cells). This attributes also can be reused for other purpose if needed.

Enhancement Aspects to support scenario 3:

- Enhancement Aspect 3.1: add attribute "timeBasedAreaContext" in ObjectContext for RadioNetworkExpectation to describe the areas for specific times which represented by a list of GeoArea and TimeWindow pairs, i.e. a list of <GeoArea, TimeWindow>.

NOTE 1: GeoArea and TimeWindow is defined in 3GPP TS 28.622 [4].

- Enhancement Aspect 3.2: add "timeBasedExclusionAreas" as an attribute of IntentFeasibilityCheckReport <<dataType>> and ExpectationFulfilmentResult <<dataType>>. The "timeBasedExclusionAreas" represents the

geographic areas that are infeasible when performing the feasibility check or can not fulfill the intent during the execution of the intent.

NOTE 2: The enhancements may be applicable to other scenarios, e.g. Intent containing an expectation on coverage performance to be assured.

Enhancement Aspects to support scenario 4:

- Enhancement Aspect 4.1: Add PRBsTarget as ExpectationTarget, it describes total available number of physical resource blocks (PRBs). This target is related to PRB-related measurements defined in 3GPP TS 28.552 [11].
- Enhancement Aspect 4.2: Add InterRATHandoverTarget as ExpectationTarget, it shows how often a handover from 5GS to EPS is successful. This target is related to 5GS to EPS handover success rate defined in 3GPP TS 28.554 [12].

5.2.3 Evaluation of potential solutions

Only one potential solution is identified, which is feasible.

5.3 Use case #3: Implicit intent report subscription with customized requirements

5.3.1 Description

In 3GPP TS 28.312 [2], NtfSubscriptionControl IOC is used for MnS consumer to subscribe the intent report information explicitly. MnS consumer needs to request to create a NtfSubscriptionControl instance to subscribe the intent report information for a specified intent instance after such intent instance is created.

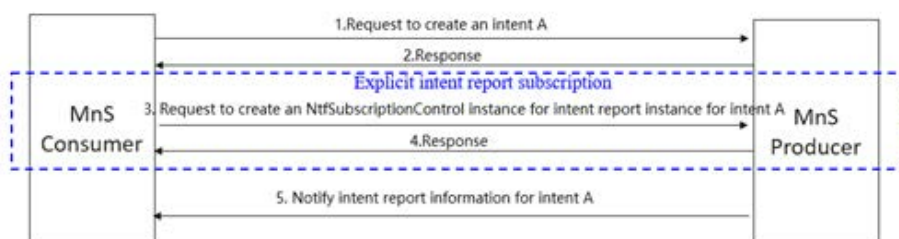


Figure 5.3.1-1: Explicit intent report subscription

However, in some scenarios, MnS consumer who expresses the intent may want to obtain the intent report by default, instead of triggering separate subscription action (i.e. request to create a NtfSubscriptionControl instance) to subscribe intent report information (especially intent fulfilment information).

In addition, MnS consumer who expresses the intent may want to obtain the intent report based on specified conditions.

EXAMPLE: MnS consumer may specify a condition where a target is not fulfilled and the achieved value for the target is stable (i.e. the value for the targetAchievedValue of the target is not updated for one or more observation periods). When the condition is satisfied, the MnS producer will send the intent report to the MnS consumer. Then, the MnS consumer could modify the target that is not fulfilled based on the stable achieved value (i.e. Reduce the target value to the stable achieved value). So, the capability to support for implicit intent report subscription is important for the MnS consumer who express the intent.

5.3.2 Potential requirements

REQ-Intent_Driven_MnS-CON-1: The intent driven MnS producer should have the capability enabling MnS consumer who expresses the intent to specify intent report control information in the intent when creating or modifying the intent.

REQ-Intent_Driven_MnS-CON-2: The intent driven MnS producer should have the capability to enable the MnS consumer to specify the conditions that trigger an intent report in the intent.

The existing **REQ-Intent_Driven_MnS_Report-1,2,3,4,5,6,7** defined in 3GPP TS 28.312 [2] also applied for implicit intent report subscription

5.3.3 Potential solutions

5.3.3.1 Potential solution #1

It proposes to add an attribute "reportRecipientAddress" in Intent <<IOC>> to represent the address of notification recipient for MnS consumer to receive the notification (i.e. notifyMOIAttributeValueChanged notification) with intent report information. If present, this attribute instructs the MnS producer to create, on behalf of the MnS consumer, a subscription for attribute value change notifications for IntentReport instance of the corresponding intent instance. Then MnS consumer does not need to request to create a NtfSubscriptionControl instance to receive the notification with intent report information.

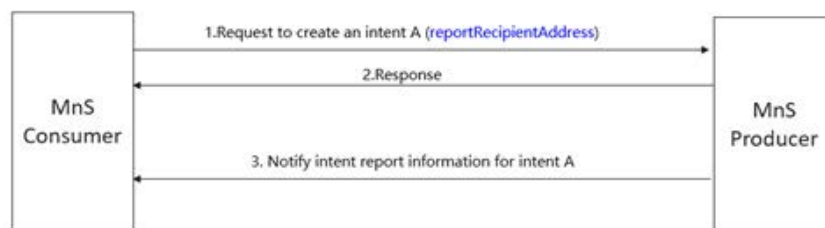


Figure 5.3.3.1-1: Implicit intent report subscription

In addition, the existing attribute "observationPeriod" in Intent <<IOC>> can be used to allow the MnS consumer who expresses the intent to configure the frequency of the intent reporting.

In case MnS consumer who expresses the intent does not want to subscribe to the intent report content, a new attribute "expectedReportTypes" can be added as an optional attribute of Intent <<IOC>> to allow the MnS consumer who expresses the intent to specify the content of the intent report. The allowed values for attribute "expectedReportType" can be intentFulfilmentReport, intentConflictReport or intentFeasibilityCheckReport.

The attribute "reportingCondition" can also be added as an optional attribute of Intent <<IOC>> to allow the MnS consumer to specify the conditions that trigger an intent report when the intent is created or modified. The definition of attribute "reportingCondition" will reuse the attribute definition for condition in 3GPP TS 28.622 [4], i.e. logical expression of one or several condition(s). Possible conditions include but are not limited to, parameter settings related with TargetFulfilmentResult.

NOTE: The condition in 3GPP TS 28.622 [4] may need to be enhanced for "reportingCondition".

5.3.3.2 Potential solution #2

The existing Intent IOC can be extended to support customized intent report.

Enhancement Aspect: Add a new IntentReportControl <<datatype>> to the Intent IOC and one Intent instance can optionally have an IntentReportControl. IntentReportControl <<datatype>> includes following attributes:

- "expectedReportTypes", represents the type of IntentReports, which can be one/any/all of "IntentFulfilmentReport", "IntentConflictReport", and "IntentFeasibilityCheckReport".
- "reportingTime", represents the specified time condition for intent reporting. For example, it can be an interval, a specific time, or a time window.
- "reportingTargets", represents the specified targets needed to be reported and corresponding conditions. This attribute can be a <<dataType>>, including targetName, targetCondition, and targetValueRange that are already defined in 3GPP TS 28.312 [2].
- "observationPeriod", represents the frequency of the intent reporting.

- "reportRecipientAddress", represent the address of notification recipient for MnS consumer.

5.3.3.3 Potential solution #3

There is no essential difference between potential solution#1 and potential solution#2, instead, they can be used to complement each other. Following is the consolidated solution.

The existing Intent IOC can be extended to support customized intent report:

Enhancement Aspect: Add a new IntentReportControl <<datatype>> to the Intent IOC and one Intent instance can optionally have an IntentReportControl. IntentReportControl <<datatype>> includes following attributes:

- "expectedReportTypes", represents the type of IntentReports, which can be one/any/all of "IntentFulfilmentReport", "IntentConflictReport", and "IntentFeasibilityCheckReport".
- "reportingConditions", represents the specified conditions for intent reporting. TimeCondition is one choice for reportingCondition. For example, TimeCondition can be an interval, a specific time, or a time window.
- "reportingTargets", represents the specified targets needed to be reported and corresponding conditions. This attribute can be a <<dataType>>, including targetName, targetCondition, and targetValueRange that are already defined in 3GPP TS 28.312.
- "observationPeriod", represents the frequency of the intent reporting.
- "reportRecipientAddress", represent the address of notification recipient for MnS consumer.

Enhancement aspect#2: Move existing attribute "observationPeriod" from Intent IOC to intentReport <<dataType>>.

5.3.4 Evaluation of potential solutions

The potential solution#3 is the consolidated solution for potential solution#1 and potential solution #2 to support implicit intent report subscription with customized requirements. It proposes to adopt the potential solution #3.

5.4 Use case #4: Intent containing an expectation to guarantee specific service characteristics

5.4.1 Description

This use case describes a scenario where the MnS consumer expresses the intent containing an expectation to guarantee specific service characteristics (such as mobile payment). The intent expectation may include area information (e.g. geographic area), time information (e.g. start time and end time), service to be guaranteed and guaranteed level (such as bit rate, priority of stream, etc.).

MnS producer notifies MnS consumer about the fulfilment information of the intent containing an expectation for guarantee of specific service characteristics.

5.4.2 Potential requirements

REQ-Intent_Guar_Ser-CON-1: The intent driven MnS producer should have capability enabling authorized MnS consumer to express intent containing an expectation to guarantee specific service characteristics to MnS producer.

REQ-Intent_Guar_Ser-CON-2: The intent driven MnS producer should have capability enabling authorized MnS consumer to obtain intent report information (including fulfilment information) for intent containing an expectation to guarantee specific services.

5.5 Use case #5: Improve intent life cycle documentation

5.5.1 Description

In clause B.1 of 3GPP TS 28.312 [2], it is stated that the intent lifecycle consists of the following phases: Detection, Investigation, Definition, Distribution, and Operation, and the processing flow of each phase is described in detail. However, for the existing processes of each phase, further enhancements can be made from several aspects, including but not limited to the following:

- In the investigation phase, no solution is provided for when the intent content (a list of expectations) is not feasible. This part needs further enhancement to identify subsequent steps when the intent is not feasible, such as re-evaluation, or adjusting intent expectations.

5.5.2 Potential Solution

A potential update to the description of the Investigation Phase in 3GPP TS 28.312 [2] "B.1 Intent Life Cycle Management" is shown below:

Investigation:

In the investigation phase, the MnS Consumer finds out what intent content (a list of expectations) are feasible before expressing the intent expectations to be fulfilled to the MnS producer. This has two aspects:

- Intent handling capability obtaining. MnS consumer needs to find right MnS producer that have the right domain responsibilities and support the intent expectations the MnS consumer wants to define.
- Intent pre-evaluation. MnS consumer needs to find out if the wanted intent expectations are realistic (i.e. suitable value of the wanted intent expectations and if these wanted intent expectations are feasible). This means, if the MnS producer would be able to successfully reach the wanted expectations. Typically, the feasibility of intent expectations is done through a guided negotiation process between the MnS Producer and MnS Consumer. The MnS Consumer can explore what the handling results of wanted intent expectations would be, what would be the best result the MnS producer can achieve.

5.5.3 Evaluation of potential solutions

Only one potential solution is identified, which is feasible.

5.6 Use case #6: Investigate potential impacts to support natural language intents translation

5.6.1 Description

Intent management aims to provide more intelligent services by understanding and implementing users' intents. In 3GPP TS 28.312 [2], the primary focus is on intent, where intent models are used. The formal intent and intent report model are defined in TS 28.312 [2] for intent driven MnS to enable that the intent should be interpreted by the machine without any ambiguity. However, with the advancement of technologies such as large language models, intents expressed in natural language are gradually becoming the focal point of research and application in intent management. There are some use cases where the use of natural language for intent expression would be preferred. For example, on the human-machine interface presenting and expressing intent using natural language can lead to a more intuitive experience for human users. One Example of natural language RAN ES intent can be "Reduce 10% RAN energy consumption without impact on user experience for Region X"

Some SDOs have also conducted research on intents described in natural language. In TM Forum IG1253 [5], it is mentioned that the intent interpreter can be used to handle intents described in natural language, and the intent interpreter assumes the role of the intent owner for the formal intent. In ETSI GR ZSM 011 [6], it is mentioned that through intent translation, the received natural language intent is mapped to the intent model, and the translation may be based on rules or AI/ML.

Regarding the existing intent management in 3GPP TS 28.312 [2], if an intent interpreter is introduced to process intents described in natural language, it is necessary to clarify its position within the existing intent management framework, especially its relationship with the MnS consumer. Additionally, further exploration is needed to assess the impact on the existing intent models and procedures for intent management.

5.6.2 Evaluation of potential solutions

The use case and corresponding solution is not ready for normative work.

5.7 Use case #7: Enablers for Intent Fulfilment

5.7.1 Description

The Issue#4.6: Intent-driven Closed Loop control and Issue#4.8: Enablers for Intent Fulfilment is investigated in 3GPP TR 28.912 [7], which describes MnS producer decides the enabler (e.g. closed loop control, MDA MnFs, SON Functions) for intent fulfilment and provide such enabler information to MnS consumer.

An intent focuses more on describing the "What" needs to be achieved but less on "How" that outcomes should be achieved. In this way, MnS producer (intent handling function) takes the important network management control, however, MnS consumer may need to know some information of how MnS producer fulfil the intent to be sure that MnS producer works in an expected manner. For example, for a radio network optimization intent, MnS consumer may need to know:

- Which base stations are updated to fulfil the intent.

Based on above analysis, it is important to introduce the MnS capability to enable MnS consumer to obtain the information of enablers for intent fulfilment to be sure that MnS producer works in an expected manner.

5.7.2 Potential requirements

REQ-Intent_Driven_MnS-CON-1: The intent driven MnS producer should have the capability to enable the MnS consumer to request to obtain the information of enablers for intent fulfilment.

5.7.3 Potential solutions

5.7.3.1 Potential solution #1

Following are the proposed solutions to support above enhancements based on existing Intent IOC and IntentReport IOC in 3GPP TS 28.312 [2].

Enhancement Aspect1: Add an optional attribute "enablerRequest" in Intent IOC, which describe the MnS consumer requirements for the information of enablers for intent fulfilment. If the value of this attribute is TRUE, MnS producer needs to provide the information of enablers for intent fulfilment. The default value is FALSE.

Enhancement Aspect2: Add an attribute "enablerInfo" in IntentFulfilmentReport <<dataType>>, which represents the information of enablers for intent fulfilment. The attribute "enablerInfo" is a <<dataType>> which includes the following information:

- List of NF/NE types.
- List of DN of NF/NE instances.

5.7.4 Evaluation of potential solutions

Only one potential solution is identified, which is feasible.

5.8 Use case #8: Network support for UAV pre-flight preparation

See clause 5.2.

5.9 Use case #9: Enhancement of Radio Network Expectation to support MOCN

See clause 5.2.

5.10 Use case #10: Improve intent handling state management

5.10.1 Description

3GPP TS 28.312 [2] studies the `intentAdminState`, `fulfilmentStatus` and states related to `NOT_FULFILLED` status (i.e. `notFulfilledState`). In clause 5.3.2 of 3GPP TS 28.312 [2], the state transitions have been described in Figure 5.3.2.1-1. However, the figure only describes the states related to `fulfilmentStatus`, and does not clarify the relation between the `intentAdminState` and `fulfilmentStatus`. Additionally, it isn't clear that the state diagram and state transition events are combined in one figure. Thus, further enhancements can be made in intent handling state management from several aspects, including but not limited to the following:

- Addressing the issue of the unclear combination of the state diagram and state transition events in one figure.
- Clarify the issues with the state transition event, e.g. the relationship between `intentAdminState` and `fulfilmentStatus`.

5.10.2 Potential solutions

It proposes to add intent handling state diagram based on Figure 5.3.2.1-1: State transitions and reporting events for Intents delivered for fulfilment in 3GPP TS 28.312 [2], and intent handling state transition table to achieve the above enhancements. Figure 5.10.2-1 shows the intent handling state diagram, where the number in the Figure identify the state changes. The explanations for the state changes are described in Table 5.10.2.1.

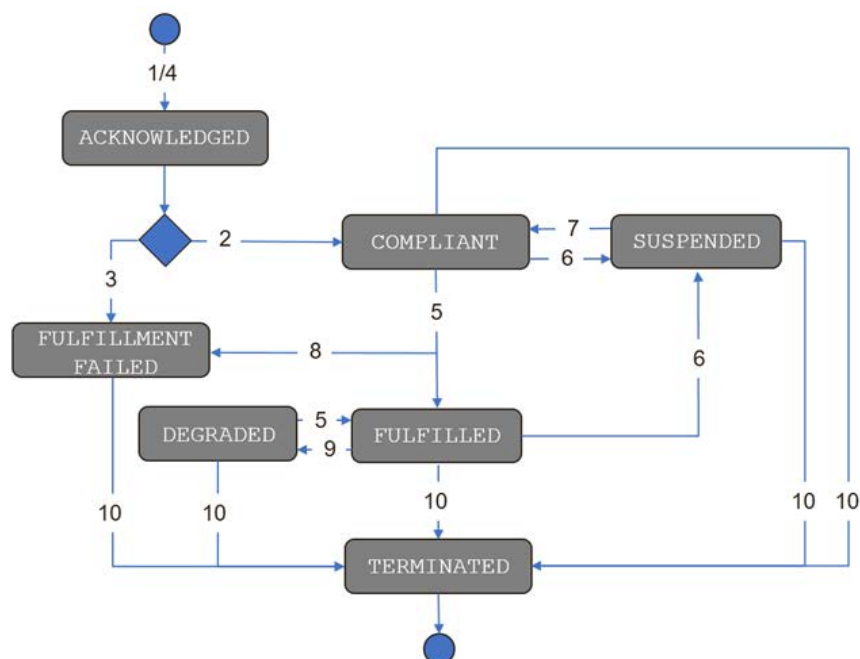


Figure 5.10.2-1: Intent handling state diagram

The transition numbers in the first column represent the state changes in Figure 5.10.2.1. The interactions specified under the column "The state transition events" of Table 5.10.2-1 should be present for the state transition.

Table 5.10.2-1: The intent handling state transition table

Transition number	The state transition events	State
1	The MnS producer creates the intent instances based on the received intent creation request.	ACKNOWLEDGED
2	The MnS Producer performs the feasibility check of the intent instance, and the feasibility check result is 'feasible'.	COMPLIANT
3	The MnS Producer performs the feasibility check of the intent instance, and the feasibility check result is 'infeasible'	FULFILLMENT_FAILED
4	The MnS producer modifies the intent instances based on the received intent modification request. Correspondingly, the state transitions from COMPLIANT, SUSPENDED, FULFILLED, FULFILLMENT_FAILED or DEGRADED to ACKNOWLEDGED.	ACKNOWLEDGED
5	The MnS producer considers that the intent has been fulfilled.	FULFILLED
6	MnS producer configure attribute <code>intentAdminState</code> with the value "DEACTIVATED"	SUSPENDED
7	MnS producer configure attribute <code>intentAdminState</code> with the value "ACTIVATED"	COMPLIANT
8	The MnS producer determines that they cannot do anything to fulfil the intent.	FULFILLMENT_FAILED
9	The MnS producer previously considers that the intent was fulfilled but after a period of observation it is found not be meeting the initially stated requirements.	DEGRADED
10	The MnS producer deletes the intent instances based on the received intent deletion request.	TERMINATED

5.10.3 Evaluation of potential solutions

Only one potential solution is identified, which is feasible.

5.11 Use case #11: Enhancement for Intent handling capability

5.11.1 Description

5.11.1.1 Capability exposure

3GPP TS 28.312 [2] supports intent handling and exposure of intent handling capability as a list of supported `expectationTargets`.

The intent handling capability does not describe the supported value ranges for the targets or the sets of targets that are supported. For instance, the intent driven MnS producer for service management intent may want to expose the description of services that they can offer. This means the intent driven MnS producer exposes the supported intents or intent expectations having a specific set of features and a specific set of values for those features as illustrated by Table 5.11.1-1. The IDMS producer should support expose of such capabilities.

Object Type					RAN or Core network services				
Feature	Units	Value Options							
End-to-end latency	ms	1.5	2	2	5	10	25	50	100
Jitter	ms	0.05	0.05	0.1	1	2	5	10	20
Survival Time	ms	0	1	2	5	10	25	50	100
Availability		99%	99.9%	99.9%	99.995%	99.999%	99.9995%	99.9999%	99.9999%
Reliability		99%	99.9%	99.9%	99.995%	99.999%	99.9995%	99.9999%	99.9999%
End user Data rate	≥ x Mbps	0.1	0.2	0.5	1	2	5	10	20
Payload	≈. x Bytes	1	2	5	10	20	100	500	1000
Traffic density	Gbps/km ²	1	2	5	10	20	50	100	1000
Connection density	'000/km ²	1	10	1	5	10	20	50	100
Service area size	A x B km	1 x 1	10 x 10	1 x 100	10 x 100	1 x 1	10 x 10	50 x 50	100 x 100
Policies	Policy 1	Policy 1 value 1		Policy 1 value 2		...		...	
	Policy 2	Policy 2 value 1		Policy 2 value 2		...		...	
	:	:		:		...		...	

Table 5.11.1-1: An example of a service offer description indicating the possible characteristics of services that can be exposed via an intent handling capability as the service characteristic offered by an intent driven MnS producer for service management intents.

5.11.1.2 Describe alternative expectations

The IDMS may be used by the RAN or Core network service management MnS producer to enable the design of a RAN or Core network service between the MnS producer and the MnS consumer.

Based on the extended content of intent handling capability as described in 5.11.1.1, the RAN or Core network service MnS consumer can generate an artifact, say called a service-offer description that describes the different candidate characteristics of the desired RAN service from the MnS consumer's point of view. The MnS consumer provides a service-offer description to the service management MnS producer for validation. The service-offer description may be viewed as a RAN service management intent that contains a list of candidate intent expectations, i.e., the expectations are candidates that may be separately submitted by the MnS consumer for fulfilment.

On receiving the service-offer description the RAN or Core network service Management MnS producer validates the service-offer description and confirms to what extent the RAN or Core network service intent as described by the service-offer description can be supported. For that, the RAN or Core network service management MnS producer returns the service-offer description but indicates only the supported combinations of RAN or Core network service features and values with contexts (e.g. policies and conditions) under which the service may be offered.

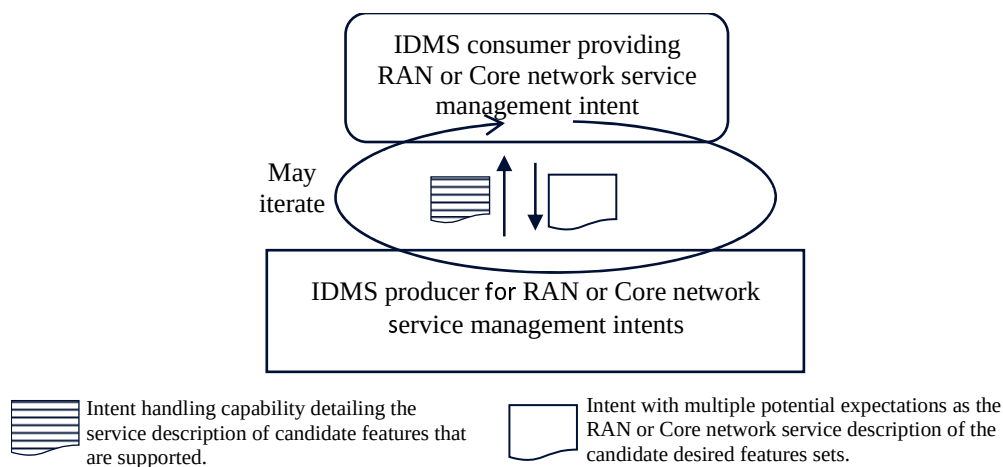


Figure 5.11.1.1-1: Example interaction between an MnS producer and MnS consumer on the exposure of capabilities for service management intents

5.11.2 Potential requirements

INT_NEGOT_REQ 1: The intent driven MnS producer should support a capability to provide a description of the supported scenario specific intents to the authorized MnS consumer.

INT_NEGOT_REQ 2: The MnS producer should support a capability enabling an MnS consumer to list the set of potential alternative expectations that the MnS consumer would like to be evaluated for whether it is feasible or fulfillable.

5.11.3 Potential solutions

5.11.3.1 Solution for MnS consumer to indicate alternatives

Extend the intent IOC to allow for `expectationSelectivity` when the intent is being provided for feasibility checking. This enables a consumer to submit a set of candidate expectations to get feedback on which expectations are supported or not. For example, a service management design function can submit the set of potential RAN service descriptions to see which set can be supported by the RAN service intent handler.

5.11.3.2 Solution for MnS producer to indicate supported targets

5.11.3.2.1 Introduce in the `IntentHandlingCapability` <<dataType>>:

- an attribute (and corresponding data Type) representing the details on information about `expectationTargets` that are supported by the intent handler. The information indicates the supported `expectationTargets` as:
 - o A list of names of supported expectation targets.
 - o A list of names of supported expectation targets and the value ranges for which they are supported.
 - o A set expressing the combination of expectation targets and value ranges that can be jointly supported.

NOTE: Needs to further verify whether above intent handling capabilities are static ((if they can change on the producer side over time) in the normative phase.

Potential updates to 3GPP TS 28.312 [2] are show below, using clause numbers and headers from it with modified text in **bold**.

5.11.3.2.1.1 To be revised: `IntentHandlingCapability` <<dataType>>

"6.2.1.3.11 `IntentHandlingCapability` <<dataType>>

The `IntentHandlingCapability` includes the following attributes (new attributes are in bold).

Attribute Name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifyable
<code>intentHandlingCapabilityId</code>	<i>M</i>	<i>T</i>	<i>F</i>	<i>F</i>	<i>T</i>
<code>supportedExpectationObjectType</code>	<i>M</i>	<i>T</i>	<i>F</i>	<i>F</i>	<i>T</i>
<code>supportedExpectationTargetName</code>	<i>M</i>	<i>F</i>	<i>F</i>	<i>F</i>	<i>F</i>
<code>supportedExpectationTargetInfo</code>	<i>M</i>	<i>T</i>	<i>F</i>	<i>F</i>	<i>T</i>

"

5.11.3.2.1.2 To be added: supportedExpectationTargetInfo <<dataType>>

"6.2.1.3.x.1 Definition

The *supportedExpectationTargetInfo* indicates the detailed information about what the intent driven MnS producer supports for a given *supportedExpectationObjectType*. It allows the intent driven MnS producer to indicate the support in any one of the three ways below as illustrated by Figure a6.2.1.3.x.1-1:

- 1) As a list of names of supported expectation targets.
- 2) As a list of names of supported expectation targets and the value ranges within which they are supported.
- 3) As a set expressing the combination of expectation targets and value ranges that can be jointly supported.

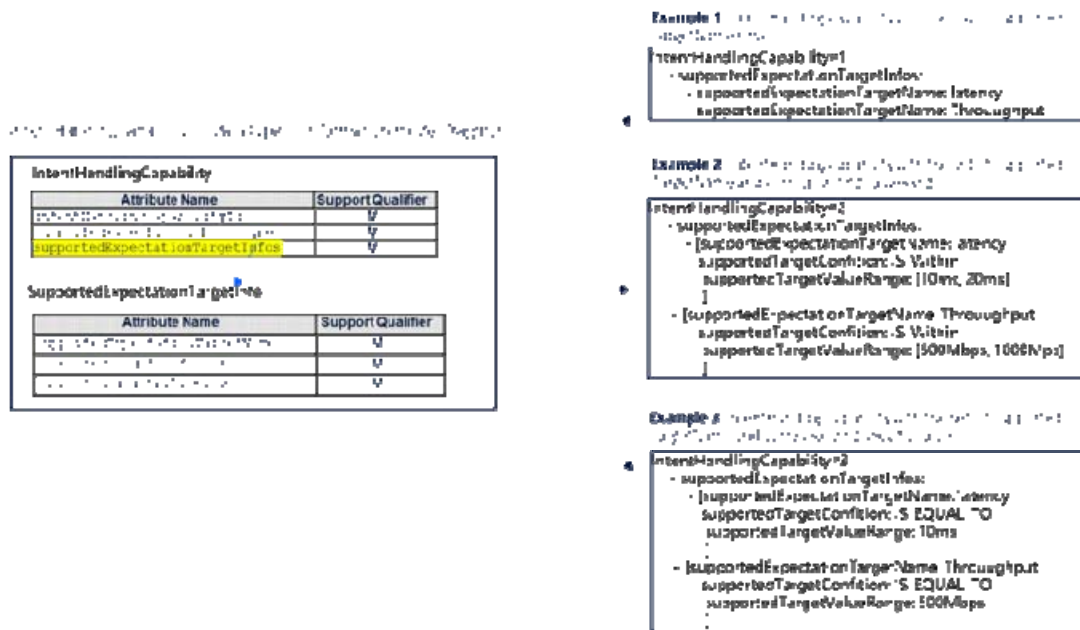


Figure a6.2.1.3.x.1-1: MnS producer can express supported capabilities in any of the 3 possible ways.

6.2.1.3.x.2 Attributes

The *supportedExpectationTargetInfo* includes the following attributes.

Attribute Name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifiable
supportedTargetName	M	T	F	F	T
supportedTargetCondition	O	T	F	F	T
SupportedTargetValueRange	O	T	F	F	T

Name	Description	
<i>supportedExpectationTargetInfo</i>	<i>It describes the supported expectation targets for the supported expectation object type.</i>	type: <i>SupportedExpectationTargetInfo</i> multiplicity: 1 ... * isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
<i>supportedExpectationTargetName</i>	<i>It indicates the name or identifier of the supported expectation targets for the supported expectation object type.</i> <i>allowedValues: depends on ExpectationObject in the IntentExpectation</i>	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: True
<i>supportedTargetCondition</i>	<i>It expresses the limits within which the supportedExpectationTargetName shall be supported.</i> <i>allowedValues: targetCondition defined in clause 6.2.1.3.3</i>	type: Enum multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: "IS_EQUAL_TO" isNullable: False
<i>SupportedTargetValueRange</i>	<i>It describes the range of values that applicable to the supportedExpectationTargetName and the <i>supportedTargetCondition</i>.</i> <i>allowedValues: targetValueRange defined in clause 6.2.1.3.3</i>	type: ValueRangeType multiplicity: 1..* isOrdered: False isUnique: True defaultValue: None isNullable: True

To be added: Attribute definitions"

5.11.4 Evaluation of potential solutions

The potential solution described in clause 5.11.3 is a fully NRM-based approach that extends the existing NRM fragments to support full exposure of Intent handling capability. The solution in clause 5.11.3.2 enables the MnS producer to provide to the MnS consumer a description of the supported scenario specific intents, e.g. a service offer description that indicates the possible characteristics of services that are supported by the RAN services intent handler. The solution in clause 5.11.3.1 enables an MnS consumer to provide a listing the set of potential alternative expectations that the MnS consumer would like to be evaluated for whether it is feasible or fulfillable, e.g. it enables a service designer to express a service description containing the multiple alternative RAN or Core network service features sets that the service designer would want to be considered to be offered. Through a feasibility checking of the intent with those different alternatives, the MnS producer provides information on which alternatives (intent expectation) are feasible and can thus be supported.

The enhancements are small, and their implementation is straightforward. Therefore, the solution described in clause 5.11.3 is a feasible solution for the full exposure of Intent handling capability.

5.12 Use case #12: Intent degradation based on expectation preference

5.12.1 Description

In 3GPP TS 28.312 [2] Rel-18, procedures for intent conflict resolution are introduced, where the MnS consumer needs to modify its intent based on received intent conflict reports. Intent conflict reports identify the conflicting intent, conflicting expectation, conflicting target, and corresponding recommended solution. However, allowed values for recommended solutions are "modify" or "delete", which means the MnS consumer may need to modify the intent many times without any assistance. It defeats the purpose of introducing IDMS, relieving the burden of the consumer.

Sometimes an MnS consumer may express multiple intent expectations with different preferences for the same requirement. The MnS producer should give priority to satisfying the IntentExpectation(s) with higher preference. For example, the MnS consumer proposes requirements that can be translated to the following expectation:

- IntentExpectation1, preference on E2E latency.
- IntentExpectation2, more preference on air latency.
- IntentExpectation3, minimum UL/DL UE throughput larger than 50 Mbps.

The MnS consumer requires the producer to fulfil all expectations above but has extra preference on latency feature. The consumer prefers lower air latency as indicated in the IntentExpectation2 and will be happy if the producer can guarantee IntentExpectation2. Such information can be utilized by the MnS producer to resolve intent degradation automatically.

EXAMPLE: The MnS producer can degrade the intent automatically by just satisfying IntentExpectation1 and IntentExpectation3 when IntentExpectation2 cannot be satisfied.

Based on the analysis above, it is significant to allow the MnS consumer to express its preference in an intent. Then, the MnS producer can leverage such preference information to address possible conflict.

5.12.2 Potential requirements

REQ-ExpectationPreference_01: The intent driven MnS producer should have the capability to enable the MnS Consumer to express its preference on expectation for fulfilment in an intent.

5.12.3 Potential solutions

5.12.3.1 Potential solution #1

This solution proposes to enhance the existing Intent IOC defined in 3GPP TS 28.312 [2] to represent the Consumer's preference on expectations. Following are the proposed enhancements.

Enhancement on IntentExpectation <<dataType>>: Introduce the following attribute:

- PreferenceWeight, representing the Consumer's preference weight on each preferred intentExpectation.

Enhancement on ExpectationTarget <<dataType>>: Introduce the following attribute:

- PreferenceWeight, representing the Consumer's preference weight on each preferred expectationTarget.

NOTE: How to report the information that the weight is leveraged by the producer to the consumer is not addressed in the present document.

5.12.4 Evaluation of potential solutions

Potential solution#1 can be used to support Intent degradation based on expectation preference, which is feasible.

5.13 Use case #13: Utility function support

5.13.1 Description

For some intents, it may not be obvious to the MnS producer how to select from multiple available solutions for fulfilling an intent. In other cases, conflicts may arise for an intent, for which the MnS producer may require extra information from the MnS consumer to decide how to resolve the conflicts. Also, the MnS consumer may not be satisfied with the fulfillment achieved by the MnS producer, for which extra information provided by the MnS consumer can assist the MnS producer in providing better fulfillment. The extra information indicates the preference for the expectation targets. It may be in the form of an Intent Utility Function, which enables the MnS consumer to express the relative value of their expectation targets to assist the IDMS producer(s) in fulfilling their intents in the most acceptable manner, or it may be an index that provides an indicator to the MnS Producer of how satisfied it is with the intent fulfilment, e.g. the utility corresponding to a specific target value.

Intent Utility Function defines a method by which consumers can express the relative value of an intent's expectations to assist the IDMS producer(s) in fulfilling their intents in the most acceptable manner.

Intent utility functions are mathematical expressions that quantify the satisfaction or utility derived from the various degrees of fulfilment. The basic components of which include:

- Variables: to quantify specific aspects of the fulfilment, e.g. network performance.
- Weights: to define the relative importance of each variable, e.g. for network performance a variable representing low latency might be assigned higher weight than throughput.
- Function: the mathematical functions to be applied to the variables, e.g. linear, logarithmic, polynomial applied to the variables.
- Result: the output of the function. The value of which represents the utility level achieved, i.e. the satisfaction of the current fulfilment based on the acceptability of potential outcomes defined by the consumer.

Intent producer(s) can use such utility information to assess the acceptability of potential outcomes, in addition to information such as resource availability and performance targets. Utility functions may be defined by the consumer and provided as part of the intent itself, i.e. the function is defined as part of the intent. A consumer may also specify that an existing (i.e. predefined) utility function is used. Predefined utility functions may be vendor specified and/or specified by the consumer.

5.13.2 Potential requirements

REQ-Intent_Util-1: The intent driven MnS producer should have the capability to advertise its support for allowing MnS Consumers to express relative value.

REQ-Intent_Util-2: The intent driven MnS producer should have the capability to advertise the methods by which an MnS Consumer can express relative value.

REQ-Intent_Util-3: The intent driven MnS Producer should have the capability to allow an MnS consumer to express the relative value of its requirements within an intent.

REQ-Intent_Util-4: The intent driven MnS producer should have the capability to report potential outcomes, with the impacts to the related ExpectationObject, including consideration for MnS Consumer relative value, when applicable to an intent.

REQ-Intent_Util-5: The intent driven MnS producer should allow a consumer to specify the relative value as part of an intent.

REQ-Intent_Util-6: The intent driven MnS producer should allow a consumer to apply an existing relative value, defined external to the intent.

A key consideration for potential solutions is the extent to which utility functions must be modelled in the solution to support the above requirements. The flexibility in defining the utility function(s) themselves, the granularity of applying them to different parts of the intent model, and the level of reporting required all affect the potential solutions.

5.13.3 Potential solutions

5.13.3.1 Potential solution #1 - Utility function support

This solution proposes support for utility function(s) be added in a relatively simple manner. This is via new attributes added to the intent common model to express intent utility and report the impact of utility on intent fulfilment.

The goal of this solution is simple implementation and vendor flexibility. The new attributes are defined simply as strings and are left to vendor-definition.

A new attribute `utilityFunction` is added to allow consumers to express relative business value within intents.

Utility functions can be defined at various levels within the intent:

- For the entire intent or a set of expectations in the intent based on criteria. The `Intent` IOC is updated to support such utility functions.
- For a specific expectation, the `IntentExpectation` datatype is updated to support such utility functions.

A method to report the impact of utility function(s) on the fulfilment is required. The `ExpectationFulfillmentResult` is updated to allowing reporting of the evaluation of the utility function(s).

Potential updates to 3GPP TS 28.312 [2] are show below, using clause numbers and headers from it with modified text in **bold**:

"6.2.1.2 Class definition

6.2.1.2.1 *Intent* <<InformationObjectClass>>

6.2.1.2.1.1 Definition

This IOC represents the properties of an Intent driven management information between MnS consumer and MnS producer.

*The **Intent** IOC contains one or multiple **IntentExpectation**(s) which includes MnS consumer's requirements, goals and contexts given to a 3GPP system.*

*The **Intent** IOC also contains **intentAdminState** to support intent lifecycle management. In case MnS consumer wants to suspend an intent, MnS consumer can request MnS producer to configure attribute **intentAdminState** with the value "DEACTIVATED". A suspended intent means this intent is not considered for fulfilment. In case MnS consumer wants to resume an intent on the MnS producer side when the intent is suspended, MnS consumer can request MnS producer to configure attribute **intentAdminState** with the value "ACTIVATED".*

The attribute "observationPeriod" indicates the time period for which the fulfilment process is observed and at the end of which the fulfilmentInfo for corresponding ExpectationTargets, IntentExpectations and Intent is updated. The observation period can be set by the MnS consumer or by the MnS producer if the MnS consumer does not provide a value.

*The **Intent** IOC includes the attribute **objectClass** and **objectInstance** from the TOP IOC. The value of attribute **objectClass** is "Intent" and the value of attribute **objectInstance** is the DN of the instance of **Intent** IOC.*

*The **Intent** IOC includes **contextSelectivity** respectively used to define how to select among the stated **intentContexts***

The `utilityFunction` is used to specify a utility function for the Intent.

The `utilityFunctionRef` is used to reference a utility function for the Intent, which is specified elsewhere.

6.2.1.2.1.2 Attributes

*The **Intent** IOC includes attributes inherited from Top IOC (defined in 3GPP TS 28.622) and the following attributes.*

Table 6.2.1.2.1.2-1

Attribute Name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifiable
<i>intentExpectations</i>	<i>M</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
<i>userLabel</i>	<i>M</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
<i>contextSelectivity</i>	<i>O</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
<i>intentContexts</i>	<i>O</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
<i>observationPeriod</i>	<i>O</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
<i>intentPriority</i>	<i>O</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>T</i>
<i>intentAdminState</i>	<i>CM</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
<i>intentPreemptionCapability</i>	<i>CM</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
<i>utilityFunction</i>	<i>CM</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
<i>utilityFunctionRef</i>	<i>CM</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
Attribute related roles					
<i>intentReportReference</i>	<i>M</i>	<i>T</i>	<i>F</i>	<i>F</i>	<i>F</i>

6.2.1.2.1.3 Attribute constraints

Name	Definition
<i>intentAdminState</i> Support Qualifier	Condition: MnS consumer-suspension mechanism is supported.
<i>intentPreemptionCapability</i> Support Qualifier	Condition: The pre-emption mechanism is supported.
<i>utilityFunction</i>	Condition: Intent utility function definition capability is supported.
<i>utilityFunctionRef</i>	Condition: Intent utility function reference capability is supported.

6.2.1.2.1.4 Notifications

The common notifications defined in clause 6.2.1.5 are valid for this IOC. In addition, the following set of notifications is also valid.

Name	S	Notes
<i>notifyMOIChanges</i>	<i>M</i>	--

6.2.1.3 DataType definition

6.2.1.3.1 IntentExpectation <<dataType>>

6.2.1.3.1.1 Definition

IntentExpectation <<dataType>> represents MnS consumer's requirements, goals and contexts given to a 3GPP system.

The *IntentExpectation* <<dataType>> includes *contextSelectivity* used to define how to select among the stated *expectationContexts*.

The *IntentExpectation* <<dataType>> includes *utilityFunction* used to optionally define the business value of the stated *expectationTargets*.

6.2.1.3.1.2 Attributes

The *IntentExpectation* includes the following attributes.

Table 6.2.1.3.1.2-1

Attribute Name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifiable
<i>expectationId</i>	<i>M</i>	<i>T</i>	<i>T</i>	<i>T</i>	<i>T</i>
<i>expectationVerb</i>	<i>O</i>	<i>T</i>	<i>T</i>	<i>T</i>	<i>F</i>
<i>expectationObject</i>	<i>M</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
<i>expectationTargets</i>	<i>M</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
<i>contextSelectivity</i>	<i>O</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
<i>utilityFunction</i>	<i>O</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
<i>expectationContexts</i>	<i>O</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>
NOTE: The scenariospecific IntentExpectations in clause 6.2.2 are defined utilizing the constructs of this generic IntentExpectation <<dataType>>.					

6.2.1.3.1.3Attribute constraints

None.

6.2.1.3.7 ExpectationFulfilmentResult <<dataType>>

6.2.1.3.7.1Definition

ExpectationFulfilmentResult <<dataType>> includes the *expectationFulfilmentInfo* and *targetFulfilmentResults* for each *IntentExpectation*.

The *expectationFulfilmentInfo* describes status of fulfilment of an *intentExpectation* and the related reasons for the infeasible status.

The *utilityFunctionResult* describes the impact of the utility function on the fulfilment.

6.2.1.3.7.2 Attributes

The *ExpectationFulfilmentResult* includes the following attributes.

Table 6.2.1.3.7.2-1

Attribute Name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifiable
<i>expectationId</i>	<i>M</i>	<i>T</i>	<i>F</i>	<i>T</i>	<i>T</i>
<i>expectationFulfilmentInfo</i>	<i>M</i>	<i>T</i>	<i>F</i>	<i>F</i>	<i>T</i>
<i>targetFulfilmentResults</i>	<i>O</i>	<i>T</i>	<i>F</i>	<i>F</i>	<i>T</i>
<i>utilityFunctionResult</i>	<i>O</i>	<i>T</i>	<i>T</i>	<i>F</i>	<i>F</i>

6.2.1.3.7.3Attribute constraints

None.

6.2.1.4Attribute definition

Table 6.2.1.4-1

Attribute Name	Documentation and Allowed Values	Properties
<i>utilityFunction</i>	Logical expression of a utility function. The syntax and capabilities of <i>utilityFunction</i> are vendor specified. An empty string is not allowed. allowedValues: N/A	type: String multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

Attribute Name	Documentation and Allowed Values	Properties
<i>utilityFunctionResult</i>	The result of the evaluation of a utility function. The syntax and values are vendor specified. allowedValues: Not Applicable	type: String multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

"

5.13.3.2 Potential solution #2 - Utility function support

The proposal enhances solution #1 by defining specific aspects of the utility function which the consumer can express as input.

The goals with this approach are to better support multi-vendor interoperability and interaction with intent handling functions in other non-3gpp management domains.

NOTE: For this solution the detailed definitions of the arguments, operations, and functions are not included in the input.

Potential updates to 3GPP TS 28.312 [2] are show below, using clause numbers and headers from it with modified text in **bold**:

"6.2.1.3.x *UtilityFunction* <<dataType>>

6.2.1.3.x.1 Definition

The *UtilityFunction* <<IOC>> represents a utility function instance.

This representation includes attributes to support a utility function, result, and/or error information. The function is a series of input arguments and operations defined as ordered lists.

The attribute *functionDefinitionInput* allows the consumer to select the utility function to be used (e.g. function name, function definition) as supported by the vendor. The semantics of *functionDefinition* are vendor defined.

The attributes *argumentName* and *argumentWeight* can be used by the consumer to indicate relative weights of specified arguments to be used in the utility function calculation.

The attribute *function* is used by the producer to provide the definition of the utility function based on the inputs. E.g. the function defined/selected by consumer.

The attribute *error* is used by the producer to indicate error(s) with the definition of the utility function. E.g. invalid specification in the *functionDefinitionInput*.

6.2.1.3.x.2 Attributes

UtilityFunction includes the following attributes:

Table 6.2.1.3.4.2-1

Attribute Name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifiable
<i>argumentName</i>	O	T	T	F	F
<i>argumentWeight</i>	O	T	T	F	F
<i>function</i>	O	T	F	F	F
<i>error</i>	O	T	F	F	F
<i>functionDefinitionInput</i>	O	T	T	F	F

NOTE: Whether to add additional attributes to allow consumer to provide producer additional utility information is not addressed in this document.

6.2.1.3.x.3 Attribute constraints

None.

6.2.1.4 Attribute definition

Table 6.2.1.4-1

Attribute Name	Documentation and Allowed Values	Properties
<i>argumentName</i>	An ordered list which contains one entry per argument. <i>allowedValues</i> : a defined expectationName.targetName in the intent <i>NOTE</i> : This definition has a dependency on the scenario specific expectationtargets and expectationcontexts in 3GPP TS 28.312 [2], clause 6.2.2, which will need to be referenced in the functions.	<i>type</i> : String <i>multiplicity</i> : 1..* <i>isOrdered</i> : True <i>isUnique</i> : N/A <i>defaultValue</i> : None <i>isNullable</i> : False
<i>argumentWeight</i>	Relative weight of the associated argument. Default value is 1. <i>allowedValues</i> : value between 0 and 1.	<i>type</i> : Real <i>multiplicity</i> : 1..* <i>isOrdered</i> : True <i>isUnique</i> : N/A <i>defaultValue</i> : 1 <i>isNullable</i> : False
<i>function</i>	The function to be used to calculate the utility of the intent fulfilment. E.g. may comprise the combination of the specified utility function input, plus any addition arguments (e.g. weights).expressed as a mathematical function. E.g. may indicate the name of the specified utility function to be used	<i>type</i> : String <i>multiplicity</i> : 1..* <i>isOrdered</i> : True <i>isUnique</i> : N/A <i>defaultValue</i> : None <i>isNullable</i> : False
<i>error</i>	Error string. <i>allowedValues</i> : N/A	<i>type</i> : String <i>multiplicity</i> : 0..1 <i>isOrdered</i> : False <i>isUnique</i> : N/A <i>defaultValue</i> : None <i>isNullable</i> : False
<i>functionDefinitionInput</i>	String representation of a utility function. The syntax and evaluation of the string are vendor defined. An empty string is not allowed. <i>allowedValues</i> : N/A	<i>type</i> : String <i>multiplicity</i> : 0..1 <i>isOrdered</i> : N/A <i>isUnique</i> : N/A <i>defaultValue</i> : None <i>isNullable</i> : False

"

5.13.3.3 Potential solution #3 - Utility function support

Intent Handlers, including an SA5 IDMS Producer, deployed in a multi-domain deployment with domain specific Intent Handlers would benefit from a consistent format for expressing utility functions. For example, TMF defined intents available in the deployment defined in 3GPP TS 28.312 [2], F.3 "Management interactions for Intent-CSC between CSC and CSP" would define utility function in RDF.

This proposed solution emphasizes close alignment with the functional ontology defined in TM Forum TR2911 [13].

This could be achieved by modifying potential solution #2 to align with functional definitions in TM Forum TR292H [14], clause 11. Some attributes (e.g. arityMin, arityMax) are excluded as those are not required.

In addition to the attributes defining the function, the attribute `sourceDefinition` maintains the original input in its native format.

NOTE: This approach could be further defined to support additional functions such as those defined in TM Forum TR292H [14] and TM Forum TR292C [15]. The mapping of expectations and targets current defined in 3GPP TS 28.312 [2], Annex C may also require update to better align with latest TMF spec versions and to ensure it is sufficient for the argument/property mappings.

Potential updates to 3GPP TS 28.312 [2] are show below, using clause numbers and headers from it with modified text in **bold**:

"6.2.1.3.x *UtilityFunction* <<dataType>>

6.2.1.3.x.1 *Definition*

The *UtilityFunction* <<dataType>> represents a utility function.

This representation includes attributes to support a utility function, result, and/or error information. The attribute *nativeRepresentation* provides the utility function in its native format.

6.2.1.3.x.2 *Attributes*

UtilityFunction includes the following attributes:

Table 6.2.1.3.4.2-1

Attribute Name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifiable
<i>argumentNames</i>	O	T	T	F	F
<i>argumentTypes</i>	O	T	T	F	F
<i>Error</i>	O	T	F	F	F
<i>operation</i>	O	T	F	F	F
<i>function</i>	O	T	F	F	F
<i>Result</i>	O	T	F	F	F
<i>resultType</i>	O	T	F	F	F
<i>nativeRepresentation</i>	M	T	T	F	F
<i>nativeFormat</i>	M	T	T	F	F

6.2.1.3.x.3 *Attribute constraints*

None.

6.2.1.4 *Attribute definition*

Table 6.2.1.4-1

Attribute Name	Documentation and Allowed Values	Properties
<i>utilityFunction</i>	Logical expression of a utility function. <i>allowedValues</i> : N/A	<i>type</i> : <i>UtilityFunction</i> <i>multiplicity</i> : 0..* <i>isOrdered</i> : N/A <i>isUnique</i> : N/A <i>defaultValue</i> : None <i>isNullable</i> : False
<i>argumentNames</i>	An ordered list which contains the function arguments. <i>allowedValues</i> : a defined <i>expectationName.targetName</i> in the intent NOTE: This definition has a dependency on the scenario specific <i>expectationTargets</i> and <i>expectationContexts</i> in 3GPP TS 28.312 [2], clause 6.2.2, which will need to be referenced in the functions.	<i>type</i> : String <i>multiplicity</i> : 1..* <i>isOrdered</i> : True <i>isUnique</i> : N/A <i>defaultValue</i> : None <i>isNullable</i> : False
<i>argumentTypes</i>	An ordered list which contains one entry per associated <i>argumentName</i> . <i>allowedValues</i> : <i>objectType</i> of the <i>argumentName</i>	<i>type</i> : String <i>multiplicity</i> : 1..* <i>isOrdered</i> : True <i>isUnique</i> : N/A <i>defaultValue</i> : None

Attribute Name	Documentation and Allowed Values	Properties
		isNullable: False
<i>operation</i>	An ordered list which contains the function operations. allowedValues: PLUS, MINUS, MULTIPLY_BY, DIVIDE_BY, LOG, MIN, MAX, MEAN	type: Enum multiplicity: 1..* isOrdered: True isUnique: N/A defaultValue: None isNullable: False
<i>function</i>	The mathematical function. Comprises the combination of the list of arguments (* by their weight) and list of operations defined for the utility function.	type: String multiplicity: 1..* isOrdered: True isUnique: N/A defaultValue: None isNullable: False
<i>result</i>	Result of the function evaluation. allowedValues: N/A	type: Real multiplicity: 0..1 isOrdered: False isUnique: N/A defaultValue: N/A isNullable: False
<i>resultType</i>	Type of the result. allowedValues: <Whether this attribute is needed, and what values it would allow depends on which functions are supported>	type: Enum multiplicity: 0..1 isOrdered: False isUnique: N/A defaultValue: N/A isNullable: False
<i>error</i>	Error string. allowedValues: N/A	type: String multiplicity: 0..1 isOrdered: False isUnique: N/A defaultValue: None isNullable: False
<i>nativeRepresentation</i>	String representation of a utility function in its native format. An empty string is not allowed. allowedValues: N/A	type: String multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
<i>nativeFormat</i>	The format of the natively defined utility function. An empty string is not allowed. allowedValues: N/A	type: String multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

"

5.13.3.4 Potential solution #4 - Utility function capability support

An Intent MnS Producer should advertise support for utility functionality (REQ-Intent_Util-1) and the available support for expressing utility functions (REQ-Intent_Util-2).

This can be achieved using existing solutions by adding the utility function capabilities to the 'intentHandlingCapabilityList' and allowing consumer to query the capabilities as defined in 3GPP TS 28.312 [2], clause 6.2.1.

5.13.3.5 Potential solution #5 - Intent satisfaction index

This solution proposes support for an MnS Consumer "satisfaction index" used by an Intent MnS Consumer to provide an indicator to the Intent MnS Producer of how satisfied it is with the intent fulfilment.

Potential updates to 3GPP TS 28.312 [2] are show below, using clause numbers and headers from it with modified text in **bold**:

"6.2.1.2 Class definition

6.2.1.2.1 Intent <<InformationObjectClass>>

6.2.1.2.1.1 Definition

This IOC represents the properties of an Intent driven management information between MnS consumer and MnS producer.

The *Intent* IOC contains one or multiple *IntentExpectation*(s) which includes MnS consumer's requirements, goals and contexts given to a 3GPP system.

The *Intent* IOC also contains *intentAdminState* to support intent lifecycle management. In case MnS consumer wants to suspend an intent, MnS consumer can request MnS producer to configure attribute *intentAdminState* with the value "DEACTIVATED". A suspended intent means this intent is not considered for fulfillment. In case MnS consumer wants to resume an intent on the MnS producer side when the intent is suspended, MnS consumer can request MnS producer to configure attribute *intentAdminState* with the value "ACTIVATED".

The attribute "observationPeriod" indicates the time period for which the fulfilment process is observed and at the end of which the fulfilmentInfo for corresponding ExpectationTargets, IntentExpectations and Intent is updated. The observation period can be set by the MnS consumer or by the MnS producer if the MnS consumer does not provide a value.

The *Intent* IOC includes the attribute *objectClass* and *objectInstance* from the TOP IOC. The value of attribute *objectClass* is "Intent" and the value of attribute *objectInstance* is the DN of the instance of *Intent* IOC.

The *Intent* IOC includes *contextSelectivity* respectively used to define how to select among the stated *intentContexts*.

The *Intent* IOC includes **fulfillmentSatisfactionIndex** that enables the MnS consumer to express their relative satisfaction for a given solution provided by the MnS producer. The **fulfillmentSatisfactionIndex** is the computation of the utility achieved by a solution provided by the MnS producer according to the MnS consumer's utility function.

The attribute fulfillmentSatisfactionIndex is used by MnS Consumer to indicate the level of satisfaction with the fulfilment.

6.2.1.2.1.2 Attributes

The *Intent* IOC includes attributes inherited from Top IOC (defined in 3GPP TS 28.622) and the following attributes.

Table 6.2.1.2.1.2-1

Attribute Name	Support Qualifier	isReadable	isWritable	isInvariant	isNotifiable
<i>intentExpectations</i>	M	T	T	F	F
<i>userLabel</i>	M	T	T	F	F
<i>contextSelectivity</i>	O	T	T	F	F
<i>intentContexts</i>	O	T	T	F	F
<i>observationPeriod</i>	O	T	T	F	F
<i>intentPriority</i>	O	T	T	F	T
<i>intentAdminState</i>	CM	T	T	F	F
<i>intentPreemptionCapability</i>	CM	T	T	F	F
fulfillmentSatisfactionIndex	CM	T	T	F	F
Attribute related roles					
<i>intentReportReference</i>	M	T	F	F	F

6.2.1.2.1.3 Attribute constraints

Name	Definition
<i>intentAdminState</i> <i>Support Qualifier</i>	Condition: MnS consumer-suspension mechanism is supported.
<i>intentPreemptionCapability</i> <i>Support Qualifier</i>	Condition: The pre-emption mechanism is supported.
fulfillmentSatisfactionIndex	Condition: The intent handler supports receiving satisfaction information from the MnS consumer

6.2.1.2.1.4 Notifications

The common notifications defined in clause 6.2.1.5 are valid for this IOC. In addition, the following set of notifications is also valid.

Name	S	Notes
<i>notifyMOIChanges</i>	M	--

6.2.1.4 Attribute definition

Table 6.2.1.4-1

Attribute Name	Documentation and Allowed Values	Properties
<i>fulfillmentSatisfactionIndex</i>	It indicates the MnS consumer's evaluation of degree to which the fulfilment satisfies the MnS consumer's requirements. It is the computation of the utility achieved by a solution provided by the MnS producer according to the MnS consumer's utility function. It is an integer in the range [0,100] . The highest possible value indicates that the solution provided by the MnS producer achieves the best possible outcomes that the MnS consumer expected, e.g., that it achieves the highest range of a target whose desired values were defining as falling in a range. Correspondingly, the values lower than 100 indicate how far from the maximum satisfaction the outcome is. <i>allowedValues: integers in the range [0,100]</i>	type: Integer multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

"

5.13.4 Evaluation of potential solutions

Potential Solution 1: Solution 1 is already covered by Solution 2. It is not recommended as a separate solution, but as part of Solution 2.

Potential Solution 2: This solution could be the basis on which to define a solution, with some further updates. Recommendation is to implement this as a new IOC (not datatype) to allow Intent MnS Consumer to provision utility function instances (REQ-Intent_Util-3). These instances would be referenced (not contained) by the Intents to which this utility function is to be applied (REQ-Intent_Util-5), allowing the same intent utility function instance to be referenced from multiple intents (REQ-Intent_Util-6). The proposed attributes 'result' and 'error', along with calculated values, are added to the respective intent reports (REQ-Intent_Util-4). The other proposed attributes require further discussion.

Potential Solution 3: It is unclear that the intent functions from another domain, and in other formats than those defined by SA5, would be of use to IDMS MnS. This solution is not recommended as a result.

Potential Solution 4: This proposal describes enhancements required for IDMS to advertise its support for utility functions (REQ-Intent_Util-1) along with details about the supported methods (REQ-Intent_Util-2). Details on how to express the specific capabilities (i.e. which functions are supported, and how) requires further discussion. This item has a dependency on the modelling to support provisioning instances of the utility functions.

Potential Solution 5: The solution provides the computation of the utility achieved by a solution provided by the MnS producer according to the MnS consumer's utility function. It is an integer in the range [0,100] . The highest possible value indicates that the solution provided by the MnS producer achieves the best possible outcomes that the MnS

consumer expected, e.g., that it achieves the highest range of a target whose desired values were defining as falling in a range. Correspondingly, the values lower than 100 indicate how far from the maximum satisfaction the outcome is.

It is recommended to support the combination of solution 2 and 5 to enable the MnS consumer to express their relative preference via a utility function according to solutions 2 and 4 and expressing the relative satisfaction of a given solution via the satisfaction index according to solution 5.

5.14 Use case #14: Intent feasibility check

5.14.1 Description

The Intent fulfilment feasibility check use case in clause 5.3.3 in 3GPP TS 28.312 [2] describes that the MnS producer automatically performs fulfilment feasibility check to determine whether the intent instance is feasible when the MnS producer receives the intent instance creation or modification request from the MnS consumer. After the fulfilment feasibility check, the MnS producer continues to fulfil the intent directly if the fulfilment feasibility check result is feasible.

Before MnS consumer expresses the intent expectations to MnS producer, MnS consumer may want to verify or check the feasibility whether the proposed intent expectation is possible for an MnS producer. Such feasibility check capability during intent pre-evaluation phase can be used to assist the MnS consumer to generate the feasible intent information for the MnS producer. For example, when the operator receives the service booking request for a video live broadcast service from vertical customer for a time window, the operator (as MnS consumer) may need to check with the MnS producer (e.g. RAN management system) the feasibility of the requested radio service.

IntentFeasibilityCheckReport defined in 3GPP TS 28.312 [2] mainly includes feasibilityCheckResult (FEASIBLE, INFEASIBLE) and infeasibilityReasons for the whole intent. The following information is missing which is important for the MnS consumer to generate a feasible intent for an intent reported infeasible with IntentFeasibilityCheckReport (feasibilityCheckResult= INFEASIBLE):

- Which intent expectations and targets are infeasible.

5.14.2 Potential requirements

REQ-IntentNegotiation-FeasibilityCheck-1: The intent driven MnS producer should have a capability to provide the intent feasibility check result including the list of infeasible expectations and targets.

5.14.3 Potential solutions

5.14.3.1 Potential solution #1

This solution proposes to reuse and enhance the existing Intent IOC and IntentReport IOC defined in 3GPP TS 28.312 [2] to support the capability of intent feasibility check during intent pre-evaluation phase.

Enhancement Aspect1: Add following attributes in the existing Intent IOC to support intent feasibility check and delivering:

- Add attribute "intentMgmtPurpose" in Intent IOC, which describe the MnS consumer requirements for the management purpose (required procedures) of the created or modified intent instance. Following are the allowed values for attribute "intentMgmtPurpose" to support intent feasibility check:
 - FEASIBILITYCHECK, it is used to represent required procedures by the MnS consumer to check the feasibility of corresponding intent expectations.
 - FULFILMENT, it is used to represent required procedures by the MnS consumer to fulfil corresponding intent expectation.

Enhancement Aspect2: Add following attributes in the existing IntentFeasibilityCheckReport <<dataType>> to support intent feasibility check:

- Add attribute "inFeasibleExpectationInfos" which is the list of InFeasibleExpectationInfo for all infeasible IntentExpectations in the intent. Each InFeasibleExpectationInfo includes the following attributes:

- ExpectationId.
- List of TargetNames for the InFeasibleTargets.

Following is the high-level procedure for intent feasibility check and fulfilment.

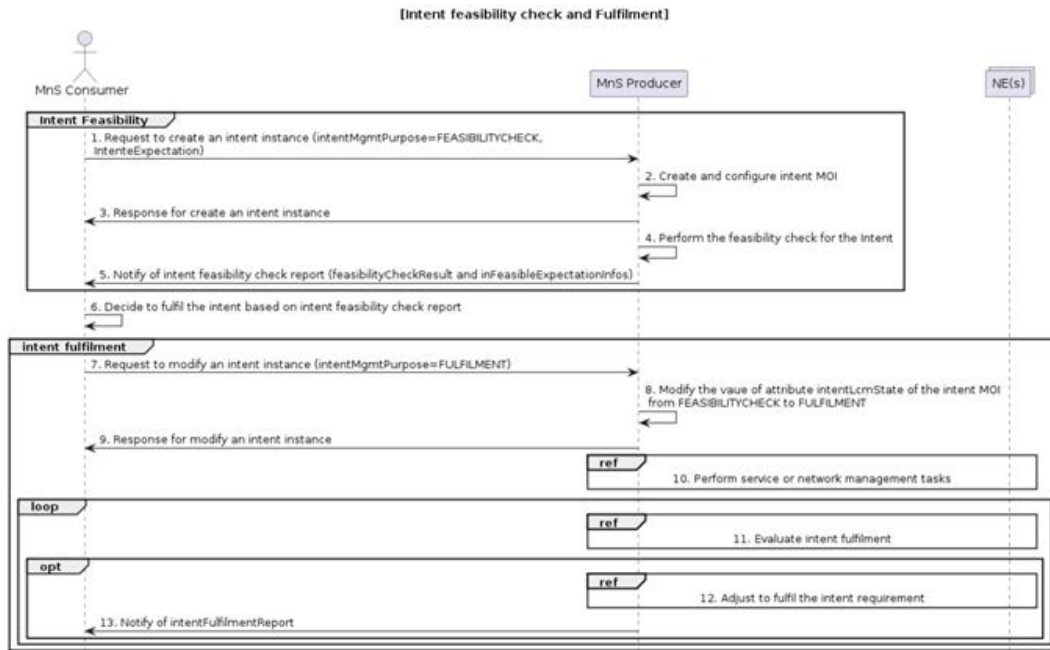


Figure 5.14.3.1-1

5.14.4 Evaluation of potential solutions

Only one potential solution is identified, which is feasible.

5.15 Use case #15: Intent Exploration

5.15.1 Description

Following management capabilities are provided by intent driven management services defined in 3GPP TS 28.312 [2]:

- Intent handling capability obtaining, which allows MnS consumer to find a right MnS producer (i.e. intent handling function) that have the right domain responsibilities and support for the intent expectations the MnS consumer wants to define based on obtained intent handling capability (i.e. supportedExpectationObjectType, supportedExpectationTargetNames).
- Intent expression, which allows MnS consumer to express the intent expectations (including expected target values for corresponding expectation targets) to MnS producer.

Before MnS consumer expresses the intent expectation to MnS producer (i.e. intent handling function), it is challenging for MnS consumer to assign the values for corresponding targets and contexts to be best aligned with both MnS consumer's expectation and MnS producer's capabilities. This depends on the current resource situation and capabilities of the system (availability of MnS Producer resources in certain area, time, etc.). For example, the high expectation on target value improves MnS consumer's satisfaction but may be out of MnS producer's capabilities (e.g. insufficient radio resources). In other aspect, the low expectation on target value can be achieved by MnS producer, but reduces MnS consumer's satisfaction and may not be best aligned with the MnS producer' capabilities (e.g. radio resources are not effectively used). So MnS consumer needs to find out if the expected intent expectations are realistic and best aligned with MnS producer's capability before expressing the intent expectation to MnS producer.

Especially for an intent with multiple targets, it is more challenging for MnS consumer to find out best combination of the values for multiple targets in an intent. For example, it is difficult for MnS consumer to assign the best values for

rANEnergyConsumptionTarget and aveDLRANUEThptTarget in RAN Energy saving intent defined in 3GPP TS 28.312 [2] to optimally balance the energy consumption expectation and RAN UE throughput performance.

Based on above analysis, it is important to introduce the MnS capability to enable MnS consumer to explore the best values for intent targets and contexts within a specific intent during intent pre-evaluation phase (i.e. before MnS consumer express the intent expectation to be fulfilled) to learn more about the MnS producer's capabilities. This would allow the MnS consumer to determine the values for intent targets and contexts which are best aligned with both MnS consumer's expectation and MnS producer's capabilities. Following are the two potential scenarios for intent exploration during intent pre-evaluation phase:

- **Scenario#1:** MnS consumer request MnS producer to explore the best value for a given target or context in an intent with a target name or attribute name specified. MnS consumer may specifies the values for other context attributes and targets in the intent to limit the exploration result.
- **Scenario#2:** MnS consumer request MnS Producer to explore the best combination of the values for multiple targets or contexts in an intent with list of target names and context attribute names specified. MnS consumer may specifies the values for other context attributes and targets in the intent to limit the exploration result. It is MnS producer's decision to provide one or multiple best combination of the values which are best aligned with MnS producer's capabilities. For example, for RAN energy saving intent which includes the energy consumption target and RAN UE throughput target, MnS producer may provide two best combination values for these two targets. One provides the better energy consumption but lower RAN UE throughput, while another provides the better RAN UE throughput but the energy consumption is not good compared to the first one.

MnS producer (i.e. intent handling function) can perform simulation/evaluation activities to provide the possible values for one or multiple targets and contexts in an intent accounting for all intents applied to the expected network. The expected network will not act on the intent exploration request.

5.15.2 Potential requirements

REQ-Intent_Driven_MnS-CON-1: The intent driven MnS producer should have the capability enabling the MnS consumer to request to explore the best value for a given target or context in an intent.

REQ-Intent_Driven_MnS-CON-2: The intent driven MnS producer should have the capability to explore the best combination of the values for multiple targets or contexts in an intent.

5.15.3 Potential solutions

5.15.3.1 Potential solution #1 Enhance the Intent IOC and IntentReport IOC to support intent exploration

This solution proposes to reuse and enhance the existing Intent IOC and IntentReport IOC defined in 3GPP TS 28.312 [2] to support the capability of exploring the best values that can be achieved for specific intent targets and intent contexts. Following are the proposed enhancements.

Enhancement Aspect1 Add following attributes in the existing Intent IOC to support the intent exploration capability:

- Add attribute "intentMgmtPurpose" in Intent IOC, which describe the MnS consumer requirements for the management of the intent instance. Following are the allowed values for attribute "intentMgmtPurpose" to support the intent exploration capability:
 - EXPLORE, it is used to represent MnS consumer's requirements to explore the best values that can be achieved for a specific intent. In this scenario, the values for intent targets and contexts to be explored in the intent expressed by MnS consumer should be set to NULL. The expected network will not act on the MnS consumer's intent.
 - FULFILMENT, it is used to represent MnS consumer's requirements to fulfil corresponding intent expectation. In this scenario, the values for all intent targets and contexts in the intent expressed by MnS consumer needs to be specified.

Enhancement Aspect2 Add IntentExploreResult <<dataType>> as an attribute of IntentReport IOC to represent the best values for one or multiple targets and contexts in an intent provided by MnS producer. IntentExploreResult <<dataType>> includes a list of ExpectationExporeResult(s) and each ExpectationExporeResult includes following attributes:

- ExpectationId:
 - List of recommended ExpectationTargets. Each ExpectationTarget include the TargetName, Target Condition and a recommended TargetValueRange.
 - List of recommended ExpectationContexts. Each ExpectationContexts include the ContextAttribute, Context Condition and a recommended ContextValueRange.

Following is the high-level procedure for exploring the combination of best values that can be achieved for specific intent targets and intent contexts in an intent.

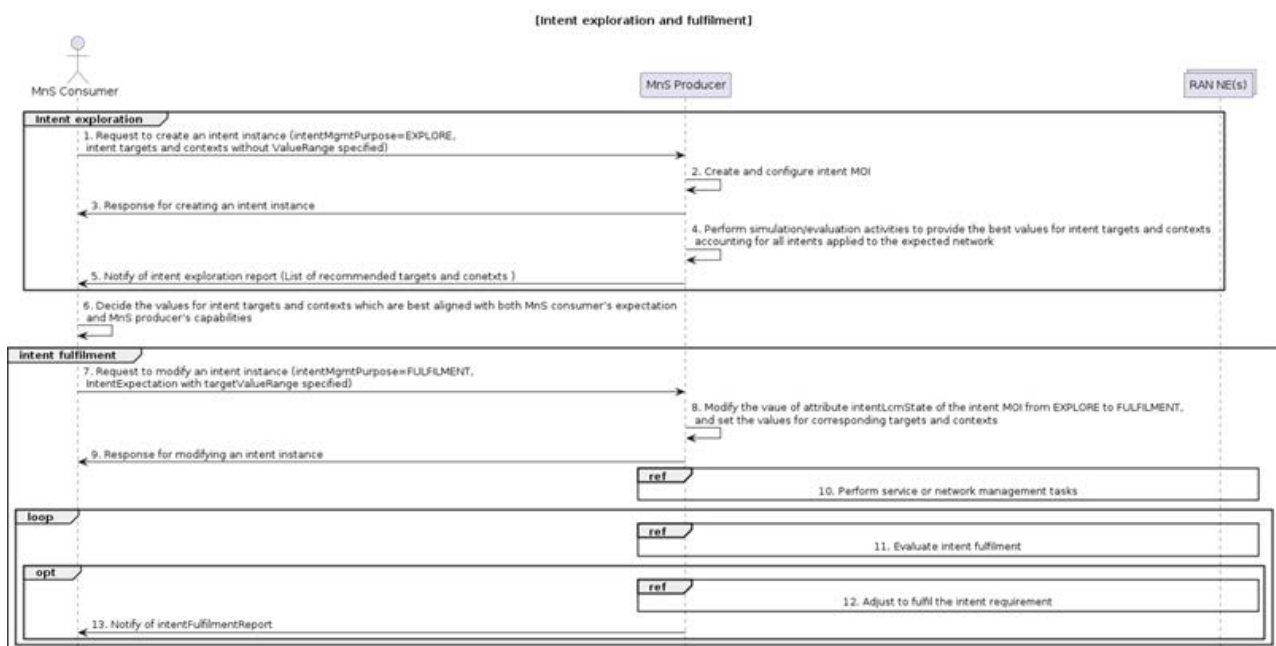


Figure 5.15.3.1-1

5.15.4 Evaluation of potential solutions

Only one potential solution is identified, which is feasible.

5.16 Use case #16: Negotiation on fulfilment of intents

5.16.1 Description

5.16.1.0 Overview

In 3GPP TS 28.312 [2] Release 18, the intent fulfilment feasibility check is already supported. When an intent-driven MnS producer receives the intent instance creation or modification request, it automatically conducts a feasibility check to determine whether the intent instance is feasible. If the feasibility check result is feasible, the MnS producer performs the service or network management tasks to satisfy the intent instance.

However, the MnS Producer cannot decide the content of the intent it receives, and the MnS Consumer may express a feasible intent, but the producer has multiple ways to fulfil it. One of these solutions might be better in one aspect and another solution might be better in another aspect. Although this intent is feasible, the producer may not have the knowledge and capability to determine which solution is appropriate. For example, the MnS Consumer may express intent for energy saving but only specify the target for energy consumption reduction without more constraints, e.g. reduce 20 % energy consumption. There will be numerous solutions to fulfil the energy consumption target with various impacts, e.g. one solution may reduce the coverage and one may reduce the user number. The consumer may have concerns on the possible impact of the selected solution by the Producer, which means that negotiation with the MnS Consumer is necessary. In such cases, the MnS consumer and Mns producer may negotiate on the best way to fulfil the intent. For example, through an MnS capability enabling the MnS producer to provide feedback (e.g. possible solutions, possible outcomes, and possible impacts) to the Mns consumer allowing the MnS consumer to select the appropriate solution.

There are multiple negotiations that can happen for an intent that is feasible, many of them employing interaction that are similar.

NOTE: Although some of these may be applicable during the feasibility check process, they are considered part of intent negotiations and not part of feasibility checking.

5.16.1.1 Checking for fulfillable outcomes

The MnS consumer wants to know the possible fulfillable outcomes for a given intent. The MnS consumer creates an intent that should be evaluated by the MnS producer to see what the MnS producer can deliver.

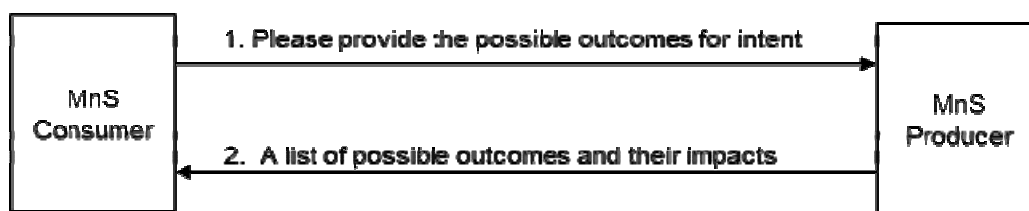


Figure 5.16.1.1-1: MnS consumer requests and receives a list of fulfillable outcomes on an intent.

Subsequently, the MnS producer provides a report indicating what is fulfillable for each intent aspect (intentExpectation and expectationTarget) within that intent. Since different fulfillable outcomes may have different impacts, the report should include the relative impacts of each outcome.

5.16.1.2 Checking for best possible outcome on an intent, intent expectation, or expectation target

The MnS consumer wants to know the best possible outcome for a given intent or intent expectation or expectation target. This could be prior to or during fulfilment.

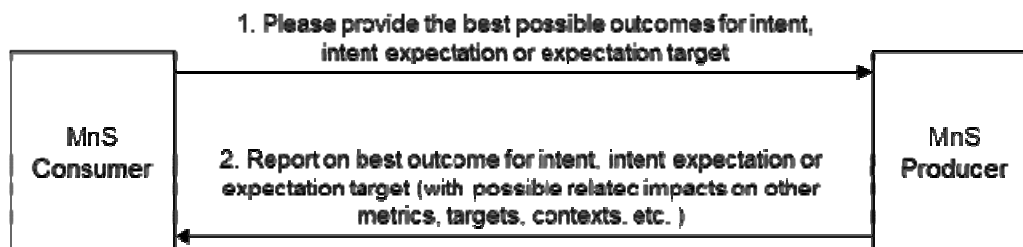


Figure 5.16.1.2-1: Checking for best possible outcome on intent or intent expectation or expectation target

The MnS consumer creates an intent that should be evaluated by the MnS producer with a request to provide the best possible outcome. Subsequently, the MnS producer provides a report indicating that best possible outcome. The best possible outcome is defined as follows:

- The request is to evaluate an intent with only 1 expectation target: The best possible outcome is the best value on that expectation target that does not adversely affect other aspects of the network.
- The request is to evaluate expectation target in an intent with multiple expectation targets (e.g. multiple expectations or one expectation with multiple expectation targets): The best possible outcome is the best value on that expectation target that maintains the other expectation targets to within the ranges specified in the intent and does not adversely affect other expectation targets or aspects of the network.
- The request is to evaluate all expectation targets in an intent with multiple expectation targets (e.g. multiple expectations or one expectation with multiple expectation targets): The best possible outcome is the best value on each expectation target that maintains the other expectation targets to within the ranges specified in the intent and does not adversely affect other aspects of the network.

The MnS producer should support an fulfillable outcomes report that lists the fulfillable outcomes for any of the three scenarios, the report including the related impact on other targets in the intent or on other metrics and contexts.

5.16.1.3 MnS producer to provide information about possible fulfillment of the intent

The MnS consumer wants to know for a specific property what the MnS producer recommends what could be applied for particular intent characteristics. The MnS consumer creates an intent and asks the MnS producer to recommend what changes for a specific property could be made to their intent or another of their intents to make the intent fulfillable (Figure 5.16.1.3-1). Alternatively, the MnS producer has attempted to fulfil the intent and indicated that it cannot be fulfilled, so the MnS consumer asks the MnS producer to recommend what changes could be made to their intent or another of their intents to make the intent fulfillable. For example, there may not enough resources for MnS producer to fulfill a new intent request from MnS consumer. In such case, the MnS consumer can create a request to query recommendations from MnS producer and use the response to modify their existing intents in an attempt to improve the ability to fulfil their new intents.

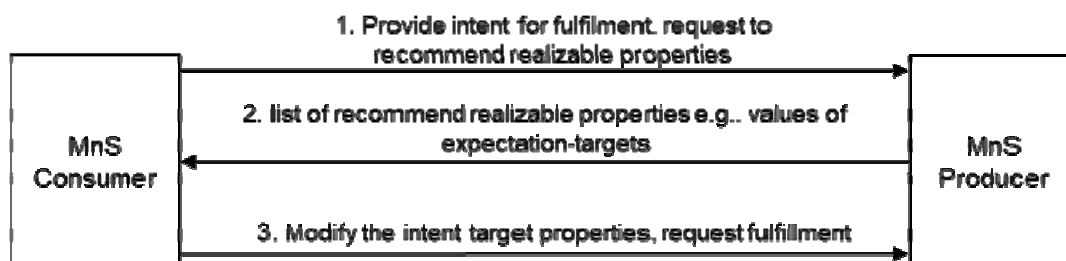


Figure 5.16.1.3-1: Enabling the MnS consumer to request and receive a recommendation on the fulfillable intent properties prior to fulfillment

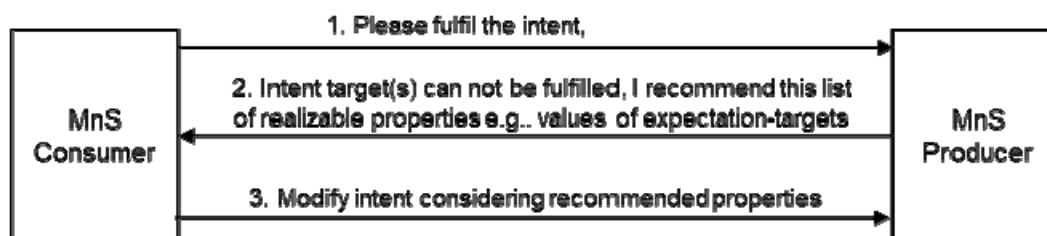


Figure 5.16.1.3-2: Enabling the MnS producer in case of inability to fulfil an intent to provide to the MnS consumer information about possible fulfillment of the intent

Subsequently, the MnS producer provides a report indicating the information about possible fulfillment of the intent. The MnS producer should support a recommended-changes report that lists different information about possible fulfillment of intent, e.g., candidate changes to unfulfillable targets within an unfulfillable expectation.

NOTE: The nature of the report and what can be included is For Further Study.

5.16.1.4 MnS consumer advises on preferred alternatives

The MnS consumer wants an intent fulfilled. The intent is feasible, but the MnS producer has multiple alternatives related to fulfilling the intent. The MnS producer wants the MnS consumer to advise on their (the MnS consumer's) preference among these alternatives.

NOTE 1: An alternative is the combination a set of expectation target values that the MnS producer can achieve together with their (expected) impacts on the network (objects). E.g. for an expectation target on energy consumption, the impact may include which cells could be deactivated, or which of their intents (e.g. coverage related intents) could be affected.

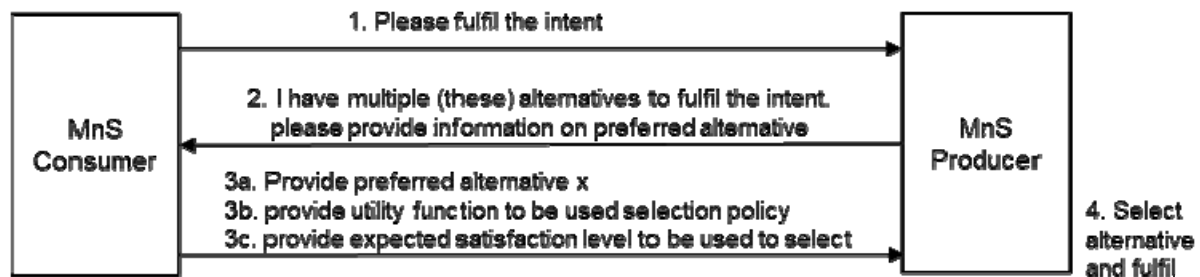


Figure 5.16.1.4-1: MnS consumer advises the MnS producer on the preferences among alternatives at the MnS producer

After the MnS consumer creates an intent to be fulfilled, the MnS producer determines that there are multiple alternatives, so the MnS producer provides a report to the MnS consumer so that the MnS consumer may choose the best alternative.

The report to the MnS consumer may include:

- The list of available/fulfillable expectation target values that the MnS producer is able to apply/achieve.
- The expected relative impacts of the different alternatives - on aspects of the submitted intent or their intents and intent expectations.
- A request to the MnS consumer to select one among the alternatives.

Given the alternatives, the MnS consumer takes any combination of these actions:

- Chooses and indicates the preferred alternative.
- Defines the relative importance of their expectation Targets (in the form of a utility function) so that the MnS producer may consider these in deciding upon the solution/ solution approach/ closed loops/ action/ outcome to be applied/deployed/achieved.

Provides the relative satisfaction level that each of the alternatives achieves. The satisfaction level is the computation of the utility achieved by each alternative according to the MnS consumer's utility function. It is an integer in the range [0,100]. The highest possible value indicates that the solution provided by the MnS producer achieves the best possible outcomes that the MnS consumer expected, e.g., that it achieves the highest range of a target whose desired values were defining as falling in a range. Correspondingly, the values lower than 100 indicate how far from the maximum satisfaction the outcome is.

5.16.1.5 MnS producer requests for extra information to be used to select another alternative post initial fulfilment

The MnS consumer wants an intent fulfilled and the MnS producer has multiple alternatives related to fulfilling the intent. After the MnS consumer creates an intent to be fulfilled, the MnS producer independently chooses the alternative to be applied. But on realizing that they cannot achieve better outcomes, MnS producer allows the MnS consumer to provide extra information that guarantee better satisfaction (see Figure 5.16.1.5-1). The MnS producer reports the fulfillment outcomes (imperfect fulfillment) and indicates to the MnS consumer that if the MnS consumer is unsatisfied with the outcomes, the MnS consumer should provide extra information to help select a better alternative.

The report to the MnS consumer may include one or more of the following:

- The list of available/ fulfillable expectation target values which can guide the MnS consumer when providing the preference policy.
- The relative impacts of the different alternatives - on the submitted intent or on other of their intents and intent expectations or on the network.
- A request to evaluate the fulfilment and provide information that could help improve fulfilment.

The extra information provided by the MnS consumer may be one or more of the following:

- A Binary indication that they accept the provided fulfilment or that they do not accept, and another alternative should be tried.
- A utility function indicating the MnS consumer's relative benefits of their expectation Targets. The utility function is the MnS consumer's policy for evaluating of the extent to which they are satisfied with the selected alternative.
- MnS consumer's level of satisfaction which is the evaluation of the extent to which the achieved outcomes match the MnS consumer's expectation as computed from the utility function.
- Changes to the expectation Targets or the relative importance of the expectation Targets to the MnS consumer's objectives.

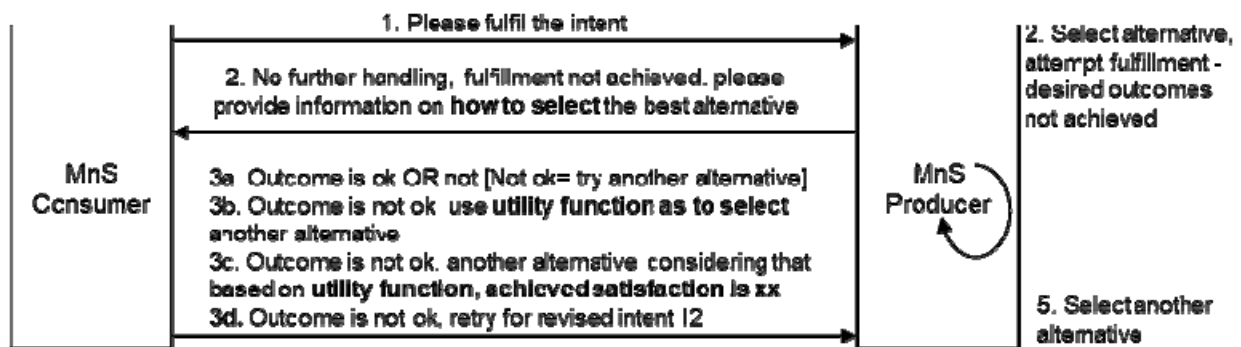


Figure 5.16.1.5-1: MnS producer requests MnS consumer to provide information to help select (better) alternative

5.16.2 Potential Requirements

REQ-Intent_Negotiation_01: The intent-driven MnS producer should have the capability to provide possible outcomes to the MnS Consumer.

REQ-Intent_Negotiation_02: The intent-driven MnS producer should have the capability enabling MnS Consumer to decide appropriate outcome for fulfilment based on possible outcomes.

NOTE 1: The definition for outcome is For Further Study.

REQ_INT_NEGOT-1: The intent driver MnS producer should support a capability enabling an MnS consumer to provide an intent with a request for the MnS producer to provide information on the alternative fulfillable outcomes for an intent.

NOTE 2: An alternative is the combination of a set of expectation target values that the MnS producer can achieve together with their (expected) impacts.

NOTE 3: The impacts refer to information about the changes and outcomes on the expectation objects of the intent and on other related intents from the same intent MnS consumer. The impact refers to outcomes of the contexts and targets that MnS consumers have not explicitly pointed out. The exact characterization of what is reported is For Further Study. E.g. for an expectation target on energy consumption, the impact may include which cells could be deactivated, or which other of their intents (e.g. coverage related intents) could be applied to make the intent fulfillable.

NOTE 4: Example changes could include: omitting certain intentExpectations and/or expectationTarget(s) or changing the properties of intentExpectations and/or expectationTarget(s).

REQ_INT_NEGOT-2: The intent driven MnS producer should support a capability to provide to an MnS consumer an intent report indicating the alternatives that the MnS producer can support for the provided intent, intent expectations, or expectation Targets and the expected relative impacts of the different alternatives.

REQ_INT_NEGOT-3: The intent driven MnS producer should support a capability to request an MnS consumer to indicate its preference among a set of alternatives that the MnS producer can support for the provided intent, intent expectations, or expectation Targets.

REQ_INT_NEGOT-4: The intent driven MnS producer should support a capability enabling an MnS consumer to provide to the MnS producer information indicating the MnS consumer's preference among alternatives that the MnS producer can support for the provided intent, intent expectations, or expectation Targets.

REQ_INT_NEGOT-5: The intent driven MnS producer should support a capability enabling an authorized MnS consumer to provide information on a policy that should be used by the be used by the MnS producer to select among the alternatives available at the MnS producer.

NOTE 5: The policy may be provided in the form of a utility function.

REQ_INT_NEGOT-6: The intent driven MnS producer should support a capability to request the MS consumer to provide an evaluation of the MnS producer's alternatives based on the expected relative impacts of the different alternatives.

REQ_INT_NEGOT-7: The intent driven MnS producer should support a capability enabling an MnS consumer to provide an evaluation of the MnS producer's alternatives to then be used to select among the alternatives.

REQ_INT_NEGOT-8: The intent driven MnS producer should support a capability to inform an authorized MnS consumer that an alternative among multiple alternatives has been selected and (will be/has been) applied for the submitted intent.

REQ_INT_NEGOT-9: The intent driven MnS producer should support a capability to inform an authorized MnS consumer that since no more improvement to intent fulfillment shall be possible the MnS consumer should evaluate the extent to which the applied alternative satisfies the MnS consumer's objectives or provide extra information which can help improve satisfaction.

REQ_INT_NEGOT-10: The intent driven MnS producer should support a capability enabling an authorized consumer to inform the producer that the alternative selected by the MnS producer was not satisfactory and another alternative should be applied.

REQ_INT_NEGOT-11: The intent driven MnS producer should support a capability enabling an authorized MnS consumer to provide information on the level of fulfillment which the MnS producer can use to differently attempt the fulfillment.

REQ_INT_NEGOT-12 (already supported): The intent driven MnS producer should support a capability enabling an authorized MnS consumer to revise the properties of an intent as the means to improve the chances of the intent being fulfillable.

INT_NEGOT_REQ 13: The MnS producer should support a capability to provide an intent report including information on what is achievable for each intent aspect (intentExpectation and expectationTarget) within that intent and the relative cost/impact of achieving that outcome.

INT_NEGOT_REQ 14: The MnS producer should support a capability enabling an MnS consumer to provide an intent with a request for the MnS producer to provide the best possible outcome on an intent or intent expectation or expectation target.

INT_NEGOT_REQ 15: The MnS producer should support a capability to provide an intent report including information on the best possible outcome on intent or intent expectation or expectation target.

NOTE 6: This requirement may be combined with REQ-13.

INT_NEGOT_REQ-16: The MnS producer should support a capability enabling an MnS consumer to provide an intent with a request for the MnS producer to provide information on what changes could be made to the intent properties or to properties of other of their intents to make the intent fulfillable.

NOTE 7: Further discussion is needed for this requirement.

INT_NEGOT_REQ-17: The MnS producer may support a capability to provide a report indicating the changes, which if applied to the intent, would make the intent fulfillable

5.16.3 Potential Solutions

This solution proposes to enhance the existing Intent IOC and IntentReport IOC defined in 3GPP TS 28.312 [2] to describe intent negotiation information between MnS producer and MnS consumer during fulfilment phase. e Following are the proposed enhancements:

Enhancement on Intent IOC: Introduce attribute "expectedReportType" and corresponding ENUM Value "IntentNegotiationReport" in the Intent IOC to determine the intent negotiation information including the possible outcomes the MnS Consumer can obtain from the MnS Producer). The detailed definition for attribute "expectedReportType" see clause 5.3.3.

- Introduce a dataType representing the feedback information for the MnS consumer's response to the MnS producer. It may be called IntentNegotiationFeedback. It may contain:
 - An attribute for a specific alternative among those indicated by the MnS producer.
 - A policy that should be used by the be used by the MnS producer to select among the alternatives. The policy may for example be MnS consumer's utility function.
 - An attribute indicating the MnS consumer's satisfaction from a deployed fulfilment as computed form the MnS consumer's utility function:
 - It may contain a list indicating the MnS consumer's expected satisfaction from the different alternatives e.g. as evaluated form the MnS consumer's utility function. This may be a key-value pair where the key is an identifier of the alternative and the value's the MnS consumer's expected satisfaction:
 - It may also be used to indicate the true MnS consumer's satisfaction as evaluated for an alternative that has been applied.
 - Optionally includes an ENUM attribute indicating the type of extra action information being provided. The values representing the type of extra information could include: IS_SELECTED_OPTION_NOT_OK, SELECTED_OPTION, SATISFACTION_POLICY
 - An attribute which indicates that the MnS consumer needs impact information for the outcomes from the MnS producer.

NOTE 1: The fulfillableOutcomesReport and SupportedAlternativesReport will include the impact on the related ExpectationObjects.

Enhancement on IntentReport IOC: Introduce an IntentNegotiationReport<<dataType>> as an attribute of Intent Report IOC to represent the MnS producer's information on the negotiations. It may indicate what is fulfillable for an intent, what the MnS producer recommends for an intent or the MnS producer's alternatives from which the MnS consumer may chose. IntentNegotiationReoprt <<dataType>> includes following attributes:

NOTE 2: Whether IntentNegotiationReport<<dataType>> as an attribute of IntentReport IOC or intentFulfilmentReport dataType needs further clarification.

- PossibleOutcomeList, it indicates the possible or fulfillable outcomes for the intent expectations and expectationTargets within that intent and the relative cost/impact (on the related ExpectationObjects) of achieving that outcome.

NOTE 3: The "PossibleOutcomeList" will include the potential impact on the related ExpectationObjects. The impact refers to outcomes of the context and targets that MnS consumers have not explicitly pointed out.

- PossibleOutcomeType, an attribute for what the information indicates, i.e. either:
 - The fulfillableOutcomes.
- RecommendedChanges, it indicates the potential changes to the intent that could make the intent fulfillable.

- SupportedAlternativesReport. Inclusion of a SupportedAlternativesReport inherently asks the MnS consumer to choose one alternative among those in the SupportedAlternativesReport.
- ExtraActionInformation indication, an ENUM attribute indicating need for extra information. The values representing the type of extra information needed could include: SELECT_FROM_OPTIONS, IS_SELECTED_OPTION_OK, PROVIDE_EXTRA_INFO_.

5.16.4 Evaluation of solutions

The potential solution described in clause 5.16.3 is a fully NRM-based approach that extends the existing NRM fragments to realise the exchanges between the Mns consumer and the MnS producer. The enhancement is small yet comprehensive enough to allow all the different negotiations to be supported. The implementation of this NRM-based solution is straightforward.

Therefore, the solution described in clause 5.16.3 is a feasible solution for negotiation during fulfilment of intents.

However, some aspects of the solution still require to be improved, so only some parts of the use case can be recommended for normative work.

5.17 Use case #17: Negotiation on the possible outcomes during the fulfilment phase

See clause 5.16.

5.18 Use case #18: Guidelines for using Intent generic information model to support new scenario which is not standardized

5.18.1 Description

The Generic Information model is defined in 3GPP TS 28.312 [2], which includes the generic IntentExpectation <<dataType>> as an attribute of intent <<IOC>>. The generic IntentExpectation <<dataType>> is utilized to construct the following standardized scenario specific IntentExpectation:

- Radio Network Expectation.
- Edge Service Support Expectation.
- End-to-end Network Resource Optimization Expectation.
- 5GC Network Expectation.
- Radio Service Expectation.

The standardized scenario specific Intent Expectation includes a list of standardized ExpectationObjects and ExpectationTargets.

The intent driven MnS solution in 3GPP TS 28.312 [2] is a simplified and flexible interface, which not only allows for scenario specific intent defined in 3GPP SA5, but also allows for extension intent to support any new specific scenarios which are not standardized in 3GPP TS 28.312 [2]. So, it is important to describe how to use intent generic information model can be defined to support new specific scenarios/services which are not standardized.

5.18.2 Potential requirements

TBD

5.18.3 Potential solutions

It proposes to add following guidelines in the Annex of 3GPP TS 28.312 [2] to illustrate how to use the generic intent model defined in clause 6.2.1 in 3GPP TS 28.312 [2] to support the new specific scenarios/services.

The new scenario which is not standardized (new specific scenario) can be satisfied by following intent model:

- Standardized Intent Expectation with vendor specific combination of standardized ExpectationObject(s) and ExpectationTarget(s). The standardized combination of standardized ExpectationObject and ExpectationTarget is documented in clause 8 Guidelines for using scenario specific intent expectation for intent driven use cases in 3GPP TS 28.312 [2].
- Standardized Intent Expectation with standardized ExpectationObject(s) and ExpectationTarget(s) and additional vendor defined ExpectationObject(s) and/or ExpectationTarget(s).
- Vendor defined Intent Expectation by utilizing generic IntentExpectation <<dataType>> defined in clause 6.2.1.3.1 in 3GPP TS 28.312 [2]. The Vendor defined Intent Expectation includes vendor extension ExpectationObject(s) and/or ExpectationTarget(s).

The vendor defined extension ExpectationObject is defined by utilizing the generic ExpectationObject <<dataType>> in clause 6.2.1.3.2 in 3GPP TS 28.312 [2]. The vendor defined ExpectationTarget is defined by utilizing ExpectationTarget <<dataType>> in clause 6.2.1.3.3 in 3GPP TS 28.312 [2].

NOTE: The above solution has no impact on the generic intent model defined in 3GPP TS 28.312 [2], the main purposes of this informative guideline is to clarify how the standardized generic intent model defined in 3GPP TS 28.312 [2] can be used to support new specific scenarios/services.

5.18.4 Evaluation of potential solutions

Only one feasible potential solution is identified.

5.19 Use case#19: Intent driven management of network maintenance

5.19.1 Description

This use case describes a scenario where an MnS consumer expresses an intent containing an expectation for delivering a network maintenance work, for example a software upgrade. After receiving the intent for network maintenance, the IDMS producer can take required actions to fulfill the maintenance. These actions may include changing the NE/NF operational state to allow maintenance to be performed, carrying out the maintenance tasks such as upgrading the related files of NE/NF, and any other actions to fulfill the maintenance expectation. As maintenance work on a network node may affect end-to-end network performance, the IDMS producer can ensure that there is no disruption in the network, can provide any conflict information if such maintenance creates any conflict to existing intents, can validate the maintenance across the network through fulfilment of expectation targets related to the maintenance and provide this in an intent report. In this scenario, an MnS consumer expresses its intent expectation for maintenance work for a network element, a network function, a network slice or a network slice subnet, which can include information regarding the object of maintenance, maintenance context information, maintenance expected start-date, maintenance expected end-date and related KPI targets to validate the maintenance.

5.19.2 Potential requirements

REQ-Intent_Opt_Maintenance_CON_1: The intent driven MnS producer should have the capability enabling MnS consumer to express intent containing an expectation for maintenance of a network element, a network function, a network slice or a network slice subnet.

REQ-Intent_Opt_Maintenance_CON_2: The intent driven MnS producer should have the capability enabling MnS consumer to obtain intent report information (including fulfilment information) for the intent containing an expectation for maintenance of a network element, a network function, a network slice or a network slice subnet.

5.19.3 Potential solutions

5.19.3.1 Potential solution

The following attributes need to be defined and added to the generic IntentExpectation in 3GPP TS 28.312 [2]:

- ExpectationVerb of IntentExpectation for network maintenance can describe the characteristic of the intentExpectation for network maintenance and can be an enum.

EXAMPLE: ExpectationVerb may be a software upgrade which may be combined with targets such as target software release and energy consumption.

- The ExpectationVerb can be used to trigger that creation of a new intent report instance to observe the impacts of network maintenance.
- The attribute "objectInstance" for network maintenance refers to a DN of a specific maintenance, for example, DN of the network slice for which to perform the maintenance.
- New attributes for network maintenance can be used to refer to the any maintenance information, for example, target version of objectType and objectInstance.

NOTE: Whether these new attributes can be considered as Expectation Context or Targets is not documented in present document.

- A new attribute "templateSupportRequirementContext" as ObjectContext refers to a requirement if there is a maintenance template to follow, for example, a template of maintenance for a network slice may include the order of maintenance of network functions. The values for templateSupportRequirementContext are True or False. If it is True, then it is followed by the DN of the Template associated with the maintenance object.

IntentExpectation for network maintenance can use attributes for time-related expectation context defined in 3GPP TS 28.312 [2] to refer to the start / end time of the intended network maintenance, to state the maintenance window.

IntentExpectation for network maintenance can use attributes for expectation context defined in 3GPP TS 28.312 [2]. For example, "edgeIdentificationIdContext" can identify the edge network where the network functions are to be maintained.

IntentExpectation for network maintenance can use the existing intent expectation targets defined in 3GPP TS 28.312 [2] in order to validate the maintenance. For example, if the maintenance of a RAN network element is aimed at reducing the RAN Energy consumption target, it can include "rANEnergyConsumptionTarget" expectation target as described in 3GPP TS 28.312 [2].

5.19.4 Evaluation of potential solutions

Only one potential solution provided in clause 5.19.3.1 is identified. This potential solution proposes an IntentExpectation for network maintenance, leveraging the generic IntentExpectation by defining and adding attributes in order to satisfy the use-case specific requirements including new attributes for ObjectContext which are associated with the objectInstance for network maintenance, ExpectationVerb, ExpectationContexts and ExpectationTargets. The implementation of this potential solution is straightforward. Therefore, the potential solution described in clause 5.19.3.1 is a feasible solution for intent driven management of network maintenance.

5.20 Use case #20: Intent containing an expectation for delivering a communication service

5.20.1 Description

Currently the intent driven management service specification 3GPP TS 28.312 [2] does not have a solution for the scenario where an MnS consumer can request an expectation to deliver and assure a service that spans a RAN and 5GC. In the study on intent-driven management for network slicing 3GPP TR 28.836 [16] it was observed that the

ServiceProfile could be used to express the NSC requirements for delivery and assurance of the NSC requested communication services.

5.20.2 Potential requirements

REQ-IDMS_CommunicationServiceIntent -CON-1: The intent driven MnS producer for communication services should have capability enabling an MnS consumer to express intent containing an expectation for delivering communication services for the specified area.

REQ-IDMS_CommunicationServiceIntent-CON-2: The intent driven MnS producer for communication services should have capability enabling MnS consumer to obtain intent report information (including fulfilment information) for the intent containing an expectation for a communication service.

5.20.3 Potential solutions

- Add new expectation for delivering communication services.
- The ObjectType for CommunicationService is currently not defined in NRM. The ObjectType for a communication service expectation can be a NetworkSlice which are defined in NRM.

6 Conclusions and recommendations

6.1 Use case #1: Enhance the radio service delivering use case

The scenario of delivering a radio service in a scheduled time is introduced in clause 5.1. In this scenario, the intent driven MnS producer for radio service needs to support the capability to allow the MnS consumer expresses the expectations for delivering a radio service in a scheduled time.

The solution proposes an enhancement of the RadioServiceExpectation defined in 3GPP TS 28.312 [2] to add "PLMNInfoContext", "maxNumberOfUEsTarget" and "SchedulingTimeContext".

It is recommended to enhance the radio service delivering use case and RadioServiceExpectation model defined in 3GPP TS 28.312 [2] to support radio service delivering scenarios. The detailed solution in clause 5.1.3 is used as baseline for normative work.

6.2 Use case #2: Enhancement of radio network expectation

The following scenarios are described in clause 5.2 which requires enhancement of radio network expectation:

- RAN energy saving scenario.
- Radio network traffic assurance for scheduled events scenario.
- Network support for UAV pre-flight preparation.
- Radio Network support MOCN undifferentiated radio service.

It is recommended to enhance the RadioNetworkExpectation and IntentReport defined in 3GPP TS 28.312 [2] to support above identified scenarios by:

- Adding "ulFrequencyContext" and "rATContext" as targetContexts for aveULRANUEThptTarget and aveDLRANUEThptTarget defined in RadioNetworkExpectation.
- Adding "ActiveUEsTarget", "PRBsTarget" and "InterRATHandoverTargets" as ExpectationTargets for RadioNetworkExpectation.
- Adding "SchedulingTimeContext" as ExpectationContext for RadioNetworkExpectation.
- Adding "cellContext" and "timeBasedAreaContext" as ObjectContexts for RadioNetworkExpectation.

- Adding attribute "targetContext" for TargetFulfilmentResult<<dataType>> defined in IntentReport.
- Adding "timeBasedExclusionAreas" as an attribute of IntentFeasibilityCheckReport <<dataType>> and ExpectationFulfilmentResult <<dataType>> defined in IntentReport.

The detailed solution in clause 5.2.2 is used as baseline for normative work.

6.3 Use case #3: Implicit intent report subscription with customized requirements

The use case of implicit intent report subscription with customized requirements is described in clause 5.3. In this use case, the intent driven MnS producer needs to support following capabilities:

- MnS consumer who expresses the intent may want to obtain the intent report by default, instead of triggering separate subscription action to subscribe intent report information.
- MnS consumer who express the intent may subscribe the intent report with customized requirements (e.g. condition for intent report).

The solution proposes to introduce the intentReport <<dataType>> as attribute of Intent IOC defined in 3GPP TS 28.312 [2], which includes "reportRecipientAddress", "expectedReportTypes", "reportingConditions", "reportingTargets" and "observationPeriod" to support above new intent report functionalities.

It is recommended to enhance the intent report use case as well as the model to support implicit intent report subscription with customized requirements in 3GPP TS 28.312 [2]. The detailed solution in clause 5.3.3.3 is used as baseline for normative work.

6.4 Use case #4: Intent containing an expectation to guarantee specific service characteristics

There is no proposed solution currently defined and it is unclear from the REQs alone which changes would be required to support this functionality.

Further discussion is recommended, including consideration for how this is defined in other SDOs.

6.5 Use case #5: Improve intent life cycle documentation

A new description for the investigation phase of Intent Life Cycle Management is proposed in clause 5.5. It is stated there that the investigation phase includes an intent handling capability obtaining functionality and Intent pre-evaluation functionality.

It is recommended to add this new description for investigation phase of Intent Life Cycle Management in clause B.1 in TS 28.312 [2]. The detailed solution in clause 5.5.2 is used as baseline for normative work.

6.6 Use case #6: Investigate potential impacts to support natural language intents translation

The use case, potential deployment scenario and impact on existing intent driven MnS are investigated in clause 5.6, which require additional investigations in future releases. is not recommended for normative work in R19.

6.7 Use case #7: Enablers for Intent Fulfilment

The use case enablers for Intent Fulfilment is described in clause 5.7. In this use case, the intent driven MnS producer needs to support the capability to allow MnS consumer to subscribe and obtain the information of enablers for intent fulfilment. The solution supports the capability to enable the MnS consumer to request to obtain the information of enablers for intent fulfilment including:

- Enhance the Intent IOC to add an optional attribute "enablerRequest" to describe the MnS consumer requirements for the information of enablers for intent fulfilment.
- Enhance the IntentReport IOC to add an attribute "enablerInfo" in IntentFulfilmentReport <<dataType>> to represent the information of enablers for intent fulfilment.

It is recommended to introduce the use case, requirements and corresponding solution to support intent fulfilment enabler information subscription and obtaining in 3GPP TS 28.312 [2]. The detailed solution in clause 5.7.3 is used as baseline for normative work.

6.8 Use case #8: Network support for UAV pre-flight preparation

See clause 6.2.

6.9 Use case #9: Enhancement of Radio Network Expectation to support MOCN

See clause 6.2.

6.10 Use case #10: Improve intent handling state management

The Intent handling state diagram and corresponding state transition events are described in clause 5.10.

It is recommended to add intent handling state diagram and intent handling state transition table in 3GPP TS 28.312 [2]. The detailed solution in clause 5.10.2 is used as baseline for normative work.

6.11 Use case #11: Enhancement for Intent handling capability

It is recommended to move on to the normative specification development phase for the use case on Extension of Intent handling capability. The normative specification development should a solution that is a combination of the solutions in clauses 5.11.3.1 and 5.13.3.2.

6.12 Use case #12: Intent degradation based on expectation preference

The use case, requirements and solutions for Use case #12: Intent Degradation Based on Expectation Preference is described in clause 5.12. In this use case, the intent driven MnS producer is enhanced to allow MnS Consumer to express its preference on expectation for fulfilment in an intent.

The solution proposes to introduce "PreferenceWeight" to the IntentExpectation <<datatype>> and the ExpectationTarget to support the intent degradation based on expectation preference.

It is recommended to start normative work using the detailed solution #1 as the baseline.

6.13 Use case #13: Utility function support

It is recommended to enable the MnS consumer to express their relative preference among solutions using a utility function according to a combination of solution 2 and solution 4

It is recommended to enable the MnS consumer to express their relative satisfaction from a given solution provided by the MnS producer using the satisfaction index according to solution 5.

6.14 Use case #14: Intent feasibility check

Intent feasibility check capability is introduced for MnS producer to assist the MnS consumer to generate the feasible intent information during pre-evaluation phase. The intent driven MnS producer needs to provide the intent feasibility check result including the list of infeasible expectations and targets. Following enhancements are identified to support intent feasibility check capability:

- Add attribute "intentMgmtPurpose" in Intent IOC for the management purpose (required procedures) of the created or modified intent instance. The allowed values for the new attribute "intentMgmtPurpose" can be FEASIBILITYCHECK, EXPLORE and FULFILMENT.
- Add attribute "inFeasibleExpectationInfos" in the existing IntentFeasibilityCheckReport <<dataType>>. It is the list of InFeasibleExpectationInfo for all infeasible IntentExpectations in the intent.

It is recommended to introduce the use case, requirements and corresponding solution for the intent feasibility check capability during pre-evaluation phase in 3GPP TS 28.312 [2]. The detailed solution in clause 5.14.3 is used as baseline for normative work.

6.15 Use case #15: Intent Exploration

The intent exploration capability is introduced for MnS producer to enable MnS consumer to explore the best values for intent targets and contexts within a specific intent during intent pre-evaluation phase to learn more about the MnS producer's capabilities. Following enhancements are identified to support intent exploration capability:

- Add attribute "intentMgmtPurpose" in Intent IOC. The detailed definition for attribute "intentMgmtPurpose" see clause 6.14.
- Add IntentExploreResult <<dataType>> as an attribute of IntentReport IOC to represent the recommended best values for one or multiple targets and contexts in an intent provided by MnS producer.

It is recommended to introduce the use case, requirements and corresponding solution for the intent exploration capability during pre-evaluation phase in 3GPP TS 28.312 [2]. The detailed solution in clause 5.15.3 is used as baseline for normative work.

6.16 Use case #16: Negotiation on fulfilment of intents

The present technical report described potential enhancements to the intent driven management specification.

It is recommended to move on to the normative specification development phase for the use case on intent negotiations during the fulfilment of intents. For the normative work:

- 5.16.1.1 is recommended.
- 5.16.1.2 is not recommended - the decision on what is best is subjective. The MnS consumer can use the solution in 5.16.1.1 to get possible alternatives and chose the one to apply.
- 5.16.1.3 is recommended - the producer may provide information about possible fulfillment of the intent.
- 5.16.1.4 is recommended - the consumer is enabled to provide the utility function, satisfaction index or both. The satisfaction index represents the consumer's computed outcome of the utility function..
- 5.16.1.5 is not recommended. It requires further study.

6.17 Use case #17: Negotiation on the possible outcomes during the fulfilment phase

See clause 6.16.

6.18 Use case #18: Guidelines for using Intent generic information model to support new scenario which is not standardized

The description requirements and solution for Use case #18: Guidelines for using Intent generic information model is described in clause 5.18.

It is recommended to start the normative work to add the guidelines for using intent generic information model in 3GPP TS 28.312 [2] to support new scenario which is not standardized. The detailed solution in clause 5.18.3 is used as baseline for normative work.

6.19 Use case #19: Intent driven management for network maintenance

The use case description, requirements and a potential solution for intent driven management for network maintenance is described in clause 5.19. This use case enables an MnS consumer to express an intent containing an expectation for delivering a network maintenance work, for example a software upgrade. Then the IDMS can take required actions to fulfill the expectation of delivering a maintenance work, ensuring that there is no disruption in the network, can provide any conflict information if such maintenance creates any conflict to existing intents, can validate the maintenance across the network through fulfilment of expectation targets related to the maintenance and provide the fulfilment information in an intent report.

The only potential solution described in clause 5.19.3.1, which is the proposed IntentExpectation for network maintenance, based on leveraging generic IntentExpectation by adding and defining attributes in order to support the use-case, can be used as baseline for normative work.

6.20 Use case #20: Intent containing an expectation for delivering a communication service

It is recommended to start the normative work to define the intent expectation for communication service.

Annex A: UML code for diagrams

A.1 UML code for Figure 5.15.3.1-1

```

@startuml
title "[Intent exploration and fulfilment]"
actor "MnS Consumer" as MnS_Consumer
participant "MnS Producer" as MnS_Producer
Collections "RAN NE(s)" as ManagedEntity
group Intent exploration
MnS_Consumer -> MnS_Producer: 1. Request to create an intent instance (intentMgmtPurpose=EXPLORE,\n
intent targets and contexts without ValueRange specified)
MnS_Producer -> MnS_Producer: 2. Create and configure intent MOI
MnS_Producer -> MnS_Consumer: 3. Response for creating an intent instance
MnS_Producer -> MnS_Producer: 4. Perform simulation/evaluation activities to provide the best values
for intent targets and contexts \n accounting for all intents applied to the expected network
MnS_Producer -> MnS_Consumer: 5. Notify of intent exploration report (List of recommended targets
and conetxts )
End

MnS_Consumer -> MnS_Consumer: 6. Decide the values for intent targets and contexts which are best
aligned with both MnS consumer's expectation \n and MnS producer's capabilities

group intent fulfilment
MnS_Consumer -> MnS_Producer: 7. Request to modify an intent instance (intentMgmtPurpose=FULFILMENT,
\n IntentExpectation with targetValueRange specified)
MnS_Producer -> MnS_Producer: 8. Modify the vau of attribute intentLcmState of the intent MOI from
EXPLORE to FULFILMENT, \n and set the values for corresponding targets and contexts
MnS_Producer -> MnS_Consumer: 9. Response for modifying an intent instance
Ref over MnS_Producer, ManagedEntity:10. Perform service or network management tasks
loop
Ref over MnS_Producer, ManagedEntity: 11. Evaluate intent fulfilment
opt
Ref over MnS_Producer, ManagedEntity: 12. Adjust to fulfil the intent requirement
MnS_Producer -> MnS_Consumer: 13. Notify of intentFulfilmentReport
end
end
end

hide footbox
@enduml

```

A.2 UML code for Figure 5.14.3.1-1

```

@startuml
title "[Intent feasibility check and Fulfilment]"
actor "MnS Consumer" as MnS_Consumer
participant "MnS Producer" as MnS_Producer
Collections "NE(s)" as ManagedEntity
Group Intent Feasibility
MnS_Consumer -> MnS_Producer: 1. Request to create an intent instance
(intentMgmtPurpose=FEASIBILITYCHECK,\n IntenteExpectation)
MnS_Producer -> MnS_Producer: 2. Create and configure intent MOI
MnS_Producer -> MnS_Consumer: 3. Response for create an intent instance
MnS_Producer -> MnS_Producer: 4. Perform the feasibility check for the Intent
MnS_Producer -> MnS_Consumer: 5. Notify of intent feasibility check report (feasibilityCheckResult
and inFeasibleExpectationInfos)
End

MnS_Consumer -> MnS_Consumer: 6. Decide to fulfil the intent based on intent feasibility check
report

group intent fulfilment
MnS_Consumer -> MnS_Producer: 7. Request to modify an intent instance (intentMgmtPurpose=FULFILMENT)
MnS_Producer -> MnS_Producer: 8. Modify the vau of attribute intentLcmState of the intent MOI \n
from FEASIBILITYCHECK to FULFILMENT
MnS_Producer -> MnS_Consumer: 9. Response for modify an intent instance
Ref over MnS_Producer, ManagedEntity:10. Perform service or network management tasks
loop

```

```
    Ref over MnS_Producer, ManagedEntity: 11. Evaluate intent fulfilment
      opt
        Ref over MnS_Producer, ManagedEntity: 12. Adjust to fulfil the intent requirement
        MnS_Producer -> MnS_Consumer: 13. Notify of intentFulfilmentReport
      end
    end
  end
end

hide footbox
@enduml
```

Annex B:

Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2024-01	SA5#153					Initial version.	0.0.0
2024-02	SA5#153	S5-240796 S5-240898	pCR pCR			Add Scope Add Structure	0.1.0
2024-04	SA5#154	S5-241974 S5-241975 S5-241976 S5-241979 S5-241980 S5-242121	pCR pCR pCR pCR pCR			Add use case, requirements and solution for radio service feasibility check and delivering. Add use case for enhancement of radio network expectation. Add key issue for implicit intent report subscription. Add use case for graded guarantee of 5G radio service. End-to-end intent handling state management. Using natural language to express the intent.	0.2.0
2024-06	SA5#155	S5-243148 S5-243149 S5-243150 S5-243151 S5-243158 S5-243159 S5-243160 S5-243161 S5-243162 S5-243163 S5-243154 S5-243152 S5-243155 S5-243156 S5-243157	pCR pCR pCR pCR pCR pCR pCR pCR pCR pCR pCR pCR pCR pCR			Add use case, requirements and solution for enablers for Intent Fulfilment Update Use case #2 Enhancement of radio network expectation Add use case, requirement and solution for intent driven management for UAV pre-flight preparation. Add use case, requirements and solution for radio network assurance for MOCN. Improve intent handling state management. Update implicit intent report subscription to support intent report based on condition. Add alternative solutions for implicit intent report subscription. Intent handling capability exposure Add use case, requirements and solution for intent degradation based on expectation preference. Add use case, requirement and solution for IDMS utility function support. Add use case, requirements and solution for intent feasibility check. Add concept for intent negotiation. Add use case and solution for exploring the possible outcomes that can be achieved for a specific intent. Negotiation on intent fulfilment. Add use case, requirements and solution for negotiation on the possible outcomes during the fulfilment phase.	0.3.0
2024-08	SA5#156	S5-243561 S5-243562 S5-243733 S5-244641 S5-244642 S5-244644 S5-244645 S5-244646 S5-244648 S5-244649 S5-244651 S5-244652 S5-244654 S5-244655 S5-244656 S5-244657	pCR pCR pCR pCR pCR pCR pCR pCR pCR pCR pCR pCR pCR pCR pCR			Add conclusion for Use case #7 Enablers for Intent Fulfilment Add conclusion for Use case #10 Improve intent handling state management Rapporteur clean up Aggregate enhancements to radio network expectation Add conclusion for Use cases for enhancement of radio network expectation Add description of vendor extension intent Add Use-Case for Intent-Driven Management of Network Maintenance Add conclusion for Intent negotiation functionalities in Intent pre-evaluation phase Conclusions on intent negotiation solution Add conclusion for Use case #3 Implicit intent report subscription Conclusion on Intent handling capability Update UC#13 evaluation and add recommendations Update description of Improve intent life cycle documentation Update the description in clause 5.13 Solution Update for Use Case #12 Intent Degradation Based on Expectation Preference Add solution for WT-5 approach for network slice delivering and assurance	0.4.0
2024-09	SA#105	SP-241139				Presented at SA#105 for Information	1.0.0
2024-09						After editHelp cleanup	1.0.1

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2024-10	SA5#157	S5-245343 S5-246053 S5-245440 S5-245344 S5-246056 S5-246054 S5-246055 S5-245776 S5-246058 S5-246057	pCR pCR pCR pCR pCR pCR pCR pCR pCR pCR			Rapporteur clean up Rapporteur clean up Editorial corrections Add conclusion for Use case #5 Improve intent lifecycle documentation Update Use case #6 Investigate potential impacts to support natural language intents translation Conclusion on negotiation and utility functions Add Evaluation and Conclusion for Use-Case #19 Update UC#13 evaluation and recommendation Add description of intent negotiation initiated by MnS producer Add description of intent negotiation	1.1.0
2024-12	SA#106	SP-241616				Presentation to SA for Approval	2.0.0
2024-12	SA#106					Upgrade to change control version	19.0.0

History

Document history		
V19.0.0	January 2026	Publication