Leading Intelligent IP Networks
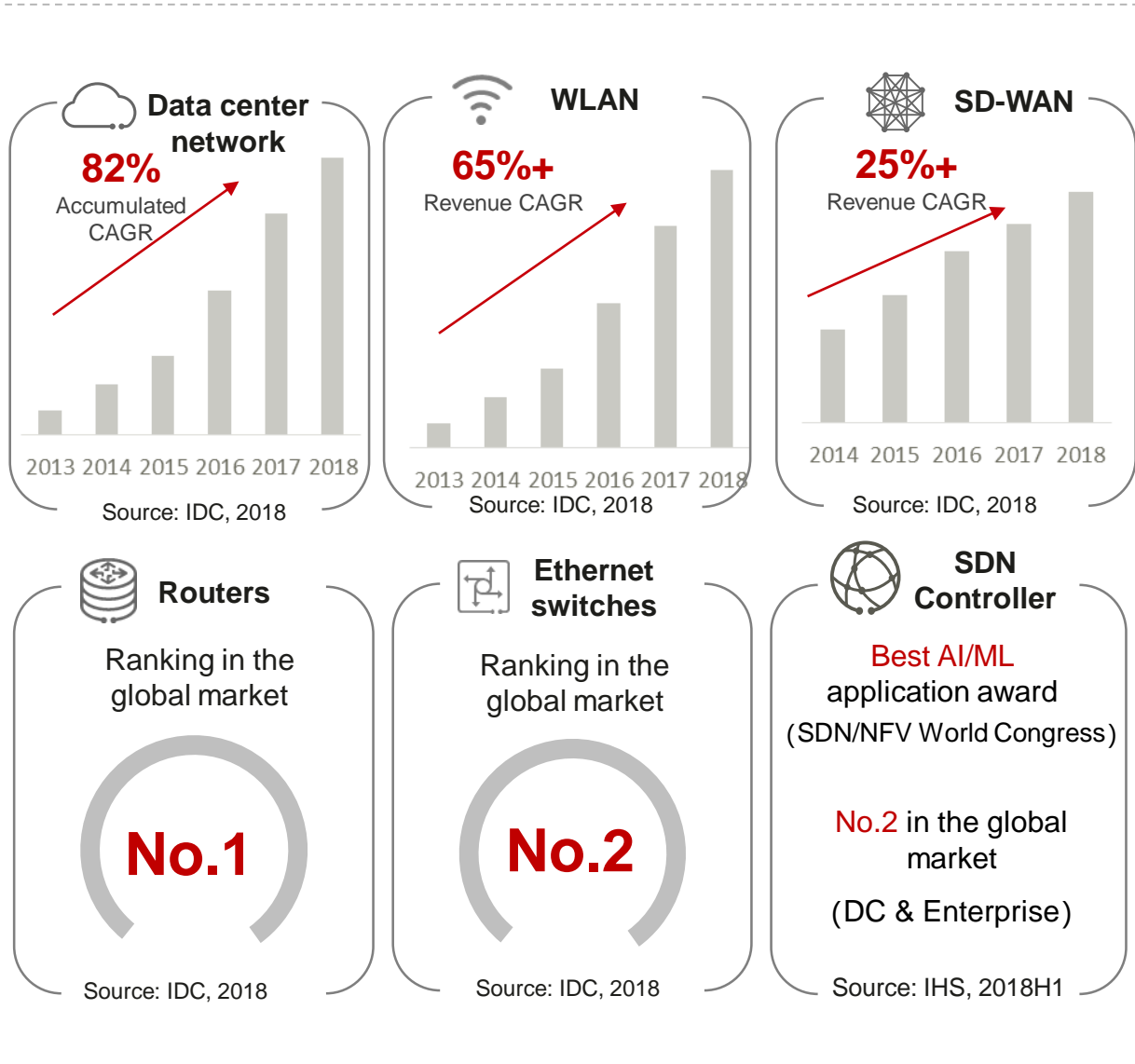
Briefing of Data Communication Product Line

Part 1

Company Overview

Huawei Confidential

HUAWEI
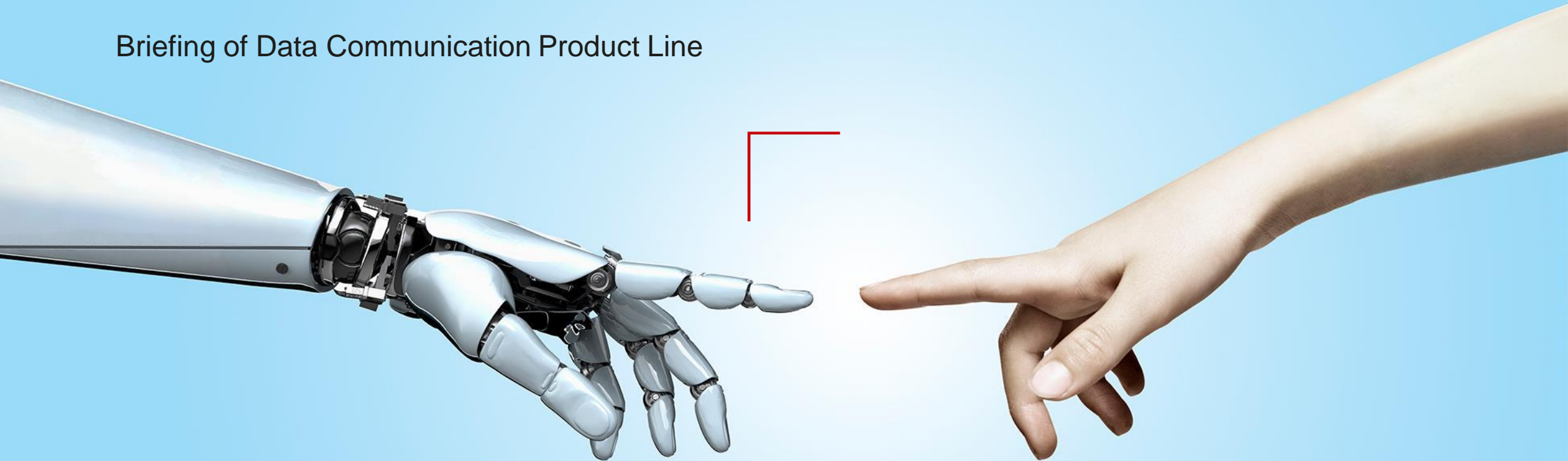
Leading the Data Communication Network Market

Data center network

82%
Accumulated CAGR

2013 2014 2015 2016 2017 2018

Source: IDC, 2018

WLAN

65%+
Revenue CAGR

2013 2014 2015 2016 2017 2018

Source: IDC, 2018

SD-WAN

25%+
Revenue CAGR

2014 2015 2016 2017 2018

Source: IDC, 2018

Routers

Ranking in the global market

No.1

Source: IDC, 2018

Ethernet switches

Ranking in the global market

No.2

Source: IDC, 2018

SDN Controller

Best AI/ML application award
(SDN/NFV World Congress)

No.2 in the global market
(DC & Enterprise)

Source: IHS, 2018H1

Gartner peerinsights customers' choice™

Gartner peerinsights Customer's Choice 2019 @ CloudFabric

Interop BEST OF SHOW AWARD 2019 Grand Prize

Interop 2019 @Routers
Interop 2019 @Wi-Fi 6
Interop 2019 @CampusInsight

Gartner® Magic Quadrant

Positioned as a Challenger for WAN Edge Infrastructure

HUAWEI USG6620E v5ooR010ooC00SPC170 NEXT GENERATION FIREWALL NSS RECOMMENDED JULY 2019

"Recommended" rating
2019 NSS Lab @HisecEngine

8-year consecutive growth of Huawei router business – unique in the industry.

1/3 of global backbone traffic bear by Huawei IP core routers.

700 million hours stable operation accumulatively.

HUAWEI

Shaping IP Industry Standards

12+

Huawei participation in industry standards bodies and open source organizations
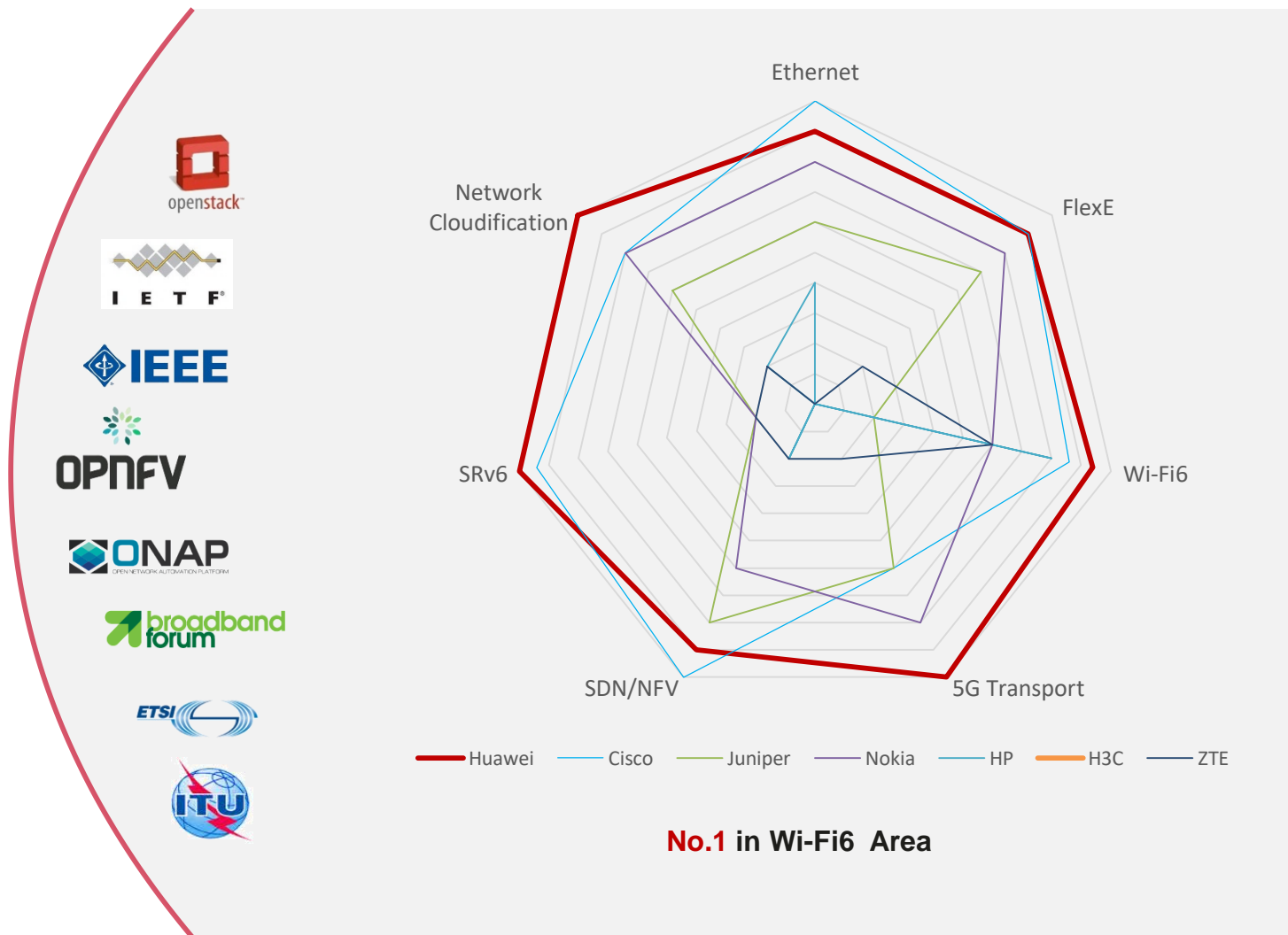
40+

Huawei holds chairman or higher roles including IETF IAB board member & IEEE Wi-Fi 6 TG chairman
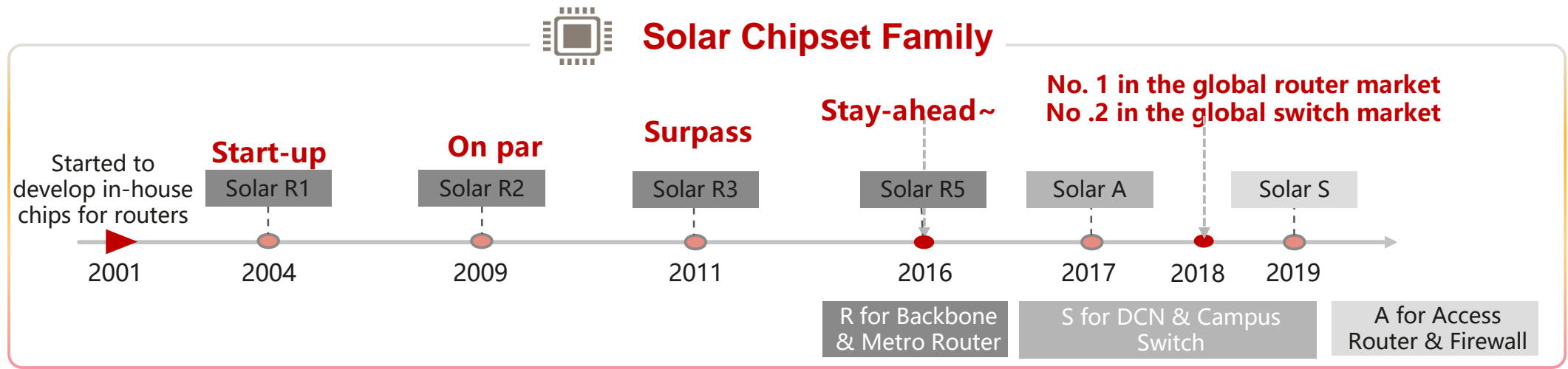
430+

Huawei contributions to IETF RFCs

5100+

Total patents licensed by the end of 2018

No.1 in Wi-Fi6 Area

HUAWEI

Breakthroughs in Foundational Technologies

Solar Chipset Family

No. 1 in the global router market
No .2 in the global switch market

Stay-ahead~

Surpass

On par

Start-up

Started to develop in-house chips for routers

| Solar R1 | | Solar R2 | | Solar R3 | | Solar R5 | | Solar A | | | Solar S |

2001 — 2004 — 2009 — 2011 — 2016 — 2017 — 2018 — 2019

R for Backbone & Metro Router | S for DCN & Campus Switch | A for Access Router & Firewall

High Speed Interconnection

Traditional Material

3~5 um surface roughness

30%↑
Transmission Efficiency

Ultra-low-loss Material

0.3 um surface roughness

56G
Serdes

Super-Cooling: 0.3W/G

Carbon nanotube thermal pad
Phase change heat dissipation

Heat dissipation efficiency — **4x ↑**

Temperature — **19℃ ↓**

Noise — **6dB ↓**

Efficient Power Supply

Intelligent power modules
From N+N -> N+1

Space of power supplies — **45% ↓**

Power supply efficiency — **90% ↑**

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Key Components: Achieving 100% Diversification of Supply Chain

IP Networking

- Comprehensive chipset used in router, switch, security gateway
- Provide programmable capabilities

Computing

- Provide high performance computing capability and AI calculating ability for network
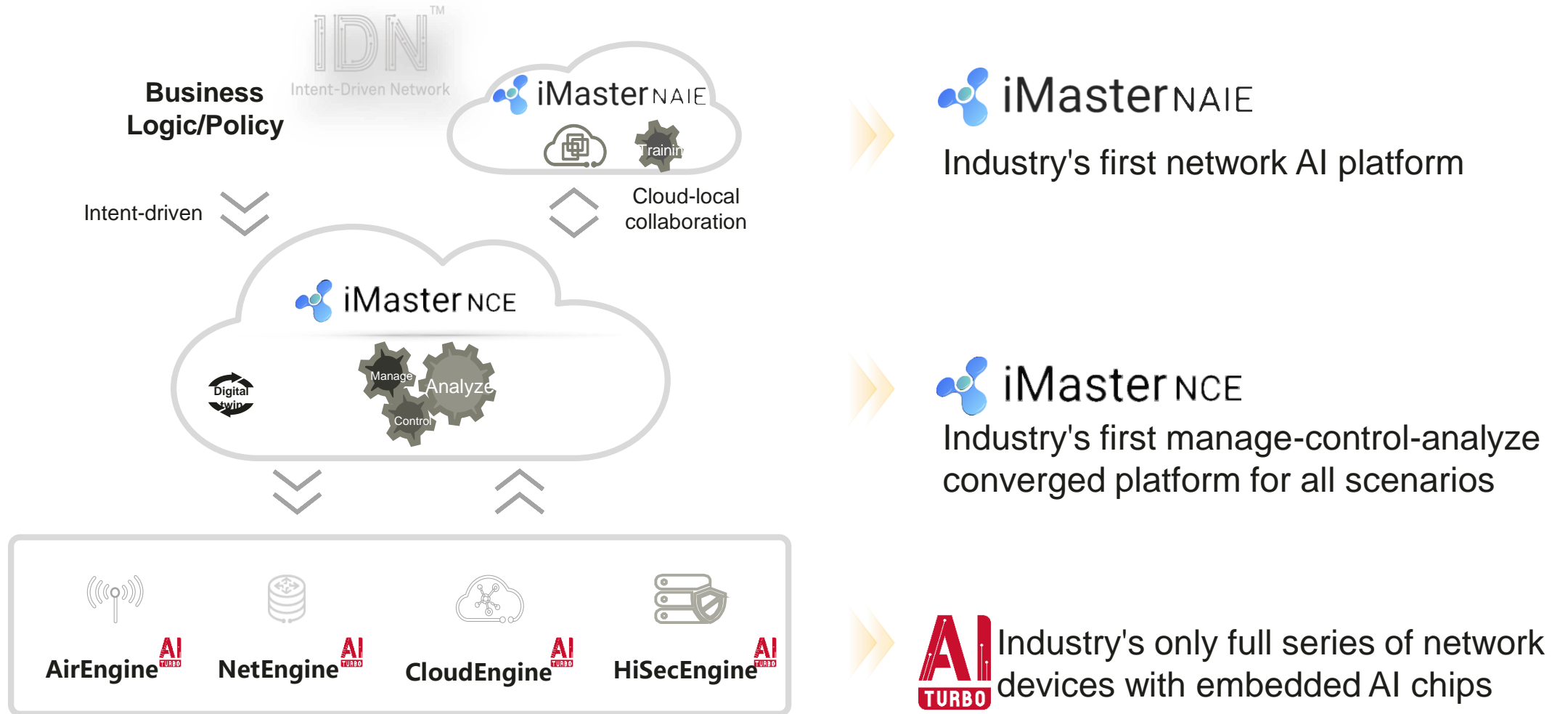
Radio Frequency

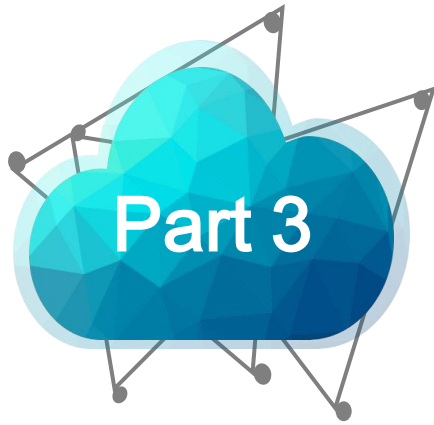- Provide high speed, stable wireless air interface connection

Optical Module

- From GE, 10GE to 100GE, 400GE series optical module

Huawei IDN, Creating a New Era of Intelligent Networks

IDN™
Intent-Driven Network

Business Logic/Policy

iMaster NAIE

Training

Intent-driven

Cloud-local collaboration

iMaster NCE

Digital twin

Manage Analyze
Control

AirEngine **AI** TURBO   NetEngine **AI** TURBO   CloudEngine **AI** TURBO   HiSecEngine **AI** TURBO

iMaster NAIE

Industry's first network AI platform

iMaster NCE

Industry's first manage-control-analyze converged platform for all scenarios

AI TURBO Industry's only full series of network devices with embedded AI chips

HUAWEI

Part 3

Trends and Insights

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Digital Transformation bring new challenges to network

Enterprise Digital Transformation Has Entered the Fast Lane, The Network Needs to be Upgraded to Support New Business Through New Technologies.

Wi-Fi 6

90% Enterprises Use Wi-Fi to bear large traffic by 2023

55% Rates of Biz. IoT in billion connections by 2025

How to deal with **large bandwidth** and **massive connections**

AI

86% of enterprises will adopt AI in services by 2025

80% Enterprise data utilization rate by 2025

How will networks **unleash** AI power?

Cloud

85% Apps on the cloud by 2020

100% Enterprises on the cloud by 2025

How can networks **ensure** the cloudification experience of enterprises?

Security

60% Digital enterprises will encounter major security incidents by 2020

How to **Guarantee** ICT Security of Enterprises by Network

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Leading Intelligent IP Networks

Everything connected
Ubiquitous connectivity, the ultimate experience

Intelligent Connection
Unparalleled intelligence, 100% AI computing power

Intelligent Security

HiSecEngine

Things

AirEngine

Persons

Ultra-broadband
fabric Interconnection

CloudEngine

AI

WAN

Cloud

5G   Enterprise

NetEngine

Home

HUAWEI

Part 3
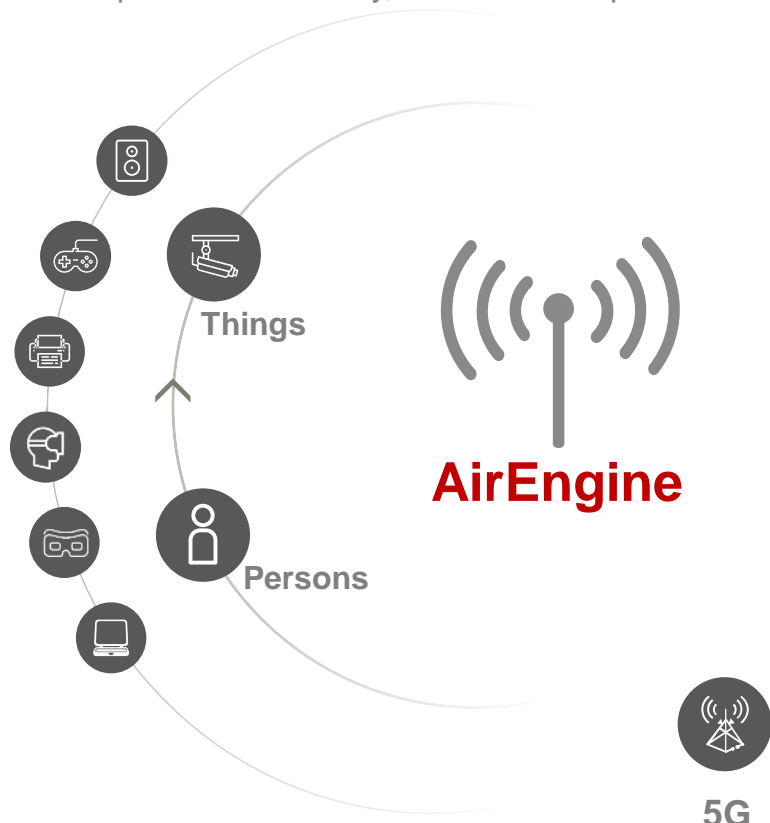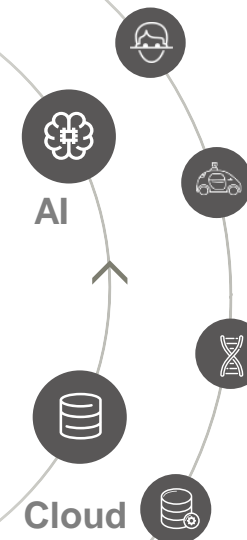
Solutions and Joint Innovations

CloudCampus: Building a Bridge Between IT Networks and Business

ESL Mgmt. Asset Mgmt. Crowd Heatmap Mgmt. Student Health Mgmt. AGV

Open Industry Application Development Platform SDK | API

iMaster NCE

Automatic network mgmt. **Intelligent network O&M**

CloudEngine S Series

AirEngine

Adaptive Array Antenna

Dynamic Turbo

Lossless Roaming

High-density Auditorium

Immersive Classroom

Unmanned Storage
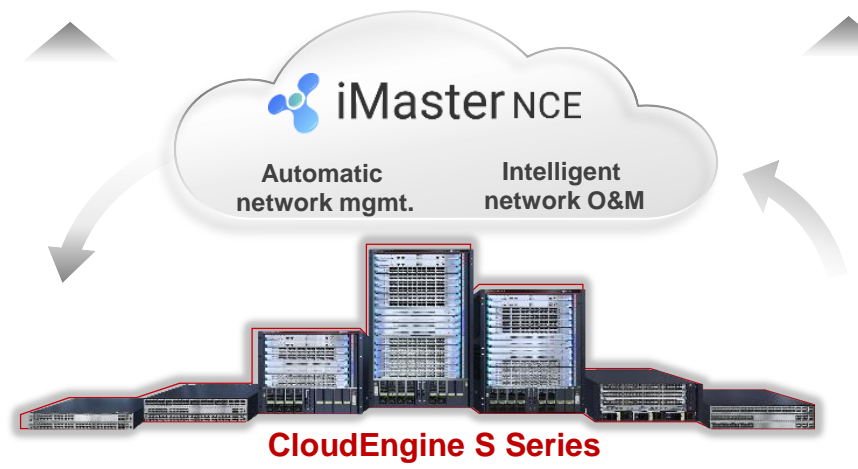
Automatic Warehouse
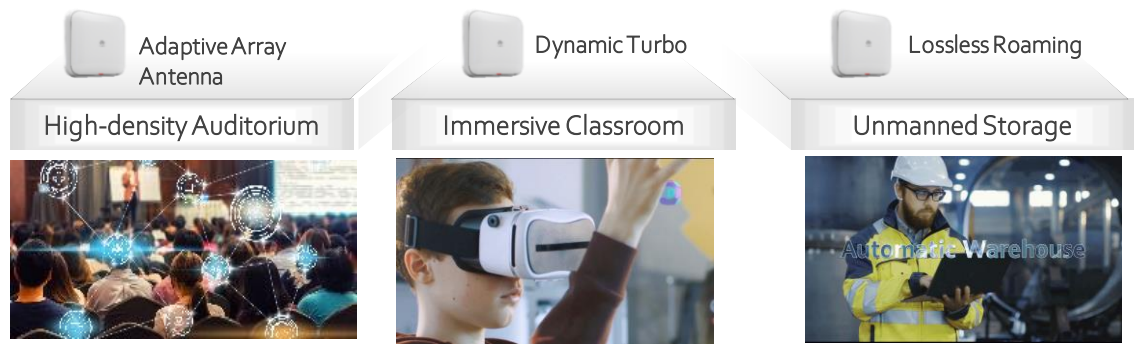
Requirement: : 500 concurrent, 100Mbps/STA

Challenge: Wi-Fi coverage with blind spot

Requirement: Network E2E delay <15ms

Challenge: VR user is easy to vertigo

Requirement: AGV roaming packet loss<0.5%

Challenge: Packet loss rate >1%, causes connection interruption

iMaster NCE-Campus: AIOps, One-stop NMS

	Huawei	Vendor C	Traditional
NMS	1 Platform TCO saving 2/3	4 Platform	CLI
Deployment	15 Mins	~2.5 Hours	Days
Operation	Intelligent Radio Calibration Terminal Speed 58%	No-support	NA

Note：one site with 1000+ devices can be deployed within 15 mins in 5 steps

CloudEngine S Series: 6x Throughput, Smooth Evolution

Capacity	Open Architecture	Reliability
6x Industry	**300+** 3rd Device	**99.999%**
Solar S Chip	Programmable Solar Chip	Distributed Design MPU and SPU

AirEngine: Highest Performance, Best Experience

		AirEngine Wi-Fi 6	Industry Wi-Fi 6	Wi-Fi 5
Highest performance	Terminal Speed	~3.6Gbps	2.5Gbps	900Gbps
	Coverage Range	1.2X	1X	1X
	Access User	1024/AP	1024/AP	256/AP
Best experience	E2E Latency	~10ms	~20ms	>30ms
	Roaming Packet Loss	0%	0.7~1.5%	1~3%

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AirEngine Wi-Fi 6, Powered by Huawei 5G Strengths

Industry vendor

AP7060DN

VR/AR e-classroom

E2E latency < 15 ms

10 ms
Low latency

Dizziness-free AR/VR

vs.

20+ ms

IoT access

Wi-Fi & IoT unified management

Wi-Fi & IoT
Network convergence

TCO reduction by 50%

vs.

None

AGVs in smart warehouses

Zero packet loss during roaming

0%
packet loss

100% roaming success

vs.

1.5%

Three Technical Innovations Deliver Ultimate Experience

Dynamic Turbo
Low latency for key services

Lossless Roaming
Zero packet loss during roaming

Adaptive Array Antenna
Full Wi-Fi coverage without blind spots
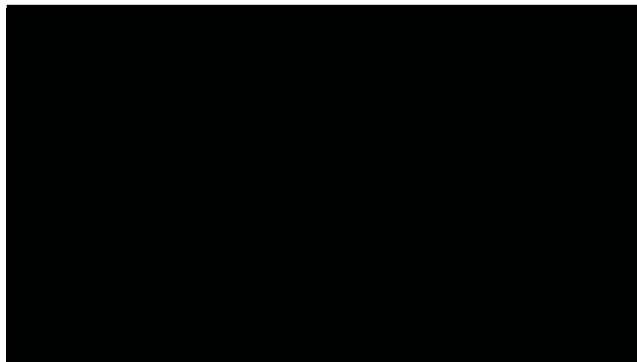
- Multi-queue packet scheduling acceleration algorithm
- Latency for high-priority applications: as low as **10 ms**
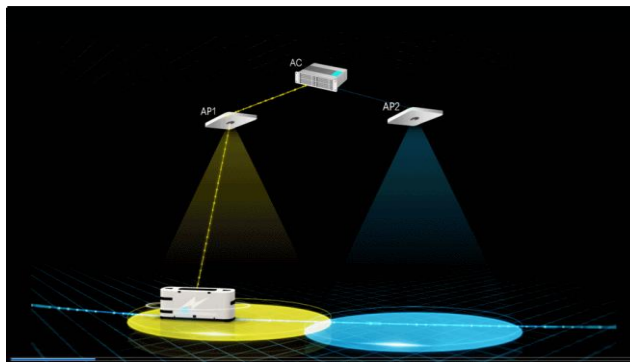
- Edge intelligence, device-pipe synergy, and lossless resumable transmission
- **Zero** packet loss during roaming for AGVs
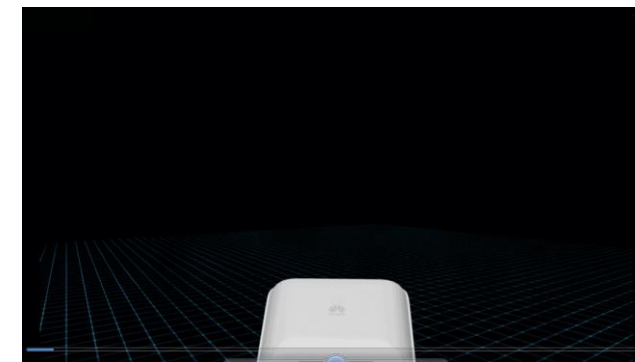
- Signal movement with users and optimized coverage directions at any time
- **20%** more coverage range

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Huawei AirEngine AP7060DN
Wins Best of Show Award Grand-Prize at Interop Tokyo 2019

· Ultra-large bandwidth   · Ultra-high capacity

· Ultra-low latency   · Flexible IoT expansion

Leading Intelligent IP Networks

Brand-new CloudEngine S12700E,the Ideal Campus Switch for Wi-Fi 6 Era
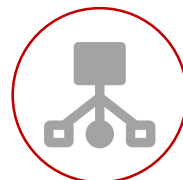
New Flagship with Solar S Chips

CloudEngine S12700E

Superfast forwarding

Super large capacity

57.6 Tbit/s, leading in the industry

Converged access

Native WLAN AC

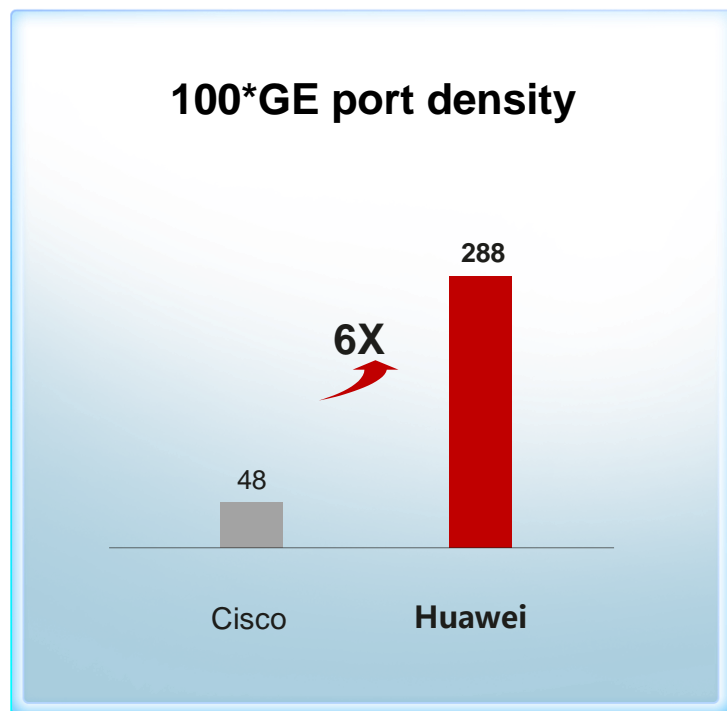Wired/Wi-Fi/IoT converged access, leading in the industry

Smooth evolution

Full programmability

Fast response to network service needs without hardware upgrades

HUAWEI

CloudEngine S12700E: an Industry's leading switch with High Performance

100*GE port density

288

6X

48

Cisco | **Huawei**

TEST REPORT

Bandwidth per slot

4.8Tbps

2X

2.4Tbps

Cisco | **Huawei**
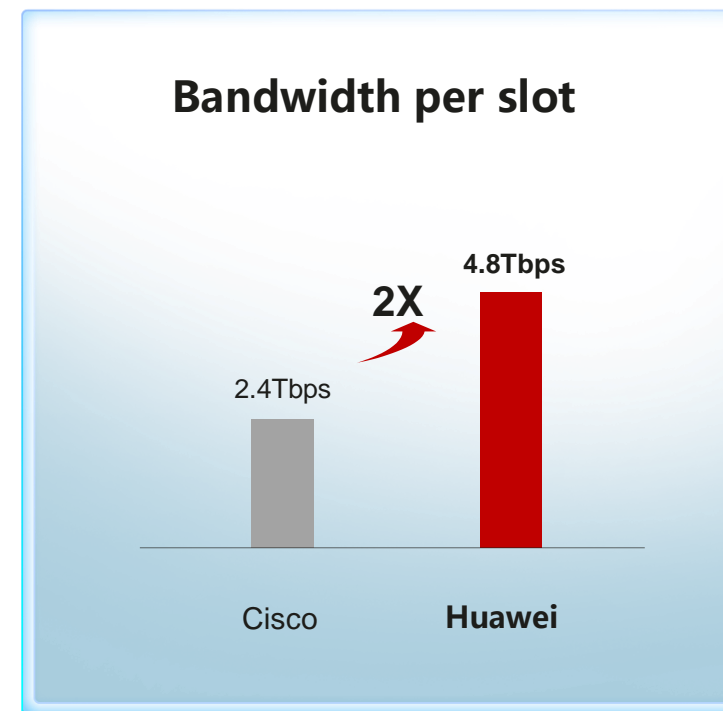
注：CloudEngine S12700E vs Catalyst 9600

HUAWEI

AI-Powered iMaster NCE-CampusInsight - Improving Wi-Fi Experience

Visualized user experience

1. **Each moment**

2. **Each client**

3. **Each application**

Issue identification and proactive prediction

1. **Automatic issue identification**
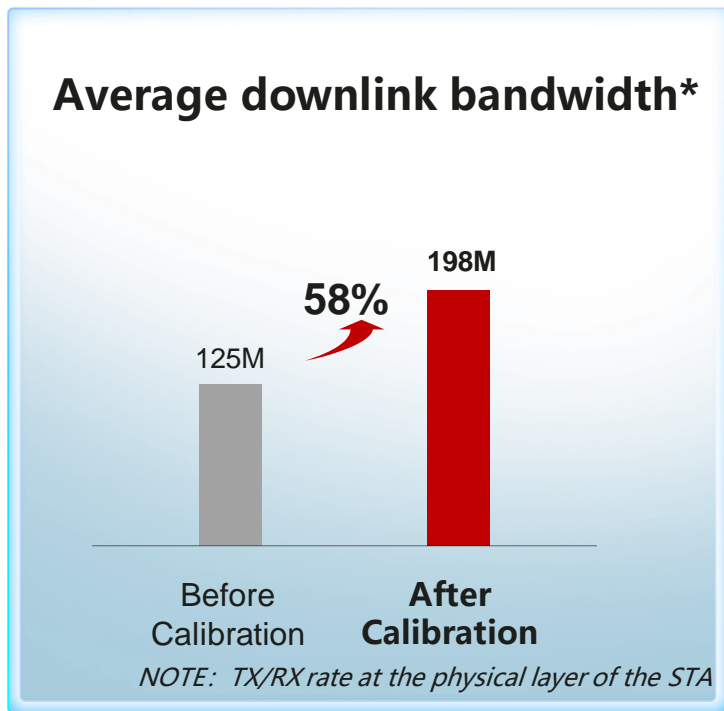
2. **Identification of potential faults**

Quick fault demarcation and root cause analysis

1. **Quick fault demarcation**

2. **Intelligent root cause analysis**

Intelligent Radio Calibration, improved Wi-Fi performance by 50%+

Test environment: Wi-Fi network in Huawei H2 office, 370 APs, and 3000+ terminals

Average downlink bandwidth*

198M

58%

125M

Before
Calibration

**After
Calibration**

NOTE: TX/RX rate at the physical layer of the STA

TEST REPORT

Average interference rate

5.5%

49%

2.8%

Before
Calibration

**After
Calibration**

Award-Winning Proven Success: Serving 1,500+ Customer

"Huawei continues product development in areas such as unified network management, location-based services and advanced analytics for network assurance, with a portfolio and roadmap that generally **keep pace with market requirements**."

—— *Gartner 2018*

CloudCampus: Interop Best of Show Award

CampusInsight: Interop Best of Show Award

AP7060DN: Interop Best of Show Award

Government & Enterprise

Haarlemmermeer municipal government in the Netherlands

BPCE Group in France

Planalto Palace in Brazil

CCTV in China

Education

ETH Zurich in Switzerland

KMITL in Thailand

Lincoln University in New Zealand

University of Hong Kong

Retail & Commerce

Unieuro in Italy

OTG Norway

Hotusa hotel Spain

Dongfeng Honda in China

Other

Enel in Italy

Prague Public Transport Company (DPP) in Czech Republic

Dortmund Stadium

China National Stadium in China

HUAWEI

Huawei CloudEngine Data Center Switches Recognized as the Gartner Peer Insights

Customers' Choice

Huawei is the only non-North American Vendor that has won this award

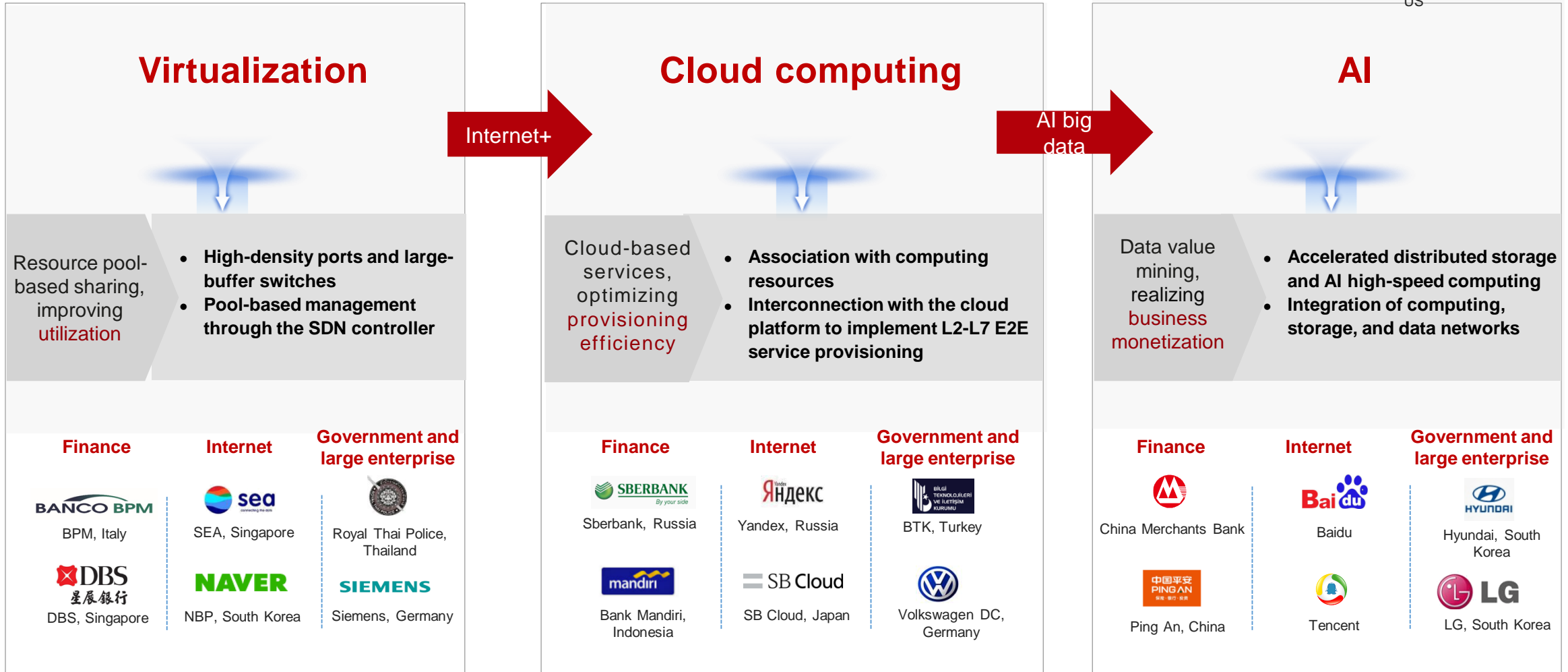| **Tier-1**	**200k**	**100%**
authoritative consultant agencies	reallife comments/scoring	from professional users

Enterprise Data Centers Have Undergone Virtualization and Are Moving from the Cloud Era to the AI Era

Data source: IDC report, excluding the US

Virtualization

Resource pool-based sharing, improving utilization

- **High-density ports and large-buffer switches**
- **Pool-based management through the SDN controller**

Finance	Internet	Government and large enterprise
BANCO BPM	sea	Royal Thai Police
BPM, Italy	SEA, Singapore	Royal Thai Police, Thailand
DBS 星展銀行	NAVER	SIEMENS
DBS, Singapore	NBP, South Korea	Siemens, Germany

Internet+

Cloud computing

Cloud-based services, optimizing provisioning efficiency

- **Association with computing resources**
- **Interconnection with the cloud platform to implement L2-L7 E2E service provisioning**

Finance	Internet	Government and large enterprise
SBERBANK By your side	Яндекс	BILGI TEKNOLOJİLERİ VE İLETİŞİM KURUMU
Sberbank, Russia	Yandex, Russia	BTK, Turkey
mandiri	SB Cloud	Volkswagen
Bank Mandiri, Indonesia	SB Cloud, Japan	Volkswagen DC, Germany

AI big data

AI

Data value mining, realizing business monetization

- **Accelerated distributed storage and AI high-speed computing**
- **Integration of computing, storage, and data networks**

Finance	Internet	Government and large enterprise
China Merchants Bank	Baidu	HYUNDAI
China Merchants Bank	Baidu	Hyundai, South Korea
中国平安 PING AN	Tencent	LG
Ping An, China	Tencent	LG, South Korea

HUAWEI

DCNs Face Four "100-Fold" Challenges Amid Server Upgrades

100-fold increase in interface bandwidth
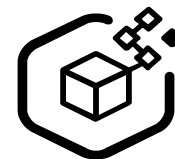
NIC: 1GE → 100GE

Challenge 1: Connection Performance

100-fold improvement in computing power
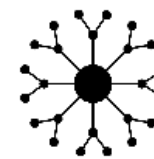
CPU: 1T FLOPS→
GPU: 100T FLOPS

Challenge 2: Connection Efficiency

100-fold improvement in virtualization capacity

1 BM → 100 containers
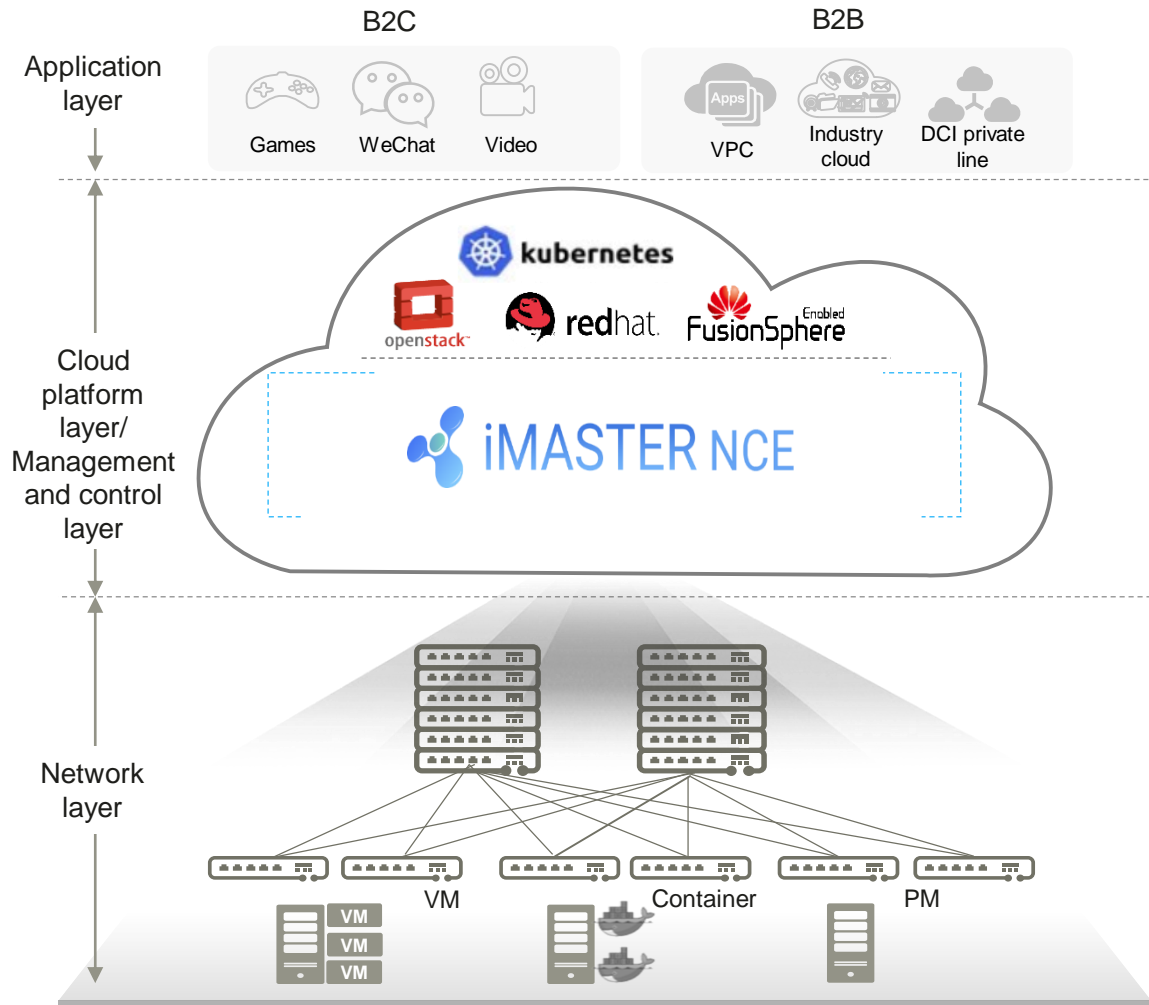
Challenge 3: Deployment Speed

100-fold increase in DC scale

Single cluster: 100 NEs → 10,000 NEs

Challenge 4: Troubleshooting

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Huawei CloudFabric Data Center Network Solution: Coping with Four "100-Fold" Challenges

B2C

B2B

Application layer

Games | WeChat | Video

VPC | Industry cloud | DCI private line

Cloud platform layer/ Management and control layer

kubernetes

openstack | redhat | FusionSphere Enabled

iMASTER NCE

Network layer

VM | Container | PM

Fastest controller deployment

Cope with 100-fold virtualization increase

iMASTER NCE

3x deployment efficiency

World's highest-performance switch

Meet needs of 100-fold interface bandwidth increase

CloudEngine16800

One CloudEngine16800 = **5** counterparts

Most intelligent analyzer

Cope with 100-fold DC expansion

iMASTER NCE

Intelligent O&M, ensuring **zero** service interruption

Industry's only zero-packet-loss Ethernet

Adapt to 100-fold computing capability improvement

AI Fabric

Zero packet loss and 100% computing power

HUAWEI
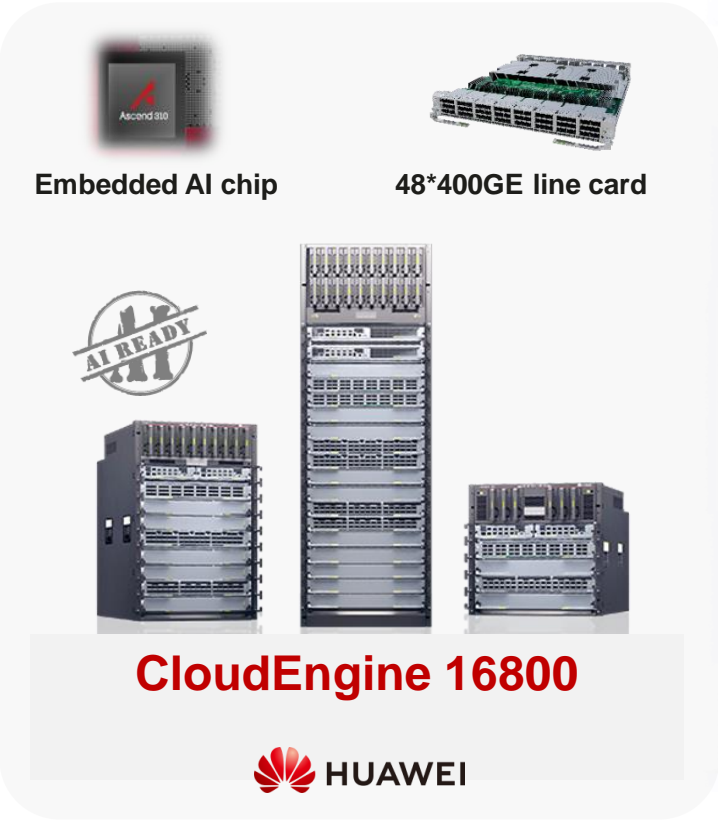
"100-Fold" Challenge 1: The Server Port Rate Is Improved 100-Fold, Requiring Higher Performing Switches

100GE
25GE
10GE
GE

400GE
100GE
40GE
10GE

Server Port   TOR downlink port   TOR uplink port   Core switch port
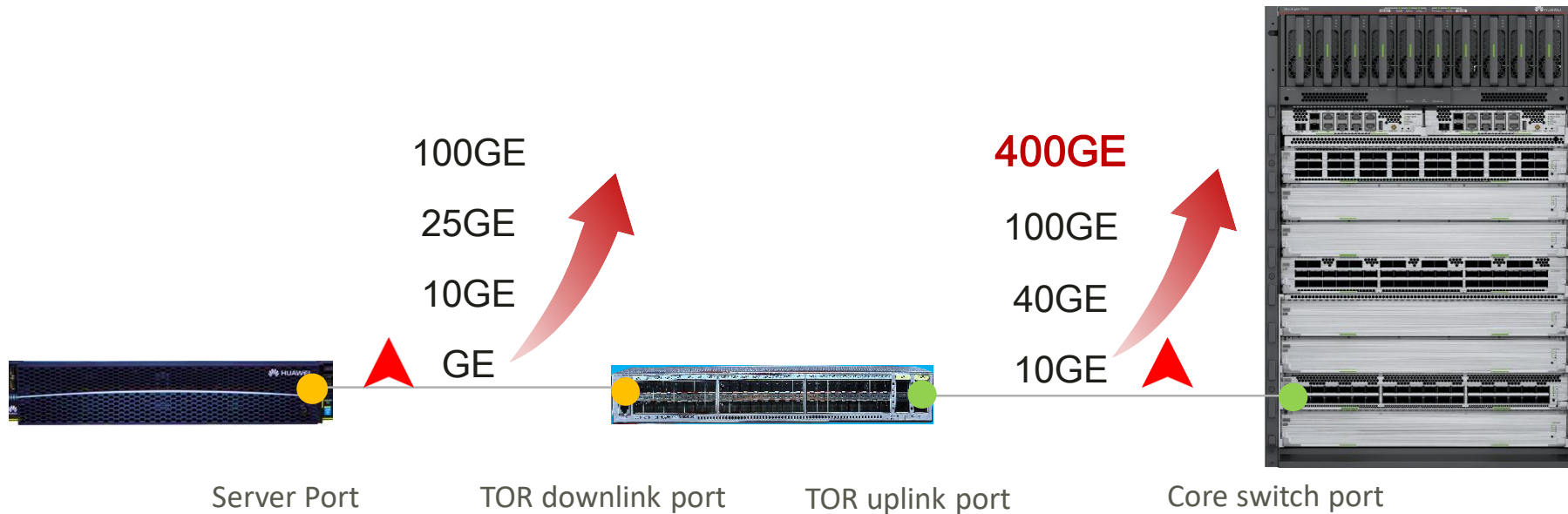
The digital flood doubles the data volume every 18 months, driving the network upgrade.

HUAWEI

Industry's First Data Center Core Switch Built for the AI Era, with Unmatched Performance
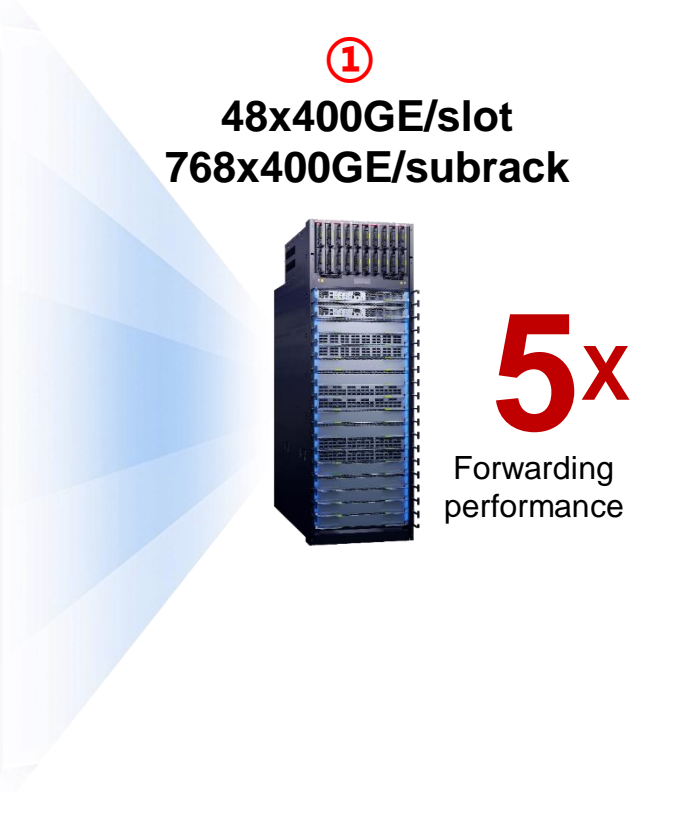
② Full compatibility:
10G→40G→100G→400G

Hardware strength: 1 CloudEngine 16800 = 5 Nexus 9500s

Embedded AI chip   **48*400GE line card**

AI READY

CloudEngine 16800
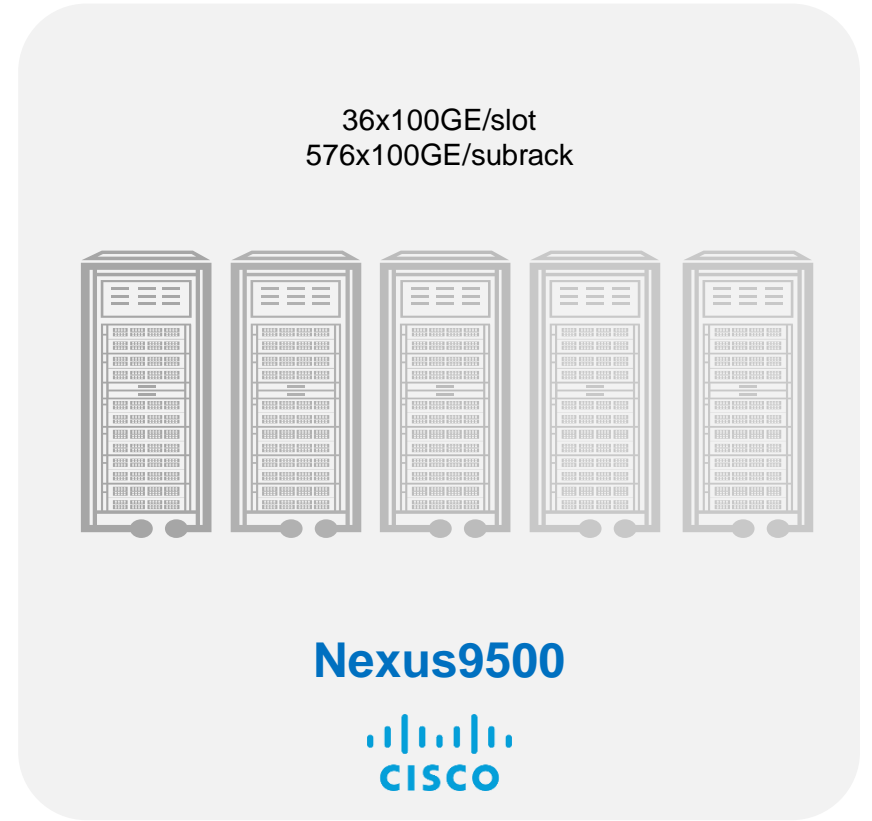
HUAWEI

①
**48x400GE/slot
768x400GE/subrack**

5x
Forwarding performance

36x100GE/slot
576x100GE/subrack

Nexus9500

CISCO

③ **Huawei's fully self-developed CloudEngine 16800 is more competitive and cost-effective than Cisco N9000**

HUAWEI

Three Innovations, Addressing the Industry's High-Density 400G Headaches

> 56GE SerDes

< 0.15 W/GE

PUE < 1.1
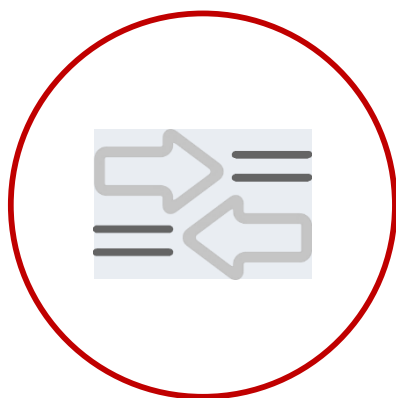
Ultra-High-Speed Signal Transmission

SuperFast™

Efficient Power Supply

SuperPower™

Powerful Heat Dissipation

SuperCooling™

112G SerDes requires lower loss of common materials. Traditional materials can only be used to achieve 12 slots in height. How can 16 slots be made available?

Higher integration: 250 A → 700 A
How can the size of a power distribution unit be controlled?

Power consumption density increases by three times in the 400GE era.
How can efficient heat dissipation be achieved to meet DC PUE requirements?

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"100-Fold" Challenge 2: Computing and Storage Performance Grows 100-Fold, and High Network Packet Loss Rate and Latency Restrict Computing Power

Compute server

Network

Storage server
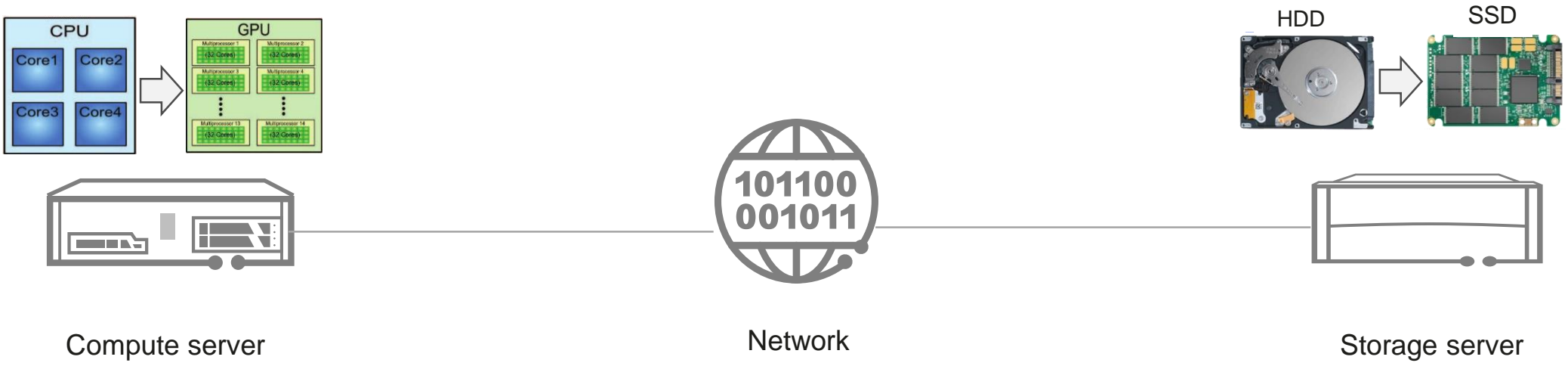
E2E latency before computing and storage performance improvement:

| 10 ms | 1 ms | 10 ms |

E2E latency after computing and storage performance improvement:

0.02 ms   1 ms   0.02 ms
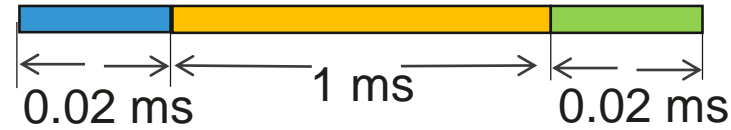
Note: 99% of the network latency is caused by packet loss.

HUAWEI

# AI Fabric Is the Only Ethernet in the Industry That Achieves Zero Packet Loss and 100% Computing Power

AI Fabric

CloudEngine 16800

CloudEngine 16800

AI chip

Ascend 810

iLossless algorithm

Compute cluster

Storage cluster

CloudEngine 8850

CloudEngine 6865

CloudEngine 8861
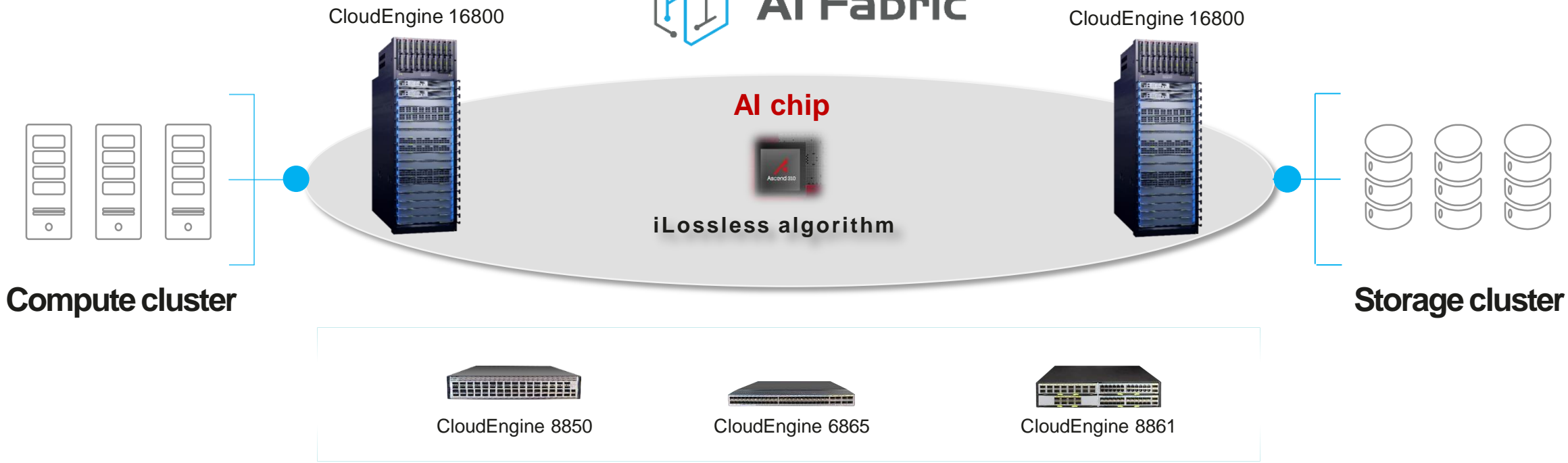
Zero packet loss   **100%** throughput   **< 10** μs E2E latency

HUAWEI

Huawei AI Fabric, Innovative iLossless Algorithm

Per-flow service awareness
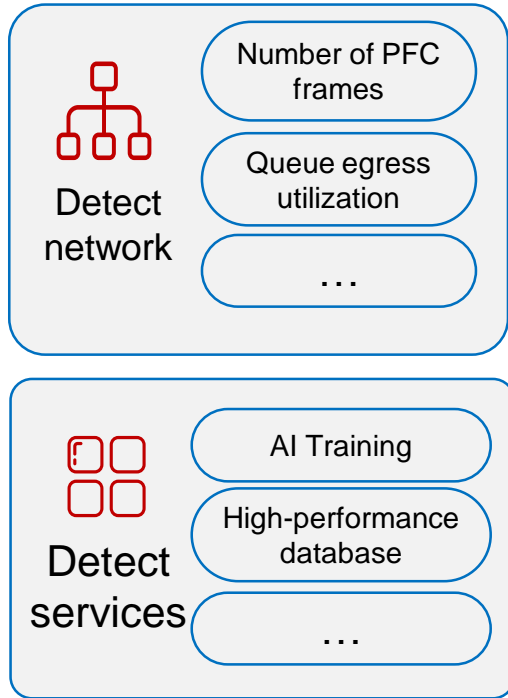
Millions of flows and tens of thousands of queues
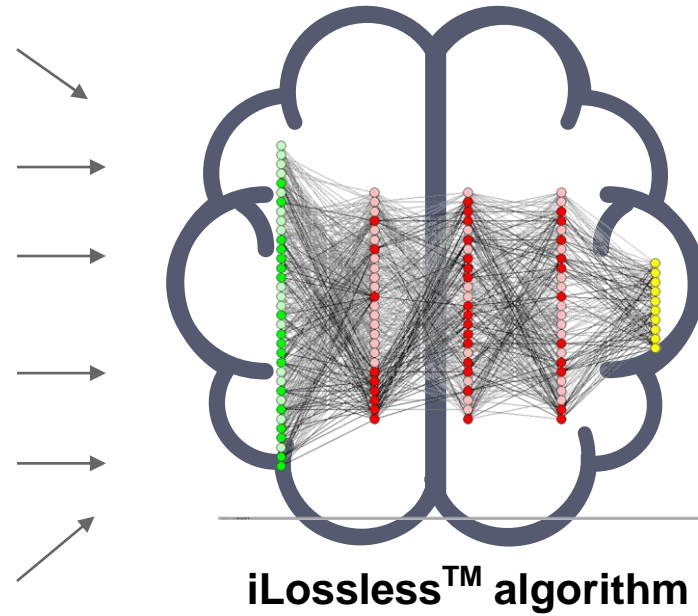
Intelligent **optimal** matching between **flows and queues**

Number of PFC frames

Queue egress utilization

…

Detect network

AI Training

High-performance database

…

Detect services

iLossless™ algorithm

Flows and queues

Dynamic waterline

< 10 µs E2E latency

Zero packet loss

100% throughput

HUAWEI
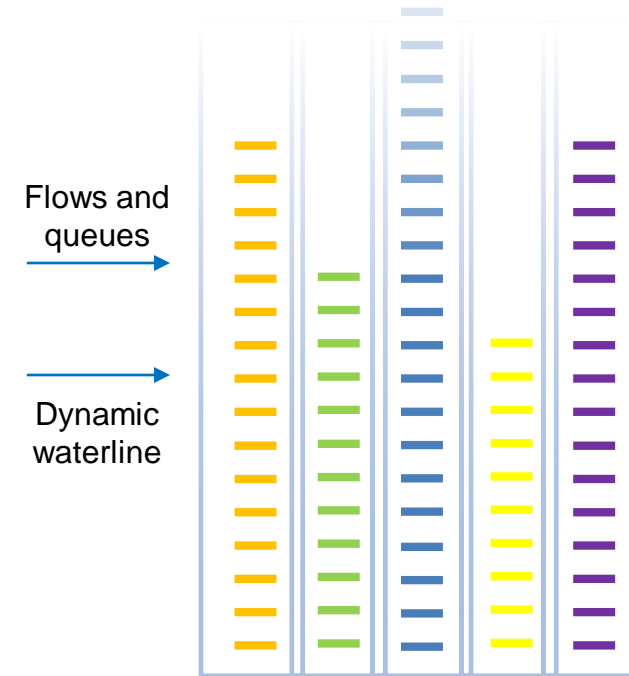
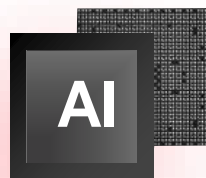# Industry's First Switch with Embedded High-Performance AI Chips: Adding an Intelligent Plane to the Switch

iLossless algorithm running on the best platform

Highly efficient AI chip

8 TFLOPS

Dual-channel high-performance CPU server

AI

= 25

Note: ML/DL running efficiency comparison
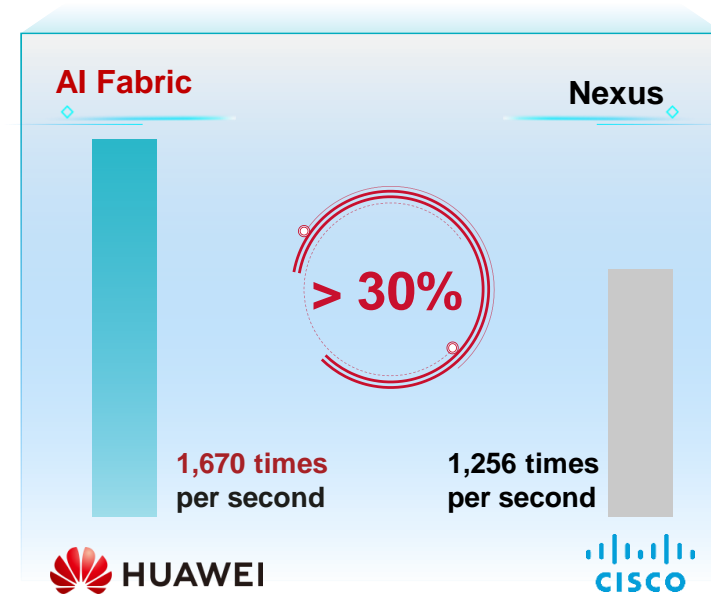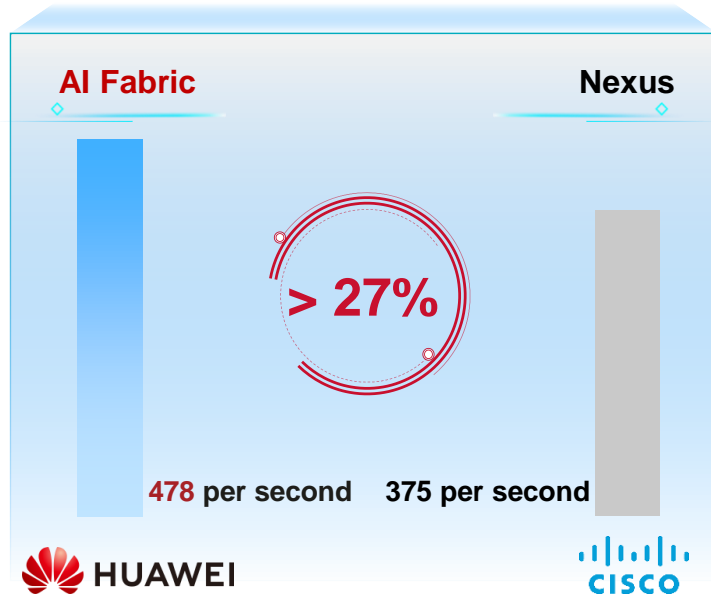
CloudEngine 16800

HUAWEI

Tolly-Certified: Performance of AI Fabric Is ~30% Higher Than Industry Average

(Number of AI training iterations per second)

(IOPS per second)

Data computing efficiency

Data storage efficiency

Best of ShowNet Award
at Interop in 2018

Third-party international
authoritative testing
institution

AI Fabric — Nexus

> 27%

478 per second   **375 per second**

HUAWEI   CISCO

AI Fabric — Nexus

> 30%

**1,670 times
per second**   **1,256 times
per second**

HUAWEI   CISCO

HUAWEI

"100-Fold" Challenge 3: 100-Fold Growth in Virtualization Capacity and Faster Rollout of Compute Nodes (Hours -> Seconds)

Each time a compute node is added, a network administrator needs to configure over 10 commands.

Configure VLANs.
[~SwitchA] vlan batch 2 3
[*SwitchA] interface 10ge 1/0/1
[*SwitchA-10GE1/0/1] port default vlan 2
[*SwitchA-10GE1/0/1] quit
[*SwitchA] interface 10ge 1/0/2
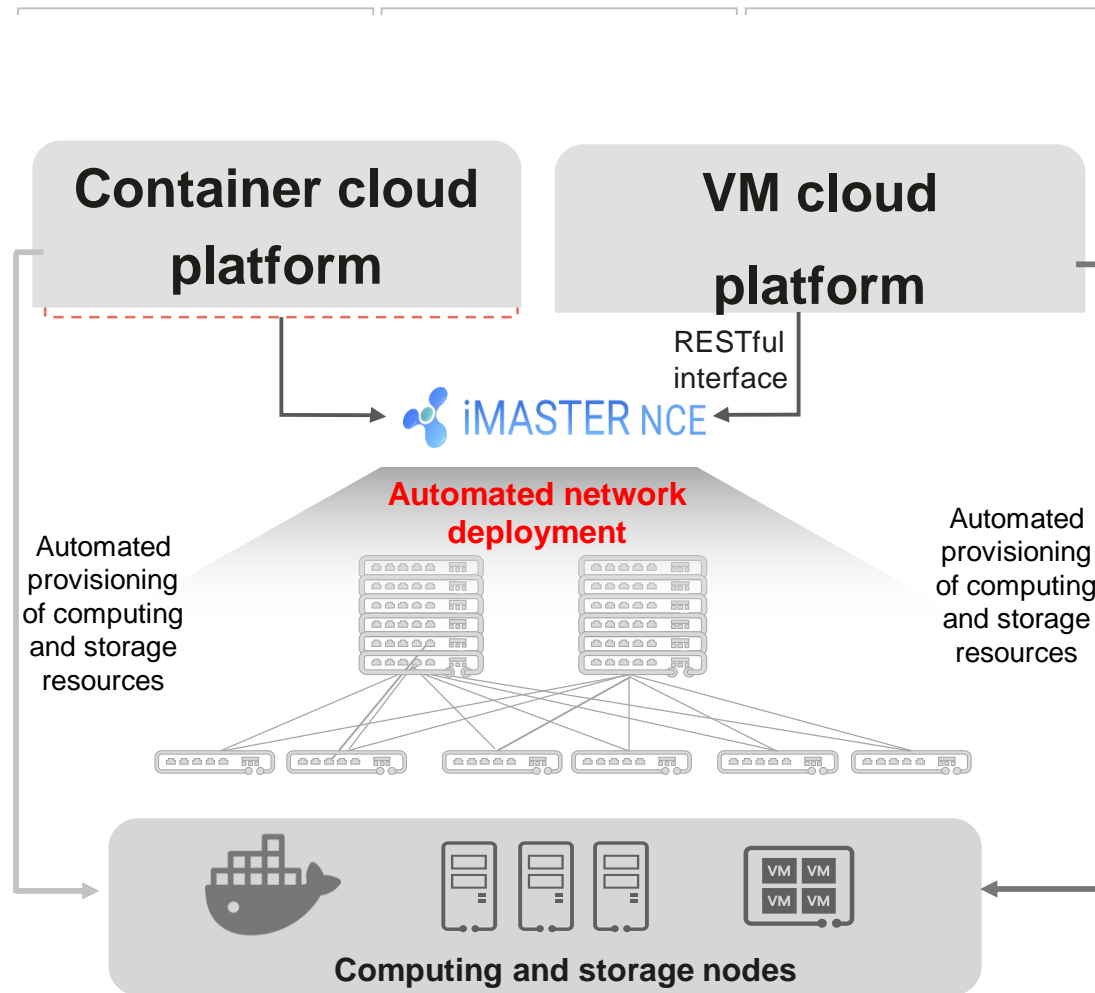[*SwitchA-10GE1/0/2] port default vlan 3

Configure a serial port.
[~SwitchA] interface 10ge 1/0/3
[~SwitchA-10GE1/0/3] port link-type trunk
[*SwitchA-10GE1/0/3] port trunk allow-pass vlan 2 3
[*SwitchA-10GE1/0/3] commit
…

Assign an IP address to a server.
BOOTPROTO=static
ONBOOT=yes
IPADDER=192.168.1.100   PREFIX=24
GATEWAY=192.168.1.1
DNS1=192.168.1.1

Virtualization Evolution	Physical Machine (PM) Phase	VM Phase	Container phase
Diagram	A network must be configured for each PM. TOR switch	A network must be configured for each VM. TOR switch	A network must be configured for each container. TOR switch
Number of nodes to be configured on the network	One PM is equivalent to **1** compute node.	A PM is virtualized into **100** compute nodes.	A PM is containerized into **10000** compute nodes.
Network configuration duration	Service rollout **in hours**	Service rollout **in minutes**	Service rollout **in seconds**

HUAWEI

Agile Controller Stands Out with Open Architecture and Simple Drag-and-Drop GUI for 3x Deployment Efficiency

HUAWEI

Container cloud platform

VM cloud platform

RESTful interface

iMASTER NCE

Automated network deployment

Automated provisioning of computing and storage resources

Automated provisioning of computing and storage resources

Computing and storage nodes

VM VM
VM VM

High deployment performance: 6x higher than industry average

10000 docker per minute login or logout

High deployment efficiency: 3x higher than industry average

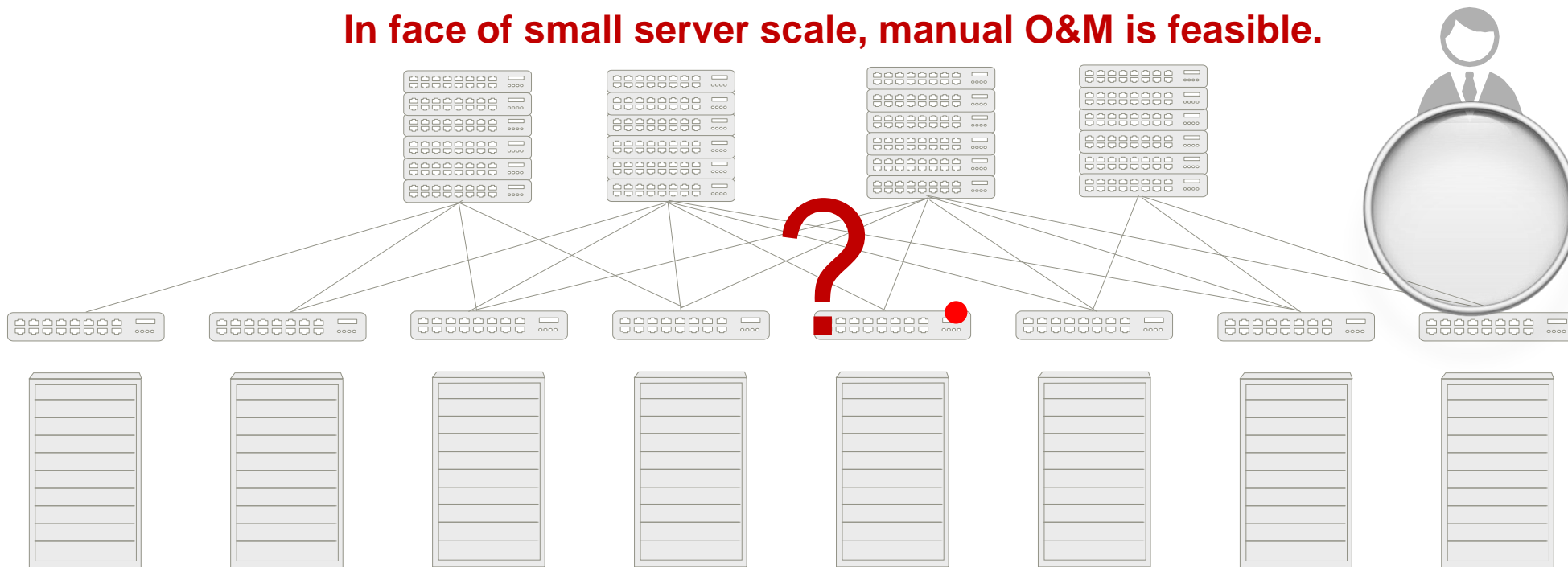**One-click ZTP, automatic deployment in full lifecycle**

Large southbound scale: 10x higher than industry average

Only one set of controller purchased for 4,000 NEs
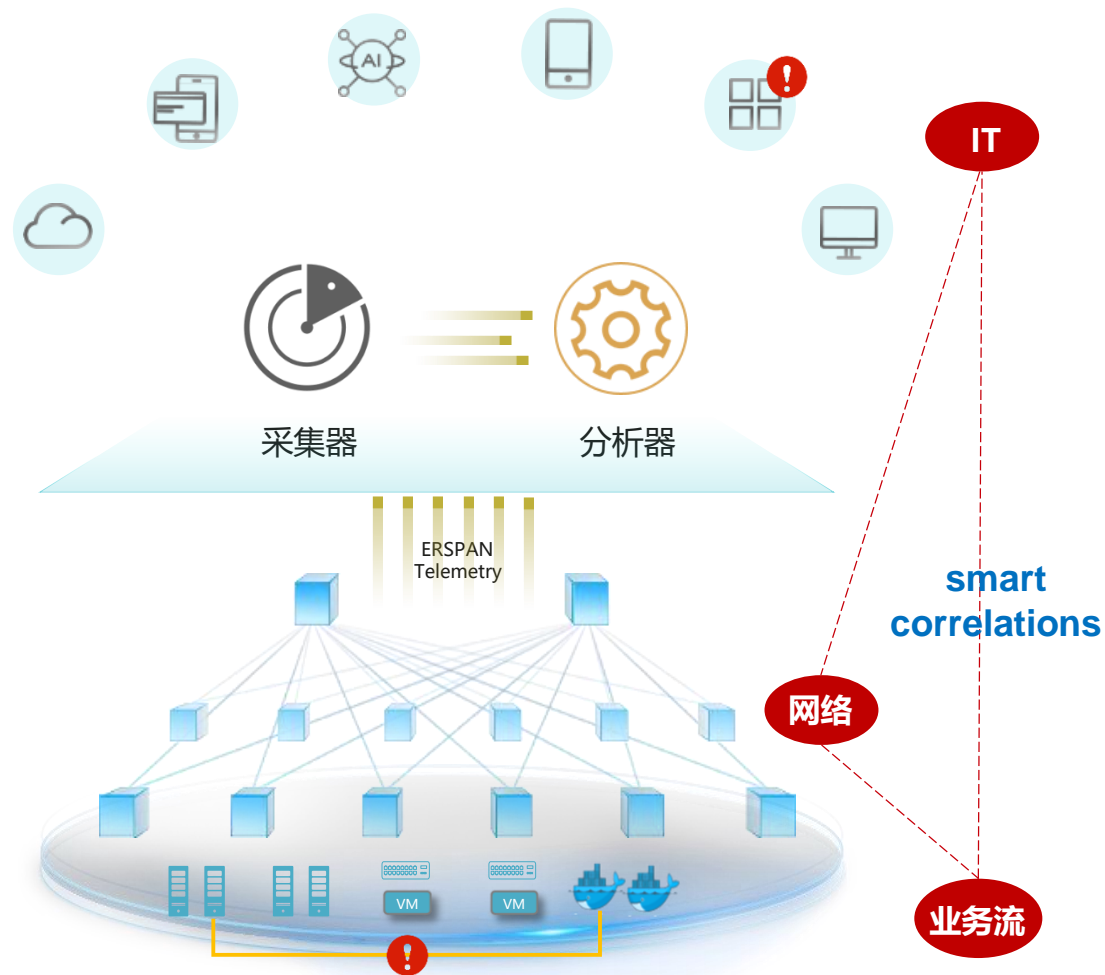
HUAWEI

"100-Fold" Challenge 4: As the Number of Servers Grows 100-Fold, Manual O&M Becomes Unsustainable

In face of small server scale, manual O&M is feasible.

?.

Number of servers: **100**

HUAWEI

FabricInsight Delivers 100% Network Visibility and Efficient Fault Prediction

采集器   分析器

ERSPAN
Telemetry

IT

**smart
correlations**

网络

业务流

VM   VM

HUAWEI

Positioning: **intelligent O&M and potential risk elimination**

100% visibility
Intelligent correlations between networks, service flows, and IT systems

Pre-event prediction
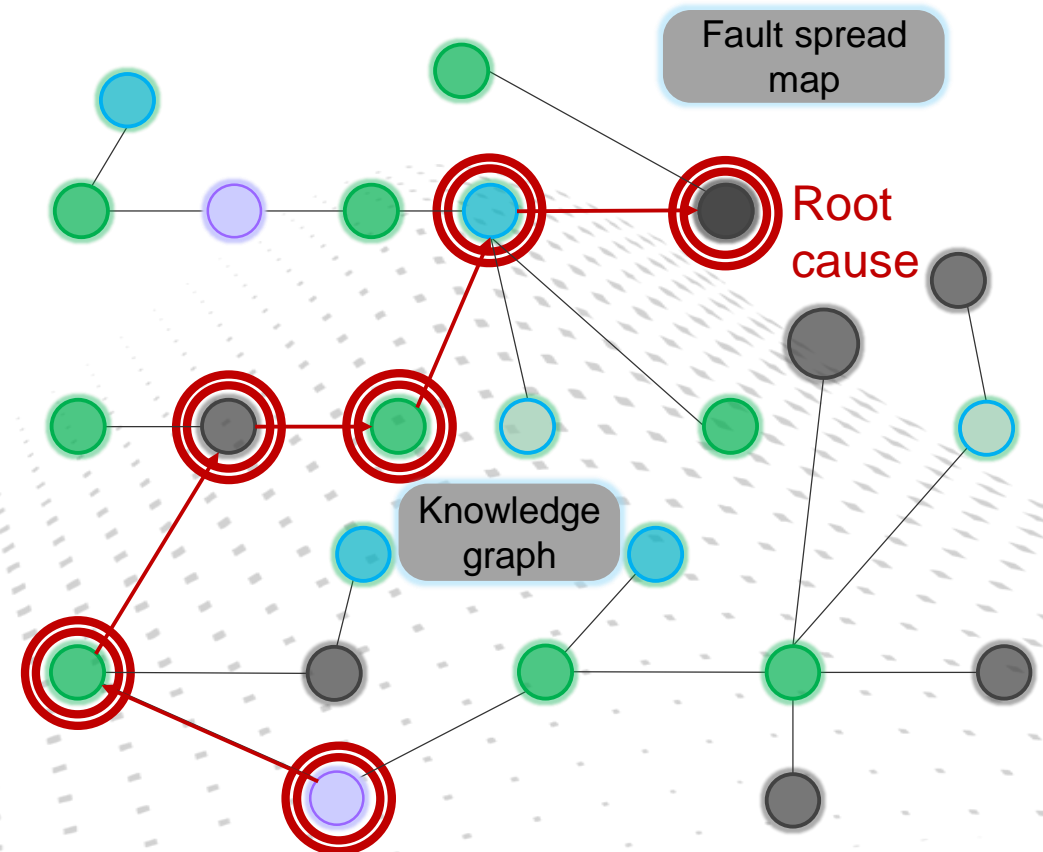**AI-powered predictive maintenance**

Use case 1: predicts device hardware faults
Use case 2: detects network behavior anomalies
Use case 3: proactively finds service-type issues
Use case 4: quickly identifies security-type issues

HUAWEI

Knowledge Graph Are Key to Locating the Root Cause of a Fault in 3 Minutes

Based on information such as the network topology, the object modeling is completed and the knowledge graph is generated. The circles represent objects such as switches, slots, interfaces, and protocols. Currently, 100+ objects can be modelled, covering most DCN scenarios.
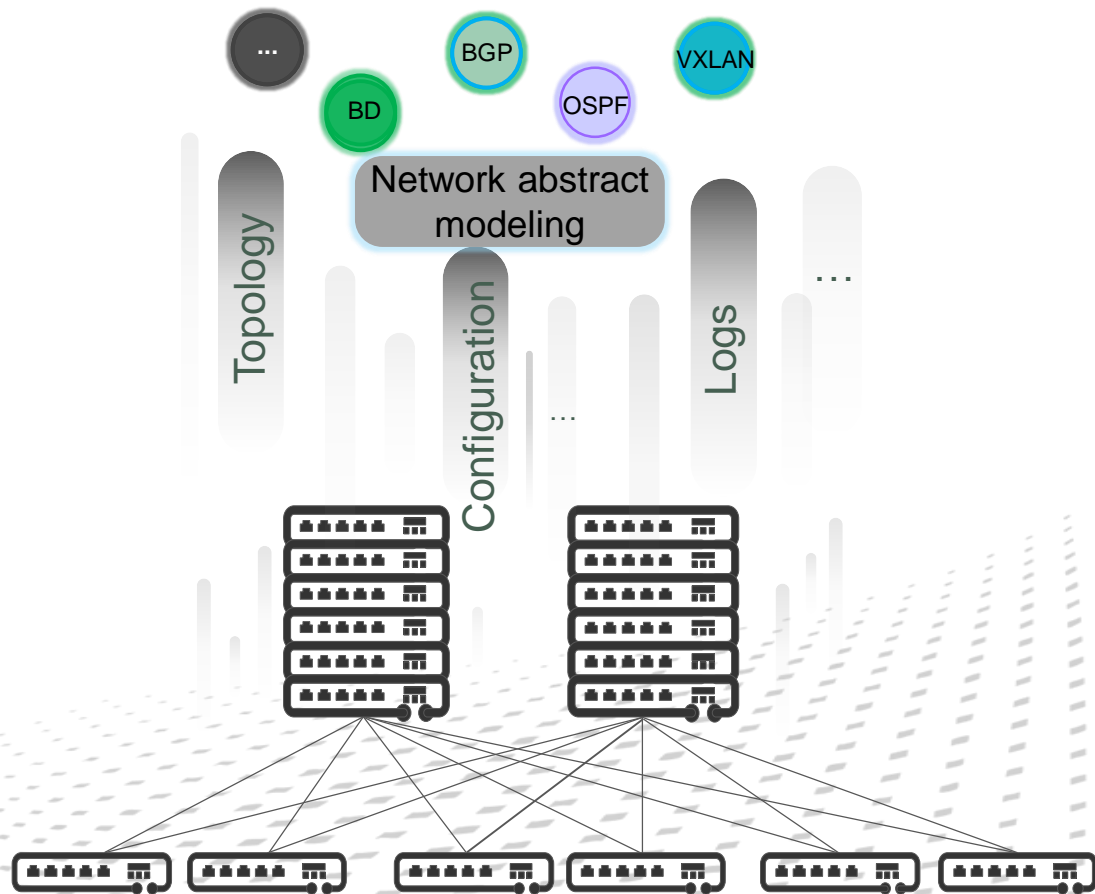
Based on Huawei's O&M experience over the past five years, 75+ common faults on networks are simulated and AI training is used to discover and identify the fault spread map (that is, the objects that affect each other after a fault occurs are identified, thereby quickly identifying the root cause).

...

BGP

VXLAN

BD

OSPF

Network abstract modeling

Topology

Configuration

Logs

...

...

Fault spread map

Root cause

Knowledge graph

HUAWEI

Four Differentiators in the DCN Field

Differentiator 1

CloudEngine 16800

Highest performance in the industry

One device instead of **5**

Industry's highest-density 400G, compatibility with 10G and 100G, protecting investment while addressing present and future needs

Differentiator 2

AI Fabric

Industry-unique Ethernet with zero packet loss

Zero packet loss, 100% computing power

Zero packet loss, low latency, and high throughput on DCNs
Outperforming all other vendors and remaining customers' preferred vendor

Differentiator 3

iMASTER NCE

Fastest deployment

3x deployment efficiency

Large management scale, and 3x deployment efficiency
Unmatched openness for easy interoperability with mainstream cloud platforms, realizing elastic scaling

Differentiator 4

iMASTER NCE

Most intelligent analyzer

Intelligent O&M and **zero** service interruption

Full fault visibility, proactive detection and predictive maintenance of risks, and zero service interruption

HUAWEI

AI-Boosted CloudWAN
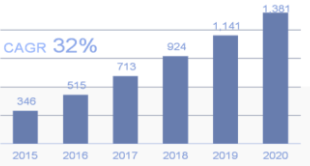
Customer Challenges

Complaint-driven reactive O&M
Fault diagnosis duration > 8 hours

How can service quality visualization and fast troubleshooting be implemented?

Low-latency connections
High-bandwidth connections
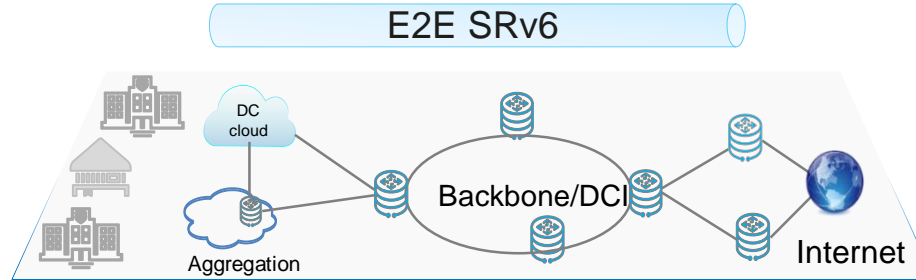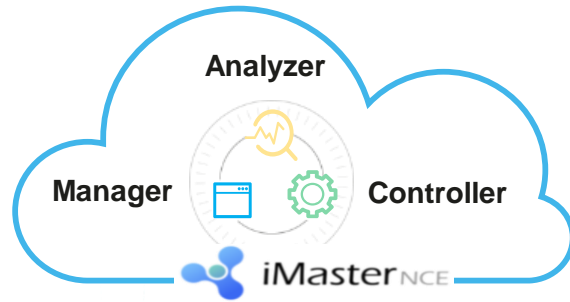High-reliability connections

How can differentiated connection services with guaranteed SLAs be provided to facilitate migration of numerous services to the cloud?

CAGR 32%
346 (2015) 515 (2016) 713 (2017) 924 (2018) 1,141 (2019) 1,381 (2020)

How can large-capacity, simplified, and converged bearer networks be built to handle the rapid traffic growth?

Analyzer

Manager **Controller**

iMaster NCE

NetEngine 8000 series

E2E SRv6

DC cloud
Backbone/DCI
Aggregation
Internet

Solutions

AI-Boosted Intelligent O&M

Real-time awareness
Real-time service quality visualization based on iFIT

Troubleshooting within minutes
AI-based fault demarcation within minutes

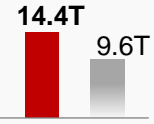### SRv6-Empowered Intelligent Connections

E2E SRv6

- Cloud-network synergy, **one-hop to the cloud**, and service provisioning within minutes.
- SRv6 identifies apps and tenants, providing **SLA assurance**.
- SRv6 unifies protocols (**10+ -> 2**) and simplifies configuration.

1st commercial SRv6 solution in the industry

All-Scenario Intelligent Routers: NetEngine 8000 Series
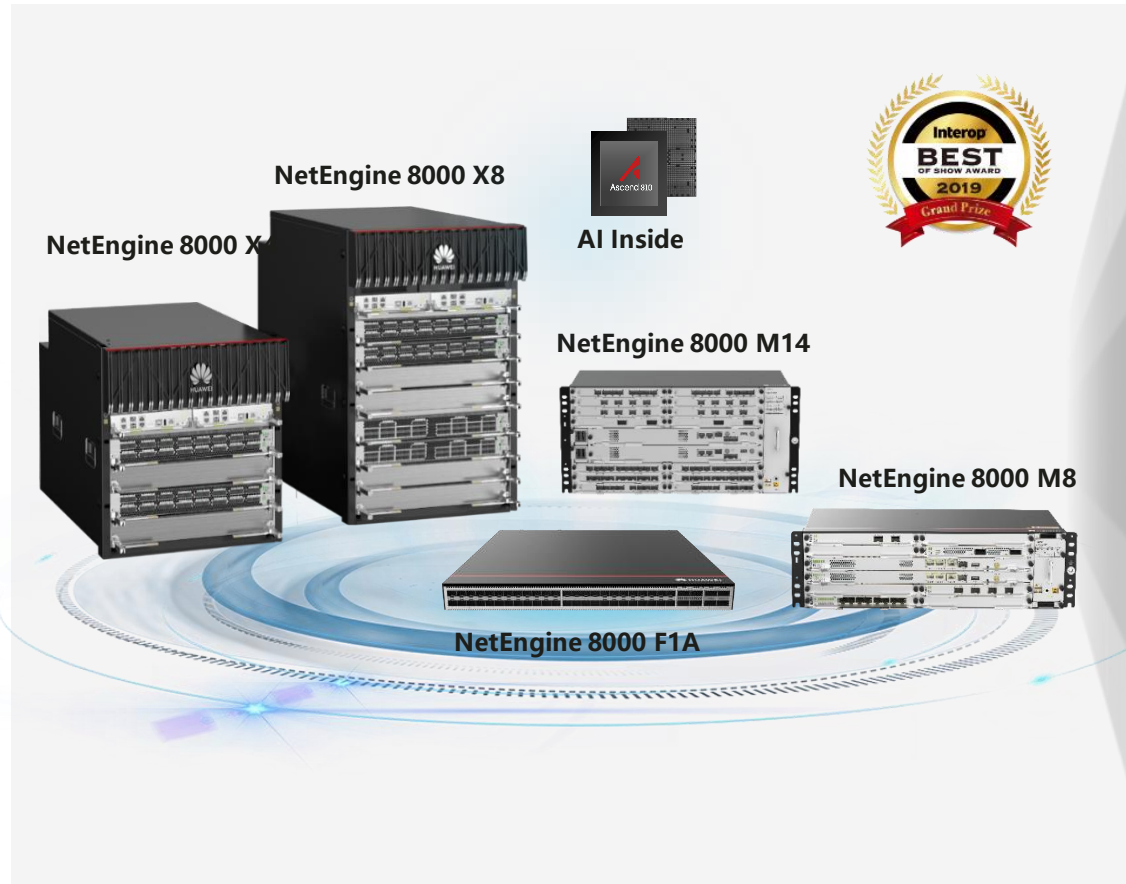
1.5x industry average

14.4T 9.6T

Per-slot capacity

- **Various interfaces**: E1/POS/GE/10GE/100GE/400GE
- **Shared platform for all scenarios**: broadband Internet access/private line/DC gateway/international gateway, **4-in-1**
- **Network slicing-based (FlexE)** hard isolation: **one network for multiple purposes**

HUAWEI

NetEngine 8000: All-Scenario Intelligent Routers for the Cloud Era

NetEngine 8000 Series

NetEngine 8000 X8

NetEngine 8000 X

AI Inside

Interop BEST OF SHOW AWARD 2019 Grand Prize

NetEngine 8000 M14

NetEngine 8000 M8

NetEngine 8000 F1A

Industry's Highest Performance — 14.4T/slot

■ Huawei   ■ Other vendor

	Per-slot capacity	400GE Interface	100GE Interface
Huawei	14.4T	36	54
Other vendor	9.6T	24	48
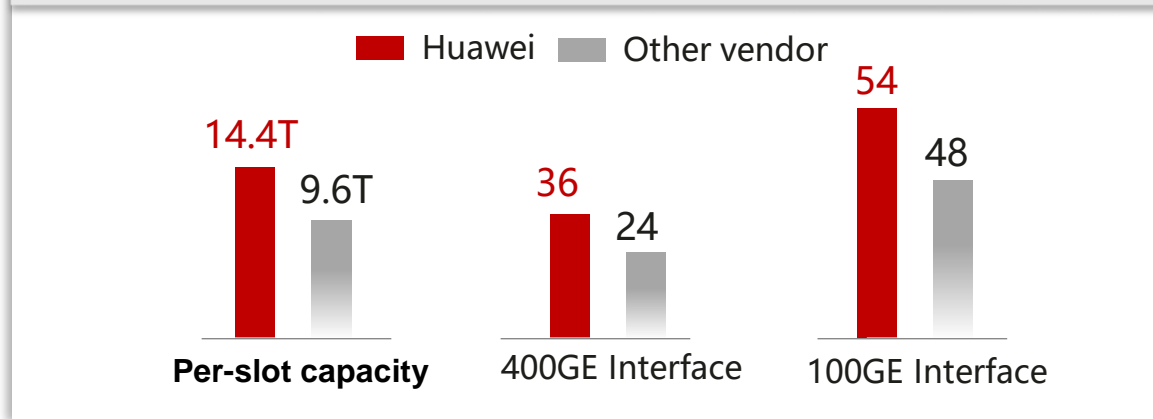
United platform for all scenarios

= SR + PE + DC-GW + BRAS

HUAWEI
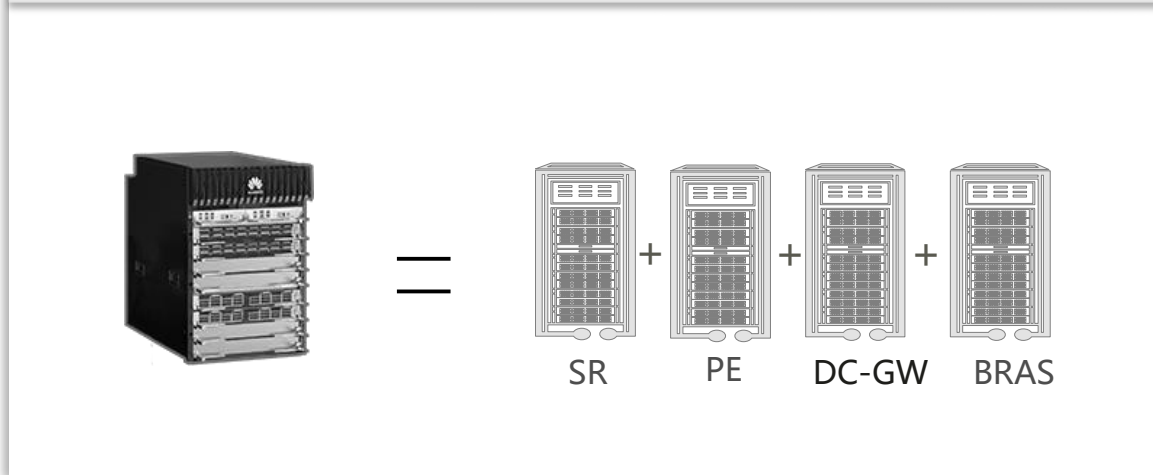
Intelligent Connections: Networks Are Aware of Service Intents, and SRv6 Enables Automated Service Provisioning and Differentiated SLA Assurance

Network Challenges

Regions with identical addressing schemes due to IPv4 address shortage, causing IP address conflicts after cloud migration.

Region A Region B
IP address conflict

Slow cross-domain service provisioning, with a long deployment cycle

Work order Work order
MPLS MPLS MPLS
Access Backbone
Aggregation

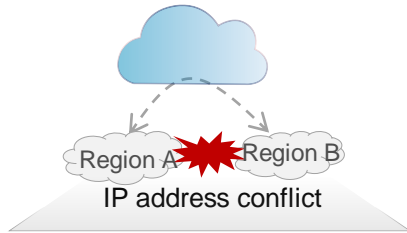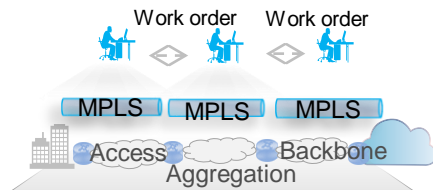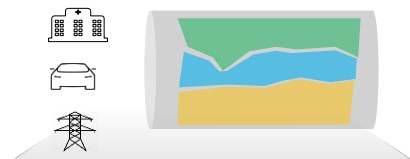**Shared pipes: how can SLAs be guaranteed for high-value services?**

Apps and tenants on the cloud schedule networks on demand, setting up connections with differentiated SLAs.

Finance Power Government Education ISP

Cloud platform

One cloud

Guaranteed latency / High reliability / Fast service provisioning / Guaranteed bandwidth / Fast cross-domain service provisioning

Tenant intent awareness

iMaster NCE

Automated service provisioning and optimization

One network

SRv6

Low-latency connections
High-bandwidth connections
High-reliability connections
...

DC DC DC
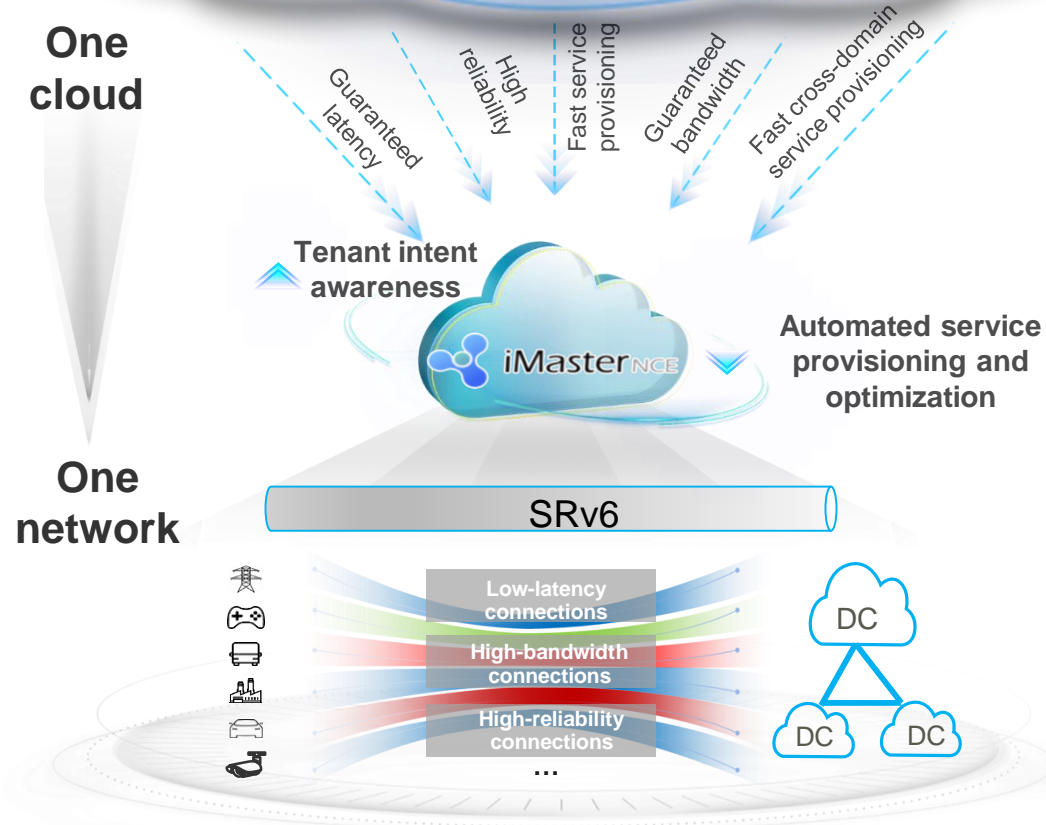
Solutions

A multitude of IPv6 addresses

- Unified IPv6 addressing scheme across the entire network, ensuring networks in multiple regions can connect to the cloud without address conflicts

SRv6-powered automated cross-domain service provisioning

- One unified protocol and seamless connections across domains
- Source node control, matching the SDN architecture and enabling automated E2E service provisioning
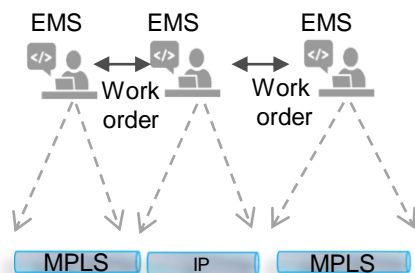
SRv6-powered tenant-level differentiated SLA assurance

- App and tenant identification through SRv6
- Intelligent traffic steering and optimization based on latency or bandwidth with guaranteed SLAs

42 **HUAWEI**

# SRv6 Enables Network Automation and Provides Tenant-Level SLA Assurance

Past

Slow cross-domain service provisioning, long deployment cycle, and SLA assurance not guaranteed

EMS   EMS   EMS

Work order   Work order

MPLS   IP   MPLS

Industrial control

Videoconferencing

Industrial Control cloud platform

Link congestion and packet loss

Manual EMS configuration, low work order interconnection efficiency

Multiple protocols, **cross-domain segment-by-segment service provisioning**, with a long deployment cycle
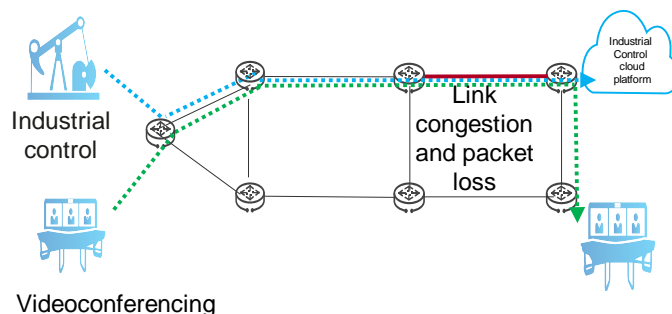
Ensures only **reachable connections**, and networks are **unaware of apps** and tenants

Now

Automated seamless connections across domains and tenant-level SLA assurance

Unified platform for management, control, and analysis, and full-lifecycle automation

SRv6-powered seamless connections across domains, source node configuration, and automated service provisioning within minutes

SRv6-powered intelligent traffic steering **based on tenants and apps**, with **guaranteed SLAs**

iMaster NCE

SRv6 Policy

SRv6

Industrial control: **Latency < 10 ms**

SID1   SID2   SID3

Industrial control cloud platform

Videoconferencing **Bandwidth: 100 Mbps**

| IPv6 H |
| **SID 1** |
| **SID 2** |
| **SID 3** |
| **Videoconference** |
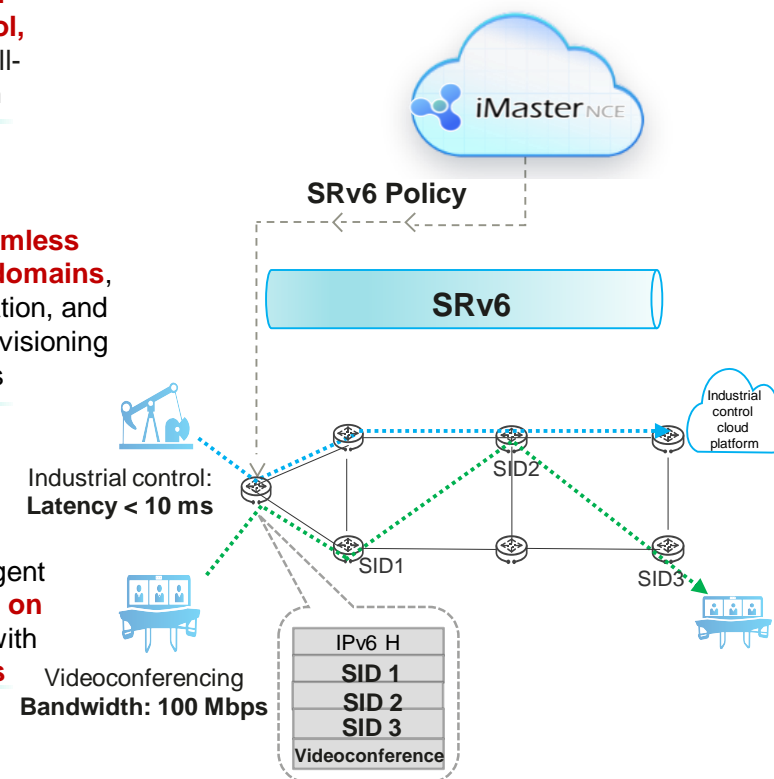
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SRv6: Huawei's Core Strategy in the IP Field, Leading Standards and Commercial Use

Leading Standards: Participation in **75%**+ of SRv6 Standards

Number of SRv6 Standards Documents Submitted to IETF Meetings

Chart values:
- IETF101: C=2, H=3, C&H=12
- IETF102: C=2, H=9, C&H=17
- IETF103: C=0, H=3, C&H=22
- IETF104: C=1, H=6, C&H=25
- IETF105: C=1, H=8, C&H=10

Legend: ■ C ■ H ■ C&H
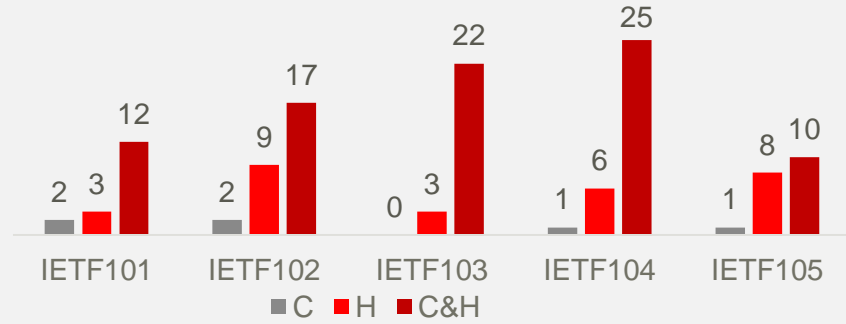
Huawei collaborates with industry partners to jointly promote the standardization of SRv6.

Leading Commercial Use: Industry' First SRv6 Commercial Use

Industry's first SRv6 commercial deployment
2019.2

Industry's first SRv6 cross-backbone cloud private line
2019.4
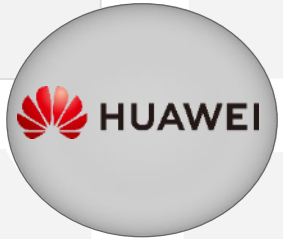
Industry Promotion: Hosting Industry Forums to Promote the Industrial Process of SRv6

Global SRv6 Industry Forum

Global SRv6 Industry Roundtable

Industry Collaboration: Cooperating with Industry Partners to Accelerate SRv6 Industry Maturity

HUAWEI — SRv6 — Vendor C | EANTC

Conducted the industry's first interoperability test
2018.9

Completed the EANTC SRv6 interoperability test
2019.3

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Proactive O&M: Real-Time Awareness and Fast Troubleshooting

Business logic/policy

Intent-driven

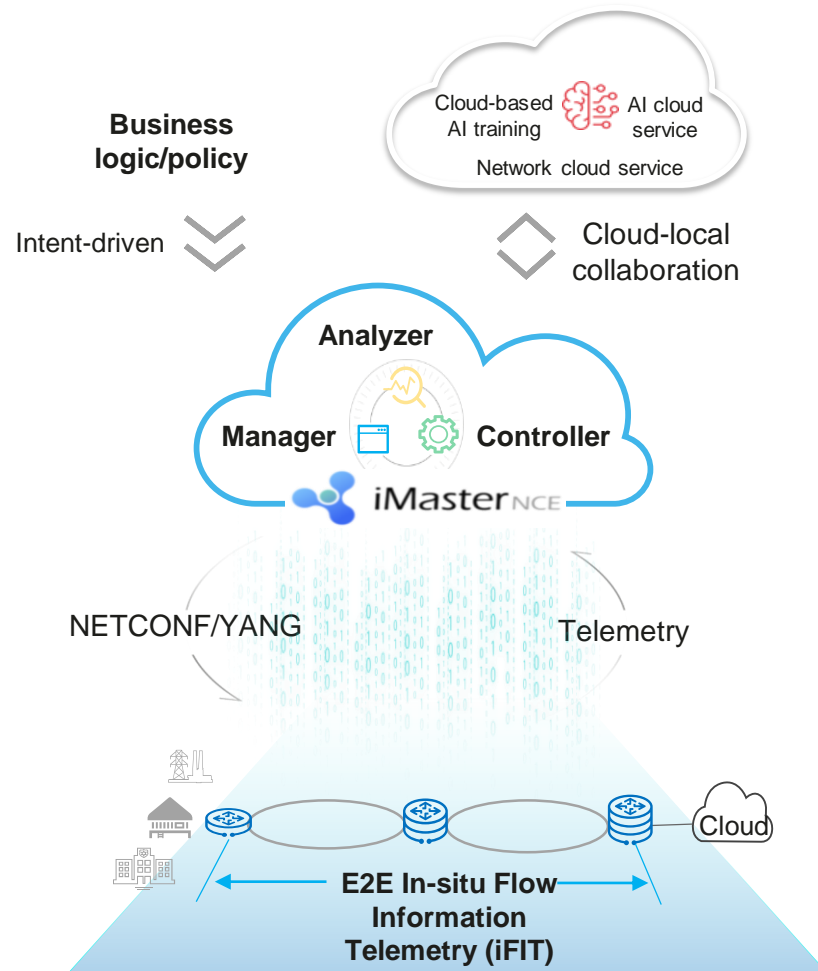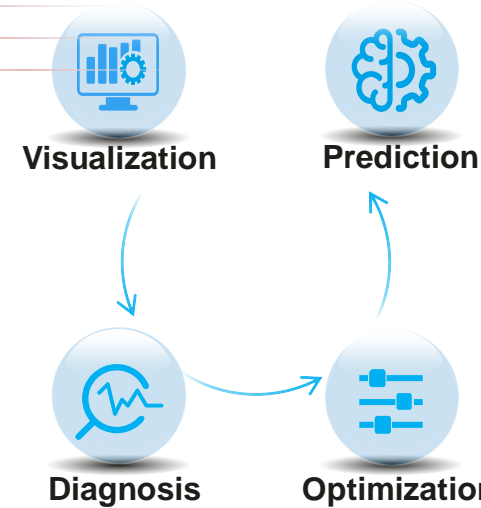Cloud-based AI training AI cloud service

Network cloud service

Cloud-local collaboration

Analyzer

Manager **Controller**

iMaster NCE

NETCONF/YANG Telemetry

Cloud

E2E In-situ Flow Information Telemetry (iFIT)

Real-Time Service Quality Visualization

- **iFIT**: data collection in seconds and real-time display of service quality (packet loss rate, latency, and jitter)

Visualization **Prediction**

Diagnosis **Optimization**

Fault Diagnosis Within Minutes

- Hop-by-hop analysis based on NCE + iFIT, automated service path restoration, and accurate locating of ports and links where packet loss occurs

AI-based Fault Prediction:

- Huawei proprietary AI algorithms: abnormal device KPI training and inference, detecting silent faults in advance

Proactive Path Optimization

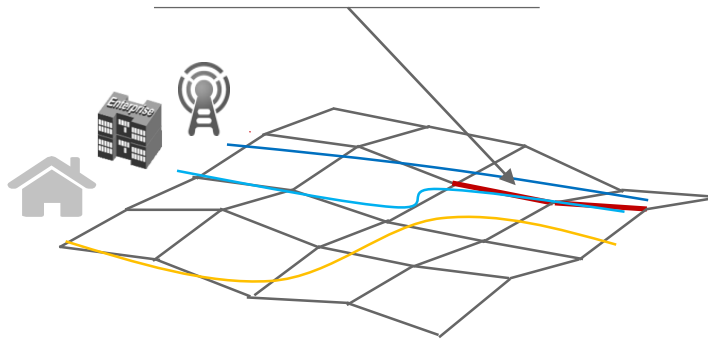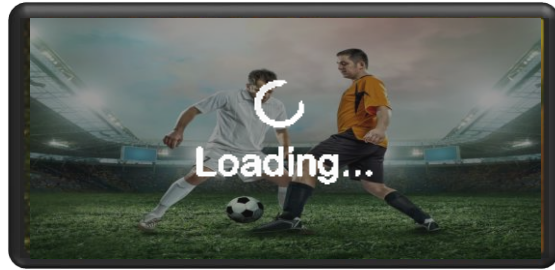- Huawei proprietary ROAM algorithm for intelligent traffic steering based on SLAs and SRv6 for fast traffic optimization

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AI-based App Awareness: 99% App Identification Accuracy, Network-wide Optimal Paths Ensured

Traditionally: The network is unaware of apps, making it difficult to ensure high-value service experiences.

Now: Real-time app type awareness helps plan network-wide optimal paths and ensure SLAs.

Cloud-based AI: Cloud-based Supreme Computing Power Supports Exploration of New App Models

VR gaming   Telemedicine   Smart grid   Autonomous driving

Network-based AI: Real-Time Latency Awareness Based on iFIT and Global Optimal Paths Planned Using NCE

Guaranteed
E2E service latency

iFIT

iMaster NCE + SRv6

Device-based AI: Intelligent App Type Awareness, Optimal Channel Allocation, Preferential Local Processing of Latency-sensitive Services

App type identification algorithm

99%
App type identification accuracy

AI

Low-latency channel
High-reliability channel
Ordinary channel

Optimal channel allocation algorithm

Loading...

- ✓ Services in the 5G and cloud era place **vastly different** requirements on networks.
- ✓ Traditional networks are **unaware** of users and apps.
- ✓ **Single path selection policy**: Routes are selected based on the shortest path.

HUAWEI
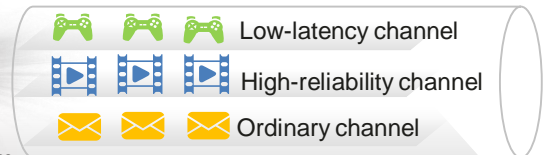
Industry 1ˢᵗ Petabit Cluster Route

NetEngine 5000E-20
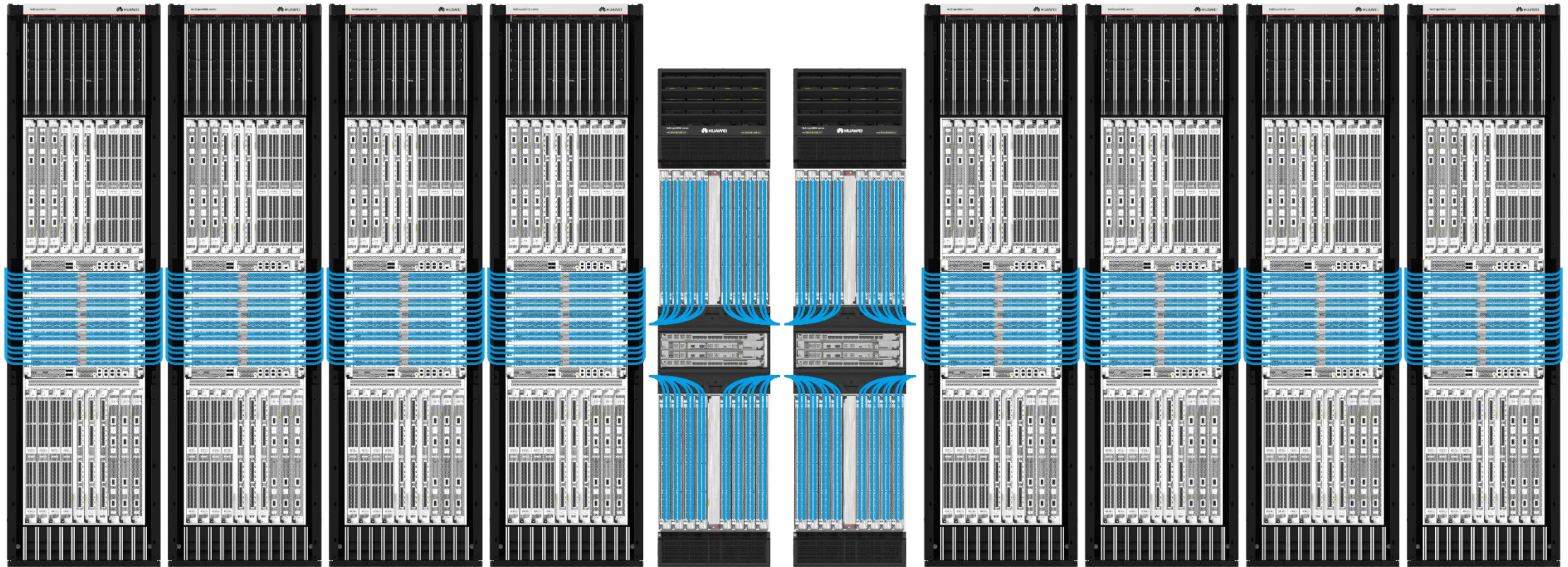
NetEngine 5000E-20 **3 highlights**
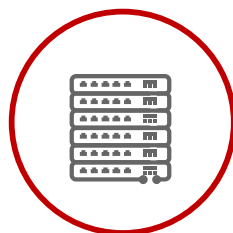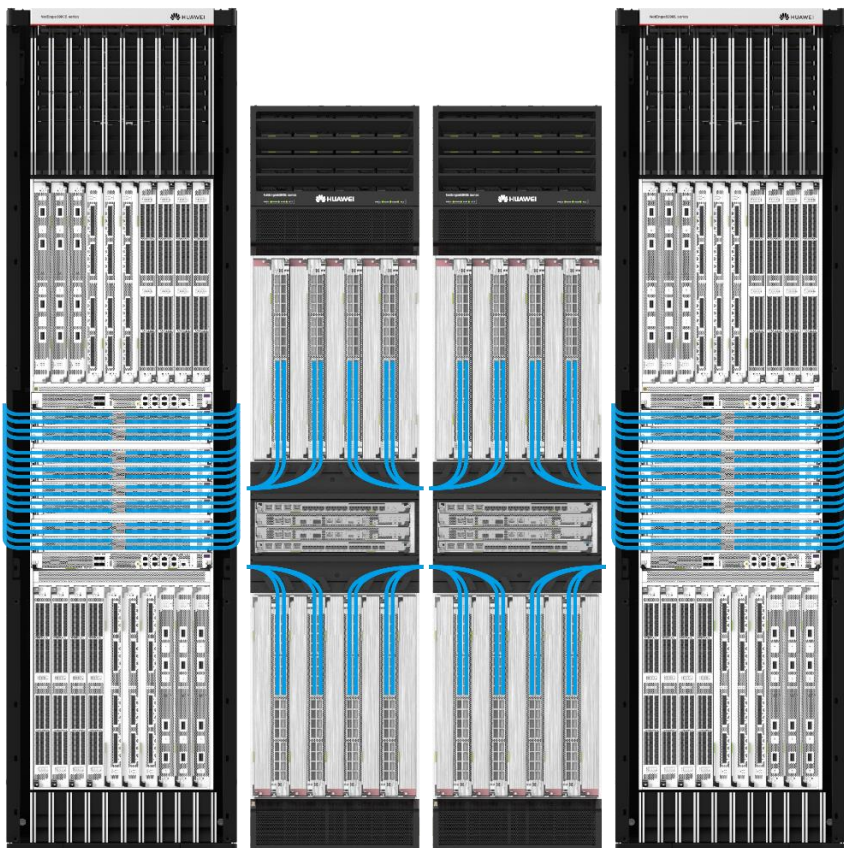
New Platform

Capacity improves 10 times to petabit level

10T/Slot, up to 1.6Pbps capacity with 2+8 cluster system, backward compatible for smooth evolution

New Protocol Stack
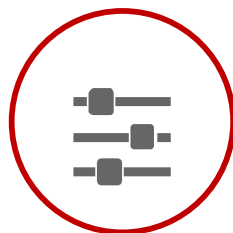
SRv6 intelligent connectivity enables business innovation

Network programming, APP-level SLA assurance, seamless connection

New Way of Operation

Full Lifecycle automation

AI base network planning, Automatic provisioning & fault locating, proactive O&M

HUAWEI

CloudWAN: Intelligent SD-WAN

Customer Challenges

Complex branch O&M

Onsite configuration required by trained engineers

Survey — Installation

Poor apps experience

Packet loss, frame freezing, etc.

Congestion on traditional CPEs

Low performance, unable to support soaring volumes of traffic

600M

Internet/LTE

50M   +

MPLS   MPLS

Past → **Now**

---

iMASTER NCE   **Intent-Driven**

Deployment → Network orchestration → Apps Policy → Visualized O&M

Distributed Control Component

NetEngine AR6100

Midsize branch

NetEngine AR650

Small branch

Internet
MPLS
LTE

IWG

Non-SD-WAN branch

AR1000V

NetEngine AR6300

HQ/Large branch
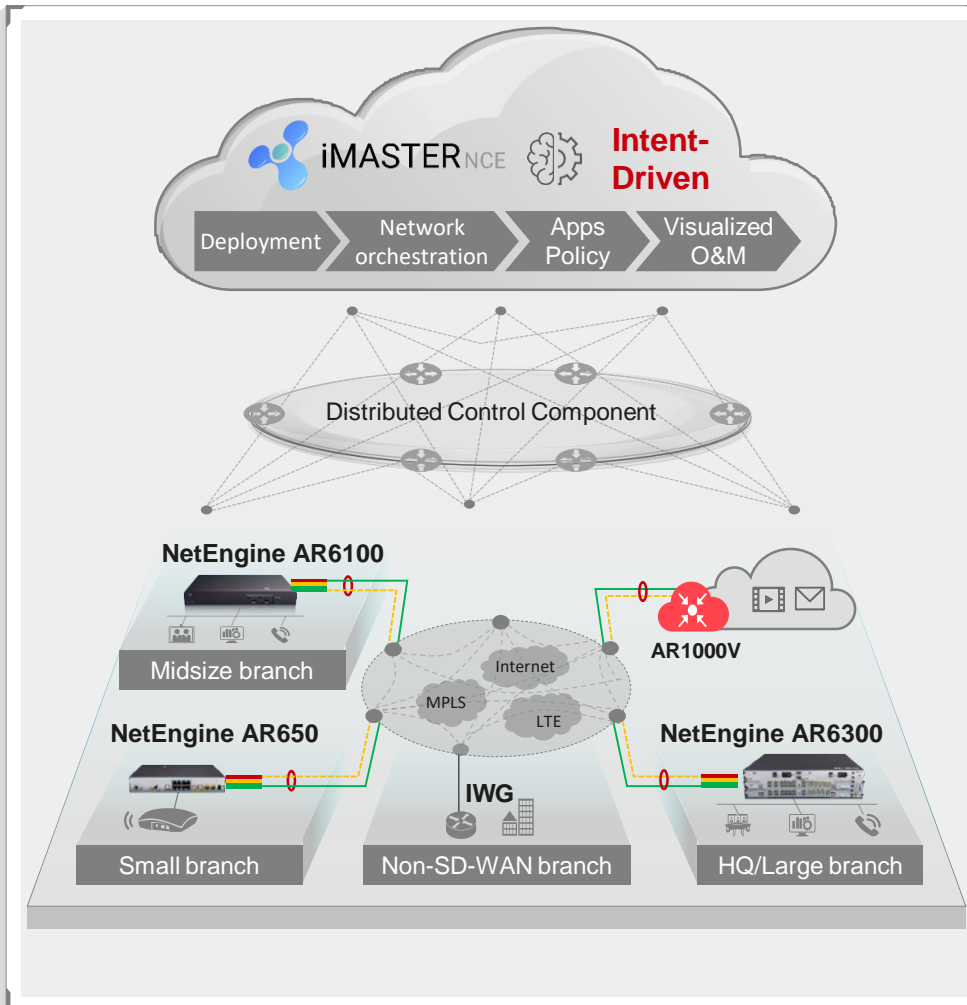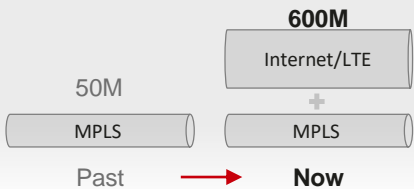
Solution Benefits

Intent-Driven, Plug-and-Play

5mins	VS	30mins
Intent-driven configuration wizard		Traditional configuration

Smooth Video at 20% Packet Loss Rate

VS

A-FEC: No frame freezing up to 20% packet loss rate

Traditional: Frame freezing at **2%** packet loss rate

Powerful CPE: 3x Industry's Performance

CPU	VS	CPU
NP		
Solar AX: 600Mbps ~3Gbps		Industry average: 100Mbps ~1Gbps

HUAWEI

Solar AX: Empowering NetEngine AR Routers with 3x Higher Performance

Solar AX Architecture

CPU + NP

NetEngine AR

3x↑ SD-WAN performance

Chips + Architecture + Algorithm Innovation

NetEngine AR651: **600 Mbit/s**

Industry: 100 Mbit/s to 200 Mbit/s

Multi-core CPU (L4-L7 service processing)

IPSec engine   **Application identification** engine   ...

Core 1 | Core 2 | Core 3 | ... | Core N

Packet scheduling and ordering engine (POE)

HQoS engine   **ACL** engine

NP (L2-L4 traffic offload)
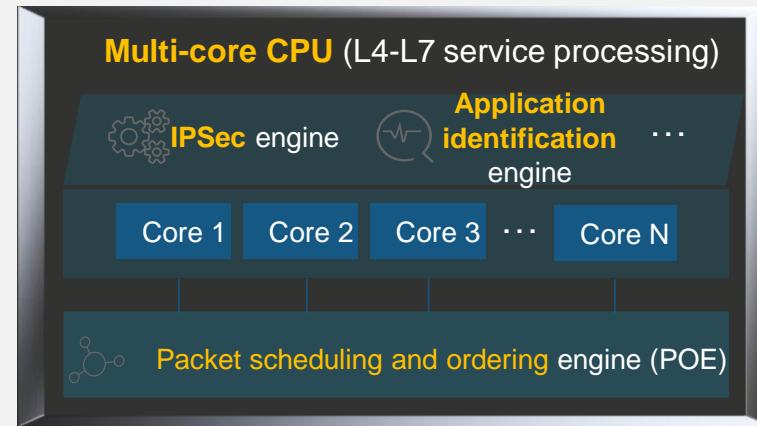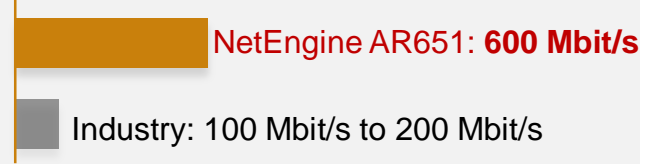
Unique Solar AX architecture
CPU + NP heterogeneous forwarding

Multiple embedded hardware acceleration engines
IPSec, SA, HQoS, and ACL acceleration engines
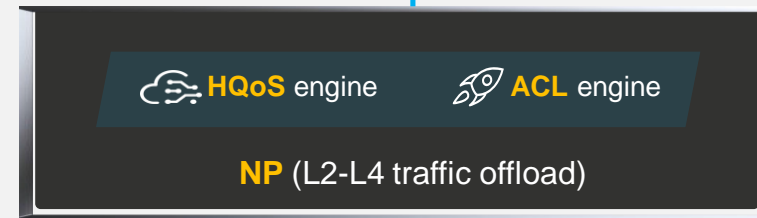
Ultra-fast algorithm, enabling ultra-fast forwarding
In-house chip acceleration instruction set, quickly matching ACL and routing entries

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Application Optimization, Better Experience

Solution

Benefit

A-FEC: adaptive forward error correction

NetEngine AR   WAN   NetEngine AR

2. Real-time detection of application packet loss

3. Adaptive redundancy for compensation

1. Packet loss on a link

4. Forward error correction for packets

no frame freezing up to **20%** packet loss rate

Application-based intelligent traffic steering

Application identification

MPLS

Link congestion

Packet loss, delay, jitter

Internet
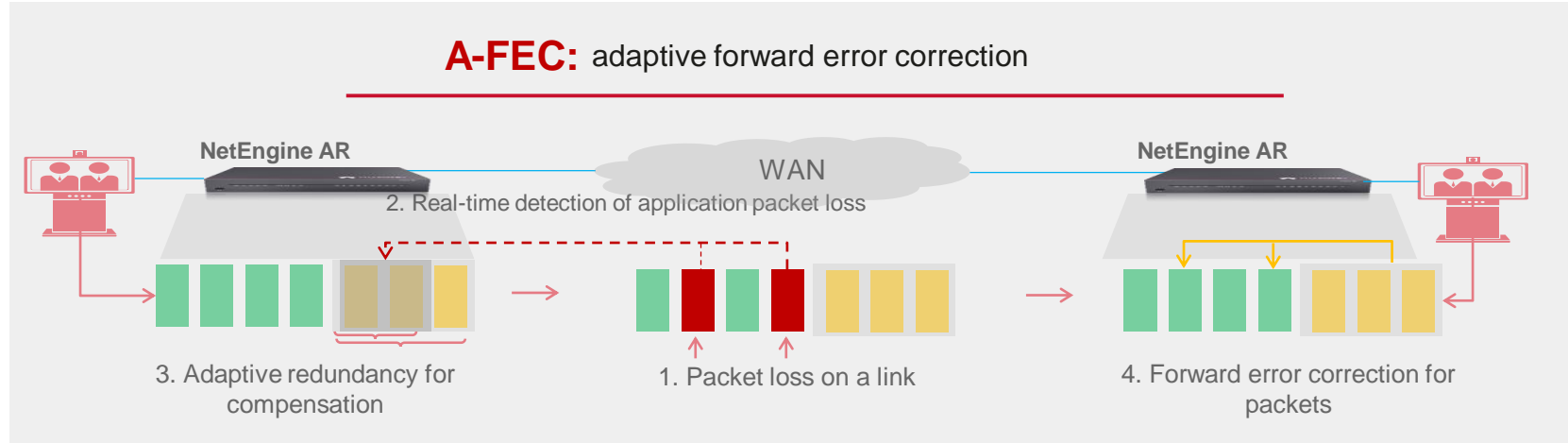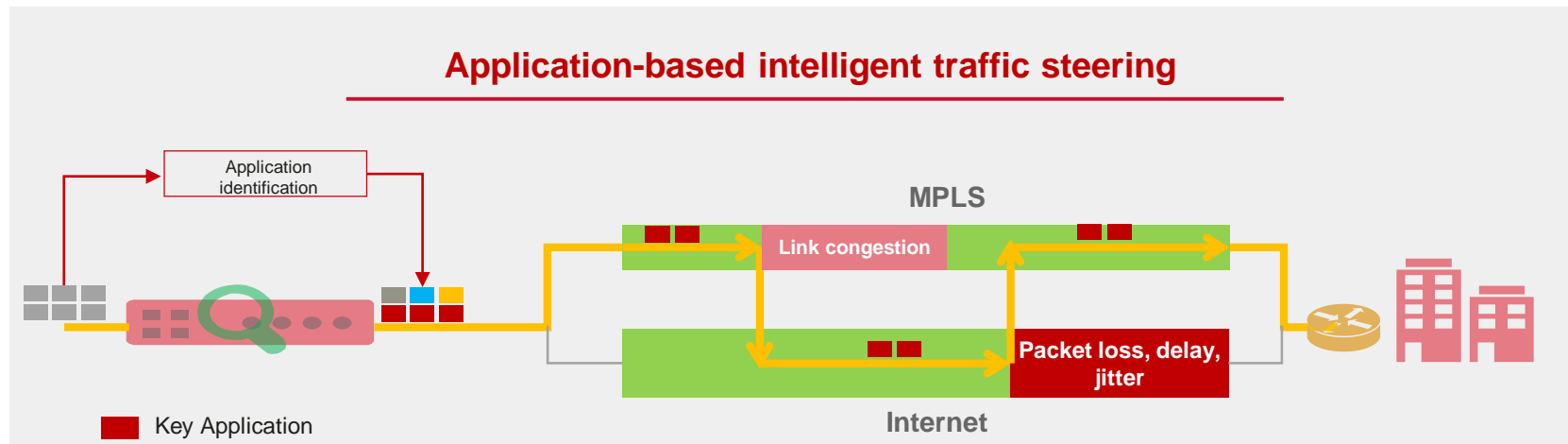
■ Key Application

Assured
Better experience for key application

> 90%
Bandwidth Utilization

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Intent-Driven, Plug-and-Play

iMASTER NCE

Visualized

GIS map | 45+ reports | Alarm | Inspection

Intent-driven

Site creation → Link establishment → Topology orchestration → Traffic steering policy → QoS scheduling → Security protection

Plug-and-play

Branch | ZTP | Email | Registration center | DHCP | USB

Fault locating

Hours → Minutes

Service configuration

30 minutes → 5 minutes

Device online

Hours → Minutes
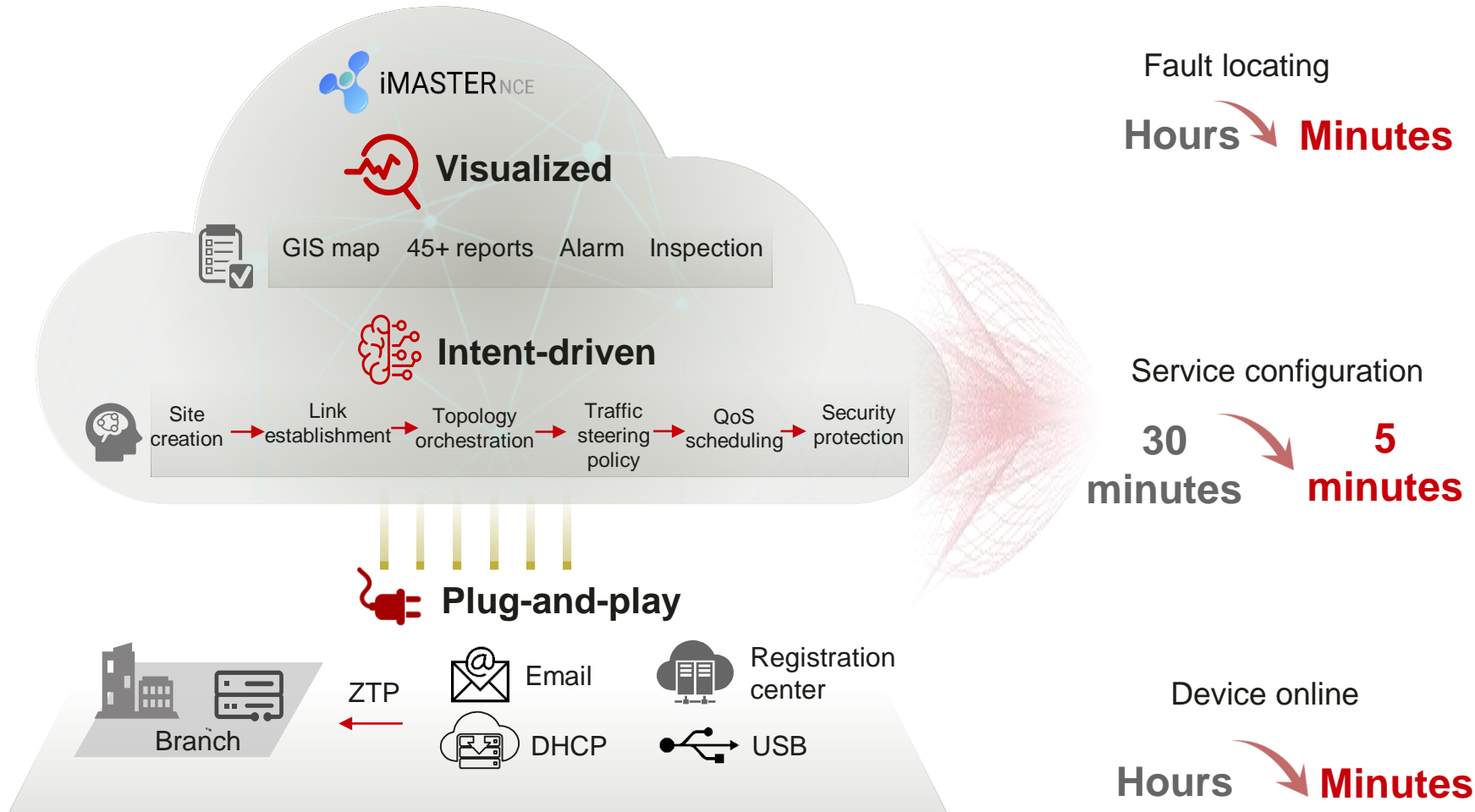
Visualized O&M

- GIS map-based network monitoring
- 45+ reports, visibility of applications, links, sites, and the entire network
- Extensive alarm information and immediate alarm notification by email
- Comprehensive network inspection, detecting potential issues

Intent-based configuration wizard

- Intent-based navigation, with service configuration reduced from **10+** pages to **1** page
- The default configuration is recommended in typical scenarios. You only need to manually configure **4** parameters.

ZTP in multiple scenarios

- Multiple ZTP modes and devices plug-and-play

HUAWEI

Huawei Was Positioned as a Challenger in Gartner's Magic Quadrant for WAN Edge Infrastructure

In 2018, Huawei was positioned as a Challenger in Gartner's first Magic Quadrant for WAN Edge Infrastructure.

Huawei CPEs and large-scale networking capabilities are highly recognized by Gartner.

- Huawei has a comprehensive hardware portfolio, with a range of appliance options and wide variety of interfaces.
- Huawei offers multiple WAN edge functions, including router, SD-WAN, and firewall functions.
- Huawei supports large WAN deployments (over 1,000 sites).

Full Report

Huawei is the only Chinese vendor positioned in Gartner's Magic Quadrant for WAN Edge Infrastructure.
Huawei is the only vendor that is positioned as a Challenger in Gartner's Magic Quadrant for WAN Edge Infrastructure based on its **strong networking capabilities**.
With the most complete SD-WAN hardware and software product portfolio, Huawei's **enterprise router market share ranks No. 2 in the industry**.

Industry-wide recognition

Huawei is one of the world's most popular SD-WAN suppliers (according to the survey of 1200+ enterprises).
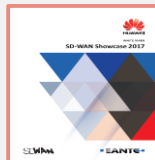
Huawei SD-WAN Solution is the first to have passed SD-WAN testing at EANTC.

Huawei AR650 is a high-performance uCPE and wins the iF DESIGN AWARD.

HiSecEngine USG6000E: First AI Firewall New Launch

Built-in NP acceleration engine, encryption engine, SA acceleration engine
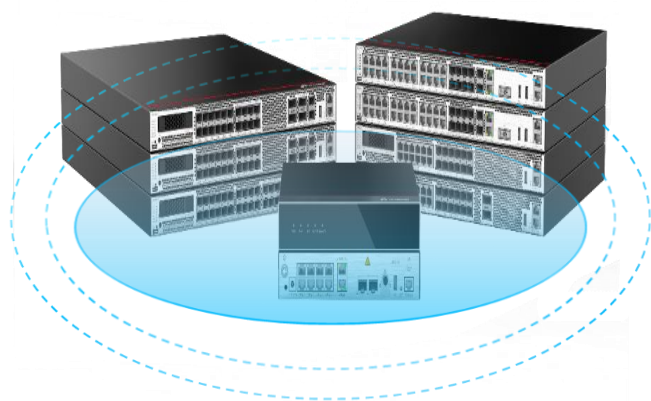
HiSecEngine USG6000E

Performance	**Latency**	**Identification of unknown threats**
IPS throughput HTTP 100K Pages **1.5x** ⬆	**70%** ⬇	**99%**
IPSec VPN throughput **4x** ⬆	Forwarding Latency	Threat Recognition Accuracy
SSL Encryption Detection Performance **5x** ⬆	**Built-in NP acceleration engine**	**Unknown Threat Detection Engine Based on AIE**

Compare with Industry's highest level

HUAWEI

iMaster NCE, a "Manage-Control-Analyze" Convergence Platform

AI-powered cloud
Training platform

HUAWEI CLOUD stack online

HUAWEI CLOUD

Model update ↓   ↑ Data

AI-powered network

Manage

Control

Analyze

Prediction   Suggestion

Detection   Analysis

iMaster NCE

Configure ↓   ↑ Telemetry

AI-powered device

Self-healing
(autonomous network)

How to solve it?
(intelligent suggestion)

What's going to happen?
(intelligent prediction)

Why did it happen?
(in-depth analysis)

What happened?
(real-time detection)

Wireless network self-optimization
• Automated, closed-loop experience optimization

Network fault prediction
• Proactive mining of group fault features

"1-3-5" intelligent troubleshooting
• Fast fault locating based on AI plus knowledge inference

Intent-driven simplified deployment
• AI-based optimal network recommendations

HUAWEI

iMaster NCE Target Product Architecture and Customer Benefits

Cloud Platform & Applications

Multi-Tenant ⇕ Multi-Service ⇕ Multi-Industry

Design Studio (Roadmap)

REST API Catalog & Gateway | Kafka Data Broker

Scenario-Specific App

Intent Engine (New)

Management | Control | Analysis

MV Southbound Framework | MV Collector

Unified Cloud Platform

Multi-Layer ⇕ Multi-Domain ⇕ Multi-Vendor

Network Infrastructure
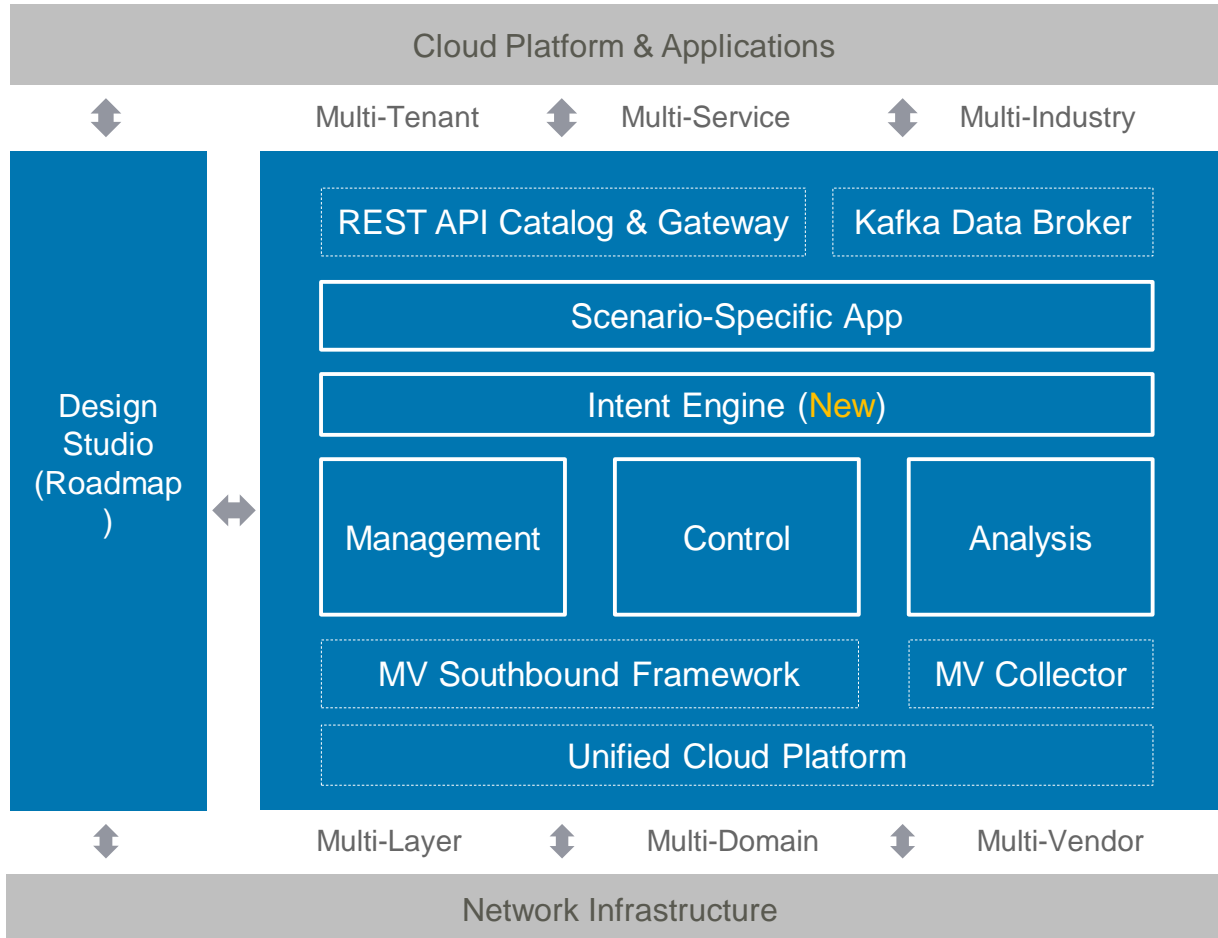
Automated network
Intent-driven, model-based
Multi-domain, multi-layer, and multi-vendor

Intelligent network
Predictive maintenance powered by big data and AI

Agile interconnection and integration
Programmable Design Studio
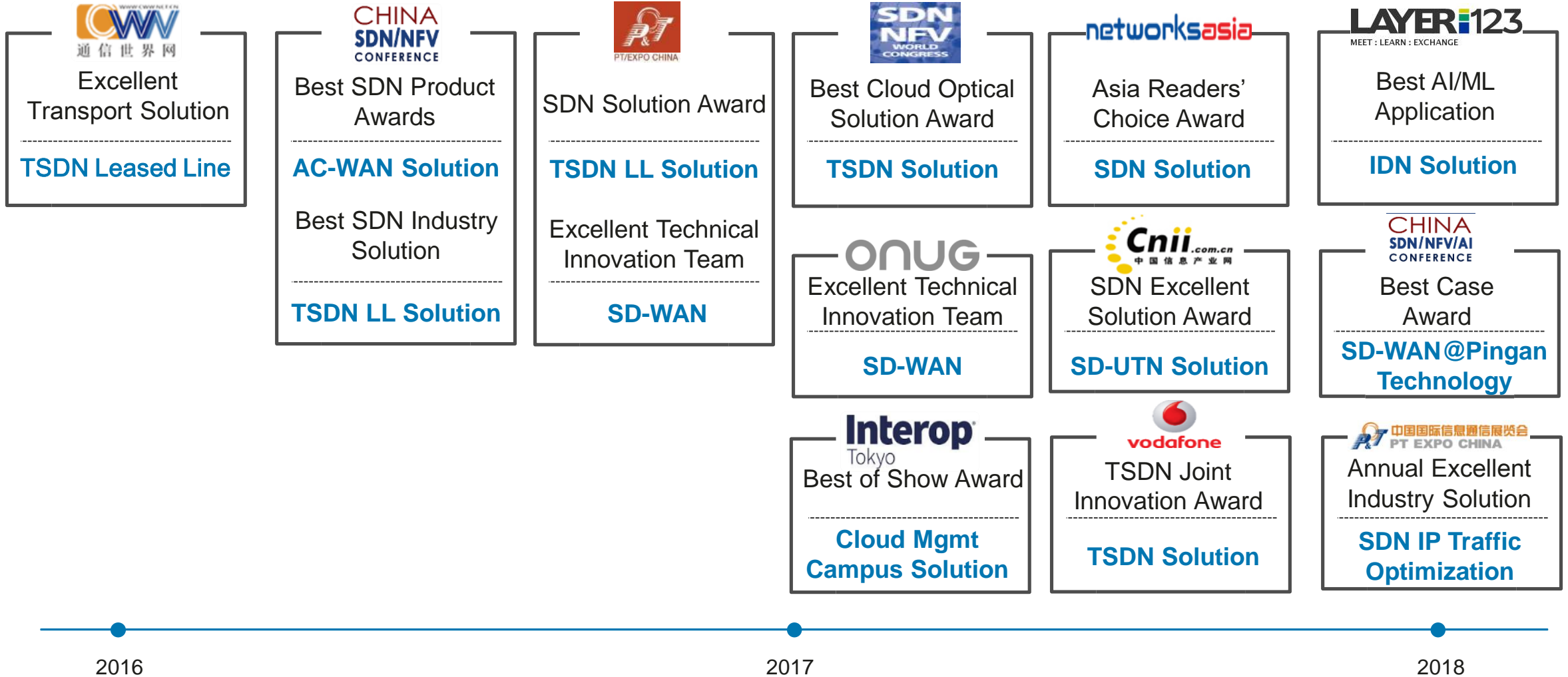**Open REST APIs and Kafka data proxy**

Cloud-based scale-out
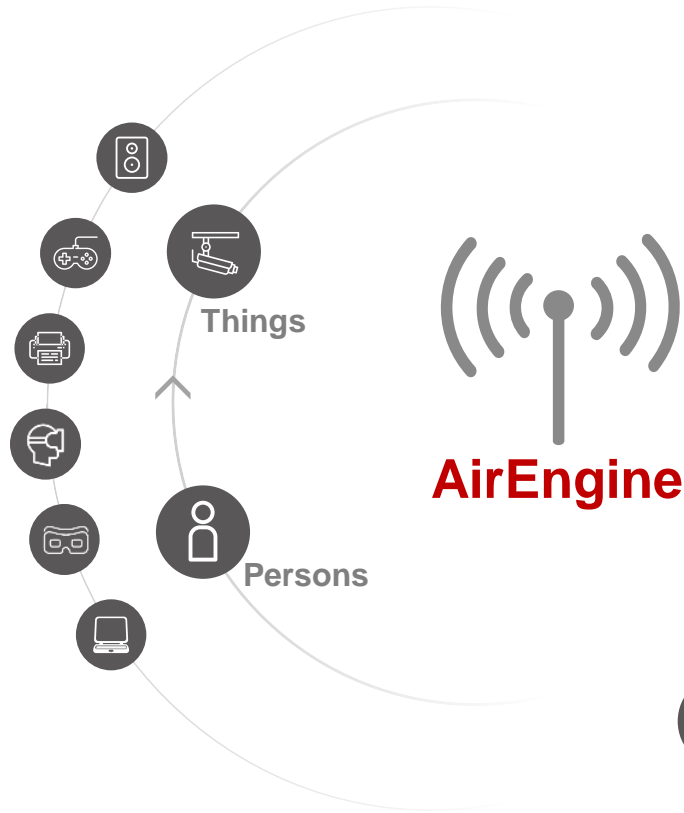**Public cloud & private cloud**
Elastic scalability & high reliability

HUAWEI

Huawei SDN Awards

Excellent Transport Solution
- TSDN Leased Line

Best SDN Product Awards
- AC-WAN Solution

Best SDN Industry Solution
- TSDN LL Solution

SDN Solution Award
- TSDN LL Solution

Excellent Technical Innovation Team
- SD-WAN

Best Cloud Optical Solution Award
- TSDN Solution

Asia Readers' Choice Award
- SDN Solution

Best AI/ML Application
- IDN Solution

Excellent Technical Innovation Team
- SD-WAN

SDN Excellent Solution Award
- SD-UTN Solution

Best Case Award
- SD-WAN@Pingan Technology

Best of Show Award
- Cloud Mgmt Campus Solution

TSDN Joint Innovation Award
- TSDN Solution

Annual Excellent Industry Solution
- SDN IP Traffic Optimization

2016 — 2017 — 2018

HUAWEI

Leading Intelligent IP Networks

Everything connected
Ubiquitous connectivity, the ultimate experience

Intelligent Connection
Unparalleled intelligence, 100% AI computing power

Intelligent Security

HiSecEngine

Things

Persons

AirEngine

CloudEngine

AI

Cloud

Ultra-broadband
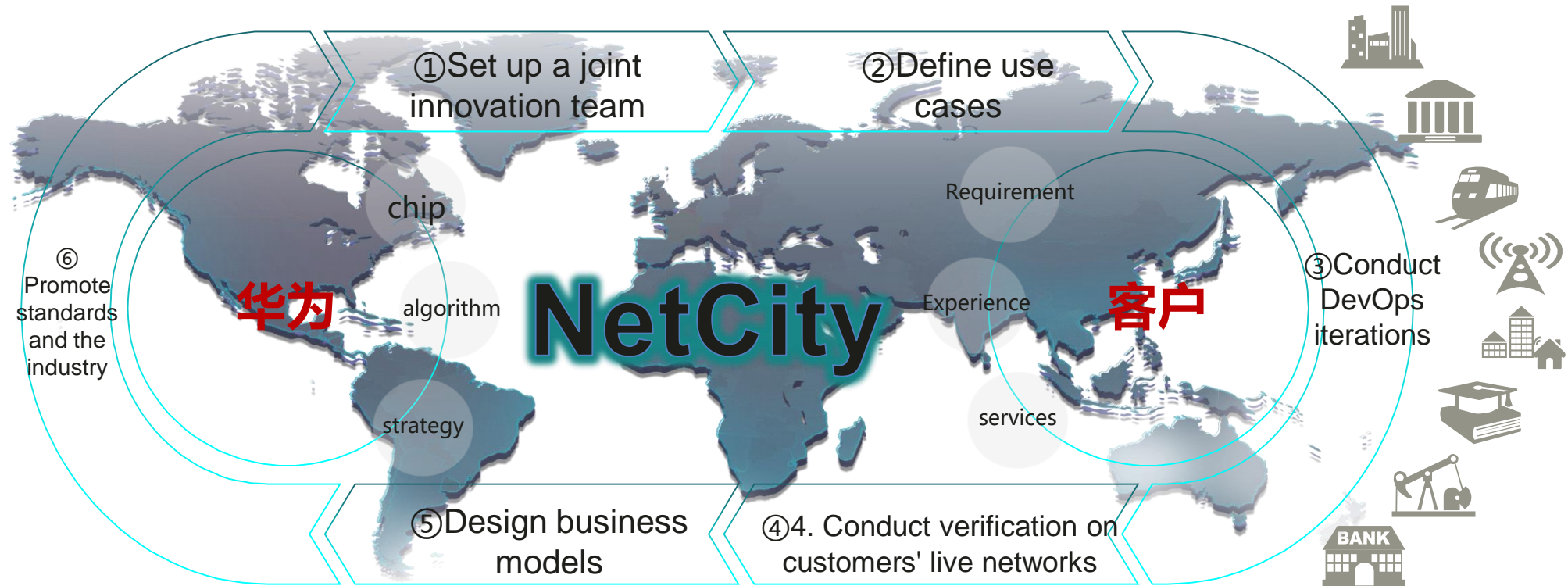**fabric** Interconnection

WAN

5G   Enterprise

Home

NetEngine

HUAWEI

NetCity: Promoting AI Industry Cooperation Together with Customers

50+ ongoing/completed NetCity joint innovation projects

① Set up a joint innovation team

② Define use cases

③ Conduct DevOps iterations

④ 4. Conduct verification on customers' live networks

⑤ Design business models

⑥ Promote standards and the industry

chip

algorithm

strategy

NetCity

Requirement

Experience

services

华为

客户

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

把数字世界带入每个人、每个家庭、每个组织，
构建万物互联的智能世界