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AN INDUSTRY WHITEPAPER

New-generation intelligent operations: the service-centric transformation path

SEPTEMBER 2023

Operations transformation insights, pragmatic evolution, and key success factors

Objective: to explore ways in which communications service providers can improve customer experiences by shifting from a network-centric to service-centric approach enabled by intelligent automation of network operations and maintenance.

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Executive summary

1.

Communications service providers (CSPs) face the challenge of shifting and expanding their business goals to respond to rapidly changing market conditions as they digitalize their businesses. And they are having to deal with massive increases in network and service complexity and scale through increasing automation. As they strive to reap the most benefit from 5G and follow-on mobile technologies, and meet the expectations of their customers, they are having to radically rethink the way they operate in both the network and service domains.

These considerations require a shift from a network-centric approach to one that is service-centric. At a minimum, if they are to improve customer experience, CSPs must better coordinate and correlate network and service incidents through tighter collaboration of their network and service operations. The 'as-is' approach, where the network operations center (NOC) and service operations center (SOC) work in silos – and where the focus is on fixing faults and performance issues in a way that is often disconnected from the customer and service view of the work – is inadequate. It does not support the level of automation required to handle the rising scale and complexity of modern CSP operations.

Operations transformation is an essential enabler of CSPs' wider digital transformation. Such a huge undertaking can seem daunting but it is more manageable if done in small, incremental steps. In this industry white paper Huawei outlines such a step-by-step "transition solution" from 'as-is' to 'to be' operations, with the aim of materially improving CSP operations while mitigating risks associated with unwieldy 'all or nothing' transformations.

As part of Huawei's transition solution, which complements TM Forum frameworks and architectures, is the implementation of key platforms and technologies, including: A converged data platform; a DevOps platform that allows operations staff with little coding experience to produce key digital assets, such as data models and algorithms to control automation; application programming interface (API)-based access methods, and artificial intelligence (AI)-driven closed loop process automation. These new approaches can be further extended over a series of steps and timeframes that best suit a CSP's competitive situation, digital transformation strategic priorities, and investment profile, to incrementally implement a 'to-be' automated operations solution based on industry standards developed by TM Forum and other standardization bodies.

Huawei's proposed 'to be' solution is a new-generation digital operations framework. Comprising governance, service, enablement, and system domains, plus the guidance methods for digital transformation, it is based on the TM Forum Open Digital Framework (ODF).

"CSPs, if they are to improve customer experience, must better coordinate and correlate network and service incidents through tighter NOC/SOC collaboration."

Some of the industry best practices of progressive CSPs making the journey to service-centric operations, as illustrated by the case studies at the end of this white paper, include:

Undertaking a comprehensive operations audit to establish a baseline

Establishing business strategic intent

Enumerating business goals

Translating business goals to operations requirements

Implementing the plan

Assessing implementation results

A comprehensive audit gives CSPs a realistic picture of their starting point, identities gaps, and allows the formulation of a path forward. The path will be stepwise and iterative, with assessments at each major milestone providing the CSP with a new baseline from which to progress. Successful plans will base operations transformation on tangible, quantified business benefits. They will also will require C-level management leadership and vision, organizational flexibility, and personnel skills training and hiring.

This service-centric operations transformation is a journey, not a destination. The next plateau on the journey is business-centric operations, where customer intent is the primary driver of operations automation, CSPs have a well-developed digital ecosystem in place to support valuable new digital services, and service and network metrics are based on customer-perceived quality and performance.

CSPs can learn from others within and external to the telecoms market as well as teach others what they have learned. Engagement in industry standards organizations such as TM Forum and proofs of concept such as TM Forum Catalysts provide valuable opportunities to learn and teach. Strategic partners, such as those that can help CSPs effect major transformations, for example through build-operate/transfer mechanisms that let CSPs incrementally build expertise to directly drive their business strategies forward, are also valuable ways to learn the skills, such as DevOps, and build the platforms, such as for converged data access, that CSPs need to succeed in the digital world.

CSP operations transformation insights

2.

2:1 DRIVERS OF SERVICE-CENTRIC OPERATIONS

Business goals are shifting and expanding
Increasing competition and new networking technologies, such as 5G and 5G Advanced, along with the emergence of artificial intelligence (AI) and machine learning (ML) as enabling tools to improve network operations, are changing the way CSPs think about their businesses. With business goals shifting and expanding, they are having to ask themselves a host of important strategic questions, including:

- What services do we want to offer?
- To whom do we want to sell these services, and in what markets?
- What assets must we have to ensure we can meet service level agreements (SLAs) and other customer experience requirements?
- What new ecosystem partners and technologies do we need to have in place to meet our business goals?
- What investment priorities, including talent recruitment, will best support our business strategy?

Growing complexity
CSPs are rethinking their business strategies so they can address a broader and more complex array of services and opportunities (see Figure 1).

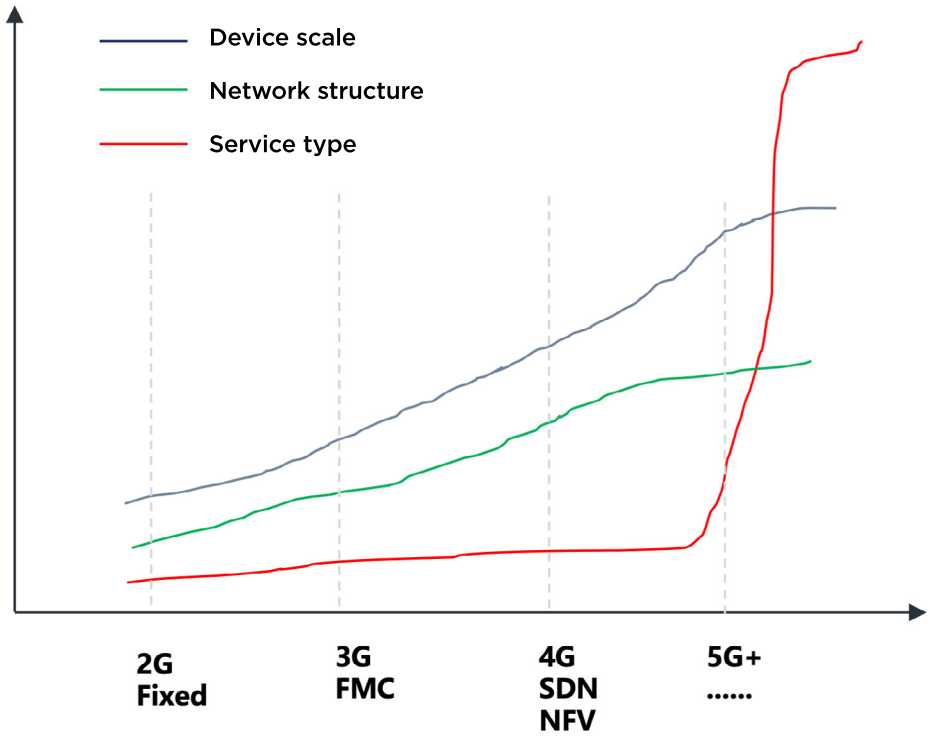


Figure 1: Operations complexity as a function of device scale, network structure, and service type

Additional complexity arises from a wide range of new digital service fulfilment options. These include: Self- and on demand-service; new network types, such as private networks for smart industrial applications; the increasing need for deterministic network behavior to support SLAs; the desire to run networks with less power; and the need to adapt CSP businesses to allow more collaboration with strategic partners, including application developers.

Taken together, these new opportunities require CSPs to change the way they operate their businesses. Technology advances, in such areas as application programming interface (API)-based secure access and intent-based automation, present CSPs with new operations tools that can enable a more autonomous, service- and customer-centric approach than they traditionally employ. Humans simply can't analyze enough data fast enough and in a systematized enough way to provide the quality and range of services that users are demanding at a price users find compelling.

"Humans can't analyze enough data fast enough to provide the quality and range of services that users are demanding."

Service-centric approaches are required
Operations must support CSPs' changing business goals and strategies, not impede them. Getting the most out of 5G, for example, will need different operational strategies than the ones typically deployed for 3G and 4G. For Huawei, this means CSPs must shift from a network- to service-centric approach if they are to meet customer expectations.

Traditional operations focus on monitoring network-centric alarms, faults, and performance, which can often be disconnected from (and hard to correlate with) service performance and customer experience impacts. Service-centric operations, in contrast, focus directly on performance of the actual services that customers buy. There is a firm emphasis, too, on predicting and fixing problems before customers experience any issues.

This shift to service-centric is not simple, however. It requires a "multidimensional" transformation, something which TM Forum strongly advocates (see TMF Forum CEO Playbook). A multidimensional approach encompasses:

- People, including company culture, organizational structure and collaboration, staff skills, and job functions;
- processes, including evolving manual processes to automated ones, focusing on services end-to-end, tying network and customer processes closely together, and developing new relevant performance metrics;
- platforms that can enable the digitalization of CSPs' businesses, including operations; and
- the successful adoption of new technologies such as AI, digital twin, intent-driven operations, and API-based access.

Without such an overhaul CSP business results will fall short of shareholders' ambitions.

2.2 OBSERVATIONS AND TRENDS

Service-centric is nascent
Embarking on such a broad and deep transformation can understandably be daunting and even overwhelming for some CSPs. Sheer complexity perhaps explains why there appears to be no headlong rush by the industry to become service centric.

TM Forum's recent autonomous operations (AO) survey, which canvassed the views of CSP respondents working in operations and management, indicates that many operators have yet to implement the people, process, platform, and technology changes that are the precursors to digital transformation, including the changes needed to power automated service-centric operations. Of those surveyed, little more than a half (56%) said there was a 3–5-year vision/strategy in place that "involves the continual improvement and automation of operations with some increase in investment". Only a third claimed they "have an ambitious automation strategy with significant investment planning that will result in a full transformation of our operations". The good news, as our case studies demonstrate, is that the CSPs which do take the transformation plunge can reap tangible benefits, often by taking small, incremental steps. As shown by Hong Kong's HKT, transformation journeys can be ongoing over a period of years, steadily improving operations efficiency (see page 43). It doesn't need to be a big bang approach.

Read the full report to find out more about the survey and operators' AN progress:

Moreover, respondents to TM Forum's AO survey feel that transformation strategies will net significant gains in Autonomous Network Level (ANL) progress in three years (see Figure 2). TM Forum ANL definitions can be found in Appendix 2.

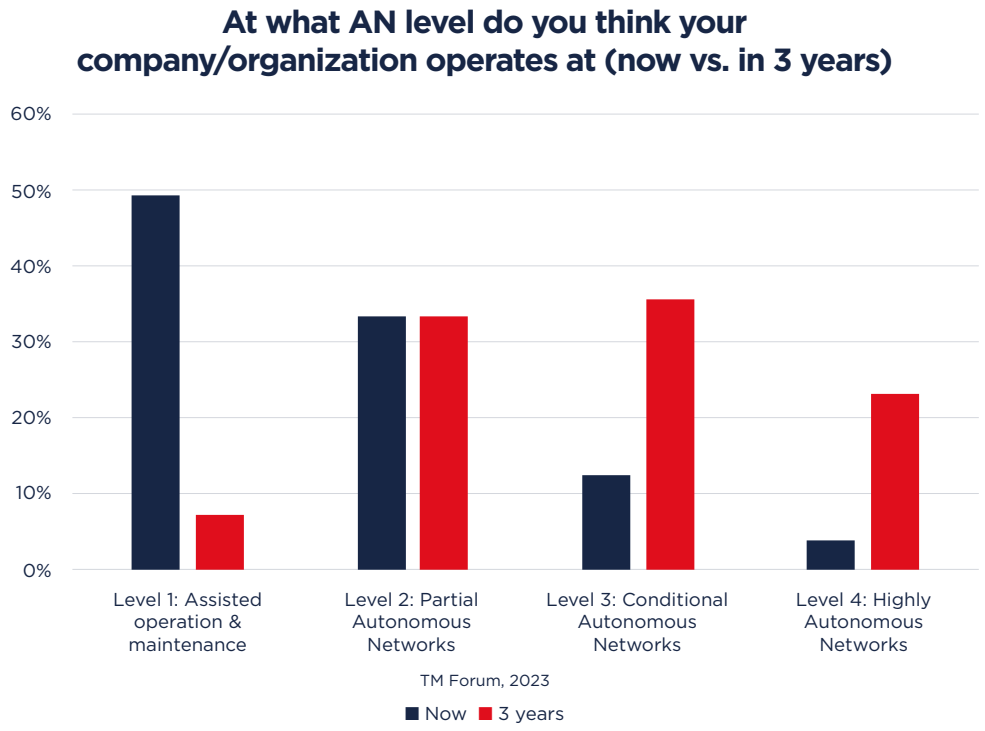


Figure 2: How respondents to TM Forum 2023 AO survey envisage ANL in three years' time

When asked about the top three processes they would like to address with network automation, respondents overwhelmingly chose service delivery and service assurance, followed by quality optimization (see Figure 3).

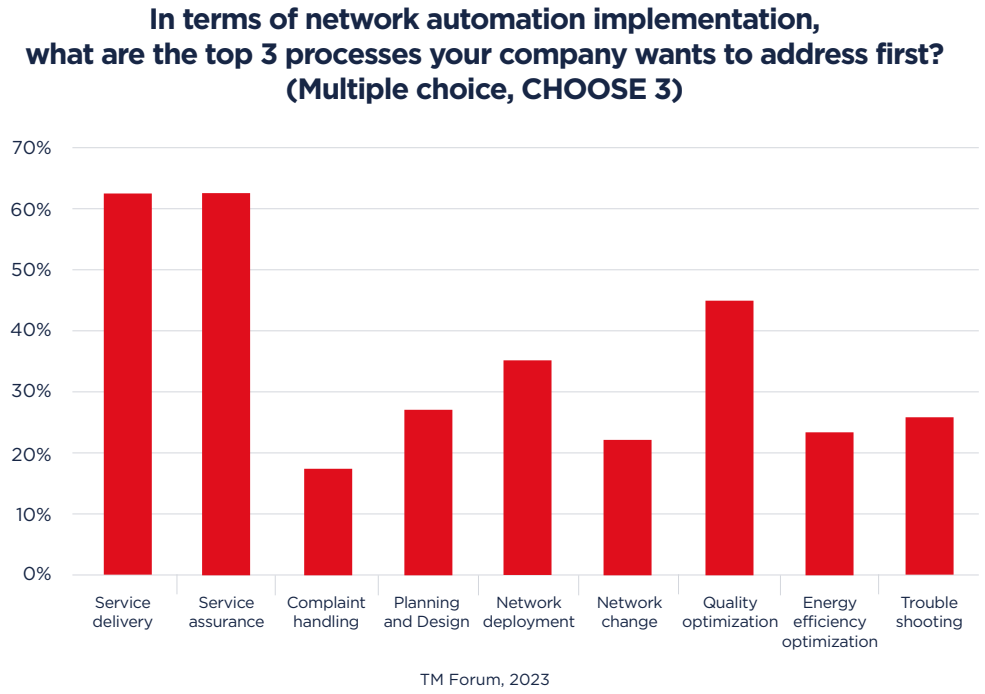


Figure 3: Process automation priorities of respondents to TM Forum 2023 AO survey

Operations transformation: Journey, not destination

Mohammed Alzaiidi, GM of Network Operations at Saudi Telecommunication Company (STC), in an interview for this report, notes that "automating operations is a continuous process". CSPs, he adds, must adapt as customers and the market changes. "Operations transformation is a journey not a destination," says Alzaiidi.

Although transformation of this magnitude is hard, Huawei says CSPs can nonetheless vastly increase their chances of success if the transformation plan includes:

- Key foundations (such as a converged data platform) and supports early wins (new revenue streams, for example);
- an honest, detailed assessment of the current state of operations; and
- methods and governance that allow regular checks against performance targets, plus scope for making iterative updates to the plan

The most progressive CSPs, including those launching new 5G-enabled services, are either well advanced in their transformation to service-centric operations or are at least well advanced in their planning for such a transformation (see case studies section).

Possible transformation paths

Sections 3 and 4 of this report outline one possible path from the 'as-is' present method of operations (PMO) to the 'to-be' future method of operations (FMO). The path, incorporating a "transition solution", is proposed by Huawei. It is a pragmatic approach, says Huawei, based on its research, observations, and experience assisting its customers.

"The most progressive CSPs are either well advanced in their transformation to service-centric operations or are well advanced in their transformation planning."

'As-is' operations and challenges they present

3.

NOC and SOC collaboration: Where are most CSPs today?
Most CSPs rely on managing their network estates using centralized network operations centers (NOCs). With the advent of 4G and full-fiber access, however, CSPs needed more visibility of customers' end-to-end service experience, including the applications running over broadband connections. Thus, many implemented a separate operations organization, the service operations center (SOC). The SOC has access to tools for service quality measurement (SQM) and customer experience management (CEM) and can monitor the quality of overall service, communicate with the customer about service status, and take rapid action to rectify service degradation and outages that negatively affect service quality and experience.

Organizationally, the NOC and SOC may be separate or combined into one entity, an NSOC. The 'as-is' approach to network and service operations for many CSPs, observes Huawei, remains one of collaboration between the NOC and SOC. Regardless of the organizational specifics, adding an organization specifically tasked with end-to-end SQM and CEM (SOC) to coordinate with the network operations team (NOC) should improve a CSP's focus on the voice of the customer. However, without the proper leadership and processes, a CSP may well simply create manual flows and handoffs between the two organizations that do not help resolve incidents or improve customer experience. Manual handoffs often manifest in disconnected silos of activity within and between the network (resource) and service (customer) operational levels.

Anomaly detection and resolution can be challenging
The service assurance domain, which includes anomaly detection and resolution, can be triggered by a customer complaint or complaints, a network fault or faults, or both. But because service and network performance are often disconnected and hard to correlate, efficient root cause analysis and remediation can be difficult at best.

As shown in Figure 4, anomaly detection tends to be done piecemeal and in silos. The NOC is responsible for monitoring fault and performance alarms at the domain and network element level, while the SOC and teams handling complaints use tools that measure and simulate user experience as well as document complaints lodged by customers.

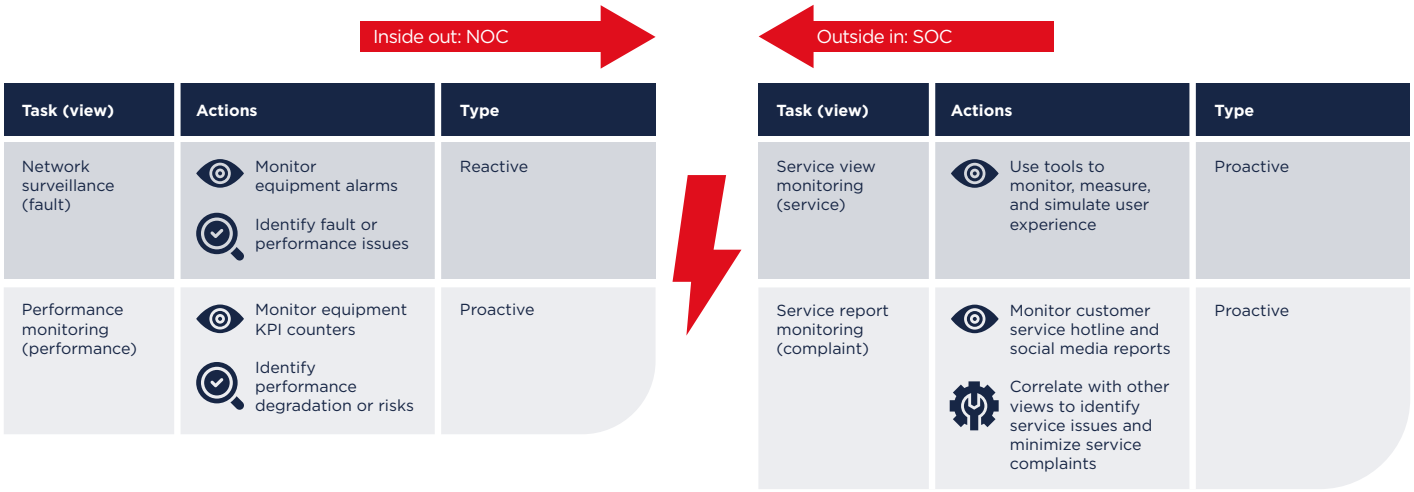


Figure 4: Anomaly detection from different view and organization "silos"

Because different departments are often in charge of each of the "views", closing the loop across the standard operations tasks or subflows, which is necessary for detecting anomalies, requires much coordination between and among service and operations staff.

Ticketing processes can incrementally improve NOC/SOC collaboration
Customer-reported complaints and service center-detected anomalies can be coordinated with network faults and performance incidents through a CSP's ticketing system.

Figure 5 illustrates task flows and subflows across the seven standardized operation tasks: Detect anomaly; analyze service impact; demarcate anomaly; root cause analysis (RCA) and location; solution recommendation; solution execution, and a check to ensure that the trouble has been resolved and the service is restored.

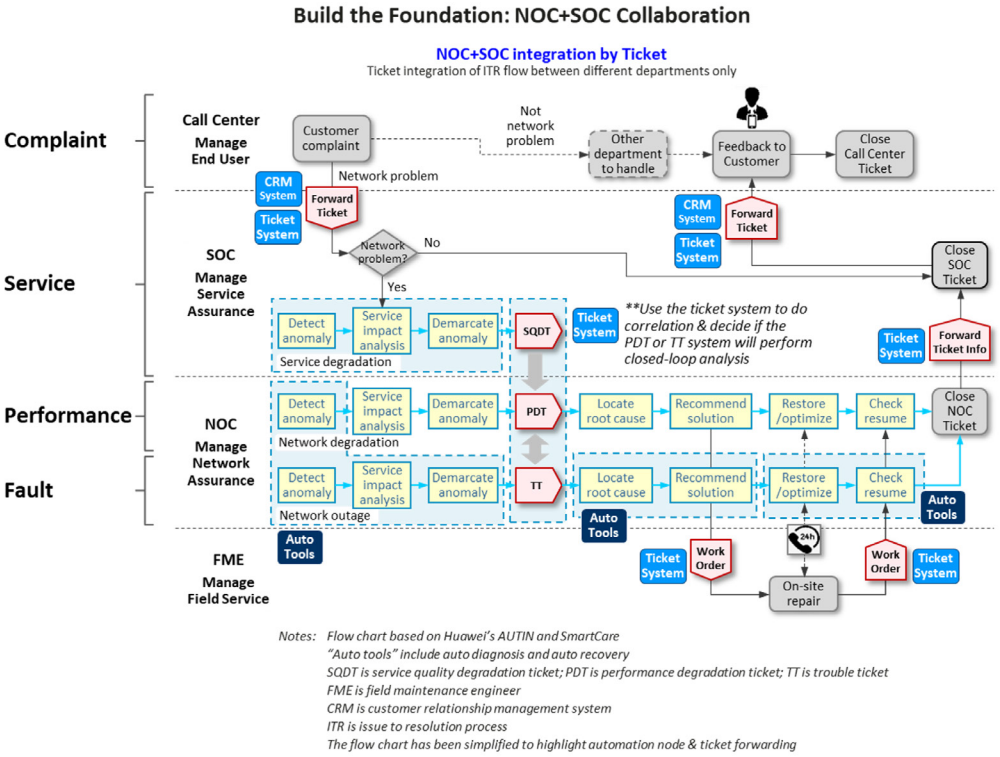


Figure 5: Typical operations flows for NOC-SOC collaboration

The seven tasks shown in the flow chart comprise TM Forum's "OODA loop" (observe, orient, decide, act). The goal is for each of the four views or subflows (fault, performance, service, complaint) OODA loops to be automated and "closed," and for the seven standard operations tasks to be augmented to include an initial first step of predicting anomalies before they occur. In practice, some of these subflows are more easily automated than others (see Figure 6 and the explanations that follow).

Subflows	Standard operations tasks: Relative ease of automation						
	Detect anomaly	Analyze service impact	Demarcate anomaly	Locate root cause	Recommend solution	Execute solution	Check, restore, and resolve
Fault	●	○	●	●	○	○	○
Performance	●	○	◔	◔	○	○	○
Service	◔	◔	Dependent on fault and performance subflows				
Complaint	◔	◔	Dependent on fault and performance subflows				

Key:

Least mature use of automation: ○

Moderately mature use of automation: ◔

Most mature use of automation: ●

Figure 6: Relative maturity of different tasks within the four operations subflows

Going with the flow: a breakdown of how subflows typically work today

- **Fault:** Almost all operations flows start from this subflow. Therefore, this subflow would seem to be a logical place to build the most sophisticated automation capabilities to derive the most business value. However, many gaps remain in the end-to-end fault subflow that make closed-loop automation challenging. For example:
  - The anomaly detection, demarcation, and RCA tasks are based on well-understood traditional alarm monitoring and correlation capabilities, and are consequently easier to automate. Gaps remain with the other four processes in the end-to-end lifecycle, however, as illustrated in Figure 6.
  - The service impact analysis capability is likely to be a manual process because most CSPs lack an integrated data model that includes both network and user/service data.
  - Closed-loop solution recommendations via scripts for restoration and verifying the fix are at best weak, and often nonexistent. Only about 5% of network faults can be resolved by remote resets or other actions; most faults require an onsite fix. Pre-building more automated scripts to perform remote service restoration based on AI and deploying more intelligent network elements could help limit field maintenance requirements. Telecoms operations are comparatively weak in this area compared to IT operations.

- **Performance:** Automation capabilities are strongest in the anomaly detection tasks, including such things as automated performance degradation detection and generation of performance alarms and events. Anomaly demarcation and RCA are also moderately mature. As with the fault subflow, more advanced scripting and AI mechanisms could improve performance automation of remote restoration to fix performance problems.

- **Service:** Anomaly detection and service impact analysis will be more mature for those CSPs that have invested in SQM/CEM tools. Demarcating the anomaly will be difficult unless the CSP can automate its ability to tap into the fault and performance subflows and use their anomaly demarcation capability to identify the root cause and implement a closed-loop fix.

- **Complaint:** This subflow is analogous to the service subflow; the key pain point is its dependence on the network fault and performance subflows to demarcate anomalies, do RCA, and implement a closed-loop fix.

Incremental improvements to the present method of operations (PMO), suggests Huawei, are worthwhile for CSPs to consider. The use of tickets to correlate the different operations subflows between the NOC and the SOC organizations, for example, can be a good first step on the journey to service-centric operations. However, ticket systems are not designed to correlate such flows; manual effort will still be required because monitoring views and data remain siloed.

"Incremental improvements to the present method of operations (PMO), suggests Huawei, are worthwhile for CSPs to consider."

Use cases illustrating incremental operations improvements to "as-is" operations
CSPs with more urgent business priorities than full-scale operations transformation can start with ticket-based approaches to NOC/SOC collaboration improvements, then continue to incrementally improve the automation maturity of specific tasks within each operations subflow. As the three use cases shown here demonstrate, approaches of this sort can positively impact both customers and CSPs' bottom lines.

Use case 1: Improved customer complaint resolution
This use case illustrates how improving service impact analysis capabilities and strengthening the complaint subflow's anomaly demarcation capability through system integration and process alignment can improve complaint resolution (see Figure 7). These improvements can improve the responsiveness of the complaint team through faster problem resolution and support proactive resolution to performance and other issues of which the customer may not have been aware.

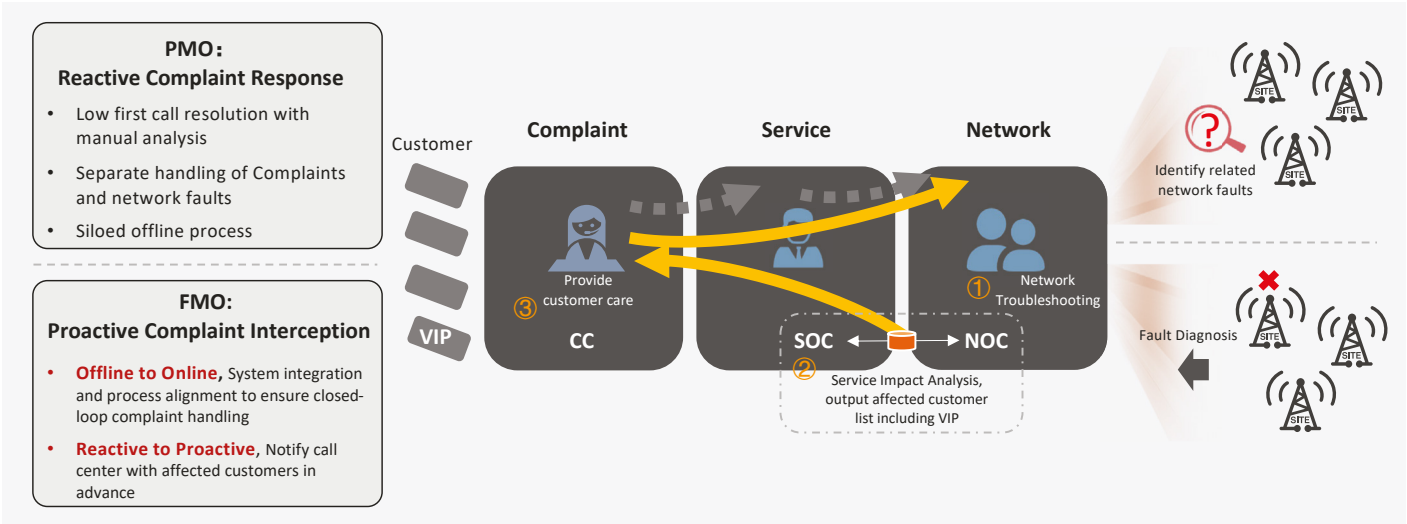


Figure 7: Improved customer complaint handling

Use case 2: Improved service quality assurance
CSPs can improve service quality assurance through improving their ability to demarcate anomalies (see Figure 8). The improvements are enabled through the creation of a data model that includes service, performance, and fault data and allows auto correlation of these data to automate RCA. This capability helps the SOC correlate service problems with NOC-managed fault and performance processes and more accurate and agile closed-loop service assurance processes.

In this use case, the creation of a combined data model and system interface available to both NOC and SOC personnel can shift service assurance processes from manual to automated and closed loop. This can reduce mean time to repair (MTTR) and improve customer experience. The combined data model allows auto correlation of service, performance, and fault incidents to swiftly identify the root cause of the service-affecting problem and enable more accurate and agile closed-loop handling of the problem.

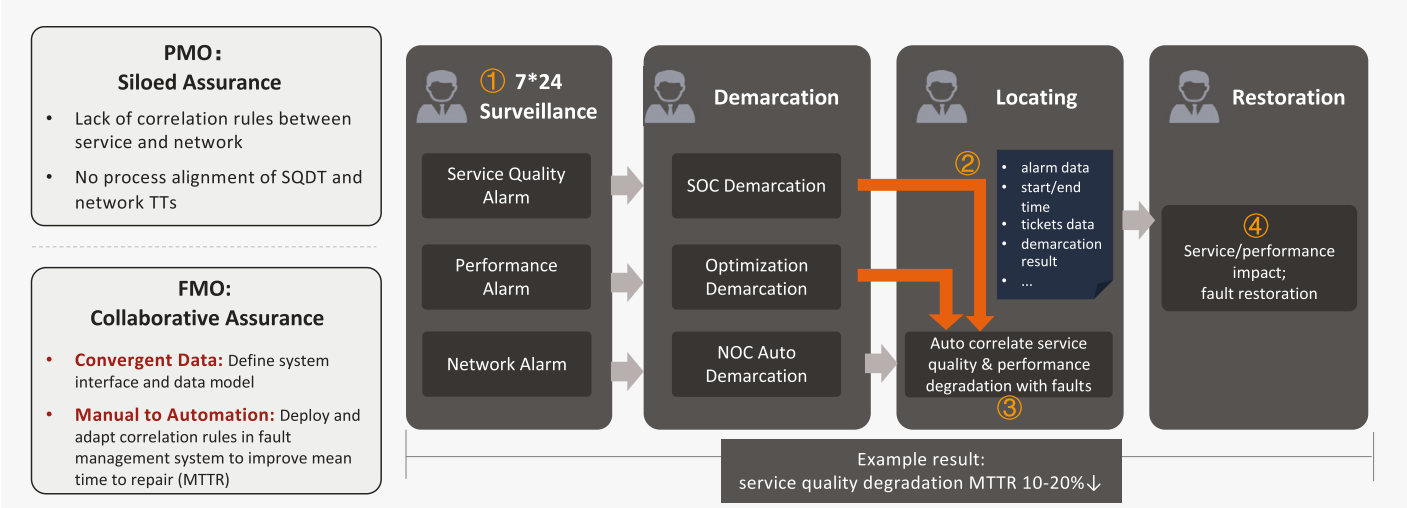


Figure 8: Improve service quality assurance through auto correlation of service and network information

Use case 3: Enhanced service restoration through improved fault handling

In this use case, algorithmic simulation provides "what if" analysis of the likely service impacts of different problem resolution approaches (see Figure 9). The starting point is the creation of a data model that comprises alarm, performance, configuration, a myriad of user- and control-plane data records, and call history record data. When a network fault occurs, the algorithm simulates the results if users and traffic were to be redirected to neighboring sites and cells, as compared to not redirecting the users and traffic. Through this process the operations system builds a more sophisticated service impact analysis in the fault subflow. With this improved input, the NOC personnel can evolve its closed-loop fault processes from alarm-oriented to service impact-oriented, reduce traffic loss, and improve customer experience.

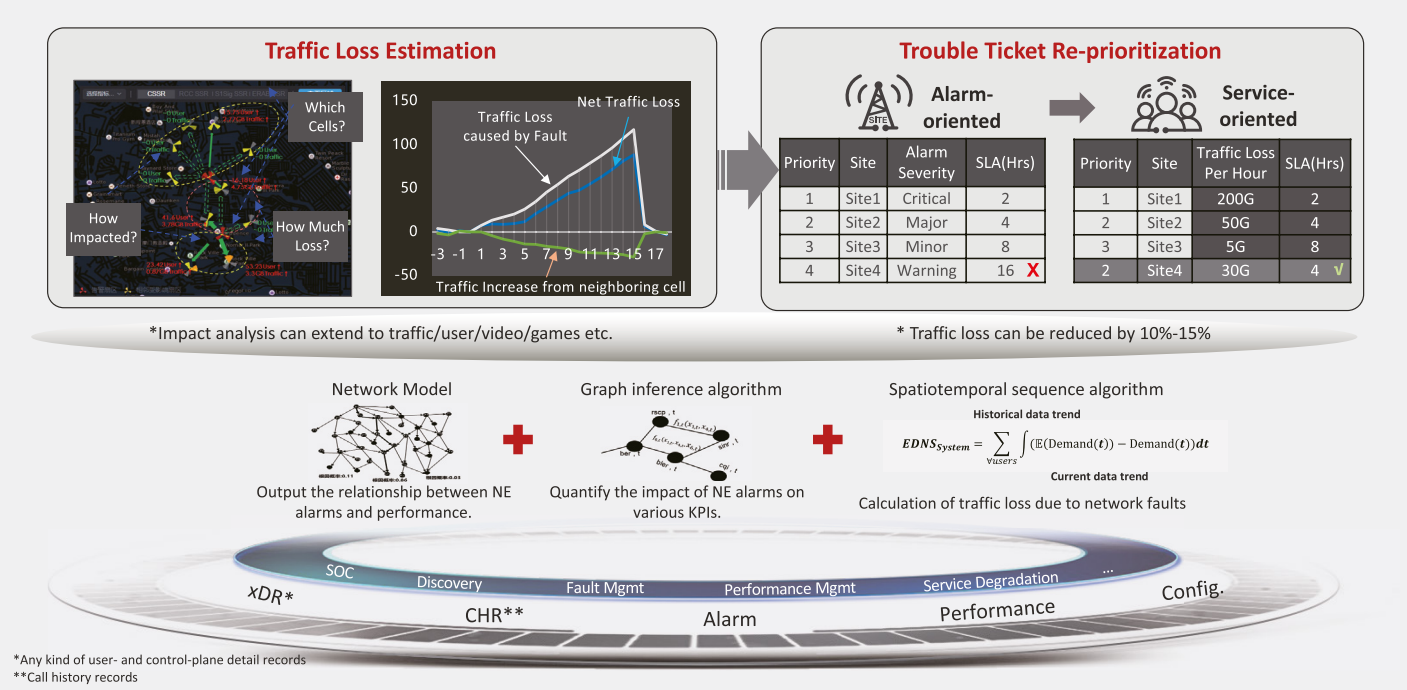


Figure 9: What-if simulation to reduce traffic loss and improve cell service

A gap analysis on the seven standard operations tasks within each subflow (anomaly detection, service impact analysis, anomaly demarcation, root cause analysis, solution recommendation, solution execution, and solution check/restore/resolve) can attack the main areas of disconnect between NOC and SOC workflows; improve incident correlation and automation of troubleshooting tasks; and move CSPs closer to service-centered operations.

Suggested framework and path to intelligent operations: 'transition' and 'to-be' solutions for service-centric operations

4.

4:1 A TRANSITION SOLUTION FOR CONVERGED SERVICE AND NETWORK ASSURANCE

Transforming a NOC-SOC collaboration operations approach into one that is truly service-centric and eliminates siloed processes can be daunting for CSPs. However, just as NOC-SOC collaboration can progressively advance, a more radical evolution does not need to be done in one step: transitional approaches can provide real business value while putting a foundation in place that will support a future service-centric operations transformation journey. This section of the report outlines Huawei's suggested transition solution.

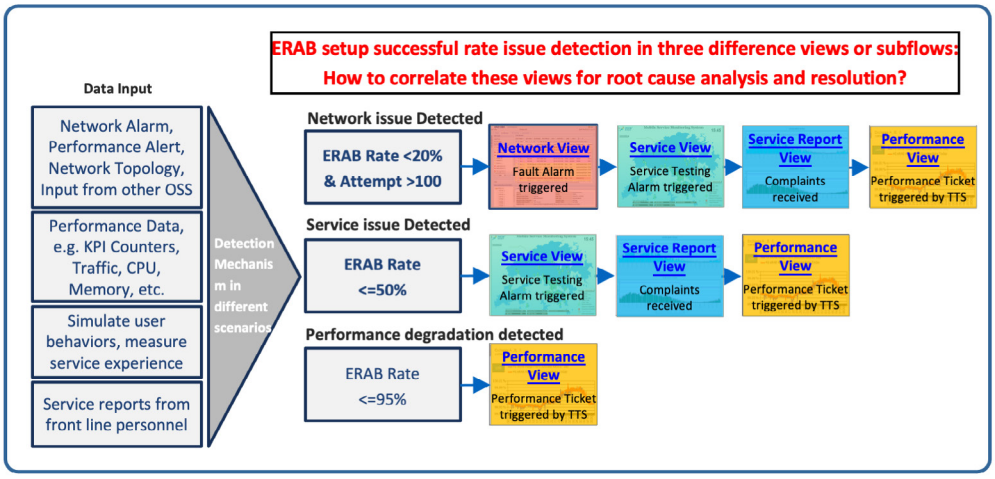
Several capabilities need to be implemented to provide an effective transition solution beyond the traditional NOC-SOC collaboration approach. Critical evolution foundations are:

- **A converged data platform.** Allows the convergence of network and service assurance and enables multi-dimensional data modeling and analysis. It couples a fully converged operations data lake with graphic, modeling, and algorithm capabilities. It is a baseline requirement for service-centric operations, so establishing the capability sooner rather than later is wise.
- **Event-based management.** Eliminates silos and empowers personnel and systems to focus on service problems end-to-end. This requires that PMO fault and alarm management systems be upgraded to include performance and service anomalies and correlation of these data with the existing resource-layer fault and alarm data.
- **Automated closed-loop processes.** Upgrades traditional automation tools to support OODA closed loops into cloud-native 'automation' API-based applications that control the closed loops. Automating OODA processes with APIs enables CSPs to shift operations' goal to service restoration rather than anomaly detection and clearing.
- **A 'mobile first' approach.** Disseminates OODA tools to field maintenance engineers, which empowers them to become extensions of the centralized digital NSOC and makes event management more seamless.

This transition solution can move the CSP in manageable steps from a traditional machine-assists-human operational model to a digital human-assists-machine model. The CSPs can pace the steps in a way that is minimally disruptive to their PMO. The traditional and digital modes of operation can coexist and evolve over time to fit the investment horizon and skills-building timeline that suits a specific CSP's competitive situation and business strategy. The period during which traditional and digital operations approaches might coexist could be short (a year or two). Or, the journey could take many years, depending on a CSP's specific situation. Meanwhile, the CSP is building expertise and capability as it steadily improves its customer experience and operations efficiency.

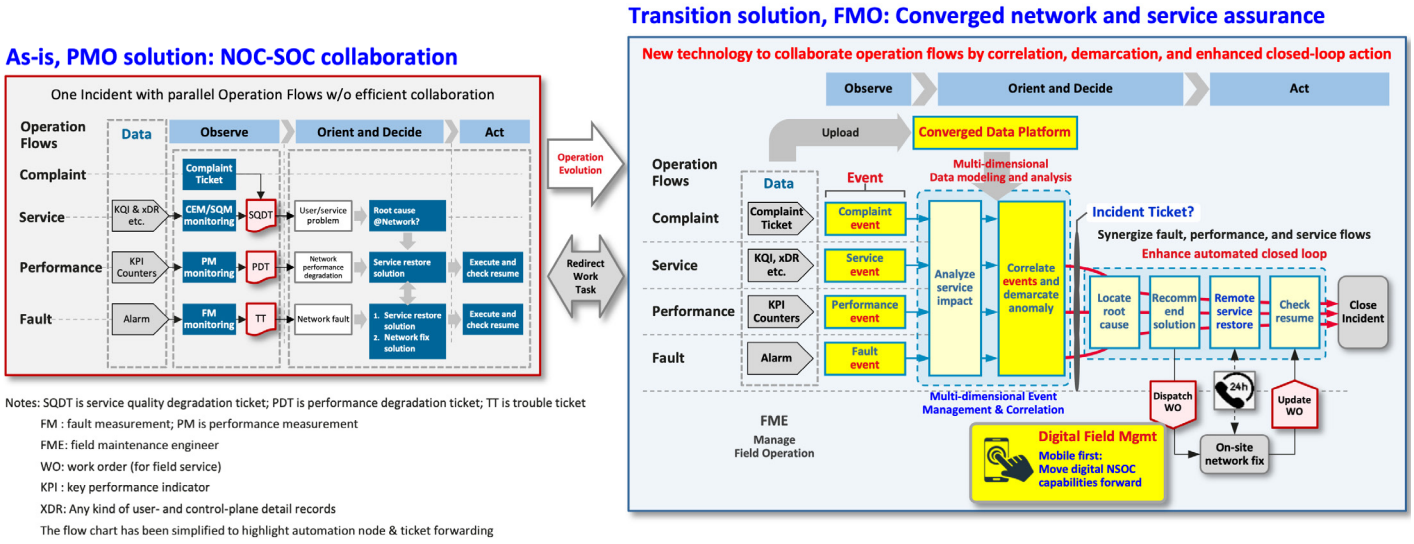
A specific example (see Figure 10) illustrates all too well the missing pieces discussed in Section 3 when it comes to anomaly detection and resolution, namely the challenges involved when the 'as-is' PMO is disconnected between network and service subflows or views.

The scenario illustrated in Figure 10 shows the possibility that multiple network and service operations subflows might detect an anomaly with an E-UTRAN Radio Access Bearer (ERAB) connection rate that could affect user services. Finding the root cause would be quicker and easier if the monitoring data from multiple views could be automatically correlated, but this is generally not the case today. Transition steps to automated correlation include correlation of multi-dimensional monitoring data. Thus, a transitional solution from the as-is PMO could look like the hybrid in Figure 11 (critical enablers shown in red text and yellow highlights at the right of the figure).



Notes: ERAB = E-UTRAN Radio Access Bearer. ERAB success rate is a major LTE KPI. It measures how well the network transfers the user data between the UE (user equipment) and the mobile core network.
TTS = the trouble ticket system.

Figure 10: Network and service data analysis need to be manually correlated to confirm RCA



Notes: SQDT is service quality degradation ticket; PDT is performance degradation ticket; TT is trouble ticket
FM : fault measurement; PM is performance measurement
FME: field maintenance engineer
WO: work order (for field service)
KPI : key performance indicator
XDR: Any kind of user- and control-plane detail records
The flow chart has been simplified to highlight automation node & ticket forwarding

Figure 11: Dual traditional-digital convergent service and network assurance solution

The transition solution requires the four major platform and process changes noted above (a converged data platform; a move to event detection rather than the simpler anomaly detection; implementation of closed-loop action; and mobile-first field management).

Perhaps most critically, the transition solution requires significant changes in the way operations personnel do their work: It requires that the vision to a more machine-driven, less human-driven approach be established in the affected organizations; that the cultural shift to more-automated operations be supported throughout the management chain; and that new training and hiring practices be implemented as soon as is practical.

The as-is operations solution's evolution to a future method of operation based on a transitional solution could require years, depending on a CSP's market and financial situation. CSPs will need to consider the cost of running two parallel systems in a hybrid mode as they consider how to time the shift.

Figures 12 and 13 illustrate the shift in another way and highlight the changes to people, process, and platform that are necessary to move from the as-is PMO to transitional solution.

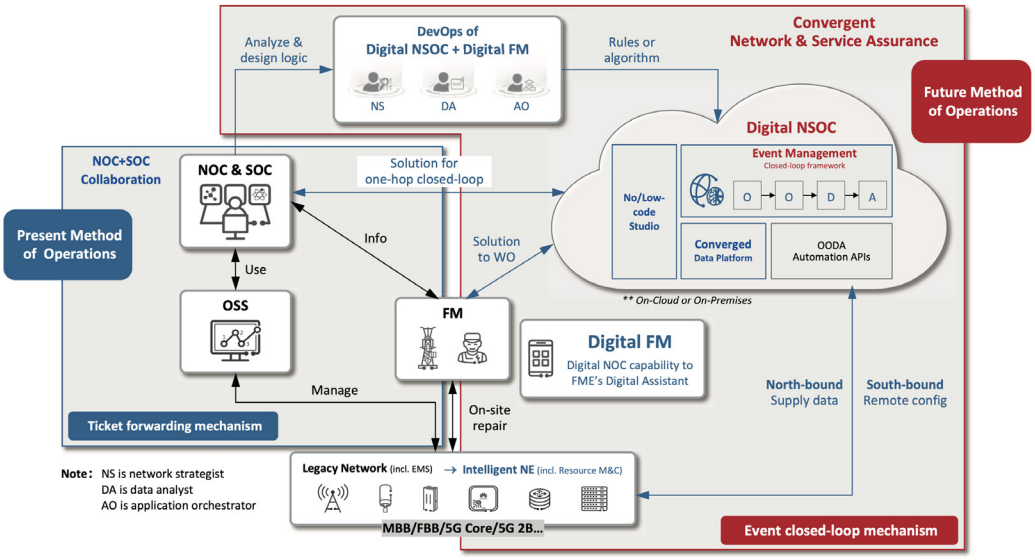


Figure 12: Hybrid as-is/convergent service and network assurance transition solution showing digital NSOC

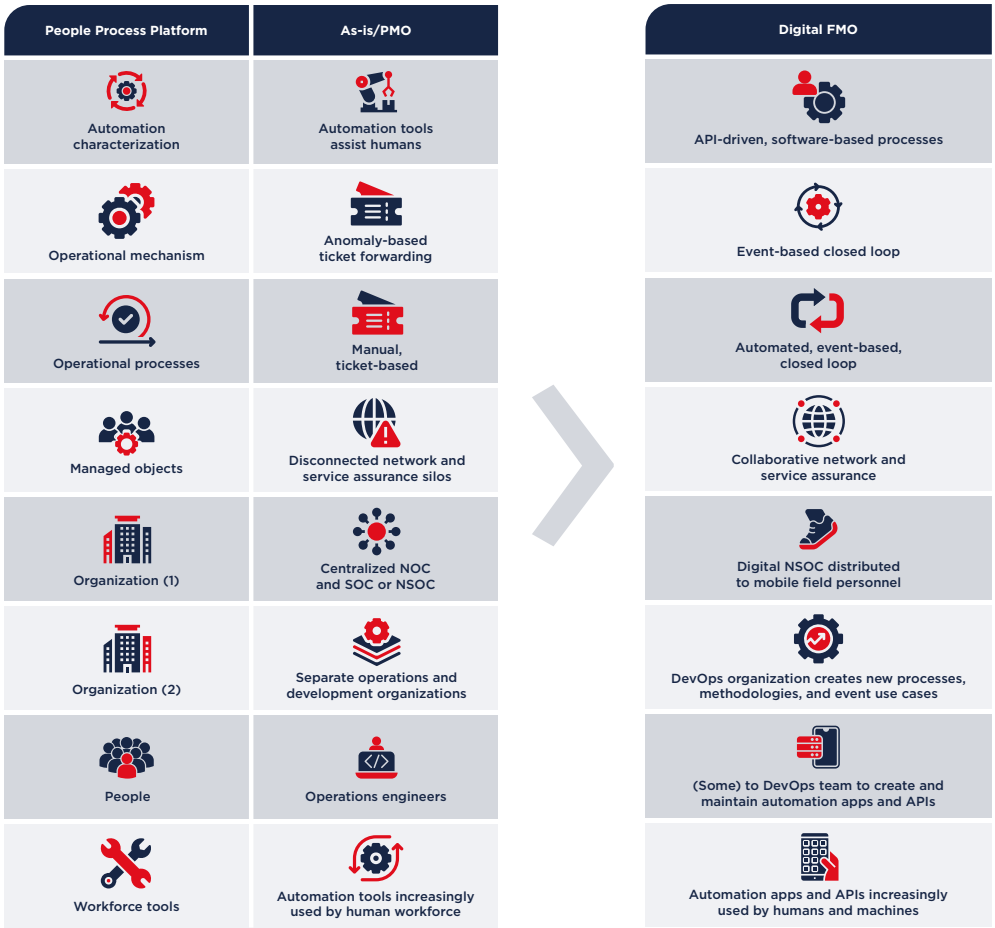


Figure 13: Critical elements needed in transition from PMO to FMO: People, process, and platform

Note: Huawei's transition solution assumes some operations engineers will move to a DevOps group to develop automation rules and algorithms. As we will see, this assumes that low-code/no-code tools are available to assist these new developers.

Alignment of the transition solution with standardized 'to-be' FMO concepts
Multiple standards development organizations (SDOs), including TM Forum and ETSI's Zero-touch Service Management group (ZSM), have published concepts of what the target FMO solution should comprise. These SDOs work together to align their 'to-be' visions, support industry coalescence, and reduce or eliminate fragmentation.

The transition solution proposed by Huawei describes a pragmatic approach to service-centric operations evolution that is compatible with the long-term (ten-year plus) visions espoused by these SDOs. As an example, as with Huawei's suggested transition solution, TM Forum AO/AN dictates or implies that:

- Single domain autonomy will be the responsibility of resource operations;
- cross-domain collaboration will be the responsibility of service operations, which will include what Huawei calls "multi-dimensional data" monitoring and anomaly detection, and require a converged data platform and event-based management automation; and
- service operations will need to be converged with network operations to carry out service- and event-based automation.

If properly planned and incrementally executed, Huawei claims its transitional approach will evolve smoothly to an industry-sanctioned target 'to-be' solution as new technologies (such as AI/ML and large models, digital twin, deterministic network assurance, intent-based operations) are added to standard industry approaches.

4.1.1 THE 'TO-BE' SOLUTION: FURTHER EVOLUTION TO SERVICE-CENTRIC OPERATIONS

The ultimate goal of a new-generation intelligent operations approach is full AO coupled to an AN to meet business goals and satisfy customer requirements. The Huawei vision includes a "3-zero" concept: zero service impact, zero touch, and zero coding. The future 'to-be' service-centric digital operations transformation that the industry aspires to implement will need to support evolving challenges that, if not addressed, will render the transition solution inadequate. As CSPs endeavor to transform operations to service-centric and automated, they will have to contend with exploding network/device complexity and scale, along with an increasing requirement for deterministic service and network behavior.

A 'to-be' digital solution that supports service-centric operations end-to-end will need to address five technical challenges. The difficulty of overcoming these challenges helps explain why operations transformation to more digital and automated approaches have been slow to progress.

Challenge 1: Increasingly stringent, deterministic service performance requirements

Business services
CSPs expect their 5G investments to enable a broad variety of latency and SLA requirements for new business services aimed at specific vertical market requirements. Many of these new services, however, come with stringent requirements at the network and user levels that depend on deterministic network assurance. Table 1 provides just a few examples of such service requirements for applications as diverse as autonomous transportation, smart mining and ports, intelligent manufacturing, and telemedicine.

Industry application	SLA reliability (% of time)	Latency (ms)
Autopilot	99.9999%	3-20
Smart mining	99.999%	< 30
Telemedicine	99.99%	10-50
Intelligent manufacturing	99.99%	1-10
Smart ports	99.99%	< 10

Table 1: Selected SLA and delay (latency) requirements for industry service use cases

In addition to stringent SLAs and low latency/delay requirements, competition and the drive to improve customer experience are also pushing CSPs to:

- Improve the high fault rate typical of campus devices;
- evolve to a 'prevention and prediction' approach from a 'fix it if it breaks' approach;
- improve their ability to demarcate and locate faults across increasingly multiple-domain services; and
- limit and control the time window needed to implement network and device changes.

Consumer services
CSPs are also offering a wider array of services to consumers, such as live sports streaming, augmented reality, or metaverse-related use cases. These services typically have more stringent service level requirements than more traditional voice or streaming audio and video services.

Customer experience factors and their interaction are complex
Even though service performance requirements are increasing, it remains difficult to track and quantify the factors that negatively affect customer experience indicators (CEIs), key quality indictors (KQIs), and key performance indicators (KPIs). There are multiple reasons why this is the case.

- First, end-to-end factors (such as the totality of the specific access devices active applications in use, network domains traversed, local network conditions, and so on, some of which a specific CSP may not control) affect CEIs, KQIs, and KPIs. Although CSPs want to attribute these factors to specific quantifiable and causal relationships between CE and network resources' status, such direct relationships can be hard to establish.

- Second, the siloed NOC-SOC relationship, which is part of the 'as-is' solution, is an impediment to establishing a strong user experience-network resource relationship.

- Third, there are yet no technical means to accurately simulate the impact of resource faults and status changes on user services.

- Finally, traditional operations indicators such as resource availability and MTTR have a network focus, not a service focus. Therefore, operations resources (personnel, investment, expenses) tend to be used to support existing network-centric priorities rather than visionary service-centric ones.

New services supported by a service-centric approach to operations will require CSPs to establish new processes, measurements, and metrics.

Challenge 2: Network and service complexity requires ultra-automated operations
5G deployments, the heterogeneity of multi-generational mobile radio installations, and the looming availability of even more advanced networking technologies (think 6G) will only increase the complexity of network and service operations. Traditional data processing platforms, tools, and analytical approaches that rely on human operators will not be able to cope with this increasing complexity. Humans will need to evolve to guide the machines through rules, policies, or intent through which the machines or 'digital employees' will execute autonomously.

Challenge 3: Intelligent operations require continuous accumulation of domain model algorithms and knowledge
The telecoms market has been investing in AI-based automation for years now, particularly on the IT and BSS side for chatbot and similar applications. Vendors and CSPs are exploring its use in network and service operations so they can get the level of automation they require to support autonomous operations.

However, the expanded use of AI implies that CSPs will be able to capture telecoms data, domain knowledge, and personnel expertise in large models to drive automated service-centric root cause analysis, decision-making, and action. Accumulation of such knowledge will be needed to manage the huge amount of unstructured data generated by service-centric operations. Storing, recycling, and abstracting knowledge and models based on these data will also create challenges for CSPs.

Challenge 4: Agile services and intelligent operations pose new requirements for scenario-based software development tools
Service-centric operations require CSPs to develop use cases and scenarios that will be used to control closed-loop operations. Eventually, these scenarios will be driven by business and customer intent; initially, they will be driven by rules and policies.

Some examples of the initial scope of some CSP efforts include:

- A European CSP that has already developed 400 use cases and planned the development of 200 more to support agile operations; and
- an Asian CSP that plans over the next five year to increase the rate of automation from 20% to 50% across 16 orchestration categories (among them service impact analysis and anomaly demarcation) with over 1,500 scenarios (including different service types, networking topology, and network domains) using DevOps practices.

This level of planned development in the context of DevOps will require low-code/no-code tools and the up-front training of CSP personnel on how to use them. As noted by some CSP senior executives in our case study interviews, operators do not want to cede use case, scenario, and intent-based logic development to partners; they want to develop the skills and keep control of these data and methods in house.

Challenge 5: Multi-vendor, heterogenous, and complex network and IT environments require open platforms and ecosystems
Telecoms supply chains and the network and IT estates built on them are complex and heterogeneous: CSP network and IT environments are multi-layered (for example, multiple generations, vintages, and types of network elements), multi-vendor, and multi-domain (wireless, transport, packet, power, cloud, and so on). Therefore, the digital platforms and tools that will enable CSP service-centric operations automation must grapple with:

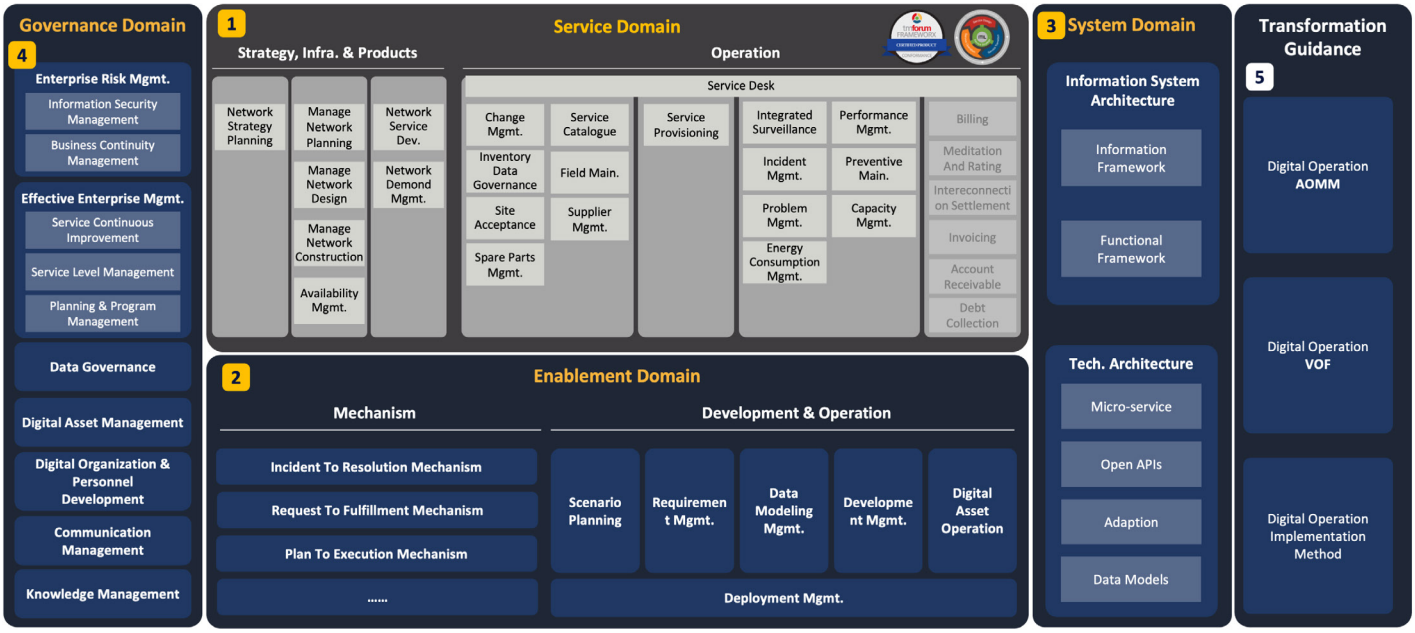
- The requirement for agile services and operation despite the complexity of the environment being used to provide the user services.
- The need for horizontal integration of equipment, software, and other resources and technology from myriad vendors.
- The southbound integration of vendor equipment via hundreds or thousands of interfaces and protocols (including resource adapters and APIs).

The digital platforms and tools that will manage such complex environments must be flexible and open, with rich integration capabilities and strong governance rules.

4.2 A PROPOSED 'TO BE' SOLUTION TO INDUSTRY: THE DIGITAL OPERATIONS FRAMEWORK

New operations processes and governance

The TM Forum Open Digital Framework (ODF) provides the basis for Huawei's proposed new-generation digital operations framework. The framework integrates processes, platforms, people (i.e., organizations), governance and digital transformation guidance methods that comprise the requirements for the digital transformation of operations and supporting the implementation of a digital operations methodology. Huawei's framework comprises four domains (governance, service, enablement, and system) plus the guidance methods for the transformation (see Figure 14). Other vendors have similar frameworks based on ODF.



Note: BSS service desk functions including billing are grayed out as they are out of scope of this report
AOMM is TM Forum's Autonomous Operations Maturity Model, VOF is its Value Operations Framework

Key: AOMM: Autonomous Operations Maturity Model; VOF: Value Operations Framework

Figure 14: Huawei's digital operations framework for the "to-be" operations solution

A snapshot of the four domains and transformation guidance is provided below.

1. **Service domain:** Comprises all the planning, management, and operations capabilities that span the network and service/customer domains. These capabilities follow important industry standards such as the ITIL V4 (2019 customer-centric approach to IT service value systems and the TM Forum Business Process Framework (eTOM), which describe the requirements of telecoms operations processes from the perspective of the service domain.

2. **Enablement domain:** This element is built on the best practices of the TM Forum Autonomous Networks project and ODF. It spans the proper mechanisms to support specific operations activities such as plan to execution (P2E) as well as a range of processes for operations and management, including those for scenario planning; requirements, data modeling, development, and deployment management; and digital asset operations. (Note: a 'digital asset' is defined in this white paper to include such items as data, files and scripts for user interfaces, models, workflows, robotic process automation tools, integration tools, network commands, and so on; they do not include network functions of any kind. It incorporates DevOps concepts such as lean and agile software development and agile and iterative development processes to support CSPs' digital operations transformations.)

3. **System domain:** The system domain supports the value realization of digital operations systems through promulgation of the microservices architecture (an open, lightweight, agile, and efficient technical architecture).

4. **Governance domain:** This domain includes governance of all the processes that help CSPs provide secure, high-quality digital services; manage risk within the enterprise; ensure data privacy and security; manage digital assets; develop personnel; and manage knowledge and communications. The rules that govern these processes are based on industry standards such as Six Sigma quality improvement standards across DMAIC (define, measure, analyze, improve, control) phases of a process, as well as TM Forum standards for data governance.

5. **Transformation guidance:** This domain provides methodologies and criteria for assessing a CSP's digital and automation maturity and implementing digital operations approaches. Its foundations include TMF's Autonomous Network Project, Measuring and Managing Autonomy (MAMA) Framework, Value Operations Framework (VOF), and Autonomous Operations Maturity Model (AOMM), among many other guidance tools. It draws on the practical experience from successful proofs-of-concept and transformation projects.

4.2.1 DOMAIN DEEP DIVE

Service domain
The service domain supports CSPs' transformation from network- to service-centric operations and their visions of autonomous operations through a client/service orientation, with a focus on 'human-based' processes. Specific capabilities are as follows:

- Provides CSPs with the digital operations framework that supports coordination and correlation of network and service incident and performance events to eliminate the traditional siloes, reduce event management workloads, and improve operations efficiency and customer satisfaction.
- Supports network operations for enterprises that support consumer, business, and home services (B2B2X).
- Sets service restoration as the highest priority activity while reducing field maintenance dispatches.
- Intercepts customer complaints through business impact analysis to minimize business losses such as those due to customer churn, and improves customer experience through closed-loop management.
- Enables NOC-SOC collaboration and integration that supports proactive customer care and enhanced user perceptions of service quality.

Enablement domain
The enablement domain uses industry best practices and taps into years of practical global IT experience with digitalization; its emphasis is on digital assets. It integrates DevOps thinking to build a globally relevant research and operations system, hastens the inclusion of digital assets into automated operations processes, and enables the efficient delivery of digital assets for use by operations staff. This domain includes two parts:

- **Mechanisms to improve the efficiency of digital asset development.** These mechanisms model operations processes that use digital assets. For example, the mechanisms establish digital asset development specifications, unify models and specifications, improve standardization of digital asset development, simplify both high-level and detailed design, and shorten development cycles. Digital asset development efficiency is improved as a result of these enablement mechanisms.
- **DevOps-based digital asset development and operations processes.** DevOps processes support continuous integration and continuous delivery (CI/CD) of digital assets. These enablement processes support development of the digital assets themselves as well as automation and assurance tools to support agile operation and assurance of the assets.

Governance domain
The governance domain provides CSPs with the capabilities needed to establish systems and processes that clarify operating norms and requirements; control management risks; and achieve improved service quality and effectiveness. The key elements of the governance domain include:

- **Service continuous improvement:** Business goal-oriented performance management ensures stable, controllable, continuous improvement of service quality and creates ongoing value for CSPs.
- **Data governance:** Strict governance of the CSPs' huge trove of valuable and often sensitive data allows the CSP to maximize the value of these data and create ongoing value from service improvements.
- **Digital asset management:** Supports the visualization and life cycle management of digital assets by ensuring their security, standardization, and integrity.
- **Digital organization and personnel improvement:** Defines the digital operations team's job responsibilities, skills requirements, and organizational structure to support the CSP's DevOps transformation.
- **Communications management:** Outlines efficient communication management mechanisms that enable high-quality, effective conversations with customers and partners.
- **Knowledge management:** Creates mechanisms for effective and efficient sharing of knowledge assets and expertise among the CSP's organizations and supports the shift to knowledge asset-enabled digital operations.
- **Risk management:** Identifies and manages business risks to avoid or reduce losses and ensure the long-term stability of CSPs' operations.

System domain: the digital enablement platform
According to Huawei, the as-is operations approach, with its siloed OSS and manual processes, is not fit for purpose in the digital, 5G era, which requires high levels of automation and continuous evolution. The 'to-be' digital enablement platform, on the other hand, draws on the design experience of IT software vendors such as Salesforce, Progress, and ServiceNow to incorporate three critical attributes: support for low-code/no-code development; openness; and a cloud-native, microservices-based architecture. These attributes provide significant benefits to both the design time and run time capabilities of the platform:

- **Design time:** Operations engineers with no software development experience can quickly complete the configuration and rollout of service applications using the low-code/no-code tools provided by the digital enablement platform. These engineers can design and develop elements such as graphical user interfaces (GUIs), APIs, data models, rules, and processes to improve operations automation and standardization. These elements can then be combined by service and integration personnel to form sophisticated applications. Compared with the traditional monolithic and suite-based OSS, the digital enablement platform 'to-be' approach allows much shorter time to market for differentiated services. It should also allow services to be more open and extensible and more easily deployed on hybrid, public, and private clouds.
- **Runtime:** The applications that are orchestrated in design time can then be deployed in a CSP's production environment through run time interpretation and execution. New capabilities that are configured and extended in design time can be immediately loaded and used securely, reliably, and efficiently in the production operations system. The digital enablement platform supports a broad array of operations processes and capabilities, including incident and event management, automation, performance management, and the like to meet CSPs' expanding requirements for operations efficiency. Microservices-based alarm handling, network incident diagnostics, and network and device integration capabilities of the run time applications can include APIs, pages for web or mobile viewing, and data models that CSPs can use to quickly launch customized operations scenarios, support new service innovation, and provide better, higher-quality customer experience.

Transformation guidance
'To-be' digital operations requires a new framework to guide transformation from the 'as-is' and transition solutions. TM Forum, acknowledges Huawei, has been the leading organization to provide transformation guidance to CSPs, including critically important assessment tools and implementation methods, to support successful digital transformation. The transformation guidance includes TM Forum assessment frameworks, such as AOMM and VOF, as well as digital operation implementation best practices based on successfully completed transformation projects:

- **Autonomous Operations Maturity Model (AOMM):** Provides the digital operations maturity assessment framework consistent with the TM Forum Autonomous Operations standards, qualitatively assessing CSPs' digital operations capability baselines and helping them to identify gaps and define future goals. All the CSPs interviewed for case studies in this report noted how important such assessments have been to the development of their digital operations transformation plans.
- **Value Operations Framework (VOF):** This assessment framework for service value quantifies operations process performance and the value that CSPs can accrue by implementing the 'to-be' operations approach. This can provide the financial justification needed to motivate CSPs to invest in the transformation journey to digital service-centric operations.
- **Digital operations implementation methods:** Global best practices honed from successful CSP transformations aided by professional services partners. Methods include implementation guidance and planning based on whether a CSP's automation priority is efficiency-driven (for example, headcount reduction), experience-driven (for example, improving user experience), or some combination of the two. Following these best practices can control risks and speed delivery of digital operations transformations.

The value proposition for the digital operations framework
The digital operations framework based on the four domains and the transformation guidance tools and methods, argues Huawei, can bring sustainable value to CSPs.

- **Improve service quality:** CSPs can build efficient, agile operations capabilities comprising massive numbers of digital assets and enable first service-centric operation, then eventually business-centric operation. Such operations can improve the CSP's top line and customer satisfaction.
- **Improve operations efficiency:** Correlation of multiple data streams from the operations framework, including incident, performance, and service quality data into a single event that can be managed through closed-loop automation can improve time to resolve incidents, reduce manual intervention, and achieve financially significant operations efficiency improvements.
- **Accelerate transformation success:** Baseline and value-based assessments, gap analysis, and prudent planning, coupled to the other elements of the 'to-be' digital operations approach reduce the risk and difficulty of the transformation and can accelerate the pace of the transformation so that the CSP can recoup investment costs and generate incremental value sooner than would otherwise be possible.

4.2.2 THE 'TO-BE' DIGITAL ENABLEMENT PLATFORM: ARCHITECTURE AND CAPABILITIES

The limitations of the 'as-is' and 'transition' solutions (siloed, overly manual operations and aged, rigid architectures with limited digital extendibility) will require CSPs to consider more radical 'to-be' operations frameworks, architectures, systems, and tools. Traditional monolithic and 'best of suite' OSS, maintains Huawei, cannot meet the operational challenges posed by digitalization.

CSPs' ongoing evolution to 'new-generation, service-centric intelligent operations,' says Huawei, requires a platform-based digital OSS that has at minimum the following characteristics:

- Enables increased efficiency and reduces the cost of operation, including the limitation of OSS fragmentation.
- Decouples design and run time operation. As previously stated, this includes low-code/no-code approaches to the development of digital assets during the design time. Then in the runtime, microservice-based capabilities can be orchestrated in service chains to accomplish operations tasks such as root cause analysis, network element command execution, data analytics using AI/ML, and similar tasks.

Such a platform-based approach to intelligent operations, argues Huawei, enables CSPs' evolution to zero-touch and autonomous operations.

Digital enablement platform requirements
Huawei's 'to-be' target architecture has four "key capabilities".

Key capability 1: Converged data platform and data governance to implement data sharing and openness
A shared and accessible data store is fundamental to Huawei's 'to-be' service-centric intelligent operations. This data platform and related tools for data mining and analysis allow the CSPs to derive maximum value from the data. For example, they can create single- and cross-domain data models and use and adapt them for different user, service, and network application scenarios. They can also securely and effectively share access to the data within and across departments to reduce process automation gaps. The governance domain sets standards and requirements for data collection, security, and openness, among other attributes.

Key capability 2: One-stop AI solution for network operations
The digital enablement platform provides centralized AI capabilities, tool chains, inference engines, out-of-the-box AI-based service, and model training for operations processes. AI capabilities must be simple to use such that they require minimal expertise by operations personnel assigned to implement them. For example, the AI training should integrate common AI algorithms, local model monitoring should automatically trigger model reevaluation and retraining, AI application development should be low-/no-code, and tool chains should be easy to invoke and use.

Key capability 3: Low-code development platform to reduce CSP development difficulties
CSP requirements for improved service agility dictate DevOps approaches to software integration and deployment. In addition, the need to efficiently train operations personnel who have valuable telecoms expertise but little development experience to develop digital assets requires a low-/no-code development environment. CSPs need these tools to become application creators, not just application users. This shift in function gives CSPs more control over value creation and service innovation and differentiation.

Key capability 4: API gateway to ease API integration across autonomous networks and legacy EMS/OSS
In the 'transition' solution suggested by Huawei, APIs were noted as essential to closed-loop operations, but specific architectural requirements for managing the APIs were unstated. In the 'to-be' digital enablement platform, Huawei suggests that an API gateway—a software application that accepts API calls from a client application and forwards them to the appropriate service—be used to properly manage the API activity and integrate an API-based approach with legacy EMS/OSS. The API gateway platform includes the integration tools, applications, and data sources that open use of its capabilities to trusted users (internal and external) to the CSP. The gateway can be extended to include management of the whole API lifecycle, including API creation, verification, implementation, operation, and exchange and governance across the span of internal and external stakeholders. Huawei's API-related suggestions are supported by various standards organizations and initiatives, including the TM Forum's Open APIs and the GSMA's Open Gateway framework, which, with the backing CSPs, is supporting network-as-a-service applications.

Future-proofing the digital enablement platform for the evolution to TM Forum's AO/AN
The architecture and capabilities of the digital enablement platform should be extensible well into the future. For example, CSPs may want to evolve the converged data platform to a full digital twin; process-driven automation to event-driven automation; extend use case-based lifecycle management to knowledge-based management; and drive automation based on business intent rather than rules or policy. Any extensions beyond the baseline 'to-be' digital enablement solution can be phased to meet a CSP's specific competitive and strategy priorities.

4.2.3 TECHNOLOGY EVOLUTION: THE IMPORTANCE OF AI

In the discussion of how Huawei's 'transition' solution might align with a standards-based 'to-be' solution, five looming challenges were described that CSPs could not effectively meet until they implement the 'to-be' solution. The five technical challenges posed by the to-be solution are listed in Figure 15 along with Huawei's suggested 'to-be' evolution that can solve them.

Challenge

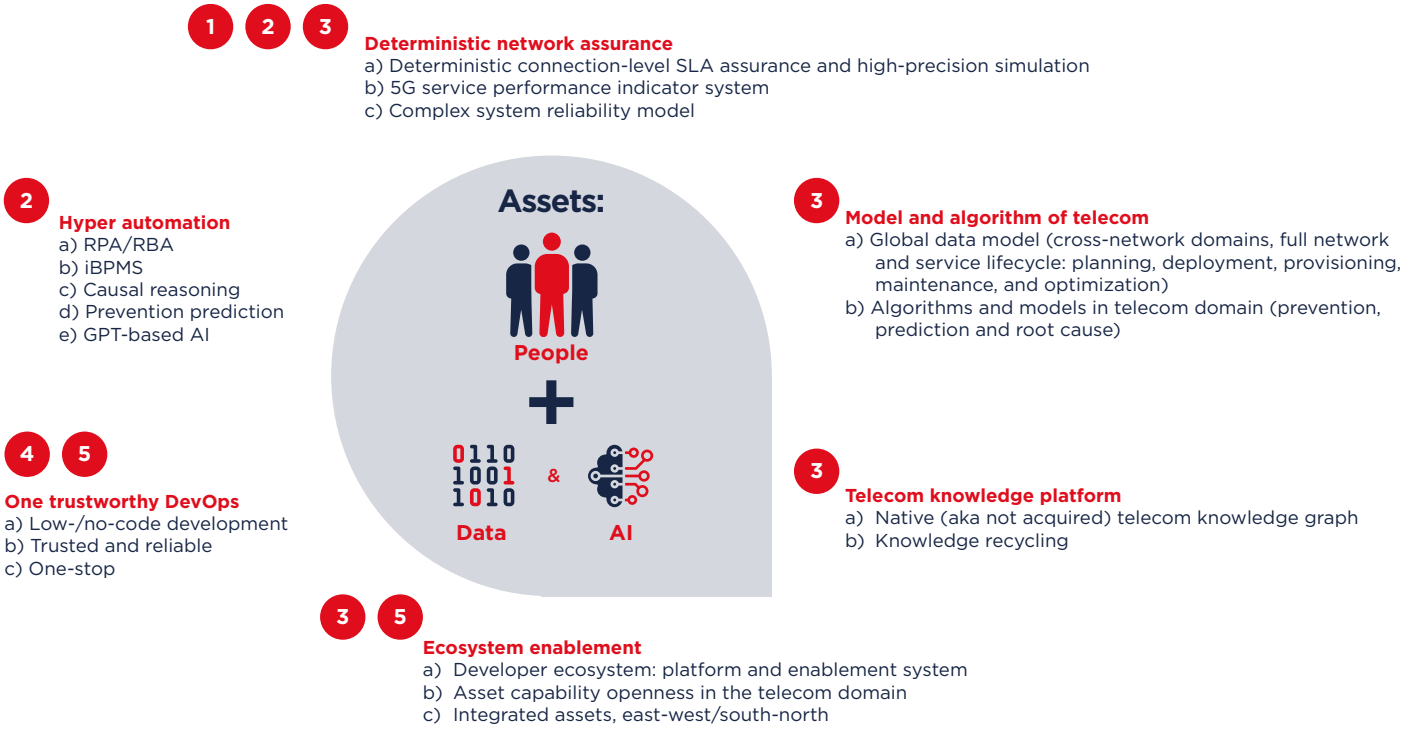
	Description	'To-be' evolution
1	Increasingly stringent, deterministic service performance requirements	Correlated service, user, and network assurance to enable real time, connection-level, end-to-end SLA assurance
2	Rapid increases in network and service complexity	AI-enabled operations super automation
3	Growing, continuous need for domain model algorithms and knowledge	Continuous creation of models and algorithms that capture telecom knowledge and expertise and enable their reuse among CSP departments
4	Scenario-based development to support agile services	DevOps implementation, including low-/no-code tools for operations personnel
5	Open platforms and ecosystems to accommodate multi-vendor, heterogeneous IT and network environments	Integrated digital frameworks and assets

Figure 15: Critical challenges that can be solved by the 'to-be' solution

Figure 16 maps these five challenges to Huawei's six dimensions of technology evolution that are needed to support service-centric digital operation. Note: The names and proposed features of the six dimensions discussed here are based on iMETHOD, a best-practice digital operations transformation framework proposed by Huawei.

Solving these challenges to enable service-centric operations requires six distinct dimensions of technology evolution, each of which addresses one or more of the five challenges or aspects of the challenges.

Moreover, claims Huawei, the six dimensions can be mapped to the seven standardized operations discussed in Section 3. In the transformation to service-centric digital operations, Huawei adds a possible eighth task: anomaly prediction. The goal with this new digital enablement platform is to move from a reactive approach to a proactive approach. The relationship between the tasks and the technical dimensions is many-to-many.



Notes: RPA/RBA: robotic process automation/rules-based automation
iBMS: Intelligent business process management system
GPT: Generative pre-trained transformer, a type of neural network-based AI

Figure 16: Mapping the five challenges to the six dimensions of technology evolution for service-centric digital operation

Standardized operations tasks	Deterministic network assurance	Hyper automation	Model and algorithm of telecom	Telecom knowledge platform	One trustworthy DevOps
Predict anomaly	👍	👍	👍	👍	
Detect anomaly	👍	👍	👍	👍	
Service impact analysis	👍	👍	👍	👍	
Demarcate anomaly	👍	👍	👍	👍	👍
Locate root cause (RCA)	👍	👍	👍	👍	👍
Recommend solution	👍	👍		👍	👍
Execute solution	👍	👍		👍	👍
Check, restore, resolve	👍	👍		👍	👍

Figure 17: Mapping of five technology dimensions to the standardized operations tasks

Note: The sixth dimension, ecosystem enablement, does not appear in Figure 17 because it does not relate directly to the operations tasks. Its role is about how developers gain access to the platform and how platform assets are exposed and integrated.

Deep dive into Huawei's six dimensions

1. Deterministic network assurance (DNA)

Deterministic network assurance is required if CSPs are to meet stringent end-to-end SLAs required by anticipated digital services such as those enabled by 5G and future mobile technologies. Service-centric DNA requires a host of automated operations capabilities. These include: Service experience definitions, awareness, and evaluation; service risk prediction; service anomaly detection; service incident diagnosis, including root cause analysis; and service keepalive, restoration, and verification.

The first step in diagnosing a service problem is awareness of the problem and analysis of its service impact, including whether incidents at multiple layers are correlated to the problem.

Digital twin technology offers long-term promise for future service-centric operations

Huawei endorses the approach of building the technical framework for deterministic network assurance on the digital twin concept, with which, per an IEEE report on 6G, a physical object such as a network can be "fully and precisely represented by its twin in the digital domain." Communication is bi-directional between the digital and physical worlds. One implication of bidirectionality is that simulations can be done quickly and accurately in the digital dimension and the results used to change the physical domain.

Implementation of the digital twin concept starts with a strong data foundation such as that of the consolidated data platform. These data can then be used to build topology restoration and network resource models, network and operations state models, and to simulate dynamic service and network resilience behavior. The digital twin, therefore, offers a powerful framework for service-centric simulation, prediction, and diagnosis.

2. Hyper Automation (HA)

Hyper automation uses technologies and techniques such as robotic process automation, causal reasoning, predictive analysis, and GPT-based AI to tame the rapid increase in network and service complexity that 5G and future networking technologies will create. Hyper automation embeds these intelligent automation technologies, many of which will be AI-based, into digital operations service flows to improve the entire operations lifecycle. HA rests on a strong centralized data foundation.

3. Model and algorithm of telecom (MAT)

Standardization and repeatability of operations actions based on service and network conditions are critical. This requires capturing and leveraging critical telecom expertise across multiple network domains and service scenarios in a way that machines can access and use it to operate in OODA closed loops. Telecom-specific cross-domain (RAN, core, etc.) and cross-layer (resource, service, user, etc.) data models must be built to which algorithms are applied to enable activities such as service impact analysis. These models and algorithms will be developed over time by human experts using DevOps tools. The state of the art will progress as humans develop the scenario-based diagnostic logic on which the models and algorithms are built, first to machine learning-assisted model and algorithm refinements, then to the use of large models, knowledge graphs, and digital twin to integrate other AI models and algorithms.

4. Telecom knowledge platform (TKP)

Once the telecom-specific models and algorithms proliferate and become more complex, there needs to be more sophisticated tools and platforms to manage these digital assets. Digital operations will generate a large amount of rich data. Mechanisms must be established to identify, compress, store, access, and update the data. This valuable knowledge, in the form of data, must be organized into knowledge graphs that enable the tuning, generalization, and regeneration of unique algorithms and models to drive automation.

The TKP will intelligently extract knowledge from routine operations data and continuously accumulate domain knowledge to be used to drive intelligent automation. Figure 18 provides a block diagram of what a TKP might comprise.

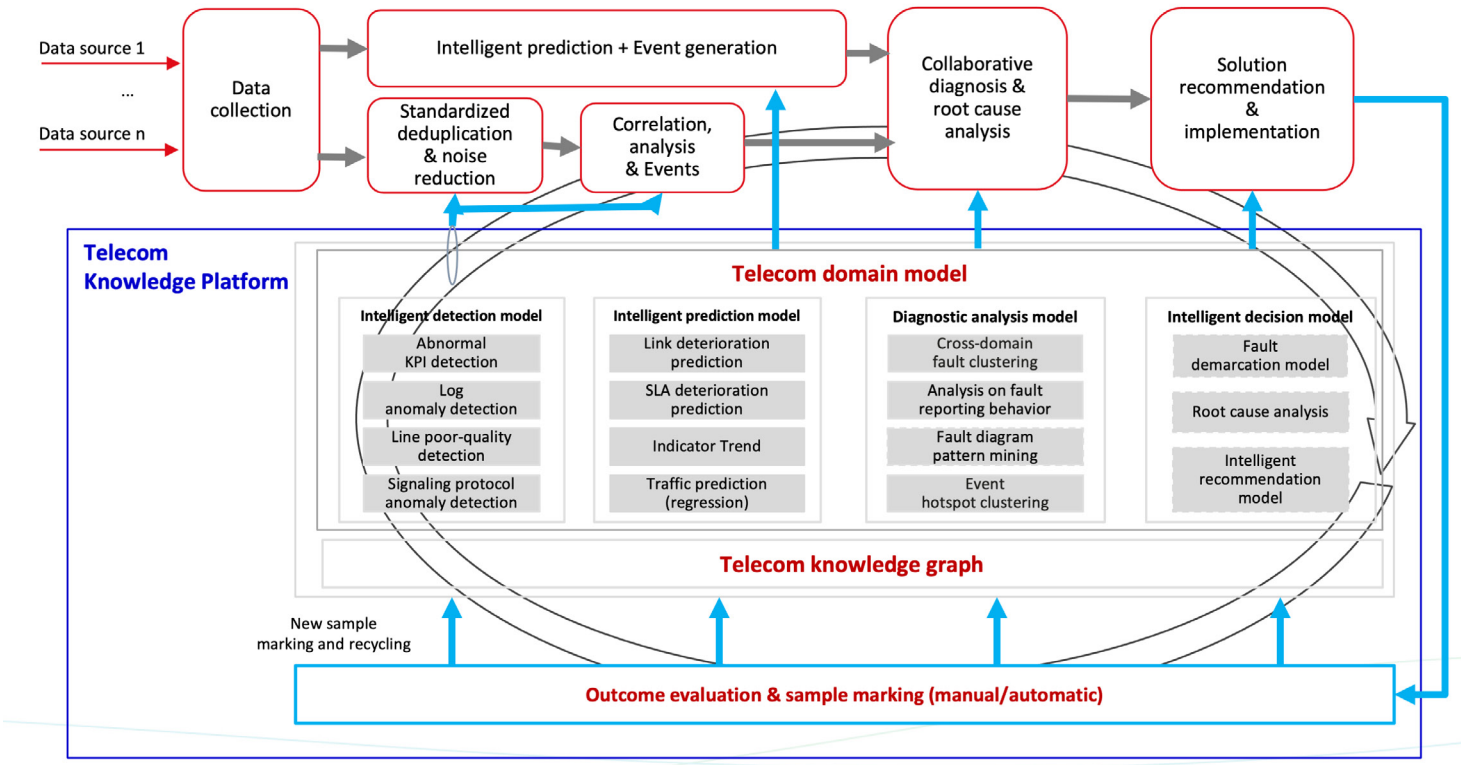


Figure 18: Telecom knowledge platform vision

How large models might accelerate digital operations automation

Large models, including LLMs, are a type of deep neural network model with parameters on the order of millions, billions, or even hundreds of billions. ChatGPT, which is the best-known of a family of neural network-based and LLM-based AI applications, has caused a sensation in the world and pushed large models to become a hot topic in telecoms.

However, there are many challenges that must be solved before the telecoms industry can use such large models in production systems. The application of large models to drive automation in telecoms would require significant compute, storage, and communication resources as well as accurate and effective base data. Data governance is critical and has always been a pain point in the telecoms industry. Therefore, it is likely that small- and medium-sized models that rely on lightweight data will be the foundation of AI-based automation in telecoms for many years.

Compared with direct training of large models in the telecoms domain, it will be more practical to use basic large models to add domain knowledge, then perform incremental pre-training and instruction fine-tuning to create a sophisticated large model over time. The computing power required by the latter approach is likely to be only a hundredth or a thousandth of what would be required by the more ambitious approach. A slower, more careful approach might be less liable to proliferate poorly structured data as well.

Figure 19 depicts a scenario for how large models might push the operations model from man-machine collaboration to man-machine interaction.

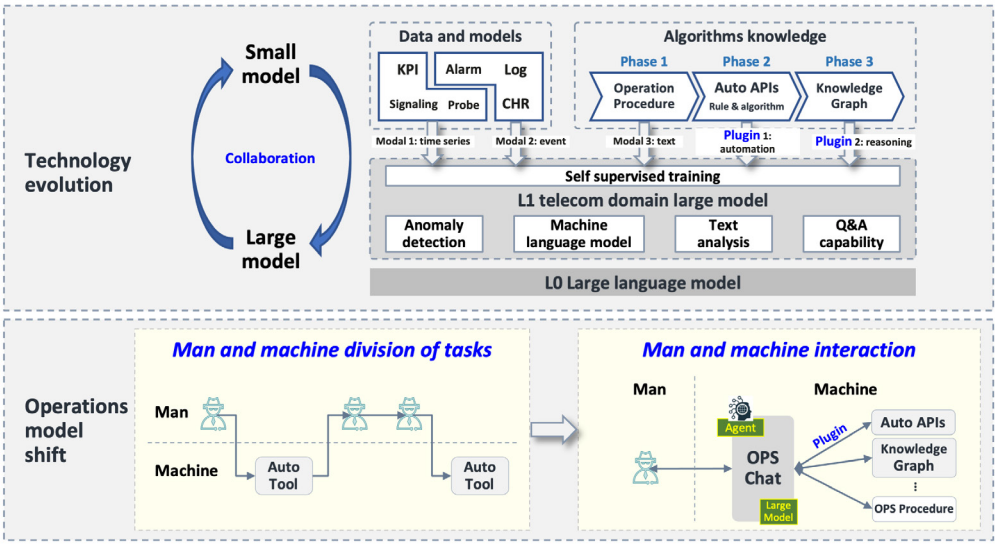


Figure 19: How large models for AI might change operations and technology evolution in telecoms

As discussed under the DNA, MAT, and TKP technology dimensions, knowledge platforms and digital twin concepts that leverage graph technology will be gradually built and used in telecom over the next decade or so. The shift to man-machine interaction operations models will come through integration of small scenario-based models with large models based on neural network technology. Front- and back-office personnel will be partially replaced by "digital employees" and the nature of the human employees will change.

One Trustworthy DevOps (OTD)

DevOps and the need to make development easier and more efficient for more operations personnel will allow more customized and agile development of digital assets. As noted by Huawei throughout this whitepaper, low-code/no-code development is essential if CSPs are to realize their agility, cost efficiency, and value creation business goals. With such digital development enablement tools, upskilled network engineers without intensive professional IT development skills will tap their telecom operations expertise to become automation developers. Figure 20 shows what such DevOps enablement technology might comprise.

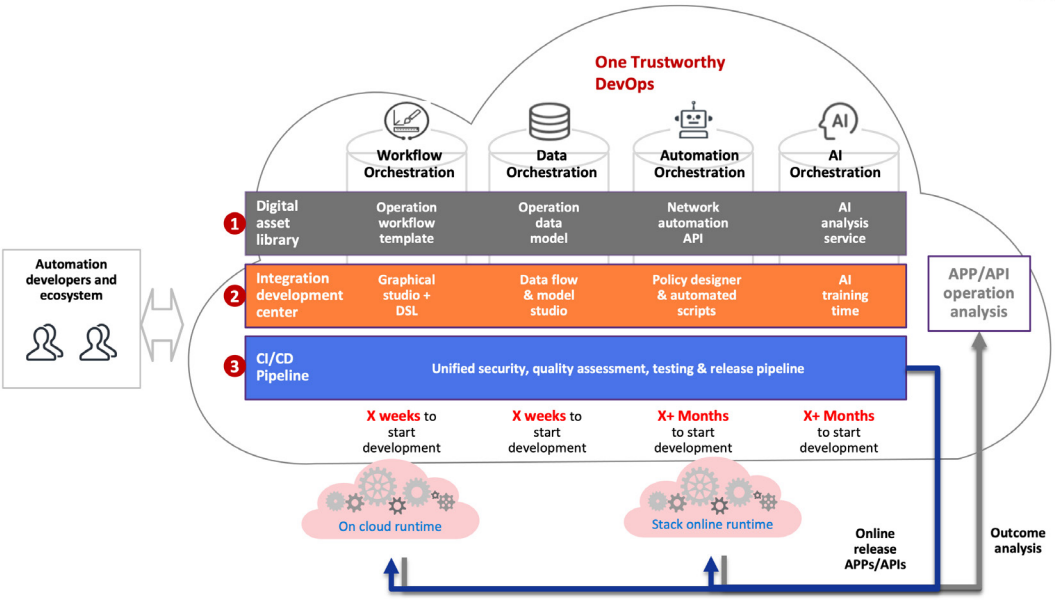


Figure 20: One trustworthy DevOps environment supports automation developers

How large models might accelerate low-/no-code development use

CSPs will likely embrace ChatGPT, GPT-4, or a similar neural network-based, LLM generative AI application to assist human automation developers. For example, such a tool could assist human developers in creating and orchestrating customized applications and operations flows based on natural language interactions and driven by business intent without any need to code. Figure 21 illustrates how this evolution might occur.

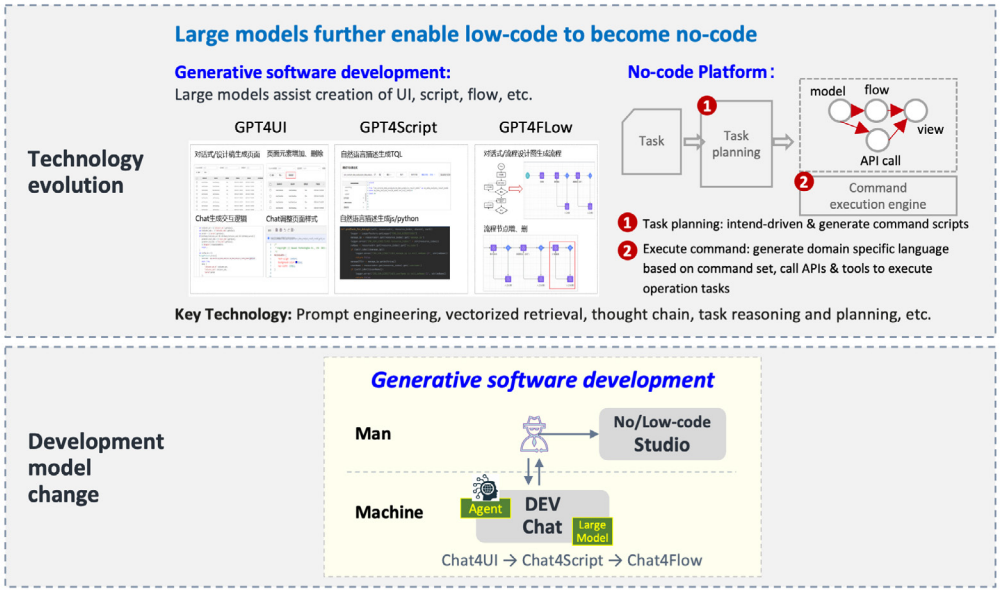


Figure 21: How large models for AI might accelerate no-code development in telecom

5. Ecosystem Enablement (EE)

CSPs want to expand their businesses and operations to accommodate a wide range of partners. Take network-as-a-service (NaaS), for example, and other open, agile service-creation approaches to trusted ecosystem partners. In addition, CSPs do not want to be forced to remove working network equipment and support systems if they are still providing useful service.

Ecosystem enablement technologies serve three important functions:

- Integration and interconnection of a CSP's existing OSS, BSS, and network resources into the digital operations automation framework and architecture. This includes adaptation and translation of a host of standard and proprietary protocols used by these systems and resources to communicate and pass data and commands back and forth.
- Integration of digital assets, regardless of their source (internal or external to the CSP), into a library the CSP can access as needed.
- Secure, API-based access control into/out of the network and operations framework and architecture for third-party developers and applications.

The main role of ecosystem enablement is to open the digital operations platform so it can accommodate multi-vendor, heterogeneous IT and network environments and support an expansion of CSPs' businesses into a broader set of services and use cases, some of which might be offered by its partners. It can also allow older operations and business support systems and network infrastructure to be managed using more modern and efficient automated and intent-driven approaches. Figure 22 illustrates how the elements of ecosystem enablement framework can support these integration and access functions.

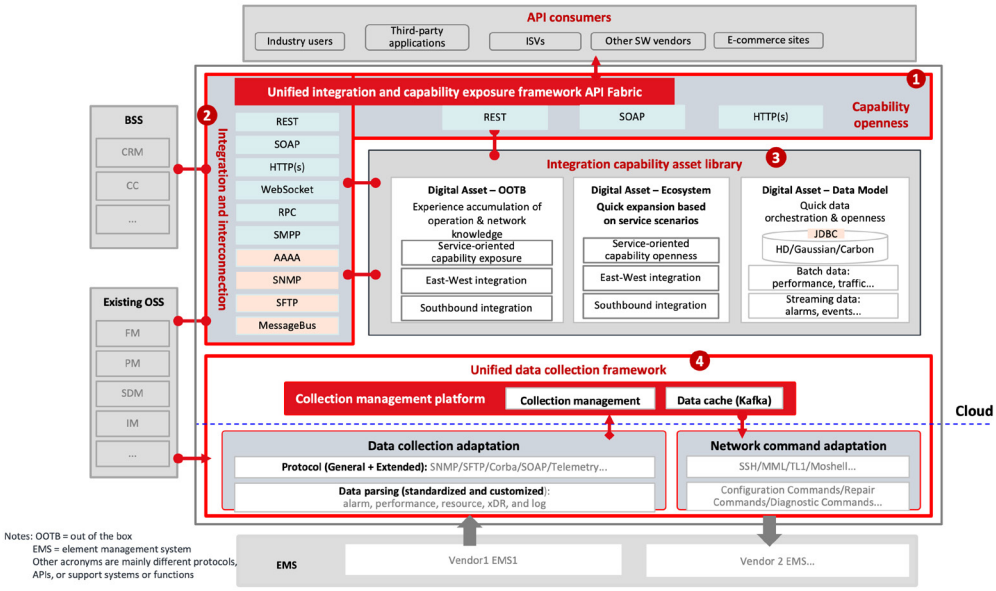


Figure 22: Ecosystem enablement integration, interconnection, and access functions

4.2.4 PEOPLE: NEW ROLES AND SKILLS

People are the most critical and valuable asset that CSPs have. Digital transformation requires that CSP personnel significantly shift their roles and responsibilities—and therefore their skills—to support automation.

Fundamentally, the PMO provides operations personnel with automation tools to help them run operations, while the digital FMO requires personnel to build digital automation assets such as APIs through which they can assist the machines.

As discussed earlier in this Section, which outlined Huawei's six dimensions of digital enablement, the vendor counsels its customers that DevOps, big data, AI, and large models will accelerate the shift to the 'to-be' digital operations approach per TM Forum's ODF and Autonomous Networks Project. TM Forum and Huawei agree that digital operations will require a shift from rules- and policy-based automation to intent- and AI-based automation and transform the nature of operations personnel's required roles and skills. Huawei envisions four new personnel roles that will emerge during and after the transition to digital, service-centric operations, as shown in Figure 23.

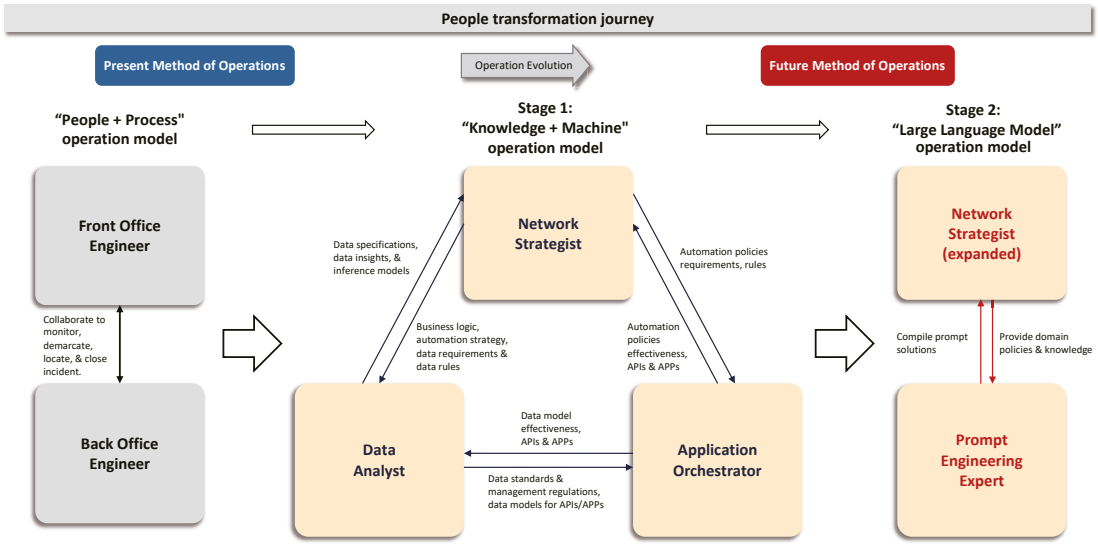


Figure 23: Staff roles and responsibilities will shift from 'as-is' to 'to-be' digital operations

Personnel roles and skills transformation

The transformation journey to service-centric digital operations will require front- and back-office operations engineers' day to day job responsibilities to shift from monitoring, demarcating, locating, and resolving incidents to applications and use case development, data analysis, specifying automation business rules/policies/intent, and so on. These new skills will build on the operations engineers' valuable telecom expertise while adding higher-order process analysis, design, and management skills.

The roles and skills transformation required to implement a transition to more automated, service-centric digital operations, as envisioned by Huawei, are outlined in Figure 24.

Roles/ titles of 'automation developers'	Major responsibilities	Skills to master
 Network Strategist	• Resolve complex operational issues • Formulate rules/policies/ intent for improving quality and efficiency • Track implementation results	**Stage 1:** • Cross-domain network resource technology understanding • Service analysis • Systematic rules/policy/intent thinking • Soft management skills (coordination, communication, promotion) **Stage 2:** • Interact with large language models and intelligent agents to direct their actions • Take on more responsibilities of the data analysts and application orchestrators
 Data Analyst	Generate network and service insights and implement rules/ policies/intent through data analysis and modeling	• Scenario-based big data and AI algorithm modeling • Analysis report preparation • A solid understanding of end-to-end services
 Application Orchestrator	• Quickly implement operations automation processes through application development and orchestration • Continuously develop, manage, accumulate, and replicate digital assets	Agile asset development, application, and management
 Prompt Engineering Expert	Interact with large language models to define and execute rules/policies/intent and monitor results	• Prompt-based interaction with large language models to achieve business goals • Constant improvement of the accuracy of generated results

Figure 24: Four new automation developer roles/titles for operations engineers

CSPs' use of large model-based AI will further transform the three automation developers' work in two stages, as posited by Huawei:

- **Stage 1:** Large AI models will enable automation developers to use natural language to build data models, use cases, applications, and actions based on specified business rules/policies/intent. Natural language interface-based development should decrease the difficulty of building and systematizing telecom domain knowledge, large model reasoning, and other critical tasks. The ultimate goal is that CSPs use large models to support skills acquisition by network strategists, data analysts, and application orchestrators to 'make everyone a developer.'

- **Stage 2:** The reasoning and generalization capabilities of large models will enable new applications using 'intelligent agents' that can execute personalized tasks. These digital agents can assume most of the data analysts' and applications orchestrators' responsibilities as directed by the network strategists in expanded roles. In addition, natural language communication with large language systems will create the new role of 'prompt engineering expert'.

Why might this new role of prompt engineering expert be critical in the to-be service-centric digital operations world? Huawei cites Robin Li, CEO of Chinese search engine Baidu, who put forward the view that in the future "raising problems will be more important than solving problems, and 50% of the global workload will require keyword prompting." In the era of large models, the accuracy and availability of 'code' generated by 'intelligence' will steadily improve. The skill requirements for operations personnel will shift from operations knowledge + data analysis + application development to operations knowledge + prompt keyword construction. The key skill with evolve to combining operations knowledge with the ability to craft the right questions to the large model to achieve business goals.

"The skill requirements for operations personnel will shift from operations knowledge + data analysis + application development to operations knowledge + prompt keyword construction."

The importance of an integrated team: value-oriented and continuous operations
Digital transformation to support service-centric operations requires a shift to value-based operations. This shift will require operations to establish new metrics, as noted in Section 3 of this report, that are focused on services and value rather than on standard KPIs such as MTTR, which measure staff and process efficiency, but not the broader service experience impacts and business value derived from efficient operations. The shift to value-based operation will require cross-functional, integrated teams that can build end-to-end service-centric processes aligned with the generation of business value and continuously improve business results. Such teams will shift their work and their way of thinking from manual to automated and from issue resolution to value creation.

4.2.5 SUMMARY AND CONCLUSIONS: A FRAMEWORK AND PATH FOR CSPS' SERVICE-CENTRIC OPERATIONS TRANSFORMATION

CSP's present mode of operation is network centric: it focuses heavily on resolving network faults and performance problems. The main limitation of the 'as-is' solution — which involve siloed data sources, isolated workflows, manual processes, legacy technologies, and platforms — is a weakening of the CSPs' ability to focus operations resources on service quality and customer experience. improvements and on the implement of end-to-end automation that can improve both staff efficiency and customer satisfaction The traditional operation model cannot meet the evolving business demands in the 5G and digital era, nor can it deliver the expected service quality and agility customers will demand. Therefore, transforming from network-centric to service-centric operations is becoming imperative for CSPs' future growth and success.

CSPs' operations transformation requires a complex, systematic framework and the integration of capabilities that span technologies, processes, platforms, and people. As this white paper has elaborated, the evolution to service-centric operations will require technology innovation, process transformation, platform transformation, and personnel skills upgrades and shifts. This transformation is a multi-dimensional challenge: CSPs don't have to tackle all the challenges all at once, however; a pragmatic step-based approach with incremental milestones and continuous analysis of business results offers a practical way forward.

A successful CSP operations transformation journey will require a strong, clear business vision executed over a decade of diligent, hard work. Successful transformation requires an honest and rigorous assessment of the CSP's current state and a plan of attack that includes replacing or updating legacy systems, platforms, and technologies and retraining, reskilling, or replacing staff to meet the new demands of service-centric digital operations. The scale and scope of such a transformation effort will likely require trustworthy strategic partners with the expertise and competence to help the CSP reduce risk and accelerate change along the journey.

Best industry practices for new-generation intelligent operations

5.

Successful digital transformations, including the intelligent operations transformations that enable them, require sustained strategic focus, planning, and execution over a decade or more.

Digital strategy and its execution
Figure 25, lays out the high-level flow chart that governs successful digital operations transformations from network- to service-centric. As previously noted in this report, the transformation is a journey, not an ultimate destination, because there will always be new requirements to consider.

Figure 25: The operations transformation plan begins with an audit to establish the starting point

The audit imperative
Almost all of the senior CSP executives interviewed for the case studies in this report emphasized how important it was to establish their operations baseline: an honest assessment of their current operations maturity was seen as essential to establishing a realistic plan forward. Those who did the assessments further noted how difficult the process could be without the help of one or more strategic partners that could provide objectivity and expertise, as well as assessment frameworks such as those provided by TM Forum's AOMM, ANL, and VOF.

Iterative execution
With the assessment baseline in place, the interviewees then noted the importance of transformation as an iterative process comprising:

- **Establishing business strategic intent:** Clarity of vision regarding what they want their digital transformation to accomplish.
- **Enumerating business goals:** Translating the strategic vision into specific goals regarding markets, customers and services.
- **Translating business goals to operations requirements:** Breaking down the overarching business intent and goals to the changes to people, processes, platforms, and technologies that are needed to enable the business goals.
- **Implementing the plan:** Implementation then proceeds in phases, typically on a six-month or annual planning and implementation cycles.
- **Assessing implementation results:** As each implementation cycle ends, the projects are assessed based on measured results against business goals and intent. Then, the process starts again for the next phase.

This iterative strategic planning and execution cycle continues until the CSP is satisfied that they have reached the 'to-be' service-centric operations automation state that supports their business goals. Then the CSP can create a new strategic intent and strive for an even more business-focused approach to operations. Outside the timeframe and scope of this report, for example, the TM Forum suggests that CSPs that reach service-centric operations will want to continue their journeys on to fully 'business-centric' operations, as shown in Figure 26.

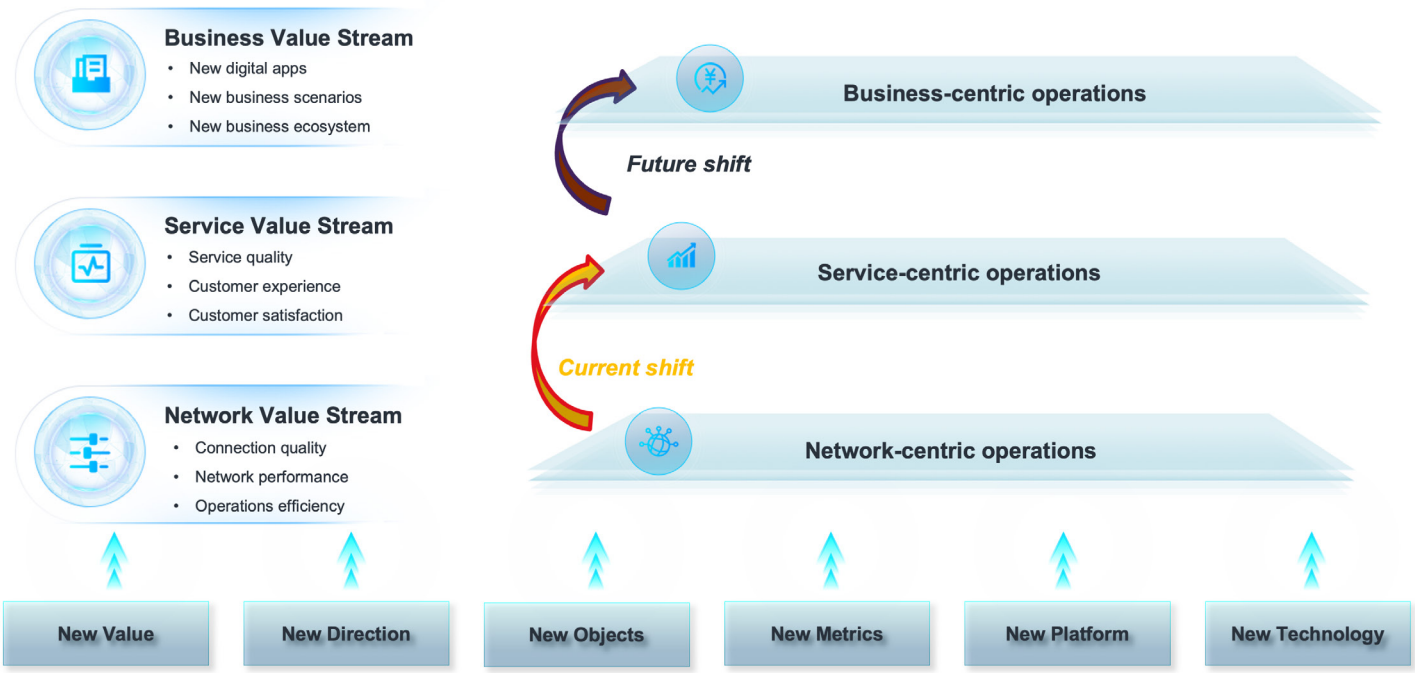


Figure 26: Service-centric operations is the target paradigm from network-centric, but the ultimate goal is business-centric operations

5.1 DIGITAL LEADERSHIP, ORGANIZATION, AND EXPERTISE

A few very important characteristics underlie the iterative planning and execution process shown in Figure 25:

Management leadership and vision: C-level leadership and vision are a must because of the extent of the changes required by those who will be executing the transformation. C-level leadership will set the tone and provide the conditions for the necessary cultural shifts that will make transformation possible.

Organizational flexibility: Rigid hierarchies, siloed organizations that make inter-department collaboration difficult, ill-prepared personnel, and fragmented tools and methods will all impede the transformation process. Interdisciplinary and matrixed teams, flexible organizations, collaboration, and centralized and standardized tools, methods and data will pave the way for successful transformation.

Skills training and hiring: Equipping experienced operations personnel with the proper training to execute the transformation, plus hiring new staff with critical expertise to add to the skills mix are critical. 'Train the trainer' approaches, supported by ecosystem enablement platforms such as those outlined in Section X, can create enthusiastic champions whose expertise can then help other staff advance more quickly than otherwise possible.

5.2 DIGITAL TECHNOLOGY ADOPTION AND INVESTMENTS

"Case study interviews highlighted several notable approaches that can lower the financial and technical barriers to new technology adoption."

While adoption of new technology can be expensive and difficult, case study interviews for this whitepaper highlighted several notable approaches that can lower the financial and technical barriers.

Learning from others/teaching others

Many of the cloud-native operations concepts – such as DevOps and AIOps, and intent-driven automation – have come from IT operations that are not linked to a particular vertical such as telecoms. The telecoms market has embraced these concepts over the last decade or so, and will continue to do so. Additionally, some telecoms approaches to workforce management automation, for example, are applicable to other enterprise verticals and could provide the basis of a new business opportunity for CSPs (see the Bharti Airtel case study.) Therefore, continuing to learn from the transformation successes of companies in other verticals, as well as to provide tested operations automation solutions to other verticals, is advised.

The TM Forum's Autonomous Networks Project provides one avenue for intra- and inter-industry cross-fertilization. Our case study interviews highlighted the particular importance of AN-focused Catalysts. (Appendix 1 summarizes a dozen 2023 Catalysts that are helping to advance the industry conversation around the evolution from 'as-is' through a transitional approach to a 'to-be' service-centric operations).

Technology adoption risk reduction and investment decisions

Working with professional services partners that have a successful track record of helping CSP customers to evolve toward service-centric operations can help lower the risk of the whole transformation journey. One specific way they can aid CSPs is to help them implement the foundational technologies and platforms, the tools, and the six dimensions of technology evolution outlined in Section 4.2.3 that are required to support first the transition and the to-be approaches.

Build/operate/transfer approaches have a long history in telecoms and can be very effective as a way to support phased transformations to new-generation intelligent operations while giving CSPs the ability to determine when they are ready to take over control of one or more elements of the automated operations.

CSPs must constantly assess what tasks they can and should outsource and what they must keep control over so that they can reduce investment and operations costs and time to market while remaining masters of their own strategic destiny. For example, HKT's Tom Chun Bong Pang, SVP of Engineering – Network Planning & Operations, stressed how important it was to the CSP to keep control of use case design and implementation, network quality, and the customer relationship, while also seeking help from strategic partners (such as Huawei) to implement the necessary technologies and digital enablement platform (see page 43). Bharti Airtel, on the other hand, implements much of its own digital transformation in its large India market, but works with professional services partners such as Huawei in its African markets. (See page 39.)

Investments in people are fundamental to digital operations transformation

Investments in people are the precursor of a successful intelligent operations evolution. IOH's Agus Sulistio, SVP of network operations, emphasized how important hiring and developing the right people is to the company (see page 46). Without trained and motivated staff who understand the business goals and vision behind the transformation, many CSP operations staff are likely to fear automation and what it might mean for their jobs rather than embrace it a way to contribute in a very meaningful and visible way to the continued success of their company and the improved experience of their customers.

"Investments in people are the precursor of a successful intelligent operations evolution."

TM Forum Catalyst C23.0.597, "Talent for tomorrow - Phase II" is championed by China Telecom and China Unicom, and supported by Huawei, with the objective of creating a platform to help develop personnel through three mechanisms: a role-based upskilling program; a low-/no-code development platform; and a knowledge repository of the type discussed in Section 4.2.4. CSP readers are encouraged to follow the results of this Catalyst to see what lessons they can learn and, if there is a third phase, perhaps they will want to participate as a champion. They can also elect to champion another Catalyst that might be more aligned with their situation.

CSP intelligent operations transformation case studies

6.

BHARTI AIRTEL'S DIGITIZATION TRANSFORMATION AND PARTNERSHIP STRATEGIES ARE DISTINCT IN INDIA AND NIGERIA, WHICH HAS OPERATIONS IMPLICATIONS

Summary

Who: Bharti Airtel

What: Airtel India's strategic operations focus is on inhouse implementation of digital platforms, starting with business support systems (BSS) to support its digital services expansion. Improving service- and customer-centric processes is a major thrust in India. In Nigeria (and Africa as a whole), Airtel's attention is on more basic operations support system (OSS) improvements to network quality and customer experience management with the help of strategic managed services providers (MSPs) such as Huawei.

How: In India, Airtel has implemented a 'platformization' strategy based on inhouse development and operations that support an omnichannel, end-to-end customer experience regardless of which services a customer buys, where they buy them, and how they pay for them, and on reducing customer complaints regardless of their source. In Nigeria, Airtel and its MSP Huawei have implemented a regional network operations center (RNOC) and a service operations center (SOC) that improve mean time to repair (MTTR) with an emphasis on those faults and performance issues, such as cell site problems and fiber cuts, that affect a large number of subscribers.

Airtel results summary:

- Reduction of Indian customer calls by 26% (compound annual rate of reduction for the four years ended March 2023)
- Nigerian RNOC improvements have resulted in, as of March 2023: 96% alarm compression; 100% performance alarm coverage; and 99% of fault TTs, 100% of performance TTs, and 100% of work orders generated automatically.
- The Nigerian RNOC has also decreased MTTR by 7.8%, short-duration outages by 63.2%, and site outages caused by the fiber network by almost 22%, while use of a "portable NOC" (field force automation tools available on mobile devices), has reduced MTTR and TTs as a whole by an overall average of 30% each.
- In the year since the SOC's introduction, Airtel's Nigerian operations have decreased mean time to create a TT by nearly 70%, mean time to find the root cause (RCA) by more than 24%, and mean time to resolve a problem by almost 50%.

Bharti Airtel (Airtel) has operations in 17 countries that vary widely in geography, demographics, wealth, regulation, and technology maturity. Consequently, although the company has an overarching corporate strategy to move from a product to a platform business that offers an array of digital services to its customers in addition to its traditional connectivity services, the strategy is unfolding differently across its markets. In its home market of India, for example, its strategy is often to build, operate, and maintain its own customer- and service-centric automation, data, and digital service platforms and applications. In its African markets including Nigeria, in contrast, its business transformation and operations strategies lean heavily on managed services and other partnerships. Its India operation leads the way with its corporate digital transformation, but Airtel's ultimate goal is consolidation and integration of approaches across its footprint.

Airtel is a top-three mobile communications service provider (CSP) by number of mobile connections (per GSMA Intelligence). Approximately two thirds of its subscribers are in India, one quarter are spread among its 14 African markets (Nigeria being the largest), and the remaining 10% are split between Bangladesh and Sri Lanka. In its fiscal year ended March 2023, Airtel reports revenues up 20% from the prior fiscal year, with net profit up an incredible 96% in the last fiscal year, indicating that its digitization strategy is working to both lower costs and increase revenues.

Solutions: Airtel's India focus is 'platformization' across telecom and digital services, while in Nigeria its focus is more traditional operations transformations
In 2023 a key initiative for Airtel has been the "platformization" of its India operations. 5G is a key catalyst for this strategy, the execution of which in 2023 includes implementing four new platforms:

- **Buy,** through which customers can buy any product on any channel,
- **Bill,** which provides converged billing for all customer services,
- **Pay,** through which customers can arrange converged payments for all services, and
- **Serve,** which is a consolidated customer service management platform that includes work force management, call center management, customer complaint resolution, and other tools for service and network engineers.

Of these four platforms, Airtel is working with a strategic partner (Amdocs) only for the comparatively-generic billing platform; the CSP views the three other platforms as competitively advantageous to develop in house. All its new platforms follow TM Forum open API standards for access, the ODN framework for platform architectures, and eTOM business practices for the operations and IT software lifecycles.

The Serve platform is at the heart of Airtel's initiative to improve customer experience and lower customer complaints. With customer service at its core, Serve helps Airtel to meet its business goals of improving service velocity, reducing customer churn, and increasing its share of customers' wallets through holistic support of what it calls the "customer flywheel: "the customer service management lifecycle that spans search, discover, purchase, onboard, experience, and refer (new customers). Airtel reports being about 70% through its Serve-based customer complain resolution automation efforts.

Architecture layers	Examples
Digital services	FinTech, Airtel IQ CPaaS, other offerings
Digital experience	Serve platform for customer service interactions
Digital infrastructure	The foundation of Airtel's digital business

Figure 2: Airtel India's three-layer digital architecture

Airtel is about halfway through its implementation of the four new operations platforms in its India market; full migration from its old platforms to the new ones will take another year or two. Meanwhile, it will continue to enhance and expand its three-tiered digital business architecture.

The CSP's African and other non-Indian opcos are on a longer digital transformation timeline, and one that is supported more directly by managed services and other strategic partners. In its Africa opcos, Airtel's strategic focus (and capital investment) is on growth initiatives that "help ensure a sustainably strong and reliable network." Airtel Africa secured its first 5G spectrum during the 2022/2023 fiscal year (in Nigeria, Kenya, Zambia, and Tanzania), but still has very low 4G service penetration. Therefore, the CSP's immediate telecom focus is improving overall customer experience and increasing 4G data and voice revenues, not in expanding 5G across the continent. Its digital service focus is growing revenues from mobile money transactions.

Huawei is a key strategic managed services partner to Airtel in Africa. Among other assets on the continent, Huawei has managed Airtel's Nigerian operations since 2017 through an RNOC (which also manages operations in Ghana and neighboring west African countries). With the RNOC, Airtel has lowered mean time to repair for mobile cells and fiber cuts that affect a great many customers in in Nigeria and beyond. In 2022, Airtel and Huawei began implementation of a service operations center (SOC) to further improve customer experience in Nigeria. The SOC went live in June 2022.

Benefits: One integrated view of, and face to, the customer in India; myriad customer experience improvements in Nigeria/Africa

Through Serve and related initiatives to implement its omnichannel customer service approach, it reports reducing Indian customer calls across its services by 26% (compound annual rate of reduction across the four years ending March 2023).

The Nigerian RNOC-enabled results since 2017 have included improving fault and performance management; implementing a trouble ticket (TT) hub and automating work force management TT generation; and deploying fiber operations and topology restoration solutions. These improvements have resulted in, as of March 2023 (from essentially zero in 2017): 96% alarm compression; 100% performance alarm coverage; and 99% of fault TTs, 100% of performance TTs, and 100% of work orders generated automatically.

Additionally, the RNOC enabled Airtel Nigeria to decrease MTTR by 7.8%, short-duration outages by 63.2%, and site outages caused by the fiber network by almost 22%. Finally, through the use of a "portable NOC" (field force automation tools available on mobile devices), MTTR and TTs as a whole were reduced by an overall average of 30% each.

In the year since the SOC's introduction, Airtel's Nigerian operations have featured decreased mean time to create a TT by nearly 70%, mean time to find the root cause (RCA) by more than 24%, and mean time to resolve a problem by almost 50%.

In sum, in Nigeria in 2022, through the actions of both the RNOC and separate SOC, benefits include that video download speeds increased by 26%, and the CSP ranked first in FaceBook experience (December 2022 testing) and Ookla speed tests (August 2022).

Metric	Organization(s)	Result (2023 unless otherwise noted)
Alarm compression	RNOC	96%
Performance alarm coverage	RNOC	100%
Automatic generation of trouble tickets	RNOC	99%
Automatic generation of performance TTs	RNOC	100%
Automatic generation of work orders	RNOC	100%
MTTR	RNOC	↓ 7.8% (2017-2023)
Short-duration outages	RNOC	↓ 63.2% (2017-2023)
Fiber network outages	RNOC	↓ 22% (2017-2023)
MTTR and TTs as a whole (average)	Field engineering	↓ 30% (2017-2023)
Mean time to create a TT	SOC	↓ 70% (June 2022-June 2023)
Mean time to RCA TT	SOC	↓ 24% (June 2022-June 2023)
Mean time to resolve a TT	SOC	↓ 50% (June 2022-June 2023)
Video download speeds	Managed services overall results	↑ 26% (June 2022-June 2023)
Facebook experience	Managed services overall results	Ranked first (December 2022 testing)
Ookla speed tests	Managed services overall results	Ranked first (August 2022 testing)

Table 1: Airtel Nigeria on an upward KPI curve

Looking ahead: Automation and zero-touch operations in the service of improved customer experience and share of wallet, and reduced churn in India; converged service/network assurance in Nigeria

In India, Airtel's operations focus will remain implementing its platformization strategy to support of its business goal of broadening the types of digital services it can offer customers (including offering -aaS platforms for its business customers to use to enhance their customers' experience), and increasing share of wallet and customer ARPU. Its ultimate operations objective is zero-touch automation that eliminates human dependencies and improves deterministic behavior of network and service operations.

In Africa, Airtel's goals will transition to converging its Nigerian RNOC and SOC processes, in concert with new tools from Huawei, such as those provided by its AUTIN OSS solution, to improve basic mobile and fiber network performance and enable end-to-end service-centric operations in the service of improving customer experience and reducing churn. With its mobile money capabilities, Airtel also wants to continue to increase the number of banked Africans as it expands its revenue from mobile financial transactions.

Although the Indian and the African (and other non-Indian) operations transformation goals and timelines are quite different in 2023, TM Forum would expect that over time these goals will merge as Airtel looks to attack a major challenge its management called out in the 2022-23 Integrated Report: its desire to consolidate and integrate operations through the use of common platforms across its diverse opcos in India, Africa, and South Asia as a means to improve profitability and customer experience in the face of low ARPUs and stiff competition. Extending the capabilities and reach of its digital services layer within and beyond India will be a critical piece of its business transformation journey, and operations transformation is critical piece of its business transformation.

HKT®

HKT'S INTELLIGENT OPERATIONS JOURNEY SUPPORTS GROWTH IN DIGITAL SERVICES

Summary

Who: HKT

What: Intelligent operations transformation underpins the automation of connectivity services and the operator's push into digital services.

How: HKT uses Huawei services and technology innovation, as well as TM Forum automation frameworks and other tools, to steadily evolve its people, processes, and platforms and improve customer experience and operations efficiency.

Results:
- Can isolate service-affecting cell site issues in minutes (not hours or days) using its converged data platform.
- Self-optimization of cell traffic through performance monitoring and automated cell traffic rebalancing in minutes (not hours).
- Self-optimization of cloud-based processing resources in minutes (not hours).

HKT's home market of Hong Kong (population 7.4 million, 1106 km2 land area) may be compact, but Hong Kong, a special administrative region (SAR) of China, enjoys a plethora of broadband service options and wide service availability, due to plenty of competition between providers. For example: Hong Kong's IPTV penetration is the world's highest (over 77% of households), and there are two pay-TV, 27 fixed, and five mobile service providers. The CSP is on a multi-year digital transformation journey to remake itself into a digital services provider (DSP) with a wide offering of digital and automated traditional telecom services. It is evolving its operations to be more automated, connected, and service-centric, and to make it simple and easy for customers to initiate, pay for, and upgrade services.

To meet Hong Kong customer requirements, HKT has been an innovator in broadband, including LTE, 5G mobile and fiber-to-the-home/premise (FTTH/P) fixed networks; IPTV and other media and entertainment services; FinTech, including mobile payments; HealthTech, including its DrGo telemedicine service; and various e-commerce travel, shopping, and loyalty applications. Its ongoing digital transformation journey supports a widening variety of core telecoms and digital business services. Its digital transformation philosophy is to focus on improving customer service and network quality, then generate opex savings.

Tying operations automation projects directly to quantifiable business outcomes is a major strategic priority for HKT. First, it needs measurable value metrics to justify the investment and develop the financial plan. Second, it needs to prioritize projects under consideration. HKT admits such key performance indicators can be challenging to quantify, so it is working diligently with SDO (Standards Development Organization) such as TM Forum to improve its ability to develop such metrics.

Establish a baseline, then deploy foundational data, AI, and API assets

HKT's starting point was to baseline its current operations processes. As with most communications service providers (CSPs), HKT's operations were heavily siloed when it started its transformation journey.

Its first move was organizational: It integrated its back office, service restoration and provisioning, and service surveillance and helpdesk organizations to create a "service-centric culture" and limit inter-team handover issues. The organizational integration, cultivating a service-centric mindset and upskilling staff, gave it a good foundation for transformation, according to Tom Pang, HKT's SVP of Engineering – Network Planning & Operations.

By 2019 HKT recognized that its internal systems would likely impede its digital services ambitions, so it started its automated operations transformation in earnest. The company began building artificial intelligence (AI)-driven use cases for fault and performance management with the help of Huawei and other partners. Then it began creating event-centric use cases for simple services such as fixed broadband. Since 2021 it has been adding closed loop assurance use cases for the end-to-end service lifecycle to improve customers' service experience. It has pragmatically chosen to prioritize automating the simpler, high-volume services such as mobile and fixed broadband / voice services because complex data and business services are more difficult to automate end-to-end.

HKT used Open Digital Framework (ODF) and related automation audits (including Autonomous Operations Maturity Matrix and Value Operations Framework (AOMM and VOF, respectively) to establish the starting point against which it could base its intelligent operations transformation financial investments. It has also used TM Forum Catalysts to help it generate ideas and determine automation priorities in the upcoming one to two years. Upgrading its centralized data store (its data lake) to add a common data layer with tools and application programming interfaces (APIs) was the first essential platform change HKT implemented; this converged data platform has allowed it to effectively access and use the data. Pang notes that prior to this evolution, HKT had no standard way to access its data, nor to make good use of its growing amount of unstructured data. HKT credits Huawei with helping it get this critical asset in place.

HKT is using Huawei's operations platform to automate an event-based approach for simpler services such as mobile and residential fixed broadband /voice services. HKT reports, for example, that it has defined use cases that automate an event-based approach to isolate service-affecting cell site issues by using the data platform to establish root causes and fix problems in minutes rather than hours or days. HKT also notes early success automating security service and enabling self-service consumer voice service upgrades. Cloud-based security services have been API-enabled to update virus signatures and patterns in real time, for example.

It has launched a host of value-added services, such as eSIM-based roaming services, which ride on top of its connectivity services and that customers can activate via mobile apps. HKT is increasingly using AI to launch services such as voice-to-text transcription services for enterprise customers.

Preliminary benefits of HKT's operations transformation
In addition to shrinking time to identify the root cause of fiber-related broadband service problems, HKT cites two additional examples where its upgraded operations capabilities have yielded quantitative improvements:

- **Cell self-optimization after detecting ultra-high loads:** Performance monitoring tools trigger an emergency optimization when they detect an ultra-high-load event. The automated processes move traffic to nearby cells/sites then verify that the problem was solved. The table shows how HKT has shrunk the full event closed loop time from over two hours to about 25 minutes (see Table below).

- **CPU resource load self-optimization** Ticket sales for popular artists such as Lady Gaga can cause dramatic traffic surges. HKT's platforms monitor the load data in near real time and automatically add/delete/move cloud-based computer processing unit (CPU) resources accordingly. Such changes used to take the CSP 2-3 hours; it can now do adjustments in five minutes.

OODA closed loop element	HKT task name	Baseline time	Improved time
Observe	Traffic monitoring	>30 minutes	<15 minutes
Orient	Problem detection	60 minutes	5 minutes
Decide	Decision making	30 minutes	3 minutes
Act	Implementation	10 minutes	3 minutes
	Total:	**2+ hours**	**~25 minutes**

Table 1: Ultra-high cell traffic load use case optimization showing time to resolution improvements

Looking ahead: human-assists-machine operations

HKT's 'to-be' solution features a move to a human-assists-machine model to create digital assets, grow a 'digital workforce,' and slowly allow the machines to be decision makers. It is building an AI engine to correlate trouble tickets to alarms and service impacts, for example, to replace its rules-based approach. Finally, it will expand to customers and ecosystem partners its use of APIs to access data and effect automation.

Starting in 2023, the company is prioritizing 'self-x' and 'zero-x' use cases enabled by continuous evolution of its people, processes, and platforms, and also by growing its AI/ML expertise to help drive automation.

HKT's Pang notes that it is "challenging" to find and train the right people. "Hiring AI and programming professionals is not too difficult, but they don't understand the telco use cases," he says. "Marrying our operations staff's telecom-specific expertise with DevOps skills will take time."

HKT also notes the challenges of running a hybrid traditional/digital operation as a transition solution: "We can't realize the full digital efficiencies until services are mostly managed by a digital workforce."

Finally, HKT plans to automate more complex business services, use TM Forum automation frameworks and audits to make financial value quantification easier for future automation projects, and develop its strategic ecosystem and transformation partnerships to meet its business goals.

IOH'S SERVICE-AND CUSTOMER-CENTRIC APPROACH UNDERPINS ITS AMBITION TO BE THE WORLD'S MOST INNOVATIVE DIGITAL SERVICE PROVIDER

Summary

Who: Indosat Ooredoo Hutchison (IOH)

What: Established an audited operations baseline and an initial three-year plan for its service-centric intelligent operations journey.

How: IOH worked with Huawei's Global Services organization to perform an operations maturity audit, implement an intelligent operations platform, and improve fault management automation processes and customer experience.

Results:

- Deployed a new generation intelligent operations and customer service architecture to provide the foundation for its digital transformation and operations automation journeys.
- Reported preliminary results for fault management automation use case implementation that include meeting or exceeding six automation KPIs related to the alarm-to-resolution process; reducing mean time to repair power-related network faults by 71%; and recording an 81.4% autodiagnosis success rate and a 67.6% autorecovery success rate. In addition, IOH improved site audit resource and time efficiency by 50% and 37%, respectively.
- Released a SuperAPP, codenamed GodamX, to provide visibility of network performance conditions and many customer experience indicator scores.

Newly created communications service provider Indosat Ooredoo Hutchison (IOH) had less than two years to consolidate its merged assets and begin offering service to its Indonesian customers. Its ambitious plan, however, was not merely to combine its assets: Its goal was to implement a digital transformation plan and make significant progress on the road to autonomous and service-centric operations and its vision to become the world's most innovative digital service provider.

IOH, was formed in January 2022 from the merged Indonesia-based telecom businesses of Indosat Ooredoo and Hutchison 3 Indonesia (H3I). Its first major business milestone was to meet its service commencement date, which required, among other tasks, combining physical sites and subscriber bases. IOH beat its target by six months to initiate service in July 2023. It is now the second largest CSP in Indonesia, with more than 70 million subscribers and 50 thousand sites.

The Indonesian concept of Gotong Royong, defined as mutual or shared assistance, is IOH's guiding philosophy and the fuel that powers its vision of implementing digital transformation to empower every Indonesian through communications and related digital services. Delivering on that goal requires IOH to automate and digitize its operations to improve customer experience and provide a solid foundation for offering innovative new services while also improving operations efficiency and lowering the cost of providing services. IOH's ambition, notes SVP of Network Operations, Agus Sulistio, is to "become the best digital service provider (DSP) and provide the best customer experience, first in our region then more globally." IOH's first step was establishing an objective baseline. Once that starting point was accepted within the organization, the CSP shaped business goals to drive its digital transformation.

Establishing an operations baseline and improvement plan

IOH's first step was a realistic assessment of its operations maturity. IOH worked in close partnership with Huawei, its main strategic partner and managed service provider, to establish its operations baseline using the TM Forum's autonomous operations maturity model (AOMM, see GB1042). IOH could then identify gaps and create a plan to allow it to reach an autonomous networks maturity level of 2.0 by the end of 2023 and put it on the path to realizing its "best DSP" business ambition.

Its plan includes elements of people, process, and platform improvements:

- **People:** Improving human resources' competencies and strengthening corporate culture through various initiatives, including: organizational restructuring; training and mentoring opportunities; and systemizing communication between IOH and Huawei personnel.
- **Process:** Improving internal processes through refining function-to-function communication and governance; daily gap analysis and SLA-KPI tracking; and instituting regular regional visits.
- **Platform:** Implementation of Huawei's digital Operation Web Services (OWS) platform, a low-code development, microservices- and API-based software platform for open and real-time network management; improving the coupling of its AUTIN and SmartCare implementations (Huawei's intelligent operations and SOC solutions, respectively); implementing a central data repository to enable analytics for alarm compression/correlation, quick problem identification, root cause analysis to automate trouble ticket and work order operations; and monitoring network usage in real time.

IOH's intelligent operations improvement plan is ongoing. "Digital transformation is a journey, not a destination," explains Sulistio. The CSP asserts it is focused on building a work culture that embraces automation, not fears it, to better serve customers.

IOH's data platform is the foundation of its digital and operations transformations

Operations improvements are a boardroom priority for IOH. "Shareholders always ask how we can improve our NOC administration and head toward zero touch operations," remarks Sulistio. A strong data foundation is fundamental to its intelligent operations and digital transformation journey; it underpins its whole analytics and automation strategy. Working with Huawei IOH has identified a few critical initial use cases, including fault management and configuration management automation. It has also used its new data foundation to implement its CXO mobile dashboard, which enables senior management to visualize and track network conditions, customer experience indicator scores, top application performance, and other key service performance data.

NOC tickets are properly integrated and correlated across multiple network domains, thanks to the single data source. For example, if there is a transport issue IOH knows exactly how many BTS are affected.

Preliminary benefits of IOH's improved operations

IOH worked with Huawei to implement two initial use cases using OWS, AUTIN, SmartCare, and managed services.

Figure 1: Benefits of IOH's improved operations approach

Figure 1 shows improvements across four areas of its operations related to implementation of new fault management automation applications.

Looking ahead: Putting the customer first with service-centric operations

IOH's next step in service-centric operations is establishing a four-step "Transformation Journey Towards The North Star" (see Figure 2): Foundation Readiness, Automation, Intelligent Operations, and Self-Healing Capability. The key objectives are to have a 'seamless link' between its SOC and its NOC, including between its customer and resource trouble ticketing processes, and between its customer experience indicators and its network/technology KPIs. These links are effected by the adoption of machine learning and artificial intelligence.

IOH's ambition, stresses Sulistio, is to be able to "in almost near real time, tell the customer what the situation is before the customer notices they have a problem. We want to move customer service from 'ok, we will give you the ticket and get back to you' to be really proactive." The CSP and Huawei are working to enable automated event and incident correlation end-to-end at the service level. In addition, IOH has plans to improve ticket-clearing automation and to build a knowledge system that is used to help identify the conditions that create network and service problems and prevent them from recurring.

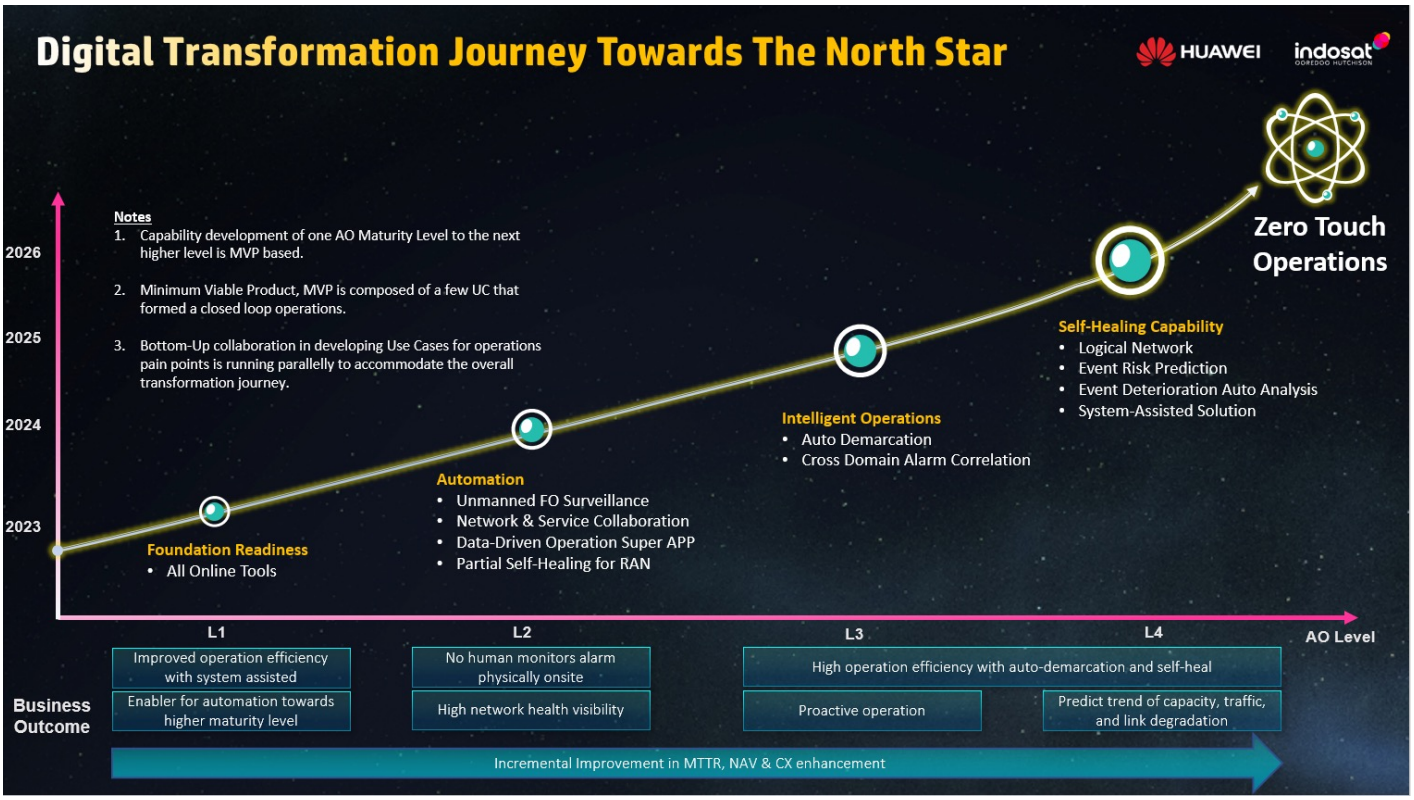


Figure 2: IOH's digital transformation journey

As IOH continues on its digital transformation and intelligent operations journey, it plans to relentlessly link its technology and internal productivity improvement strategies to its corporate business financial performance improvements. It has built a roadmap with Huawei to take it through 2026. When people are asked "who is the best, most innovative digital service provider (DSP)?" IOH wants to be the answer. It wants to be the telecom benchmark for digital technology. This will require continuous operations improvement, deepening its 'digital culture' through hiring and training, and "democratizing" its data so that personnel in its various departments can develop and scale their own applications to support CE improvements.

Tools and technology aren't enough, notes Sulistio: "You need to have a full vision so you can sustain your tools and technology ecosystem not just for one to two years, but well into the future. To keep improving you need to train your people and keep them trained. People will drive the AI/ML; they will define the logic and implement the digitization strategy. We will not stop until we are the acknowledged DSP leader."

MTN DEPLOYS CENTRALIZED AND STANDARDIZED OPERATIONS TO ENABLE AMBITION 2025

Summary

Who: MTN Group

What: MTN Ambition 2025 is backed by MTN's PACE new Group technology strategy. PACE (platform, agile, connectivity, and experience) is anchored in building the largest and most valuable platform business in 17 OpCos and has a clear focus on Africa, Achieving the goals of Ambition 2025, says MTN, will require scaling connectivity and infrastructure, making use of both mobile and fixed access networks across the consumer, enterprise, and wholesale segments. The implementation of this growth strategy will be accelerated through selective partnerships and by leveraging the MTN brand, which the operator claims is the most trusted and valued in Africa. "This strategy will be operationalized with vital strategic enablers, guaranteed network service readiness, and high operational service efficiencies for MTN customer delight," says Mohamed Salah, Head of Network Operations & Transformation at MTN Group

How: MTN focuses on investments in Autonomous Networks (AN) to automate network and service operations, achieve real-time network visibility, and improve MTN customer experience with smart business services. In 2021, an Automation Framework initiative was established, leading to the development of the Automation Framework Blueprint 1.0 and an agile DevOps operational environment. This framework improves network performance and can be used to implement innovative high-value use cases which are in line with MTN's Ambition 2025 strategy. In 2022, MTN released the Automation Framework Blueprint 2.0 with an enhanced target architecture, five commercial use cases, and nine completed use cases for proof-of-concepts. It also successfully aligned all of its OpCos on the AN strategy, Autonomous Networks Level (ANL) – defined by TM Forum IG1252 standard definitions and evaluation methodology – and effectiveness metrics to measure the business values.

In 2023, MTN plans to put the AN framework in practice, focusing on five key scenarios: One-Stop Cloud Service; Transport for 5G Readiness; AI for Smart Operation; Premium Home Broadband Experience; and F5G Autonomous Networks Standardization. It also plans to deploy a solution covering optical premium private line, artificial intelligence AI-driven network assurance, congestion-free network, cell outage analysis, intelligent battery backup, and 4G/5G user migration and development. Huawei's Digital QuickODN (DQ ODN), which helps operators simplify optical distribution network (ODN) installation and improve O&M efficiency, is also on the MTN roadmap.

By 2025, MTN is planning to centralize all local network operations centers (NOCs) to one global centralized NOC along with digital operational support systems (OSS) deployment across all network domains in order to standardize and accelerate the implementation of AI targets and different use cases across all OpCos.

Results:

- 'Portable NOC' field productivity tool reduced MTN Nigeria fault trouble ticket mean-time-to-repair (MTTR) by 30% (2018-2022)
- MTN Nigeria network reliability is now over 99%, the best in the country (2022), up from 95.77% in 2016
- MTN Nigeria mobile site outage MTTR declined 46% (2018-2022)
- MTN Nigeria handles most Level 0 incidents (those requiring the most basic assistance) automatically; 95% of NOC staff moved to Level 1 (more complex) support

MTN Group is implementing Ambition 2025 to position for long-term growth in the digital economy. This strategy is geared towards enlarging both its telecoms business (fixed, mobile, home broadband) and increasing momentum for its various 'platform' businesses: FinTech, including mobile money; 'digital,' including messaging; enterprise; network-as-a-service; and API Marketplace. Many of its markets feature significant room to grow revenues due to very young and growing populations, low saturation for broadband and banking, and leading share positions in markets such as Nigeria. Improving efficiency across diverse markets is a key driver for operations transformation.

MTN's operations support platform consolidation and centralization process predates Ambition 2025 and PACE, starting about seven years ago through rollout of a single charging system to be used across OpCos. It has continued this effort by centralizing and standardizing platforms for big data management, customer relationship management (CRM), application programming interface (API) management, and service management. It is now implementing a centralized digital OSS platform backed by a centralized NOC.

These standardization and centralization efforts are designed to enhance resource efficiency (capex, opex, personnel, managed services partnerships) and to simplify realization of its growing operations automation efforts across its footprint. Sharing new technologies, platforms, and processes across opcos will let smaller, less resource-rich markets such as Sudan reap benefits that historically have been enjoyed only in its larger markets such as Nigeria. (Nigeria provided 46% of Group EBITDA and 29% of active data subscribers in FY2022.) MTN Group uses many strategic partners to help guide its journey to intelligent automated operations. Huawei is the Group's chief managed services partner in Nigeria.

Per-OpCo baselines, goals, and measurements underpin transformation plans

MTN's various operations have been fairly siloed and fragmented, using different operations systems and approaches in each market. The larger markets, for example, have implemented both NOCs and service operations centers (SOCs), while the less-developed markets do not have SOCs. Moreover, each OpCo tends to have distinct managed services environments and different network equipment vendors. At Group level, MTN has developed a more deliberate, stepwise approach that considers such factors as local budgets, managed services contract timelines, and personnel availability and expertise.

MTN started its Ambition 2025 operations transformation with a rigorous assessment of its 'as-is' state with the help of Huawei using TM Forum maturity assessment tools such as the Autonomous Operations Maturity Model (AOMM). Through its assessments, MTN identified gaps in current operations and confirmed that its larger, more developed markets, such as Ghana, Nigeria, and South Africa were averaging about ANL 1.5. Smaller, less-mature markets were assessed at lower ANLs. As such, MTN's opcos will move at different paces toward autonomous networks and service-centric operations given different starting points and specific market conditions.

With baselines in place, MTN has set transformation goals and metrics for each of its OpCos. It measures progress to each OpCo's goals every three to six months, and then sets new goals as appropriate.

Since data are the foundation of MTN's automation plans, reassessment of its centralized data lake, which was created for IT-oriented data, was one of the first steps taken towards the transition solution. The Group is deliberating on whether this platform can be expanded to include network operations data, or whether it should be replaced.

The implementation of a centralized digital OSS supported by a new digital NOC (again, centralized) is MTN's biggest upcoming automated operations transformation project. It plans to award the project to a single strategic partner that can provide both the digital OSS and NOC support through a 2023 request for proposal (RFP). Once these platforms and organizations are in place MTN will move Level 0 and Level 1 technical support from local to centralized organizations. Then MTN will develop a detailed plan that phases in the centralization of processes, services, and local operations and minimizes customer exposure to poor or degraded experience.

Because not all Group opcos have SOCs or an operations focus beyond incident-level processes, a move to service-centric operations and more extensive closed loop automation are future goals. Nigeria and its other more advanced markets will continue to act as testing grounds through the TM Forum Catalyst Program and other proofs of concept (PoCs) with strategic partners. These PoCs, says MTN, can become blueprints that are adopted and adapted by all opcos.

Preliminary benefits of MTN's operations transformation

The work MTN and its partners have done together to improve operations outcomes has realized tangible benefits for MTN Nigeria in shorter MTTR and improved KPIs (see Table 1).

Key performance indicator (KPI) KPI	Result Note: improvements are 2018-2022*; other results are 2022
Mobile network site outage MTTR improvement	46%*
Incident management alarm compression	96%
Incident management automatic trouble ticketing	>99%
Incident management automatic trouble ticketing closure	>99%
Incident management MTTR improvement	35%*
NOC transformation of level 0 to level 1 support	95%
Improved fault handling MTTR from providing field maintenance engineers with a 'portable NOC' mobile digital productivity tool	30%*

Table 1: Reported operations KPI improvements for MTN Nigeria

Looking ahead: Establish new use cases, models, plans, and milestones

The digital OSS and related NOC are critical to MTN's plans to have all OpCos read from a standardized playbook. MTN;s Salah says "driving all our opcos at different [operations maturity] levels to ANL 4 [highly automated networks] is a nightmare, given budgets and so on. We need to have a strong platform and regional NOC supplier. Then we can establish the use cases, the plan, and the milestones to get from where we are to ANL 4 across all opcos."

The consolidated data platform will drive the desired automation. For example, MTN wants to build machine learning AI models centrally, then train them locally based on market conditions. Centralized operations support platforms will also let MTN standardize on specific open APIs rather than have variations proliferate. Priority automation use cases enabled by the new operations assets include fault, performance, and configuration management. Processes will be managed at the incident level; event-level automation will come later. MTN will also tackle automated service management after it automates the basic processes. Personnel hiring and retraining are a priority for MTN's transformation; strategic partners will assist through build-operate-transfer managed services contracts.

STC EVOLVES INTELLIGENT OPERATIONS TO PURSUE "DIGITAL GLOBAL LEADER" AMBITION AND SUPPORT SAUDIA ARABIA'S VISION 2030

Summary

Who: Saudi Telecommunication Company (STC)

What: Use managed services partners to support day-to-day network operations so STC can focus its resources on DARE 2.0, the operator's strategy to enhance customer experience through implementation of a digital services capability overlay.

How: Incrementally move the organization and its operations to a service- and customer-centric process approach through upgrades to people, processes, platforms, and technology.

Results (mobile network operations):
- 96% automatic alarm compression.
- 99% of trouble tickets automatically created, 95% automatically closed.
- 95% of work orders automatically created, 98% intelligently dispatched.

Saudi Telecommunication Company (STC) has been engaged on a digital transformation journey since 2018 when it launched DARE (digitization, accelerate performance, reinvent experience, expand scale and scope). DARE 2.0 is the latest iteration, unveiled in 2020, which is focused on improving customer experience. DARE/DARE 2.0 is aligned with goals laid out by Saudi Arabia's overarching Vision 2030. As such, STC's own operations goals include "making operational processes more intelligent and enhancing customer experience to enable society and the economy to thrive in the Kingdom of Saudi Arabia and beyond" and underpin the communications service provider's (CSP) broader corporate vision. STC has various plans and contingencies in place to mitigate DARE/DARE 2.0 risks. These include investing in young talent and the latest technologies, such as artificial intelligence (AI), and leveraging managed services providers and other strategic partners.

STC has moved its 'as-is' operations approach from "technology-oriented" to service-oriented. The final stage will be 'service-centric'. As part of this ongoing transformation, STC, in response to TM Forum questions, says it has "integrated NOC [network operations center] and SOC [service operations center] functions, optimized collaboration and automation, and measured digitization maturity using TM Forum's AOMM [autonomous operations maturity matrix] and digital value KPIs [key performance indicators]"." The CSP aspires to increase its use of AI and automation to implement autonomous network principles and run proactive, predictive operations. The key driver transformation is to enhance customer experience.

Service-oriented operations underpins "digital global leader" ambition

STC's AOMM audit confirmed its hypothesis that its average operations autonomous networks level (ANL) is within level 1 (assisted management) and it is approaching ANL 2 (partial autonomous network). STC's efforts to interconnect and automate operations have focused on three areas: network performance and optimization; network operations; and service operations. This gives the CSP an "end-to-end, 360-degree view" of a service, with the ability to correlate whatever might affect it, according to Mohammed Alzaaidi, STC's GM of Network Operations. The CSP has plans in place to move itself into the top quarter of AN maturity among its peers.

The CSP believes it has already moved beyond service-oriented to "customer-oriented" because its operations are integrated all the way from the network subflows to the customer complaint subflow. STC's time to repair (TTR) and KPIs, for example, are tracked at the customer level, not at some aggregated mean-time-to-repair (MTTR) level.

Mobile operations area	KPI
Alarms	96% of alarms automatically compressed
Trouble tickets	99% automatically created 95% automatically closed 2.5% fully zero touch
Work orders	95% automatically created 98% intelligently dispatched to field engineer
Use cases	29 processes fully digital (using robotic process automation, or RPA) 16 operations scenarios auto diagnosed

Table 1: STC automation successes in the mobile domain

STC's initial transformation has been enabled by cloud, AI, and big data technology. For example, STC Group has had a central data lake containing all its OpCo operations data for seven years. It has more recently coupled the data lake to an AI engine that allows the data to be securely accessible to all who need access. The CSP also reports implementation of AI-based use cases such as those that allow it to rapidly detect mass faults (such as those related to fiber incidents) that are associated with a single root cause that could trigger many customer complaints. When such a use case is triggered, customer complaints will automatically generate both proactive and interactive voice messages to the customer acknowledging the cause and notifying them when the trouble is fixed. It has strict escalation and notification processes that span its many vendors. In addition, service degradations will trigger processes to quickly reestablish service.

Priority services that STC is automating and striving to make fully autonomous include mobile roaming. STC sees enormous fluctuations in international visitors due to global events such as the Hajj, a pilgrimage to Mecca by Muslims, when international traffic can jump 990% compared to a normal day's peak traffic. STC uses closed-loop cognitive tools to manage capacity during such events, which detect faults or capacity issues and automatically compensate through cell and related network management, regardless of which vendor's equipment is involved.

The CSP's operations transition plan rests on STC strengthening network operations foundation; strengthening and integrating its digital ecosystem, which includes managed service providers; extending its ability to invoke closed-loop automation; and increasing the number of telecom services it can manage automatically. STC's business goal is growing its digital services offerings.

Benefits to mobile services include improved alarm, trouble ticket, and work order KPIs
STC has advanced automation in the mobile domain. The table below includes some KPI improvement driven by its automation successes.

Looking ahead: Striving towards autonomous operations
With a strong foundation in place, STC's focus will be fixed mobile convergence (FMC) operations automation and implementing DevOps as it strives to achieve ANL 5 (full autonomous networking) by 2025 or beyond.
STC's top operations goals are "exceptional customer experience, optimized operations, and high efficiency through automation and AI." Some automation operations capabilities the CSP plans to implement in the next several years include:

- Precise predictive operations and maintenance
- Deterministic, automated SLA management
- AI/ML-driven decision-making processes within service operations
- End-to-end digital closed-loop and one-hop repair through a digital network operations center (NOC)

Talent acquisition, training, and development are critical enablers of STC's operations automation plans. It has developed a 'SEED' program (Skill Enhancement Employee Development methodology) to support its personnel needs.

Appendices

7.

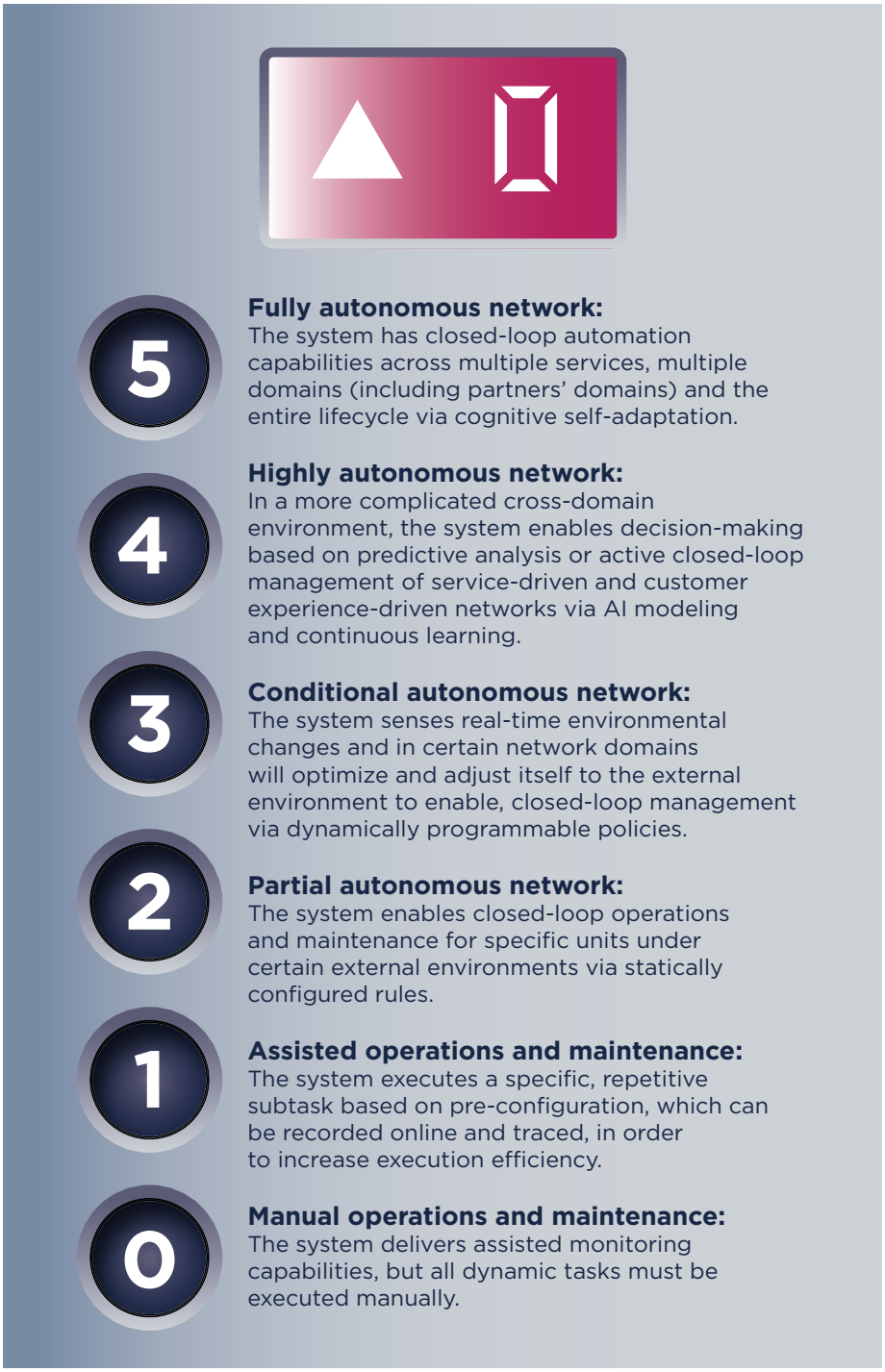
APPENDIX 1: SELECTED OPERATIONS AUTOMATION CATALYSTS (2023)

There are at least a dozen Catalysts underway in 2023 that aim to move aspects of service-centric and autonomous operations forward through industry collaboration. The table below provides capsule summaries of the Catalysts most relevant to the concepts discussed in this white paper. The reader is urged to learn more about the Catalysts at Digital Transformation World in Copenhagen in September 2023 or through the TM Forum website.

Reference #	Title	CSP champions	Key goals
C23.0.591	Intelligence and value driven digital operation transformation for network	HKT, STC, XL Axiata	• Showcases how AI can correlate and analyze cross-domain data to assess service quality impacts in changing network environments and implement "self-x" operations. • Additionally, puts TM Forum's VOF (IG1269 and IG1292) and the RISE values (revenue, Innovation, customer satisfaction, and operations efficiency) into practice.
C23.0.542	AN empowers distinctive experience for cognitive transformation	China Unicom, MTN South Africa, Telkomsel, Zain	This Catalyst tests ANL 3 and ANL 4 value scenarios across network (wireless, IP, transmission, and core) and service domains. It uses industry standards to achieve self-x and zero-x visions in the context of improving operations efficiency, user experience, and service agility. Finally, it seeks to feedback to TM Forum's AN Project improvements in ANL definitions and assessment methods and standards.
C23.0.537	AI and knowledge driven 5G operations	China Telecom, China Unicom	The goals of this 5G-focused project are to: • Use AI to analyze root cause, determine responses using a decision knowledge base, and send the requested action to the NMS for implementation • Implement an intent-driven approach to service assurance • Realize autonomous closed-loop 5G network operation
C23.0.573	Evaluation of autonomous network service experience for the cloud network	China Unicom	Test CSPs' ability to provide cloud network leased line services to meet distinct requirements of customers in different vertical industries as the CSPs evolve to ANL 3 and 4. Customers should perceive the desired SLA regardless of the CSP providing the service. The Catalyst also aims to facilitate future evolution to ANL 5 and intent-driven operations using intent APIs.
C23.0.582	Experience guaranteed connectivity	BT Group, Verizon	Demonstrate how service quality can be validated and certified through on-demand service simulation and automated active assurance, both presales and throughout order activation and delivery so that CSPs can differentiate services based on QoE, properly monetize QoS, and meet SLAs.
C23.0.549	Revolutionizing service assurance through AI powered, intent-based systems for continuity and customer satisfaction	TIM, Telia	Demonstrate how AI/ML can improve service assurance for telco cloud CaaS and CNFs. AI/ML will provide the data and decision framework to allow event correlation, RCA, and problem resolution. The Catalyst will develop a prototype system and recommendations for how it might be improved with further work.

Reference #	Title	CSP champions	Key goals
C23.0.597	Talent for tomorrow - Phase II	China Telecom, China Unicom	This Catalyst creates a low-code platform to help train and upskill personnel to operate autonomous networks. The three aspects of the platform are: A role-based upskilling program for training and skills development; a low-code/no-code platform through which personnel can develop and deploy applications; and a knowledge repository for capturing, sharing, and managing operations expertise.
C23.0.467	Intent-driven closed-loop autonomous services towards next-generation networks	China Telecom, China Unicom, SLT Mobitel	Implements intent-driven closed-loop autonomous networks to support SLAs based on changing customer requirements and under different business scenarios, such as end-to-end slicing and cloud leased lines.
C23.0.594	Unlocking revenue and efficiency with intent-driven autonomous operations - Phase III	KDDI, Orange, Telus, Verizon	Demonstrate how TM Forum Open API 921 can be used to autonomously translate vertical customers' requirements into business intent to drive zero-touch offers, pricing, and SLAs. The Catalyst uses AIOps to reduce the friction of B2B partnerships and streamline operations.
C23.0.563	Intent-driven autonomous networks - Phase III	AIS, China Mobile, China Unicom, Sparkle, TIM, Telenor	Phase III of this project aims to dig deeper into the use of intent APIs (TMF921) to understand customer service expectations and improve business outcomes. The goal of the project is to enable CSPs to implement intent APIs to improve their businesses.
C23.0.530	Digital Twin for network operations - Phase II	China Mobile, STC, Sparkle, Vodafone	Explore how digital twin technology can improve 5G network robustness, improve operations simplicity and efficiency (through RCA and knowledge generation), enhance customer experience, and find and verify possible new business opportunities.
C23.0.511	Techco practicing decision intelligence for sustainable growth	China Mobile, China Unicom, HKT, Maxis, MTN, Robi Axiata, STC	Demonstrate the use of data to drive operations processes and decision intelligence to generate business value, achieve sustainable growth, better support business customers.

APPENDIX 2: TM FORUM AUTONOMOUS NETWORK LEVELS



TM Forum, 2023