TM Forum Guidebook

Objective Approach to AOMM for ANL Process Automation

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Notice

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Executive Summary

Digital transformation has been in the heart of most organizations as they reinvent their operating model to win in the digital world. To ensure that their digital operating model is effective, organizations are integrating customer experience management as part of the core elements across their organization. To enhance on developing an effective customer centricity capability, customer experience focus has been added to the AOMM operation flow as we assess and grow the maturity level of the service capabilities.

The intent of this guidebook is to provide organizations with an objective approach in assessing their autonomous operation maturity level. With a clear understanding of the current maturity level, organizations will be able to set their next level target along their digital transformation journey towards operational excellence in aligning to their business strategy. The objective approach will include:

- Process mining technique in providing a process transparency to identify areas of optimization.
- An AOMM model to provide a methodical step in classifying the autonomous operation capabilities and designing a service capability roadmap.
- A value operation framework in quantifying and assessing the values through a list of operation metrics.

To guide organizations in effectively measuring and managing their autonomous operations, a step by step best practice to a catalyst contributed scenario has been included as an illustration to pursue the ZTO journey.

Introduction

Digital transformation journey is in acceleration mode across all industries. Organizations are rapidly transforming and building business capabilities across functions to realize their corporate strategic framework. The intent of this guidebook is to make use of the assets generated from the Catalyst contribution which includes the Autonomous Operation Maturity Model (AOMM) tool and an objective approach to the AOMM assessment for the Autonomous Network Level (ANL) process automation. The use of ANL to formulate an impact on autonomous operations by way of improving process automation helped the CSP to establish a baseline and target state for its process automation. This helped to identify process automation capability gaps. The impact analysis can support prioritization and re-prioritization based on business motivation that is linked to the Value Operations Framework (VOF).

The champion's challenge statement of the Catalyst defined the requirement of having a more objective approach to assess the current service capability maturity level, and transparently identify areas of optimization driving towards ZTO. To realize the capability development and value assessment of the digital transformation initiative, a minimum viable product (MVP) on VoLTE service quality monitoring to problem resolution was introduced and served as an illustration to guide the understanding of the objective AOMM approach and value assessment. To execute the digital transformation strategy, many organizations have adopted customer experience management or customer centricity as a core element to their operating model. In shaping the operation model to align with the strategic framework, maturity assessment of the service capabilities related to customer experience management are considered in the operation flow.

The innovative asset generated from the Catalyst is the data and value driven operations that adopts the process mining technique which replays a process map that mapped against the ANL model to provide an objective assessment approach and enables identification of areas for process optimization.

The above provides concise text to help introduce the catalysts focus. This document is targeted at business decision makers and operations owners in the Communication Service Provider industry and Enterprise undergoing digital operation transformations, as well as being of particular relevance to CTO, CIO, CMO, Head of Customer Experience Management, Head of Digital Transformation, Head of Networks Operation, Head of Network Operations Center, Head of Service Operations Center together with their architects, network planning, designers, customer care, customer experience management, OSS and DevOps team from both IT and CT backgrounds.

This document will also position the TM Forums work on Autonomous Networks Concept & Framework, and Autonomous Network Realization Approach Framework in relation to the Autonomous Operations project implementation and service capability roadmap planning in the solution's development moving forward.

1. The Catalyst Challenge

This TM Forum catalyst 22.0.387 focused on a challenge of service providers tackling increasing OPEX and customer experience management shortfalls as network expansion and sophistication brought scale and multi-class of service delivery to operations. Typically, CSPs need clear understanding of existing business capabilities in order to set milestone targets given knowledge of the gaps between AS-IS and TO-BE maturity levels. These gaps can then be analyzed from viewport of their operations pain points, as well as the underpinning capabilities required in order to realize their ambition. The challenges identified for the catalyst to address are covered in the following section.

1.1. Infrastructure Complexity

CSPs are going through major infrastructure transitions to deal with increasing bandwidth demands from customers. While 5G networks are increasingly coming online and expanding, CSPs still have to manage their 2G, 3G, and 4G networks too. In addition, CSPs are also transforming their hardware-based network to virtualized, and software architecture to bring agility and improve service delivery. Besides, the transition also includes integrating cloud model into a backhaul of telecom network, as central or edge cloud to raise scalability. With the co-existence of 4 network generations, virtualization and cloudification, the infrastructure is not only becoming more complex, but also costlier to manage as it requires higher caliber talents who are kept updated with operation competence and knowledge. With the network grows in complexity, the operating cost can be contained by keeping the network reliable. This can be made possible through service capability development in accelerating the maturity level for autonomous operation.

1.2. Increased Operational Expenditure

In a competitive telecommunications market, the telecommunications sector was firmly focused on revenue growth rather than operational efficiency. However, the revenue is not growing at a faster rate than the growing cost, forcing communications service providers (CSPs) to focus increasingly on cost management and, more recently, cost-cutting.

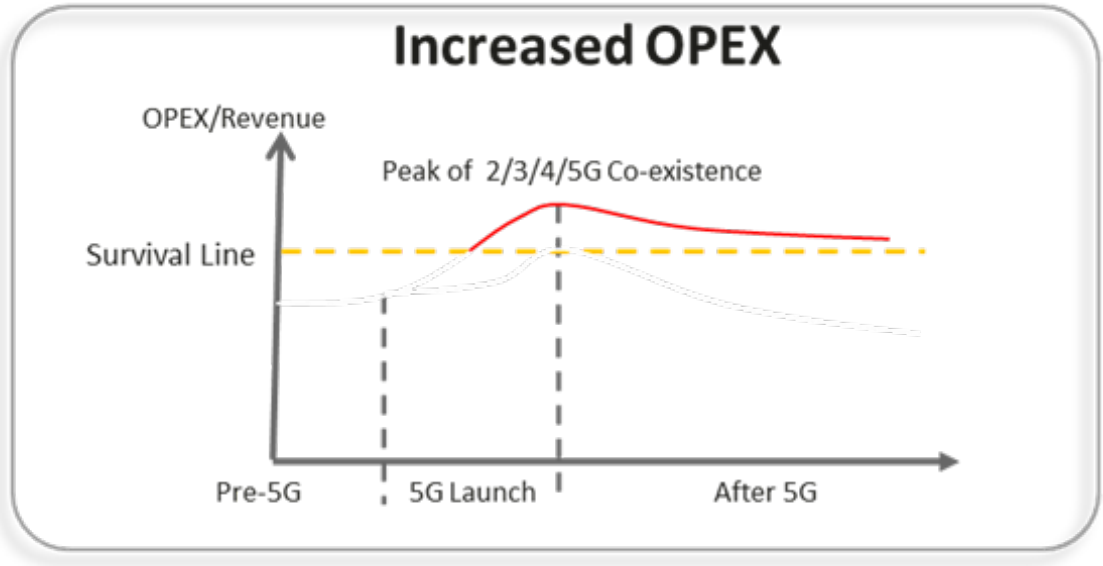

Figure 1-1 Increased OPEX at the Peak of 2/3/4/5G Co-existence

The operating expenses (OPEX) are going to rise sharply during the 5G migration as the legacy networks (2G/3G/4G) will continue to function in parallel with 5G for years to come. Although 5G services could generate new revenue, the prevalence of legacy systems and operational processes that aren't equipped to handle the increasing complexities of service and network operations would result in high consumption of budgetary resources and process inefficiencies, which would eventually affect long-term profitability and Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA).

CSPs will continue to struggle to provide high-quality services and maintain their competitive advantage if they rely on increasing headcount and skills to manage future networks, which is not sustainable in the long run. A new digital operating model is needed to deliver service agility, significantly reduce OPEX and tackle the complexities of new foundational technologies.

1.3. Necessity for new class of services

Service evolution has given a new dimension to end users' expectation where end users may be non-human and that need communication loop to complete just in time and in rare situations just on time. Such a critical form of service delivery cannot be achieved if there is no end to end full automation with a high degree of accuracy. Hence, automation becomes a basic foundational need for certain evolving services. It is not a desire but a necessity.

Delivering Digital Services Profitably with Excellent Customer Experience
Besides focusing on OPEX reduction with network automation assisted with Artificial Intelligence/Machine Learning to gradually reduce costly and time-consuming legacy practices regarding service and network operations, it is also imperative for CSPs to shift their operational focus from the network toward customers and services to deliver superior customer experience. An excellent customer experience can help CSPs differentiate themselves from the rest of the competition, enabling them to realize business value by delivering digital services profitably. A Temkin Group Study measured customer experience across 61 large tech companies using the Net Promoter Score (NPS) metric. It was found that even a moderate increase in NPS for a company with a $1B revenue resulted in an $823M increase in revenue over three years (Theht).

Customers who are satisfied with the service will spend more than compared to the ones who have had an unpleasant experience. The research report, "Global Insights on Succeeding in the Customer Experience Era," reveals that for telecommunication industry, 49% of customers are willing to pay more for great customer experiences (O'Keeffe & Company, 2013).

This shows that by improving your customer experience offering, the company can increase the Customer Lifetime Value (CLV). A high CLV means each customer will bring in more revenue for the company, maximizing the marketing Return on Investment (ROI) and reducing the cost on customer acquisition to drive sales. Thus, it is important to develop capabilities in the customer experience management to provide enhanced and personalized digital services to develop a sustainable operating model in delivering digital services to their customers.

2. Reinvent Operating Model

2.1. Winning Formula for Autonomous Operations

There is a need to have a digital operating model in approaching digitalization of their operations – meaning the use of technology to improve performance. The need to put in place a digital operating model that is sustainable for new levels of speed, agility, efficiency, and effectiveness. However, implementing new technologies should not be seen as a tick-box activity of isolated performance improvements, but rather as a vital next step in the continuous quest to better address customers' needs throughout the customer journey to ensure sustainable competitiveness. The question is what would be the capabilities an organization would need to build in order to support the digital operating model. The capabilities that are required to align operation to business in executing the digital transformation strategy effectively.

2.2. Customer Experience Management

To enable the offer of a profitable and personalized digital service, it is imperative to build capabilities in the customer experience management that effectively integrate to the organization and digital operation model. A customer experience is a journey or amalgamation of interactions a customer or potential customer has with a business. It is how customers perceive the services offered by a service provider which results in how they think of the service provider as a brand and ultimately creates brand loyalty. Measuring this process with customer experience metrics is important if the service provider wants to boost customer retention. Quality of Experience (QoE) is a measure of the overall level of customer satisfaction with a service provider. It is a subjective measure from the user's perspective of the overall quality of the service provided. QoE has historically emerged from Quality of Service (QoS), which attempts to objectively measure service parameters (such as packet loss rates or average throughput). Therefore, operations should be equipped with the ability to be aware of how the customers perceive the services through transaction net promoter score survey and automatically detect service anomaly. The failure to be aware, analyze, decide and execute service recovery on time before customer experiences the service disruption is subject to impact on customer lifetime value or even churn. As a result, the revenue, profitability and even brand name are affected. In order to build capabilities that are related to customer experience, we need the ability to assess the maturity level and build the capability within the digital operation model in aligning to the strategic framework.

3. New approaches and capabilities to drive the digital operation model

There is an increasing interest across the ICT industry to further develop the digital operation model and drive implementations aimed to provide verticals, enterprise and consumers with autonomous operations and more innovative services featuring zero-wait, zero-contact, zero-fault and full autonomy capabilities. At the same time, many challenges need to be solved in terms of how to objectively approach the AOMM for ANL process automation, build, operate and run those networks that are characterized as self-served, self-healing and above all, self-optimized deployments \[1\]. The simple answer is to follow its target architecture and satisfy the industry accepted implementation path for full digitalization and intelligentization of network operation and maintenance. In reality, more constructive and concrete help is needed from many aspects in practice.

Here, we are trying to provide some clear steps and more constructive directions that would be of use and instrumental in Autonomous Operations practices, when deploying and operating the "3 Layers and 4-Closed Loops" TM Forum AN Framework \[2\]. The AN Level Framework illustrates the combination of both human operators (P) and autonomous systems (S) involved in achieving certain level of autonomy and proposes the following Lifecycle Management categories of capabilities shown below:

- Execution – the execution of a decided solution which could be adjusting and configuring the network parameters.
- Awareness – the tasks of collecting data from external environment which include network performance data, network configuration data, quality or status of the service, and customer related information such as SLA.
- Analysis – the group of tasks that analyze data generated in the awareness stage and use available technology to predict a change or future status or make an applicable recommendation for decision.
- Decision – the tasks of evaluating the recommended network adjustment solutions, operation scope or customer experience related solution options for required management and operation decision to be executed.
- Intent/Experience – the tasks of generating and determining network optimization related, service operation related, or customer experience related control information.

3.1. Service Capability Maturity Assessment through AOMM Operation Flows

The AOMM provides organization with a best practice methodology and tool to assess as-is business capability and set target across the business operation, service and resource operations flow that includes Planning, Deployment, Maintenance, Optimization and Operations. For each of the operation flow, it is decomposed into sub-flow with service capabilities that can be referenced to the eTOM business process. For ease of reference to the eTOM business process, each of the operation sub-flows is mapped with the eTOM process. In order to build service capability in the areas of customer experience management, a few customer experiences related sub-flows are added to the Planning and Operations AOMM operation flow introduced in IG1269.

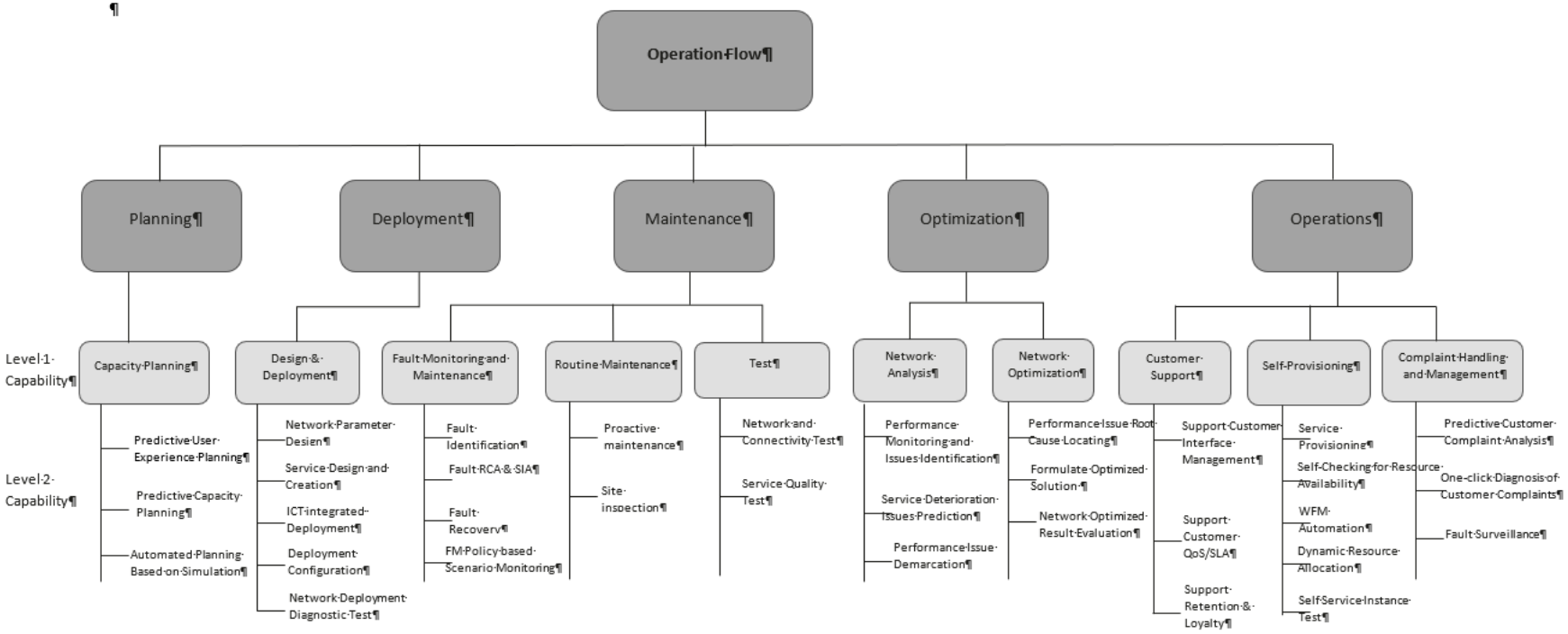

Figure 3-1 The 5 AOMM Operation Flows

The Autonomous Operations (AO) capabilities for any relevant scope of activities and tasks needed to be defined within the operation flow context are realized by designing service intents and associated control loops to describe necessary steps needed to fulfill defined business goals and certain management purposes.

This intent-driven approach starts from describing "what" are desired outcomes from an Autonomous Domain, rather than exposing details of "how" to configure resources within any Autonomous Domain and presents essential prerequisites for enabling Self-X capabilities. Closed-loops are on the other side an essential part of an Autonomous Domain optimization of relevant services and their operational behaviors, like resource usage optimization, cost-effectiveness goals and perfecting trade-offs between tenant service types and resource instances required to be involved.

Autonomous Domains may be composed of one more closed-loop and if required those closed control loops could be bound together to realize the intent-driven services for supporting resources according to the defined supervision and control objectives. Also, one control loop can be used across multiple Autonomous Domains, so a bigger Autonomous Domain can be constructed by its design to serve necessary business goals.

The key focus of building Autonomous Operations deployments is on developing stronger and more effective Customer Experience Management and Customer Support capabilities, based on agility through specific intents and the consistency imposed by relevant closed-loop control mechanisms.

3.2. Capability Build-up Domains

3.2.1. Customer Experience Management

As part of the Planning stage, the first proposed Capacity Management capability is aimed, through its intent at proactively strengthening Customer Experience Management (CEM) where possible and delivered through carefully defined tasks within each closed-loop. Proactive User Experience Management is designed through a Machine learning model for eliciting customer insights and predictive user experience planning based on measuring service usage characteristics (service uptake, app trend, service KQIs) and customer behavior patterns (HVC trends, customer complaints, FCR) to improve customer satisfaction.

The five Lifecycle Management categories of tasks for the Proactive User Experience Planning capability are shown in the following figure.

3.2.2. Predictive User Experience Planning

Catalyst Scenario for Predictive User Experience Planning

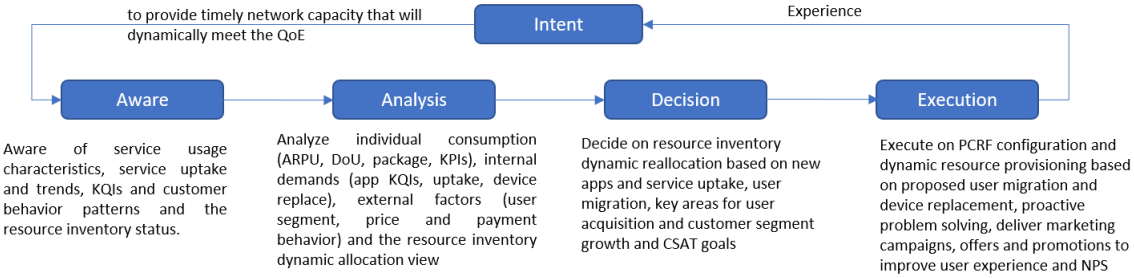

Figure 3-2 Capacity Planning - Predictive User Experience Planning Closed Loop

The Aware dimension of the predictive user experience planning operation flow covers the group of tasks aimed at being continuously aware about service usage characteristics, service update and usage trends through Key Performance Indicators and Key Quality Indicators of the particular service. At the same time, the system is aware of the resource inventory management status to achieve a balance between QoE and resource dynamically reallocation.

Then, Analysis category is about the group of tasks with a goal to analyze individual service consumption and resource demand through metrics like ARPU, Data of Usage (DoU), type of package, KPIs, as well as internal service demands measured via Key Quality Indicators, service update, number of device replacements and supply factors metrics like network capacity utilization rate, traffic congestion rate, and the geographical coverage.

Following the Analysis stage and based on all results generated, a Decision group of tasks makes relevant decisions about the analyzed service uptake, user migration or other type of user acquisitions and customer segment growth and in general performs decision-making how to achieve the Customer Satisfaction goals and at the same time balance the network supply.

Based on all decisions made, the Execution group of tasks actually deliver this predictive user experience planning operation flow as part of Capacity Management. The execution also includes the activation of the policy, control function and service provisioning, proposed user migration and device replacement activities, proactive problem-solving, as well as delivering marketing campaigns and relevant offers and promotions, all with an ultimate goal of proactively and continuously improving customer experience and Net Promoter Score (NPS).

3.2.3. Customer Support

Catalyst Scenario for Customer Support Interface Management

Within the Operation stage, Customer Support capabilities defined here with an intent to be able to interact with customer more effectively. Therefore, they are aimed at fully automating customer profile and interface management where feasible to implement those operation flows and needed to explore, record and manage customer profile and contact details, customer inventory and service requirements within its given closed-loop, to achieve a more effective customer relationship during the whole Customer Lifecycle Management (CLM).

The Customer Support Interface Management closed-loop with its Lifecycle Management categories of tasks are depicted in the figure below.

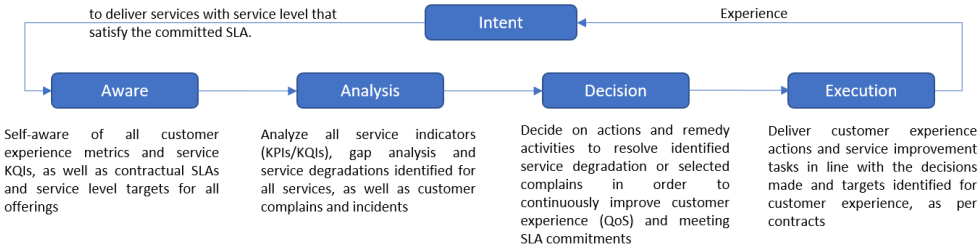

Figure 3-3 Customer Support – Customer Support Interface Management closed-loop

The Aware dimension of the customer support interface management capability covers the group of tasks for monitoring a fully available set of customer profile and service requirements that are stored and regularly maintained in the user inventory.

In the next closed loop stage, the Analysis dimension of tasks performs all necessary analysis of key customer details for effective support and specific tasks aimed at improving customer support interface functionality and customer experience management.

Following the Analysis stage and based on all results generated, a Decision group of tasks decide on customer channel and right end-user interactions, and where feasible, appropriately selecting right user segments to deliver certain actions or tailored marketing campaigns.

Based on all decisions made, the Execution group of tasks actually execute defined Customer Support activities across selected channels and perform selected tasks by using up-to-date customer details during the customer interaction and service complaint resolution support.

Catalyst Scenario to SLA Delivery using QoS Configuration

The next operation flow is defined around Customer Support capability for Improving Quality of Service (QoS) in line with contractually binding Service Level Agreements (SLA). The closed-loop defined here has a goal of defining QoS metrics for analyzing key customer facing indicators and then, determining capability gaps. This autonomous capability, through its Lifecycle Management categories of tasks should be continuously adapting the E2E Operation maturity evaluation.

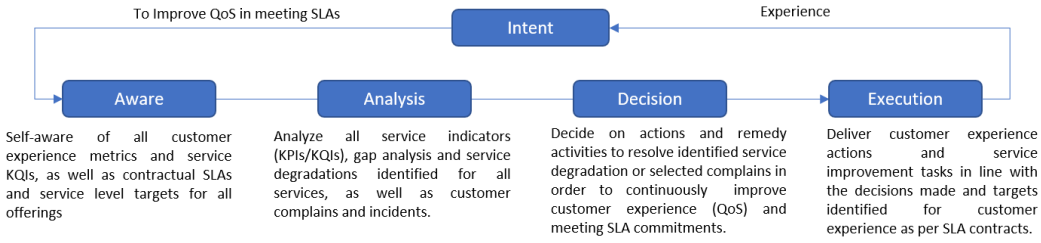

Figure 3-4 Customer Support - Improve QoS in Meeting SLAs closed-loop

The Aware category of this customer support operation flow for improving Customer Experience is about self-aware performing tasks for all customer experience metrics and service KPIs/KQIs, as well as contractual SLAs and service level targets defined for all service offerings.

Then, the Analysis category of tasks analyzes all service indicators and metrics to identify potential gaps and service degradation for all commercially available services and their associated customer complaints and registered incidents.

Based on all analysis outputs and results generated, a Decision group of tasks decide on actions and remedy activities needed to resolve identified service degradation and selected complaints. The decision-making should be driven with an ultimate goal of improving customer experience and meeting all defined Service Level Agreement targets and contractual commitments.

Based on the decisions from the previous stage, the Execution group of tasks for this operation flow delivers actions and improvement tasks from the list of available activities in line with the criteria and targets setup in the contract or re-defined in line with the business goals.

Catalyst Scenario of Customer Retention and Loyalty

The Customer Support capability for improving Customer Retention and Loyalty defines an intent of improving customer experience based on AI/ML support for managing customer Interaction and deriving real-time customer insights for automating Customer Lifetime Value (CLV) calculation. As such, it should include a self-learning model built with efficient customer behavior and pattern recognition and self-learning capability for identifying customer service usage trends, high value customer usage identification, registering events, campaigns and promotions taken, and where possible, optionally tracking typical and peculiar service preferences with perceived experience levels.

The closed-loop for improving Customer Retention and Loyalty with its Lifecycle Management task categories is shown in the figure below.

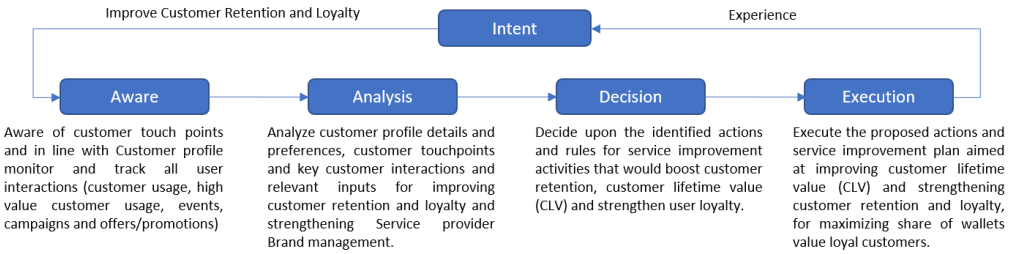

Figure 3-5 Customer Operation – Customer Retention and Loyalty closed-loop

The Aware category of this operation flow for improving Customer Retention and Loyalty in line with Omnichannel strategy looks at all customer touch-points available and monitors all user interactions, like customer/high-value customer usage events, customer complaints, service and promotion uptakes and marketing conversion success rate, renewals, in order to get a full picture of all customers.

Then, the Analysis category within this capability should define tasks to analyze all collected events and customer details, sorted out per each touch-point and prioritized in line with evaluation metrics and relevant criteria to better understand the context and right purpose analysis results can fulfil.

Based on all analysis outputs and the results generated, a Decision group of tasks decide upon identified actions and rules for service improvement activities that would boost customer satisfaction and brand loyalty. All decisions should have a direct correlation with Customer Satisfaction (CSAT) and Customer Lifetime Value (CLV) indicators to prove their validity in strengthening customer retention and loyalty.

Based on all decisions made available, the Execution group of tasks should, in line with the priority list, execute proposed actions and service improvement activities, that would ultimately boost customer retention and customer loyalty with actual monetization and potential revenue improvement metrics.

3.3. Capability Assessment for Service

The maturity level assessment of AOMM is carried out based on three steps:

1. Defining the autonomous operation behavior of a specific network operations closed loop automation lifecycle that is made up of intent, awareness, analysis, decision, and execution stages of a control loop.mechanism.
2. Assessing degree of Autonomy for each of the stages of a control loop using coverage of the operation flow and the corresponding sub-flows.
3. Scoring the service capability of each operation sub-flow by weighting the results of the Step 2 assessment to create and overall Autonomous Level value.

The assessment of each sub-flow will be on the capability of each closed loop stage; intent, awareness, analysis, decision, and execution to complete its operation process. The following table provides a list of the operation flow, capabilities that are referenced to the leTOM business process, and questionnaires.

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
Planning	Capacity Planning	Predictive User Experience Planning	Machine learning model for customer smart insights and predictive user experience planning based on service usage characteristics (service uptake, app trend, service KQIs) and customer behavior patterns (HVC trends, customer complaints) to improve customer satisfaction	33%	Q1. To have planning that includes customer experience consideration, describe your approach to deliver Predictive User Experience Planning and supporting capabilities? 1. Customer experience is measured reactively, and specific experience planning activities are tool assisted. 2. Predictive user experience planning activities are delivered with predefined rules to track key customer dimensions in a closed loop operation. 3. Predictive user experience planning is context aware and human decision-making through data analytics and AI-modelling of real-time inputs, all necessary metrics and customer experience dimensions. 4. The system performs automated analytics and decision-making through data and AI modeling for predictive user experience planning and forecasting through self-learning capability and close loop management.

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
		Predictive Capacity Planning	Machine learning model for capacity planning built with efficient pattern recognition and self-learning capability (network insight analysis on coverage, high value customer usage, network KPI definition)	33%	Q2. To prepare for a new service rollout, which approach best describes your operations towards capacity planning? 1. The market forecast input is provided by the product and marketing management and the capacity planning is tooled assisted. 2. Market insight and Internal forecast which provides a closed-loop system for capacity planning. 3. Capacity planning through context aware and data structured for effective planning recommendation through machine learning that is based on AI modeling of the market complexity. 4. The system makes predictive forecast based on network coverage pattern, high value customer usage, network KPI, and adaptive closed loop learning.
		Automated Planning Based on Simulation	Simulated service and network planning	33%	Q3. To enhance the accuracy and timely of the capacity planning, which capability your operation is equipped with? 1. Certain parts of the service and network capacity planning have been automated with tool assisted.

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					2. The service and network capacity planning are equipped with closed loop automation. 3. The automated capacity planning is through context aware, and data structured for effective planning recommendation through machine learning that is based on AI modeling of the market complexity. 4. Capable of gaining real-time insight on coverage analysis, high value customer usage, SLA, and competitive landscape as an input to the capacity planning simulation system for decision-making purpose.
Deployment	Design & Deployment	Self-Network Parameter Design	Network device aware to implement parameter configuration design	20%	Q4. For the network product design, how do you go about designing the network parameter? 1. The network parameter design is accomplished with tool assisted. 2. The network parameter design can be accomplished through closed loop automation. 3. With network awareness, the network parameter is configurable based on a defined data structure and AI modeling. 4. The network service design is across multiple network domains and the network parameters are configurable

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					through predictive closed loop management.
		Service Design and Creation	Low code design, model driven	20%	Q5. For the network service design and creation, what is the design capability your operation has now? 1. The network service design and creation process is accomplished with tool assisted. 2. The network service design and creation process is model driven based on low code design and can be accomplished through closed loop automation. 3. With network aware, the network parameter for the network design and creation is configurable based on a defined data structure and AI modeling 4. The network service design is across multiple network domains and the network parameters are configurable through predictive closed loop management.
		ICT integrated Deployment	Hardware installation and software deployment	20%	Q6. How does your operation proceed to the ICT integrated deployment after the capacity planning stage? 1. Based on the capacity planning output, the operation proceeds with the hardware and software

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					deployment assisted by a deployment system. 2. Based on the capacity planning output, a complete bill of material can be generated automatically and submitted to the respective vendor. The ICT hardware and software deployment process are automated through closed loop automation. 3. The ICT integrated deployment process is context aware and completed through closed loop management between network performance and network planning process. 4. The ICT integrated deployment process is automated across multiple network domains through a closed loop between network performance and network planning process upon BOM approval.
		Self-Deployment Configuration	automated software deployment but manual commissioning	20%	Q7. How does the software configure in the ICT deployment environment? 1. Once the hardware and software are deployed, the software is configured manually with a tool. 2. The ICT hardware and software are deployed with closed loop automation through preconfigured template.

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					3. At least one network domain is contexture aware and is self-configured through service orchestration and the rules and policy configuration is recommended through ML/AI modeling. 4. The operations are capable of traffic or external environment changes prediction through data analytics and self-configured the network to meet dynamic capacity demand.
		Self- Network Deployment Diagnostic Test	Self-Acceptance Diagnostic and error Correction	20%	Q8. How does the diagnostic test carry out during network deployment? 1. The network deployment diagnostic test is carried out with a tool 2. The network completes its deployment with closed loop diagnostic test. 3. The network automatically completes its closed loop diagnostic test with resolution through adaptive ML learning. 4. The network deployment supports outcome prediction and automatically runs diagnostic test and trigger a closed loop resolution.
		Fault Identification	Service alarm monitoring- network alarm monitoring- Network Performance monitoring	25%	Q9. In your network O&M, which option best describes your operation stage?

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
Maintenance	Fault Monitoring & Management				1. The operation performs fault surveillance and alarm handling with assistance of a fault management tool. 2. The fault management system is capable of fault monitoring and fault identification with preconfigured filtering and compression rules to automate the alarm handling process. 3. The fault management system is capable of service and environmental aware to dynamically setting the parameters of the alarm handling rules to enable a close loop recovery. 4. The system enables the analysis and decision-making in a cross-network domains without human intervention to execute a predictive and closed loop operations in driving customer experience.
		Fault Impact Analysis Demarcation and Root Cause Location	Self-Fault Demarcation and Localization	25%	Q10. For your network fault management, what is your approach in identifying and locating the root cause of a problem? 1. The operation team makes use of fault management tools to assist but manually demarcate and locate the fault.

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					2. The operation team has configured cross domain correlation rules to demarcate and locate the root cause, and performed auto-diagnostic to enable a close loop self-healing. 3. The operation makes use of a system to automatically be aware of environmental changes and dynamically set the parameters of the quality of service to enable a close loop recovery. 4. The operation makes use of AI modeling to analyze and learn the historical patterns and behavior and assist in recommendation and decision on predictive close-loop management.
		Fault Recovery Solution	Closed loop fault management	25%	Q11. For the fault recovery, which solution best describes the approach taken by your operation? 1. The operation team makes use of preconfigured rules of the fault management system to identify the alarms and manually recover the fault. 2. The operation team has configured cross domain correlation rules to demarcate and locate the root cause, auto diagnose and resolve

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					the fault through closed loop self-healing. 3. System enabled service and environmental awareness and dynamically setting the parameters of the quality of service to enable a close loop recovery. 4. The operation makes use of AI modeling to analyze and learn the historical patterns and behavior to make predictive recommendation and decision on active close-loop management.
		Fault Management Policy based Scenario Monitoring	Scenario based fault management monitoring	25%	Q12. What is the approach your operation team is using for scenario monitoring? 1. The operation team makes use of preconfigured rules and policy for the scenario monitoring. 2. Based on the scenario, the operation team configured filtering rules and cross domain correlation rules to demarcate and locate the root cause. In addition, the system performs auto-diagnostic and resolution procedures to enable a close loop self-healing. 3. The operation makes use of a system to create specific service scenario and environmental aware

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					to dynamically configure the quality of service for close loop recovery. 4. The operation makes use of AI modeling to analyze and learn the historical patterns and behavior of the scenario and make predictive recommendation and decision on active close-loop management.
	Routine Maintenance	Proactive maintenance	Predictive maintenance	50%	Q13. To improve on the service uptime, what are the maintenance initiatives taken by your operation team? 1. The operation team collects data during routine maintenance and offline analyzes the data with the help of an analytical tool. 2. The operation team is able to perform their routine maintenance online, collect the network health report data for analysis and carry out a close loop maintenance with corrective action. 3. The operation makes use of a system to create scenario specific service and environmental aware and recommend corrective maintenance through data analysis and AI modeling. 4. The operation makes use of AI modeling to analyze and learn the hardware historical patterns and

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					behavior, and assist in recommendation and decision for predictive close loop management
		Site inspection	Field maintenance	50%	Q14. To ensure high service availability, which approach best describes your field maintenance initiative? 1. Performs scheduled preventive maintenance and manually executes a standard checklist steps for field maintenance 2. The operation team is able to perform remote scheduled maintenance, provide online network health reports and perform corrective action as a closed loop operation. 3. The operation team performs field data collection for data analysis and an expected network device life span for decision recommendation based on AI model. 4. The system enables analysis and make decision on field maintenance based on predictive network device life span and network performance across multi- autonomous domains.
	Test	Network and Connectivity Test	Predictive Performance Management	50%	Q15. As part of the quality control, what is the test approach carried out on

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					network performance recovery by your operation team? 1. The network performance management test is carried out with a test tool in a pre-configured test environment. 2. The network performance will undergo an automatic diagnostic test and complete a close loop with self-configuration. 3. The historical network performance patterns are collected and analyzed, and a diagnostic test and resolution is recommended through AI modeling. 4. The system is configured with data collection for analysis and a predictive close loop performance management test is recommended through AI modeling.
		Service Quality Test	Predictive Service Quality Management	50%	Q16. As part of the quality control, what is the test approach carried out on service quality by your operation team? 1. The service quality management test is carried out with a test tool in a pre-configured test environment. 2. The operation will carry out a service quality automatic diagnostic test and

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					complete a close loop with self-configuration. 3. The historical service quality patterns are collected and analyzed, and a diagnostic test and resolution is recommended through AI modeling. 4. The system is configured with data collection for analysis and a predictive close loop service quality management test is recommended through AI modeling.
Optimization	Network Analysis	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.	33%	Q17. To achieve and maintain network optimization, what is the operation team's approach in monitoring the network performance and identifying the issues? 1. Centralized data collection and performance analysis with tool assistance. 2. Centralized data collection, data cleaning, data enrichment, and data sharing for an enablement of partial automated O&M based on predefined rule/policy. 3. The network management system is capable of perceiving the services, analyze the data collected and automatically recommend an optimized option through AI model.

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					4. Through alarm pattern and network behavior analysis, the operation supports predictive closed loop automation across some services and specific domains.
		Service Deterioration Issues 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.	33%	Q18. To achieve and maintain service optimization, what is the operation team's approach in managing the service quality to minimize customer experience service disruption? 1. Tool assisted for analysis of aggregated performance of the raw data collected by probes or agents. 2. Based on predefined service quality indicator, the service quality is monitored and assured with close loop automation between service and resource operation. 3. The network management system is capable of perceiving the services, relate the required quality of service and automatically recommend an optimized option through AI model 4. Through alarm pattern and service behavior analysis, the operation supports predictive close loop automation across some services and specific domains.

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
		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).	33%	Q19. For the network performance resolution, which option best describes your operation capability? 1. Manual effort correlation coupled with operation KPI assisted by tool to demarcate performance issue. 2. The system configured with cross domain correlation rules and identifies the performance impacted domain. 3. The system analyzes the network performance alarm trend and performance behavior, provides recommendation on the impacted network domain through AI modeling. 4. The system automatically learns rules/policies (such as dynamic KPI thresholds) of the operation to automatically predict the failing network domain.
	Network Optimization	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.	33%	Q20. To locate the root cause of a performance issue, which operation capability best describes where you are now? 1. The operation KPI tool and the manual correlation effort enable the locating of the root cause performance issue.

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					2. The system configured with fault - performance correlation rules, automatically identifies the root cause of the performance issue. 3. The system analyzes the network performance alarm trend and performance behavior, provides solution recommendation to the root cause performance issue through AI modeling. 4. The system analyzes the network performance behavior and recommends an appropriate solution to the predictive failing network.
		Formulate Optimized Solution	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	33%	Q21. To improve on the resolution effectiveness of a network performance related issue, what is your solution approach? 1. The solution will be developed and tested through tools and pre-configured template. 2. The system is tested in a close loop automation environment that is based on pre-configured rules and logics. 3. The system is aware of the service, analyzes the network behaviors and recommend the necessary solution through AI modeling. 4. The system enables analysis on simulated environment and makes

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					decision on predictive close loop management of some services across specific domain.
		Network Optimized Result Evaluation	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.	33%	Q22. How does your operation evaluate an optimized network solution? 1. The network performance solution is tested and evaluated through tools and pre-configured templates. 2. The network performance solution is tested and evaluated in a well-equipped close loop automated test environment. 3. The network performance solution is tested and evaluated in a service aware test environment which is capable of recommending test cases and test plans through AI modeling. 4. In addition to a well-equipped automated test environment setup, the test cases and test plan include predictive network optimization use cases.
Operations	Self-Provisioning	Self Service Provisioning	Service Orchestration and Service Provisioning Automation	20%	Q23. For order fulfillment, which service provisioning capability best describes your operation readiness? 1. The order is manually provisioned with tool assisted. 2. The service provisioning is automated through service

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					orchestration which is based on pre-configured rules and logic. 3. The system adapts itself with real time environment changes awareness (e.g., bandwidth on demand) and provisioned the order through dynamic resource allocation recommended by AI modeling. 4. The system supports adaptive service provisioning that requires a proactive approach to QoS management with support for predictive auto-scaling of service capacity.
		Self-Checking for Resource Availability	Self-Network Planning and SIA Simulation	20%	Q24. How does your operation ensure resource availability when handling order management? 1. The system is capable of checking resource availability in the Inventory Management system. 2. The network planning system automates the resource design which relates to service impact analysis that is based on pre-configured rules and policy. 3. The system is service aware to enable optimized network planning through service impact data analytics and AI modeling.

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					4. The system automates the network planning through predictive service impact analysis with a balance of quality of service and customer experience.
		WFM Automation	Automated WFM, site inspection and self-acceptance	20%	Q25. How do the field engineers schedule for dispatch to the enterprise customer premise project implementation? 1. The WFM system dispatch onsite inspection and project implementation work based on pre-configured rules and policy 2. The WFM system enables closed loop site inspection and remote provisioning and configuration for certain domains. 3. The WFM system is contexture aware that allows intelligent scheduling of workforce through close loop automation 4. The system enables predictive analysis of the site acceptance and commissioning based on the site inspection quality through image recognition and necessary test results.

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
		Dynamic Resource Allocation	Self-service instance configuration and service activation.	20%	Q26. For the service provisioning to activation operation, which option best describe your service orchestration capability? 1. Users perform service provisioning to activation with tools assisted and predefined templates. 2. The system enables close loop service orchestration for service provisioning to activation based on pre-configured rules and policy. 3. The system is equipped with contexture awareness of the order, enable closed loop management to recommend an optimized service orchestration for service provisioning to activation through AI modeling. 4. The system enables analysis of the QoS, bandwidth availability and traffic engineering to dynamic allocate resource for service provisioning to activation through predictive close loop automation.
		Self Service Instance Test	Service order self-test and verifications on SLA ordering	20%	Q27. For service order that has an SLA obligation, how does your operation validate the order integrity and completeness?

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					1. The operation team leverage on tools and template mapping to assist in the service order validation. 2. The system enables service orchestration to achieve closed loop service order verification test. The service order with SLA is provisioned through pre-configured rules and logics. 3. The system with service order awareness enables closed loop management in SLA order validation test through data analytics and AI modeling. 4. The system enables analysis of the network environment and make predictive decision on SLA order correction through closed loop management.
	Customer Support	Customer Support Interface Management	Customer Profile & Interface Management aimed to explore, record and manage Customer Profile and Contact details, all necessary Customer database and service requirements, to be regularly maintained for a strong customer relationship during the entire Customer Lifecycle Management (CLM)	33%	Q28. For a successful E2E Customer Support and a continuous improvement in Customer Lifecycle Management (CLM), what activities and techniques do you use to manage Customer Interface effectiveness across the Customer Journey? 1. Customer support adopts tools for Customer Interface Management but operate manually.

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					2. Customer support adopts Customer Interface Management with predefined rules and policy to provide closed loop interaction with customer for their service requirement. 3. Customer Smart Interface and Inventory per customer touch points are generated and modelled by AI/ML to derive full customer interactions behavior analytics across the customer journey. 4. Customer Smart Interface and Inventory are modelled with AI/ML analytics and automatically decide on the preferred channel for a desired customer lifecycle value.
		Support Customer QoS/SLAs	Customer Experience defines the customer maturity matrix, analyze key customer facing capability Indicators, and determine customer experience gaps, service degradation and incidents (reported and not-reported) for the E2E Autonomous Operation maturity of the overall Customer journey.	33%	Q29. To support customer experience initiatives, what techniques are you adopting to ensure a high level of customer satisfaction? 1. Tool assisted surveillance on service quality and service performance are regularly monitored, and the QoS is manually analyzed and recovered. 2. The operation is designed with closed loop management which includes service quality management, customer complaints and incidents through pre-configured

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					rules and policy to ensure SLA is observed. 3. The service quality is monitored, and anomaly detected by AI modeling, analyzed automatically through KQIs and KPIs mapping and customer complains demarcation. Through system analytic recommendation, the support engineer will decide on the most effective solution to execute. 4. Through continuous experience adaption, the system acquires the cognitive capability to decide on the most effective solution analyzed by the ML/AI algorithm.
		Support Retention and Loyalty	AI/ML support for managing Customer Interaction and deriving real-time customer retention and loyalty metrics, using self-learning model for building efficient customer behavior and pattern recognition and self-learning capability (customer usage, high value customer usage, events, campaigns and promotions taken, service preferences and perceived experience levels)	33%	Q30. To enhance on Customer retention and loyalty, how do you describe your operation approach in aligning to business? 1. 1Manual operation through tools assisted to monitor and manage customer satisfaction activities. 2. Customer satisfaction is managed through closed loop operation with predefined rules and policy. 3. Customer sentiment aware with AI modeled on the customer behavior and responses to support the

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					customer retention and loyalty program. 4. Customer retention and loyalty support is fully autonomous and predictive through AI modelling based on market trends, network coverage pattern, event history and customer changing behavior, high value customer usage, network KPI, as well as adaptive closed loop learning.
	Complaint Handling and Management	Predictive customer complaint analysis	Customer Complaint Prediction Data Model	33%	Q31. For the customer compliant analysis and handling, which of the following best describes your operation capability? 1. The customer complaint handling is assisted by a customer care system with predefined rules and policy. 2. The system enables closed loop customer handling and management for services based on pre-configured rules and policy. 3. The system with awareness on real time environment changes (e.g., churn) enables closed loop automation on customer complaint management and resolution through data analytics and AI modeling. 4. The system enables the analysis of the customer behavior patterns,

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					interaction data, and problem management cases to make predictive decision on customer complaint handling and resolved through closed loop operation.
		One-click diagnosis of customer complaints	Customer complaint demarcation	33%	Q32. To improve on the First Call Resolution rate, how is your customer care operation manage the problem demarcation? 1. The customer complaints handling, and diagnosis is tool assisted and is based on defined template. 2. The system enables one-click closed loop customer complaints diagnosis for certain domains that is based on pre-configured rules and policy. 3. The system with contextual awareness of the customer complaint type, enables closed loop single click diagnosis through data analytic and AI modeling. 4. The system enables fault tree problem demarcation and make predictive decision on single click closed loop management to address the problem.
		Fault surveillance	Onsite network fault resolution and commissioning	33%	Q33. Which fault surveillance capability best describes your operation for the

Operation Domain	Level 1 Capability	Level 2 Capability	Detail capability description	Weighting	Questions
					onsite network fault resolution and commissioning? 1. Tools assisted for onsite network fault resolution and commissioning that is based on pre-configured rules. 2. The system enables closed loop onsite network fault resolution and commissioning that is based on pre-configured rules and logics. 3. The system with awareness of the field environmental changes, is adaptive to the environment changes and is capable of enabling closed loop fault resolution and commissioning. 4. The system supports customer site fault surveillance and enable predictive operation through closed loop management.

Table 1. AOMM Tool

Questionnaires sample to assist in maturity level establishment
To ensure a consistent assessment, the AOMM tool includes a sample of questionnaires which can be referred in table 1.

The questionnaires are structured in a closed ended manner, guiding the survey participants to select the option that best describes the existing operation mode.

The sample questionnaires potentially could be opened to further discovery questions in uncovering the existing operation capability level and pain points that underpinning the People, Process, Resource and Information.

Assessment Scoring Mechanism

The autonomous level of the service capability can be evaluated on its effectiveness in carrying out the closed loop automation throughout the 5 stages that includes intent, awareness, analytics, decision, and execution. However, the question is that does each of the 5 stages carry the same weightage. Prior to the framework maturing with a dimension weightage distribution methodology, the AOMM tool takes the assumption of an equal weighting distribution as shown in table 2.

The list of questionnaire samples is constructed in a way to assist quick assessment of CSP's maturity in the ANL. The sequence of each response is mapped to the corresponding ANL. For example, the selection "1" of a question is mapped to Level 1 of the ANL. The selection "2" of a question is mapped to Level 2 of the ANL and so forth.

After which, each sub-flow will be scored based on the merit of each of autonomous networks closed loop stage. The Level 2 capability scoring is computed based on weighted average of the individual sub-flow. The Level 1 capability will take the aggregate of each domain of the operation flow. An illustration based on arbitrary score of the Fault Monitoring & Management capability in table 2 provides a self-explanatory scoring mechanism.

Level 1 Capability	Level 2 Capability	Weighting	Intent/ Experience	Aware	Analysis	Decision	Execution	ANL Assessment @ L1 Capability	ANL Assessment @ L2 Capability
			20%	20%	20%	20%	20%	100%	100%
Customer Support	Customer Support Interface Management	33%	2.2	2.2	2.5	2.2	2	1.89	2.22
	Support Customer QoS/SLAs	33%	2	1.8	2	2.3	1.5		1.92
	Support Retention and Loyalty	33%	2	1.5	2	1	1.5		1.6

Table 2 AOMM Scoring Sample Mechanism

4. Leveraging AOMM to align operations to business strategy

The success of executing an organization strategy is dependent on how well the organization executes its operating model to achieve its business strategy. The operating model defines the model which includes the required business capabilities underpinning the people, process, resources and information necessary to implement the strategy. For instance, if an organization seeks the digital operating model to execute its digital transformation strategy, the question is whether there is a strong alignment between the organization capabilities, operating model and the business strategy. The AOMM will serve the purpose in the capability gaps identification and the capability blueprint formulation to prepare the operation in executing the strategy.

4.1. Objective AOMM Assessment

The AOMM is introduced to provide an assessment of the organization as-is capability maturity level, set the next level target, and identify the business capability gaps. The maturity assessment is scored from both the inside-out and the outside-in view which could be from various functional teams and external consulting company. The objective for engaging multiple parties in the assessment is to assist in eliminating biasness or any possible hidden agenda.

Maturity models are a common part of the transformation toolkit and are heavily used in project & process management, however research shows that they rarely result in performance improvements (Jugdev, 2002). Maturity models are characterized by check lists against paper process which probably has undergone several rounds of changes in the field without diligently updated or process models that oversimplify reality and lack quantifiable evidence (McCormack, 2009). This lack of empirical foundation results in recommendations and priorities that lack the economical foundation and the level of business justification required in telecom operators and enterprises who are looking for return of investment in months and not years.

The company has agreed that they need to transform a part of the business and a transformation lead and team is established. This team will usually start by carrying out face-to-face interviews with top managers and operational managers to get some guidance.

Then key individuals in the organization will be identified for data gathering through workshops, questionnaires, calls etc. In parallel with this activity the key performance indicators (KPIs) of the programme will be identified and systems teams will be engaged to start producing glide paths and other relevant information. Data driven operations with process transparency will provide obvious and clear areas of enhancement and process optimization opportunity.

Furthermore, consultants may be brought into benchmark, assess and advise on the current way of working and opportunities for change which typically introduces an industry maturity model. But all too often the consultant is applying lessons learned from a commercial environment (geography, regulatory, contractual etc.) that is often far different from the current operator.

Therefore, when it comes to the AOMM assessment, it is imperative to have a transparent data driven process mining model in providing guidance to an objective and consistent approach in determining the AO maturity level and identifying areas of capability requirement to drive operation efficiency towards autonomy.

4.2. Process Mining Model

There are four key stages behind the process mining model which will enable companies to use the model efficiently and technology providers to develop it further for specific industries. At the same time, the industry standard will provide the basis for further innovations, such as for expanding the scope of the system to include artificial intelligence, machine learning and then industrializing it. The process mining model when established as an industry standard will be instrumental in companies' successful digital transformation.

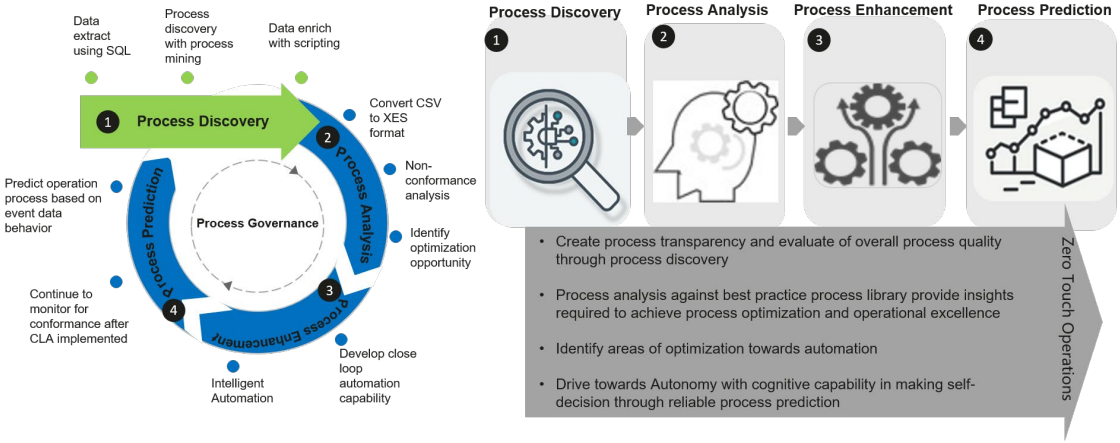

Figure 4-1 Process Mining Model

The process mining model defines the 4-stage process mining methodology, tools and process governance for standardized best practices, and rules and policy for closed loop automation enablement. The 4-stage process mining are as follows:

4.2.1. Process Discovery

This technology extracts data from event logs in transactional systems that support key processes and makes it possible to understand and measure actual process flows and variations. In other words, it allows for process analysis without much human intervention.

case id	event id	properties				
		timestamp	activity	resource	kpi	...
PDT-20200121-00019	9718616Z	21/01/2020 11:42	Create	OPM_RAN_Provl_Mindanao	Create	...
	9718619Z	21/01/2020 11:42	Accept	OPM_RAN_Provl_Mindanao	Accept	...
	2017303012	21/01/2020 11:47	Dispatch via WO	OPM_RAN_Provl_Mindanao	Dispatch	...
	9829139Z	27/01/2020 09:17	Resolved	OPM_RAN_Provl_Mindanao	Resolve	...
	9829149Z	27/01/2020 09:17	Resolve	OPM_RAN_Provl_Mindanao	Resolve	...
	9829297Z	27/01/2020 09:23	Close	OPM_RAN_Provl_Mindanao	Close	...
CR-20200124-00281	9797560Z	24/01/2020 18:38	Create	NFS_MM_SMM_WFS11	Create	...
	9828792Z	27/01/2020 09:01	Accept	NFS_MM_SMM_WFS11	Accept	...
	9828905Z	27/01/2020 09:06	To Approver	NOC_CNCC	Analyse	...
	9829746Z	27/01/2020 09:44	Reanalyse	NFS_MM_SMM_WFS11	Reassess	...
	9829828Z	27/01/2020 09:48	To Approver	NOC_CNCC	Analyse	...
	9837661Z	27/01/2020 16:05	Approved	CENTRALIZE COMMAND AND CONTROL	Approve	...
	9837799Z	27/01/2020 16:11	Schedule	NOC_CNCC	Dispatch	...
	9922038Z	31/01/2020 19:01	Finish	NFS_MM_SMM_WFS11	Resolve	...
	9943288Z	02/02/2020 12:39	Close	NFS_MM_SMM_WFS11	Close	...

Figure 4-2 Event Log Sample

Input for process mining is an event log. A traditional event log views a process from a particular angle provided by the case notion that is used to correlate events. Each event in such an event log refers to (1) a particular process instance (called a case), (2) an activity, and (3) a timestamp. There may be additional event attributes referring to resources, people, costs, etc., but these are optional. With some effort, such data can be extracted from any information system supporting operational processes. (processmining.org, n.d.)

4.2.2. Process Analysis

Process mining methodically discover event data and process models from the event logs, covert the CSV file to XES format where the process map is replayed and revealed the actual operation process flow. eXtensible Event Stream (XES) is the standard format for process mining adopted by the IEEE Task Force for logging events.

During the process analysis stage, the application highlights the process non-conformance from the target operating model, areas of process friction, identify improvement opportunities and recommends process enhancement.

An understanding and measuring a process and the resources it consumes is important and valuable because it provides insights on the end-to-end process with the alarm size and transit duration from one state to another.

4.2.3. Process Enhancement

After much analysis is done on the event data behavior and process model, areas of optimization or improvement on the existing process model using information about the actual process recorded in the event log. One type of enhancement is service quality recovery, modifying the model to better reflect reality. For example, if two activities are modeled sequentially but in reality, can happen in any order, then the model may be corrected to reflect this. Extension could be another perspective of the process enhancement, for example, by using timestamps in the event log of the customer complaint handling process, the existing process model could be extended to show bottlenecks, service levels, and frequencies. To drive process automation, process models that involved long and much manual effort could be identified for process optimization, for example, introducing rules, policy and API for a closed loop automation.

4.2.4. Process Prediction

The process discovery can be extended with information to predict the completion time of running instances.

By replaying event logs one can build predictive models, i.e., for the different states of the model particular predictions can be made. For example, a predictive model learned by replaying many cases could show that the expected time until completion after enabling is "X" hours.

In the data-based industrial process prediction practice, there are multiple classification strategies for the data-based industrial process prediction techniques, in which three aspects are the most commonly considered, e.g., data feature-based methods, timescale based, and the prediction reliability-based. For each of the characteristics of predicting modeling, there are commonly used prediction techniques which include the time series-based methods, the factor-based methods, the prediction intervals construction methods, and the granular-based long term prediction methods.

In network operations, there are many scenarios where reliable time prediction is beneficial to service providers especially when it comes to enhancing the customer experience through effective customer complaint handling. For example, when a customer calls in the contact center to make a complaint on VoLTE service quality, the Customer Complaint handling agent would be able to response to the customer with an expected service quality recovery time through the reliable time prediction modeling

4.3. Process Mining Model for AN Levels

Process mining model that connects the data science and process science in providing process transparency to the Autonomous Operation framework. The process mining model optimizes business outcomes and drives business value in accelerating the zero touch operation journey.

AO Maturity Model assessment provides a means to establish the as-is capability maturity level which is classified into 6 levels. Apart from a few distinct characteristics that describes each autonomous network level (ANL), the 6-level ANL varies between level of maturity by the degree of man-machine collaboration. The question is that is there an objective approach to determine the degree of man-machine collaboration and consequently classifying the ANL the operation is at.

The process mining discovers an end-to-end process model from the event logs.

For the man-machine collaboration analysis, this guide will only be focusing on the common trace of the process flow and leaving the exceptional trace for non-conformance analysis. Common trace of the process model can be easily identified through the event data size and behavior. For the mapping of the process model to the ANL analysis, only the common trace will be considered.

The end-to-end process lifecycle can be divided into 5 stages; namely intent, aware, analysis, decision, and execution. Based on the time stamp of the event data transits from one activity to the next, one can quickly deduce if the operation is manual effort, automated or people assisted by system.

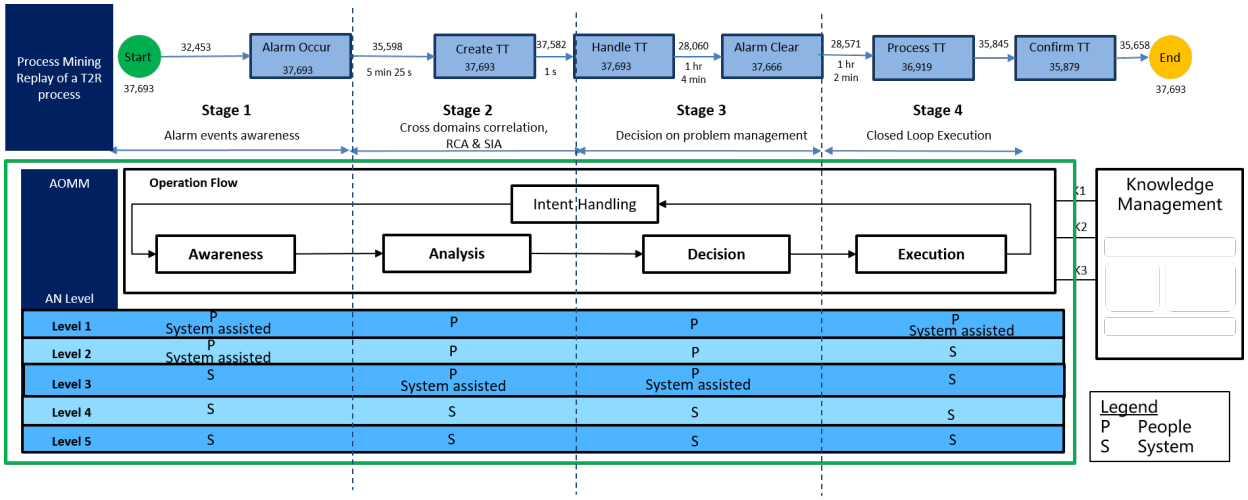

Figure 4-3 Mapping of Process Mining Replay to ANL

Take for example the trouble-to-resolution process model replayed on the process mining map, we can gather from the diagram that the activity from alarm generate to trouble ticket create took only 5 mins 25s. The task between those two activities will include alarm compression, alarm correlation and trouble ticket create. Given the amount of effort in processing the fault management, it is undoubtedly to conclude that the fault management process is automated. This means that the operation would have been equipped with a system to be aware of the network equipment details which include the alarm type and classification collected from the EMS. The analysis of the alarm compression, cross domain correlation and root caused analysis has been automated through predefined rules and policy. At the Decision stage on problem management and Execution stage on problem resolution, the duration from one activity to the next took about one hour plus respectively. One can conclude that the two stages are primarily manual driven. There is room for process optimization through automation at those two stages.

5. Assessing and Measuring Values of Autonomous Operations

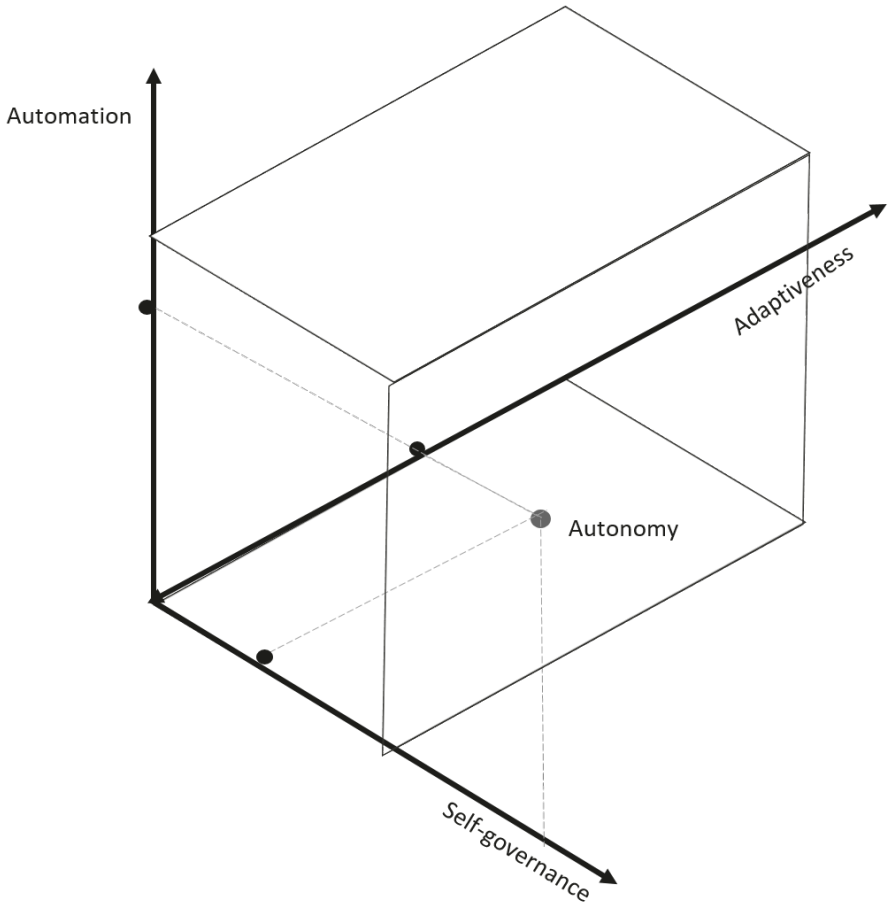

Figure 5-1 Capabilities and attributes of Autonomy

To assess and measure the values of autonomous operations, it is important to understand the capabilities and the respective attributes that autonomous operations should be equipped with. Autonomous Operations involve the ability to automate, to adapt to dynamic environments, and to self-governing without much human intervention. Autonomous operation is about building capabilities on automation that learns and adapts to dynamic environments and evolves as the environment around it changes. The autonomous system will learn from an increasing data set faster, and eventually more reliably in decision-making under an evolving and non-deterministic environment, than what would be reasonable for a human.

Autonomous Operations in the automation spectrum requires a complex mix of advanced technologies such as AI and ML in combination with organization design and process changes. There is no doubt that autonomous operations will bring great value to an organization that is worth the investment. Investment in technology to build capabilities in realizing business benefits needs to be justified. The values of building the autonomous operation capabilities could be assessed through well-defined use cases and measured by a set of operational metrics. To illustrate the applications of

the AOMM assessment and the approach to realize value in building capability towards the ZTO journey, a step-by-step approach is provided in the next section to guide the success of an autonomous operation planning, design, and implementation.

6. Use Cases in the Catalyst

Use Case Background
Operator XYZ is the market leader in the country, serving over 50 million subscribers. The company provides voice, data, video and digital services to consumers, enterprise and home customers. Operator XYZ has embarked on digital operation transformation as part of their strategy to achieve their business objectives; to lead NPS and reduce annual operating expenses by 20%.

In preparation for the 5G launch, Operator XYZ is retiring the 3G networks to free up spectrum for 5G networks. VoLTE service subscription is expected to grow in 10 folds. VoLTE service quality will have a direct impact on customer experience.

Operator XYZ is embarking on zero touch operation journey through leveraging technology and building intelligent operation capabilities to drive autonomy.

A step-by-step guide to the identification and capability development through the use of AOMM assessment, process mining model and Value Operation Framework (VOF) can be applied:

Stage 1: Assessment and Planning
Step 1: Assessment of as-is maturity level through Process Mining and Discovery Workshop

The as-is maturity level will be carried out with a combination of process mining and discovery workshop. The SOC and NOC process discovered from the event logs provides event data throughout an end-to-end process model. Finding from the process map can be summarized as follows:

	Intent	Aware	Analysis	Decision	Execution
Duration	-	1 hr 42 mins	27 mins	1 hr 2 mins	1 hr 13mins
Autonomous Network Level 1.X	P (No API implemented)	P (System assisted in general service monitoring. Aware of VoLTE service degrade through customer complaint)	P	P	P (System assisted to recover service quality)

P People S System

To assess the as-is maturity level with only the process map is not sufficient. The assessment must be accompanied by the ANL characteristics and the AOMM tool to distinctly determine the maturity level. Details on the pain points and the operation effort required could be filled in during the discovery workshop.

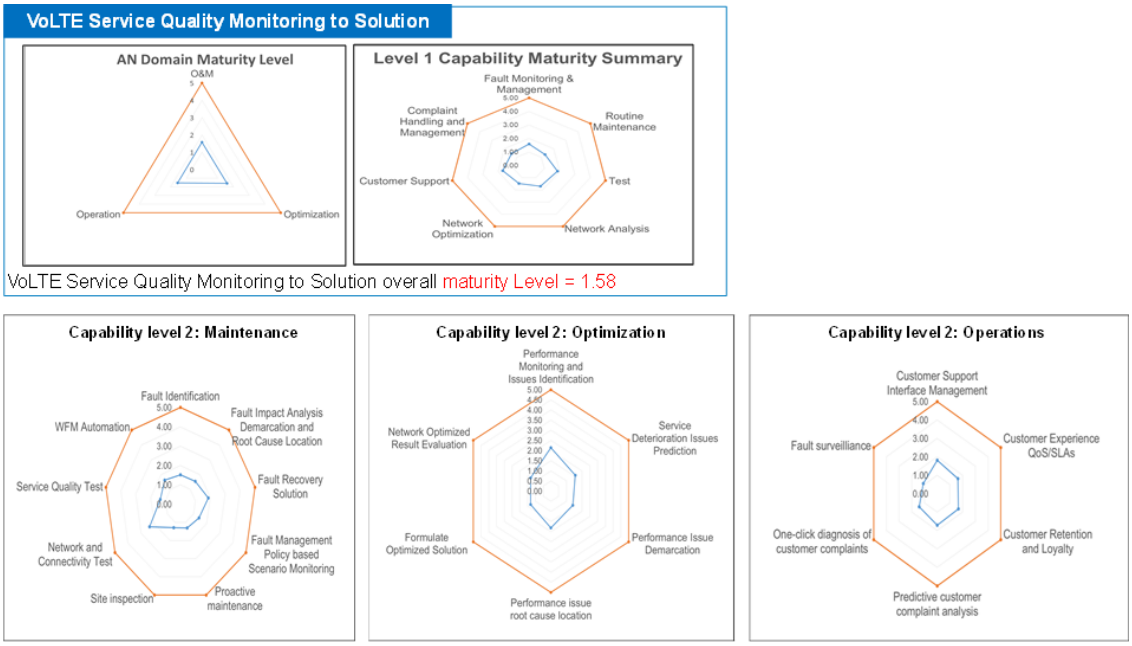

Figure 6-1 AOMM Assessment Radial Diagram - Sample for illustration purpose

With the scoring based on AOMM tool, a clear reflection on the maturity level of each operation flow and sub-flow could be presented in the visual radial diagram shown above.

Step 2: Set the next ANL as the to-be target

Step 3: Capability Gap Analysis and Capability Development Roadmap Planning

AO Service	AO Use Case	AO Requirement and Capability
VoLTE Service Monitoring	**1. Service monitoring to resolution process.** • Monitoring of the VoLTE service quality • Model the relationship between KQI and KPI for VoLTE that cover the accessibility, retainability, call integrity, and mobility. • KQI threshold setting • Configure rules and policy for auto ticket creation and closure, auto ticket dispatch. • Explore some self-healing capability	**1. Service monitoring** • Modeling of VoLTE service throughout its registration, connection, call, and handover phases. • Define the KQI against the QoE; Accessibility, retainability, integrity, mobility. • Mapping the performance counters, network performance KPI and KQI. • The machine learning of the contributing KPI weightage and service quality sensitivity.
		2.SQM and anomaly detection • List of KQI threshold library according to geographical behavior.

AO Service	AO Use Case	AO Requirement and Capability
		• The machine learning of each of the QoE pattern behavior and prediction.
		3. Automation rules and policy. • Service quality degrading ticket automatically created and closure. • The knowledge management modeling and buildup. • The work order auto dispatch rules. • Auto self-healing policy. • The autonomy algorithm that is balanced between automation, adaption and self-governance.

Table 3 Capability Gap Analysis

Stage 2: Design
The business capability can be developed through a well-defined use case that will meet the milestone objective and at the same time generate cumulative values in meeting the long term vision and goals.

VoLTE High Level Design
For illustration purpose, a service lifecycle management on VoLTE service monitoring to problem resolution process is selected to build a list of required capabilities identified from the process mining map.

A HLD logical diagram is designed to provide a basis of subsequent low level solution design. Besides a solution architecture design with resources and information integration, business processes that is based on eTOM best practice and an organization design are required.

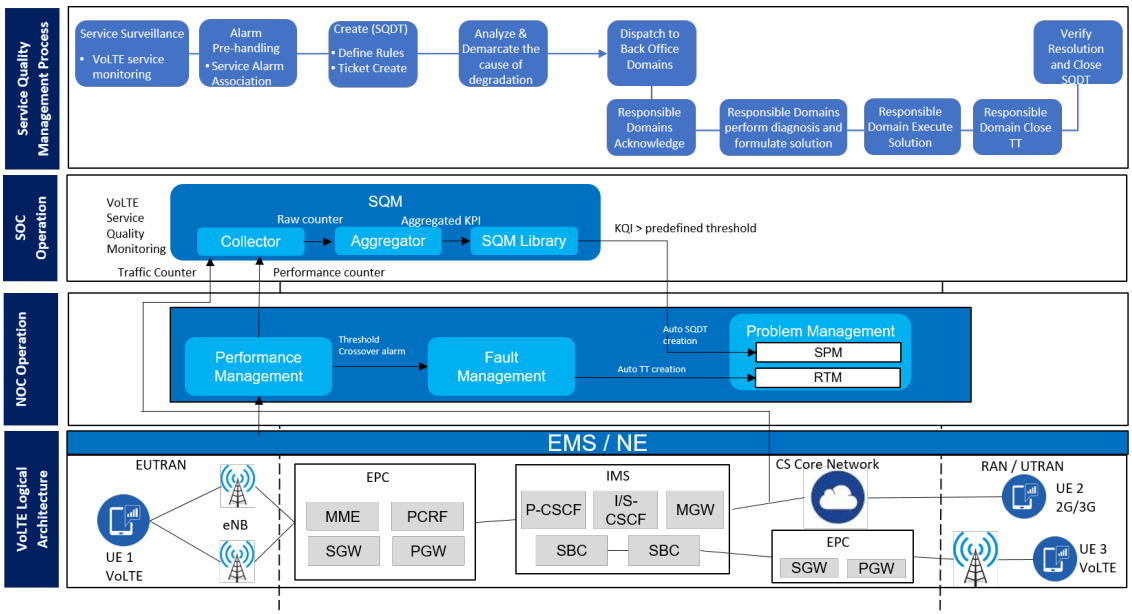

Figure 6-2 Service Monitoring to Problem Resolution and VoLTE Logical Diagram

Value Assessment

Prior to the resource investment in the MVP implementation, it will be a hygiene factor to assess the values of elevating the as-is ANL to to-be level through the targeted MVP.

The value assessment is performed through the Value Operation Framework (VOF).
Step 1: Assign OPM to each stage of the MVP value stream. Define KPI for the OPM aggregation.

Step 2: Map the KPI/OPM to the business outcome with objectives defined in the category of Revenue, Innovation, customer Satisfaction, and operation Efficiency (R.I.S.E)

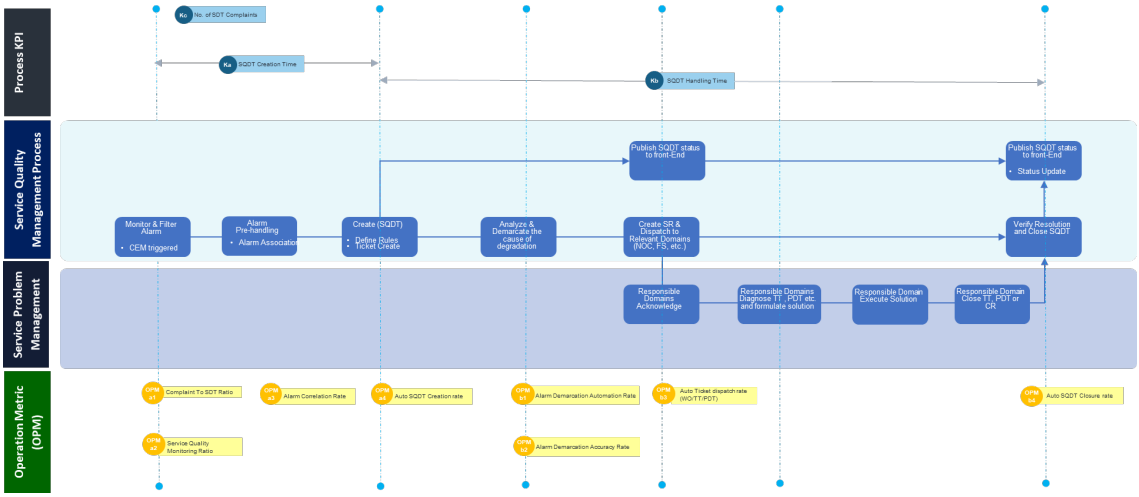

Figure 6-3 OPM Assignment to MVP Value Stream

Step 3: Assess the MVP values through the MVP process optimization. The ultimate goals of business are consolidated from the business outcomes, which can be presented to the executives in financial aspects.

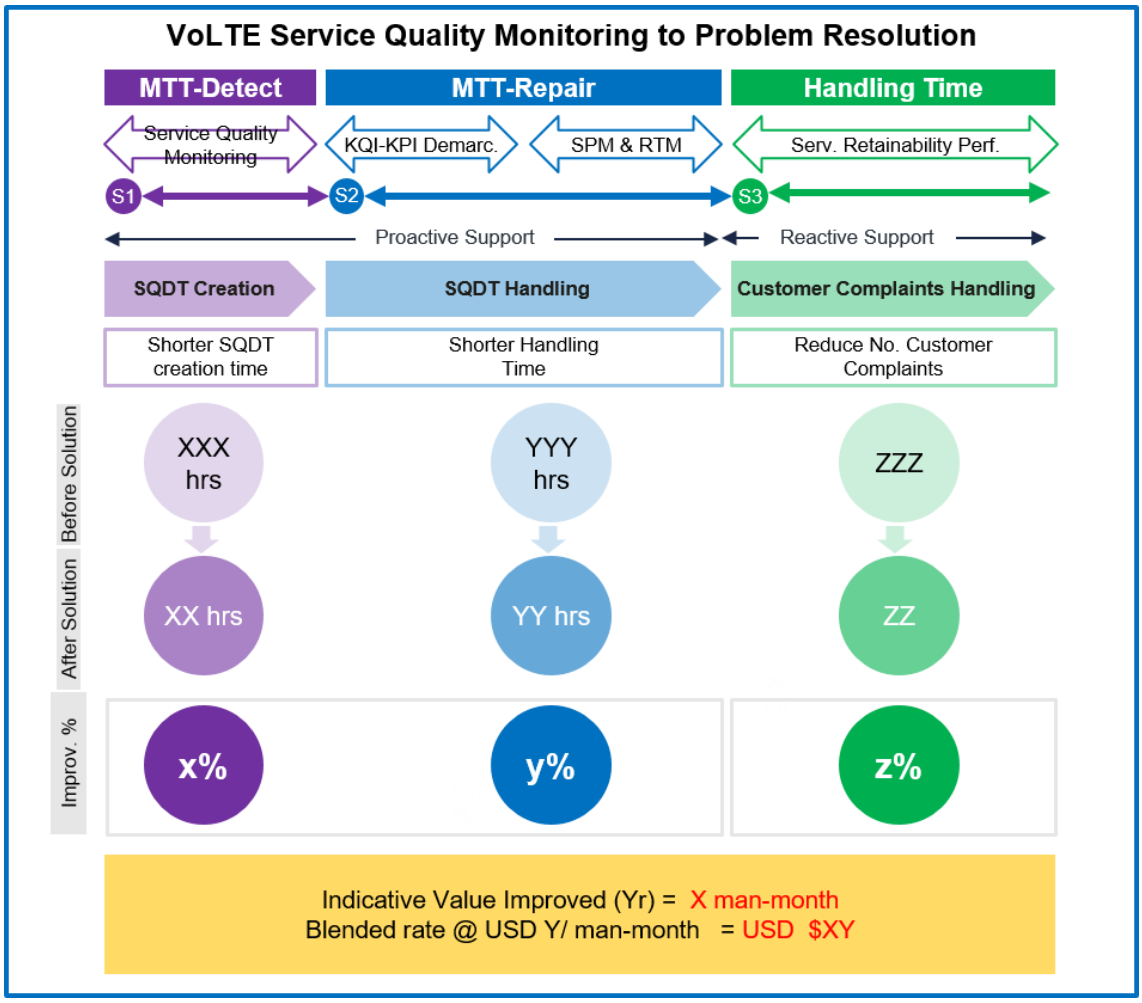

Figure 6-4 MVP Value Assessment

Stage 3: Transition and Implementation

Step 1: List the application development pipeline while the project implementation and system integration are carrying out concurrently.

Step 2: Staff transition plan for an agile organization design. This includes the priority and sequence of the role transition to a new organization.

Step 3: Execution of the competency framework which includes the skill set assessment, enrichment through self-online learning, instructor-led training and on-the-job training.

Step 4: Execution of DevOps activity based on the project plan.

Stage 4: Operations

Step 1: Appoint change agents from various operation team to play the role of a change champion in supporting a sustainable change management program as studies show that culture change could take at least 3 years to be effective.

Step 2: Maintain an operation scorecard for the monitoring and management of the autonomous operations outcome.

Step 3: Initiate a continuous improvement program to ensure sustainable competitiveness.

7. Administrative Appendix

7.1. Glossary

Abbreviation	Description
AI	Artificial Intelligence
AN	Autonomous networks
ANL	Autonomous network level
AO	Autonomous Operations
AOMM	Autonomous operations maturity model
BOM	Bill of Materials
C2S	Complaint to Solution
CSP	Communication Service Provider
CSR	Customer Service Representative
CS	Circuit switched
CX	Customer experience
FS	Field Service
HLD	High level design
IMS	IP multimedia subsystem
LLD	Low level design
MTT(R)	Mean Time To (Repair)
MVP	Minimum Viable Product
NOC	Network Operations Center
O2A	order to activation
O&M	Operation and Maintenance
OPM	Operational metrics
P2D	Planning to deployment
PDT	Performance Degradation Ticket
PID	Process Identifier
PS	Packet switched
RFC	Request for Configuration
ROI	Return on investment
SDT	Service Degradation Ticket
SOC	Service Operations Center
SQDT	Service Quality Degradation Ticket
SQM	Service Quality Management

Abbreviation	Description
SRE	Site Reliability Engineering
T2R	Trouble to resolve
TTS	Trouble Ticketing System
TCO	Total cost of ownership
USD	US Dollar currency
VOF	Value Operation Framework
VoLTE	Voice over Long Term Evolution
ZTO	Zero Touch Operation

7.2. References

1. TM Forum IG1301 Whitepaper – Measuring and Managing Autonomy v1.0.0
2. GB1040 MAMA Framework Guidebook v1.0.0 DRAFT (CLA-112)
3. GB1042 - GB1042 Autonomous Operations Maturity Model
4. TM Forum, IG1269 Autonomous Networks From Concept and Framework to Practice v1.0.0, 18-Mar-2022.
5. TM Forum, IG1218 Autonomous Networks Business Requirements and Architecture v1.1.0, October 2020.
6. TM Forum introductory Guild, IG1252 Autonomous Network Levels Evaluation Methodology v1.1.0, 30-Jul-2021.
7. TM Forum, IG1230 Autonomous Networks Technical Architecture v1.1.0, 23 July 2021
8. TM Forum, GB921D Business Process Framework (eTOM), 28-May-2021
9. TM Forum, GB921DX Business Process Framework (eTOM), 28-May-2021
10. Analysys Mason, Addressing the customer experience challenges in VoLTE services, February 2016.
11. McKinsey on Digital Services, Introducing the next-generation operating model, January 2017
12. McKinsey on Consumer sentiment and behavior continue to reflect the uncertainty of the COVID-19 crisis, October 26, 2020.
13. ResearchGate, Service level agreements: A main challenge for next generation networks, Marilly, Emmanuel; Martinot, Olivier; Papini, Hélène ; Goderis, Danny, 2002
14. TM Forum, Global trends in telco OpEx, Mark Newman, May 2021
15. O'Keeffe & Company, Global Insights on Succeeding in the Customer Experience Era, 2013
16. Project Management Journal, Project Management Maturity Models: The silver bullet, Jugdev, K. and Thomas, J., 2002
17. Business Process Management Journal, A global investigation of key turning points in business process, McCormack, 2009

7.3. Document History

7.3.1. Version History

Version Number	Date Modified	Modified by:	Description of changes
v0.1.0	11-Jul-2022	KC Goh	First draft for the MAMA community briefing
v0.1.1	16-Oct-2022	KC Goh	Edited with community's comments. Added the value assessment section.
v0.1.2	09-Nov-2022	KC Goh	Document edited with Catalyst contribution focused
v1.0.0	09-Dec-2022	Alan Pope	Final edits prior to publication

7.3.2. Release History

Release Status	Date Modified	Modified by:	Description of changes
Pre-production	09-Dec-2022	Alan Pope	First release
Pre-production	23-Jan-2023	Adrienne Walcott	Updated to Member Evaluated status

7.4. Acknowledgments

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