Huawei New-Generation
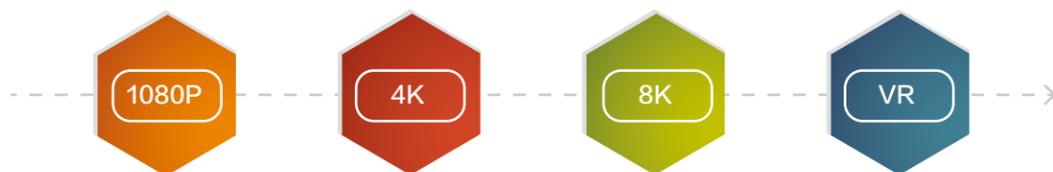
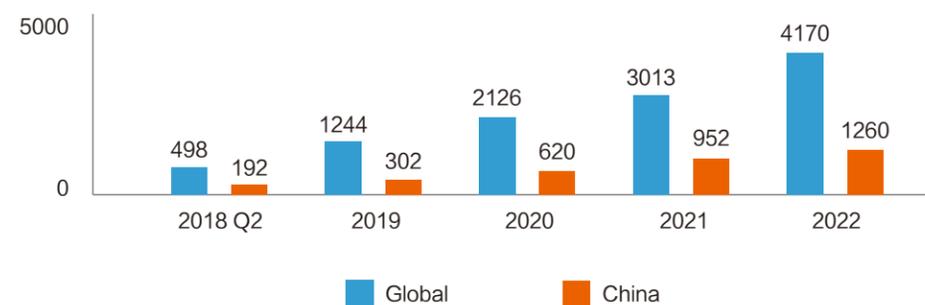## 4K/8K-Oriented Media Fabric Solution White Paper

4K/8K UHD Era Pushes the Evolution of the Production and Broadcasting System Towards IP

With the increasing requirements for audiovisual experience, traditional SD and HD TV services are evolving towards 4K/8K.

According to statistics, the number of global 4K TV shipments in 2017 was 75 million, accounting for 35% of the total TV shipments. According to the Ovum report, the number of global 4K paid TV subscribers will increase year by year in the next few years. The number of subscribers is expected to reach 30 million by 2020.

1080P → **4K** → **8K** → **VR**

Trend for 4K TV User (ten thousand)

	2018 Q2	2019	2020	2021	2022
Global	498	1244	2126	3013	4170
China	192	302	620	952	1260

■ Global ■ China

At present, most TV stations use the Serial Digital Interface (SDI) matrix to schedule and distribute video streams. It plays an important role in the development of SD and HD video services. However, with the evolution of video services, the SDI technology is developing slowly, which cannot meet the requirements of 4K/8K services for high bandwidth, high flexibility, and low costs.

IP has become a key enabling technology for the development of UHD video services.

By the end of 2017, SMPTE, the industry's authoritative standard organization, officially released the IP standard ST2022 and ST2110, which indicates that IP will gradually replace SDI in production and broadcasting.
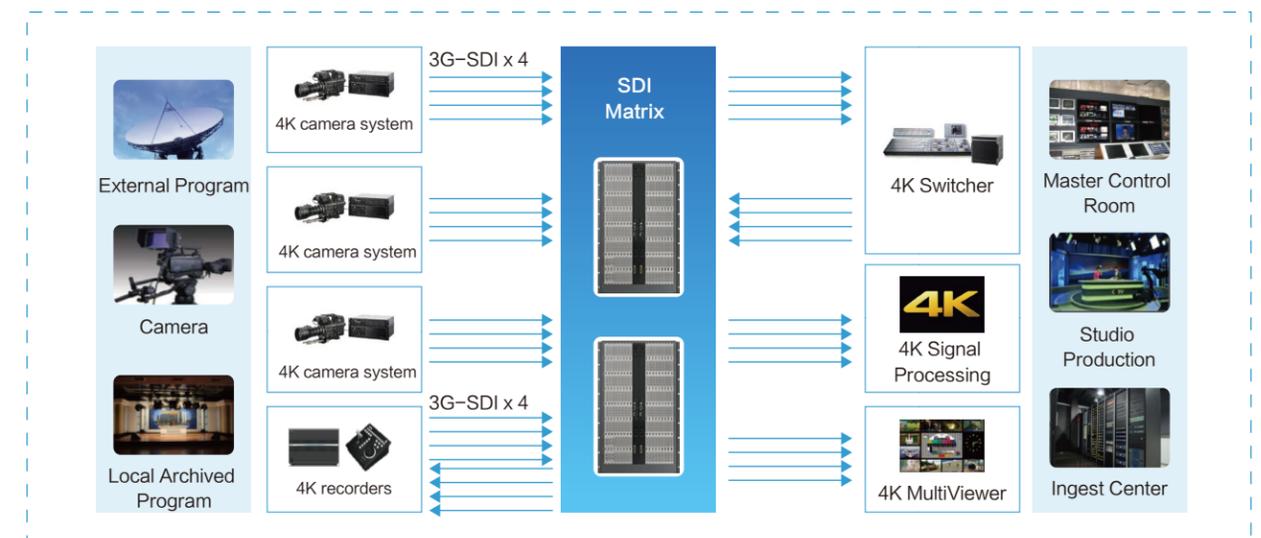
In addition, mainstream device suppliers in the industry have launched their own IP products. Traditional network device vendors have also launched IP products and solutions that adapt to the TV stations' internal production and broadcasting networks.

SDI Restricts UHD Content Production and Becomes the Industry Development Bottleneck

The content production process in a TV station consists of three parts. The front end receives camera input signals, external signals, and local ingesting programs. The video is transmitted through the SDI switching matrix of the studio, OB van, master control, and recording domain. The back end implements 4K signal processing and provides continuous presence display.

As a key part of UHD content production, the SDI switching matrix has multiple disadvantages, such as difficult maintenance & capacity expansion and technical closure, which severely restrict the industry development.

External Program — Camera — Local Archived Program — 4K camera system — 4K recorders — 3G-SDI x 4 — SDI Matrix — 3G-SDI x 4 — 4K Switcher — Master Control Room — 4K Signal Processing — Studio Production — 4K MultiViewer — Ingest Center

Many cables and difficult maintenance

- The number of 3G-SDI cables required by 4K is four times that required by HD.
- The 3G-SDI transmission distance is 60 m or less. Optical transceivers need to be deployed for long-distance transmission, which increases the maintenance difficulty.
- Costs double if SDI is used to build 4K production and broadcasting systems.

Small capacity and difficult to expand

- The 3G-SDI/12G-SDI has a small capacity, is difficult to expand, and can hardly meet the 4K/8K service requirements.
- The SDI technology and standards develop slowly, and the investment of media vendors does not produce large-scale effects. As a result, the SDI construction cost is high.

Technical closure and low efficiency in production and broadcasting

- The technology of the production and broadcasting network is different from that of the distribution network. The architecture is complex. It is difficult to use advanced ICT technologies such as virtualization, cloud, and AI to improve the production efficiency of program content.

TV Stations Are Transforming to Converged New Media and Need to Embrace New ICT Technologies

To improve program production efficiency and user experience, traditional TV stations are actively exploring new media transformation. During the transformation, TV stations use the latest ICT technologies such as cloud computing, big data, AI, and 5G to transform traditional TV services.

| Cloud Computing | Big Data | 5G | AI |

To introduce new ICT technologies, TV stations need to use the IP technology to simplify the system architecture and implement unified production and distribution of traditional TV services and new media programs to provide latest and vibrant audiovisual experience.

To adapt to the transformation development trend of the broadcasting and TV industry, eliminate the restraints of the traditional SDI switching matrix on the rapid development of new broadcasting and TV services, and embrace the coming 4K/8K era, IP-based reconstruction of the production and broadcasting network has become an inevitable choice for industry development.

New-Generation 4K/8K-Oriented Media Fabric Solution

To promote the development of the UHD industry and enable more users with UHD service experience, Huawei launched the new-generation 4K/8K-oriented Media Fabric solution. This solution has succeeded in breaking through the bottleneck of the UHD production and broadcasting technology.

The Media Fabric solution can be deployed in various service scenarios, such as the OB van, studio, broadcasting domain, ingesting, and master control. Based on the service scale, the NE series routers can be flexibly used to form the IP switching matrix of the master/backup or spine-leaf structure. In this way, the IP-based reconstruction of the production and broadcasting network is implemented.

Breaking the bottleneck of 4K/8K industry development, Improve the production efficiency of 4K/8K content
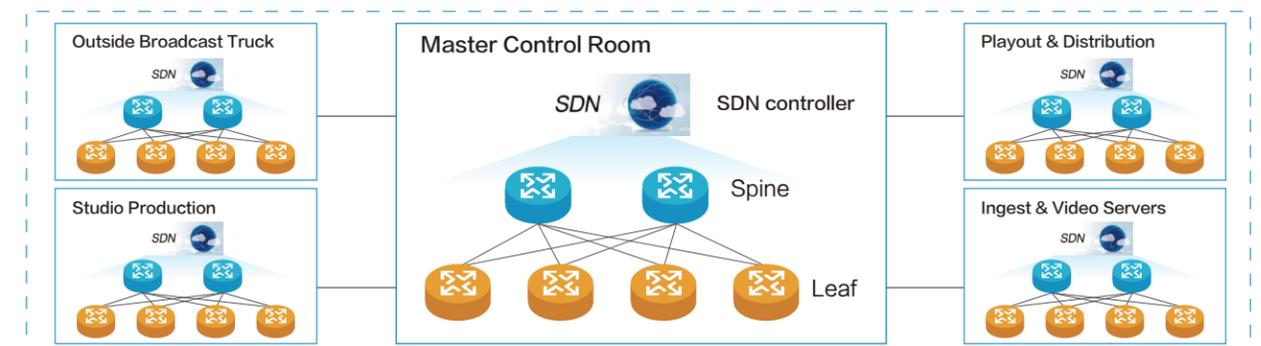
Huawei Media Fabric solution uses innovative algorithms and flexible programmable network processor technologies to support IP switching matrix-based clean switching and intelligent identification of 4K/8K stream frame boundary, implementing reliable scheduling of large-scale audio and video services and providing high-quality broadcast-level 4K/8K video content for back-end broadcasting. In addition, the solution is developed based on a simplified Spine/Leaf Fabric architecture, supporting flexible expansion of the production and broadcasting system and smooth UHD evolution.

The Media Fabric solution has the following advantages:

■ **High–quality broadcasting**
The solution supports net video stream switching based on the IP switching matrix, intelligently identifies frame boundaries of audio and video streams, and provides instant switching service experience. Multiple audio and video standards, such as ST2022-6, ST2110, and ST2059, are used together with PTP to implement precise clock synchronization.

■ **Highly reliable production and broadcasting**
Huawei routers have been deployed in the carrier market for more than 20 years and have chip-, device-, and network-level reliability, meeting the ST2022-7 standards and ensuring the continuity of TV services.

■ **Simplified production and broadcasting**
The auxiliary devices support GE/10GE/25GE/40GE/50GE/100GE interfaces to implement access and scheduling of IP audio and video streams at any bit rate. Precise PTP clock synchronization is used to provide high-precision synchronization signals for various audio and video terminals.

■ **Open ecosystem**
This solution provides open northbound interfaces, which can be flexibly integrated with media controllers of mainstream vendors. In addition, Huawei actively cooperates with video industry standards organizations, industry alliances, and mainstream broadcasting and television vendors.

Key Technologies: Clean Switch

Huawei uses the NP chip and innovative algorithm to implement content clean switching based on the IP switching matrix, ensuring the video quality of each frame.

Clean Switch Algorithm:

- Frame switching instead of packet switching
- Implemented on IP fabric instead of receivers, decoupling & save bandwidth
- Self-Learning, adaptive to different video formats

Network Processor Chip：

- Deep packet header parsing, to identify frame boundary
- Programmability, adaptive to different standards and implementations
- High performance, the first 16nm 1Tbps NP chipset

Solar 5.0

The clean switch technology ensures lossless image switching and provides visual experience of instant switching.
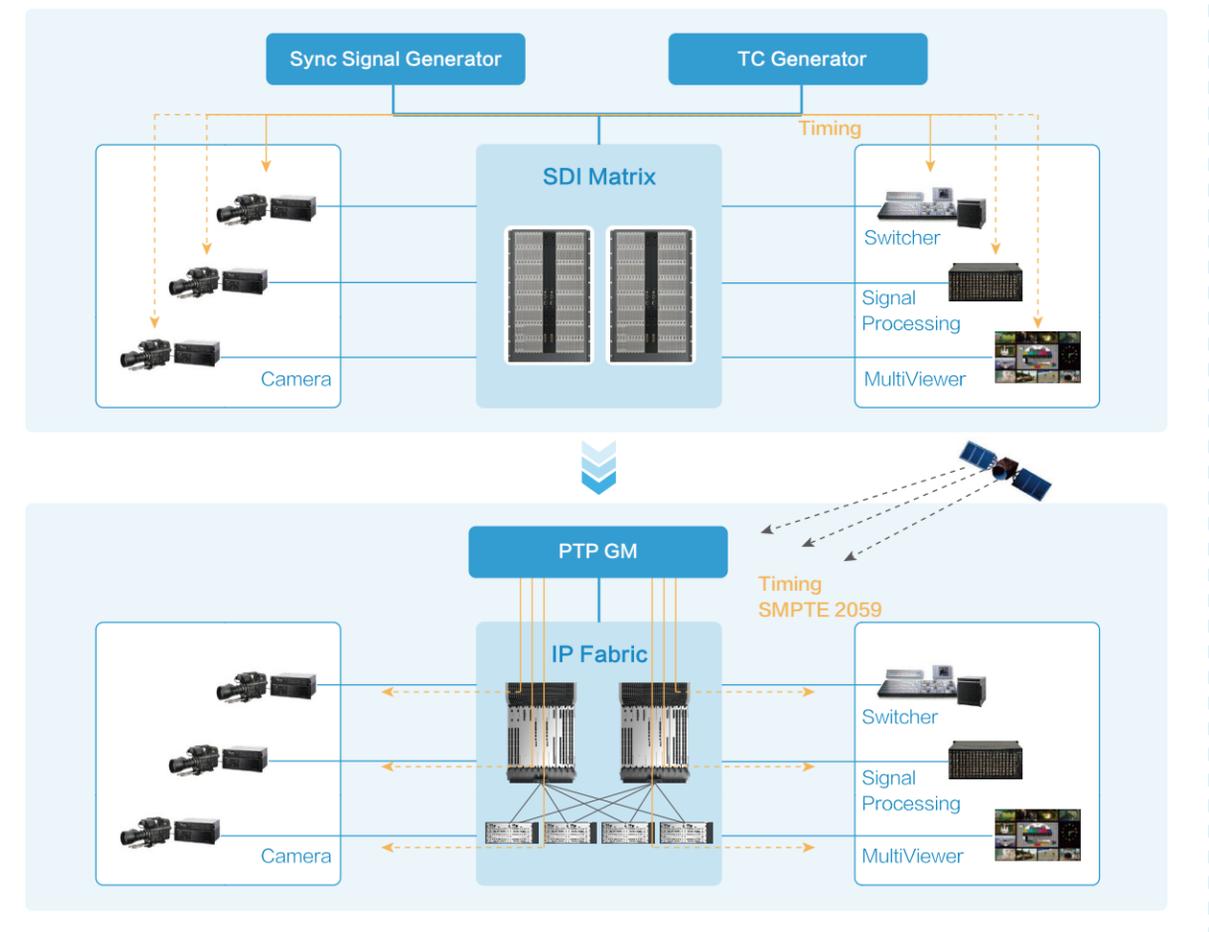
- **Lossless images：**

  During the switching of common packets, black screen, erratic display, and video pause occur. The clean switch algorithm switches the entire frame to ensure lossless switching of each video frame.

- **Instant switching：**

  A powerful chip processing capability of the network processor may complete a clean switching within 40 ms after the chip receives a switching instruction, thereby providing an unperceivable video switching experience for users.
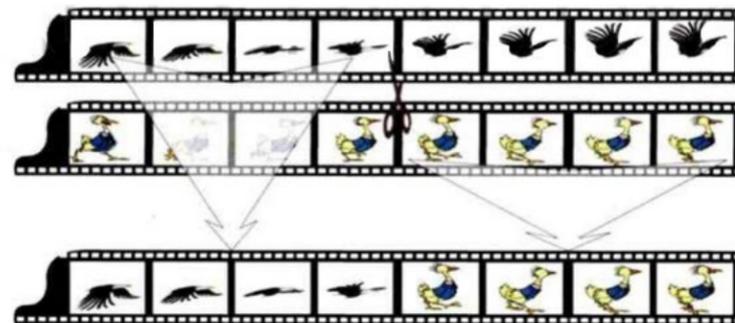
In addition, the clean switch technology complies with the ST2022-6 and ST2110 protocols. It supports the switching of audio and video streams in various formats such as SD/HD/UHD, and supports the production and broadcasting of various standard audio and video contents.

Key Technologies: PTP Precise Clock Synchronization

The production and broadcasting system requires strict clock synchronization. For SD and HD video streams, the traditional SDI broadcasting system uses black field signals (BB) and three levels (TLS) for precise clock synchronization, achieving frame alignment and ensuring image stability and lip synchronization. After IP transformation of the production and broadcasting network is complete, how to ensure clock synchronization between the IP production and broadcasting system and other systems is a key challenge. Therefore, the video industry standard organization SMPTE has launched the ST2059 clock standard.

Sync Signal Generator   TC Generator

Timing

SDI Matrix

Switcher

Signal Processing

Camera   MultiViewer

PTP GM

Timing
SMPTE 2059

IP Fabric

Switcher

Signal Processing

Camera   MultiViewer

In this solution, the PTP technology is used to implement precise clock synchronization. This technology has the following advantages:

- **High precision:**

  The precision of the synchronization clock is less than 1 µs.

- **Flexible deployment:**

  complies with the ST2059 standard and supports three clock deployment modes, BC, TC, and OC.

- **Secure and reliable:**

  Active and standby clocks can be deployed, and clock switching protection can be implemented based on the BMC algorithm.

Key Technologies: Built-in Multicast NAT

The SDI switching matrix manages physical connections. Video streams are switched based on physical connections, and no address conflict occurs.

SDI Matrix: Manage Physical Links

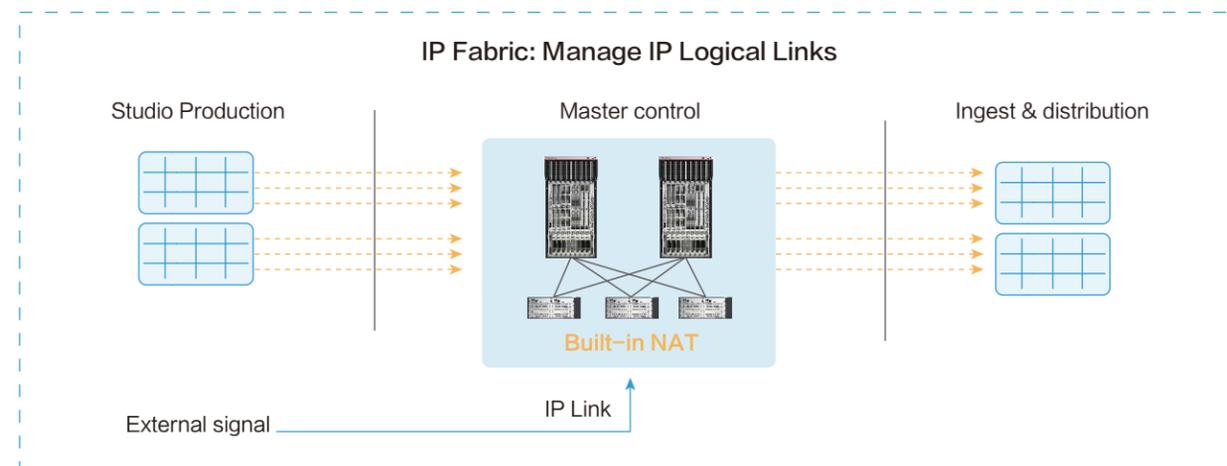Studio Production　　　　　　Master control　　　　　　Ingest & distribution

External signal
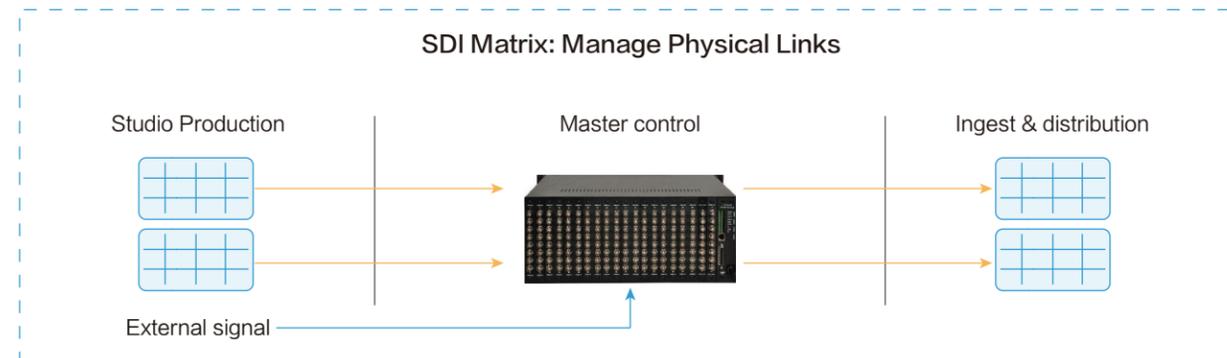
The IP switching matrix will face the following challenges:

- The IP switching matrix switches video streams based on IP logical links. Address conflicts occur if there are cross-department connections or off-site interconnection.
- The physical topology and logical topology of the IP switching matrix must be stable to eliminate the performance bottleneck caused by excessive 4K/8K video scheduling.

IP Fabric: Manage IP Logical Links

Studio Production　　　　　　Master control　　　　　　Ingest & distribution

Built-in NAT

External signal　　　　　　IP Link

To address these challenges, the built-in multicast NAT technology is added to the Media Fabric solution to ensure that the IP switching matrix is similar to the traditional SDI switching matrix in terms of simple connections.

- Multicast NAT is implemented based on powerful network processors to achieve on-demand address translation. It is easy to deploy and flexible and does not need to adjust the network topology or routes.
- Distributed NAT has a large capacity and has no performance bottleneck.
- The device itself provides multicast NAT. Therefore, no additional NAT device is required, which saves investment.

Open Collaboration, Jointly Promoting the Development of the 4K/8K UHD Industry

Huawei Media Fabric solution provides open northbound interfaces and supports standard protocols such as NETCONF, Telemetry, and SNMP. It can be flexibly integrated with third-party controllers through standard interface documents to implement video stream scheduling and O&M.

In addition, the auxiliary devices comply with standard protocols such as ST2022, ST2110, and ST2059, and have good interoperability with various audio and video terminals of broadcasting and television vendors. This ensures that the network devices can be smoothly integrated into the ecosystem of the broadcasting and TV media.

3rd SDN Controller

NETCONF/Telemetry/SNMP

Camera　　IP Gateway　　Switcher　　Clock Generator　　Video Server
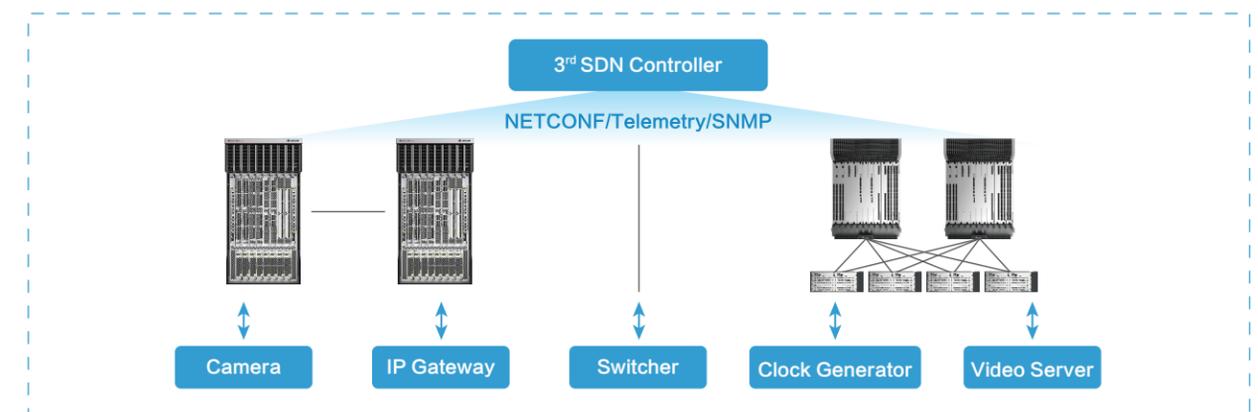
Huawei has been cooperating and innovating with key customers, mainstream broadcasting and television suppliers, and industry standards organizations/alliances to promote the development of the 4K/8K UHD industry.

- Huawei implements joint innovation with key customers such as HBS and CCTV. The first phase of joint verification has been completed with HBS. In 2018, Huawei and IBC jointly released the IP solution for the production and broadcasting network.

- Huawei has established partnerships with mainstream broadcasting and television vendors (including GV, SONY, Imagine, Nevion, Ge Fei, CDV Zhengqi, and Dayang). Huawei is committed to providing customers with the best end-to-end integration solution.

- Huawei collaborates with standards organizations and industry alliances to make contributions to the continuous development and market promotion of UHD standards.

Build the Media Fabric Solution Based on Huawei NE Series Routers

To meet customers' service requirements in various scenarios, Huawei provides different models of NE series routers with the Media Fabric solution.

3rd SDN Controller

Spine

Media Fabric

Leaf

Ultra-large IP Switching Fabric

NE40E-M8A	NE40E-F1A-14H24Q

- 5U, 220mm depth, 1Tbpst
- Flexible Card, 10GE/25GE/50GE/100GE

- 1U, 600mm depth, 2Tbps
- Fixed port, 10GE/25GE/50GE/100GE

Compact Size & Large Capacity

NE40E-X8A	NE40E-X16A	NE9000-8	NE9000-20

- **Ultra-large Capacity:** 4T line cards available & 8T line cards planned on NE9000
- **High-density Interface:** 40*100GE, 8*400GE line cards available on NE9000, 20*100GE available on NE40E

Media Fabric