

# **HUAWEI Intelligent Operations Solution**

White Paper



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### Trends and Challenges in Network Operations

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# Trends and Challenges in Network Operations

# 1.1 Market trends for network operations

The market and technology have driven the evolution of telecommunication industry, bringing disruptive changes and new requirements to communication networks.

More diversified business ↓ more flexible and efficient operations	new business products and services based on new technology are continually launched (IoT, HD video, video calls, VoLTE, vertical business services, cloud services, etc.), requiring new operations systems and processes. The implementation time for these new products and services needs to meet the demands of their expected lifecycle. As one of the key business enablers, network operations must have better flexibility and efficiency so they adapt to the requirements of future business changes while being more robust in ensuring network quality and performance.
Greater cost pressure ↓ more cost-effective operations and maintenance	in the 5G era, operators are investing heavily in building infrastructure. Accompanied by the growth of CAPEX, OPEX increased dramatically (more than 20% in five years), while the operators' current revenue growth rate is less than 1% worldwide. Considering that OPEX accounts for 74% <sup>1</sup> of operators' revenue, current revenue growth has been unable to support the rising cost pressure. In the future, reducing operations cost will become one of the key drivers for the transformation.
More stable network ↓ tighter focus on customer experience	a more stable network environment along with more customized, differentiated, and high-quality operations services will be key factors for improving customer experience and customer loyalty.
More complex network environment ↓ more intelligent operations and maintenance	in the past three years, the number of global physical stations has increased from 4 million to 6 million; meanwhile, the number of logical stations has expanded from 7.8 million to 15 million <sup>2</sup> , and the frequency spectrum has increased from three main frequency bands to more than ten, resulting in large-scale simultaneous usage of heterogeneous networks (LTE, UMTS, WLAN).



Global business trends and revenue growth curves of operators

Figure 1: Global business trends of operators

Complex network environments bring a higher frequency of faults and significantly increase their complexity and resolution difficulty. Network maintenance requires not only efficiency and optimized cost of operations, but also new and more intelligent (i.e. AI-driven) operating models to support the complex and heterogeneous telecommunication services of the future.



The development trend of telecommunication networks determines the need to design and deploy new network operating models supporting future business expectations, while current network operations are still too reactive, slow, and not agile enough to face the new expectations listed above. There is a significant gap between the current, outdated operating model and the expectations raised by the digital business and demanding end users.

The below figure shows how the major trends in the telecom industry affect the demands on network operations and how the new demand confronts the current situation, resulting in the following challenges.

Figure 2: The development trend of telecommunication network brings challenges to network operations and maintenance



# **Challenges brought by diversified business**

Advanced network technology enables a plentiful spectrum of services covering all aspects of human life. At the same time, with the rapid development of innovative business, the industry's requirements for the launch of new products and services have changed from months to days.

Below, we show an overview of current business development trends.



Figure 3: Panorama of current business trend

**Current operations and maintenance status:** more than 60%<sup>3</sup> of operators in the world are maintaining multiple isolated OSS systems. Business data and systems supporting mobile networks, fixed networks, and broadband are not fully integrated yet, resulting in poor resource efficiency, incomplete end-to-end operations capabilities, slow processes, and a high cost for new requirements customization. Siloed applications restrain agile and flexible operations. At present, 90%<sup>3</sup> of the working time of operations personnel is spent on fault location, and that leads to low operational efficiency.

The architecture of traditional network operations and maintenance systems is shown below.



Figure 4: Architecture of traditional network operations and maintenance mode

**Challenges that network operations and maintenance may face:** in the context of business diversification, the lack of necessary flexibility in complex interfaces will lead to a longer operations service lifecycle, resulting in a longer timeline for the launch of new products and services, higher operational costs, and difficulty in effectively supporting business development.

## Challenges brought by cost pressure

In the past decade, the OPEX share in operators' revenue has increased from 64% to 74%<sup>4</sup>, with an average annual growth rate of 1%. Global operators have entered a period of slow revenue growth, with annual CAGR less than 0.5%, and negative profit growth. It can be predicted that with the further expansion of the number of global stations and frequency bands, operators will face greater OPEX pressure.





**Current state of operations and maintenance:** many operational activities of existing networks still heavily rely on human interventions. Daily operations and maintenance costs account for more than 70% of the total OPEX cost. The degree of automation is generally low. For example, the integration between different procedures are handled manually.

Because of more complex network environments and the exponential growth of network elements and devices in the future, there may be several network slices. Network slices are completely separated and independent layers designed to not affect other slices if something goes wrong in one of them. This separation and independence also enables adding new slices without impacting the rest of the network. Each network slice will have a specific topology structure and will need to manage a huge amount of equipment information.

The current operating model, which highly relies on human interventions, will generate more manual operations in the future, and further increase the operational costs.

## **b** Challenges with customer experience management

At present, customer behavior has significantly changed. Customers' loyalty to operators has lowered, and their overall satisfaction in the telecom industry is only 11% on average, at the bottom of the ranking in the NPS (net promoter score) survey<sup>5</sup> of 15 industries and half that of the insurance industry. This will have negative effects on maintaining long-term stable customer relationships and on creating value. Today, the competition for telecom operators crosses industry boundaries. 54% of telecom executives believe that their future strongest competitors will come from other industries.

Under the pressure of increasing market competition and higher customer-acquisition cost, operators need to seriously focus on customer experience and provide better services.

Influencing factors	Consideration	Evaluation	Purchase
Overall experience	31	51	69
Advertisement	30	18	5
Public praise	22	13	9
Network quality	27	30	27
Direct marketing	8	8	8

Factors influencing broadband network subscription

Figure 7: Factors influencing broadband network subscription

160%	When choosing wireless network services, they have
10%0	specific requirements for operators' brands

- **45%** Willing to try new network services provided by digital subversives
- **49%** Think the new network service will be better than the old one

**70%** Priority will be given to service providers that can provide fixed network, wireless and other forms of switching

Figure 8: Behavior statistics of user changing operators



### Current state of operations

customer experience management is still mainly reactive. 75%<sup>6</sup> of network problems are discovered and raised by customers. 60%<sup>7</sup> of telco carriers' operations lack full automation capacity and closed-loop operations processes for rapid problem solving. Faults can be very difficult to detect and prevent in advance, and customer experience and satisfaction are difficult to guarantee.

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### Challenges network operations may face

with the continuous increase of network scale and data volume, the frequency of failures will be higher. The current operations struggle to meet users' demands for network quality and performance, and the current fierce market competition leads to potential loss of customers.

# >> Challenges brought by more complex network environment

In the past three years, the number of physical stations has increased from 4 million to 6 million globally, meanwhile the number of logical stations has expanded from 7.8 million to 15 million, and the frequency spectrum has increased from 3 main frequency bands to more than 10.<sup>8</sup> Under the existing EPC (Evolved Packet Core) network, and with the continual network development, the complexity of the network elements and their functions has gradually increased together with the number of the interfaces: from 2G and 3G to the 4G network, whenever a new network element is added, the interface of the network element and its compatibility with the existing network need to be managed.

The introduction of new network elements and interfaces may affect many other existing network elements, with further impacts on the end-to-end network maintenance costs.

### Current operations and maintenance status

37%<sup>9</sup> of the failures are caused by network changes that increase complexity, and the current operating models heavily relying on human intervention and individual skills struggle to effectively handle the volume of problems. The demands of network management has exceeded people's knowledge and ability.

### The challenges that network operations and maintenance may face

in the future, the number of interfaces will increase by 120%, and the number of nodes will grow more than 20 times.<sup>10</sup> Fault frequency will also increase exponentially. With this perspective, the current traditional operating models relying on human experience and knowledge will become inadequate to manage incidents, meet the demand, and ensure the expected customer experience.

# 1.3 The urgency of operations and maintenance transformation

Due to the diversification of network services and the plethora of application scenarios in the era of 5G, telecom operators are accelerating the deployment of network infrastructure to meet the demands of business development. Therefore, the number of connections, network elements, paths, and business partners will obviously increase. With the increasing network-environment complexity, the number of faults, complaints, service requests, network changes, and demands managed by operators will increase exponentially. The relationship between the two parts can be expressed by formula  $f_1$ :

Service demand =  $f_1$  (network complexity), where  $f_1$  fits the exponential function

- Network complexity = {number of connections, number of network elements, number of paths, number of B2B parties}
- Service demand = {number of faults, number of complaints, number of service requests, number of network changes}

Consequently, the number of operational staff, overall time spent on addressing problems and new demands, and the quantity and probability of human errors will be amplified. The relationship between these two parts can be reflected by formula  $f_2$ .

O & M manageability =  $f_2$  (service demand) =  $f_2$  ( $f_1$  (network complexity))

- Network complexity = {number of connections, number of network elements, number of paths, number of B2B parties}
- Service demand = {number of faults, number of complaints, number of service requests, number of network changes}

perations and maintenance manageability = {number of operations and maintenance staff, closed-loop processing time, number of human errors}



According to industry forecasts, the development trend of operations will gradually change from reactive and proactive management of network infrastructure to predictive and preventive management of customer experience. Self-service modes for customers will be provided through highly automated services.





Capacities of operations and maintenance

Although network environments tend to be increasingly complex and diverse, through the customer-oriented and predictive/defensive intelligent operating model driven by AI, the processing time of network faults and the cost of operations, as well as human errors, can be effectively controlled.



The deployment of AI in operations within the telecom industry is still at the initial stage of development.

Since the concept of industry 4.0 was introduced in 2011<sup>11</sup>, industrial giants in the manufacturing industry, such as Siemens and GE, have been gradually using AI to predict risks in the production process, reduce material waste and energy consumption, and improve overall production efficiency.

In the medical industry, intelligent health care has been able to collect data including step counts, blood glucose levels, heart rate, lifestyle and habits, and sleep quality through aggregation and processing to achieve monitoring, diagnosis, treatment, and other purposes.

In the media industry, AI programs can automatically write news, therefore not only the improving the timeliness of news but also reducing journalists' workload.

In the transportation field, the use of AI technology can analyze urban traffic flow in real time, adjust the interval between traffic lights, shorten the waiting time of vehicles, and improve the traffic efficiency of urban roads.

According to Goldman Sachs<sup>12</sup> research (shown in the figure below), operational costs of the telecom industry are higher than traditional industries like automobile and construction, and most of the manual activities could be easily automated by exploiting AI's long-term potential.



Source: Digital Divergence, How European Telcos can cut costs with automation, AI and big data, Goldman Sachs Figure 14: Proportion of labor cost in various industries

Telecom operators are keen to design and adopt new operating models in order to meet the operational needs of the current physical networks and the future hybrid and virtual networks. Indeed, nearly 90%<sup>13</sup> of the current operators have started or are getting ready to start operations-transformation projects. According to Gartner, intelligent operations and maintenance platforms will become the mainstream in the next five years. By 2022, 40%<sup>14</sup> of large- and medium-sized enterprises will deploy intelligent operations platforms, significantly reducing operational costs while ensuring more stable, efficient, and safe operations of their business systems. At the same time, many leading operators are taking effective measures in multiple directions to carry out operations transformation in order to meet the current business development demands.

Reduce OPEX: in the past five years, OPEX expenditure of global operators has increased by 20%<sup>15</sup>.



Orange announced in their investors' conference at the end of 2017<sup>16</sup> that, in the future, it will promote the network automation strategy and save network OPEX with the help of big data and AI capabilities in order to reduce repetitive work, energy cost, rental cost, and idle time.

China Unicom uses automation as well as other technologies to improve the execution speed of network operations and adopts the full set of automatic collection-analysis-execution, resulting in a 19% improvement of operations efficiency in the analysis process.



China Mobile uses PON (Passive Optical Network), for fault location and prediction as well as remote fault demarcation, location, and root cause analysis, so that the frequency of on-site visits is greatly reduced while the early warning and prediction accuracy of optical device and path degradation is significantly improved.

Improve user experience: currently, many telecom organizations have begun to invest in AI, big data analysis, robotic process automation (RPA), and other technologies to achieve fault "self-healing" and active maintenance.

Vodafone applies AI to network operations to predict network problems and preprocess them in order to reduce fault risk.

AT&T developed and launched the UNI (UAV Network Inspection) system. UAVs were introduced into the operations support systems to realize intelligent inspection of the towers so that they can conduct real-time monitoring and reduce faults.

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Promote the transformation of operations and maintenance: a new wave of transformation of the telecommunication industry is on the rise, and many operators have launched digital and intelligent transformation programs in the field of network operations, reengineering traditional organizations, processes, and platforms.	and an and a second sec
China Telecom has carried out an "intelligent development & transformation upgrading" plan to deploy SDN + NFV + Cloud to redesign the network operating model.	
SK Telecom is deploying the TANGO platform, which runs as an independent OSS platform with a central intelligent platform, performing data collection, real-time analysis, decision-making, control functions, and intelligent troubleshooting.	

At present, the leading enterprises in the market are transforming their network operations in many dimensions. Operators should embrace the current market trends, accelerate their transformation, increase operations efficiency, improve customer experience, and realize their business development plans.



The key challenges mentioned above cannot be addressed by using traditional operating models.

AI, combined with and empowered by advanced analytics, big data and virtualized computing power, will drive the automation and enhancement of network operations, enabling new operating models.

In July 2019, Gartner released a new technology maturity curve. At the peak of the curve, 12 technologies related to AI, such as AI PAAS, Auto ML (automatic machine learning), and others, have created high expectations about the adoption of AI. AI can handle massive data more effectively, select the relevant information more precisely, provide decision support, and automate human tasks.

Below is the technology maturity curve issued by Gartner in 2019, showing that AI technology is on the peak of inflated expectations, and, especially, that edge AI is about to be mature within 5 years.

Figure 15: 2019 new technology maturity curve from Gartner



### Gartner Hype Cycle for Emerging Technologies, 2019

○ less than 2 years ● 2 to 5 years ● 5 to 10 years ○ more than 10 years ● obsolete before plateau As of August 2019

Omdia/Tractica a global leader in emerging technology market research, has conducted a research on nearly 300 real AI use cases in 30 fields and found that the telecom industry is particularly active in AI technology, being the largest potential AI market segment in the future. According to Omdia/Tractica's forecast, by 2025, the telecom industry will invest 36.7 billion US dollars globally in AI software, hardware, and services. The AI software market for the telecom industry will grow from \$419 million in 2018 to \$11.3 billion in 2025. It is expected that by 2025, telecom operators will heavily use AI for network operations, maintenance, monitoring, and management, which will account for 61% of AI expenditure in the telecom industry, as shown in Figure 16.



Source: Omdia/Tractica "Global AI revenue forecast 2018–2025" Figure 16: AI revenue forecast of telecom industry from Tractica



Source: Omdia/Tractica "Global AI revenue forecast 2018–2025"

Figure 17: Global Telecom AI software revenue forecast by application scenario : 2018-2025

The gradual deployment of AI and big data technology will drastically increase the level of automation, improve service performance and quality, and reduce maintenance costs.



# 2.1 Requirements for the future operating model

In order to address the challenges described above, a new operating model for the network operations and maintenance processes and activities must be designed and built. This new operating model should include a new generation of operational capabilities enabling flexible business development, closed-loop automation, AI-driven processes, open platforms, and operational knowledge capitalization, as shown in the figure below.



Figure 18: Capability requirements of future operations and maintenance mode

# 2.2 The role of AI in telecom network operations and maintenance

Through the connection of knowledge, people and machines can work closely together. By exploring the unique advantages of artificial intelligence, we can solve problems and challenges that could not be fully addressed by traditional methods so far.

The main capabilities of AI technology are:

- AI software has learning ability. It can analyze new input data, learn from them, and strengthen the AI model through continuous learning. By mastering the AI/ML training process, the accuracy of the AI models can be continuously improved.
- 2 AI can handle and explore volumes of data and details where humans would hardly keep up with the pace.
- It is efficient. It can simulate human behavior to conduct repeatable work, improving production efficiency.

In the figure below, we classify network operations activities according to four main drivers:

Efficiency	Customer Experienc	Effectiveness	Innovation
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These are all key drivers for moving to intelligent operations.



Figure 19: Application of artificial intelligence in network operations and maintenance

Let's analyze the fault management process, which is one of the key processes to ensure normal network operations. In traditional operations, when network components fail, operation engineers handle the faults reactively according to their knowledge and experience and with the help of instructions summarized in knowledge management tools. Traditional fault management requires a lot of human experience and is consequently inefficient and expensive.

AI technology, combined with the experience of operations engineers, enables the set-up of intelligent and automatic monitoring and fault management systems.

The new AI-driven fault management systems collect real-time network management data and alarms, and perform data analysis, flexible filtering, classification, fault localization, and instant diagnosis on network faults with the support of well-trained AI algorithms. Fault location and root cause analysis then become more accurate, fast, and efficient.

Additionally, AI enables the prediction and prevention of faults, transforming this process from reactive to predictive and allowing network issues to be solved before end users notice anything. Continuous self-learning based on historical and new input data ensures a gradual and progressive improvement of the AI-driven fault management system's accuracy and reliability.

The picture below shows how AI is working in the fault management process in the intelligent operating model.



Figure 20: operations and maintenance mode of artificial intelligence in network fault management

### 2.3 Future model of network operations: "Human + Machine" Collaboration Model

As AI continues to mature and play an increasingly important role in operations, network operations management will be shifting from the traditional "person + process" model to the new "Human + Machine" Collaboration Model.

In the "Human + Machine" Collaboration Model, machines assist operations by applying AI and machine learning (ML) algorithms to large data sets collected by operations support tools and business systems, and simulating human thought processes and behavior, such as risk perception, pattern recognition, data analysis and interpretation, complex decision-making, and execution of elaborated tasks. The "Human + Machine" Collaboration Model provides operations management with AI and ML capabilities that free operational personnel from repetitive and routine tasks that machines can do even better than humans.

Under the new operating model, new technologies will greatly empower the traditional operations teams. The human's unique experience and judgment skills are being transformed into data and then injected into the knowledge base. The machine learning ability will form the closed loop of telco's self-decision and self-execution capabilities. As a result, the convergence of human insight and machine learning will offer unlimited possibilities to network operations.

Below, the figure shows how the role of person and machine is evolving through different development stages of the intelligent operations system transformation.



Figure 21: The role and relationship of human, data and machine in the iterative development of operations and maintenance system

In the future operating model, the roles of humans and machines will change significantly. At the design stage of the systems and processes lifecycle, people will transfer their knowledge and experience on complex operational domains to machines through the ML training process. Machine learning will facilitate the continuous advancement of computing through exposure to new scenarios, testing, and adaptation, while employing patterns and trend detection for improved decisions in subsequent (though not identical) situations.

The figure below shows how machines and humans are working and interacting with each other, and how is this interaction enabled by programming data.



Figure 22: Diagrammatic sketch of operations and maintenance mode of new generation telecommunication network



Big data and AI technology are used to predict and prevent network failures, greatly reducing the number of failures and complaints and improving the perceived quality of the network.

Additionally, the new AI-driven operating model enables the control and management of the growing complexity and diversification of the network environments.

At the same time, the conflict between complexity, maintenance costs, number of people, and other operational workloads will be mitigated, alleviating the pressure on cost-optimization programs.



Figure 23: Value analysis of intelligent operations and maintenance

### In summary, the business benefits brought by the "Human + Machine" Collaboration Model are:



The first step of the operating model transformation is to build a basic intelligent platform, and then implement simple, intelligent applications on the platform, focusing on addressing relevant operational issues and pain points.

It starts from a single-point application scenario to achieve a single-point intelligence, such as implementing automatic application inspections, intelligent early warning indicators, etc., and initially establishes a data system to import knowledge of single-point scenarios, realizing the series intelligence, and completing the data system based on perception, analysis, decision-making, execution, and intention.

Finally, the whole scenario becomes a highly integrated intelligence, achieving closed-loop intelligent operations. The operational personnel can gradually shift their focus from tedious operational activities to exploring needs, defining scenarios, and performing other key tasks.



# Intelligent Operations of HUAWEI

HUAWEI has provided more than 580,000 instances of technical support, over 10,000 instances of problem positioning, and more than 130,000 instances of network major operations support for more than 1,700 networks around the world. Based on this rich network operations experience and our innovation practices, HUAWEI is proposing an AI-driven human-machine cooperative intelligent operations solution.

# 3.1 Design principles of HUAWEI's intelligent operations and maintenance service

# >> Integrated human-machine cooperative operations and maintenance

At the design stage, knowledge of skilled people is captured and codified in the knowledge management platform. Combining this knowledge with comprehensive input data, ML training, and process design thinking, we implement into our platform the repetitive and deterministic tasks previously performed by operations people, and we continuously improve them. Through such iteration, more and more jobs are gradually handed over to machines, improving the accuracy of the operations and maintenance services. In production, the machines run autonomously. In addition to scheduled operations and maintenance tasks, we implement predictive and self-healing capabilities into our platform using big data and AI.

The human-machine collaboration operating model will leverage and value existing operations systems and tools, deploying the knowledge management platform on top of them and integrating existing processes, interfaces, and needs.

The human-machine collaborative operating model is not a substitute for human operations, but an enabler for people to create more value with the assistance of the machine. As shown in Figure 24, by upgrading the skills of current operations personnel, such as front office (FO) engineers, back office (BO) engineers, 3<sup>rd</sup>-party engineers, etc., they are transformed into network strategy engineers, application orchestration engineers, data engineers, and other new operations roles, letting people playing key roles in solution design, exception handling, and decision-making.



Figure 25: Huawei's hyper-integrated operations and maintenance concept of man-machine coordination

As shown in Figure 25, the knowledge assets include the following categories: perception analysis model, policy logic model, API control & operations, data model, process assets, reporting template assets, presentation interface assets, and system integration assets.



Figure 26: Classification display of knowledge assets

## Service offerings

The HUAWEI Intelligent Ops platform aims to support the next generation of operations powered by machine and knowledge. Using AI-based automation, HUAWEI's platform continuously absorbs operational knowledge and transforms concrete use cases into componentized services. HUAWEI Intelligent Ops includes three types of offerings:



In addition, HUAWEI offers professional services, such as deployment and consulting services, to accelerate our clients' success.



Figure 27: Huawei's intelligent operations and maintenance works

# >> Transformation of operations and maintenance model

HUAWEI Intelligent Ops transforms not only the systems, but also the operations culture, processes, and working style.

In the new operating model (Figure 27), data scientists and data engineers in the training center collect data from the operations data lake for data cleansing, data management, and modeling. Engineers in the design center build data models, design the user interface, and create policies. The NOC (NPM), SOC, and local operations teams will conduct emergency interventions and make decisions in escalated ad-hoc situations.



Figure 28: Logic structure diagram of intelligent operations and maintenance

Traditional back office (BO), front office (FO) and subcontractors will gradually be adapted to fit into the new organization. As shown in Figure 28, around 20% of the positions will be transformed into Network Policy Engineers, Application Orchestration Engineers, and Data Analytics Engineers. About 30% of the original workforce would be replaced by machines handling automatic monitoring and device inspection. Current operations personnel can be retrained and reskilled to cover design management, supervision, and governance roles, giving them the opportunity to grow professionally into new career paths.



Figure 29: Personnel transformation

The domain knowledge and expertise will continue to be harvested into the platform. It will be "digitized" and "capitalized" so that the platform can become "smarter." Knowledge mainly comes from the technical and operational experiences and insights, which is captured from Network Policy Engineers, Application Orchestration Engineers, and Data Analytics Engineers. They will take the knowledge assets from different FBB, MBB, and 5G / NFV use cases (standard reusable libraries, performance reports, heat maps, etc.) and package them into components in the orchestration center, then customize them with real-world insights, human experiences and professional reviews. Driven by AI and ML, the knowledge-based platform will be able to power the machine's run-time analysis-decision-execution-perception cycle.



Figure 30: Knowledge transformation

![](_page_24_Picture_4.jpeg)

In HUAWEI's Intelligent Ops platform, we have overcome the siloed architecture. We have gradually decoupled the existing network management applications and transformed them into a layered, service-oriented architecture. Using a unified middle layer, data from different business lines can be pooled and shared. We provide a centralized AI training and application platform to better respond to the market demands of the telecom industry.

In the figure below, we show the components of the Intelligent Ops architecture.

![](_page_25_Figure_1.jpeg)

Figure 31: Framework of Intelligent Ops

- Monitoring (alarm / performance / service status): Basic support services, including alarms and metrics monitoring as well as comprehensive service status and performance monitoring. This component provides alarm correlation analysis, RCA, KPI aggregation calculation and layout, and dashboard report functions.
- Operations Analysis Service: Based on the original or correlated alarms, as well as KPI thresholds, this module comprehensively analyzes and identifies operational events, including fault events, service degradation events, operational risks, etc., establishing an analytical mechanism for use case-based faults.
- Oynamic Resource Service: Unified resource management module, supporting dynamic modeling, unified management of business and data correlation, and quick search and presentation of topology.
- Policy Automation Service: Problem localization, using issue-tree and event-analysis tools to achieve self-healing (executed through automatic triggered actions).
- AI & Algorithm Service: This component provides AI algorithms and analytics services, such as alarm correlation compression, trend prediction, KPI detection, etc.
- Intelligent Operations Supporting Services: This module provides work orders and external process management, restricted access to mobile phones, and screen monitoring capabilities.
- Automatic Business Opening Service: Automatic execution of various service activation requests.
- Inified Data Service: Big data analytics service, providing distributed computing and data orchestration functionalities.
- Unified Data Collection and Instruction Adaptation Service: Unified southbound command layer, interfacing with network management system, adapting the interface with the network admin system, and implementing data collection and command dispatching.
- Operations Use Case & Assets: This component provides operations management solution assets based on fixed networks, mobile networks, and 5G / NFV distilled from 160+ operation engagements.

# 3.3 Core capabilities

### Domain expertise in telecom use cases

With extensive project experience and a rich technology portfolio, HUAWEI is a reliable and highly competitive player in the telecom industry with a deep understanding of MBB / FBB / NFV and 5G use cases.

![](_page_26_Figure_4.jpeg)

![](_page_27_Figure_1.jpeg)

### The figure below shows the HUAWEI "Use Case-Based" Intelligent Ops.

![](_page_27_Figure_3.jpeg)

Figure 32: HUAWEI "Use Case-Based" Intelligent Ops

### AI and data analytics

HUAWEI supports predictive fault management by unifying AI capabilities and intelligent data governance and services.

### **Unified AI Algorithms**

As shown in the Figure 32, HUAWEI infuses AI capabilities into its operations, algorithms, and offerings. With the Intelligent Ops solution, AI algorithms are packaged into components to make them easy to reuse.

![](_page_28_Figure_1.jpeg)

### Figure 33: Data enabled fault prediction and management

### Data governance and service

As shown in the Figure 33, high-quality data is the foundation of intelligent operations. Thanks to HUAWEI's data collection framework, we broke the siloes and now manage a common data lake. Using standardized data models for multiple telco services, Intelligent Ops has laid an effective analytics foundation for AI training, enabling applications such as fault prediction and prevention, automated fault management, root cause recognition, etc.

Figure	34:	Unified	AI	algorithm	capability

Before Event: Prediction & Prevention					A	After Event: Diagnosis and Recovery					
Network Worsening Model			Fault Predication		A	Alert					
User Model		Al Com		Completeness : 50%		Business Topology		Root Cause Identification			
Daaaa	Tl			Prediction	Physical La	Physical Layer Topology		Coverage: >85%			
Resour	ce Topology		Accu	iracy. 50%	Faul	Fault Tree					
Decision	Event	Exec	ution mands	Feature Model	Resource	IP Layer	Model	Application Layer Model			
Data	Sample Fau Repository		It Tree Decision Tree		Topology	Physical Layer Model		Link Layer Model			
Data Serv	ices: Data pro	ocessing a	nd analyt	tics for busines	s Data (	Governance:	Standardiz	zation for	business		
Data	Flow	Al Model Di		Multi- Dimensional	Cross- Domain	Events Resources		Data Governance Tools			
Storage	Processing	Data	Linkage		Model	Policies & Ru	les Da	ata Security	Data Standardization		
& Pre- Processing	& Pre- Processing Cleansing Cleansing Cleansing A		KPI Aggregatio	Feature on Extraction	Basic Model	AlertsPerformanceResourcesCHR		Meta Data	Data Quality		
	- 1							-			
Collection Framewor	Customize Data Probe	d EMS es Pi	General robes	Topology Template Probes	User Feature Data	Probe Visualizatio	on Standa	itput rdization	Protocol Management		

## Operational ecosystem

HUAWEI aims to simplify the operations of our clients by encapsulating the rules, models, and AI algorithms distilled from a great number of successful real-world engagements into a unified Intelligent Ops platform. We give our customers and partners access to this knowledge so that everyone in our business ecosystem can develop their skills by leveraging that experience.

OWS (Operation Web Services) is the enabling platform for HUAWEI Intelligent Ops, with big data and AI capabilities, which can be quickly deployed in any telecom operations environment. It is designed to adapt quickly to the evolution of technology and telecom services, enabling the telco's engineering team to develop customized applications through open APIs. Based on the microservice architecture, OWS decouples IT services from business services. Its unique service orchestration ability will enable telco engineers worldwide to address their specific operational needs. HUAWEI is building a global developers' ecosystem where telco and other HUAWEI partners are able to develop applications in Design Studio, then easily deploy them into production (the whole system is shown in the figure below).

![](_page_29_Figure_4.jpeg)

Figure 35: operations ecosystem transformation

### 3.4 Transformation plan to HUAWEI's intelligent operations platform

Intelligent operations cannot be achieved overnight. It can coexist with legacy OSS in the short term and then take over gradually. A telco can select the use case-based entry points with the greatest business impact, based on its own business needs and pain points, import operational data from the existing OSS system, and launch applications such as intelligent anomaly alerts, fault discovery and recovery, and smart inspections. The telco can protect its investment in the existing OSS, find a use case to introduce intelligent operations, bring it live, and then reinforce and replicate the success to the rest of the operations, eventually taking over the legacy OSS.

HUAWEI's intelligent operations-transformation plan is based on the principle of protecting operators' existing investment and supporting the smooth evolution of operators from the traditional operating model to the intelligent operating model of human-computer cooperation. The roadmap can be divided into three phases:

Phase 1: Single-Point Adoption. Evaluate the status quo and select a key application for the use case that demands new operational solutions and delivers the greatest impact. Start with a specific service scenario (e.g., 5G fault recovery), develop the corresponding application in the HUAWEI Intelligent Ops platform by adding an application overlay on top of the legacy OSS and a data layer to support perception, analysis, decision, and execution. Integrate the legacy OSS as a data source for intelligent monitoring, abnormality alerts, fault discovery and analysis, root cause analysis, and self-healing. Take this as an opportunity for building platform and data governance for fault and performance monitoring. The detailed transformation process is shown in the figure below.

![](_page_30_Figure_5.jpeg)

Phase 2: Clustered Use Cases. A telco can extend the success of a single Intelligent Ops application to other use cases. In the application layer, we can replicate it to more value-based use cases (e.g., home Internet, corporate services, wireless, etc.) In the platform layer, we recommend a plan to bring Intelligent Ops modules online such as process center, orchestration center, and resource centers. The legacy OSS system functions will gradually be replaced in an orderly manner. The business value of the new intelligent operations will be unlocked through the process, and the telco will be able to capture new value in user experience improvements and cost savings in workforce and other operational resources. The detailed transformation process is shown in the figure below.

![](_page_31_Figure_2.jpeg)

Phase 3: Highly intelligent operations and maintenance. In this phase, Intelligent Ops are now enabling all aspects of network operations, enabling Autonomous Driving Networks (ADN) with smart decision-making and automated closed loop for control and data feedback. Intelligent Ops have gradually replaced the legacy OSS for all service use cases. In the meantime, the telco will be able to reorganize its core operations workforce, moving most of it to design, training, supervision, and governance roles and responsibilities—as the most time-consuming operational tasks have been taken over by the machine and by the application orchestration center's engineering team. At this point, the full potential of the human+machine platform will be unlocked for the greatest business value impact.

The detailed transformation process is shown in the figure below.

![](_page_31_Figure_5.jpeg)

![](_page_32_Picture_1.jpeg)

# 4.1 Large operator in China: Automatic fault management

### **Case Background**

After many years of network construction, along with new technology development, a large telecommunications operator group in China has brought in many OSSs. However, traditional siloed OSSs have high maintenance costs and cannot be managed across domains and vendors. New services need to be integrated with multiple systems for online service deployment, so it is difficult to support the rapid launch of new business. As 5G, loT, and industrial digitization have increased network complexity, and multigeneration technologies have coexisted for a long time, delimiting and positioning network faults accurately have become more difficult and urgently needed.

 Siloed OSS, data dispersion » OSS tools are separated from each other with poor correlation of resources and data, and there is no end-to-end operational capability. • There are many repeated invalid work orders and the proportion of invalid on-site visits is high » 28.4% of the work orders do not have information regarding fault location, resulting in a large number of invalid on-site records. » Limited accurate fault positioning and delimitation methods, abundant incorrect manual operations for troubleshooting, and a great deal of invalid requests for help together lead to low processing efficiency. The average fault recovery time (MTTR) is long **Operations &** Maintenance » It is difficult to communicate across different departments, and the average fault recovery Challenges time is 1,125 minutes. Maintenance depends on manpower, which is low skilled and high cost » As the network scale becomes increasingly larger, more and more network resources are maintained, so it is difficult to rely on human labor. » Decentralized troubleshooting methods and experience in cities cannot be shared. Most maintenance personnel are of high mobility, and generally lack accurate troubleshooting capabilities.

## **HUAWEI Solutions**

Through building an intelligent operations platform, HUAWEI helped the group to connect the OSSs of different provinces and integrate the data sources. By using big data analysis and AI algorithm technology, HUAWEI helped them mine huge amounts of web data and expert experience, and continuously evolve according to each scenario's needs, with applications like the intelligent troubleshooting center and intelligent inspection center assisting the operators reduce the network risk, comprehensively improve maintenance quality, strengthen technical support for smaller cities, reduce the dependence on staff skills, and realize the transformation of the intelligent operations.

![](_page_33_Figure_3.jpeg)

# 4.2 Intelligent operations & maintenance transformation of a large Southeast Asia telco

### **Case Background**

The business of a large telecommunications operator in Southeast Asia includes fixed and mobile networks, with 2 million fixed network users and 65 million mobile network users. As the scale of the network continues to expand, the user perception of the entire network is poor. Under fierce competition from its competitor G operator, the number of users has dropped, and a modern operations system is urgently needed to enhance business agility, improve network quality, user experience, as well as operational efficiency.

![](_page_34_Figure_4.jpeg)

# **HUAWEI** Solutions

On one hand, HUAWEI helps the operator build a unified intelligent operations platform. As shown in the following figure, it integrates the existing OSS systems, unifies data collection platforms, unifies operational processes, and provides an independent automation strategy engine based on the intelligent operations platform, making it possible for multiple network events to drive closed-loop automation. Facing future business needs, it provides alarm, performance, log, and other event-driven automation; builds an AI training platform; provides AI training capabilities based on massive operational data; and realizes automatic system learning.

![](_page_34_Figure_7.jpeg)

Figure 40: Intelligent operations and maintenance solution architecture of a large telecommunications operator in Southeast Asia

On the other hand, HUAWEI uses the integrated development center of the intelligent operations platform to help the operator organize the application of operations scenarios. As shown in Figure 41, it is mainly divided into four categories:

- Reorganize the existing key operation scenarios in the new operations platform, such as wireless network health assessment, 3G alarm monitoring, 4G alarm monitoring, CS KQI monitoring, terminal analysis, overlap analysis, TT automatic dispatch, TT order automatic association, etc.
- Enhance operational functions, such as traffic analysis, coverage analysis, neighbor analysis, frequency analysis, single user analysis, automatic creation of TT orders, automatic closing of TT orders, etc.
- Build operational applications, such as VoLTE KQI monitoring, VNF alarm monitoring, IMS KPI monitoring, etc.
- Plan operational applications, such as one-key diagnosis and recovery of household broadband complaints, copperaccess failure prediction and prevention, fiber-access failure prediction and prevention, wireless-hardware failure prediction and prevention, etc.

The figure below shows the intelligent operations and maintenance application architecture.

![](_page_35_Figure_7.jpeg)

Figure 41: Intelligent operations and maintenance application architecture of a large telecommunications operator in Southeast Asia

Through the reorganization of these operational activities, we helped operators realize skills transformation for operations personnel, hand over repetitive tasks to machines, such as traffic analysis and coverage analysis, and transform the operating model to a new model of human-machine collaboration. Additionally, we have also solved the previous operations problems, such as low operation efficiency and correspondingly high customer complaints. Finally, through organizing Studio, business agility is enhanced and business TTM is shortened.

Improvement of quality: MTTR reduced by 30%–35%. User complaints reduced by 10%. Onsite work orders reduced by 5%–20%.
Reduction of cost: Operations efficiency is expected to increase by 10%–20%, and the number of faults is expected to decrease by 10%–20%.
Realized Transformation: The operations model has shifted from human-oriented to a new model of human-machine collaboration and has achieved skills transformation for operations personnel.

![](_page_36_Picture_1.jpeg)

With the continuous advancement of 5G network deployment and the deep integration of AI in network operations, HUAWEI's human-machine collaborative intelligent operations solution transforms the operations from "human-dependent" to "automated and intelligent." Through skill transformation, the operations personnel are converted into data engineers, network strategists, and application orchestrators. The experts' experience is packaged into operations processes and cognitive assets and injected into the intelligent operations platform. Through the new human-machine collaborative operating model, HUAWEI's intelligent operations solution can break the law of linear resource growth with equipment, use automation to reduce human errors, and improve operations efficiency. Through the adoption of AI technology, HUAWEI's intelligent operations solution enables the prediction and prevention of network and business failures, improves the quality of operations, and contributes to realize the ultra-reliable fourth-generation telecommunications network.

In the future, HUAWEI will continue to use its knowledge and experience in products, technologies, and professional services to bring more "activeness, predictiveness, and preventiveness" into reality and work with the industry to create a healthier and more dynamic telecommunications operations ecosystem. HUAWEI is willing to work with operators to continuously explore and innovate telecommunications network operations, open the HUAWEI's global operations experience, and help operators to build intelligent operations capabilities in order to reduce costs, improve network quality, and enable operations transformation.

![](_page_37_Picture_1.jpeg)

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#### HUAWEI TECHNOLOGIES CO., LTD.

Huawei Industrial Base Bantian Longgang Shenzhen 518129, P. R. China Tel: +86-755-28780808 www.huawei.com