**3GPP TSG-SA5 Meeting #156S5-243533**

**19 - 23 August 2024, Maastricht, Netherlands**

**Source: Nokia**

**Title: Rel-19 pCR 28.914 Conclusion on Utility function support**

**Document for: Approval**

**Agenda Item: 6.19.3**

# 1 Decision/action requested

***The group is asked to discuss and agree on the proposal.***

# 2 References

[1] 3GPP TR 28.914: " Study on intent driven management service for mobile network phase 3 v0.3.0"

# 3 Rationale

Some intent feasibility has been agreed in R18. However intent feasibility is related to other intent related negotiations. This pCR adds an evaluation and conclusion for the use case

# 4 Detailed proposal

|  |
| --- |
| **First Change** |

## 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 may be in 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.

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 degree of fulfilling various intents. 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 consumer’s definition of acceptability

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 be used. Predefined utility functions may be vendor specified and/or specified by consumer.

5.13.2 Potential requirements

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

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

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

5.13.3 Potential solutions

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.

#### 5.13.3.1 Potential solution #1

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 28.312 [2] are show below, using clause numbers and headers from it prefaced by ‘a’. Modified text is shown in **bold**:

##### *a6.2.1.2* Class definition

###### a6.2.1.2.1 Intent <<InformationObjectClass>>

###### a6.2.1.2.1.1 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 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.***

###### a6.2.1.2.1.2 Attributes

The Intent IOC includes attributes inherited fromTop IOC (defined in 3GPP TS 28.622 [6]) and the following attributes.

Table 6.2.1.2.1.2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute Name | Support Qualifier | isReadable | isWritable | isInvariant | isNotifyable |
| intentExpectations | M | T | T | F | F |
| userLabel | M | T | T | F | F |
| contextSelectivity | O | T | T | F | F |
| intentContexts | O | T | T | F | F |
| observationPeriod | O | T | T | F | F |
| intentPriority  | O | T | T | F | T |
| intentAdminState | CM | T | T | F | F |
| intentPreemptionCapability | CM | T | T | F | F |
| ***utilityFunction*** | ***CM*** | ***T*** | ***T*** | ***F*** | ***F*** |
| ***utlityFunctionRef*** | ***CM*** | ***T*** | ***T*** | ***F*** | ***F*** |
| **Attribute related roles** |
| intentReportReference | M | T | F | F | F |

###### a6.2.1.2.1.3 Attribute constraints

|  |  |
| --- | --- |
| Name | Definition |
| intentAdminStateSupport Qualifier | Condition: MnS consumer-suspension mechanism is supported. |
| intentPreemptionCapabilitySupport Qualifier | Condition: The preemption mechanism is supported. |
| ***utilityFunction*** | **Condition: Intent utility function definition capability is supported.** |
| ***utilityFunctionRef*** | **Condition: Intent utility function reference capability is supported.** |

###### a6.2.1.2.1.4 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 |
| --- | --- | --- |
| notifyMOIChanges | M | -- |

##### a6.2.1.3 DataType definition

###### a6.2.1.3.1 IntentExpectation <<dataType>>

a6.2.1.3.1.1 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*.

a6.2.1.3.1.2 Attributes

*The* *IntentExpectation includes the following attributes.*

*Table 6.2.1.3.1.2-1*

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

a6.2.1.3.1.3 Attribute constraints

*None.*

a6.2.1.3.7 ExpectationFulfilmentResult <<dataType>>

a6.2.1.3.7.1 Definition

*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.***

a6.2.1.3.7.2 Attributes

*The ExpectationFulfilmentResult includes the following attributes.*

*Table 6.2.1.3.7.2-1*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Attribute Name*** | *Support Qualifier* | *isReadable* | *isWritable* | *isInvariant* | *isNotifyable* |
| *expectationId* | *M* | *T* | *F* | *T* | *T* |
| *expectationFulfilmentInfo* | *M* | *T* | *F* | *F* | *T* |
| *targetFulfilmentResults* | *O* | *T* | *F* | *F* | *T* |
| ***utilityFunctionResult*** | ***O*** | ***T*** | ***T*** | ***F*** | ***F*** |

a6.2.1.3.7.3 Attribute constraints

*None.*

##### a6.2.1.4 Attribute definition

*Table 6.2.1.4-1*

| *Attribute Name* | *Documentation and Allowed Values* | *Properties* |
| --- | --- | --- |
| *utilityFunction* | Logical expression of a utility function. The syntax and capabilities of utilityFunction 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* |
| *utilityFunctionResult* | 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 is similar to solution #1 but enhances the definition of the attribute *utilityFunction*by defining the semantics by which the consumer can express their utility function..

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

##### a6.2.1.3.x UtilityFunction <<dataType>>

a6.2.1.3.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 function is a series of arguments and operations defined as ordered lists.

An optional attribute functionDefinition is also included to support vendor defined formats.

**Editor’s Note:** For this solution the detailed definitions of the arguments, operations, and functions will need to be defined to ensure the required functions can be properly expressed. Other formats, e.g. key-value pairs <argument, operand> and support for parenthesis, may be required.

a6.2.1.3.x.2 Attributes

UtilityFunction includes the following attributes:

Table 6.2.1.3.4.2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute Name | Support Qualifier | isReadable  | isWritable | isInvariant | isNotifyable |
| argumentName | O | T | T | F | F |
| argumentWeight | O | T | T | F | F |
| operation | O | T | T | F | F |
| function | O | T | T | F | F |
| result | O | T | F | F | F |
| error | O | T | F | F | F |
| functionDefinition | O | T | T | F | F |

a6.2.1.3.x.3 Attribute constraints

None.

##### aa6.2.1.4  *Attribute definition*

*Table 6.2.1.4-1*

| *Attribute Name* | *Documentation and Allowed Values* | *Properties* |
| --- | --- | --- |
| *utilityFunction* | Logical expression of a utility function. allowedValues: N/A | *type: UtilityFunction**multiplicity: 0..1**isOrdered: N/A**isUnique: N/A**defaultValue: None**isNullable: False* |
| *argumentName* | An ordered list which contains one entry per argument.allowedValues: a defined expectationName.targetName in the intentEditor’s Note: This definition likely has a dependency on the note in [1], clause 6.2.2.1.3.3 as measurements/KPI will need to be referenced in the functions. | *type: String**multiplicity: 1..\***isOrdered: True**isUnique: N/A**defaultValue: None**isNullable: False* |
| argumentWeight | Relative weight of the associated argument.Default value is 1.allowedValues: value between 0 and 1.  | *type: Real**multiplicity: 1**isOrdered: True**isUnique: N/A**defaultValue: 1**isNullable: False* |
| operation | 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* |
| Function | 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* |
| Result | Relative weight of the associated argument.Default value is 1.allowedValues: N/A | *type: Real**multiplicity: 0..1**isOrdered: False**isUnique: N/A**defaultValue: 1**isNullable: False* |
| Error | Error string.allowedValues: N/A | *type: String**multiplicity: 0..1**isOrdered: False**isUnique: N/A**defaultValue: None**isNullable: False* |
| functionDefinition | String representation of a utility function. The syntax and evaluation of the string are vendor defined. 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. 3.3 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 [1], 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 by TMF in [4].

This could be achieved by modifying potential solution #2 to align with functional definitions in [4], clause 11. Some attributes (e.g. arityMin, artiyMax) 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.

##### a6.2.1.3.x UtilityFunction <<dataType>>

a6.2.1.3.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.

**Editor’s Note:** this approach could be further defined to support additional functions such as those defined in [4] and [5]. The mapping of expectations and targets current defined in [1], 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.

a6.2.1.3.x.2 Attributes

UtilityFunction includes the following attributes:

Table 6.2.1.3.4.2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute Name | Support Qualifier | isReadable  | isWritable | isInvariant | isNotifyable |
| argumentNames | O | T | T | F | F |
| argumentTypes | O | T | T | F | F |
| Error | O | T | F | F | F |
| operation | O | T | F | F | F |
| function | O | T | F | F | F |
| Result | O | T | F | F | F |
| resultType | O | T | F | F | F |
| nativeRepresentation | M | T | T | F | F |
| nativeFormat | M | T | T | F | F |

a6.2.1.3.x.3 Attribute constraints

None.

##### a6.2.1.4  *Attribute definition*

*Table 6.2.1.4-1*

| *Attribute Name* | *Documentation and Allowed Values* | *Properties* |
| --- | --- | --- |
| *utilityFunction* | Logical expression of a utility function. allowedValues: N/A | *type: UtilityFunction**multiplicity: 0..\***isOrdered: N/A**isUnique: N/A**defaultValue: None**isNullable: False* |
| *argumentNames* | An ordered list which contains the function arguments.allowedValues: a defined expectationName.targetName in the intentEditor’s Note: This definition likely has a dependency on the note in [1], clause 6.2.2.1.3.3 as measurements/KPI will need to be referenced in the functions. | *type: String**multiplicity: 1..\***isOrdered: True**isUnique: N/A**defaultValue: None**isNullable: False* |
| *argumentTypes* | An ordered list which contains one entry per associated argumentName.allowedValues: objectType of the argumentName | *type: String**multiplicity: 1..\***isOrdered: True**isUnique: N/A**defaultValue: None**isNullable: False* |
| operation | 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* |
| function | 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* |
| Result | Result of the function evaluation.allowedValues: N/A | *type: Real**multiplicity: 0..1**isOrdered: False**isUnique: N/A**defaultValue: N/A**isNullable: False* |
| resultType | 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* |
| Error | Error string.allowedValues: N/A | *type: String**multiplicity: 0..1**isOrdered: False**isUnique: N/A**defaultValue: None**isNullable: False* |
| nativeRepresentation | 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* |
| nativeFormt | 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\_UTI-1) and the available support for expressing utility functions (REQ-Intent\_UTI-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 [1], clause E.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. It should be provided for each alternative provided by the MnS producer, e.g. for each intent report if each alternative is sent is a separate intent report.

Potential updates to [1] are show below, using clause numbers and headers from it. Modified text is shown in **bold**:

##### *a6.2.1.2* Class definition

###### a6.2.1.2.1 Intent <<InformationObjectClass>>

###### a6.2.1.2.1.1 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 attribute fulfilmentSatisfactionIndex is used by MnS Consumer to indicate the level of satisfaction with the fulfilment.**

###### a6.2.1.2.1.2 Attributes

The Intent IOC includes attributes inherited fromTop IOC (defined in 3GPP TS 28.622 [6]) and the following attributes.

Table 6.2.1.2.1.2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute Name | Support Qualifier | isReadable | isWritable | isInvariant | isNotifyable |
| intentExpectations | M | T | T | F | F |
| userLabel | M | T | T | F | F |
| contextSelectivity | O | T | T | F | F |
| intentContexts | O | T | T | F | F |
| observationPeriod | O | T | T | F | F |
| intentPriority  | O | T | T | F | T |
| intentAdminState | CM | T | T | F | F |
| intentPreemptionCapability | CM | T | T | F | F |
| ***fulfillmentSatisfactionIndex*** | ***CM*** | ***T*** | ***T*** | ***F*** | ***F*** |
| **Attribute related roles** |
| intentReportReference | M | T | F | F | F |

###### a6.2.1.2.1.3 Attribute constraints

|  |  |
| --- | --- |
| Name | Definition |
| intentAdminStateSupport Qualifier | Condition: MnS consumer-suspension mechanism is supported. |
| intentPreemptionCapabilitySupport Qualifier | Condition: The preemption mechanism is supported. |
| ***fulfillmentSatisfactionIndex*** | **Condition: The intent handler supports receiving satisfaction information form the MnS consumer** |

###### a6.2.1.2.1.4 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 |
| --- | --- | --- |
| notifyMOIChanges | M | -- |

##### a6.2.1.4 Attribute definition

*Table 6.2.1.4-1*

| *Attribute Name* | *Documentation and Allowed Values* | *Properties* |
| --- | --- | --- |
| ***fulfillmentSatisfactionIndex*** | **It indicates the MnS consumer’s evaluation of degree to which the fulfilment satisfies the MnS consumer’s requirements*****allowedValues: integers in the range [0,100]*** | ***type: Integer******multiplicity: 1******isOrdered: N/A******isUnique: N/A******defaultValue: None******isNullable: False***  |

#### 5.13.3.6 Potential solution #6 – Utility function and satisfaction index

#### This solution combines solution 2 and solution 5 as alternatives

The solution combining solutions 2 and 5 is as below. Modified text is shown in **bold**:

##### *a6.2.1.2* Class definition

###### a6.2.1.2.1 Intent <<InformationObjectClass>>

###### a6.2.1.2.1.1 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 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.***

**The attribute ComputedUtilityResult is the MnS Consumer’s computation of the utility function for a given fulfilment. It can be used by MnS Consumer to indicate the level of satisfaction with the fulfilment.**

###### a6.2.1.2.1.2 Attributes

The Intent IOC includes attributes inherited fromTop IOC (defined in 3GPP TS 28.622 [6]) and the following attributes.

Table 6.2.1.2.1.2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute Name | Support Qualifier | isReadable | isWritable | isInvariant | isNotifyable |
| intentExpectations | M | T | T | F | F |
| userLabel | M | T | T | F | F |
| contextSelectivity | O | T | T | F | F |
| intentContexts | O | T | T | F | F |
| observationPeriod | O | T | T | F | F |
| intentPriority  | O | T | T | F | T |
| intentAdminState | CM | T | T | F | F |
| intentPreemptionCapability | CM | T | T | F | F |
| ***fulfillmentSatisfactionIndex*** | ***CM*** | ***T*** | ***T*** | ***F*** | ***F*** |
| ***utilityFunction*** | ***CM*** | ***T*** | ***T*** | ***F*** | ***F*** |
| ***utlityFunctionRef*** | ***CM*** | ***T*** | ***T*** | ***F*** | ***F*** |
| **Attribute related roles** |
| intentReportReference | M | T | F | F | F |

###### a6.2.1.2.1.3 Attribute constraints

|  |  |
| --- | --- |
| Name | Definition |
| intentAdminStateSupport Qualifier | Condition: MnS consumer-suspension mechanism is supported. |
| intentPreemptionCapabilitySupport Qualifier | Condition: The preemption mechanism is supported. |
| ***utilityFunction*** | **Condition: Intent utility function definition capability is supported.** |
| ***utilityFunctionRef*** | **Condition: Intent utility function reference capability is supported.** |
| ***fulfillmentSatisfactionIndex*** | **Condition: The intent handler supports receiving satisfaction information from the MnS consumer** |

###### a6.2.1.2.1.4 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 |
| --- | --- | --- |
| notifyMOIChanges | M | -- |

##### a6.2.1.3 DataType definition

###### a6.2.1.3.1 IntentExpectation <<dataType>>

a6.2.1.3.1.1 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*.

a6.2.1.3.1.2 Attributes

*The IntentExpectation includes the following attributes.*

*Table 6.2.1.3.1.2-1*

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

a6.2.1.3.1.3 Attribute constraints

*None.*

a6.2.1.3.7 ExpectationFulfilmentResult <<dataType>>

a6.2.1.3.7.1 Definition

*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.***

a6.2.1.3.7.2 Attributes

*The ExpectationFulfilmentResult includes the following attributes.*

*Table 6.2.1.3.7.2-1*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Attribute Name*** | *Support Qualifier* | *isReadable* | *isWritable* | *isInvariant* | *isNotifyable* |
| *expectationId* | *M* | *T* | *F* | *T* | *T* |
| *expectationFulfilmentInfo* | *M* | *T* | *F* | *F* | *T* |
| *targetFulfilmentResults* | *O* | *T* | *F* | *F* | *T* |
| ***utilityFunctionResult*** | ***O*** | ***T*** | ***T*** | ***F*** | ***F*** |

a6.2.1.3.7.3 Attribute constraints

*None.*

##### **a6.2.1.3.x UtilityFunction <<dataType>>**

**a6.2.1.3.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 function is a series of arguments and operations defined as ordered lists.**

**An optional attribute functionDefinition is also included to support vendor defined formats.**

**Editor’s Note: For this solution the detailed definitions of the arguments, operations, and functions will need to be defined to ensure the required functions can be properly expressed. Other formats, e.g. key-value pairs <argument, operand> and support for parenthesis, may be required.**

**a6.2.1.3.x.2 Attributes**

**UtilityFunction includes the following attributes:**

Table 6.2.1.3.4.2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute Name | Support Qualifier | isReadable  | isWritable | isInvariant | isNotifyable |
| **argumentName** | **O** | **T** | **T** | **F** | **F** |
| **argumentWeight** | **O** | **T** | **T** | **F** | **F** |
| **operation** | **O** | **T** | **T** | **F** | **F** |
| **function** | **O** | **T** | **T** | **F** | **F** |
| **result** | **O** | **T** | **F** | **F** | **F** |
| **error** | **O** | **T** | **F** | **F** | **F** |
| **functionDefinition** | **O** | **T** | **T** | **F** | **F** |

**a6.2.1.3.x.3 Attribute constraints**

**None.**

##### **aa6.2.1.4  *Attribute definition***

*Table 6.2.1.4-1*

| *Attribute Name* | *Documentation and Allowed Values* | *Properties* |
| --- | --- | --- |
| ***utilityFunction*** | **Logical expression of a utility function.** **allowedValues: N/A** | ***type: UtilityFunction******multiplicity: 0..1******isOrdered: N/A******isUnique: N/A******defaultValue: None******isNullable: False*** |
| ***argumentName*** | **An ordered list which contains one entry per argument.****allowedValues: a defined expectationName.targetName in the intent****Editor’s Note: This definition likely has a dependency on the note in [1], clause 6.2.2.1.3.3 as measurements/KPI will need to be referenced in the functions.** | ***type: String******multiplicity: 1..\*******isOrdered: True******isUnique: N/A******defaultValue: None******isNullable: False*** |
| **argumentWeight** | **Relative weight of the associated argument.****Default value is 1.****allowedValues: value between 0 and 1.**  | ***type: Real******multiplicity: 1******isOrdered: True******isUnique: N/A******defaultValue: 1******isNullable: False*** |
| **operation** | **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*** |
| **Function** | **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*** |
| **Result** | **Relative weight of the associated argument.****Default value is 1.****allowedValues: N/A** | ***type: Real******multiplicity: 0..1******isOrdered: False******isUnique: N/A******defaultValue: 1******isNullable: False*** |
| **Error** | **Error string.****allowedValues: N/A** | ***type: String******multiplicity: 0..1******isOrdered: False******isUnique: N/A******defaultValue: None******isNullable: False*** |
| **functionDefinition** | **String representation of a utility function.** **The syntax and evaluation of the string are vendor defined.** **An empty string is not allowed.****allowedValues: N/A** | ***type: String******multiplicity: 0..1******isOrdered: N/A******isUnique: N/A******defaultValue: None******isNullable: False*** |
| ***ComputedUtilityResult***  | **It indicates the MnS consumer’s computation of the utility function for the fulfilment.** It should be provided for each alternative provided by the MnS producer, e.g. for each intent report if each alternative is sent is a separate intent report.***allowedValues: integers in the range [0,100]*** | ***type: Integer******multiplicity: 1******isOrdered: N/A******isUnique: N/A******defaultValue: None******isNullable: False***  |

#### 5.13.3.7 Potential solution #7 – intentExpectaionWeight and expectaionTargetWeight

The requirement to enable the consumer to express their relative value for different options available at the producer can be achived by enabling the consumer to state a weight for each intentExpectaion and expectaionTarget.

This solution proposes support for a weight used by an Intent MnS Consumer to indicate to the Intent MnS Producer the relative importance of different intentExpectaions and expectaionTargets.

Potential updates to 28.312 [2] are show below, using clause numbers and headers from it prefaced by ‘a’. Modified text is shown in **bold**:

##### a6.2.1.3 DataType definition

###### a6.2.1.3.1 IntentExpectation <<dataType>>

a6.2.1.3.1.1 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 expectationWeight used to define the relative degree of importance of the intentExpectation. It is an integer in the range [0,10] ]used to indicate:***

* **For a weight value > 0: that the intent expectation must be fulfilled for intent to be considered fulfilled**
* **For a weight value = 0: thst the intent expectation must not be fulfilled for intent to be considered fulfilled, i.e. that the intent expectation is optional**
* **For all wight values : the relative importance of the intent expectation, i.e. a value of 10 indicates the highest level of the intent expectation and the relative importance reduces with the weight value. A value of 0 indicates that the intent expectation is not important at all.**

a6.2.1.3.1.2 Attributes

*The IntentExpectation includes the following attributes.*

*Table 6.2.1.3.1.2-1*

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

a6.2.1.3.1.3 Attribute constraints

*None.*

##### a6.2.1.3.3 ExpectationTarget <<dataType>>

###### a6.2.1.3.3.1 Definition

The ExpectationTarget <<dataType>> represents the target of the IntentExpectation that are required to be achieved.

The ExpectationTarget <<dataType>> includes a contextSelectivity used to define how to select among the stated targetContexts.

***The IntentTarget <<dataType>> includes targetWeight used to define the relative degree of importance of the expectationTarget . It is an integer in the range [0,10] ]used to indicate:***

* **For a weight value > 0: that the expectation target must be fulfilled for intent to be considered fulfilled**
* **For a weight value = 0: thst the expectation Target must not be fulfilled for intent to be considered fulfilled, i.e. that the intent expectation is optional**
* **For all wight values : the relative importance of the expectation Target, i.e. a value of 10 indicates the highest level of the expectation Target and the relative importance reduces with the weight value. A value of 0 indicates that the intent expectation is not important at all.**

###### a6.2.1.3.3.2 Attributes

The ExpectationTarget includes the following attributes.

Table a6.2.1.3.3.2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Attribute Name | Support Qualifier | isReadable  | isWritable | isInvariant | isNotifyable |
| targetName | M | T | T | F | T |
| targetCondition | M | T | T | F | F |
| targetValueRange | M | T | T | F | F |
| contextSelectivity | O | T | T | F | F |
| targetContexts | O | T | T | F | F |
| ***targetWeight*** | ***O*** | ***T*** | ***T*** | ***F*** | ***F*** |

###### a6.2.1.3.3.3 Attribute constraints

None.

###### a6.2.1.3.3.4 Notifications

The notifications specified for the IOC using this <<dataType>> for its attribute(s), shall be applicable.

##### **a6.2.1.4  *Attribute definition***

*Table 6.2.1.4-1*

| *Attribute Name* | *Documentation and Allowed Values* | *Properties* |
| --- | --- | --- |
| **expectationWeight** | **It indicates the relative importance of the associated intent expectation. *The IntentExpectation <<dataType>> includes expectationWeight used to define the relative degree of importance of the intentExpectation. It is an integer in the range [0,10] ]used to indicate:**** **For a weight value > 0: that the intent expectation must be fulfilled for intent to be considered fulfilled**
* **For a weight value = 0: thst the intent expectation must not be fulfilled for intent to be considered fulfilled, i.e. that the intent expectation is optional**

**For all wight values : the relative importance of the intent expectation, i.e. a value of 10 indicates the highest level of the intent expectation and the relative importance reduces with the weight value. A value of 0 indicates that the intent expectation is not important at all.****allowedValues: value between 0 and 10.**  | ***type: Integer******multiplicity: 1******isOrdered: True******isUnique: N/A******defaultValue: 10******isNullable: False*** |
| **expectationWeight** | **It indicates the relative importance of the associated expectation target. It is an integer in the range [0,10] ]used to indicate:*** **For a weight value > 0: that the expectation target must be fulfilled for intent to be considered fulfilled**
* **For a weight value = 0: thst the expectation Target must not be fulfilled for intent to be considered fulfilled, i.e. that the intent expectation is optional**

**For all wight values : the relative importance of the expectation Target, i.e. a value of 10 indicates the highest level of the expectation Target and the relative importance reduces with the weight value. A value of 0 indicates that the intent expectation is not important at all.****allowedValues: value between 0 and 10.**  | ***type: Integer******multiplicity: 1******isOrdered: True******isUnique: N/A******defaultValue: 10******isNullable: False*** |

This solution is feasible and should be applied in the normative work.

5.13.4 Evaluation of potential solutions

Solution 1 is too vendor specific and adds no value for interoperability. The solution will not be recommended. It will not be updated further in the current document.

Potential solution #3(i.e., clause 5.13.3.3) add extra functionality to the concept of the utility function, which extra functionality has not been justified and does not have corresponding requirements which have been agreed by the group. Moreover it is overly complicated to implement. On the other hand, Potential solution #2(i.e., clause 5.13.3.2) has all the needed capabilities without these extras and does not limit the extras from being added in an implementation where needed. So, Potential solution #2 should be the baseline for any normative work on utility function.

Potential solution #5(i.e., clause 5.13.3.5) compliments the solution in Potential solution #2 for the scenario where an MnS consumer do not want to expose their intent evaluation policy, i.e., their utility function . On the other hand, potential solution #4 (i.e., clause 5.13.3.4) compliments the Potential solution #2, enabling the MnS produce to provide information on whether they support utility functions. So, a final solution that is a combination of Potential solutions 2,4 and 5 would be a feasible solution.

However, the solutions based on solution 2 (including solution 6) provide too much information that MnS consumers may not be comfortable to express to the MnS producers. Yet the need to indicate relative importance of desired outcomes ca easily be expressed by indicating the importance of different intent expectations and expectation targets. This is the supported by solution 7. So since solution 7 meets the requirements without requiring the MnS consumer to express too much information, it is the preferred solution.

|  |
| --- |
| **Next Change** |

# 6 Conclusions and recommendations

Editor's note: this clause will contain conclusions and recommendations for corresponding use cases identified in clause 5.

## 6.13 Use case #13: Utility function support

* It is recommended to move on to the normative specification development phase for the use case on “enabling the MnS consumer to provide the relative importance of intent outcomes” to support fulfilment of intents. The normative specification development should follow solution 7. .