Autonomous Driving Network for Enterprises

01
Background

From office to production: The network connects applications and devices

From campus to DC: Continuous boundary extension

From static to dynamic: The network changes with its applications.

As we approach a world characterized by all things sensing, all things connected, and all things intelligent, enterprises require network that can keep up, ubiquitously connecting all people, terminals, applications, and devices. These network ensure service continuity and recurring revenues for enterprises, making it a key asset for enterprises looking for sustainable development.

Enterprise digitalization accelerates services iteration, and to provision and launch these services involves a network configuration work order that spans enterprise campuses, WANs, and data centers, from one cloud to multiple clouds, extending the scope of network O&M. The quick adjustments that enterprises need to make to an increasing number of key services are a big challenge for manual network O&M. To solve this, enterprises need to offer intelligent detection and self-optimization to move from traditional static policies to dynamic policies.
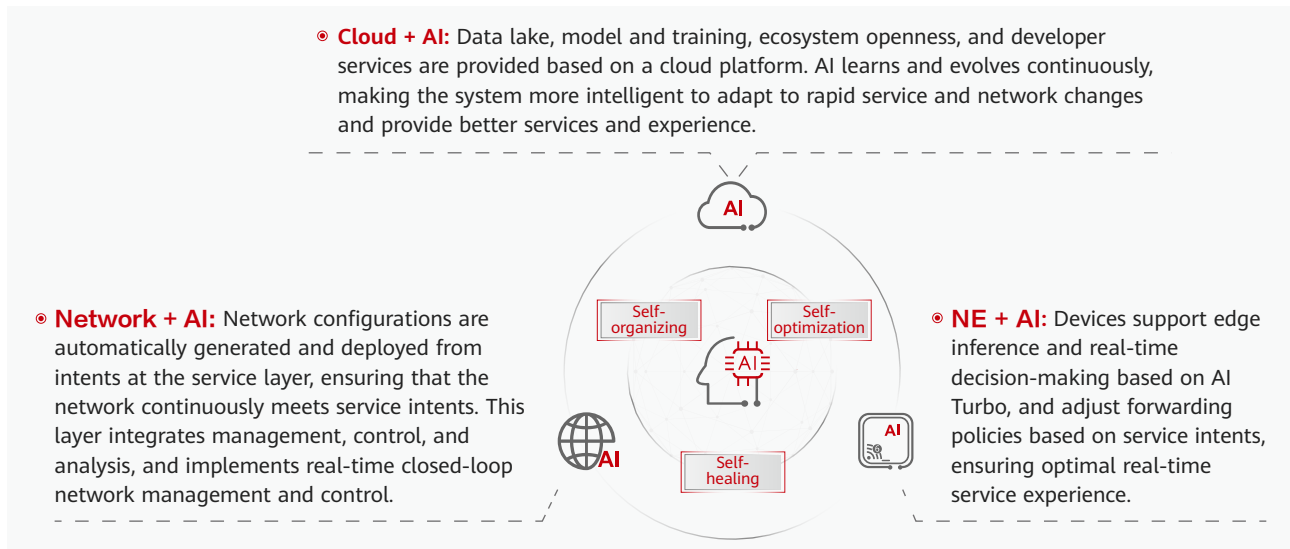
As such, enterprises need to use an Autonomous Driving Network (ADN) that integrates AI and big data technologies to automate the network, provide intelligent O&M, improve service agility, ensure optimal network experience, and reduce OPEX.

02

What Is ADN?

ADN makes optimal use of AI to drive continuous innovation of the network architecture through knowledge and data, transcending the limits of manual processing. With deep learning, ADN automatically understands service intents and network objectives; with data computing, ADN compensates for people's insufficient considerations; with continuous machine learning, ADN passes the limits of experience-based decision-making. Combining these together, ADN achieves **self-organizing, self-healing, self-optimization,** and **autonomy**, building ubiquitous intelligent network and accelerating digital transformation across industries.

A three-layer AI architecture is used to build intelligent IP network and accelerate the evolution towards ADN. The three layers are as follows:

⊚ **Cloud + AI:** Data lake, model and training, ecosystem openness, and developer services are provided based on a cloud platform. AI learns and evolves continuously, making the system more intelligent to adapt to rapid service and network changes and provide better services and experience.

⊚ **Network + AI:** Network configurations are automatically generated and deployed from intents at the service layer, ensuring that the network continuously meets service intents. This layer integrates management, control, and analysis, and implements real-time closed-loop network management and control.

⊚ **NE + AI:** Devices support edge inference and real-time decision-making based on AI Turbo, and adjust forwarding policies based on service intents, ensuring optimal real-time service experience.
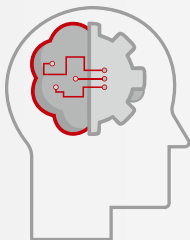
Full-stack AI is introduced to automatically translate service requirements into network models and languages through deep self-learning. AI and knowledge inference are used to detect the network status and predict network risks in real time, accurately identifying root causes and automatically rectifying faults. This greatly reduces network faults, significantly improves network O&M efficiency, and is ultimately a big factor in providing the **self-organizing, self-healing**, and **self-optimization** in an ADN network, based on which network **evolve towards autonomy**.

⊚ **Self-organizing:** Automates network-wide deployment of intents as services, throughout the lifecycle, also implementing end-to-end management.

⊚ **Self-healing:** Predicts and prevents faults, and implements self-recovery based on events, achieving automated O&M on the entire network.

⊚ **Self-optimization:** Enables self-adaptation and optimization of user experience to automate optimization of the entire network.

03
What Changes Does ADN Bring to Network?

Huawei's ADN Solution passes the limits of man and bridges the human brain gap by learning baselines for three capabilities: deep learning of network and serviced model intents, digital simulation based on network calculus and formal verification, and intelligent decision-making based on knowledge graphs and machine learning algorithms.
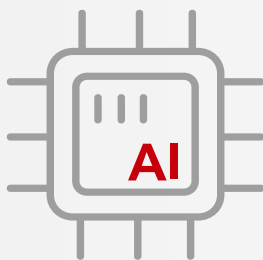
Intent understanding

Machines replace humans to understand service intents and objectives. The intent engine understands and translates intents, and ADN uses the result to recommend a network deployment solution, translating the service intents into network language. It then recommends an optimal network deployment solution for the live network based on the digital twin model, expert experience, as well as AI algorithms.

Digital simulation

ADN collects network status data in real time, constructs a five-dimensional digital twin model, and verifies all changes on the network against models and formal verification algorithms.
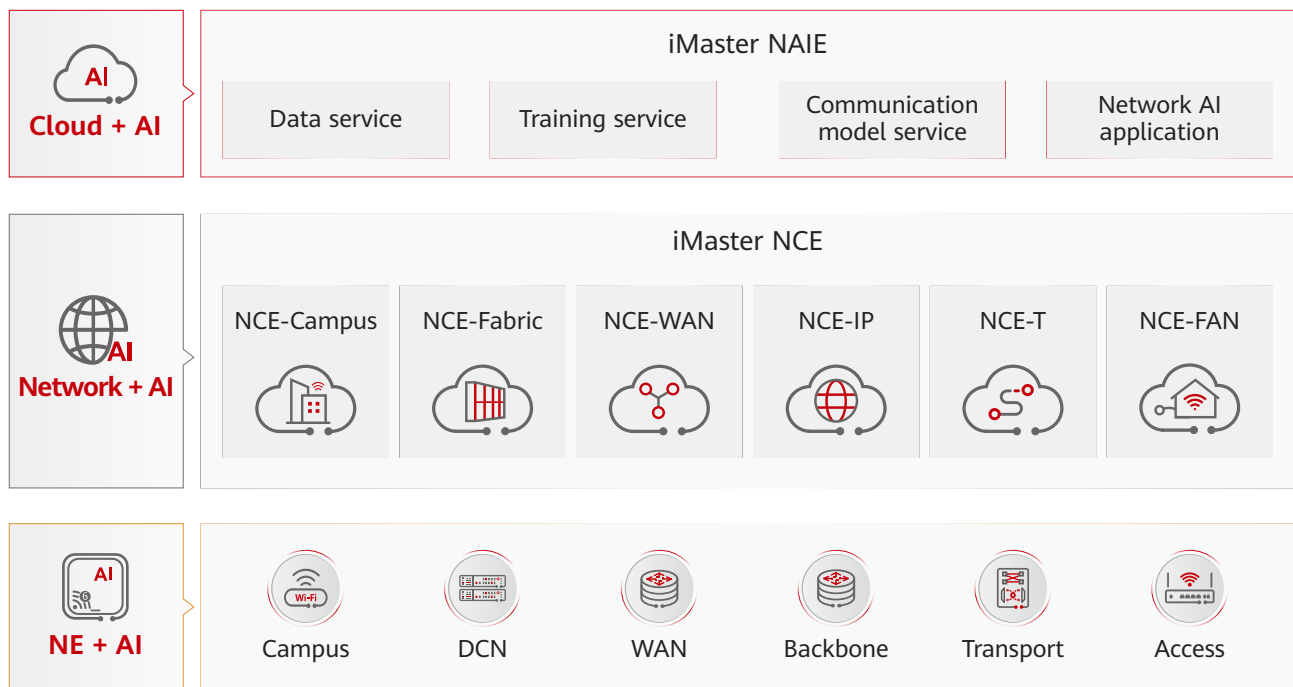
Intelligent decision-making

ADN detects network faults by leveraging AI chips to collect and analyze all flow data. Then, it infers the root cause and diagnoses a fault based on knowledge graphs and locates the root cause through continuous learning and training. Finally, ADN uses its intelligent decision-making system to analyze the fault impact and recommends an optimal solution for quick troubleshooting and rectification.

04 Products in the ADN Solution

Huawei plans, designs, and develops products related to the ADN Solution in adherence to the core concepts of simplified network and O&M. AI is introduced into each of the open three-layer architecture: NE, network, and cloud. Huawei's ADN Solution consists of: iMaster Network AI Engine (NAIE) — a cloud-based network AI unit; iMaster NCE — an intelligent network management and control unit; and network infrastructure products with built-in AI capabilities.

Cloud + AI	iMaster NAIE			
	Data service	Training service	Communication model service	Network AI application

Network + AI	iMaster NCE					
	NCE-Campus	NCE-Fabric	NCE-WAN	NCE-IP	NCE-T	NCE-FAN

NE + AI	Campus	DCN	WAN	Backbone	Transport	Access

4.1 iMaster NCE

Huawei iMaster NCE is a network automation and intelligence system that integrates management, control, analysis, and AI functions and bridges physical network and business intents. In the southbound direction, it implements centralized management, control, and analysis on the entire network and enables resource cloudification, full-lifecycle automation, and data analysis-driven intelligent closed-loop capabilities. In the northbound direction, it provides open network APIs for quick IT integration. ADN is mainly used in data center, enterprise campus, WAN, and transport and access scenarios.

4.1.1 iMaster NCE-Fabric

iMaster NCE-Fabric — an Autonomous Driving Network management and control system for data center network scenarios — integrates management, control, analysis, and AI functions, as well as implements network resource cloudification, full-lifecycle network automation, and data analysis-driven intelligent closed-loop capabilities based on business and service intents. Together, these innovative features greatly improve the service provisioning and O&M efficiency of data center network.

4.1.2 iMaster NCE-Campus

iMaster NCE-Campus is Huawei's next-generation Autonomous Driving Network management and control system for campus network. It is a first-of-its-kind intelligent network automation platform that integrates management, control, analysis, and AI functions, provides full-lifecycle automation, and implements intelligent fault closure through big data analytics and AI. With these innovative features, iMaster NCE-Campus helps enterprises reduce OPEX and O&M costs and accelerate enterprise digital transformation.

4.1.3 iMaster NCE-WAN

iMaster NCE-WAN is an Autonomous Driving Network management and control system launched for enterprise branch network. It offers centralized management, fast service provisioning, application experience optimization, and visualized O&M capabilities to quickly provide cloud-based private line management services for enterprises. This helps enterprises reduce OPEX and accelerate digital transformation.

4.1.4 iMaster NCE-IP

iMaster NCE-IP is an autonomous management and control system oriented to scenarios such as IP backbone and DC interconnection. iMaster NCE-IP integrates network management, control, and analysis functions to offer the following capabilities:

- ◉ Model-driven, simplified, agile service automation
- ◉ Differentiated SLAs based on Huawei's intelligent multi-constraint path computation algorithms
- ◉ Network traffic forecast based on network big data analysis and AI
- ◉ Open programmable APIs for quick integration with the OSS/BSS and IT applications

4.1.5 iMaster NCE-T

iMaster NCE-T is a management and control system for all-optical DCI network. It focuses on resource automation, service automation, and intelligent maintenance to provide autonomous-driving optical network for enterprises. It provides the following benefits:

◉ Real-time online resource visualization allows early warning on network bottlenecks and automatic resource management.

◉ Flexible optical network slicing enables agile service provisioning and service automation.

◉ Optical fiber health prediction and intelligent alarm management enable intelligent network O&M.

4.1.6 iMaster NCE-FAN

iMaster NCE-FAN is Huawei's autonomous management and control system oriented to access and home network. For small- and medium-sized Internet service providers (ISPs), iMaster NCE-FAN improves service provisioning efficiency through automated FTTH service activation. Moreover, iMaster NCE-FAN can proactively identify access and home network faults with its intelligent O&M powered by AI and big data analysis. All this helps small- and medium-sized ISPs reduce OPEX and quickly boost user experience.

4.2 iMaster NAIE

Huawei iMaster NAIE is a fundamental AI design and development platform for ADN. It implements continuous AI training and extracts knowledge from various types of network data uploaded to the cloud to generate AI models and network knowledge. AI models and knowledge can be injected into the network infrastructure and iMaster NCE, making network smarter and easier to use. iMaster NAIE also acts as a sharing center for enterprise-wide network intelligence assets and centrally manages various AI models and network knowledge for full sharing and reuse, reducing unnecessary repetition of development and training.

iMaster NAIE mainly includes data services, model and training services, an AI marketplace, and AI applications. Its cloud services provide a broad range of AI services for third-party service application developers, lowering the barrier to entry for AI application development. iMaster NAIE simplifies network AI development with higher efficiency, accelerating evolution towards ADN.

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