

# ETSI GR ENI 035 V4.1.1 (2023-12)



GROUP REPORT

## Experiential Networked Intelligence (ENI); Definition of IP networks autonomicity level

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## Foreword

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

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## Modal verbs terminology

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# 1 Scope

The present document define network autonomy features and levels for IP networks, including the intelligent characteristics at each layer (from Level 0 to Level 5) and closed-loop management process, including:

- The concept, scope, dimension and overall method of IP network operation and management autonomous level classification, evolving from ETSI GR ENI 007 [i.2] and ETSI GR ENI 010 [i.3].
- IP network operation and management processes and classification method, including service and resource management.
- Technical requirements for autonomous level classification, and its key technical processes.

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## 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 GR ENI 004 (V3.1.1): "Experiential Networked Intelligence (ENI); Terminology".   |
| [i.2] | ETSI GR ENI 007 (V1.1.1): "Experiential Networked Intelligence (ENI); ENI Definition of Categories for AI Application to Networks". |
| [i.3] | ETSI GR ENI 010 (V1.1.1): "Experiential Networked Intelligence (ENI); Evaluation of categories for AI application to Networks".     |

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## 3 Definition of terms, symbols and abbreviations

### 3.1 Terms

For the purposes of the present document, the terms defined in ETSI GR ENI 004 [i.1] and the following apply:

**autonomous networks:** set of self-governing programmable and explainable systems that seamlessly deliver secure, context-aware, business-driven services that are created and maintained using model-driven engineering and administered by using policies

**evaluation dimension:** one of the five dimensions defined as ManMachine Interface, Decision Making Participation, Data Collection and Analysis, Degree of Intelligence and Environment Adaptability

NOTE: As defined in ETSI GR ENI 004 [i.1].

**evaluation object:** AI application or a part of Network Lifecycle, defined from two dimensions: the subsystems and the network lifecycle

**network lifecycle:** work-flow of activities including network planning, network deployment, network service provisioning, network changes, network maintenance, network optimization in real-time

**subsystem:** network element, management system, network platform

**technical expert:** person in charge of defining or supporting Operational Procedures within a CSP Network (e.g. in charge of Capacity Planning, Engineering and Designing, Troubleshooting)

## 3.2 Symbols

Void.

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GR ENI 004 [i.1] and ETSI GR ENI 007 [i.2] apply.

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# 4 Overall Framework for Autonomicity Classification targeting IP Network lifecycle

The IP network operation and management autonomous level classification framework describes the categorization dimensions (Intent management, Perception, Analysis, Decision making, Execution) of evaluating the autonomous level of specific network operation and management functional characteristics, and the categorization principle (human participation in the whole process) and qualitative descriptions (operator, system, operator + system).

Referring to ETSI GR ENI 010 [i.3], the TMF autonomous network closed-loop framework in the reference, the research on the intelligent hierarchical capability of network operation management mainly involves the service operation layer and the resource operation layer. From the end-to-end network service operation perspective, the IP network operation management process is mapped to the management and operation of one or more IP networks.

The main scope of IP network operation management in the present document involves the resource operation layer and the business operation layer, which are decomposed into life cycle operation phases (network planning, network deployment, network service provisioning, network changes, network maintenance, network optimization); each operation phase can be further split into operation sub-phases. The specific content is shown in table 1.

**Table 1: Overall Framework of Network Operation Management**

Operation management process	Operation Management Task
01 Network Planning, Design and Deployment	Requirements analysis and forecast
	Resource survey
	Resource analysis
	Solution design and decision-making
	Integrated configuration
02 Service provisioning	Onsite acceptance
	Service provisioning process
	Resource survey
	Solution design
03 Monitoring and Troubleshooting	Solution implementation and service verification
	Scenario-based monitoring
	Fault awareness
	Demarcation and location of faults
04 Network Change	Evaluation and Decision-making
	Solution implementation and service verification
	Intent translation
	Resource survey
05 Network Optimization	Change analysis and design
	Evaluation and Decision-making
	Change implementation and service verification
	Quality monitoring
	Optimization identification
	Optimization solution
	Solution implementation and service verification

The present document will focus on the closed-loop workflows of each sub-phase in the entire life cycle of IP network operation and management, and describe the operation management tasks that each process should have at different levels. The present document will serve as the basis for the evaluation of intelligent and hierarchical categorization of IP network operation and management.

In clause 5 a deep analysis of each of the operation management process and task identified in table 1 will be analysed for each autonomous level (from 0 to 5), as defined in ETSI GR ENI 007 [i.2].

Clause 6 gives the general procedures and detailed capabilities of typical scenarios, respectively, and specifies each typical scenario. Autonomic Classification for different autonomous levels of the more relevant scenarios involving IP network.

## 5 Autonomous Workflow for IP Network Operation and Management

### 5.1 Network Planning, Design and Deployment of IP Network

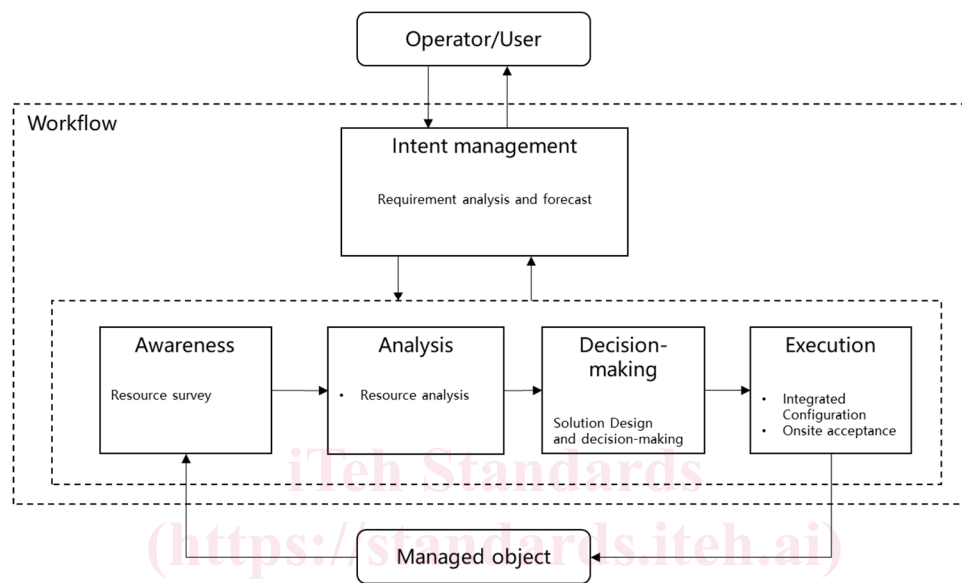
#### 5.1.1 Workflow and Task Definition

Although the network planning and design and deployment of the IP network are two phases of intelligent network operation and management, they together form a closed loop of operation and management activities.

Network planning refers to the process of surveying key information such as network coverage and high-value user distribution based on network KPI requirements, providing network planning requirements, and evaluating whether the planned solution meets network KPI requirements. The core objective of network planning is to improve the utilization of network resources.

Network deployment refers to the design of network topology, choosing appropriate hardware and software devices, estimating network capacity, IP/MPLS network design, and routing selection based on network planning. Network deployment also includes installing and deploying devices on site according to the network plan, configuration, and network test. The core objective of network deployment is to accurately construct the network according to the planning and to shorten the deployment duration as much as possible.

According to the closed-loop processing process, the IP network planning and deployment process can be divided into seven sub-tasks: network planning requirements, resource collection, resource analysis, solution design, simulation decision-making, integration configuration, and on-site acceptance. The seven subtasks can be mapped to the general workflow of network management, control, and operation, and used to further analyse the intelligent Classification of each task against the overall method of the intelligent classification framework.



**Figure 1: Mapping between network planning and design deployment tasks and operation management activities**

Definition of the operation management tasks for IP network planning, design and deployment:

- **Intent management tasks:**

- Requirement analysis and forecast: Output the network planning requirements based on the customer's business intention, service development objective, and network deployment plan (including Network topologies, IGP/BGP routings, IP addresses/VLANs space allocation, network resource bandwidth requirements, and service quality requirements).

- **Awareness tasks:**

- Resource survey: Based on the network planning objectives and requirements, survey the resource usage (such as traffic performance, and resource usage) of the whole existing network or some areas, and collect O&M data of the existing network. (Requirements related to monitoring and troubleshooting, network optimization, service provisioning, and network complaints) Conduct a survey.

- **Analysis tasks:**

- Resource analysis: Based on the network planning requirements and resource survey results, analyse the gap between the planning requirements and the current network resource status, obtain the resource bottleneck, and output the High-Level Design (HLD), including the IP network topology architecture (for example, multi-level AS and IP network topology). Network scale, service model (such as VPN network design), network security solution, and deployment solution.

- **Decision-making tasks:**

- Solution design and decision-making: Output the Low-Level Design (LLD) based on the HLD, existing network survey results, device procurement, and networking technical requirements. (such as network topology, board resources and interconnection relationships, IP addresses/VLANs space planning, IGP/BGP route selection and policy configuration, QoS policy formulation, security policy design, and network monitoring and optimization policies, etc.). Evaluate the correctness and rationality of network planning requirements and perform simulation verification based on the solution planning or design results.

- **Execution tasks:**

- Integrated configuration: Complete hardware installation and software deployment (NE initialization and NE software installation) based on the network simulation decision, and open O&M channels to ensure that NEs are managed. In addition, the NE data is delivered to the network to ensure correct software and hardware configurations.
- Onsite acceptance: Verify the service connectivity, SLA, and reliability, generate a verification report, and pass the acceptance criteria to meet the transfer-to-maintenance requirements.

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## 5.1.2 Classification Requirements

**Table 2: Network Planning, Design and Deployment Capability Classification Requirements**

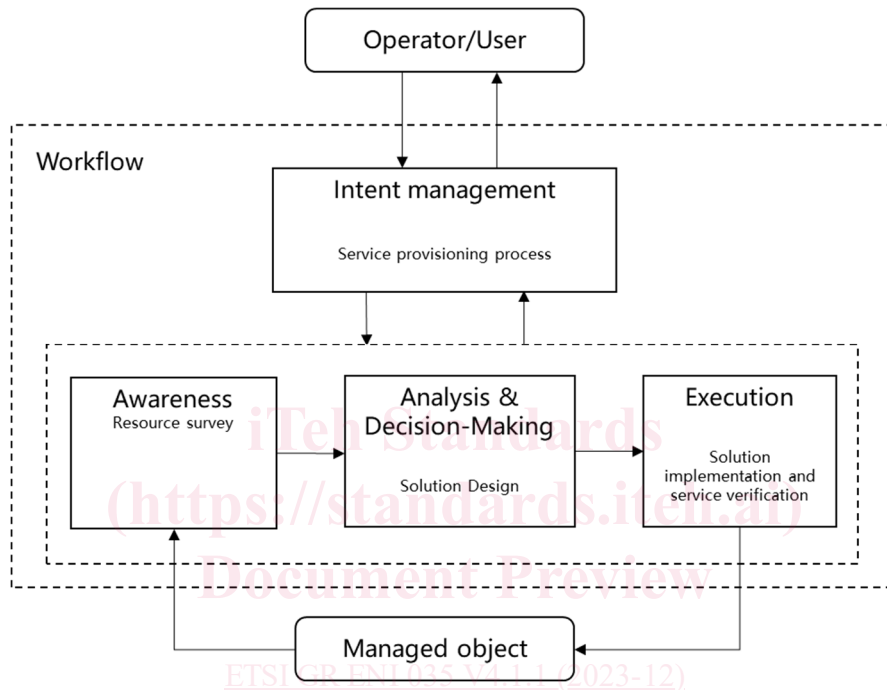
Operation management activities	Task	L0	L1	L2	L3	L4	L5
Intent management.	Requirement analysis and forecast.	Manually analyse planning requirements.	Manually analyse planning requirements.	Collect network resource data based on the system and manually analyse planning requirements.	The system automatically collects and analyses the data. (e.g. network resource usage data, network traffic growth data, etc.), manually analyse and plan requirements.	The system automatically predicts network and service requirements based on collected data and AI models. (e.g. network traffic growth trend, network connection scalability, and service quality level).	In all scenarios, the system automatically identifies planning requirements and completes the entire process of planning and design, including requirement mapping, resource survey, planning, design, simulation, data production, data delivery, commissioning and optimization, and service verification. When AI models need to be iterated, Supports automatic optimization of online learning.
Awareness.	Resource survey.	Manual resource survey.	Manual resource survey.	Manually survey resources in limited scenarios based on auxiliary tools.	The system supports the automatic online collection of online IP resources and their status, including network device resources, L2/L3 topology, and L2/L3 network connections.	The system supports the automatic collection of online IP resources, operation and SLA status, including network device resources, L2/L3 topologies, L2/L3 network connections, traffic, and applications status.	
Analysis.	Resource analysis.	Manual resource analysis.	Manual resource analysis.	The system displays resource statistics based on fixed rules, facilitating manual analysis.	The system supports device resource bottleneck analysis, such as board, port usage, and traffic analysis, and automatically identifies board resource bottlenecks.	The system can predict the growth trend of network traffic and IP connections based on AI models or digital twins and automatically identify network bottlenecks, such as network devices, boards, ports, link bandwidth, and connection reliability.	

Operation management activities	Task	L0	L1	L2	L3	L4	L5
Decision-making.	Solution design and Decision-making.	Manually perform network simulation and decision-making.	Manually perform network simulation and decision-making with tools.	Manually perform network simulation and decision-making using tools.	The system provides templates, and the planning design is performed manually based on the templates (such as the historical project cases).	The system uses the intelligent model or digital twin to make network simulation decisions. The system automatically generates the network design scheme (such as network topology, device types, IGP/BGP route planning, and tunnel and VPN services). Perform network design, and the system automatically outputs the network design result.	
Execution.	Integrated configuration.	Prepare NE parameters and assurance policy data by using the tool and manually deliver the configuration.	Use the tool to prepare NE parameters and assurance policy data, and use the tool to deliver configurations onsite.	Use the system to prepare NE parameters and assurance policy data, and use the tool to remotely deliver configurations.	The system automatically creates NEs settings based on the design scheme, When physical network resources are ready, the system can automatically deliver configurations.	The system automatically creates NEs configuration based on the design scheme. When physical network resources go online, the system automatically manages devices and activates predefined configurations.	
	Onsite acceptance.	Manually perform onsite acceptance.	Manual on-site acceptance (such as dialling test by meter, tool, and service verification).	Use the system to verify services remotely and generate reports automatically. The system supports automatic validation of device configurations and software versions based on the manually entered acceptance data.	Based on the manually entered acceptance data, the system validates the software version, configuration, device status, and network service quality.	The system supports the flexible definition of the service validation process. After the service goes online, the system automatically validates the service and generates the validation report.	

## 5.2 Service provisioning in the IP network operation phase

### 5.2.1 Workflow and Task Definition

In the IP network operation management, carriers expect the service provisioning process to be e-commerce-based, one-click, and visible. In addition, the service provisioning process can be continuously ensured for services with differentiated SLAs, improving network serviceability. The present document divides the service provisioning sub-phase in the IP network operation phase into four tasks: service provisioning process, resource survey, solution design, solution implementation and service verification. The four tasks can be mapped to IP network operation management activities.



**Figure 2: Mapping between service provisioning tasks and operation management activities**

The following tasks can be obtained by dividing the service provisioning process based on the IP network operation management activities:

- **Intent management activities:**
  - Service provisioning process: based on user service requirements (such as the number of sites, site location, service volume, and security requirements), convert to specific network requirements (such as bearer technologies, protection requirements, security policies, and SLA assurance policies).
- **Awareness-like activities:**
  - Resource survey: Based on user service requirements and real-time network status, the resource operational status is collected.
- **Analysis and decision-making activities:**
  - Solution design: Assessment, design, and allocate network resources based on the network requirements. (for example, the device types, fibre/cable connection, port/interface numbers, and IP/VLAN space. If resources are insufficient, add new devices.) and comprehensively evaluate the design scheme (e.g. whether the customer's requirements are met and whether the existing services are affected) and provide the evaluation result.

- **Execution activities:**
  - Solution implementation and service verification: Deliver network configurations (including SLA assurance policies) to network devices based on the final solution. After the solution is implemented, verify and confirm the service implementation result, for example, whether the service is connected and whether the service SLA meets the requirements.

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