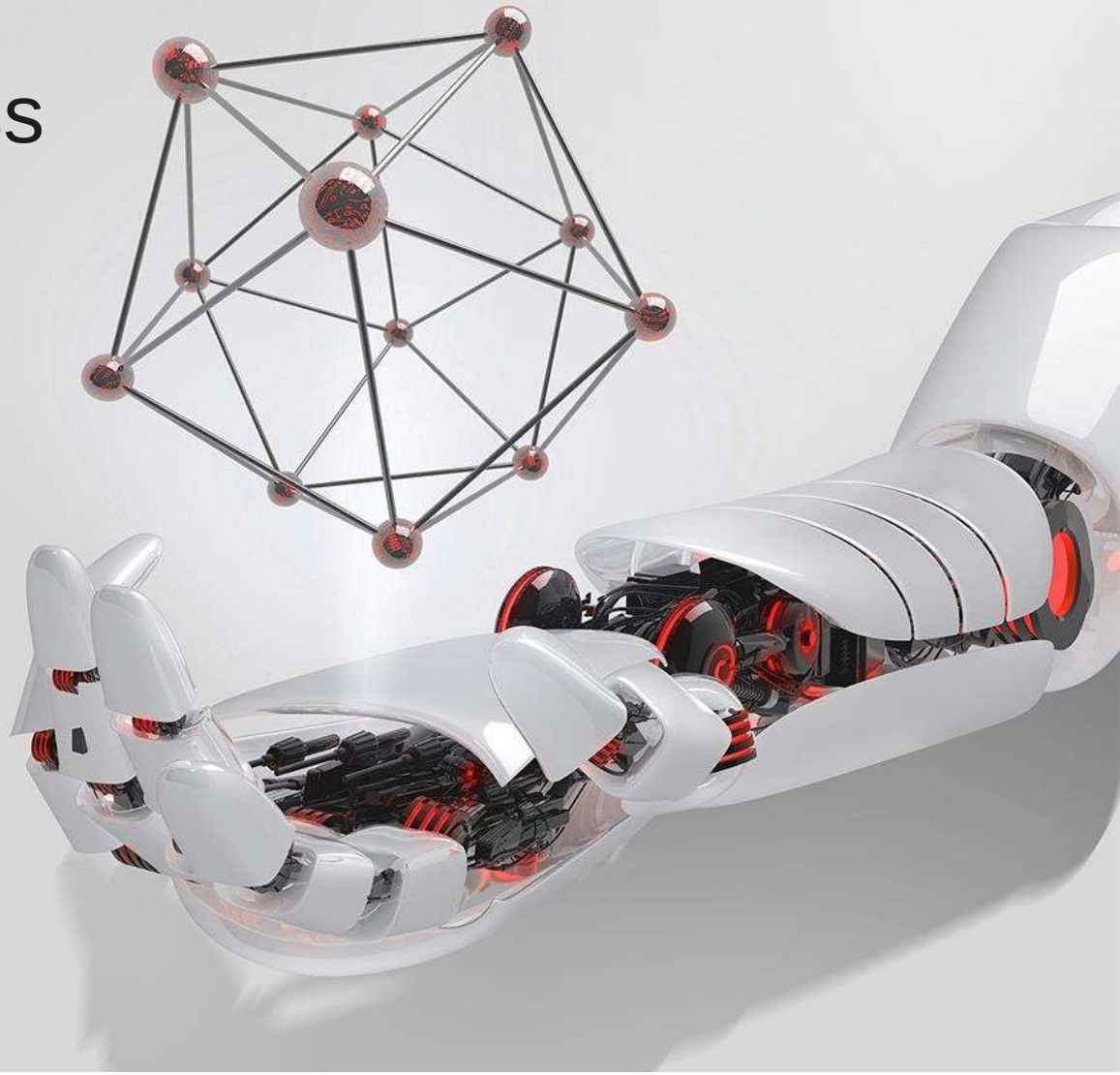
Building & Operating a fully Wireless & Intent-Driven Campus Network

with

iMaster NCE



Christian Kuster
CTO Enterprise Networks
Huawei Switzerland

25.8.20 Zoo Zuerich

Security Level:

HUAWEI

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Three Core Forces Drive Enterprise Digital Transformation

Enhance user experience

Real-time, on-demand, all online, DIY, social

Source: HUAWEI MI

Connect Users

Improve operations efficiency

30%
Improved production efficiency

40x
Improved quality

Source: BCG

Connect Machines

Build a brand new ecosystem

3.7%
GDP growth brought by digitalization transformation

Source: Accenture (China)

Connect New Services

Connectivity Creates Value

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New Challenges for Networks in the Digital Era

Rapid service explosion + increasing branches
How does the network quickly respond to such changes?

Diversified services
How does the network automatically deliver configurations?

Ever-changing mobile applications
How to quickly adjust network policies?

Isolation of multiple services
How to isolate multiple services to prevent them from affecting each other?

LAN and WAN management
How to effectively orchestrate network resources in a unified manner?

Insufficient bandwidth due to swarm traffic
How to preferentially guarantee experience of VIP users?

The more NEs, the more complex O&M
How to intelligently perform network O&M and optimization?

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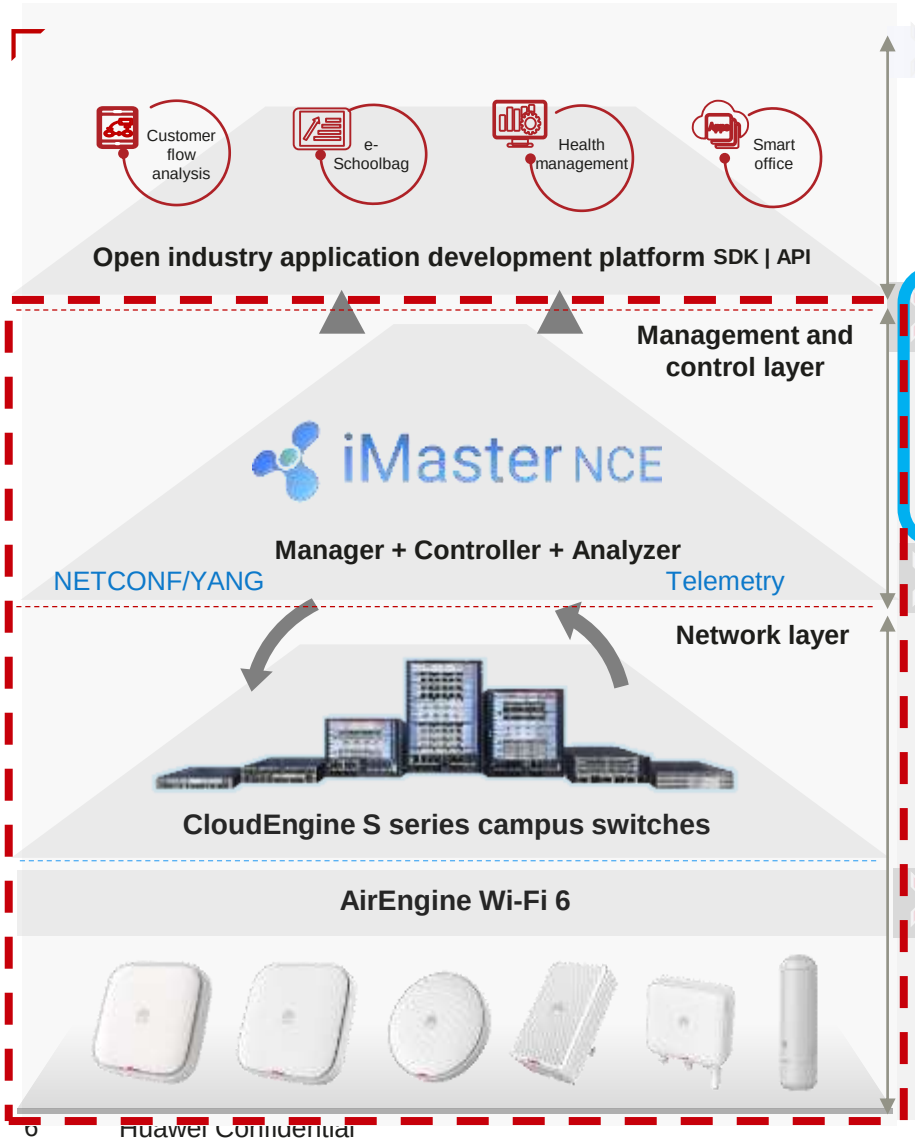
Huawei CloudCampus Solution: Building a Fully Wireless, Intent-Driven Campus Network Ideal for the Wi-Fi 6 Era



Wi-Fi 6 transforms enterprises

Transform workplaces | **Transform production** | **Transform public services**

iMaster NCE-Campus: autonomous driving platform that integrates management, control, and analysis, ideal for the Wi-Fi 6 era

Full automation, enabling Wi-Fi 6 services
Planning automation · Network construction automation · Policy automation

Intelligent O&M, ensuring Wi-Fi 6 experience
User experience visibility · Fault demarcation · Network optimization & self-healing

High-quality bearer network ideal for Wi-Fi 6 era

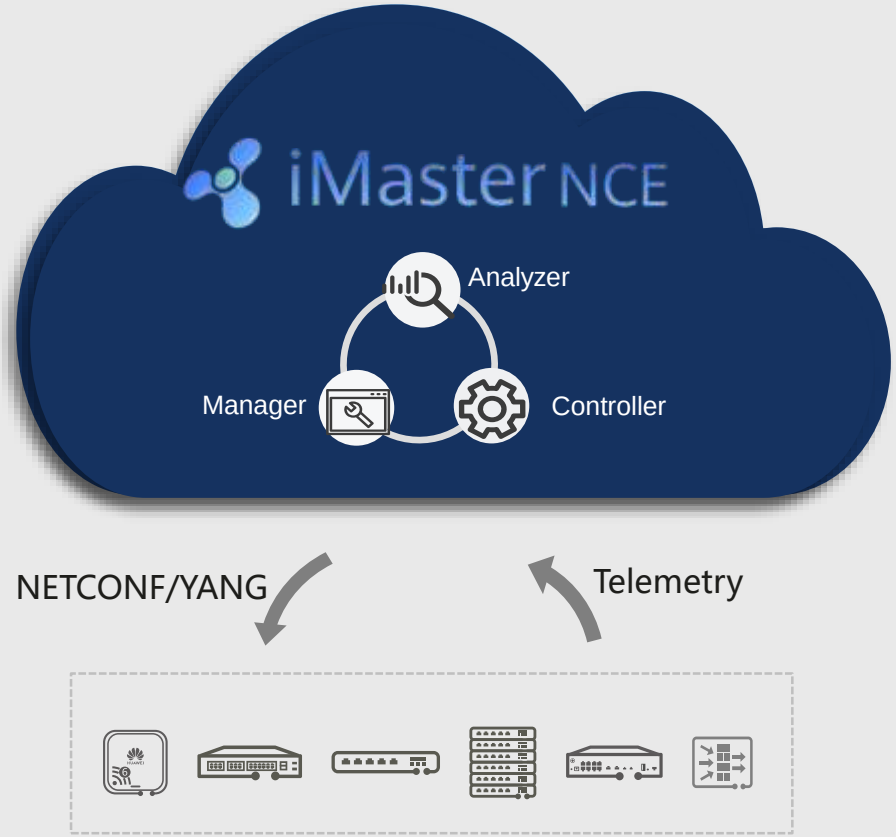
Full-10GE access, embracing the speed of Wi-Fi 6

- Multi-GE switch + high-density 25GE fixed switch + 100GE core, building ultra-broadband channels for Wi-Fi 6
- Integrated wireless policy management (managing up to 10k APs and 50k concurrent users), meeting massive user concurrency in the Wi-Fi 6 era
- Wireless campus with 10k users, thanks to 100GE capable core switches — CloudEngine S12700E (57.6 Tbps, 50k wireless users, 6x performance)

AirEngine Wi-Fi 6 powered by Huawei 5G, building a fully wireless campus network

Lightning speed	*More stable coverage*	*More stable application*	*More stable roaming*
Industry's only dual-band 16 smart antennas: 10.75 Gbps, 2x the industry average	*Smart antenna: signals moving with users, 20% greater coverage distance*	*Dynamic Turbo: application acceleration, < 10 ms latency*	*Lossless roaming: zero packet loss during roaming*

iMaster NCE-Campus: Autonomous Driving Campus Network Management and Control System



Fully converged — Manager + controller + analyzer

All-scenario — Simple-service campus + multi-service campus + multi-branch interconnection campus

Full lifecycle — Planning + deployment+ O&M + optimization

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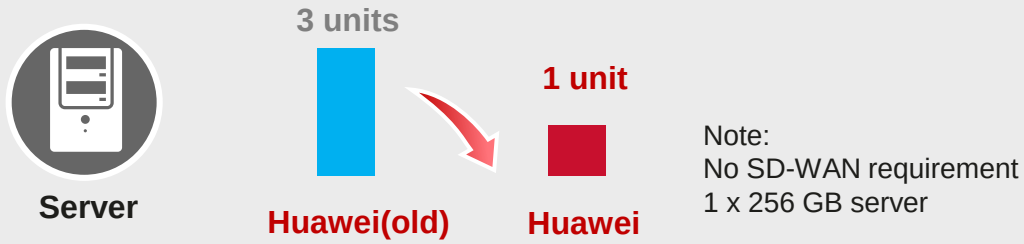
Fully Converged Platform: Manager + Controller + Analyzer

Lower costs
Fewer servers

- Hardware cost
- Deployment cost
- O&M cost



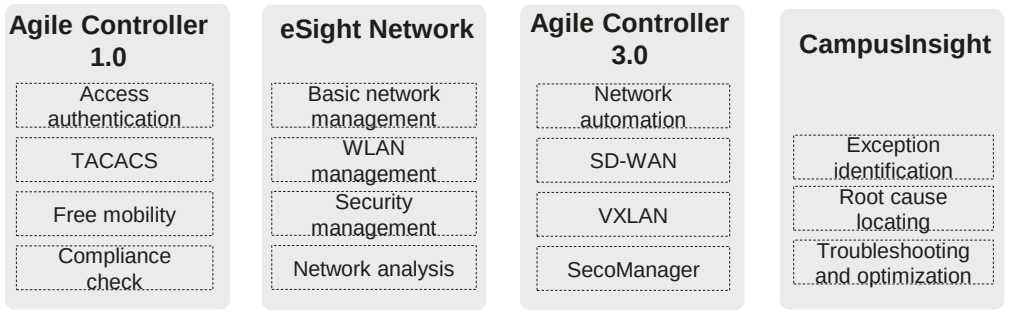
Note:
No SD-WAN requirement
1 x 256 GB server

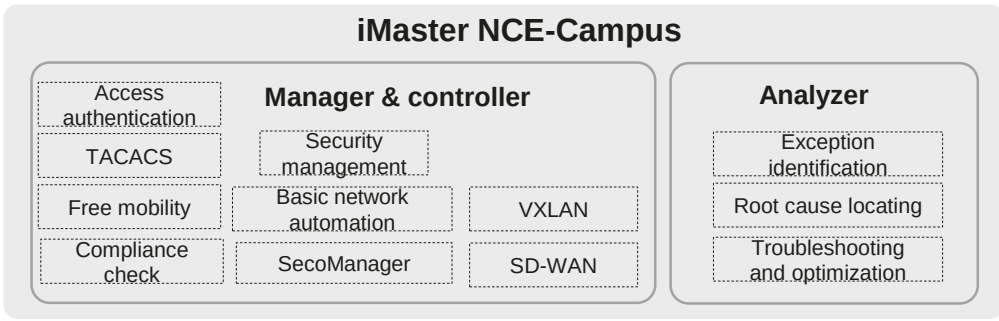
Higher efficiency
One-stop full lifecycle management

Design | Provision | Admission | Monitoring | Maintenance | System

Menu/Dashboard integration

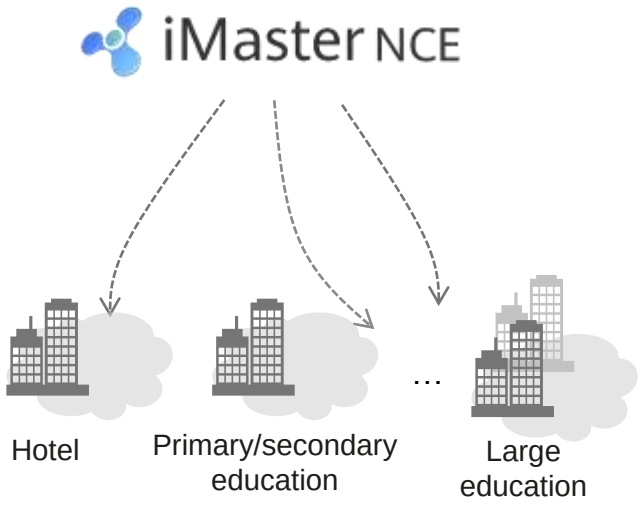
Workflow integration



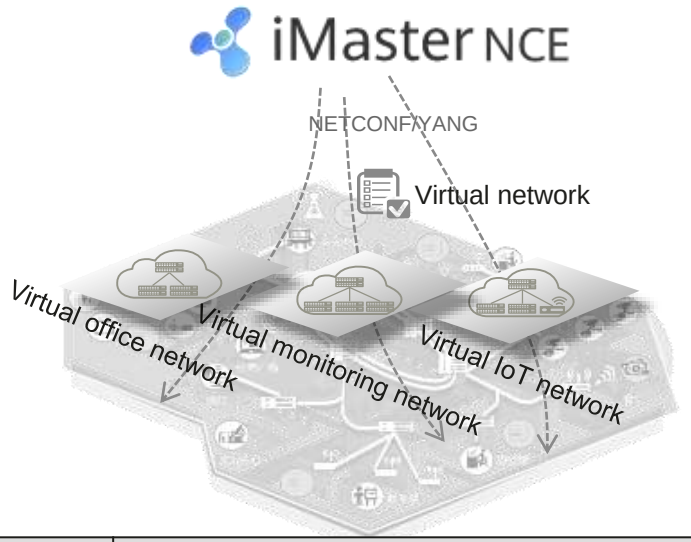


All-Scenario: Ranging from Single-Service Campus to Multi-Branch Interconnection Scenarios

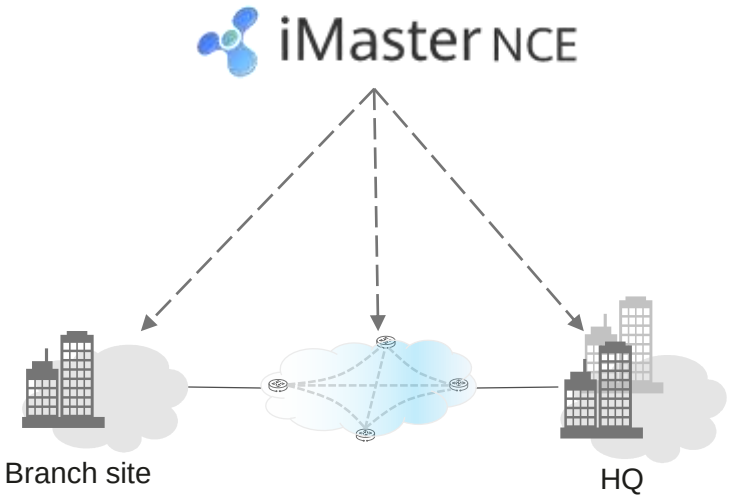
Simple-service campus



Multi-service campus

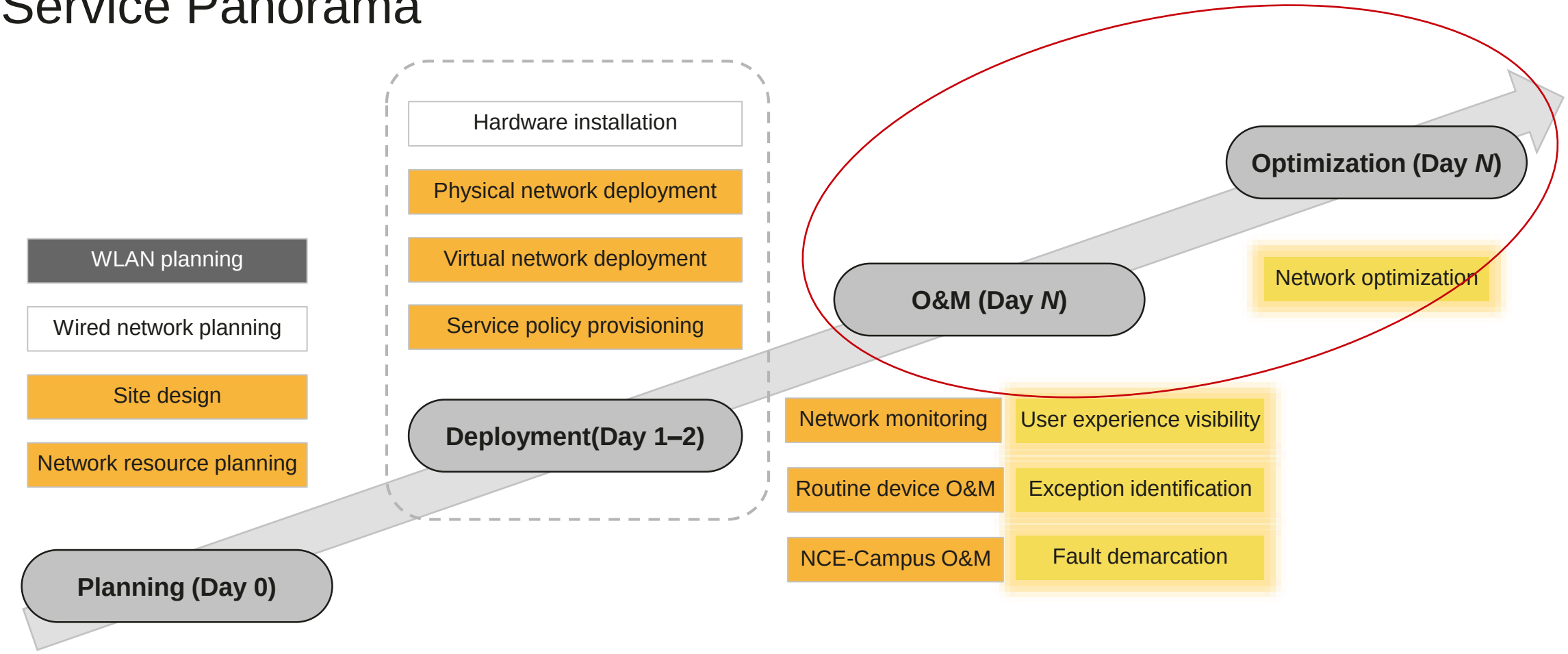


Multi-branch interconnection campus



	Simple-Service Campus	Multi-Service Campus	Multi-Branch Interconnection Campus
Network architecture	Single campus dominated, focusing on Internet access and network connectivity	Complex network with many areas and multiple services, such as campuses with multiple buildings	Wired and wireless network for Internet access in the HQ and branches VPN connections between the HQ and branches
Common requirements	Management and authentication for multiple network devices, such as APs, switches, and firewalls	Management, authentication, and multi-service isolation for multiple network devices, such as APs, switches, and firewalls	Management and authentication for multiple network devices, such as APs, switches, firewalls, and AR routers, and multi-branch interconnection management
Typical scenarios	Multi-branch and small enterprise campuses, such as hotels and primary/secondary education scenarios	Universities, governments, and large enterprise campuses	Large enterprises and financial service outlets

iMaster NCE-Campus: Full-Lifecycle Campus Network Service Panorama



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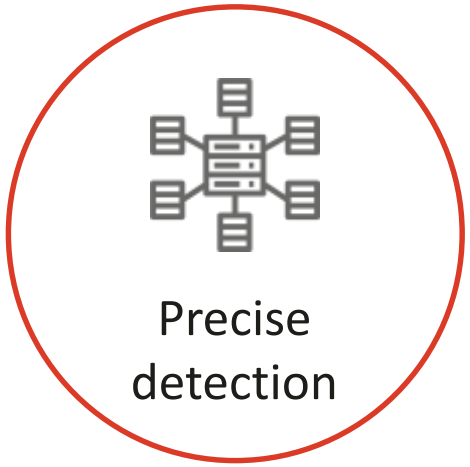
Challenges Facing Campus Network O&M



Precise detection

Traditional O&M is based on SNMP and data is collected in minutes. **Once a fault occurs, data at the fault occurrence time cannot be obtained in real time.**

Experience detection

During traditional O&M, only device metrics are monitored. However, user experience may be poor when the metrics are normal. **Traditional O&M lacks means of correlatively analyzing the client and network.**

Issue identification

During traditional O&M, network faults can be detected only after receiving clients' complaints. **As a result, faults cannot be effectively and proactively identified and analyzed**.

AI-Powered Intelligent O&M: User Experience-Centric O&M, Shortening Fault Response Period from Days to Minutes

As-Is: Device-Centric Network Management

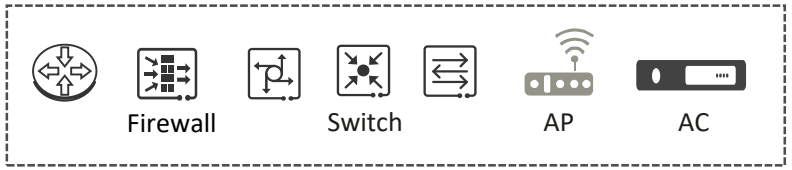
eSight

Network management system

- Topology management
- Performance management
- Alarm management
- Configuration management

SNMP

Network data collection within minutes



- **Device-centric management**: User experience cannot be perceived.
- **Passive response**: Potential faults cannot be identified.
- Professional engineers **locate faults on site**.

In 2017, a large number of employees at the X representative office of Huawei could not access the network. It took one day for fault locating and rectification.

To-Be: User Experience-Centric AI-Powered Intelligent O&M

iMaster NCE CampusInsight

Intelligent network analyzer

- Visible experience management
- Client journey tracing
- Identification of potential faults
- Location of root causes
- Intelligent network optimization

Telemetry

Network data collection within seconds

- **Experience visibility**
  Telemetry-based data collection within seconds, enabling visible experience for each client, in each application, and at each moment
- **Identification of potential faults and location of root causes**
  - Identification of potential faults based on the dynamic baseline and big data correlation
  - KPI correlation analysis and protocol tracing, helping accurately locate root causes of faults
- **Network optimization and self-healing**
  - Continuous learning and predictive analysis through AI algorithms, implementing predictive optimization of wireless networks

Customer benefits: The transformation is to improve efficiency by using algorithms. With scenario-based continuous learning and expert experience, intelligent O&M frees O&M personnel from complex alarms and noises, making O&M more automatic and intelligent.

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iMaster NCE-CampusInsight: Improving User and Service Experience Based on Prediction and AI

Real-Time Experience Visibility

1. **Each region:** Intuitively display the network status and user experience on the entire network or in each region through the seven-dimensional evaluation system.
2. **Each client:** Display network experience (who, when, which AP to connect, experience, and issue) of all clients in real time throughout the journey.
3. **Each application:** Perceive experience of audio and video applications in real time, demarcate faulty devices quickly and intelligently, and analyze the root cause of poor quality.

Fault Locating Within Minutes

1. **Proactive issue identification**: Proactively identify 85% of potential network issues through the AI algorithms that are continuously trained via Huawei's 200,000+ terminals.
2. **Fault locating within minutes**: Locate issues within minutes, identify the root causes of issues, and provide effective fault rectification suggestions based on the fault reasoning engine.
3. **Intelligent fault prediction**: Learn historical data through AI to dynamically generate a baseline, and compare and analyze the baseline with real-time data to predict possible faults.

Intelligent Network Optimization

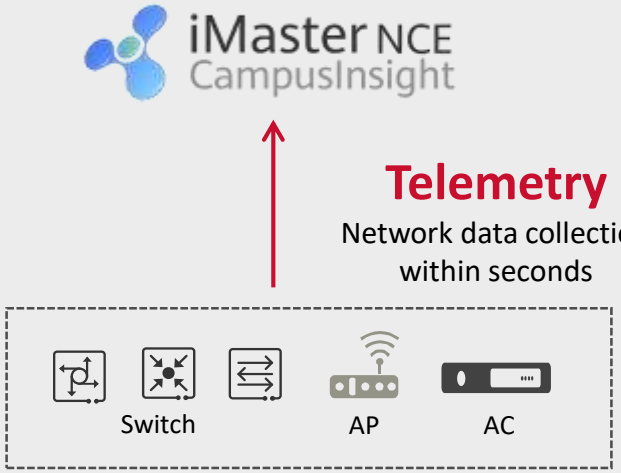
1. **Real-time simulation feedback**: Evaluate channel conflicts on wireless networks in real time and provide optimization suggestions based on the neighbor relationship and radio information of devices on each floor.
2. **Predictive optimization**: Identify edge APs, predict the load trend of APs, perform predictive optimization on wireless networks, and compare the gains before and after the optimization based on historical data analysis. This practice improves the network-wide performance by 50%+ (Tolly-verified).

Meeting Real-Time Analysis Requirements Based on the Telemetry Technology

X

SNMP + Traditional device

- Protocol development stagnation --- SNMP is designed for **limited processing capabilities.**
- Polling technology --- The **minute-level** polling cycle cannot meet the service requirements of **real-time management**.
- Rigid data structure --- **Fixed data structures** are defined, and multiple data requests are required to complete each effective data collection.



Streaming Telemetry technology that uses a de facto standard in the industry:

- Based on HTTP and Protobuf
- Subscription-based release and on-demand use
- Efficient encoding and decoding technology to obtain multiple data records at a time, implementing second-level data acquisition

The quasi-real-time data acquisition capability is the key dependency for the analyzer to mine data.

Monitoring Telemetry Metrics on Wireless Networks

Monitor key metrics on wireless networks based on the telemetry technology, display the wireless network quality from the AP, radio, and client dimensions, and proactively identify air interface performance issues, such as weak-signal coverage, high interference, and high channel usage.

Real-time data display

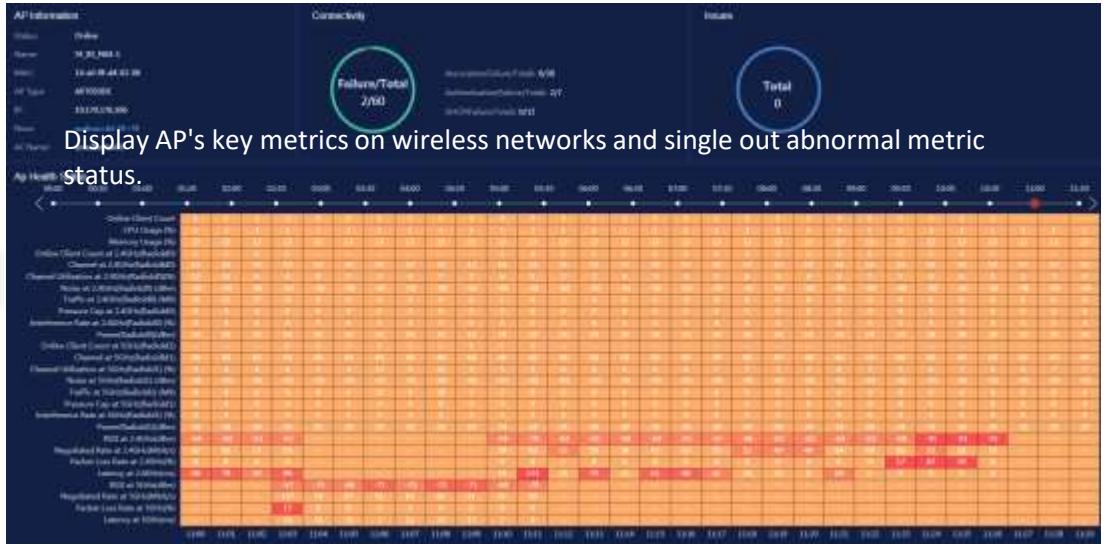
Display key metrics on wireless networks and single out abnormal metric status.

Automatic issue identification

Automatically identify air interface performance issues based on AI algorithms, correlative analysis, and exception modes.

Telemetry metric collection on wireless networks

Measured Object	Measurement Metric	Supported Device Type	Minimum Collection Period
AP	CPU usage, memory usage, and number of online clients	AP	10 seconds
Radio	Number of online clients, channel usage, noise, traffic, backpressure queue, interference rate, and power	AP	10 seconds
Client	RSSI, negotiated rate, packet loss rate, and latency	AP	10 seconds



Display AP's key metrics on wireless networks and single out abnormal metric status.

Automatically identify air interface performance issues based on telemetry metrics, AI algorithms, correlative analysis, and exception modes.

Monitoring Telemetry Metrics on Wired Networks

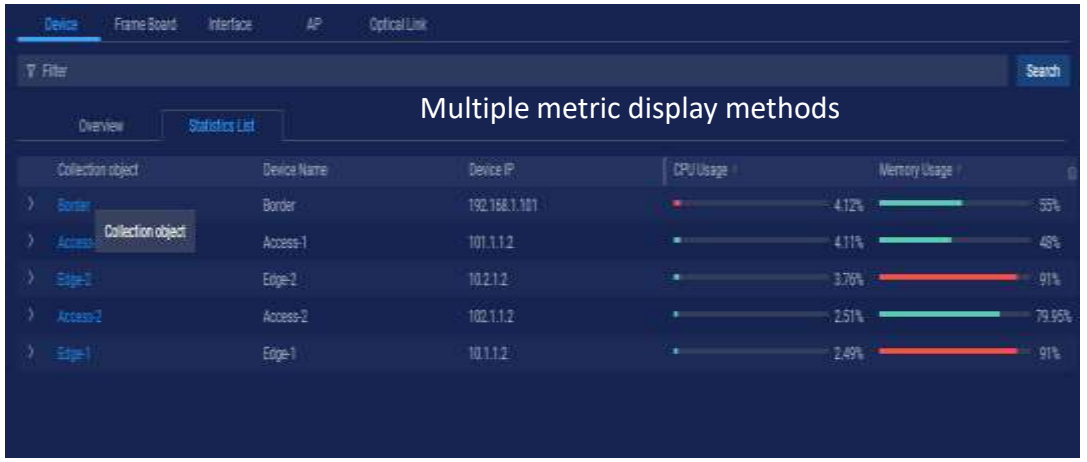
Analyze telemetry metric data of devices, interfaces, and optical links collected through Telemetry on wired networks, and proactively monitor and predict network issues.

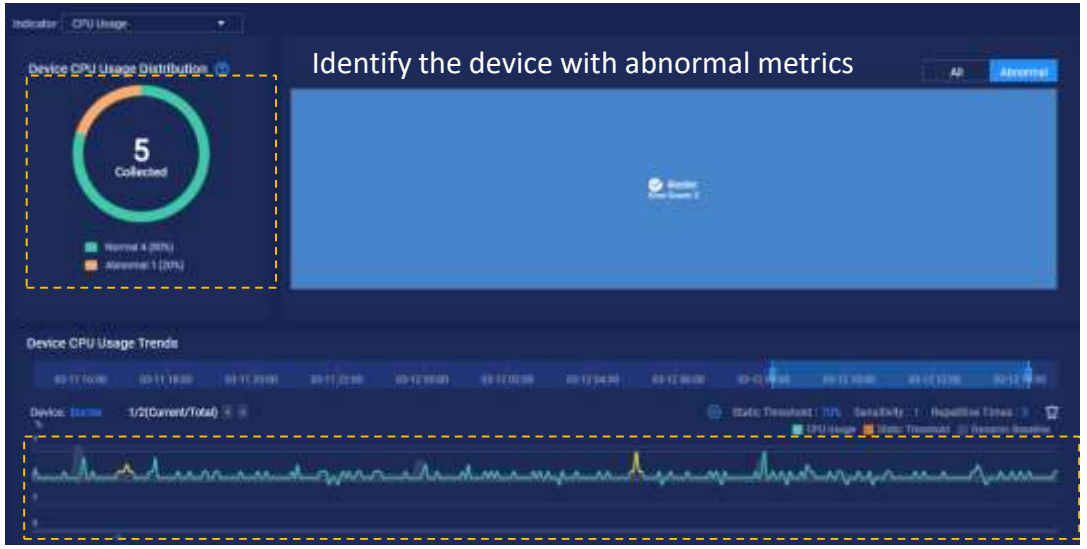
Real-time display of key metrics

Display key metrics on wired networks in real time, including top N devices and historical trend.

Exception detection based on dynamic baselines

Use AI algorithms to predict the baselines of key metrics, such as the CPU/memory usage. Identify network metric deterioration before service interruptions through comparison with dynamic baselines.





Telemetry metric collection on wired networks

Measured Object	Measurement Metric	Supported Device Type	Minimum Collection Period
Device/Card	CPU usage	Switch and AC	1 minute
	Memory usage	Switch and AC	1 minute
Interface	Number of received/sent packets, number of received/sent broadcast packets, number of received/sent multicast packets, number of received/sent unicast packets, number of received/sent packets that are discarded, and number of received/sent error packets	Switch and AC	1 minute

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Use Case 1: Quality Evaluation System

Quality evaluation system:
precisely evaluating network conditions

Rankings: Is the network at the local site better than those of other sites?

Rank sites at same levels in different areas based on their network quality.

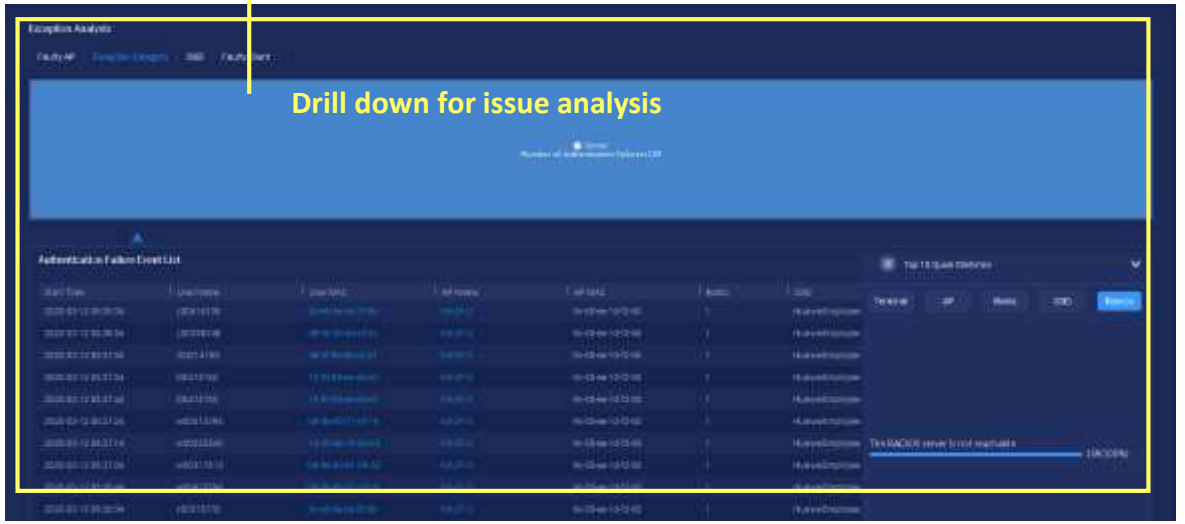
Trend: Is today's network better than several days ago?

Check the network quality trend of a specific site or area to clearly understand the network performance.

Industry benchmark established from 7 dimensions

Establish industry benchmarks from 7 dimensions to continuously improve network quality.

Category	Evaluation Indicator	Root Cause Indicator
Access experience	Access success rate	Association/Authentication/DHCP success rate
	Access time consuming	Time required for association/authentication/DHCP
Roaming experience	Roaming fulfillment rate	Roaming success rate/roaming duration
Throughput experience	Signal and Interference	Client RSSI，Interference rate
	Capacity fulfillment rate	Channel usage/Number of clients
	Throughput fulfillment rate	Interference rate/Non-5G priority rate/Air interface congestion fulfillment rate
Network availability	Device in-service rate	Device in-service rate



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Use Case 2: Protocol Tracing, Locating the Root Cause of Access Faults Within Minutes

3 simple steps to resolve connection issues

Step1 Status — **Check terminal connections**

Check the session access result to determine whether access issues occur.

Step2 Interaction — **Check protocol interaction**

Check the association, authentication, and DHCP phases to determine the abnormal phase.

Step3 Root cause — **Check root causes**

Check possible causes and rectification suggestions.

Connection Phase	Scenario	Supported or Not	
		Wired	Wireless
Association	✓ Associate Request ✓ Associate Response	√	√
Authentication	✓ 802.1X authentication ✓ Portal authentication (Portal2.0 and HTTPS) ✓ MAC address authentication	√	√
DHCP	✓ DHCP Discover: broadcasted by a client. ✓ DHCP Offer: sent by the DHCP server to respond to the DHCP Discover packet. ✓ DHCP Request: sent by the client to request for the IP address carried in the DHCP Offer packet. ✓ DHCP ACK/NAK: sent by the DHCP server to notify the client whether the address request is successfully.	√	√

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Use Case 3: Correlation Analysis for Wi-Fi Experience Deterioration

AI for correlation analysis for Wi-Fi experience deterioration

Step 1
AI identification

Use the AI algorithm to detect outliers and identify clients with deteriorated Wi-Fi experience.

Step 2
AI analysis

Use the correlation analysis algorithm to analyze the network metric with the highest relevance and locate the root cause.

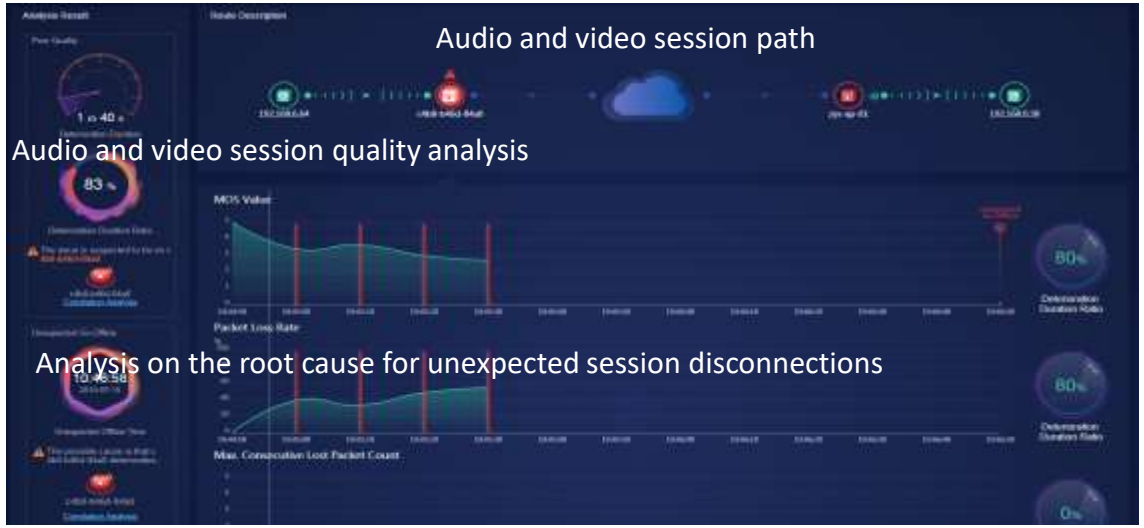
Step 3
AI closed-loop management

Provide the most reasonable rectification suggestions based on Huawei's accumulated O&M expertise.

Use Case 4: Audio and Video Quality Detection

Key technology:

- **Proactive detection of the audio and video quality:** Through the SIP Snooping technology, the analyzer **proactively senses** SIP+RTP audio and video streams, **detects** the setup and teardown of audio and video sessions **in real time**, and automatically uses the **eMDI** technology to monitor the audio and video stream quality during the session period and identify poor-quality audio and video streams.
- **Analysis on the root cause for poor audio and video quality**: Analyze the correlation between the MOS value and air interface metrics (signal strength, interference rate, channel usage, negotiation rate, number of backpressure queues, etc.), wired interface metrics (packet loss rate, buffer usage, etc.), and device metrics (CPU and memory usage), identifying the root cause of poor quality.
- **Analysis on the root cause for unexpected session disconnections**: Automatically analyze the root causes for unexpected audio and video session disconnections, including roaming exceptions, Wi-Fi disassociation, network-side metric deterioration, and signaling interaction exceptions.



Case:

The O&M personnel check the audio and video session list in the office area and find that the session quality is poor for a client. After checking the poor-quality session details, the O&M personnel find that a large number of packets are lost on the access switch of the client. The correlative analysis result of access switch port KPIs shows that the port is congested. After the traffic rate limit is adjusted and the port congestion issue is solved, the quality of the audio and video session becomes normal.

Constraints:

- This feature is supported only for audio and video applications that use non-encrypted SIP signaling and are carried by the RTP in the IPv4 scenario. The supported applications may vary depending on the capabilities of specific device models. Currently, some applications, WeChat, Skype, and WeLink are not supported. Huawei IP phones, such as HUAWEI Video Phone 8950, can function as hard terminals.
- Switches of specific models support audio and video service analysis, while APs of specific models support only audio service analysis. For details, see **HUAWEI Device Support SPEC List** in the CampusInsight specification list.
- Switches of V200R013C00 or a later version and APs of V200R010C00 or a later version are supported.
- Path analysis is supported only on cloud devices.

Use Case: AI-Powered Intelligent Radio Calibration, 50%+ Network-Wide Performance

Scenario 1: manual calibration

About 20% of customers choose to manually plan channels. However, they may face the following challenges:

- Channels planned in manual mode are not the optimal ones.
- Real-time network awareness is not supported.
  The network environment is complex and interference changes rapidly.

Scenario 2: automatic calibration

About 80% of customers choose automatic calibration. However, they may face the following challenges:

- Load balancing is not considered during load sharing calibration
- Only the current network status can be detected.
  Unable to detect historical loads and interference

Real-time simulation feedback

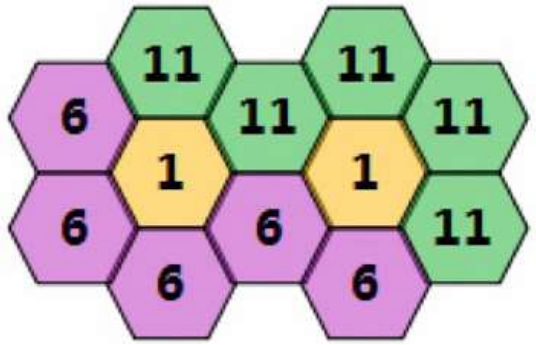
Provide prediction and simulation tools based on real-time feedback of environment changes to drive network optimization.

Predictive calibration

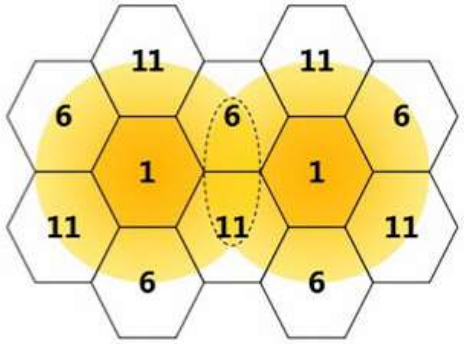
Provide the service weight balancing and optimization capability based on big data analytics and AI.

Manual Optimization, Providing Optimal Channel Planning Suggestions Based on Neural Network Simulation Feedback

Problem:
An IT engineer optimizes the network in the area where a fault is reported. However, faults are reported in surrounding areas after the optimization. The optimization is performed multiple times in several days, but the optimization result is not satisfactory, and the network stability becomes worse.



Interference between APs caused by improper channel planning



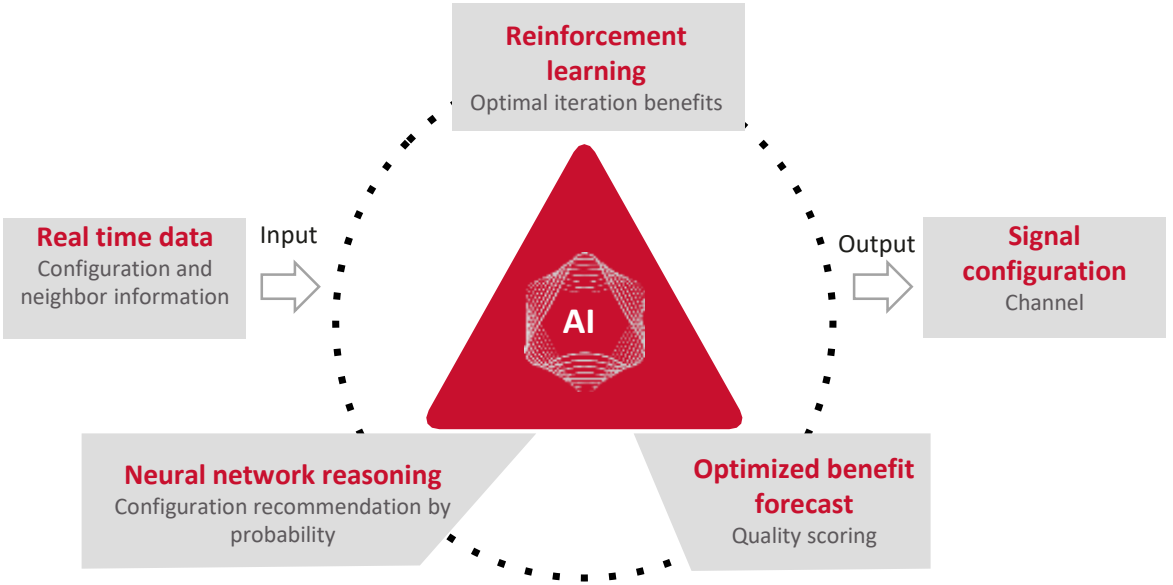
Two APs using channel 1 are too close to each other. As a result, the two APs interfere with each other.

Technical root cause: The impact of inter-AP interference, surrounding interference, and distance must be fully considered during AP configuration. In most cases, optimization can only ensure that the local network is at its optimal state, and **comprehensive network-wide evaluation cannot be provided**.

Challenge

Expert experience-based optimization, high professional requirements; heavy analysis workload; wireless network not planned from the entire network perspective in manual mode

Wireless Network Simulation Feedback Solution

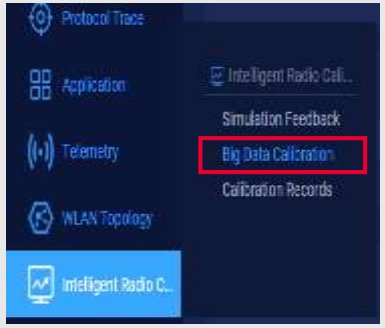


Expected result: network-wide optimal reasoning to **properly** allocate air interface resources; simulation capability (customers evaluate the simulation result based on network scores and **determine whether to deliver the simulation result**)

Predictive Optimization: Demonstration Procedure

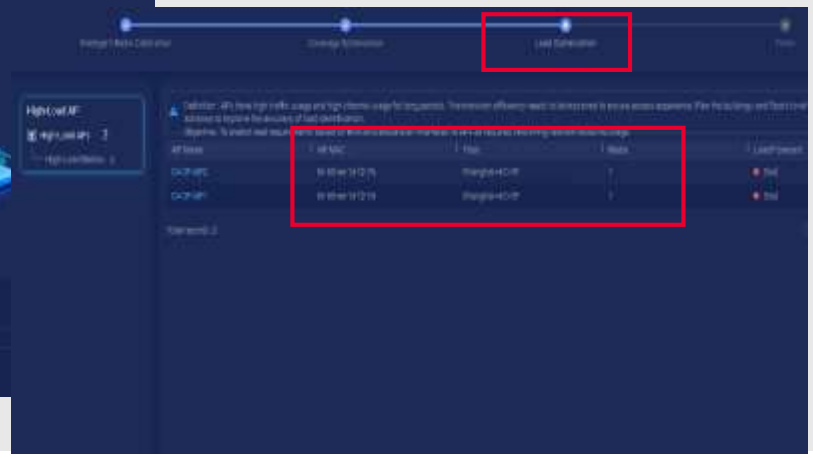
Case:
The wireless network office area of a company was upgraded and reconstructed. Employees were temporarily moved to building C4 for centralized office. As a result, the number of employees in building C4 increased, and the network load also increased. Employees complained that the wireless network response was getting slower. Using the intelligent radio calibration, CampusInsight automatically identified high-load areas in building C4 and accordingly adjusted APs' frequency bandwidth, thereby improving client bandwidth and network experience.

1. Choose Intelligent Radio Calibration and Big Data Calibration.



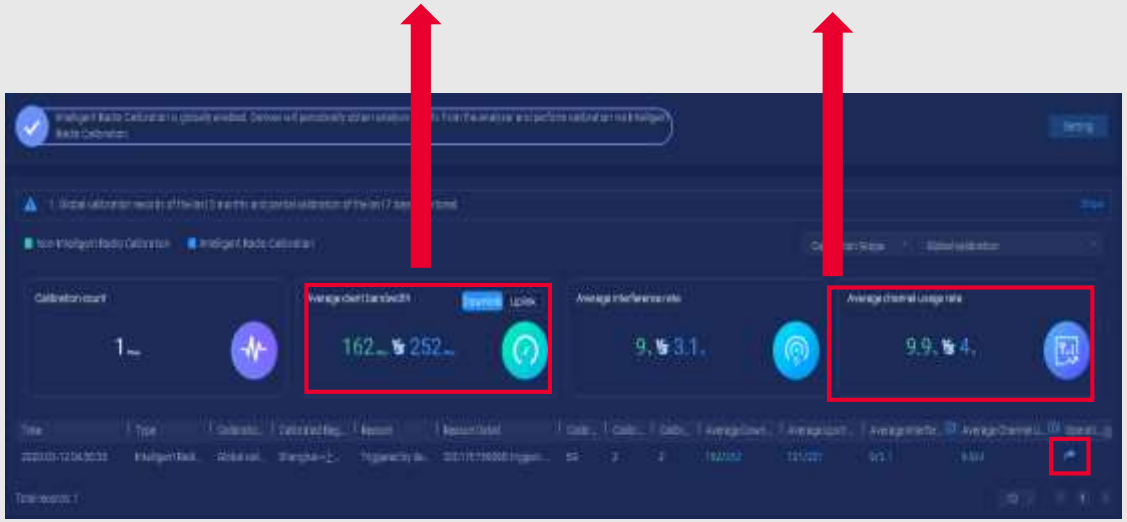
2. Enable intelligent radio calibration. You are advised to enable this function in advance to improve the data training accuracy.

3. Click Next. On the Load Optimization page, many high-load APs are identified by C4-3F.



Demonstration Procedure and Issue Analysis

4. On the second day after big data calibration is enabled, the bandwidth of the APs on the third floor of building C4 is increased to **252 Mbps (by 50%)** and the average channel usage is reduced to **4% (by 50%)**.



5. Check the calibration details. The 5 GHz frequency band of the high-load APs on the third floor of building C4 is **changed from 20 MHz to 40 MHz**. **The Internet access experience is improved and no frame freezing occurs**.
Note: If the frequency band of APs increases, the client bandwidth will also increase.

Use Case Benefits

Using intelligent radio calibration, CampusInsight continuously collects massive data of real clients, identifies high-load APs and edge APs through AI algorithms, and provides decision-making data for differentiated system optimization, enabling the network to follow clients.

Thank you.

Bring digital to every person, home, and organization for a fully connected, intelligent world.