



Experiential Networked Intelligence (ENI); Intent Policy Model Gap Analysis

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Reference

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Experiential Networked Intelligence (ENI).

Modal verbs terminology

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1 Scope

The present document contains:

- 1) work on a gap analysis report on intent information model based on existing SDO work, including the policy management model as specified by ETSI ISG ENI in the system architecture deliverables; and
- 2) a list of recommendations on general guidelines addressing the high-level policy model of a number of each SDO's intent policy model (i.e. 3GPP SA5, NFV, TM Forum, IRTF, and ZSM), and how these guidelines compare with those stated in the ETSI ENI system architecture.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] ETSI GS ENI 001 (V3.1.13): "Experiential Networked Intelligence (ENI); ENI use cases".
- [i.2] ETSI GS ENI 005 (V2.1.1): "Experiential Networked Intelligence (ENI); System Architecture".
- [i.3] ETSI GS ENI 019 (V3.1.1): "Experiential Networked Intelligence (ENI); Representing, Inferring, and Proving Knowledge in ENI".
- [i.4] ETSI TS 128 312 (V17.1.1): "LTE; 5G; Management and orchestration; Intent driven management services for mobile networks (3GPP TS 28.312 version 17.1.1 Release 17)".
- [i.5] ETSI GR NFV-IFA 041 (V4.1.1): "Network Functions Virtualisation (NFV); Release 4 Management and Orchestration; Report on Enabling Autonomous Management in NFV-MANO".
- [i.6] ETSI GS NFV-IFA 005 (V4.3.1): "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification".
- [i.7] 3GPP TR 28.812: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Telecommunication management; Study on scenarios for Intent driven management services for mobile networks (Release 17)".
- [i.8] ETSI GR ZSM 011 (V1.1.1): "Zero-Touch Network and Service Management (ZSM); Intent-driven autonomous networks; Generic aspects".
- [i.9] TM Forum IG1253 (V1.3.0): "Intent in Autonomous Networks".
- [i.10] TM Forum IG1253A (V1.1.0): "Intent Common Model".
- [i.11] TM Forum IG1253C (V1.1.0): "Intent Life Cycle Management and Interface".

- [i.12] IRTF draft-irtf-nmrg-ibn-concepts-definitions-09: "Intent-Based Networking - Concepts and Definitions", March 2022.
- [i.13] IRTF draft-irtf-nmrg-ibn-intent-classification-08: "Intent Classification", May 18, 2022.
- [i.14] ETSI GS NFV-IFA 050: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Intent Management Service Interface and Intent Information Model Specification".

3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3GPP	3 rd Generation Partnership Project
API	Application Programming Interface
ATTR	Attribute
CRUD	Create Read Update and Delete
CSC	Communication Service Customer
CSP	Communication Service Provider
DB	Database
DC	Data Center
DDOS	Distributed Denial of Service Attack
DHCP	Dynamic Host Configuration Protocol
DSL	Domain Specific Language
ENI	Experiential Networked Intelligence
GEN	General
GPU	Graphics Processing Unit
HD	High Definition
IBS	Intent-Based Systems
IDA	Intent Driven Action
IDO	Intent Driven Object
IFA	Interface and Architecture
IM	Intent Management
INF	Information
IPv4	Internet Protocol version 4
IRI	Internationalized Resource Identifiers
IRTF	Internet Research Task Force
KPI	Key Performance Indicator
MEF	MEF (a Standards body)
MnS	Management Service
MOD	Model
MPM	MEF Policy Model
NFV	Network Functions Virtualisation
NFV-MANO	Network Functions Virtualisation Management and Orchestration
NFVO	Network Functions Virtualisation Orchestrator
NMRG	Network Management
NOP	Network Operator
NS	Network Service

NSD	Network Service Descriptor
OCL	Object Constraint Language
OPEX	Operating Expense
OSS/BSS	Operation Support Systems/Business Support System
QoE	Quality of Experience
RAN	Radio Access Network
RAT	Radio Access Type
RDF	Resource Description Framework
REC	Recommendation
REQ	Requirement
SA5	Service and System Aspects Working Group 5
SDO	Standard Development Organization
SD-WAN	Software Defined Wide Area Network
UE	User Equipment
UML	Unified Modeling Language
URI	Uniform Resource Identifier
VDI	Virtual Desktop Interface
VM	Virtual Machine
VNF	Virtual Network Function
VPN	Virtual Private Network
ZSM	Zero touch network & Service Management

4 Background and Overview

With the development of intelligent networks, the requirements for network management are stricter. To improve the performance of connectivity, bandwidth, latency and reliability, and reduce operational expenditure, the concept of intent is introduced as a key enabling technology.

Some SDOs have worked on intent, but the concept of intent is still defined differently. However, there are still some gaps in intent information model, intent management and other aspects are specified requirements to deploy intent in real world situations is other documents.

In ETSI ISG ENI, intent policy is regarded as a key deliverable to help improve the operator experience. Considering the gaps in the different definitions and modelling by SDOs, a gap analysis is necessary for the ENI system. The gaps include but not limited to the following items:

- The definition of intent.
- The targeted use cases.
- The intent information models designed in other SDOs.
- The management of intent, including management roles, life cycles and operations.

The present document is targeted to recognize the gaps on intent information model and provide guidelines for ETSI ISG ENI.

5 Survey on Existing Areas of Work

5.1 ETSI ENI

5.1.1 Targeted Use Cases and Intent Definitions

5.1.1.1 Use Cases from ENI Specifications

The following ENI use cases are described in ETSI GS ENI 001 [i.1]. There are several use cases that use intent, and are summarized as follows.

Use Case #3-3: "Intelligent carrier-managed SD-WAN". It is possible for ENI to expose an intent-based interface that allows enterprises to customize their SD-WAN service using natural language with a terminology that is familiar to them.

Use Case #3-6, "Intent-based Cloud Management for VDI Service". The Intent-Based Cloud Manager is able to determine the optimal resource configuration for various user QoE requirements, and present them as intent.

Use Case #5-2: "Limiting profit in cyber-attacks". This use case has a goal of defining an ENI entity that uses machine learning to detect ransomware and cryptojacking attacks. Once detected, another ENI entity, which uses an intent based policy language, will propose a set of new security policies to the OSS to mitigate the attack.

5.1.1.2 Use Case types from ETSI GS ENI 005

The ENI System Architecture [i.2] describes two specific use cases for Policies processed by an ENI System. The first use case type is when an External Entity (e.g. an Operator) sends a Policy (of any type) to the ENI System that *affects the behaviour of the Assisted System (or its Designated Entity)*. This means that the ENI System will translate the Policy if needed, process it, and send recommendations and/or commands back to the Assisted System (or its Designated Entity). Note that an Intent Policy will always require translation as specified in ETSI GS ENI 005 [i.2].

The second use case type is when an External Entity sends a Policy (of any type) to the ENI System that *affects the behaviour of the ENI System*. This means that the ENI System will translate the Policy if needed, process it, and act on it to affect its own behaviour (e.g. add or remove knowledge from the Knowledge Management Functional Block, or define new goals that it should try and achieve). Note that an Intent Policy will always require translation.

5.1.1.3 Use Cases from ETSI GS ENI 001

Clause 5.1.1.2 describes two types of use cases in ENI. In Table 5.1.1.3-1, the use cases from ETSI GS ENI 001 [i.1] are listed. In addition, ETSI GS ENI 001 [i.1] uses cases are mapped into ETSI GS ENI 005 [i.2] use case types as follows:

- 1) Affect the behaviour of the system being managed.
- 2) Affect the behaviour of the ENI System.

Table 5.1.1.3-1: The related information of targeted use cases

Creator of intent	Targeted use cases	Corresponding clause in ETSI GS ENI 001 [i.1]	Corresponding management layer (Business/Service/Resource)
CSP	Intelligent carrier-managed SD-WAN	5.4.3 of [i.1]; affects system being managed	Service
CSP	Intent-based Cloud Management for VDI service	5.4.6 of [i.1]; affects system being managed	Service
CSP	Limiting profit in cyber-attacks	5.6.2 of [i.1]; affects system being managed	Service

5.1.1.4 Intent Definition from ETSI GS ENI 005

ETSI GS ENI 005 [i.2] provides the following definitions that involve intent.

policy: set of rules that is used to manage and control the changing and/or maintaining of the state of one or more managed objects:

- **ENI Policy Rules:** set of imperative, declarative, and/or intent policy rules.
- **intent policy:** type of policy that uses statements from a restricted natural language (e.g. an external DSL) to express the goals of the policy, but does not specify how to accomplish those goals. In particular, Intent Policy will refer to policies that do not execute as theories of a formal logic.

Hence, an intent policy is one type of policy. This enables other types of policies to interwork with an intent policy. This is realized using the ENI Extended Policy Model [i.3].

5.1.2 Extracted Requirements from ETSI GS ENI 005

According to the definition and other modelling related content, Table 5.1.2-1 provides the general requirements for ENI intent policy model.

Table 5.1.2-1: General requirements for ENI intent policy model

Req Number	ENI Requirement Description	Comments
ENI. INTENT. MODEL. GEN. 001	ENI intent policy model is recommended to express the goals of the policy.	Intent policy can be used to express the goals of the policy, but does not specify how to accomplish those goals. Based on the content of clause 6.3.9.3.4 of [i.2].
ENI. INTENT. MODEL. GEN.002	ENI intent policy model enables intent policies to interoperate with imperative and declarative policies, as well as the combination of these.	Based on the content of clause 6.3.9.3.4 of [i.2].
ENI. INTENT. MODEL. GEN.003	ENI intent policy model is able to be used to specify the behaviour of a Domain and entities within a Domain.	Based on clause 5.2 of [i.2].
ENI. INTENT. MODEL. GEN.004	ENI intent policy model is able to represent ENI recommendations and/or commands.	Based on clause 5.8.3 of [i.2].
ENI. INTENT. MODEL. GEN.005	ENI intent policy model provides model elements to define all or part of a grammar of one or more Domain Specific Languages.	Based on clause 5.8.3 of [i.2].
ENI. INTENT. MODEL. GEN.006	ENI intent policy model is able to equate goals to recommendations or commands (depending on operational mode) that result in desired behavioural changes to the Assisted System.	Based on clause 5.8.3 of [i.2].
ENI. INTENT. MODEL. GEN.007	ENI intent policy model is able to represent context information and incorporate any contextual changes at runtime.	Based on clause 5.8.3 of [i.2].
ENI. INTENT. MODEL. GEN.008	ENI intent policy model is able to incorporate situationally aware information and how those information relate to goals to be achieved as a function of changing situational information at runtime.	Based on clause 5.8.3 of [i.2].
ENI. INTENT. MODEL. GEN.009	ENI intent policy model is able to provide model elements to represent the negotiation of how intent policies are defined and executed. The actual negotiation is done by other mechanisms using the intent policy model.	Based on clause 5.8.3 of [i.2].
ENI. INTENT. MODEL. GEN.010	It is recommended that the ENI intent policy model have descriptive and/or prescriptive metadata (in the form of classes or attributes).	Based on clause 5.8.3 of [i.2].
ENI. INTENT. MODEL. GEN.011	ENI intent policy model is recommended to use the Policy Continuum to differentiate between the needs of different constituencies in defining and expressing an Intent Policy.	Based on clause 6.3.9.6.2 of [i.2].
ENI. INTENT. MODEL. GEN.012	It is recommended that the ENI intent policy model contains model elements that represent the administrative and operational status of ENI Policies. (ENI Policies are continuously monitored and updated throughout the life cycle of the ENI System).	Based on clause 6.3.9.6.6 of [i.2].

Table 5.1.2-2 provides the general requirements for ENI intent policy model information elements.

Table 5.1.2-2: General requirements for ENI intent policy model information elements

Req Number	ENI Requirement Description	Comments
ENI. INTENT. MODEL. INFO. 001	The design of information elements of the ENI intent policy model are recommended to express the goals of the policy.	Based on ENI. INTENT. MODEL. GEN. 001 in Table 5.1.2-1.
ENI. INTENT. MODEL. INFO. 002	The design of information elements of the ENI intent policy model are recommended to interact with imperative and declarative policies as well as their combination.	Based on ENI. INTENT. MODEL. GEN. 002 in Table 5.1.2-1.
ENI. INTENT. MODEL. INFO. 003	The design of information elements of the ENI intent policy model is recommended to include model elements that define the characteristics and behaviour of a Domain and entities within a Domain.	Based on ENI. INTENT. MODEL. GEN. 003 in Table 5.1.2-1.
ENI. INTENT. MODEL. INFO. 004	The design of information elements of the ENI intent policy model is recommended to include model elements that represent ENI recommendations and/or commands (as different classes).	Based on ENI. INTENT. MODEL. GEN. 004 in Table 5.1.2-1.
ENI. INTENT. MODEL. INFO. 005	The design of information elements of the ENI intent policy model is recommended to include model elements that are able to define all or part of a grammar of one or more Domain Specific Languages.	Based on ENI. INTENT. MODEL. GEN. 005 in Table 5.1.2-1.
ENI. INTENT. MODEL. INFO. 006	The design of information elements of the ENI intent policy model is recommended to include model elements that are able to equate goals to recommendations or commands (depending on operational mode) that result in desired behavioural changes to the Assisted System.	Based on ENI. INTENT. MODEL. GEN. 006 in Table 5.1.2-1.
ENI. INTENT. MODEL. INFO. 007	The design of information elements of the ENI intent policy model is recommended to include model elements that are able to represent context information and incorporate any contextual changes at runtime.	Based on ENI. INTENT. MODEL. GEN. 007 in Table 5.1.2-1.
ENI. INTENT. MODEL. INFO. 008	The design of information elements of the ENI intent policy model is recommended to include model elements that are able to incorporate situationally aware information and how those information relate to goals to be achieved as a function of changing situational information at runtime.	Based on ENI. INTENT. MODEL. GEN. 008 in Table 5.1.2-1.
ENI. INTENT. MODEL. INFO. 009	The design of information elements of the ENI intent policy model is recommended to include model elements that are able to represent the negotiation of how intent policies are defined and executed. The actual negotiation is done by other mechanisms using the intent policy model.	Based on ENI. INTENT. MODEL. GEN. 009 in Table 5.1.2-1.
ENI. INTENT. MODEL. INFO. 010	The design of information elements of the ENI intent policy model is recommended to include model elements that are able to provide descriptive and/or prescriptive metadata (in the form of classes or attributes).	Based on ENI. INTENT. MODEL. GEN. 010 in Table 5.1.2-1.
ENI. INTENT. MODEL. INFO. 011	The design of information elements of the ENI intent policy model is recommended to use the Policy Continuum to differentiate between the needs of different constituencies in defining and expressing an Intent Policy.	Based on ENI. INTENT. MODEL. GEN. 011 in Table 5.1.2-1.
ENI. INTENT. MODEL. INFO. 012	The design of information elements of the ENI intent policy model is recommended to represent the administrative and operational status of ENI Policies.	Based on ENI. INTENT. MODEL. GEN. 012 in Table 5.1.2-1.

Table 5.1.2-3 provides the general requirements for ENI intent policy model attributes.

Table 5.1.2-3: General requirements for ENI intent policy model attributes

Req Number	ENI Requirement Description	Comments
ENI. INTENT. MODEL. ATTR. 001	The design of attributes of ENI intent policy model is recommended to support the log data about VDI resource, workload and performance data.	Based on clause 5.4.6.3.2 of [i.1].
ENI. INTENT. MODEL. ATTR. 002	The design of attributes of ENI intent policy model is recommended to support the VDI QoE requirements.	Based on clause 5.4.6.3.2 of [i.1].

5.1.3 Intent Information Model

The ENI Policy Model is subclassed from the MEF Core Model. Both of these models are being extended by ETSI GS ENI 019 [i.3]. This enables any set of managed entities defined in the MEF Core Model to be used as the target of an ENI Policy (i.e. the set of managed entities whose behaviour will be affected by the ENI Policy). It also enables ENI Policies to make use of other model elements defined in the MEF Core Model, such as Role objects and MetaData.

The ENI Policy Model defines a unified policy model. A unified policy model provides three benefits:

- 1) It enables different types of policies to be used to accomplish tasks independent of the type or structure of policy.
- 2) It enables one type of policy to call any other types of policy.
- 3) It serves as a common language that enables concepts used by different policy authors to be mapped to equivalent concepts in other levels.

The ENI Policy Model defines three types of policies from the same information model (i.e. its unified Policy Model). These three types of policies (i.e. imperative, declarative, and intent) are examples of deriving different types of policies from a unified policy information model. Clause 6.3.9.6.3.5 of ETSI GS ENI 005 [i.2] describes how to use a unified model to represent different types of policies.

The unified policy information model is made up of two parts. One of the parts is used to represent the type of policy, and the other part is used to represent the contents of policy. The type of policy determines the allowed set of policy components that it can contain.

The MPM uses five important abstractions that collectively enable it to model multiple types of policies:

- 1) The first is the concept of a policy container. This means that any type of policy will be structured as an object that is made up of policy components.
- 2) The second defines two fundamental types of objects, a policy (called MPMPolicyStructure) and a policy component (called MPMPolicyComponentStructure). Hence, any policy consists of one instance of MPMPolicyStructure and one or more instances of MPMPolicyComponentStructure.
- 3) Third, the content of any policy will be made up of one or more statements (called MPMPolicyStatement).
- 4) Fourth, any MPMPolicyStatement may be made up of one or more clauses (called MPMPolicyClause).
- 5) Fifth, the type of policy will determine the set of statements that it can contain. This is enforced by a novel software pattern.

Figure 5.1.3-1 shows a simplified functional diagram of the foundation of the ENI Policy Model.

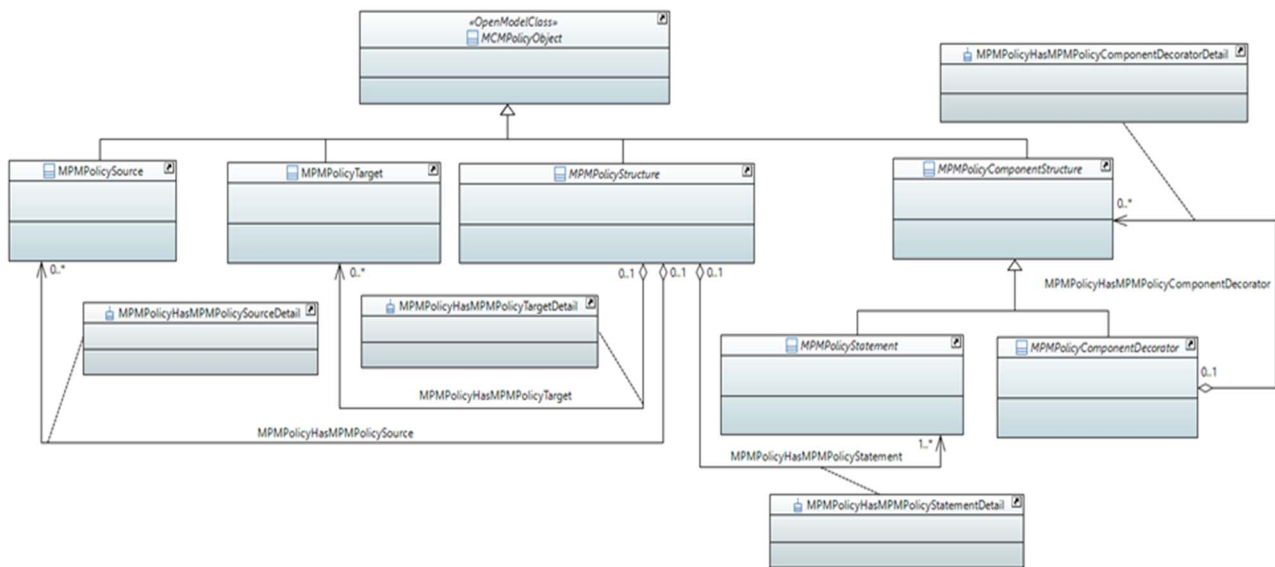


Figure 5.1.3-1: Simplified Functional Diagram of the ENI Policy Model

Conceptually, the "left side" of Figure 5.1.3-1 represents the type of policy, and the "right side" represents the contents of the policy. When a given policy is defined on the left side, the set of components that can be used to populate its content are then defined on the right side.

Figure 5.1.3-1 shows that different types of policies are represented by different subclasses of MPMPolicyStructure. Once a particular subclass of MPMPolicyStructure is chosen, this choice restricts the types of MPMPolicyStatements that can be used to define its content. The restriction should be implemented using a combination of the attributes, methods, and relationships of the MPMPolicyHasMPMPolicyStatementDetail association class. In addition, OCL may be used for formal specification of these restrictions.

The content of any policy is defined as a set of one or more statements. Any statement can be decorated by subclasses of the MPMPolicyComponentDecorator class.

For further details of this model, and ENI extensions to it, see ETSI GS ENI 019 [i.3].

5.1.4 Intent Management as is in ETSI GS ENI 005

5.1.4.1 Management Roles

In ETSI GS ENI 005 [i.2] here are two roles within policy management, which are external entity (Assisted System and/or its Designated Entity and infrastructure, OSS-like functionality, BSS-like functionality, application, orchestrator and user) and the ENI system (policy management is a functional block within an ENI system). ENI system functions as the intent handler, and an external entity (except for infrastructure) functions as intent creator.

5.1.4.2 Management Operations and life cycle

ETSI GS ENI 005 [i.2] does not provide a formal life cycle model. However, it does describe the following management operations:

- Create (see clause 6.3.9.6.5)
- Edit (see clause 6.3.9.6.5)
- Deploy (see clause 6.3.9.6.5)
- Activate (see clause 6.3.9.6.5)
- Meta policies (see clause 6.3.9.6.6)

- Deactivate (see clause 6.3.9.6.5)
- Remove (see clause 6.3.9.6.5)

NOTE: A Metapolicy is a policy that governs the life cycle of another policy.

In addition, clause 6.3.9.6.6 specifies four additional types of policy-specific operations:

- continuously monitoring the working set of policies for correct execution;
- continuously monitoring the working set of policies for possible conflicts;
- continuously look to improve the accuracy of its active knowledge repositories;
- support *goal-orientated* tasks (i.e. enable the system to focus on dynamic procedures, rather than static, pre-defined tasks) to reflect the changing prioritization of user needs, business goals, and environmental conditions.

5.2 3GPP SA5

5.2.1 Targeted Use Case and Intent Definition

The definition of intent is "expectations including requirements, goals and constraints given to a 3GPP system, without specifying how to achieve them" in ETSI TS 128 312 [i.4]. intent is recommended to be understandable for humans and needs to be interpreted by machines unambiguously.

The detailed information of targeted use-cases in ETSI TS 128 312 [i.4] is found in Table 5.2.1-1.

Table 5.2.1-1: The related information of targeted use-cases

Creator of intent	Targeted use-cases	Corresponding clause in ETSI TS 128 312 [i.4]	Corresponding management layer (Business/Service/Resource)
CSP	Intent containing an expectation for delivering radio network	5.1.1.1	Service
	Intent containing an expectation for delivering a radio service	5.1.2.1	Service
	Intent containing an expectation for delivering a service	5.1.3.1	Service
NOP	Intent containing an expectation on coverage performance to be assured	5.1.4.1	Resource
	Intent containing an expectation on RAN UE throughput performance to be assured	5.1.5.1	Resource

5.2.2 SA5 Requirements

According to the use cases, definition and other modelling related content, Table 5.2.2-1 provides the general requirements for 3GPP management system intent model.

Table 5.2.2-1: General requirements for 3GPP management system intent model

Req Number	SA5 Requirement Description	Comments
3GPP. INTENT. MODEL. GEN. 001	The 3GPP management system intent model supports one or more intent expectations that express the requirements, goals and constraints of the intent creator.	Based on the definition of intent, an intent is made up of requirements, goals and constraints given to a 3GPP system.
3GPP. INTENT. MODEL. GEN. 002	The 3GPP management system intent model supports the reporting of intent.	Among all the use cases (except "Intent containing an expectation for delivering a service"), the MnS producer is recommended to notify the MnS consumer about the fulfillment information.
3GPP. INTENT. MODEL. GEN. 003	The 3GPP management system intent model aligns with the semantics and structure of the existing 3GPP Model (e.g. network resource model) and is capable of using the specified 3GPP design and information.	The intent model of 3GPP management system is not defined separately and thus is expected to leverage the semantics and requirements expressed in 3GPP documentation. For example, the <<InformationObjectClass>> Intent inherits from <<InformationObjectClass>> TOP.

Table 5.2.2-2 provides the general requirements for 3GPP management system intent model information elements.

Table 5.2.2-2: General requirements for 3GPP management system intent model information elements

Req Number	SA5 Requirement Description	Comments
3GPP. INTENT. MODEL. INFO. 001	The designing of information elements of 3GPP management system intent model supports one or more intent expectations to express the requirements, goals and constraints of intent creator.	Corresponding to the 3GPP. INTENT. MODEL. GEN. 001 in Table 5.2.2-1.
3GPP. INTENT. MODEL. INFO. 002	The designing of information elements of 3GPP management system intent model supports the reporting of intent.	Corresponding to the 3GPP. INTENT. MODEL. GEN. 002 in Table 5.2.2-1.
3GPP. INTENT. MODEL. INFO. 003	The designing of information elements of 3GPP management system intent model aligns with the semantics and structure of the existing 3GPP Model (e.g. network resource model) and is capable of using the specified 3GPP design and information.	Corresponding to the 3GPP. INTENT. MODEL. GEN. 003 in Table 5.2.2-1.

Table 5.2.2-3 provides the general requirements for 3GPP intent model attributes.

Table 5.2.2-3: General requirements for 3GPP management system intent model attributes

Req Number	SA5 Requirement Description	Comments
3GPP. INTENT. MODEL. ATTR. 001	The design of attributes of a 3GPP management system intent model supports the types of delivery information specified in 3GPP.	Based on the targeted use cases of ETSI TS 128 312 [i.4], the types of delivery information are possible to be: a certain radio network, a radio service, a service delivering, an network coverage performance assurance and RAN UE throughput performance assurance. Also, the area information is mentioned in all the targeted use cases except "intent containing an expectation for delivering a service". In addition, REQ-Intent_Deploy_Net-CON-1, REQ-Intent_Deploy_Sev-CON-1, REQ-Intent_Opt_Cov-CON-1 and REQ-Intent_Opt_Thp-CON-1 of [i.4] stated that the specified area is expressed by MnS consumer.
3GPP. INTENT. MODEL. ATTR. 002	The design of attributes of a 3GPP management system intent model supports description of the area information.	

Req Number	SA5 Requirement Description	Comments
3GPP. INTENT. MODEL. ATTR. 003	The design of attributes of a 3GPP management system intent model supports description of radio setting parameter sets.	Clause 5.1.1.1 of ETSI TS 128 312 [i.4] states that an MnS consumer is recommended to express its intent for radio network delivering to an MnS producer, including coverage area information, radio setting parameter sets, transport setting parameters, and supported network capacity information and network performance information.
3GPP. INTENT. MODEL. ATTR. 004	The design of attributes of a 3GPP management system intent model supports description of the transport setting parameters.	
3GPP. INTENT. MODEL. ATTR. 005	The design of attributes of a 3GPP management system intent model supports description of the network capacity information.	
3GPP. INTENT. MODEL. ATTR. 006	The design of attributes of a 3GPP management system intent model supports the description of network performance information.	
3GPP. INTENT. MODEL. ATTR. 007	The design of attributes of a 3GPP management system intent model supports the description of radio service capacity information.	Clause 5.1.2.1 of ETSI TS 128 312 [i.4] states that an MnS consumer is recommended to express its intent for radio service provisioning to an MnS producer, including coverage area information, and supported service capacity information and service performance information.
3GPP. INTENT. MODEL. ATTR. 008	The design of attributes of a 3GPP management system intent model supports the description of radio service performance information.	
3GPP. INTENT. MODEL. ATTR. 009	The design of attributes of a 3GPP management system intent model supports the description of service requirements.	Clause 5.1.3.1 of ETSI TS 128 312 [i.4] states that an MnS consumer is recommended to express its intent for service deployment to an MnS producer, including service type, service requirements, service availability and the target location.
3GPP. INTENT. MODEL. ATTR. 010	The designing of attributes of a 3GPP management system intent model supports the description of service availability.	
3GPP. INTENT. MODEL. ATTR. 011	The design of attributes of a 3GPP management system intent model supports the description of target location.	
3GPP. INTENT. MODEL. ATTR. 012	The design of attributes of a 3GPP management system intent model supports the description of RATs.	
3GPP. INTENT. MODEL. ATTR. 013	The design of attributes of a 3GPP management system intent model supports the description of coverage targets.	Clause 5.1.4.1 of ETSI TS 128 312 [i.4] states that an MnS consumer is recommended to express its intent for coverage optimization to an MnS producer, including area information, RATs and coverage targets.
3GPP. INTENT. MODEL. ATTR. 014	The design of attributes of a 3GPP management system intent model supports the description of RAN UE throughput targets.	
3GPP. INTENT. MODEL. ATTR. 015	The design of attributes of a 3GPP management system model supports the description of optional performance scope.	Clause 5.1.5.1 of ETSI TS 128 312 [i.4] states that an MnS consumer is recommended to express its intent for RAN UE throughput optimization to an MnS producer, including area information, RATs, RAN UE throughput targets and optional performance scope.
3GPP. INTENT. MODEL. ATTR. 016	The design of attributes of a 3GPP management system intent model supports the description of the intent fulfillment information.	
		This corresponds to the 3GPP. INTENT. MODEL.INFO. 002 in Table 5.2.2-2. In addition, REQ-Intent_Deploy_Net-CON-2, REQ-Intent_Deploy_Sev-CON-2, REQ-Intent_Opt_Cov-CON-2 and REQ-Intent_Opt_Thp-CON-2 of [i.4] state that the MnS consumer obtains the fulfillment information of intent.

5.2.3 Intent Information Model

In ETSI TS 128 312 [i.4], intent information model is composed by ManagedEntity, Intent, IntentExpectation, IntentContext, ExpectationObject, ExpectationContext, ObjectContext and TargetContext. The model of IntentReport is not shown in ETSI TS 128 312 [i.4]. In Figure 5.2.3-1, the relationship related to the objects is shown.

In the intent information model shown in Figure 5.2.3-1, multiple intent instances are possible to be executed on the same ManagedEntity. An Intent is composed by one or more IntentExpectations and multiple IntentContexts. <<InformationObjectClass>> Intent is recommended to inherit from <<InformationObjectClass>> TOP.

The detailed information of classes and attributes is found in clause 6.2.1.2 of ETSI TS 128 312 [i.4].

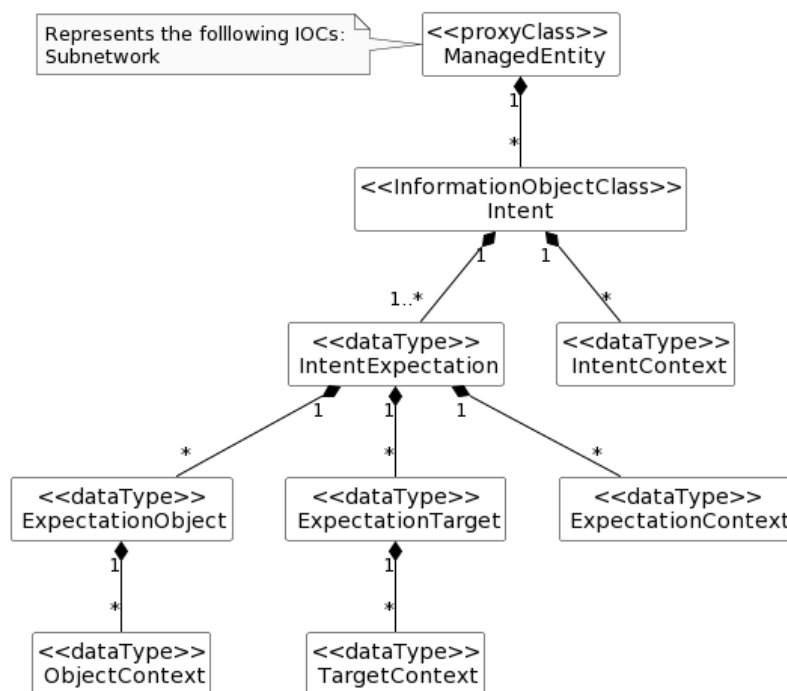


Figure 5.2.3-1: Relationship UML diagram for intent, source ETSI TS 128 312 [i.4]

In addition, Inheritance UML is depicted in Figure 5.2.3-2.

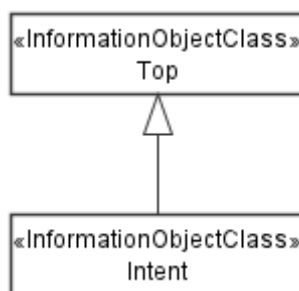


Figure 5.2.3-2: Inheritance UML diagram for intent, source ETSI TS 128 312 [i.4]

5.2.4 Intent Management

5.2.4.1 Management Roles

The service-based management architecture is used to describe network management functions and interfaces in 3GPP SA5. As a new managed object, intent also has its management function and service-based interface. The implementer of the management function is called MnS producer, and the requester calling the management function is called MnS consumer.

5.2.4.2 Management Operations

The intent management operations involved in ETSI TS 128 312 [i.4] including:

- Create an intent.
- Activate an intent.
- De-activate an intent.

- Delete an intent.
- Modify an intent.
- Query an intent.

NOTE: The above operations is included in clause 4.2.2 of ETSI TS 128 312 [i.4]. In clause 6.3 of ETSI TS 128 312 [i.4], the procedures of Activate and De-activate are not included.

5.2.4.3 Life Cycle

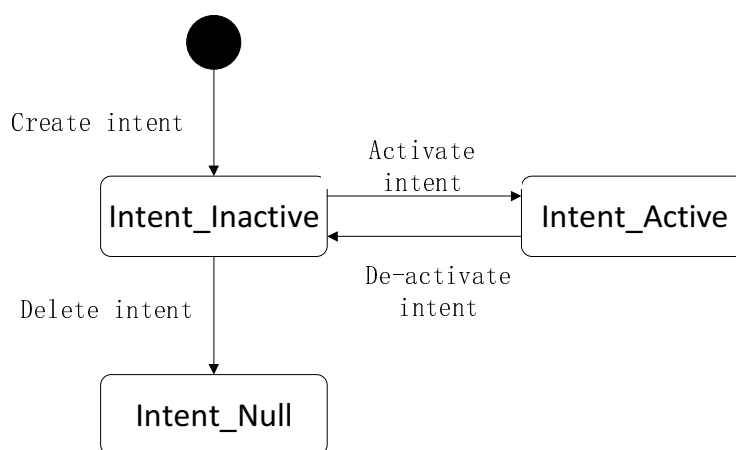


Figure 5.2.4.3-1: Intent life cycle states

According to the intent management operations involved, the corresponding intent life cycle states is shown in Figure 5.2.4.3-1. There are three states: Intent_Inactive, Intent_Active and Intent_Null.

5.3 ETSI NFV

5.3.1 Targeted Use-case and Intent Definition

The definition of intent is "A formal specification of all expectations including requirements, goals, and constraints given to a system" in ETSI GR NFV-IFA 041 [i.5].

There are three use-cases of intent based network service management in ETSI GR NFV-IFA 041 [i.5], and the detailed information are found in Table 5.3.1-1.

Table 5.3.1-1: The related information of targeted use-cases

Creator of intent	Targeted use-cases	Corresponding clause in ETSI GR NFV-IFA 041 [i.5]	Corresponding management layer (Business/Service/Resource)
NOP	Intent based network service instantiation	5.2.2	Resource
	Intent based network service scaling	5.2.3	Resource
	Intent based network service termination	5.2.4	Resource

5.3.2 Requirements

According to the use cases, definition and other modelling related content, Table 5.3.2-1 provides the general requirements for NFV-MANO intent model, referring to ETSI GR NFV-IFA 041 [i.5].

Table 5.3.2-1: General requirements from the ETSI GR NFV-IFA 041 [i.5]

Req Number	NFV Requirement Description	Comments
NFV-MANO. INTENT. MODEL. GEN. 001	NFV-MANO intent model supports a specific intent expression form, which is able to choose from two alternatives, i.e. intent expression is possible to be composed by IDO and IDA, or IDO and its desired state. See note.	These alternatives are introduced as "key issues #4 Design of information model for intent" in clause 6.2.4 of [i.5]. The details of these alternatives are shown in clause 5.3.3 of the present document.
NFV-MANO. INTENT. MODEL. GEN. 002	NFV-MANO intent model should align with the semantics and structure of the existing NFV models and be capable of using the specified NFV design and information (e.g. ETSI GS NFV-IFA 005 [i.6]).	The intent model of NFV-MANO is not defined separately and thus is expected to leverage the semantics and requirements expressed in ETSI NFV-IFA documentation. For example, based on the NS functionality information of the NSD and the requested dimensions of the intent, the Intent Management selects the suitable VNF deployment flavours and generates an appropriate NS deployment flavour for the NS to be instantiated.
NOTE: NFV-MANO. INTENT. MODEL. GEN. 001 is derived by clause 6.2.4 key issue #4 "Design of information model for intent" of ETSI GR NFV-IFA 041 [i.5].		

Table 5.3.2-2 provides the general requirements for NFV-MANO intent model information elements.

Table 5.3.2-2: General requirements for NFV-MANO intent model information elements

Req Number	NFV Requirement Description	Comments
NFV-MANO. INTENT. MODEL. INFO. 001	The design of information elements of an NFV-MANO intent model supports a specific intent expression form. Three options are proposed (i.e. intent management resides in the NFVO, reside in the OSS/BSS, or in a new functional block).	Corresponding to the NFV-MANO. INTENT. MODEL. GEN. 001 in Table 5.3.2-1.
NFV-MANO. INTENT. MODEL. INFO. 002	The design of information elements of an NFV-MANO intent model aligns with the semantics and structure of various NFV Information Models (e.g. ETSI GS NFV-IFA 005 [i.6]) and be capable of using the specified NFV design and information in those models.	Corresponding to the NFV-MANO. INTENT. MODEL. GEN. 002 in Table 5.3.2-1.

Table 5.3.2-3 provides the general requirements for NFV-MANO intent model attributes.

Table 5.3.2-3: General requirements for NFV-MANO intent model attributes

Req Number	NFV Requirement Description	Comments
NFV-MANO. INTENT. MODEL. ATTR. 001	The design of attributes of an NFV-MANO intent model supports the types of NS delivery information.	Based on the targeted use cases of ETSI GR NFV-IFA 041 [i.5], the types of NS delivery information are related to instantiation, scaling and termination.
NFV-MANO. INTENT. MODEL. ATTR. 002	The design of attributes of an NFV-MANO intent model supports the dimensions of performance metrics.	As the Table 5.2.2.5-1 of clause 5.2.2.5 of ETSI GR NFV-IFA 041 [i.5] written, "the intent identifying the NS functionality with certain dimensions of performance metrics is available in the OSS/BSS".

5.3.3 Intent Information Model

There is no intent information model in ETSI GR NFV-IFA 041 [i.5], but two alternatives are given for designing the intent information model.

The first one is based on the research in 3GPP TR 28.812 [i.7], the intent is possible to be modelled as IDO and IDA. For ETSI GR NFV-IFA 041 [i.5], the IDO is possible to be NSs or other managed objects in the NS level, e.g. NSD. IDA is possible to be related to one or multiple life cycle management operations acting on the NSs, e.g. instantiation, scaling. Management operations encapsulated in IDA also is possible to be represented by high-level and abstract operations, e.g. deploy an NS.

The second one is modelling the intent with IDO and its desired state. The use-cases of ETSI GR NFV-IFA 041 [i.5] is possible to be categorized into this kind of design. In this situation, the OSS/BSS does not indicate the IDA directly, but expresses the IDO's expectations, which are translated and converted into corresponding actions by the Intent Management function.

In above alternatives, the consumer of Intent Management is recommended to monitor the progress of the action.

5.3.4 Intent Management

5.3.4.1 Management Roles

The Intent Management interface named IM-1 is introduced by ETSI GR NFV-IFA 041 [i.5]. The Intent Management function is positioned as a producer, which exposes Intent Management operations to the external consumer through IM-1 interface.

5.3.4.2 Management Operations

The Intent Management operation involves one or more of the following:

- Create intent.
- Query intent.
- Delete intent.
- Subscription/notification related to intent management.
- Reporting on intent fulfillment.

In ETSI GR NFV-IFA 041 [i.5], intent request is assumed to be one-time and does not happen cyclically. Updating is possible to be regarded as the combination of deletion and creation. Therefore, the activate/deactivate, update operations are not included in intent management operations.

5.3.4.3 Life Cycle

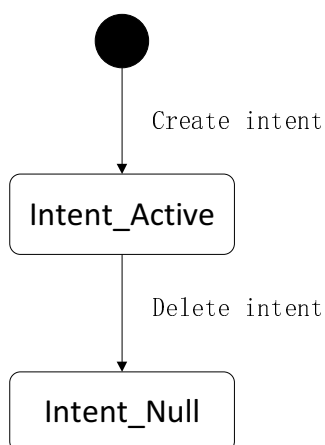


Figure 5.3.4.3-1: Intent life cycle states

According to the intent management operations involved, the corresponding intent life cycle states are shown in Figure 5.3.4.3-1. There are two states: Intent_Active and Intent_Null.

5.4 ETSI ZSM

5.4.1 Targeted Use Case and Intent Definition

The definitions of intent in 3GPP, TM Forum and IRTF are analysed in ETSI GR ZSM 011 [i.8]. Then ETSI GR ZSM 011 [i.8] suggests adopting the intent definition from TM Forum, which is "Intent is the formal specification of the expectations, including requirements, goals, and constraints, given to a technical system".

There are two use-cases of intent in ETSI GR ZSM 011 [i.8], and the detailed information is possible to be found in Table 5.4.1-1.

Table 5.4.1-1: The related information of targeted use-cases

Creator of intent	Targeted use-cases	Corresponding clause in ETSI GR ZSM 011 [i.8]	Corresponding management layer (Business/Service/Resource)
CSP	Cloud network convergence + intelligent slicing: ensure the performance, efficiency and safety of the connected cars	4.3.2	Service
	Cloud private line services: satisfy the parameters related to the intent of cloud private line services	4.3.3	Service

5.4.2 Requirements

According to the definition and other modelling related content, Table 5.4.2-1 provides the general requirements for ZSM intent model.

Table 5.4.2-1: General requirements for ZSM intent model

Req Number	ZSM Requirement Description	Comments
ZSM. INTENT. MODEL. GEN. 001	ZSM intent model is recommended to support one or more intent expectations to express the requirements, goals and constraints of intent creator.	ETSI GR ZSM 011 [i.8] suggests adopting the intent definition from TM Forum, which is "Intent is the formal specification of the expectations, including requirements, goals, and constraints, given to a technical system". Based on the criteria for selection of intent meta models, more details can be found in clause 5.4.2 of ETSI GR ZSM 011 [i.8]. Especially, ZSM. INTENT. MODEL. GEN. 004 is derived based on clause 5.4.1 of ETSI GR ZSM 011 [i.8].
ZSM. INTENT. MODEL. GEN. 002	ZSM intent model is recommended to use cases agnostic.	
ZSM. INTENT. MODEL. GEN. 003	ZSM intent model is recommended to allow a common structure.	
ZSM. INTENT. MODEL. GEN. 004	ZSM intent model is recommended to provide the extension mechanism to support the expressiveness for specific domains.	
ZSM. INTENT. MODEL. GEN. 005	ZSM intent model is recommended to provide the reusing mechanism for different organizations.	
ZSM. INTENT. MODEL. GEN. 006	ZSM intent model is recommended to avoid ambiguity to make sure the information elements provided by an intent will not be interpreted by different ways.	

Table 5.4.2-2 provides the general requirements for ZSM intent model information elements.

Table 5.4.2-2: General requirements for ZSM intent model information elements

Req Number	ZSM Requirement Description	Comments
ZSM. INTENT. MODEL. INFO. 001	The designing of information elements of ZSM intent model are recommended to support one or more intent expectations to express the requirements, goals and constraints of intent creator.	Corresponding to the ZSM. INTENT. MODEL. GEN. 001 in Table 5.4.2-1.
ZSM. INTENT. MODEL. INFO. 002	The designing of information elements of ZSM intent model are recommended to be use case agnostic.	Corresponding to the ZSM. INTENT. MODEL. GEN. 002 in Table 5.4.2-1.
ZSM. INTENT. MODEL. INFO. 003	The designing of information elements of ZSM intent model are recommended to allow a common structure.	Corresponding to the ZSM. INTENT. MODEL. GEN. 003 in Table 5.4.2-1.
ZSM. INTENT. MODEL. INFO. 004	The designing of information elements of ZSM intent model are recommended to provide the extension mechanism to support the expressiveness for specific domains.	Corresponding to the ZSM. INTENT. MODEL. GEN. 004 in Table 5.4.2-1.
ZSM. INTENT. MODEL. INFO. 005	The designing of information elements of ZSM intent model are recommended to provide the reusing mechanism for different organizations.	Corresponding to the ZSM. INTENT. MODEL. GEN. 005 in Table 5.4.2-1.
ZSM. INTENT. MODEL. INFO. 006	The designing of information elements of ZSM intent model are recommended to avoid ambiguity to make sure the information elements provided by an intent would not be interpreted by different ways.	Corresponding to the ZSM. INTENT. MODEL. GEN. 006 in Table 5.4.2-1.

Table 5.4.2-3 provides the general requirements for ZSM intent model attributes.

Table 5.4.2-3: General requirements for ZSM intent model attributes

Req Number	ZSM Requirement Description	Comments
ZSM. INTENT. MODEL. ATTR. 001	The designing of attributes of ZSM intent model are recommended to support the main KPIs, including resource efficiency, multi-tenancy support, latency, positioning, trust/privacy and OPEX reduction.	Derived from the cloud network convergence + intelligent slicing use case, more details can be found in clause 4.3.2 of ETSI GR ZSM 011 [i.8].
ZSM. INTENT. MODEL. ATTR. 002	The designing of attributes of ZSM intent model are recommended to support the parameters related to cloud private line services intent, including service end-points, service connection topology type, service ingress flow identifiers (if applicable), bandwidth, latency, scheduling parameters, availability, restoration.	Derived from the cloud private line services use case, more details can be found in clause 4.3.3 of ETSI GR ZSM 011 [i.8].

5.4.3 Intent Information Model

ETSI GR ZSM 011 [i.8] holds the view that intent modelling needs a common expressiveness and an extension mechanism to promote the intent driven operations across management domains. In ETSI GR ZSM 011 [i.8], the different meta models are summarized. The first one is referred to TM Forum IG1253A [i.10], a set of expectation classes is summarized, including delivery, property, metric, allocation, coexistence, sharing, connection and reporting expectation. In the present document, the intent related works of TM Forum is surveyed in clause 5.5, including targeted use cases, intent definition, model federation of intent and intent management.

A second model called "declarative intent model" is as follows.

Intent model is composed by intent expectations, intent targets, intents, managed entities, context, filter information and intent fulfillment status.

The detailed attributes of classes are found in clause 5.4.4.6 and clause A.2 of ETSI GR ZSM 011 [i.8].

5.4.4 Intent Management

5.4.4.1 Management Roles

The intent life cycle management of a certain intent object instance is distributed between two intent management entities. The intent management entity is possible to assume two different roles, intent owner and intent handler.

5.4.4.2 Management Operations

In ETSI GR ZSM 011 [i.8], several options are surveyed and the operations on intent interfaces will be set up according to CRUD pattern. The operations including mandatory and optional operations.

The mandatory operations include Create, Read, Update and Delete. The optional operations are Judge, Feasibility, Best.

In addition, Activate, Deactivate, Suspend, Resume, Test, Logging, Notification and Verification capabilities are introduced as optional operations to ensure trust in intent-driven autonomy in ETSI GR ZSM 011 [i.8].

5.4.4.3 Life Cycle

The life cycle of intent begins before the intent is received. The life cycle is divided into 5 stages which are detection, investigation, definition, distribution and operation.

In the detection stage, the intent owner determines whether it is needed to define new intents or change/remove existing intents.

In the investigation stage, the intent owner determines which intent handler is suitable based on the domain responsibilities, and executes the feasibility negotiation.

In the definition stage, the intent owner specifies and create a set of intent that are needed to be sent to intent handler.

In the distribution stage, the intent owner distributes the defined intent.

In the operation stage, the intent handler operates its intent handling domain based on the received and accepted intent. The intent handler cannot change the intent. It is possible to report the intent fulfillment state to the intent owner.

More details can be found in clause 5.5.1 of ETSI GR ZSM 011 [i.8].

5.5 TM Forum ANP

5.5.1 Targeted Use Case and Intent Definition

The definition of intent in TM Forum is inspired by IRTF. An intent provides the goals, requirements and constraints by declarative way. The definition of intent is "Intent is the formal specification of all expectations including requirements, goals, and constraints given to a technical system", which is proposed by TM Forum Autonomous Networks Project in IG1253 [i.9].

At present, TM Forum has not released use case related documents for intent, but TM Forum is positioned to cover all management layers and specific domains. And, based on the work plan of intent, the relevant use case will be released in IG1253E (a sub-document of IG1253 series) later.

5.5.2 Requirements

According to the definition and other modelling related content, Table 5.5.2-1 provides the general requirements for TM Forum intent model.

Table 5.5.2-1: General requirements for TM Forum intent model

Req Number	TM Forum Requirement Description	Comments
TM Forum. INTENT. MODEL. GEN. 001	TM Forum intent model supports one or more intent expectations to express the requirements, goals and constraints of intent creator.	Based on the definition of intent, intent is the formal specification of all expectations including requirements, goals, and constraints given to a technical system.
TM Forum. INTENT. MODEL. GEN. 002	TM Forum intent model supports intent report.	Based on the clause 8 of [i.9], intent report is TM Forum's requirement in the operation stage. The intent handler is able to report the status of intent to the intent owner.
TM Forum. INTENT. MODEL. GEN. 003	TM Forum intent model supports model federation to provide the extension mechanism for specific domains.	The model federation is introduced in [i.9]. The domain independent expression is defined in intent common model, and the domain specific concerns are defined by intent extension model and intent information model.

Table 5.5.2-2 provides the general requirements for TM Forum intent model information elements.

Table 5.5.2-2: General requirements for TM Forum intent model information elements

Req Number	TM Forum Requirement Description	Comments
TM Forum. INTENT. MODEL. INFO. 001	The designing of information elements of TM Forum intent model supports the "Expectation" to express the requirements, goals and constraints of intent creator.	Corresponding to the TM Forum. INTENT. MODEL. GEN. 001 in Table 5.5.2-1. More details can be found in clause 4 vocabulary specification of IG1253A [i.10].
TM Forum. INTENT. MODEL. INFO. 002	The designing of information elements of TM Forum intent model supports intent report.	Corresponding to the TM Forum. INTENT. MODEL. GEN. 002 in Table 5.5.2-1.
TM Forum. INTENT. MODEL. INFO. 003	The designing of information elements of TM Forum intent model supports model federation to provide the extension mechanism for specific domains.	Corresponding to the TM Forum. INTENT. MODEL. GEN. 003 in Table 5.5.2-1.
TM Forum. INTENT. MODEL. INFO. 004	The designing of information elements of TM Forum intent model supports "Context", the objects of which carry additional conditions and applicability ranges related to requirements.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "Context" is defined as a class for intent modelling.
TM Forum. INTENT. MODEL. INFO. 005	The designing of information elements of TM Forum intent model supports "DeliveryExpectation" to express what is needed to be delivered.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "DeliveryExpectation" is defined as a class for intent modelling.
TM Forum. INTENT. MODEL. INFO. 006	The designing of information elements of TM Forum intent model supports "DeliveryExpectationReport" to report the state of delivery expectation.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "DeliveryExpectationReport" is defined as a class for intent reporting.
TM Forum. INTENT. MODEL. INFO. 007	The designing of information elements of TM Forum intent model supports "DeliveryParam" to specify the detailed requirements of delivery expectation.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "DeliveryParam" is defined as the class for intent modelling and intent reporting.
TM Forum. INTENT. MODEL. INFO. 008	The designing of information elements of TM Forum intent model supports "ExpectationParam" to express the detailed parameters of expectation.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "ExpectationParam" is defined as a class for intent modelling.
TM Forum. INTENT. MODEL. INFO. 009	The designing of information elements of TM Forum intent model supports "ExpectationReport" to report the measured state of requirements and goals.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "ExpectationReport" is defined as a class for intent reporting.
TM Forum. INTENT. MODEL. INFO. 010	The designing of information elements of TM Forum intent model supports "ExpectationReportParam", which is used as parameters of expectation reports.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "ExpectationReportParam" is defined as a class for intent reporting.
TM Forum. INTENT. MODEL. INFO. 011	The designing of information elements of TM Forum intent model supports "ExpectationTarget" to represent the targets of expectation objects.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "ExpectationTarget" is defined as a class for intent modelling.
TM Forum. INTENT. MODEL. INFO. 012	The designing of information elements of TM Forum intent model supports "Information" to express the additional information which is not related to requirements.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "Information" is defined as a class for intent modelling.
TM Forum. INTENT. MODEL. INFO. 013	The designing of information elements of TM Forum intent model supports "InformationElement" which is involved in additional information.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "InformationElement" is defined as a class for intent modelling.
TM Forum. INTENT. MODEL. INFO. 014	The designing of information elements of TM Forum intent model supports "Intent", the object of which is represents the individual intent.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "Intent" is defined as a class for intent modelling.
TM Forum. INTENT. MODEL. INFO. 015	The designing of information elements of TM Forum intent model supports "IntentManagementState" to specify the state in intent management state machine.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "IntentManagementState" is defined as a class for intent modelling and intent handling.
TM Forum. INTENT. MODEL. INFO. 016	The designing of information elements of TM Forum intent model supports "IntentReport" which is used in the communication between intent management functions.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "IntentReport" is defined as a class for intent reporting.

Req Number	TM Forum Requirement Description	Comments
TM Forum. INTENT. MODEL. INFO. 017	The designing of information elements of TM Forum intent model supports "PropertyExpectation" to express a requirement based on a property of the expectation target.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "PropertyExpectation" is defined as a class for intent modelling.
TM Forum. INTENT. MODEL. INFO. 018	The designing of information elements of TM Forum intent model supports "PropertyExpectationReport" to report the state of the property expectation	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "PropertyExpectationReport" is defined as a class for intent reporting.
TM Forum. INTENT. MODEL. INFO. 019	The designing of information elements of TM Forum intent model supports "PropertyParam" to express the detailed requirements of property expectations.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "PropertyParam" is defined as a class for intent reporting and intent modelling.
TM Forum. INTENT. MODEL. INFO. 020	The designing of information elements of TM Forum intent model supports "ReferenceableNode" to address via IRI/URI.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "ReferenceableNode" is defined as a class for intent modelling.
TM Forum. INTENT. MODEL. INFO. 021	The designing of information elements of TM Forum intent model supports "ReportingExpectation" to express the requirement about that the intent report will be sent under when and what conditions.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "ReportingExpectation" is defined as a class for intent modelling.
TM Forum. INTENT. MODEL. INFO. 022	The designing of information elements of TM Forum intent model supports "ReportingParam" to specify the requirements for intent report.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "ReportingParam" is defined as a class for intent modelling and intent reporting.
TM Forum. INTENT. MODEL. INFO. 023	The designing of information elements of TM Forum intent model supports "ReportingExpectationReport" to report the state of reporting expectation.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "ReportingExpectationReport" is defined as a class for intent reporting.
TM Forum. INTENT. MODEL. INFO. 024	The designing of information elements of TM Forum intent model supports "RequirementDefiner" to specify the requirements that the intent handler will comply with.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "RequirementDefiner" is defined as a class for intent modelling.
TM Forum. INTENT. MODEL. INFO. 025	The designing of information elements of TM Forum intent model supports "RequirementElement" which is involved in setting or reporting on requirements.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "RequirementElement" is defined as a class for intent reporting.
TM Forum. INTENT. MODEL. INFO. 026	The designing of information elements of TM Forum intent model supports "RequirementExplainer" to specify the constraints and side-conditions for requirements.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "RequirementExplainer" is defined as a class for intent modelling.
TM Forum. INTENT. MODEL. INFO. 027	The designing of information elements of TM Forum intent model supports "RequirementReporter" which is used to report the requirements that specified by "RequirementDefiner" object.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "RequirementReporter" is defined as a class for intent reporting.
TM Forum. INTENT. MODEL. INFO. 028	The designing of information elements of TM Forum intent model supports "RequirementReportExplainer" to specify the constraints and side-conditions for requirements of intent report.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "RequirementReportExplainer" is defined as a class for intent reporting.

Table 5.5.2-3 provides the general requirements for TM Forum intent model attributes.

Table 5.5.2-3: General requirements for TM Forum intent model attributes

Req Number	TM Forum Requirement Description	Comments
TM Forum. INTENT. MODEL. ATTR. 001	The designing of attributes of TM Forum intent model supports "IntentHandlingEvent" to specify the event that occurs in the process of intent handling.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "IntentHandlingEvent" is defined for intent modelling and intent handling.
TM Forum. INTENT. MODEL. ATTR. 002	The designing of attributes of TM Forum intent model supports "IntentManagementProcedure" to specify the intent or intent report in which procedure of intent life cycle.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "IntentManagementProcedure" is defined for intent modelling and intent handling.
TM Forum. INTENT. MODEL. ATTR. 003	The designing of attributes of TM Forum intent model supports "IntentHandlingState" to specify the state in intent handling state machine.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "IntentHandlingState" is defined for intent modelling and intent handling.
TM Forum. INTENT. MODEL. ATTR. 004	The designing of attributes of TM Forum intent model supports "RejectionReason" to express the reason why the intent was rejected.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "RejectionReason" is defined for intent reporting.
TM Forum. INTENT. MODEL. ATTR. 005	The designing of attributes of TM Forum intent model supports "IntentUpdateState" which is used to specify the state in the intent update state machine.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "IntentUpdateState" is defined for intent reporting and intent handling.
TM Forum. INTENT. MODEL. ATTR. 006	The designing of attributes of TM Forum intent model supports "ParamReason" to express the reason why there is an issue with the expectation parameter.	Derived from the clause 4 vocabulary specification of IG1253A [i.10]. "ParamReason" is defined for intent reporting.

5.5.3 Model Federation of Intent

Model federation is introduced in TM Forum IG1253 [i.9], which includes intent common model, intent extension model and intent information model. The intent common model is the only mandatory model in model federation. The expectation class and the related common properties are defined in intent common model which is the generic root model of intent and intent reporting.

The domain independent expression is defined in intent common model, and the domain specific concerns are defined by intent extension model and intent information model. The intent extension model is defined based on the intent common model to extend its expressiveness. The intent information model is independent from intent, that means it is not designed for any one specific intent, but rather, models the concept of any intent independently of its content.

In intent common model, the "Intent" is the instance for class "RequirementDefiner". "Expectation" and "ExpectationParam" are subclasses of "RequirementDefiner". Similarly, the "IntentReport" is the instance for class "RequirementReporter". "ExpectationReport" and "ExpectationReportParam" are subclasses of "RequirementReporter". "icm:reportsAbout" is used to link the "RequirementReporter" to the "RequirementDefiner".

A set of generic "Expectation" subclasses are defined, which are "DeliverExpectation", "PropertyExpectation", and "ReportingExpectation". The corresponding "ExpectationParam" subclasses are "DeliveryParam", "PropertyParam" and "ReportingParam" which are used to express the requirement and report the status.

The objects of classes "RequirementExplainer" and "Context" do not carry requirements directly, but carry the information that is related to requirement. The classes "RequirementReportExplainer" and "ReportContext" are the mirror of classes "RequirementExplainer" and "Context".

The basic classes and properties of intent common model and the properties of the intent report are shown in clause 4 of TM Forum IG1253A [i.10].

5.5.4 Intent Management

5.5.4.1 Management Roles

There are two management roles in TM Forum IG1253C [i.11], which are intent owner and intent handler. Intent owner is the intent creator and in charge in the life cycle management of an intent object. Intent handler is able to receive the intent object from the intent owner. It is possible for the intent management function to assume the intent owner and intent handler, the role depends on the position where the intent management function is.

5.5.4.2 Management Operations and intent Life Cycle

In TM Forum IG1253C [i.11], there are 5 phases in intent life cycle, which are detection, investigation, definition, distribution and operation.

In the detection stage, the intent owner monitors and analyses the states of underlying infrastructure and determines whether the requirements, goals or constraints need to be modified.

In the investigation stage, the intent owner searches the suitable intent manager to handle the intent.

In the definition stage, the intent owner decides the solution strategy (by defining the intent) based on the results of detection and investigation stages. If needed, intent owner has the possibility to create a new intent, modifies or retires the existing intent.

In the distribution stage, intent owner distributes the defined intent. Setting a new intent, modifying the existing intent and removing the intent are included.

In the operation stage, intent handler operates the autonomous domain based on the intent and reports the status of intent.

In TM Forum IG1253 [i.9], there are several mandatory and optional procedures to support the communication between the intent owner and intent handler. The mandatory procedures includes: SET, REMOVE and REPORT. The optional procedure includes PREFERENCE, PROBE, BEST, JUDGE, ESTIMATE and PROPOSAL the detailed information is found in clause 10 of TM Forum IG1253 [i.9].

5.6 IRTF NMRG

5.6.1 Targeted Use Case and Intent Definition

The definition of intent is "A set of operational goals (that a network meets) and outcomes (that a network is supposed to deliver), defined in a declarative manner without specifying how to achieve or implement them" in draft-irtf-nmrg-ibn-concepts-definitions [i.12].

Based on IRTF draft-irtf-nmrg-ibn-intent-classification [i.13], intent is possible to be classified by users and solutions. Aims to different solutions, some intent examples are given in [i.13]. The Intent Descriptions of each requirement have an Intent example. These examples are quoted in Table 5.6.1-1.

Table 5.6.1-1: The related information of intent examples for carrier solution

Creator of intent	Intent examples (extracted from the Intent Descriptions in [i.13])	Corresponding clause in intent-classification [i.13]	Corresponding management layer (Business/Service/Resource)
CSC	Always maintain high quality of service and high bandwidth for gold level subscribers.	6.3.1	Business
	Request reliable service during peak traffic periods for apps of type video.	6.3.1	Business
NOP	Request network service with delay guarantee for access customer A.	6.3.1	Service
	Request high priority queueing for traffic of class A.	6.3.1	Service
	Request migration of all services in Network N to backup path P.	6.3.1	Service
	Ensure the load on any link in the network is not higher than 50 %.	6.3.1	Service
CSP	Provide service S with guaranteed bandwidth for customer A.	6.3.1	Service
	Provide network guarantees in terms of security, low latency and high bandwidth.	6.3.1	Service
	Update service operator portal platforms and their software regularly. Move services from network operator 1 to network operator 2.	6.3.1	Service
	Request network service guarantee to avoid network congestion during special periods such as Black Friday, and Christmas.	6.3.1	Service
Application Developer	API to request network to watch HD video 4K/8K.	6.3.1	Business
	API to request network and monitoring and traffic grooming.	6.3.1	Service
	API to request network resources configuration.	6.3.1	Resource
	API to request server migrations.	6.3.1	Resource
	API to design network load balancing strategies during peak times.	6.3.1	Resource

Table 5.6.1-2: The related information of intent examples for data center solution

Creator of intent	Intent examples (extracted from the Intent Descriptions in [i.13])	Corresponding clause in intent-classification [i.13]	Corresponding management layer (Business/Service/Resource)
CSC	Request GPU computing and storage resources to meet 10k video surveillance services.	6.4.1	Business
	Request dynamic computing and storage resources of the service in special and daily times.	6.4.1	Business
NOP	Request connectivity between VMs A, B, and C in Network N1.	6.4.1	Resource
	Request automatic life -cycle management of VM cloud resources.	6.4.1	Resource
	Request upgrade operating system to version X on all VMs in Network N1.	6.4.1	Resource
	In case of emergency, automatically migrate all cloud resources to DC2.	6.4.1	Service
	Request underlay service between DC1 and DC2 with bandwidth B.	6.4.1	Service
	Establish and allocate DHCP address pool.	6.4.1	Resource
	Request automatic rapid detection of device failures and pre-alarm correlation.	6.4.1	Resource
Application Developer	For all traffic flows that need NFV service chaining, restrict the maximum load of any VNF node/container below 50 % and the maximum load of any network link below 70 %.	6.4.1	Resource
	API to request configuration of VMs, or DB Servers.	6.4.1	Resource
	API to request automatic life cycle management of cloud resources.	6.4.1	Resource
	API to request real-time monitoring of device condition.	6.4.1	Resource
	API to request dynamic management of IPv4 address pool resources.	6.4.1	Resource
	API to request automatic rapid detection of device failures and pre-alarm correlation.	6.4.1	Resource
API to request load balancing thresholds.	6.4.1	Resource	

Table 5.6.1-3: The related information of intent examples for enterprise solution

Creator of intent	Intent examples (extracted from the Intent Descriptions in [i.13])	Corresponding clause in intent-classification [i.13]	Corresponding management layer (Business/Service/Resource)
CSC	Request access to VPN service. Request video conference between user A and B.	6.5.1	Business
	Create a video conference type for a weekly meeting.	6.5.1	Business
Administrator	For any user of application X, the arrival time of hologram objects of all the remote tele- presenters are recommended to be synchronized within 50ms to reach the destination viewer for each conversation session create management VPN connectivity for type of service A.	6.5.1	Service
	Configure switches in campus network 1 to priorities traffic of type A.	6.5.1	Resource
	Request network security automated tasks such as Web filtering and DDOS cloud protection.	6.5.1	Service
	In case of emergency, automatically shift all traffic of type A through network N.	6.5.1	Service
Application Developer	API for request to open a VPN service.	6.5.1	Business
	API for request network bandwidth and latency for hosting video conference.	6.5.1	Business
	API for request of network devices configuration.	6.5.1	Resource
	API for requesting automatic monitoring and interception for network security	6.5.1	Service
	API for strategy intent in case of emergencies.	6.5.1	Business/Service/Resource

Most of the Intent examples shown above in the tables are not using Natural intent based language (e.g. "API for ..." is not an Intent description).

However, some of the intent examples do use natural language of varying levels of ambiguity, therefore the intent is recommended to be described by a declarative language which the draft-irtf-nmrg-ibn-concepts-definitions [i.12] currently does not have.

5.6.2 IRTF Requirements

According to the use cases, definition and other modelling related content, Table 5.6.2-1 provides the general requirements for IRTF intent model.

Table 5.6.2-1: General requirements for IRTF intent model

Req Number	IRTF Requirement Description	Comments
IRTF. INTENT. MODEL. GEN. 001	IRTF intent model is recommended to support a specific intent expression form, which is able to be modelled based on the three-tuple as { Context, Capabilities, Constraints }.	In IRTF, the modelling of intents only be described as the intent expression like the three-tuple in clause 5.6.3.
IRTF. INTENT. MODEL. GEN. 002	IRTF intent model is recommended to support intent report.	Based on the clause 6 of [i.12], report is necessary for intent user to assess whether the executed intent has produced the desired effect.

Table 5.6.2-2 provides the general requirements for IRTF intent model information elements.

Table 5.6.2-2: General requirements for IRTF intent model information elements

Req Number	IRTF Requirement Description	Comments
IRTF. INTENT. MODEL. INFO. 001	The designing of information elements of IRTF intent model are recommended to support a specific intent expression form, which is able to be modelled based on the three-tuple as { Context, Capabilities, Constraints }.	Corresponding to the IRTF. INTENT. MODEL. GEN. 001 in Table 5.6.2-1.
IRTF. INTENT. MODEL. INFO. 002	The designing of information elements of IRTF intent model are recommended to support intent report.	Corresponding to the IRTF. INTENT. MODEL. GEN. 002 in Table 5.6.2-1.

Table 5.6.2-3 provides the general requirements for IRTF intent model attributes.

Table 5.6.2-3: General requirements for IRTF intent policy model attributes

Req Number	IRTF Requirement Description	Comments
IRTF. INTENT. MODEL. ATTR. 001	The designing of attributes of IRTF intent model are recommended to support the certain operational goals, that a network is recommended to meet.	Based on the definition of intent in IRTF, intent is a set of operational goals (that a network are recommended to meet) and outcomes (that a network is supposed to deliver), defined in a declarative manner without specifying how to achieve or implement them.
IRTF. INTENT. MODEL. ATTR. 002	The designing of attributes of IRTF intent model are recommended to support the certain outcomes, which a network is supposed to deliver.	Based on the definition of intent in IRTF, intent is a set of operational goals (that a network are recommended to meet) and outcomes (that a network is supposed to deliver), defined in a declarative manner without specifying how to achieve or implement them.

5.6.3 Intent Information Model

In IRTF, the modelling of intents only be described as the intent expression like the three-tuple below. In fact, the intent expression is an alternate concept. The element in intent expression is possible to be reflected to a class in intent information model, therefore, the intent expression is possible to be an alternate concept to do the gap analysis.

In IRTF draft-irtf-nmrg-ibn-intent-classification [i.13], the modelling of intents is possible to be abstracted by using the three-tuple as follows:

{ **Context, Capabilities, Constraints** }

Context is the basic of intent, and it determines whether the intent is relevant to the situation at present. Context is used to compare with the intent database to determine the input intent type which is possible to be customer service intent, strategy intent, network service intent, network intent and operational task intent.

Capabilities are used to describe the capabilities that an intent is possible to be reached. Based on intent expression and programming paradigms is possible to have different forms. For input intent, expressing the intent requires the ability provided by the system. For the intent database, it represents the ability provided by the system.

Constraints define the restrictions on capabilities to be used for the particular context.

5.6.4 Intent Management

5.6.4.1 Management Roles

Intents are managed by the intent user.

5.6.4.2 Management Operations and Life Cycle

Intents are possible to be divided into transient intent and persistent intent in IRTF draft-irtf-nmrg-ibn-intent-classification [i.13]. A transient intent has no life cycle management. When the specified operation is executed successfully, the intent is completed and the target object is no longer affected. A persistent intent is managed by intent life cycle. Once the intent is activated and deployed successfully, the system will keep the intent active until the intent is de-activated or removed.

The intent life cycle is possible to be found in draft-irtf-nmrg-ibn-concepts-definitions [i.12]. There are two functional planes and three spaces. In the horizontal view, the functional planes are made up of fulfillment and assurance. In the vertical view, the user space, translations/IBS (intent-based system) space and network ops space show the different interactions between these functions and the rest of the system.

In user space, the intent life cycle defines the interaction between the user and the IBS. This includes functions that create the intent by the user, recognize the intent by the network, to report the network state related to the intent, and enable users to assess whether the executed intent has produced the desired effect. Intent reporting enables the progress towards achieving the goals of the intent to be monitored.

In the translation/IBS space, the intent life cycle translates the intent into a form that the network is possible to understand. This is possible to be conceptualized as transforming intent to network operations. This transformation requires planning and optimizing processes that guide the actions taken towards achieving the goal(s) of the intent. In this space, the observation and monitoring results of the network are recommended to be analysed and summarized, so as to verify whether the network state meets the intended expectation, and take corrective action when necessary. In addition, the results of analysis and summary is possible to be abstracted, which is conducive to the reporting function in user space.

In the network operations space, the intent life cycle involves orchestration, configuration, monitoring, and measurement, which are conducive to executing intent and observing its effect on the network.

There are two loops included:

- The inner loop is between IBS and Network Operations space, and is completely autonomic without involving any human interaction. This loop automatically analyses and verifies that the intent is performing as expected, based on observing the results of the network operations space.
- The outer loop extends the intent control loop to the user space, and the user is possible to act or adjust the intent according to the feedback given by the IBS. Hence, intent is managed by life cycle, that is possible to be generated, modified, changed, or removed.

6 Analysis

6.1 Analysis summary

Based on the survey of clause 5, the analysis summary would be carried out from the following aspects:

- 1) Targeted use cases

Table 6.1-1: The related information of targeted use-cases

SDOs and the corresponding documents	Creator of intent	Corresponding management layer (Business/Service/Resource)
ETSI GS ENI 001 [i.1]	CSP	Service
ETSI TS 128 312 [i.4]	CSP and NOP	Service and Resource
ETSI GR NFV-IFA 041 [i.5]	NOP	Resource
ETSI GR ZSM 011 [i.8]	CSP	Service
TM Forum IG1253E	Unreleased	Business, Service and Resource
IRTF NMRG [i.12]	CSC, CSP, NOP and the specific roles	Business, Service and Resource
NOTE: TM Forum has not released use case related documents for intent, but TM Forum aims to cover all management layers and specific domains. The relevant use case would be released in IG1253E (a sub-document of IG1253 series) later.		

At present, only the targeted use cases of TM Forum and IRTF covered the three management layers (business/service/resource). The use cases of 3GPP are for the service and resource management layer, the use cases of ETSI ISG NFV-IFA are only for the resource management layer, and the use cases of ETSI ISG ZSM only covered the service management layer.

Therefore, if the positioning of ETSI ISG ENI is to cover the targeted use case of a certain SDO, it is recommended that ETSI ISG ENI refers to the corresponding document listed in Table 6.1-1. If the positioning of ETSI ISG ENI is to cover the general intent use case scenarios, it is recommended that ETSI ISG ENI aligns with the analysis and the recommendation of the present document.

2) Intent definition

Table 6.1-2: The definition of intent of SDOs

SDOs and the corresponding documents	Intent definition
ETSI GS ENI 005 [i.2]	Policy: "set of rules that is used to manage and control the changing and/or maintaining of the state of one or more managed objects". Intent policy: "type of policy that uses statements from a restricted natural language (e.g. an external DSL) to express the goals of the policy, but does not specify how to accomplish those goals".
ETSI TS 128 312 [i.4]	"The expectations including requirements, goals and constraints given to a 3GPP system, without specifying how to achieve them."
ETSI GR NFV-IFA 041 [i.5]	"A formal specification of all expectations including requirements, goals, and constraints given to a system."
ETSI GR ZSM 011 [i.8]	"Intent is the formal specification of the expectations, including requirements, goals, and constraints, given to a technical system."
TM Forum IG1253 [i.9]	"Intent is the formal specification of all expectations including requirements, goals, and constraints given to a technical system."
IRTF NMRG [i.12]	"A set of operational goals (that a network is recommended to meet) and outcomes (that a network is supposed to deliver), defined in a declarative manner without specifying how to achieve or implement them."
NOTE:	The definition of intent in ETSI GR ZSM 011 [i.8] is a suggestion, not a formal definition. It is suggested to adopt the definition of intent in TM Forum IG1253 [i.9].

At present, the above SDOs agree that the intent is used to describe "what", not "how". Therefore, in a broad sense, both declarative and intent policies in ETSI GS ENI 005 [i.2] conform to this definition. The difference is that an ENI declarative policy is written using formal logic, whereas an ENI intent policy is written in a restricted natural language.

ETSI GS ENI 005 [i.2] is more focused on building model-driven systems, while the other SDOs pay more attention to the exchanged information on the external interface. In a narrow sense, ETSI GS ENI 005 [i.2] further refines the declarative policy and the intent policy by defining the description language of the intent policy as a restricted natural language, and the declarative policy use a formal logic.

Based on the definitions in Table 6.1-2, it is easy to get the consensus of all SDOs that the "goal" is included in "what". For other terms specific to SDOs, it needs to be aligned before further analysis. Therefore, if the positioning of ETSI ISG ENI is to cover the targeted use case of a certain SDO, it is recommended that ETSI ISG ENI considers aligning with the terms of the certain SDO or providing explicit mapping; If the positioning of ETSI ISG ENI is to cover the general intent use case scenarios, it is recommended that ETSI ISG ENI extract the consensus of SDOs on intent definitions firstly, and then align terms or provide explicit mapping for the part of consensus.

3) Intent information model

Table 6.1-3: The intent information model of SDOs

SDOs and the corresponding documents	Intent information model
ETSI GS ENI 005 [i.2] and ETSI GS ENI 019 [i.3]	The unified modelling of different policy types is supported by a number of abstractions. Modelling naming rules and guidelines are provided. The details of the models are specified in [i.3]. The base models inherited from MEF are complete, but extensions needed by ENI still need to be finished.
ETSI TS 128 312 [i.4]	The designing of intent information model relies on use cases to derive specific classes and attributes in specific domains. More work needs to be done to finish them. At present, the use case only involves the wireless access network and the mobile core network, and its applicability to other domain is unknown.
ETSI GR NFV-IFA 041 [i.5]	There is no intent information model. The normative work of intent information model would be specified in ETSI GS NFV-IFA 050 [i.14]. The modelling of intents from other standards organizations (e.g. TM Forum, 3GPP SA5) would be used as a reference in the development of the NFV-MANO intent information models.
ETSI GR ZSM 011 [i.8]	Two intent modelling options are provided, one is the TM Forum's intent information model, and the other is called "declarative intent model". The second model is similar to 3GPP and lacks specific guidance for the specific domains. The current use case only involves the network management layer, and its applicability to other management layers and specific domains is unknown.
TM Forum IG1253 [i.9] and IG1253A [i.10]	TM Forum uses a federation of ontologies (in TM Forum IG1253 [i.9] and IG1253A [i.10], it is called model federation), which consists of intent common model, intent extension model and intent information model. The design of common classes and attributes in the intent common model is good but still needs work. It provides modelling guidance for the intent extension model and intent information model of the specific domain. The modelling method is flexible.
IRTF NMRG [i.13]	The three-tuple {context, capabilities, constraints} is used for intent modelling, but the description of these three components is lacking (for example, would the components be introduced as a class or attribute in the intent information model), hence, it is not very referential.

At present, the most mature intent information model are ENI, 3GPP and TM Forum (TM Forum offers an ontology solution). The modelling of other SDOs is not complete. However, if those models are published with a referenceable URI, then both the ENI models and the TM Forum ontologies could reference them.

Therefore, if the positioning of ETSI ISG ENI is to cover the targeted use case of a certain specific domain and its related work is mature (e.g. 3GPP), it is recommended that ETSI ISG ENI considers aligning with the existing work of the certain SDO or providing explicit mapping; If the positioning of ETSI ISG ENI is to cover the general intent use case scenarios, it is recommended that ETSI ISG ENI refer to the intent modelling work of TM Forum and determine how to integrate its ontologies into its models.

NOTE: ETSI GS ENI 005 [i.2] has stated that its future direction is to build semantic networks using models and ontologies. Examination of the TM Forum ontologies fits into this future direction.

4) Intent management

Table 6.1-4: The information of intent management SDOs

SDOs and the corresponding documents	Management roles	Management operations
ETSI GS ENI 005 [i.2]	The external entity and the ENI system	Create, Edit, Deploy, Activate, Meta policies, Deactivate, Remove.
ETSI TS 128 312 [i.4]	The MnS producer and MnS consumer	Creation, activating, de-activating, deleting, modifying, querying.
ETSI GR NFV-IFA 041 [i.5]	Intent Management is introduced as a role to expose the operations to external consumer	Creation, querying, deleting, subscription/notification and reporting.
ETSI GR ZSM 011 [i.8]	The intent owner and intent handler	Create, Read, Update and Delete are mandatory operations. The optional operations are Judge, Feasibility, Best. Activate, Deactivate, Suspend, Resume, Test, Logging, Notification and Verification capabilities are introduced as optional operations to ensure trust in intent-driven autonomy.
TM Forum IG1253 [i.9]	The intent owner and intent handler	SET, REMOVE and REPORT are mandatory procedures. PREFERENCE, PROBE, BEST, JUDGE, ESTIMATE and PROPOSAL are optional procedures.
IRTF NMRG [i.12]	The intent user and intent-based network	Recognize/generate, translate, refine, learn/plan/render, configure/provision, monitor/observe, validate, analyse, aggregate, abstract and report.

Based on Table 6.1-4, the general method is to embed intent management operations as part of a Functional Block and provide appropriate services to intent creators. The intent management Functional Block is able to act as a producer/handler, and the intent creator is able to act as a consumer/owner for the above SDOs. The naming of management roles is slightly different. In addition, TM Forum takes into account the decomposition of intents by layers, so the same module is able to act two roles. Finally, ENI uses the Policy Continuum to assign more granular roles to business, network, service, resource, and admin levels of the network.

At present, the CRUD pattern is mainly used for management operations, and asynchronous reporting mechanism is mentioned in a few SDOs. It is suggested that ETSI ISG ENI consider its own needs to choose the reference.

7 Recommendations

7.1 Recommendations on general guidelines

7.1.1 General guidelines

According to previous analysis, Table 7.1.1-1 provides the general guidelines for future work related to intent information model.

Table 7.1.1-1: The general guidelines related to intent information model

Guideline Number	Description
GENERAL. GUIDELINE. INTENT. INF. MOD. 001	It is recommended that the intent information model support the combination of one or more intent expectations to express the requirements, goals and constraints of the intent creator, completely.
GENERAL. GUIDELINE. INTENT. INF. MOD. 002	It is recommended that the intent information model is based on the specific general structure, vocabulary, semantics and mechanisms to avoid ambiguity.
GENERAL. GUIDELINE. INTENT. INF. MOD. 003	It is recommended that the description of intent information model is able to use formal machine readable semantics.
GENERAL. GUIDELINE. INTENT. INF. MOD. 004	It is recommended that the intent information model uses common modelling components that are independent of specific domains to support reuse by different organizations.
GENERAL. GUIDELINE. INTENT. INF. MOD. 005	It is recommended that the intent information model provides the extension mechanisms for specific domains to supplement the expressiveness of the model.
GENERAL. GUIDELINE. INTENT. INF. MOD. 006	It is recommended that the intent creator receives the intent fulfillment information by active and passive ways.
NOTE:	GENERAL. GUIDELINE. INTENT. INF. MOD. 004 and GENERAL. GUIDELINE. INTENT. INF. MOD. 005 are specific to the common part of general intent information model.

7.1.2 Proposed recommendations

Based on Table 7.1.1-1, Table 7.1.2-1 provides a list of recommendations related to intent information model.

Table 7.1.2-1: The recommendations related to intent information model

Rec Number	Description
REC. INTENT. INF. MOD. 001	It is recommended that the design of intent information model is able to provide multi-dimensional/category intent expectation classes, and allow multiple expectation classes to be combined.
REC. INTENT. INF. MOD. 002	It is recommended that the design of intent information model is able to follow the general method, i.e. based on the general structure, vocabulary and mechanism and according to the unified rules to modelling.
REC. INTENT. INF. MOD. 003	It is recommended that the design of intent information model is able to support human-machine and machine-machine interactions, and adopt industry-wide and mature description methods for modelling, such as UML, RDF, etc.
REC. INTENT. INF. MOD. 004	It is recommended that the design of intent information model is able to cover different domains' use cases, and use the intent class, intent expectation class and other domain independent classes and attributes as mandatory modelling components.
REC. INTENT. INF. MOD. 005	It is recommended that the design of intent information model is able to support the certain domain supplement the intent expectation class and related common components, and allow to use the existing intent independent information elements to supplement the expressiveness of the model.
REC. INTENT. INF. MOD. 006	It is recommended that the design of intent information model is able to support the intent reporting and intent creator querying.
NOTE:	REC. INTENT. INF. MOD. 004 and REC. INTENT. INF. MOD. 005 are specific to the common part of general intent information model, and its specific design needs to meet the requirements of clauses 5.1.2, 5.2.2, 5.3.2, 5.4.2, 5.5.2 and 5.6.2.

Annex A: Change History

Date	Version	Information about changes
09-02-2021	0.0.1	1 st draft.
18-02-2021	0.0.2	Aligned with ENI(21)000_005r2 and uploaded as v0.0.2.
08-03-2021	0.0.3	New baseline with clause 2.2, 3.3, 5.2.1 and 5.2.2 inputs.
31-03-2021	0.0.4	A wrong version created.
31-03-2021	0.0.5	New baseline with clause 5.2.3 and 5.2.4 inputs.
02-04-2021	0.0.6	A wrong version created.
10-05-2021	0.0.7	New baseline with combination of v0.0.5 and ENI(21)017_054r1.
14-05-2021	0.0.8	New baseline with clause 2.2 changes.
10-06-2021	0.0.9	New baseline with the title of sub-clause, annex changes and clause 5.6.1 inputs.
03-08-2021	0.0.10	New baseline with clause 5.6.1 changes and clause 5.6.2 inputs.
03-08-2021	0.0.11	New baseline with clause 5.6.3 and clause 5.6.4 inputs.
25-08-2021	0.0.12	New baseline with clause 2.2, 3.3, 5.2 changes and clause 5.3 inputs.
26-08-2021	0.0.13	New baseline with clause 5.3.2 changes.
08-09-2021	0.0.14	New baseline with clause 2.2, 3.3 changes and clause 5.7.1, 5.7.3, 5.7.4 inputs.
27-12-2021	0.0.15	A wrong version created.
21-01-2022	0.0.16	New baseline with clause 2.2, 3, 5.2.1, 5.2.3, 5.2.4, 5.3.1, 5.3.4, 5.6.3 and the sub-title of 5.4 changes.
08-02-2022	0.0.17	New baseline with clause 2.2, 3.3, 5.2.1, 5.2.2, 5.2.3, 5.3.2 changes and the clause 5.5 inputs.
23-02-2022	0.0.18	New baseline with clause 2.2 changes, and clauses of ONAP and ONOS are deleted to align with the scope.
10-03-2022	0.0.19	New baseline with clause 5.3.4, 5.6.1, 5.6.2, 5.6.4 changes and the clause 5.4 inputs.
10-06-2022	0.0.20	New baseline with ENI(22)000_093r1, ENI(22)000_110, ENI(22)000_111r1, ENI(22)000_112r1, ENI(22)000_113 and ENI(22)021_025r1 inputs.
22-07-2022	0.0.21	New baseline with ENI(22)022_029, ENI(22)022_030, ENI(22)022_035r1, ENI(22)022_036r1, ENI(22)022_037r1, ENI(22)022_038, ENI(22)022_039.
09-08-2022	0.0.22	New baseline with ENI(22)022_031r3, ENI(22)022_032r3, ENI(22)022_033r1, ENI(22)022_034r3.
08-09-2022	0.0.23	New baseline with ENI(22)000_169r1 and ENI(22)023_028.
21-10-2022	0.0.24	New baseline with ENI(22)000_207r3.

History

Document history		
V1.1.1	January 2023	Publication