TM Forum Introductory Guide

Autonomous Network Levels Evaluation Methodology

IG1252

Team Approved Date: 30-Jul-2021

Release Status: Production	Approval Status: TM Forum Approved
Version 1.1.0	IPR Mode: RAND

Notice

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1. Terminology

1.1. Terms

Term	Description
Autonomy	The capability to make decisions free from human control.
Autonomous Network	An Autonomous Network is a system of networks and software platforms that are capable of sensing its environment and adapting its behavior accordingly with little or no human input.
Autonomous Network Level	AN Levels describe the level of autonomic capability in a given operational workflow or for an autonomous domain (L0->L5). AN Levels identify contextual autonomous capability.
Control loop	Control loops are used to enable autonomous systems to adapt their behavior to respond to changes in user needs, business goals, or environmental conditions.

For full list of terms related to autonomous networks see IG1230.

2. Scope of Document

This document defines the Autonomous Networks Level based on TM Forum IG1218, IG1230, and serves as the autonomous level evaluation component of the Autonomous Network Maturity Model. It describes the concepts of Autonomous Networks Level, which include Autonomous Networks Level methodology and approach, operational processes, their underlying sub-processes and tasks, task evaluation criteria etc., and finally establishes a standardized evaluation approach for assessing (in an offline manner) the Autonomous Networks Level of a network, or part of a network.

Note: The current version 1.1.0 does not cover business operation layer, and it will be extended in the future version.

3. Background, Benefits, and Usage

3.1. Background and benefits

A common understanding of the levels of autonomous network will be helpful to the telecommunications industry. The operator's operational and management efforts and dedicated human resources will vary according to different autonomous networks levels. It would be beneficial for operators to have clear view on the expectation of the level of their network (s) to indicate the maturity of the network autonomy, so that they could firstly focus on the important features which should be prioritized to achieve a certain level of autonomy in their networks. This approach will help operators to smoothly migrate to a higher autonomy level and a better operational efficiency.

Several standards development organizations (SDOs) have been trying to assess the different levels of network automation across different service providers and enterprise businesses. However, the reference guidelines in systematic evolution of automation and quantized measurement methods are still unclear.

The clearly defined autonomous network levels in this document has the following benefits:

- Providing guidance to operators, vendors and other participants of the telecommunications industry for roadmap planning.
- Providing reference for gap and priority analysis for future work on network autonomy.
- Providing a basis for measuring the level of an autonomous network, or autonomous network feature, along with its components and workflows.
- Providing detailed process-oriented approach and effect-oriented metrics to achieve quantized evaluation.

3.2. Usage of this document

The document is intended to be used by service providers and solution provider to help them in conducting high level autonomy assessments of their existing network and system, identifying their maturity and specific areas for future improvement. The baseline process structure used within the methodology may vary slightly from one operator to the next. A service provider can, if required, adapt the flows or structures to suit their own environment. The evaluation methodology remains fully valid, thus has broad applicability.

4. Autonomous Network Levels Methodology

4.1. Autonomous network levels

The work done in «SAEMOTORLEV» was the original inspiration for autonomous network levels. Automation can be applied to four broad classes of functions: information acquisition, information analysis, decision and action selection, action implementation. Within each of these types, automation can be applied across a continuum of levels from low to high, i.e., from fully manual to fully automatic. A particular system can involve automation of all four types at different levels «MODLEVELTYPE». Based on these frameworks for automation, the autonomous network level methodology has been designed, shown in Table 4-1.

Table 4-1. Autonomous network level methodology

Autonomous Levels	L0: Manual Operation & Maintenance	L1: Assisted Operation & Maintenance	L2: Partial Autonomous Networks	L3: Conditional Autonomous Networks	L4: High Autonomous Networks	L5: Full Autonomous Networks
Execution	P	P/S	S	S	S	S
Awareness	P	P/S	P/S	S	S	S
Analysis	P	P	P/S	P/S	S	S
Decision	P	P	P	P/S	S	S
Intent/Experience	P	P	P	P	P/S	S
Applicability	N/A	Select scenarios				All scenarios

P：People (manual)；S：Systems (autonomous)

Note 1: System including management system, O&M tools and network.

Note 2: The table 4-1 is consistent with IG1218 and may be adjusted in the future version.

4.2. Characteristics and effects of autonomous network levels

Based on the methodology above, the level description and the typical characteristics with expected effects of each autonomous network levels can be abstracted as shown in Table 4-2:

Table 4-2. Autonomous network level characteristics and effects

Level	Description	Typical characteristics	Expected effects
Level 0 - Manual management	All dynamic tasks have to be executed manually.	**Offline, Full manual O&M**	Awareness, analysis, decision, execution and intent are fully manually accomplished. No manpower is saved.
Level 1 - assisted management	The system executes certain repetitive sub-tasks based on pre-configured logic or policy to increase execution efficiency.	**Online, Assisted execution**	Awareness and execution are assisted by system. Actions of awareness, execution and intent/experience can be online recorded and traced. Part of manpower can be saved and more manpower can be focused on analysis and decision.

Level	Description	Typical characteristics	Expected effects
Level 2 - Partial autonomous network	The system enables partial automatic O&M for certain domains based on predefined rule/policy under certain external environments.	**Static rule/policy based automation**	Execution is automated. Some awareness and analysis functions can be accomplished for certain scenarios based on static (human predefined) rules/policies. Part of manpower can be saved from simple and repetitive work on data collection, pre-processing and analysis.
Level 3 - Conditional autonomous network	Building on L2 capabilities, the system is capable to optimize and adjust itself to the external environment under the instructions from dynamic rules/policies.	**Dynamic rule/policy based automation**	Awareness, execution and most analysis are automated. Scenario decoupled common rules/policies/AI models which can be dynamically updated. Some automatic decision making can be achieved under human predefined rule/policy.
Level 4 - High autonomous network	Building on L3 capabilities, the system enables AI assisted automation capability that is capable of automated continuous learning and rapid evolution.	**AI assisted automation capable of continuous learning and rapid evolution**	Awareness, analysis, decision, and execution are automated, intent/experience driven closed-loop control can be accomplished for certain scenarios under human supervision in emergency situations. Most of the manpower can be focused on expert experience, AI model management, and novel or unsupported scenarios.
Level 5 - Full autonomous network	This level is the end-goal for telecom network evolution. The system possesses autonomous capabilities across the entire lifecycle for self-X management with little manual interference.	**Auto-evolution, Full autonomy, All scenarios**	Awareness, analysis, decision, execution and intent/experience are autonomous. The whole autonomy mechanisms including expert experience and AI model management can be auto-evolved for all scenarios. Manpower is only needed to generate intent and monitor the progress and status.

Note: The content related to (awareness, analysis, decision, execution, intent/experience) is subject to change to keep consistent with IG1218, IG1253 in the future version.

5. Autonomous Network Level Evaluation

5.1. Autonomous Network Level Evaluation Procedure

5.1.1. General principles

The approach is intended to provide a pragmatic assessment of nominated "AS-IS" use cases with the view to seeing how they can benefit from autonomous networking in the future "TO BE". The approach consists of selecting an operational use case in a given network domain and services domain. For the purposes of this description this is called an "evaluation object". A process and task oriented decomposition is then performed on the evaluation object, using both qualitative and quantitative methods, the approximate network level is derived. Note that it is approximate, to aid process, component, and vendor assessment, and generally longer term planning.

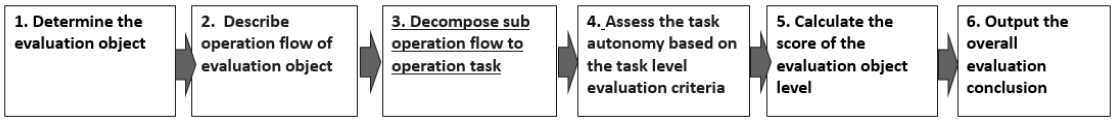

Figure 5.1. Autonomous network level approach and procedure

5.1.2. Determine the evaluation object

The evaluation object is a service and/or network with selected operation flow for autonomous network level evaluation.

Determine the evaluation objects based on selecting an operational use case from three-dimensional elements of services domain, network technology domain, and operational flows shown in Figure 5-2.

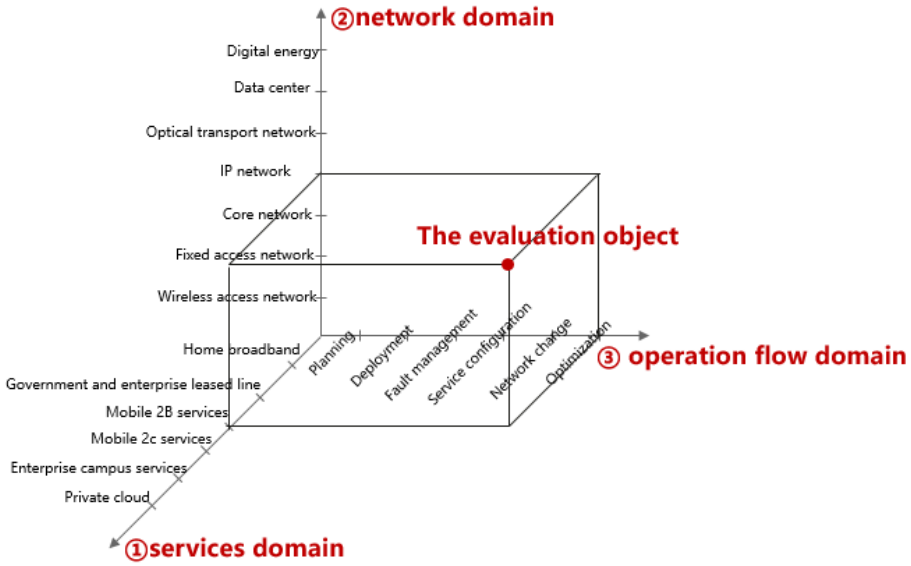

Figure 5.2. Determine the evaluation object

5.1.3. Describe operational flow of the evaluation object

Authenticity：This should reflect the flows of the evaluation object in an actual production environment.
In business/service/ resource operation layer, the operational flows include: Planning, Deployment, Service providing , Maintenance, and Optimization.

5.1.4. Decompose operation flows into operation tasks

Each production activity can be mapped to a unique, or atomic, operation task. One production activity-to-many operations task cannot exist. If one production activity is mapped to multiple standard operation tasks, the production activity needs to be further decomposed. This decomposition should continue until it is no longer possible to further break down items.

5.1.5. Assess autonomy at the task level

For each task: Assess the autonomy of the task based on the autonomy level evaluation criteria. Valid scores are between 1.0 (manual operation) and 5.0 (full autonomy).

5.1.6. Calculate the score of the evaluation object level

Calculate the overall autonomy level for the evaluation object level by averaging the levels for each task. Using average aggregation is relatively balanced and objective. It can reflect the overall situation of the evaluation object and avoid too many human factors (such as weights) which will need to be looked at as part of more detailed measurements. A final score will be between 1.0 (manual operation) to 5.0 (full autonomy).

5.1.7. Output the overall evaluation conclusion

Using the autonomy scores derived across the evaluation object, identify strengths and weaknesses, highlighting that tasks that require significant improvement. Based on the evaluation object level score calculation result and identification of strengths and weaknesses, an overall evaluation conclusion.

5.2. Autonomous network (AN) operation flow

Based on service provider perspectives and best practices, each operational layer of the autonomous network can be decomposed to the following operation flows:

- End-to-end operation flows in business layer: Including customer lifecycle management processes and product/offering lifecycle management processes.
- End-to-end operation flows in services layer: Including the flows of resource-facing services planning, deployment, maintenance, optimization and inventory management . Also, includes the flows of customer-facing services planning, deployment, service providing, maintenance, and optimization.
- End-to-end operation flows in resource layer: Including the processes of resource/network planning, deployment, maintenance ,optimization and inventory management.

Planning, deployment, service providing, maintenance, and optimization compose the whole life cycle process of the production. Inventory management is an important foundation for operators in network O&M, and also a general inventory management process may be used and embodied in the other 5 flows. Based on the requirement of operators for the building and evaluation of the operation flows, the logic relation of flows is put forward as Figure 5.3

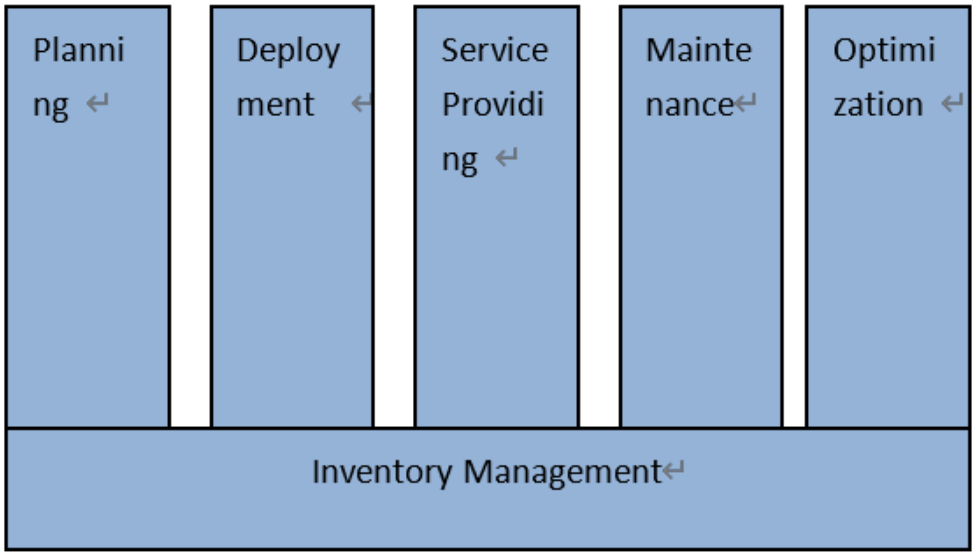

Figure 5.3. Logic relation of flows

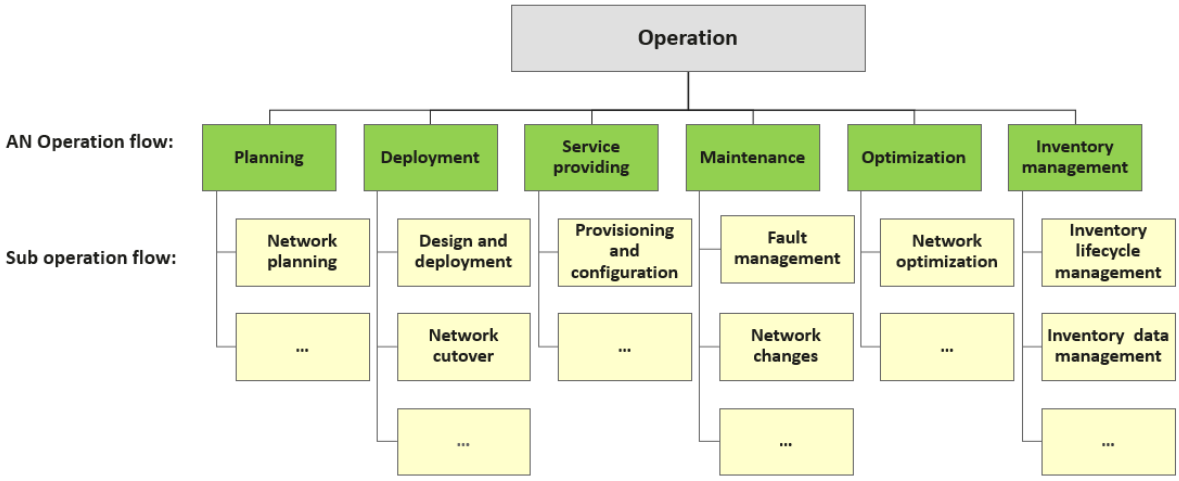

Figure 5.4. AN Operation flow

The AN operation flows definition may cover business layer, services layer and resource layer of AN network.

Table 5-1. AN Operation Flow

AN Operation Flow	AN Operation Flow Description
Planning	Based on the market strategy and deployment policy, forecast and analyze product, services and network requirements, to form service and network planning. Include: 1) Based on the customer's business requirement, service development objective, network construction plan, and network capacity analysis and prediction, output the planning solution. 2) Based on the planning solution, the services and network survey, technical requirements of the solution, output the high level design.
Deployment	Design, install and deliver, and verify the service and network based on the planning to complete the preparations before service provisioning. Including: 1) Based on the planning, complete hardware and software detail design, installation and optimization, and complete services and network initial configuration. 2) Output acceptance reports, pass the acceptance criteria and ready for service and network provision &maintenance
Service providing (TBA)	Configure services and networks based on service requirements of customers, and monitor the service quality, discover service quality problems in a timely manner, and quickly respond to them.
Maintenance	Based on Customer’s SLA requirements, monitor and manage service quality or network operation status, find and solve related problems or faults (including hidden faults) in time, and ensure that service quality and network operation are at state.
Optimization	To improve service quality and network performance, analyze services KQI and network KPIs and adjust services and network configurations to ensure optimal service and network running. This includes: 1) Analyze network status and service quality trend, performance tests, customer complaints/feedback, and resource utilization. 2) Formulate and implement services and network optimization solutions, to meet customer service experience and resource utilization requirements
Inventory management	Establish, manage and administer the enterprise's resource inventory, as embodied in the Resource Inventory Database, and monitor and report on the usage and access to the resource inventory, and the quality of the data maintained in it.

Using these best practices, we can then decompose the AN operation flows into sub operation flows. Note: The sub operation flows mainly focus on services layer and resource layer in document version, further detail will be added in later document versions.

Table 5-2. Sub Operation Flow

AN Operation Flow	Sub Operation Flow	Description of Sub Operation Flow
Planning	**Network planning**	Analyze network expansion requirements, calculate network expansion goals, formulate network adjustment plans based on the current network status, and formulate network construction projects.
	TBA	
Deployment	**Design and deployment**	Design, develop, installation, and verify the service and network resources
	Network cutover	Migrate subscribers from other networks to the new network so that the new network enters the production process and provides services to subscribers, and network status information changes are synchronized to inventory management.
	TBA	
Maintenance	**Fault management**	Set monitoring rules based on the customer's SLA requirements, monitor the services quality and network status in real time, detect faults or potential risks in a timely manner, demarcate and locate the faults, analyze the root causes, and rectify the faults or potential risks, to ensure the normal running of the network and provide reliable service quality.
	Network change	Network change requests cover many cases, such as equipment replacements, network topology adjustment, software upgrades or patches, etc. These changes are generated as a result of maintenance. Taking into account impact on user services, network change plans are formulated (such as change time, network elements, operation steps, verification plans, fallback plans, etc.), and changes are implemented. Network status information changes are synchronized to inventory management.
	Routine maintenance	In order to ensure the normal operation of the network, routine checks and maintenance are carried out on the operation status of the network. Routine maintenance is mainly completed through the formulation, implementation, and inspection of regular operation plans.
	Test (TBA)	Verify the corresponding indicators of service connectivity, service SLA, network KPI, etc., to ensure the normal operation of the network.
	TBA	

AN Operation Flow	Sub Operation Flow	Description of Sub Operation Flow
Optimization	**Network Optimization**	Based on the collection and processing of data related to network operation, statistical analysis and data mining, the network operation status is evaluated in multiple dimensions such as network operation and cost efficiency, and hidden network operation risks are discovered. Based on the current network operation status, formulate network optimization plans, implement network optimization plans and evaluate optimization results. Control the entire network optimization process.
	TBA	
Service providing	**Provisioning and configuration**	According to service requirements, schedule and arrange service processes and resources, design corresponding network plans. Based on the plan, adjust operation and network configuration
	Customer complaint (related to services)	Specially monitor the service quality, discover the customer's service quality problems in a timely manner, and quickly respond to them. At the same time, the service SLA is monitored and managed, and the risk of SLA violations is timely warned. To locate and analyze the problem of customer complaints, deal with the problems caused by the network and follow up the results, ensure the resolution of customer complaints, and improve customer satisfaction.
	TBA	
Inventory management	**Inventory lifecycle management**	Determine, provide and maintain the inventory management of corresponding hardware, software and supporting equipment and facilities, and enable inventory alterations in time according to the user needs such as software updates, topology changes
	Inventory data management	Manage existing network data resources, record the type and quantity of resources, the relationship between resources, topology and other information, so as to improve the efficiency of process and resource use.
	TBA	

Note: TBA = to be added

5.3. Operation flow and operation tasks

Control-loops are used to describe (and execute) the necessary steps to fulfill certain management purposes. An operation flow is an encapsulation of one or more management tasks that exist in the context of a control loop. The autonomy capabilities of the tasks within the operation flow may impact the network autonomy level. The following are the potential categorization of the tasks in an operation flow:

- **Intent/Experience:** The group of tasks which translate intent from operator or customer into detailed operations which may affect one or more of the following groups of tasks (i.e., awareness, analysis, decision, execution), also evaluate and feedback intent fulfilment information (e.g., the intent is satisfied or not).
- **Awareness:** The group of tasks that monitor and understanding what happening or exists in quality/state of network/services, such as collecting network/services information, preprocess information and selective notification, etc.
- **Analysis:** The group of tasks which analyze data generated in the awareness phase, use technologies (such as model inference) and analysis, make a recommendation for decision.
- **Decision:** The group of tasks that decide the necessary management operation for execution, e.g., network configuration or adjustment.
- **Execution**: The group of tasks which execute the management operations and feedback the result to the intent requester.

For example, the relationship between tasks and AI-based cognitive workflow in monitoring and troubleshooting operation process is as follows:

- A task group of fault management policies generation and fault management intent fulfillment evaluation constitutes intent.
- A task group of fault impact analyze, and display, fault identification, and risk prediction constitutes awareness.
- A task group of fault demarcation fault root cause location and fault recovery solution generation constitutes analysis.
- A task of fault recovery solution selection constitutes decision.
- A task of fault recovery solution implementation group of solution implementation and verification constitutes execution.

The principles for decomposing operation flow to operation task are as follows:

- Completeness: All the O&M must be included in the operation tasks.
- Balance: The sizing and granularity of each task is relatively balanced.
- Non-Overlapping: The operation task is atomic and does not have functional overlaps with other tasks.

5.4. Operation flow decomposition and task definition

5.4.1. Planning flow decomposition and task definition

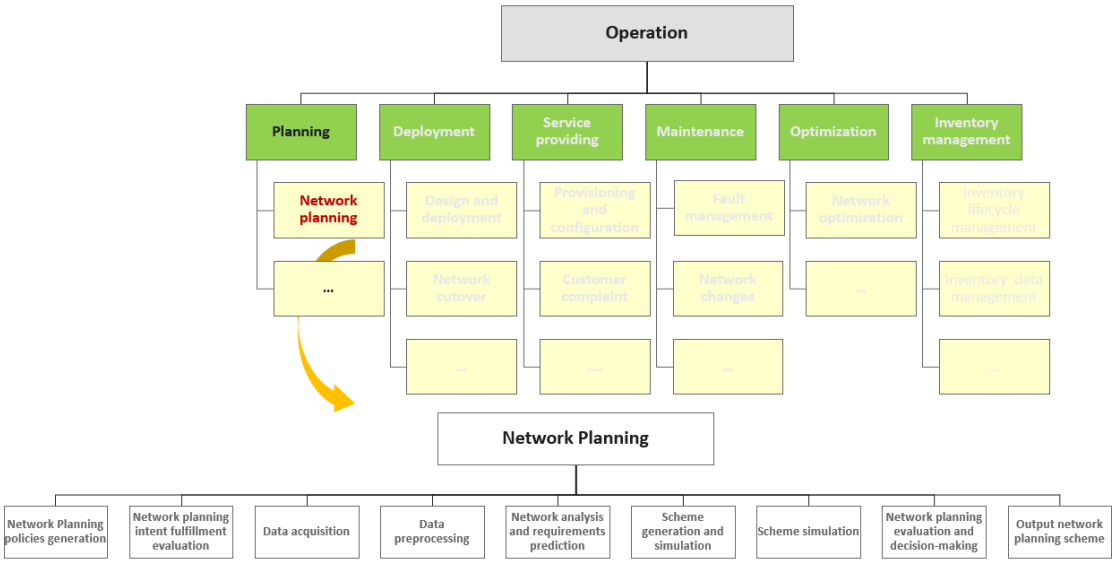

Figure 5.5. Operation Tasks of Network Planning

Table 5-3. Operation Tasks of Network Planning

Sub Operation Flow	Task category Note*	Operation task	Operation task desperation
Network planning	**Intent/Experience**	Network Planning policies generation	According to customers' business intentions, business/service development goals, and network construction plans, output network construction strategies (such as coverage area priority, deployment frequency band priority, network architecture priority) and network construction standards (such as coverage/rate/delay).
		Network planning intent fulfillment evaluation	Evaluate and confirm the results of the network planning and evaluate the satisfaction of the network planning goals and the expected network capabilities to be met.
	Awareness	Data acquisition	Collect related data (such as traffic, performance data, user data, resource utilization) according to data collection rules.
		Data preprocessing	The necessary processing of the collected data before analysis and prediction, such as data review, filter, and classification.
	Analysis	Network analysis and	According to network planning policies generation results (network construction strategy and network construction standards), and existing

Sub Operation Flow	Task category Note*	Operation task	Operation task desperation
		requirements prediction	performance data and user data, analyze and predict the use of resources on the existing network (such as traffic, performance, user scale, resource utilization), and perform prioritizing, and output a list of planning requirements (such as coverage area, capacity requirements).
	Analysis	Network planning scheme generation and simulation	Based on the network planning requirements and insight analysis results, output the High Level Planning schemes (network architecture, capacity requirements, and networking solution) and further output the Low Level Planning schemes(such as naming conventions, address planning, number of wireless sites and cells, frequencies, bandwidth, and TAC), and network cutover plan (such as cutover service type, scope, involved network elements, etc.)
		Scheme simulation	Evaluate and simulate the correctness and rationality of the HLP schemes based on the network planning result, and further evaluate the correctness and rationality of the LLP schemes and perform simulation verification.
	Decision	Network planning evaluation and decision-making	Comprehensively evaluate HLP schemes and LLP schemes, and determine the final HLP scheme and LLP scheme.
	Execution	Output network planning scheme	Output the decided high level plan and low level plan for deployment.

Note: The content related to (awareness, analysis, decision, execution, intent/experience) is subject to change to keep consistent with IG1218, IG1253 in the future version.

5.4.2. Deployment flow decomposition and task definition

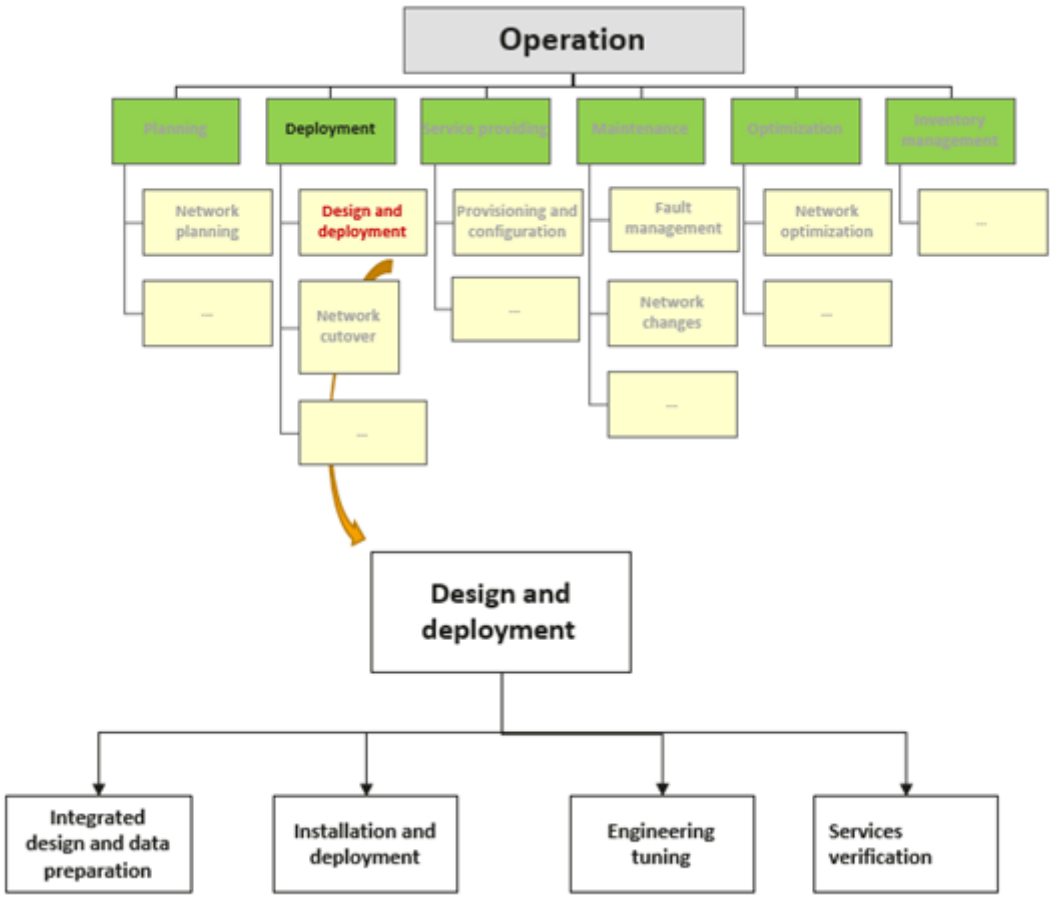

Figure 5.6. Operation Tasks of Design and deployment

Table 5-4. Operation Tasks of Design and deployment

Task category Note*	Sub Operation Flow	Operation Task	Operation Task Description
Analysis	**Design and deployment**	**Integrated design and data preparation**	According to the LLD in the planning stage, output the integrated network delivery plan, and prepare network element initialization data, network element parameter data (interface, IP, protocol, etc.) and assurance policy data (link bandwidth/delay/jitter, QoS, Monitoring rules, etc.) and other detailed and full parameters.
Execution		**Installation and deployment**	Complete the hardware and software installation (traditional network element software installation, VNF network element initialization) according to the

Task category Note*	Sub Operation Flow	Operation Task	Operation Task Description
			network planning output and perform physical acceptance.
		Engineering tuning	Convert the network element data (network element configuration parameters, guarantee policy data) into detailed instructions (such as MML, CLI, API, NETCONF, etc.) and configure it to the network. Execute software and hardware commissioning to ensure that the software and hardware configuration is correct, alarms cleared, or the performance is tuned to be optimal.
Analysis		**Services verification**	Perform services test verification, generate a verification report, pass the acceptance criteria, and meet the specified requirements.

Note: The content related to (awareness, analysis, decision, execution, intent/experience) is subject to change to keep consistent with IG1218, IG1253 in the future version.

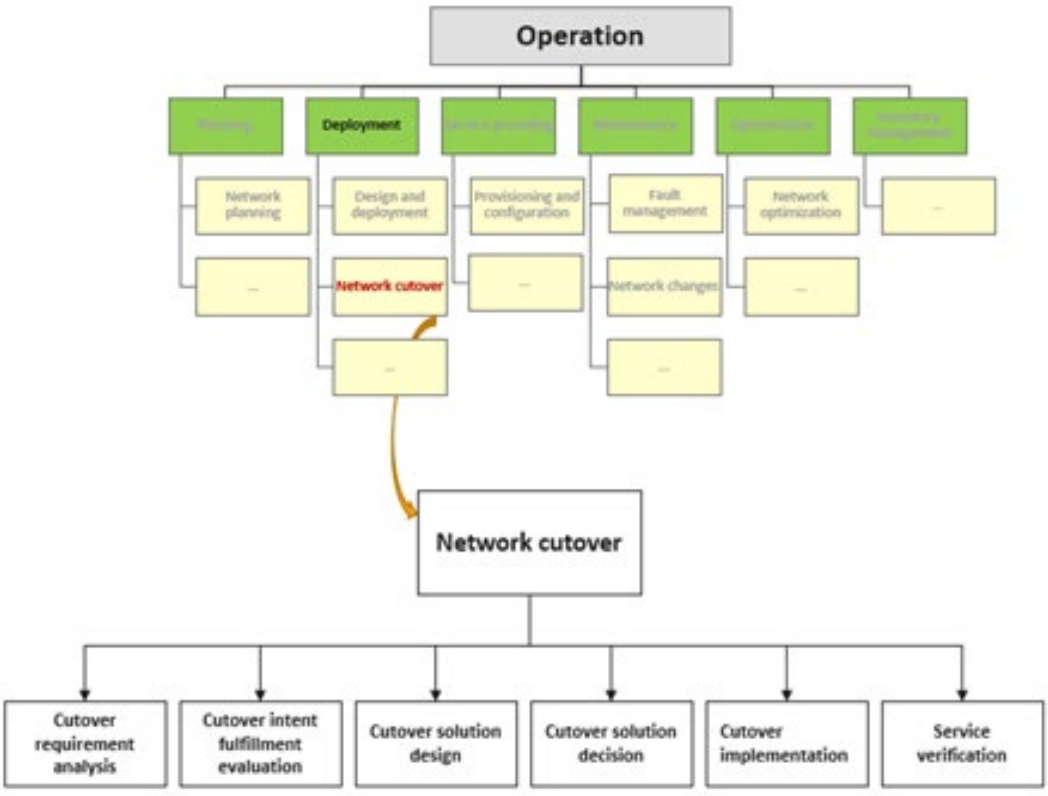

Figure 5.7. Operation Tasks of Network cutover

Table 5-5. Operation Tasks of Network cutover

Sub Operation Flow	Task category Note*	Operation Task	Operation Task Description
Network cutover	**Intent/experience**	**Cutover requirement analysis**	According to the network cutover plan (cutover service type, scope, involved network elements, etc.), evaluate the range of users affected by the cutover, combine the current network service SLA, allowable cutover time period and other factors, and output cutover constraints (such as cutover time window, business interruption time, etc.).
		Cutover intent fulfillment evaluation	Evaluate network cutover intent fulfillment information.
	Analysis	**Cutover solution design(s)**	According to the network cutover plan and cutover constraints, complete the cutover solution designs.
	Decision	**Cutover solution decision**	Comprehensively evaluate alternative cutover solutions (such as whether cutover constraints are met, whether other existing network services are affected, etc.) and determine the best solution.
	Execution	**Cutover implementation**	According to the best cutover solution, cutover the network (such as modifying the configuration, path adjustment, UNI port adjustment, etc.).
	Analysis	**Service verification**	After the cutover is implemented, verify and confirm the execution results (such as whether the business SLA meets the expected goals, etc.), and perform cutover monitoring, and deal with problems in time.

Note: The content related to (awareness, analysis, decision, execution, intent/experience) is subject to change to keep consistent with IG1218, IG1253 in the future version.

5.4.3. Maintenance flow decomposition and task definition

Fault management

Fault management is one of the sub operations flows of maintenance. Fault management is decomposed into the following operation tasks. (Note: these tasks mainly cover resource layer and services layer of AN). Fault include multiple types of managed objects, e.g., network alarm, incident of service outages or degradations. Distinguishable from alarm, an incident is identified based on multi-dimensional data and has service impacts.

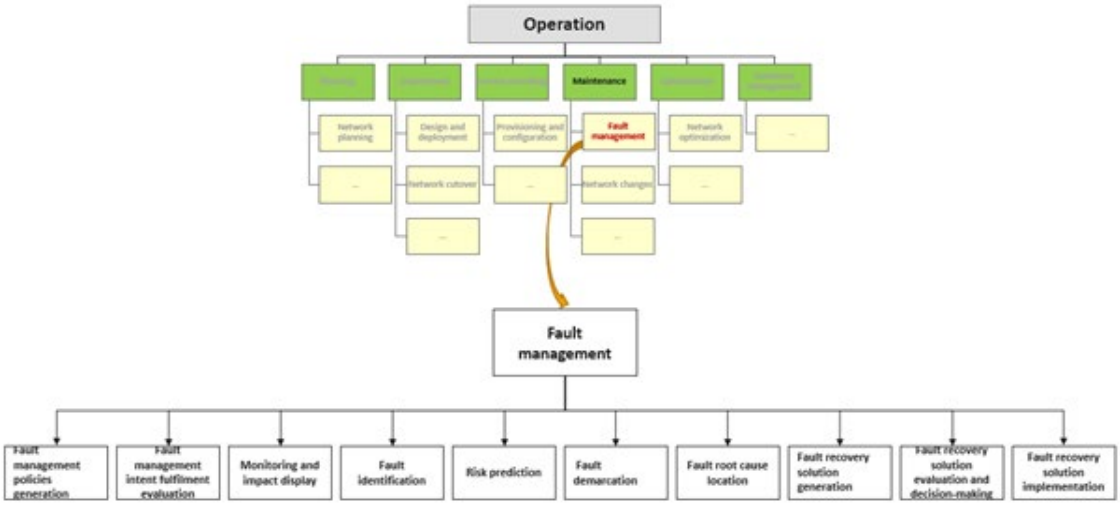

Figure 5.8. Operation Tasks of Fault management

Table 5-6. Operation Tasks of Fault management

Sub Operation Flow	Task category Note*	Operation Task	Operation Task Description
Fault management	**Intent/experience**	**Fault management policies generation**	Based on the fault management intent (e.g., routine monitoring requirements, fault recovery requirements etc.) , to generate fault management intent related rules/policies (e.g., monitoring objects, alarm types/levels/filtering rules, alarm reporting strategy, fault recovery policy, etc.) (TBA)
		Fault management intent fulfillment evaluation	The group of tasks of evaluating fault management intent fulfillment information. After fault rectification and risk elimination are performed, verify and confirm the execution results, such as whether service interruption, quality deterioration, and alarms, KPI exceptions, and incidents are cleared.

Sub Operation Flow	Task category Note*	Operation Task	Operation Task Description
	Awareness	**Fault identification**	Based on data collection, analyzes network/services operation data and external spatio-temporal data to detect unexpected service interruptions or service quality deterioration in a timely manner.
		Potential fault prediction	Based on data collection, monitors and analyzes network/services running data and external spatio-temporal data, predicts the development trend of network software and hardware status, and identifies risks that may cause fault in advance, and report it as incident
		Fault impact analysis and display	Based on fault identification and potential fault prediction, analyze and display impacts to service/customer (such as affected base stations and home broadband users).
	Analysis	**Fault Demarcation**	Demarcate faults based on the identified faults and potential risks. In the cross-domain scenario, demarcate the fault to a specific technical domain. In the single-domain scenario, demarcate the fault to a specific NE.
		Fault root cause location	Based on the fault demarcation result further locate the specific software and hardware causes (such as configurations, boards, and optical modules) of the fault to support the generation of rectification solutions and rectify services as soon as possible.
		Fault recovery solution generation	Based on the fault demarcation and locating results, generate several alternative recovery/recovery solutions, such as modifying configurations, restarting NEs, replacing boards, and isolating NEs.
	Decision	**Fault recovery solution selection**	Comprehensively evaluate the alternative repair solution (such as whether the solution can solve the fault, whether the repair cost is acceptable, and whether the extra impact on the network) and provide the optimal solution.

Sub Operation Flow	Task category Note*	Operation Task	Operation Task Description
	Execution	**Fault recovery solution implementation**	Rectify faults and eliminate potential risks based on the optimal solution. For example, deliver configurations to the network for software faults, isolate NEs or links for hardware faults, or replace or remove boards or optical modules onsite.

Note: The content related to (awareness, analysis, decision, execution, intent/experience) is subject to change to keep consistent with IG1218, IG1253 in the future version.

Network change management

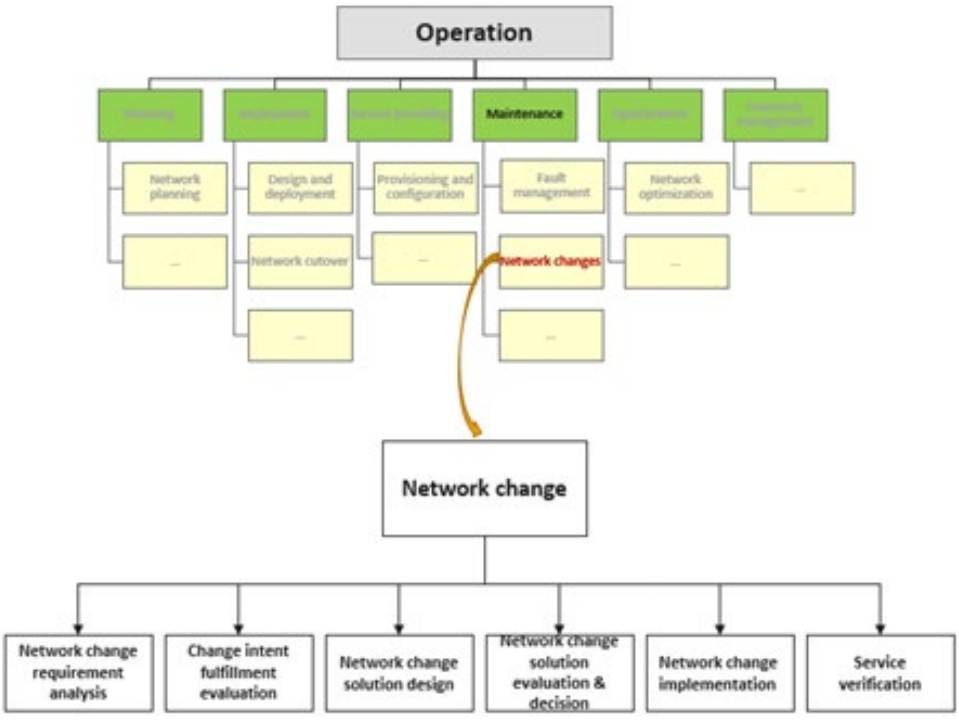

Figure 5.9. Operation Tasks of Network change

Table 5-7. Operation Tasks of Network change

Sub Operation Flow	Task category Note*	Operation Task	Operation Task Description
Network change	**Intent/experience**	**Network change requirement analysis**	According to the network maintenance change request (change type, area range, network elements involved, etc.), evaluate the range of users affected by the change, combine user business SLA, allowable change time period and other factors, and output change constraint (such as change time window, service interruption time, etc.).
		Network change intent fulfillment evaluation	Evaluate the network maintenance change intent fulfillment information.
	Analysis	**Network change solution design**	Design of alternative the network maintenance change plans according to the intention and the change constraint output by the services impact assessment.
	Decision	**Network change solution evaluation & decision**	Comprehensively evaluate of alternative network maintenance change plans (such as whether change constraints are met, whether the cost is acceptable, etc.) and give the best plan.
	Execution	**Network change implementation**	Convert the optimal plan into implementation instructions and implement them to the network and roll back in time when problems occur.
	Analysis	**Service verification**	After the network maintenance change is implemented, verify and confirm the implementation results, such as whether the services SLA meets the expected goals

Note: The content related to (awareness, analysis, decision, execution, intent/experience) is subject to change to keep consistent with IG1218, IG1253 in the future version.

5.4.4. Service providing flow decomposition and task definition

Provisioning and configuration

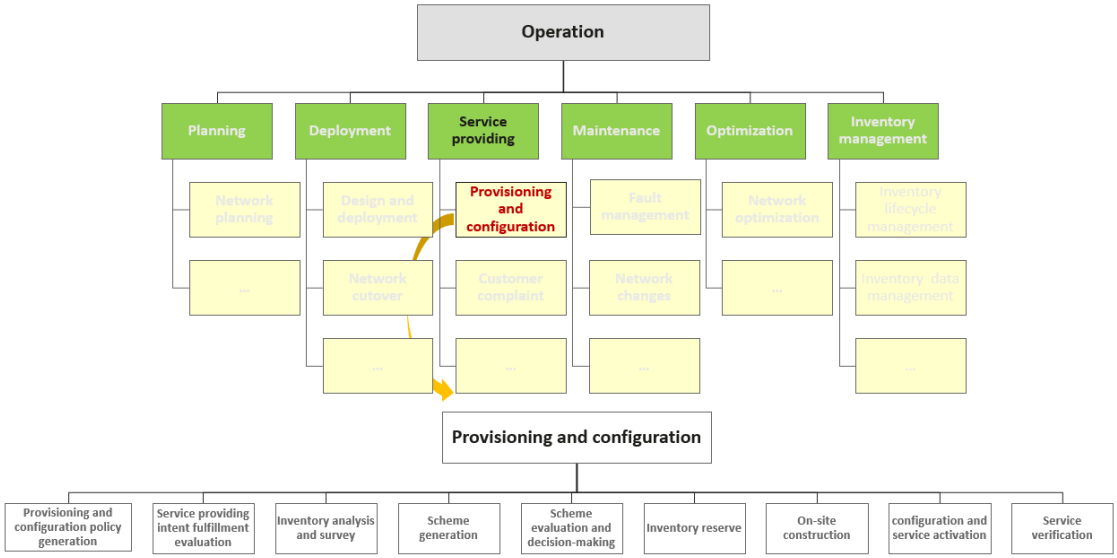

Figure 5.10. Operation Tasks of Provisioning and configuration

Table 5-8. Operation Tasks of Provisioning and configuration

Sub operation flow	Task category Note*	Operation task	Operation task description
Provisioning and configuration	**Intent/experience**	Provisioning and configuration policy generation	Convert user service requirements (such as the number of sites, site location, service volume, and security requirements) to specific network requirements (such as bearer technologies, protection requirements, and NEs (including VNFs lists, security policies, SLA assurance policies, etc.).
		Service providing intent fulfillment evaluation	Evaluate the satisfaction of the intention.
	Analysis	Inventory analysis and survey	According to the collected network resources and service data, conduct survey and analysis.
		Scheme generation	Based on the converted network requirements and analysis results, generate provisioning schemes(such as coverage area, deployment location, network topology, and resource allocation).

Sub operation flow	Task category Note*	Operation task	Operation task description
	Decision	Scheme evaluation and decision-making	Comprehensively evaluate the schemes (e.g., whether user requirements are met, whether existing services are affected, and whether resources are sufficient) and provide the evaluation results, output the determined scheme which is to be implemented.
	Execution	Inventory reserve	Based on the determined scheme and service requirements, through the workflow engine, the work orders are sent to various relevant departments, and relevant resource(such as network infrastructure resource, transport resource, and pipeline resource) are requested to be reserved by inventory management system , and the relevant process is scheduled and orchestrated.
		On-site construction	Based on the provisioning scheme, carry out on-site construction to ensure that the network is ready on physical resources to support new service and functional requirements, including internal construction, external construction, etc., and carry out quality inspection and acceptance
		configuration and service activation	Convert the decided solution into implementation instructions and deliver the instructions to the network infrastructure, and smoothly activate services. If a problem occurs, roll back the solution in a timely manner.
	Analysis	Service verification	After the configuration and service activation are implemented, verify and confirm the implementation result (such as service SLA assurance, service connectivity).

Note: The content related to (awareness, analysis, decision, execution, intent/experience) is subject to change to keep consistent with IG1218, IG1253 in the future version.

Customer complaint

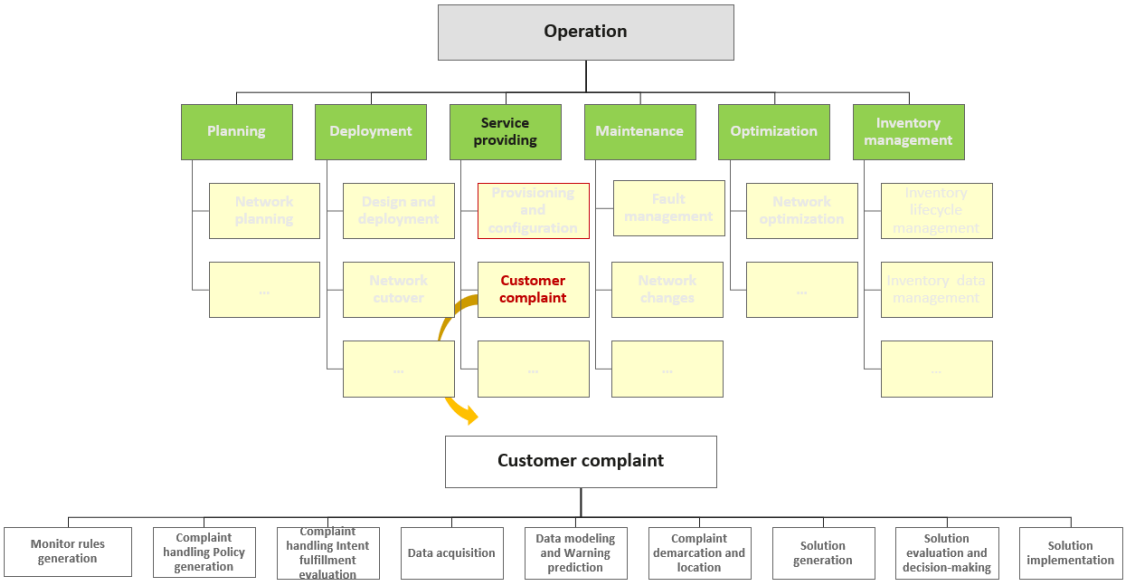

Figure 5.11. Operation Tasks of Customer complaint

Table 5-9. Operation Tasks of Customer complaint

Sub operation flow	Task category Note*	Operation task	Operation task description
Customer complaint	**Intent/experience**	Monitor rules generation	Generate network monitoring rules based on customer complaint intentions, such as monitoring area, monitoring object, performance data category, data collection cycle, etc.
		Complaint handling Policy generation	Based on customer complaint intentions, generate complaint handling policies, which may include related policies for awareness, analysis, decision, and execution.
		Complaint handling Intent fulfillment evaluation	After the complaint handling solution is implemented, verify the results and evaluate the satisfaction of the intention.
	Awareness	Data acquisition	Collect kinds of service data based on defined data collection rules.
	Analysis	Data modeling and Warning prediction	Based on the collected service data, an analysis model required to predict customer complaints can be generated, and customer complaints can be predicted.

Sub operation flow	Task category Note*	Operation task	Operation task description
		Complaint demarcation and location	Based on the acquired monitoring, performance, service quality and other data analysis to realize the demarcation and location of complaints.
		Solution generation	Based on the analysis results of the demarcation and location of the complaints, generate several alternative solutions .
	Decision	Solution evaluation and decision-making	Evaluate the feasibility of each complaint handling solutions and predict the recovery effect and direct/indirect impact, etc., and determine the optimal solution based on the evaluation result.
	Execution	Solution implementation	Implementation of customer complaint solution.

Note: The content related to (awareness, analysis, decision, execution, intent/experience) is subject to change to keep consistent with IG1218, IG1253 in the future version.

5.4.5. inventory management flow decomposition and task definition

inventory lifecycle management

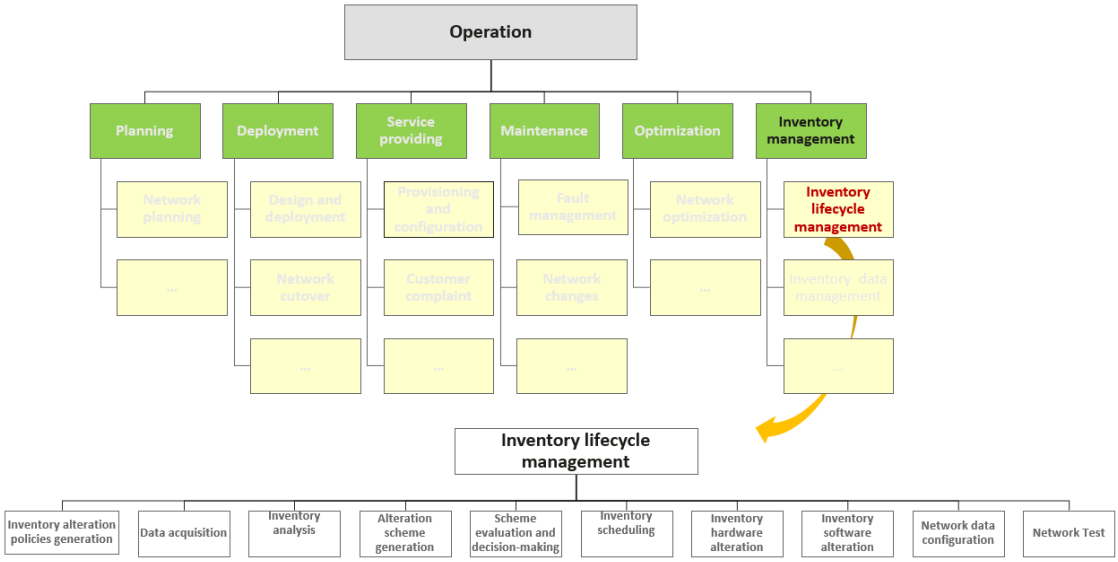

Figure 5.12. Operation Tasks of Inventory lifecycle management

Table 5-10. Operation Tasks of Inventory lifecycle management

Sub-operation flow	Task category Note*	Operation Task	Task description
Inventory lifecycle management	**Intent/experience**	Inventory alteration policies generation	Based on the inventory alteration intention (such as resource status and alteration requirements), output the alteration strategy.
	Awareness	Data acquisition	Collect resource data based on defined data collection rules.
		Inventory analysis	Based on the collected resource data, check the network status before the change and output the survey and analysis.
	Decision	Alteration scheme generation	Based on alteration policies and generated analysis results, design alteration schemes .
	Execution	Scheme evaluation and decision-making	Comprehensively evaluate the schemes (e.g., whether user requirements are met, whether existing services are affected, and whether resources are sufficient) and provide the evaluation results, output the determined scheme which is to be implemented.
		Inventory scheduling	Based on the determined scheme and alteration requirement, , inventory are scheduled.
		Inventory hardware alteration	According to the inventory scheduling result, reserve hardware resources, and cooperate with other OSS system to make changes to the hardware facilities of the system, , monitor and report on the usage and access to the hardware resource in inventory .
		Inventory software alteration	According to the inventory scheduling result, reserve software resources, and cooperate with other OSS system to upgrade software, monitor and report on the usage and access to the software resource in inventory .
		Network data configuration	According to the inventory scheduling result, cooperate with other OSS system to configure network, monitor and report on the usage and access to the physical and logical resources in inventory .

Sub-operation flow	Task category Note*	Operation Task	Task description
		Network Test	After the implementation of alteration and configuration, cooperate with other OSS systems(such as orchestration system, network dashboards) to test the network KPI to ensure the normal operation of the network in inventory.

Note: The content related to (awareness, analysis, decision, execution, intent/experience) is subject to change to keep consistent with IG1218, IG1253 in the future version.

inventory data management

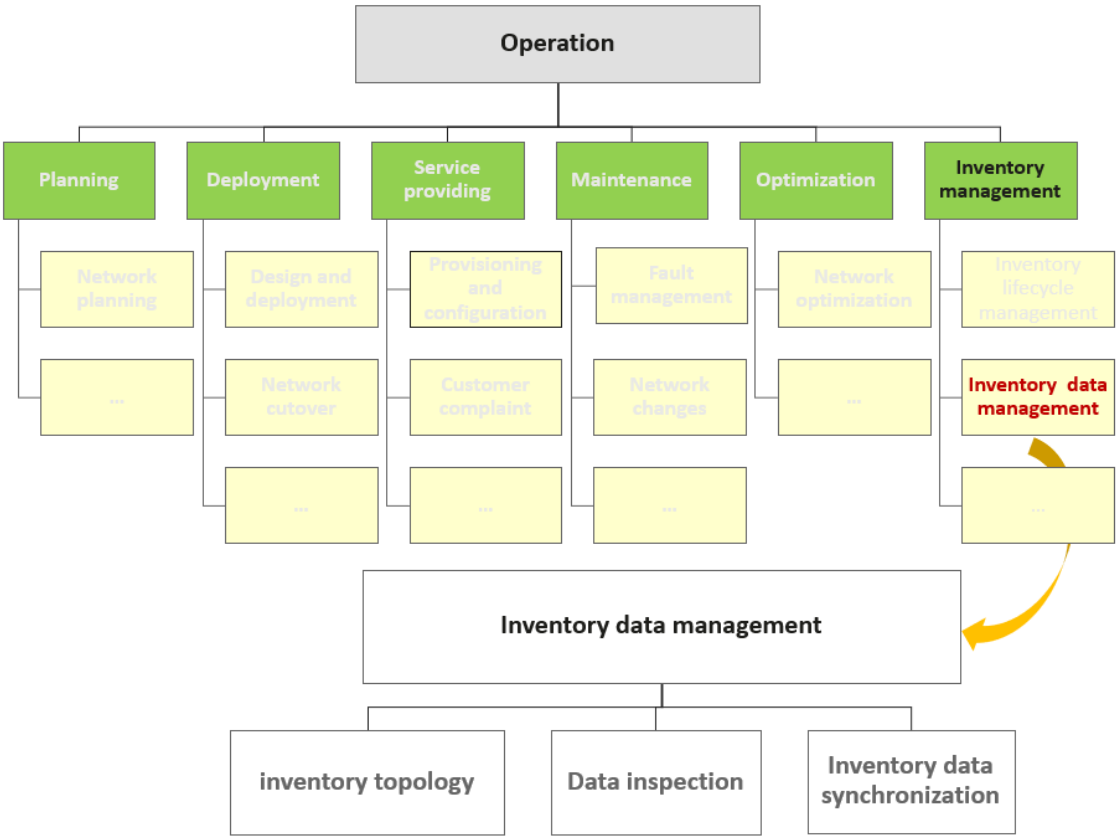

Figure 5.13. Operation Tasks of Inventory data management

Table 5-11. Operation Tasks of Inventory data management

Sub-operation flow	**Task category** **Note***	Operation Task	Task description
Inventory data management	**Awareness**	inventory topology	The internal topological relationships of data resources can be queried and can realize automatic maintenance and analysis in higher levels.
	Analysis	Data inspection	Analyze, review, and inspect resource data
	Execution	Inventory data synchronization	Routine operations of resource data, add, delete, modify, and check

Note: The content related to (awareness, analysis, decision, execution, intent/experience) is subject to change to keep consistent with IG1218, IG1253 in the future version.

5.5. Network optimization flow decomposition and task definition

The optimization flow is decomposed with the following operation tasks. (Note: these tasks mainly cover resource layer and services layer of AN)

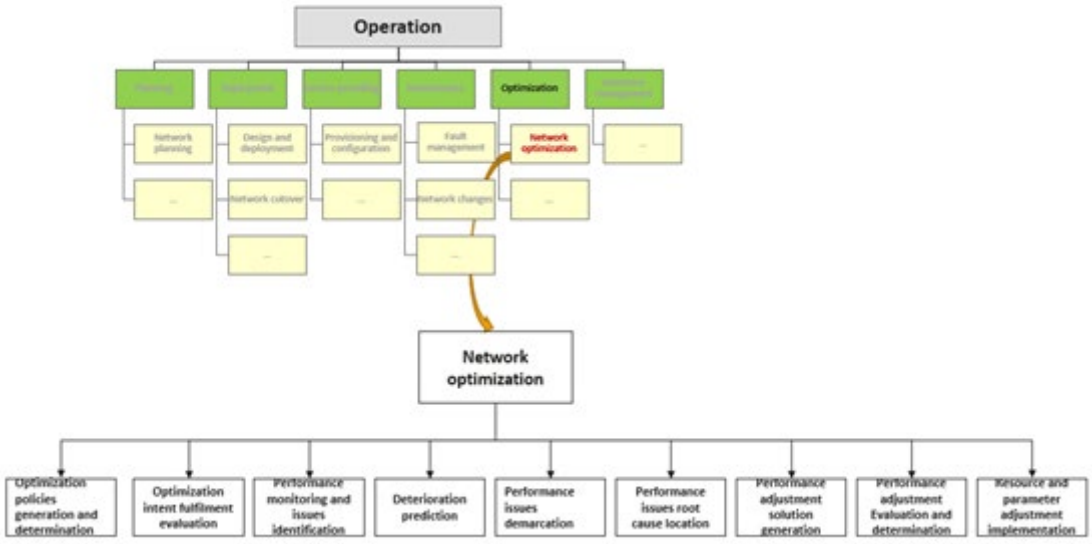

Figure 5.14. Operation Tasks of Network Optimization

Table 5-12. Operation Tasks of Network Optimization

Sub Operation Flow	Task category Note*	Operation Task	Operation Task Description
Network Optimization	**Intent/experience**	**Optimization policies generation and determination**	Based on the optimization intent (e.g., resource utilization, user experience, energy saving requirements, public opinion analysis, and proactive user planning/improvement requirements), determine optimization intent related rules/policies (e.g., monitoring rules, issue identification policies, issue analysis policies and parameters adjustment policies). (TBA)
		Optimization intent fulfillment evaluation	Optimization intent fulfillment evaluation, after the optimization action is executed, verify and confirm the execution effect, such as whether the customer experience, energy saving requirements, and resource utilization meet the requirements.
	Awareness	**Performance monitoring and issues identification**	Based on information collection, monitors and analyzes network/services running data and external spatiotemporal data to identify issues to be optimized that affect customer experience (such as weak coverage areas), improper resource usage (excessive energy consumption and unbalanced resource load), and proactive performance issues identification.
		Deterioration issue prediction	Analyzes network/services running data and external spatiotemporal data, predicts performance and resource utilization trends, and identifies risks (such as insufficient capacity and insufficient licenses) that may affect customer experience in advance, and report it as incident.
	Analysis	**Performance issue demarcation**	Demarcate performance issues based on the identified performance abnormality or deterioration prediction information and environment monitoring. In cross-domain scenarios, demarcate the issues to specific technical domains (such as wireless, transport, and core networks). In single-domain scenarios, demarcate the -issues to specific optimization objects (such as NEs).

Sub Operation Flow	Task category Note*	Operation Task	Operation Task Description
		Performance issue root cause location	Based on the performance issues demarcation result, locate the software and hardware causes (such as configuration, air conditioner, and power environment) that cause performance abnormality or deterioration to support optimization solution generation.
		Performance adjustment solution generation	Generate several alternative parameter adjustment solutions (such as software parameter modification and hardware adjustment) based on the performance issues demarcation and root cause locating results
	Decision	**Performance adjustment solution selection**	Comprehensive evaluation of alternative adjustment solutions (e.g., whether customer experience is affected, whether the adjustment solution meets the optimization objective, and whether the adjustment cost is acceptable) and give the optimal scheme.
	Execution	**Resource and parameter adjustment implementation**	Performs optimization based on the optimal solution and delivers the optimized resource and parameter configurations to the network through CLI, MML, NETCONF, or other interfaces.

Note: The content related to (awareness, analysis, decision, execution, intent/experience) is subject to change to keep consistent with IG1218, IG1253 in the future version.

5.6. Task evaluation criteria

Once all tasks are defined each one must be evaluated for autonomy. A key criterion for determining the *intelligence* level of each task in L0 to L5 is to consider what agents are performing the task：

- Human: The task is completed by human, and no system assistance capability is available.
- System assists human: The task is jointly completed by human and system. The main operations are completed by person and a few actions are automatically completed by the system.
- Human assists system: The task is jointly completed by human and system. The main operations are automatically completed by system and a few actions are completed by human.
- System: The task is automatically completed by system. No human intervention is required.

6. Autonomous Network Level Evaluation Example

6.1. Use case - wireless domain fault management to support mobile B2C services

To describe and demonstrate autonomous network levels, and the evaluation methodology, this section selects the wireless network fault management operation flows within China Unicom that support mobile B2C services. The fault management process is one of the most critical processes in a service providers network O&M. A fault management operation flow that has a high level of autonomy can yield the following benefits:

- Reduce the workload of personnel.
- Lower the overall skill and competence requirements for O&M personnel
- Reduce the overall time to resolution of incidents, thereby improving end-user experience.

6.2. Evaluation worked example

6.2.1. Approach

Based on the methodology set out in this document, the AN level evaluation procedure is as follows, and shown in Figure 6-1:

1. Determine the evaluation object
2. Describe operation flows of the evaluation object
3. Decompose operation flows to operation task
4. Assess the autonomy level of each operation task
5. Aggregate the operation task autonomy levels to calculate the overall score of the evaluation object
6. Output the overall conclusion and assessment of the evaluation.

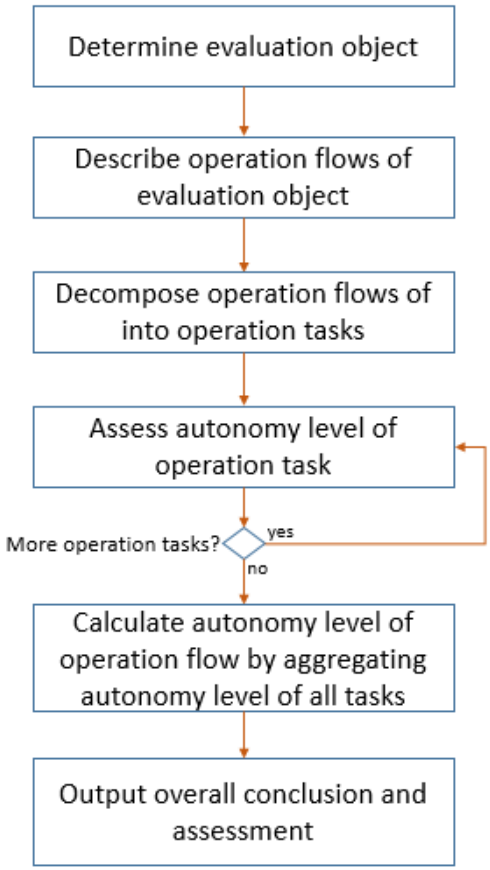

Figure 6.1. Autonomous network level evaluation procedure

6.2.2. Determine the evaluation object

Evaluation object: The fault management operational flows for the wireless network domain that support mobile B2C services.

6.2.3. Describe the operation flow of evaluation object

Fault Management: Set monitoring rules based on the customer's O&M policies, monitor the services and network status in real time, detect faults or potential risks in a timely manner, demarcate and locate the faults, analyze the root causes, and rectify the faults or potential risks.

6.2.4. Decompose operation flow to operation tasks

The fault management operational flow, shown as a flow in Figure 6-2, and Table 6-1 can be decomposed into ten operation tasks. Each task can be mapped into one of the task categories that implement the operational flow.

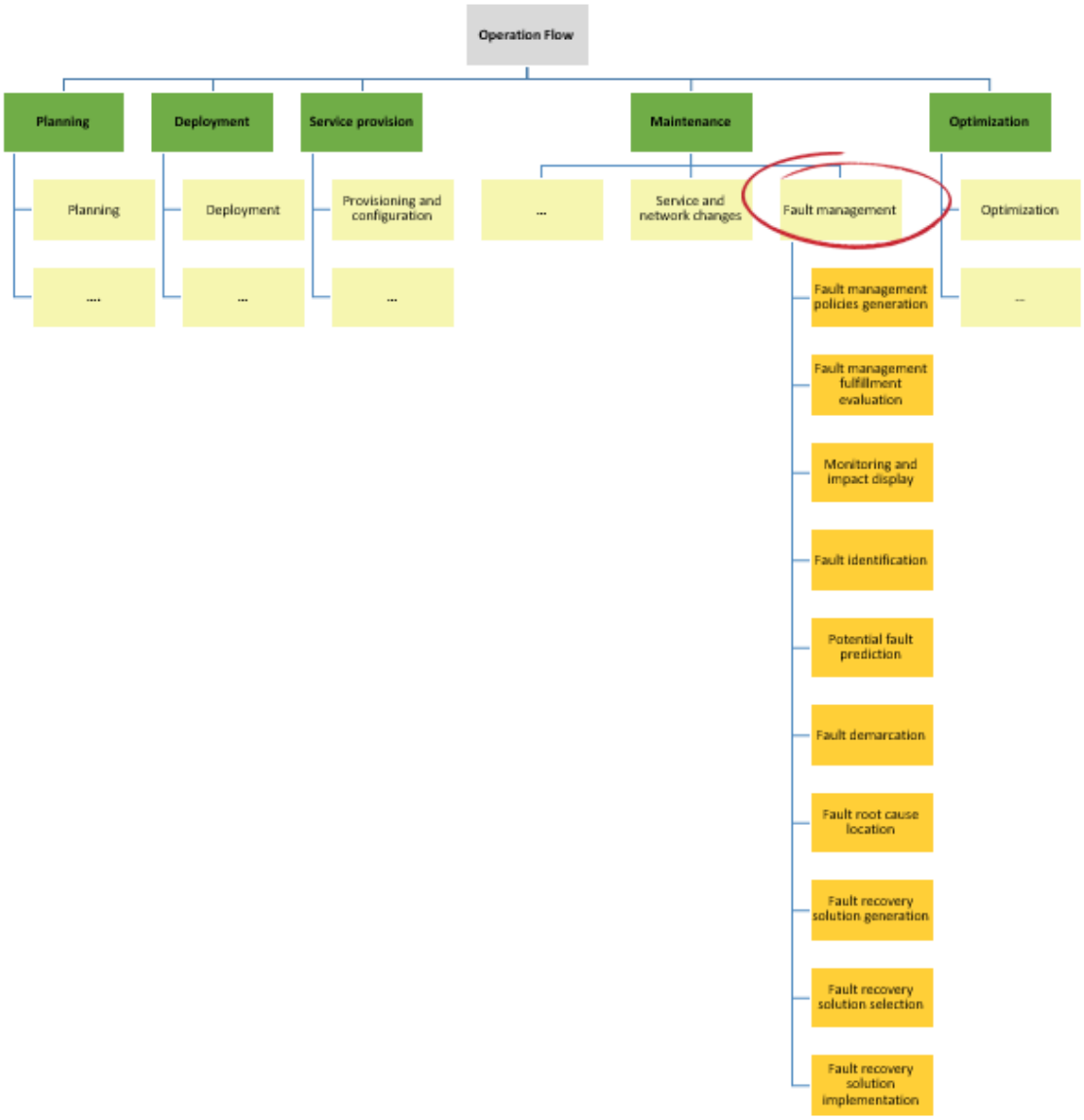

Figure 6.2. Fault Management operation flow and task decomposition

Table 6-1. Operation Task of Fault Management operation flow

Sub Operation flow	Operation Task	Operation Task Description
Fault management	Task A: Fault management policies generation	Based on the fault management intent (e.g., routine monitoring requirements, fault recovery requirements etc.) , to generate fault management intent related rules/policies (e.g., monitoring objects, alarm types/levels/filtering rules, alarm reporting strategy, fault recovery policy, etc.)
	Task B: Fault management intent fulfillment evaluation	The group of tasks of evaluating fault management intent fulfillment information. After fault rectification and risk elimination are performed, verify and confirm the execution effects , such as whether

Sub Operation flow	Operation Task	Operation Task Description
		service interruption, quality deterioration, and alarms, KPI and incident exceptions are cleared.
	Task C: Fault impact analysis and display	Based on information collection , analyze and display network faults and potential risks and impacts (such as affected base stations and home broadband users), helping O&M personnel understand the status of the network.
	Task D: Fault identification	Analyzes network/services operation data and external spatio-temporal data to detect unexpected service interruptions or service quality deterioration in a timely manner.
	Task E: Potential Fault Prediction	Monitors and analyzes network/services running data and external spatio-temporal data, predicts the development trend of network software and hardware status, and identifies risks that may cause fault in advance, and report as incident.
	Task F: Fault Demarcation	Demarcate faults based on the identified faults and potential risks. In the cross-domain scenario, demarcate the fault to a specific technical domain. In the single-domain scenario, demarcate the fault to a specific NE.
	Task G: Fault root cause location	Based on the fault demarcation result, further locate the specific software and hardware causes (such as configurations, boards, and optical modules) of the fault to support the generation of rectification solutions and rectify services as soon as possible.
	Task H: Fault recovery solution generation	Based on the fault demarcation and locating results, generate several alternative recovery/recovery solutions, such as modifying configurations, restarting NEs, replacing boards, and isolating NEs.
	Task I: Fault recovery solution selection	Comprehensively evaluate the alternative repair solution (such as whether the solution can solve the fault, whether the repair cost is acceptable, and whether the extra impact on the network) and provide the optimal solution.
	Task J: Fault recovery solution implementation	Rectify faults and eliminate potential risks based on the optimal solution. For example, deliver configurations to the network for software faults, isolate NEs or links for hardware faults, or replace or remove boards or optical modules onsite.

6.2.5. Assess autonomy level of operation tasks

Each task can be completed manually by a human operator, or jointly by the operator and the system, or fully automatically by the system. The following table lists the division of responsibility between humans and system.

Table 6-2. Task evaluation criteria for monitoring and troubleshooting of wireless of mobile 2C service

Human	System assists Human	Human assists System	System

Operation Task	L0	L1	L2	L3	L4	L5
Task A: Fault management policies generation	Human	Human	System assists Human	System assists Human	Human assists System	System
Task B: Fault management intent fulfillment evaluation	Human	Human	System assists Human	System assists Human	Human assists System	System
Task C: Fault impact analysis and display	Human	System assists Human	Human assists System	System	System	System
Task D: Fault identification	Human	System assists Human	Human assists System	System	System	System
Task E: Potential Fault Prediction	Human	Human	System assists Human	Human Assists System	System	System
Task F: Fault Demarcation	Human	System assists Human	Human assists System	System	System	System
Task G: Fault root cause location	Human	System assists Human	Human assists System	Human assists System	System	System
Task H: Fault recovery solution generation	Human	Human	System assists Human	Human assists System	System	System
Task I: Fault recovery solution selection	Human	Human	System assists Human	Human assists System	System	System
Task J: Fault recovery solution implementation	Human	System assists Human	System	System	System	System

Operation Task	L0	L1	L2	L3	L4	L5
Scenario Applicability	Selected fault scenarios					All fault scenarios

- Level0：All monitoring and troubleshooting tasks are manually completed.
- Level1：Fault identification and demarcation, fault root cause location (task G), fault recovery solution implementation(task J) are completed by human and systems (for example, automatic data collection and manual fault identification). Fault impact analysis and display (task C) can be completed automatically by the system.
- Level2：Based on level 1, fault recovery solution implementation (Task J), fault impact analysis and display (task c) can be completed automatically by the system.
- Level3：Fault impact analysis and display (task C), Fault identification (Task D), fault Demarcation (Task F), fault recovery solution implementation (Task J) can be automatically completed by the system.
- Level4：All other tasks except fault management policies generation (Task A) and Fault management intent fulfillment evaluation (task B) are automated.
- Level5：All tasks are automatically completed by the system.

The details of task evaluation criteria is as per Table 6-3.

Table 6-3. Details of Task evaluation criteria (note: L0 excluded)

Sub-operation flow	Operation Task	Task evaluation criteria				
		Level 1 Tool-assisted automation	Level 2 Partial Autonomous Network	Level 3 Conditional autonomous network	Level 4 Highly autonomous network	Level 5 Fully autonomous network
Fault Management	Task A: Fault management policies generation	Manually configure monitoring rules based on expert experience. (Network Intent Conversion)	Manually design a monitoring rule template. The system monitors network/services based on the manually selected template (network	Same as L2	Manually enter the service intent (such as the monitoring area, VIP customer, and KQI). The system automatically converts	All-scenario automation

Sub-operation flow	Operation Task	Task evaluation criteria				
			intent conversion).		the monitoring rule for monitoring and suggests manual adjustment. (service intent conversion).	
	Task B: Fault management intent fulfillment evaluation	Manually verify and confirm any execution results, determine whether the fault is rectified (or whether the risk is avoided) based on alarm lists or KPI plots.	Humans use some systems to verify and confirm any execution results, and to invoke reports - the results of which are verified by a human.	System verifies and confirm any execution results. System invokes reports - the results of which are verified by a human.	The system automatically verifies that service intents remain intact, a human is engaged if there are any exceptions or conflicts which require analysis and possible action.	The system automatically verifies that service intents remain intact and takes actions to deliver the best outcome (according to intents) in the event of exceptions or conflicts.
	Task C: Fault impact analysis and display	Manually visualize and make sense of alarm sequence and KPI plots.	Human use system to do fault impact analysis.	System automatically analyzes the fault impact.	Same as L3	Same as L3
	Task D: Fault identification	System data collection	System identifies faults based	System automatically learns	Same as L3	Same as L3

Sub-operation flow	Operation Task	Task evaluation criteria				
		and manual fault identification	on static rules and policies (such as alarm correlation and KPI threshold) defined by O&M personnel.	rules and policies (such as correlation and threshold) and identifies faults.		
	Task E: Potential Fault Prediction	The system collects data and manually checks items based on the inspection policy (such as checklist) to identify potential risks.	The system checks the network item by item based on static inspection policies (such as health check rules and KPI thresholds) formulated by users and identifies potential risks manually (identifying potential risks based on expert experience).	The system predicts the network status trend and roughly identifies potential risks (for example, a port may have weak optical signals).	The system predicts the network status trend and accurately identifies potential risks in a quantitative manner. For example, the probability (confidence) of a port that has a weak optical signal within a week is 90%.	Same as L4
	Task F: Fault Demarcation	Use tools or systems to assist fault demarcation (such as	The system automatically demarcates faults based on static rules/policy (such as the	The system automatically demarcates faults based on	The system can automatically learn and update	Same as L4

Sub-operation flow	Operation Task	Task evaluation criteria				
		connectivity tests).	expert experience tree) formulated by O&M personnel.	predefined AI models (such as knowledge base and fault propagation diagrams).	predefined AI models (such as the knowledge base and fault propagation diagram) for automatic demarcation.	
	Task G: Fault root cause location	Use tools or systems to locate faults, such as packet analysis and operation log analysis.	The system automatically locates faults based on the static rules or policies (such as the expert experience tree) formulated by O&M personnel and manually confirms the fault.	The system automatically locates the fault based on the AI model (such as the knowledge base and fault propagation diagram) before delivery (the system provides the possible cause).	The system automatically learns and updates AI models (such as the knowledge base and fault propagation diagram) for automatic fault location (the system provides the unique and accurate cause).	Same as L4
	Task H: Fault recovery solution generation	Manually determine the	The system provides rectification suggestions	Same as L2	The system automatically	Same as L4

Sub-operation flow	Operation Task	Task evaluation criteria				
		alternative solution.	and manually formulates alternative solutions.		generates alternative solutions.	
	Task I: Fault recovery solution selection	Manual selection of the optimal solution	Manually use real-time data of tools/systems to evaluate and select the optimal solution.	The system performs online evaluation based on real-time data, provides evaluation results, and a human manually decides the optimal solution.	Online evaluation based on real-time data and automatic decision-making	Same as L4
	Task J: Fault recovery solution implementation	Fault rectification and risk elimination using tools/systems	The system automatically generates executable instructions based on the optimal solution to automatically rectify faults and eliminate potential risks.	Same as L2	Same as L2	Same as L2

6.2.6. Calculate the score of the evaluation object level

For each task:

- Assess the autonomy of the task based on the task level criteria as documented in Tab5-3. Valid scores are between 1.0 and 5.0.

For the evaluation object:

Calculate the overall autonomy level for the evaluation object level by averaging the levels for each task. Valid scores are between from 1.0 to 5.0. Using average aggregation is relatively balanced and objective. It can reflect the overall situation of the evaluation object and avoid too many human factors (such as weights) which will need to be looked at as part of measurements.

Table 6-4. Calculate the score of the evaluation object level

Task	Compare and analyze the current situation with the task evaluation criteria.	Task autonomy		Evaluation Object Level	
		AS-IS	**TO-BE**	**AS-IS**	**TO-BE**
Task A: Fault management policies generation	Fault management policies are manually formulated and setup.	1	1	1.1	1.4
Task B: Fault management intent fulfillment evaluation	Fault management objectives are assessed manually	1	1		
Task C: Fault impact analysis and display	Conventional: Alarms are monitored based on SNs and KPI plots.	1	2		
	Improvement: Improvement: Vendor H OMC/management and control unit visualizes faults (versus lists of alarms and KPI plots)				
Task D: Fault identification	Conventional: Tickets are generated based on manually formulated rules and policies (such as alarm correlation and KPI thresholds).	2	2.5		
	Improvement: Vendor H OMC/management and control unit can automatically aggregate alarms based on cross-domain rules and policies and then dispatch relevant tickets.				
Task E: Potential Fault Prediction	No related activities/manual inspection.	1	1		
Task F: Fault Demarcation	Conventional: Users need to manually analyze ticket information with the help of OMC systems, and tickets do not provide fault causes.	1	2		
	Improvement: Vendor H OMC/management and control unit can automatically demarcate power and fiber cut faults.				

Task	Compare and analyze the current situation with the task evaluation criteria.	Task autonomy		Evaluation Object Level	
Task G: Fault root cause location	Users need to manually analyze ticket information with the help of OMC systems, and tickets do not provide fault causes.	1	1		
Task H: Fault recovery solution generation	Manually generate a set of potential solutions to recover from the fault	1	1		
Task I: Fault recovery solution selection	Manually determine the best alternative from the set of potential solutions generated.	1	1		
Task J: Fault recovery solution implementation	Some faults are remotely and automatically recovered.	1	2		

6.2.7. Output the overall conclusion and assessment

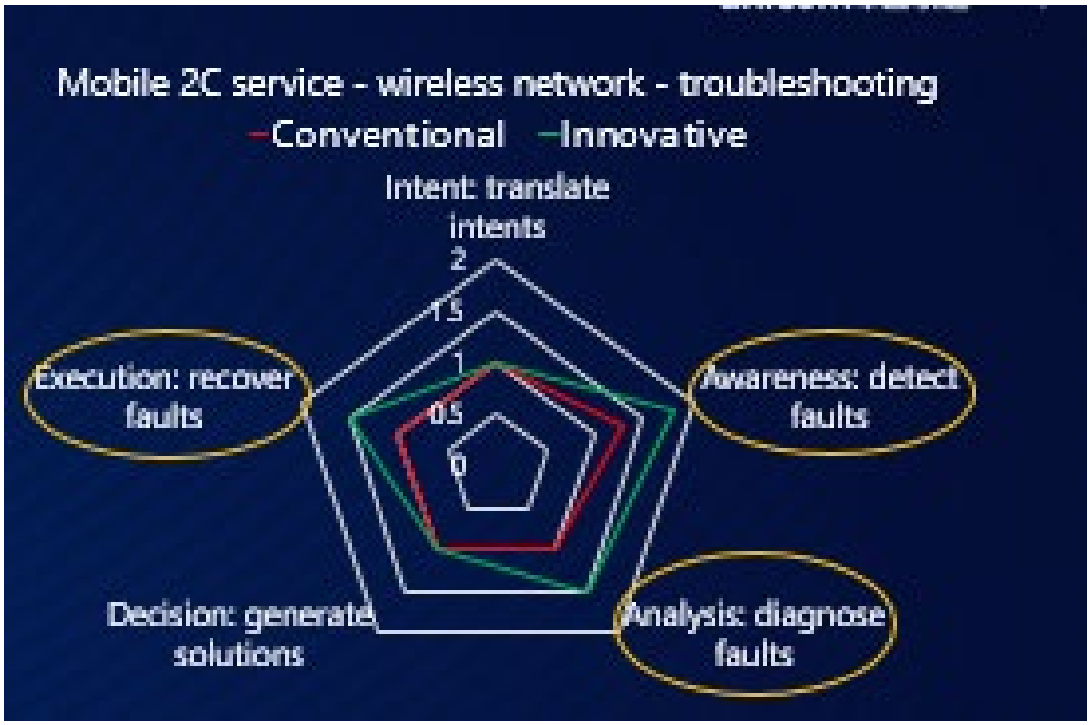

Figure 6.3. Overall evaluation conclusion

The evaluation score increased from 1.1 to 1.4 after innovation cases are implemented, with several noticeable improvements. Some challenges remain:

- Awareness, Analysis, and Execution still require more improvements. Cases verified on the live network can be implemented first, if technical capabilities permit.
- Intent-related technologies are still under research. Decision relies on Awareness automation and is therefore postponed.

7. References

#	Title	Organization
IG1230	Autonomous Networks Technical Architecture V1.0.0	TM Forum
SAEMOTORLEV	Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles SAE J3016, April 2021	SAE
MODTYPELEVEL	A model for types and levels of human interaction with automation IEEE Transactions on Systems Man and Cybernetics - Part A Systems and Humans Parasuraman, Sheridan, & Wickens	IEEE Paper

8. Administrative

8.1. Version History

Version Number	Date Modified	Modified by:	Description of changes
0.1 - 0.8	05-May-2021	Wang Xu James O'Sullivan Feng Chengcheng	Initial draft, several iterations
0.9	10-May-2021	Wang Xu James O'Sullivan Feng Chengcheng	Edits after TA meeting held 5th May Updates to section 6 to reflect changes in section 4 and 5 Various reformatting
0.91	19-May-2021	James O'Sullivan	Applying minor updates
0.92	25-May-2021	Wang Xu	Minor editorial updates
1.0.0	28-May-2021	Alan Pope	Final edits prior to publication. Incorporated all sections on a single Confluence page.
1.1.0	30-Jul-2021	Wang Xu James O'Sullivan Feng Chengcheng	Updates for sprint 4, elaborating deployment and inventory mgt flows adding subsections to maintenance flows diagram updates

8.2. Release History

Release Status	Date Modified	Modified by:	Description of changes
Pre-production	28-May-2021	Alan Pope	Initial release
Production	26-Jul-2021	Adrienne Walcott	Updated to reflect TM Forum Approved status
Pre-production	30-Jul-2021	Alan Pope	Updated to v1.1.0

Release Status	Date Modified	Modified by:	Description of changes
Production	17-Sep-2021	Adrienne Walcott	Updated to reflect TM Forum Approved Status

9. Acknowledgements

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