ZTE Common Edge White Paper

TABLE OF CONTENTS

FIGURES

1 Background Overview of MEC

1.1 Drive Force of MEC

1.1.1 Service Drive

In the 5G era, mobile communication started from communication between people and people, and then changed to communication between people and things. Services such as AR/VR, IoT, industrial automation and unmanned driving are introduced in large quantities, bringing about high bandwidth, low latency and large connection, which are also the three 5G scenarios defined by 3GPP. New services require more strict bandwidth, latency, and security, and traditional cloud computing cannot meet service requirements. The MEC (Multi-Access Edge Computing) is such a powerful platform, which can solve such problems as network latency, congestion and security in the future. Edge computing effectively integrates wireless networks with the Internet, and provides cloud computing and wireless network capabilities at wireless network edges. Application services and contents are deployed at the local edge to reduce data transmission links, improve data security, reduce end-to-end latency, reduce bandwidth usage, and reduce power consumption.

1.1.2 Technology Drive

Technologies such as 5G, NFV, SDN, and cloud computing promote MEC development and accelerate ICT integration. To meet service requirements in three 5G scenarios, the control plane of NEs is separated from the forwarding plane, the control plane is deployed and dispatched in a centralized manner, and the user plane is deployed close to users in a distributed manner. Thus, management costs and user experience are balanced. In addition, MEC is introduced to effectively implement the deployment of service anchor points at the edge, shorten the service response time, and expose the communication capability of traditional mobile networks. MEC is becoming one of the driving forces for network transformation. By dropping core network functions to the network edge, and providing IT services, environments, and cloud computing capabilities near mobile users, MEC can meet 5G low-latency and high-bandwidth service requirements. On the application level, MEC can provide customized and differentiated services for vertical industries to improve network utilization efficiency and value. MEC seamlessly connects the network and the cloud, which is required for 5G.

1.1.3 Value Drive

At present, operators' tariffs and business models are relatively single. Because no service priority is distinguished, many services that occupy a large amount of bandwidth cannot generate sufficient value, such as video streaming media, while some services that require high real-time performance and high value, such as industrial control, cannot be guaranteed with priority.

As an innovation in network architecture and commercial models, MEC edge computing is a powerful tool for vertical industries of 5G network services. MEC edge computing is an opportunity for operators to improve network values and promote value reconstruction of the industry chain. The network connection of MEC edge computing is the key, the computing power is the effective guarantee, and the network capability and exposure are the driving force. By deploying the MEC platform, operators can make full use of 5G network advantages, fully explore wireless network capabilities, empower digital transformation in the industry, and provide infinite possibilities for creating more network values in the future. MEC will help the carrier achieve the transition of the network from the access channel to the information service enabling platform.

The network connection of the MEC platform is the key, its computing power is the effective assurance, and its network capability and its openness are the driving force. By deploying the MEC platform, the operator can make full use of 5G network advantages, fully explore wireless network capabilities, enable digital transformation in the industry, and provide infinite possibilities for creating more network values in the future.

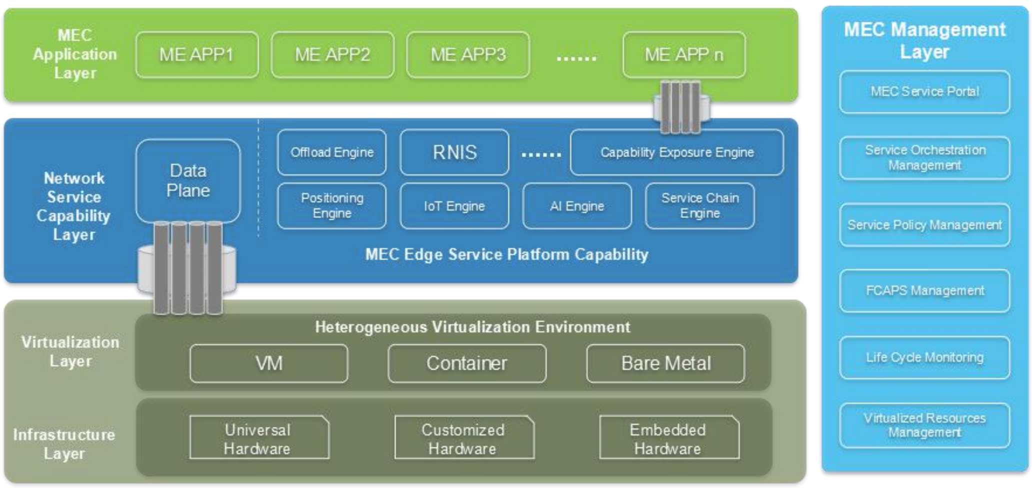
2 MEC Platform Architecture

2.1 Solution Overview

MEC deeply integrates traditional telecom networks with Internet services to reduce the end-to-end latency of user service interaction and improve user experience by exploring the inherent capabilities of wireless networks. Considering the complete MEC solution, MEC not only needs the support of communication network capabilities (CT capabilities), but also needs the support of cloud computing capabilities (IT capabilities), which is the best combination of ICT technology integration.

2.1.1 MEC Overall Architecture

Figure 2-1 MEC Overall Architecture



The basic MEC architecture can be generally divided into the following parts:.

- The first part is the infrastructure, including various types of servers, such as computing servers (computing capability), storage servers (storage capability), and hardware acceleration cards, meeting multiple requirements such as AI reasoning, graph/image rendering, and high-speed network forwarding.
- The second part is the virtualization, which provides virtualization platform resources and management for upper-layer capability services and APPs, including VMs and containers, so that different applications can share the same

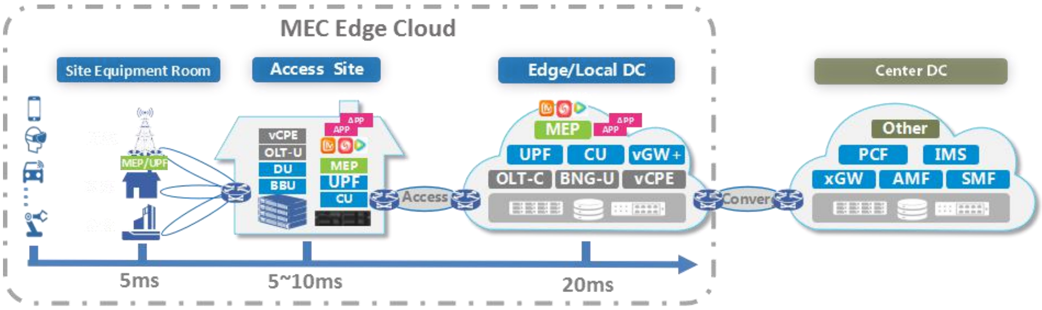
infrastructure.

- The third part is the network and service capability. The network capability contains traffic offload and basic service capabilities such as NAT, virtual firewall VFW, DNS and service load balancing. In addition, it provides RNISs (Radio Network Information Service), bandwidth management services, service routing rules and wireless indoor positioning services. These services are provided through the network capability exposing framework through the API interface. The edge service capability layer uses a MicroService framework, and can introduce new capabilities such as AI capability and big data capability, to enrich and improve the MEC capability layer.
- The fourth part is the MEC management. It provides the MEC service portal, service orchestration management, service policy management, FCAPS management, life cycle management, and virtualized resource management.
- The fifth part is the applications deployed at the edge, such as video surveillance, AR/VR video and park applications.

2.1.2 Position of Deploying MEC

Traditional centralized deployment of core network cannot meet the requirements of 5G services, and it is an industrial trend to calculate power along the edge of services. 5G network uses cloud-based construction, which is more lightweight and flexible. Fully-distributed clouds based on central DC, edge DC, and access site become the common path for operators' infrastructure evolution. MEC does not restrict the network deployment mode. It can be flexibly deployed in accordance with different service scenarios and latency requirements. In most cases, it can be deployed in access equipment rooms, convergence equipment rooms, and city core equipment rooms, as shown in the following figure.

Figure 2- 2 Position of Deploying the MEC Edge Cloud



By deploying an MEC platform at the edge, the computing capability of the cloud can be effectively extended from the center to the edge to implement fast service processing and on-line forwarding, meeting the diversified application scenarios of 5G.

The cloud platform (such as OpenStack) based on the MEC edge cloud provides the upper-layer MEC applications with a unified virtualization software environment and resource management. MEC applications are deployed on the edge cloud platform as VMs or containers. MEC applications can be flexibly deployed in accordance with different scenarios to meet the service requirements of large bandwidth and low latency.

2.1.3 Features of MEC

MEC is both a resource computing platform and a wireless network capability platform. By integrating the mobile access network with Internet services, it can not only improve user experience and save bandwidth resources, but also deploy computing capabilities to the network edges to provide third party's integrated applications, offering imaginary space for service innovation at the mobile edge entrance.

The following equation can be simply used to describe the relationship:

MEC = (Access + Compute) * Capability

Multiple access: Users can access the same service deployed at the edge of the network and obtain the same user perception no matter whether they access the network through 4G, 5G, or even fixed networks.

Compute: edge customized servers and accelerated hardware devices such as GPU/FPGA, together with the edge ICT cloud platform, provide computing, storage, networking and acceleration capabilities to applications on the edge.

Capability: MEC provides the cloud computing resource capability, wireless network capability, and service enablement capability, and facilitates local computing and processing of edge applications.

2.2 Edge Servers and Acceleration Hardware

2.2.1 Edge Server

Compared with a core data center, edge equipment rooms have different conditions, and cannot meet the deployment and operation requirements of general servers in many aspects. This brings challenges to edge servers.

- The transmission and access equipment room rack is mostly 600 mm deep and a few racks reach 800 mm.
- The stability of the cooling system in the edge equipment room cannot be guaranteed effectively. In case of cooling system failure, the temperature of the equipment room may be higher than 45℃.
- The edge equipment room is generally lower than the load-bearing standard of the data center.
- Other restrictions: Servers deployed in edge equipment rooms also face many restrictions, such as high seismic resistance, electromagnetic compatibility, and noise protection, and poor air quality.

Due to limited edge site equipment room environments and deployment costs, the MEC-based edge cloud-based server features small size, low power consumption, and high computing density. The server uses the front cabling design for easy maintenance and management. It supports strong heterogeneous computing and greatly improves the performance and power consumption ratio. It has a good heat dissipation design, supporting the working temperature from -5°C to 45°C, and meeting the wide temperature working conditions of the telecom edge cloud equipment room.

2.2.2 Acceleration Hardware

The MEC edge cloud hardware generally uses x86 universal servers. However, the x86 universal servers have low performance in processing specific service requirements, resulting in a low price/performance ratio, and cannot meet commercial deployment requirements in 5G scenarios. Different hardware acceleration solutions should be considered for different services.

- For computing intensive services, such as 5G CU PDCP air interface encryption/decryption and MEC location algorithm, they consume a lot of CPU and require special hardware acceleration.
- For traffic forwarding services, such as 5G UPF/GW-U, MEC local distribution, CDN, and BRAS-U, they require high network forwarding capability and require hardware acceleration of data forwarding.
- For video-related services, such as AR/VR and live video broadcast services, hardware acceleration is required for video rendering and transcoding.
- AI field: The training and reasoning operations involved require the introduction of GPU for hardware acceleration.

2.3 Lightweight Edge Cloud

MEC is mainly used to process local user services in an area, improving user experience and providing limited coverage. Therefore, the edge cloud that bears the MEC features small scale and large quantity. If a small-scale edge cloud uses complete IaaS deployment, the VIM occupies a large proportion of resources, which not only increases the construction cost of the edge cloud but also wastes management resources. Therefore, lightweight and simplified deployment must be used to improve resource utilization.

- Lightweight VIM and Hypervisor

Lightweight VIMs and Hypervisors tailor components, keep basic components only, and take other components as optional components. At the same time, the component service configuration is modified to reduce the number of working threads of the component service to reduce the consumption of physical resources. In addition, the integrated deployment of computing and control needs to be supported so that the resources can be utilized effectively.

- Lightweight storage

The edge cloud has a small scale, bears local processing, and requires small storage capacity. Local storage or cloud storage can be used for storage. The local storage performance is high, less resources are used, but its reliability is poor, and migration is not supported. If cloud storage uses independent distributed storage devices or disk arrays have high costs, the computing storage convergence solution is an effective solution. Distributed storage devices are deployed on computing nodes, and the computing and storage devices share a physical platform to save costs. Multiple copies are used for storage. There is no single point of failure, and a policy configuration allows VMs to preferentially use local copies. Different storage modes can be selected in accordance with service requirements to achieve the balance among performance, reliability, and cost.

- Lightweight network

The services on the edge are mainly third party services and change frequently. If manual configuration is adopted in the network configuration, the O&M workload is huge. The unattended operation of some edge sites makes the network configuration more difficult. Therefore, it is necessary to use SDN for automatic network configuration. Due to its small scale, edge sites need lightweight SDN controllers, such as OVN, to implement automatic network deployment, improve O&M efficiency, reduce O&M workload and adapt to frequent service changes.

2.4 MEP Platform

For operators, the MEC should consider how to give full play to the advantages of mobile communications networks, and take CT capabilities as the focus to provide a unified MEC platform for ICT integration. MEP (Mobile Edge Platform) provides CT specific wireless network capability, for example:

1. **Traffic offload capability**

The traffic offload capability is the core capability of the MEC. In application scenarios such as local computing and enterprise parks, how to flexibly and efficiently perform local unloading of service data streams is first solved.

Depending on different networking conditions, the optional solutions are the TOF+ solution oriented to the 4G network (implemented through the SGW dropping to the MEC to implement the Local breakout (LBO) function). CUPS solution (deployed with CU separation solution, GW-C in the core equipment room and GW-U in the edge equipment room to implement local traffic distribution through GW-U traffic distribution). The 5G-oriented UPF solution can use LADN (Local Area Data Network), uplink classifier UL CL (Uplink Classifier) or IPv6-based Multi-homing.

ZTE provides the 4G/5G integrated MEC local distribution solution. On the same platform, the above distribution functions are used as service plug-ins on the MEC platform. The flexible plug-in mode is used to support local distribution under 4G, 5G NSA and 5G SA networking conditions.

2. **NAT/VFW/DNS/LB**

After the service data traffic is distributed and unloaded locally, it is transferred to the MEP platform in tunnel mode. The MEP platform provides NAT address translation, virtual firewall VFW, domain name service DNS and load balancing LB, and distributes the service data traffic from the carrier network to each APP application.

3. **Radio indoor positioning**

By integrating multiple positioning technologies such as indoor base station and Bluetooth, the MEC provides the indoor positioning capability of 3~5 meters. In addition, it can implement coordination management through the MEC-based IoT management platform such as geomagnetic field, fire-fighting nozzle, fire alarm and other wireless sensors. This indoor positioning capability can be opened to third party applications and the big data platform in the shopping mall in the API mode, to provide users with indoor navigation, intelligent parking and other service applications, so as to provide location service capability on the basis of the existing communication capability network.

ZTE's QCell equipment based on indoor coverage, together with the MEC location service, has cooperated with such application partners as Innsmap and INNS Big Data for multiple projects with respect to smart shopping center, smart building, and smart park.

4. **Traffic rule**

The MEC platform needs to provide the service rule management configuration function. Edge applications can dynamically change the local traffic distribution policy through the corresponding service rule configuration interface, so that local services can be flexibly controlled by domain name, IP 5-tuple, user, and base station location.

5. **DPI/TCP optimization**

This function aims to optimize network performance and improve user QoE. The MEC-based DPI function implements in-depth packet recognition on the MEC platform, and notifies the recognition result to the base stations through the accompanying packet. The base station guarantees differentiated scheduling algorithms for specific service types according to the set policy, thus achieving better service experience.

The MEC-based TCP optimization solution integrates TCP air interface optimization (that is the unique feature of the wireless network) with TCP congestion optimization on the wired side to improve TCP service performance through HTTP fragmentation proxy, TCP transparent proxy, TCP congestion control, and wireless resource scheduling optimization.

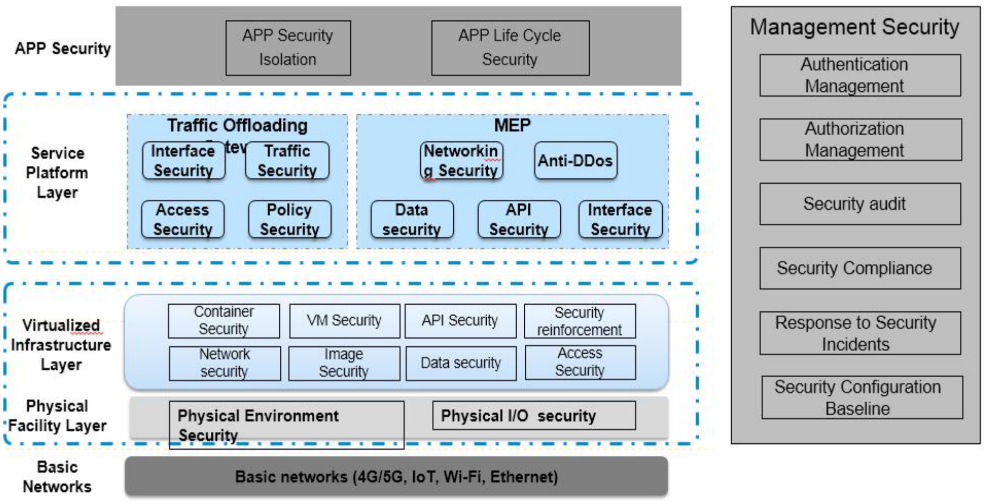
6. **RNIS**

RNIS (Radio Network Information Service) provides wireless network-related services for MEC applications and the MEC platform, and the information can be used to optimize the existing services. RNIS can provide such information as cell ID, radio channel quality, cell load and throughput. With the introduction of AI and other artificial intelligence analysis and reasoning capabilities, the service QoS can be guaranteed from the user level, flow level to packet level at a finer granularity, and new network capabilities such as location perception and link quality prediction can be provided.

2.5 MEC Security

Edge computing introduces multi-dimensional security risks. Typical problems include edge network security, physical equipment room security, edge infrastructure security, service openness security, and application lifecycle security. Therefore, MEC edge computing requires a security response in multiple dimensions:

Figure 2- 3 Edge Computing Security Architecture



- Application layer: MEC needs to provide the application isolation and life cycle security management capabilities. Among them, life cycle security needs to further solve the security requirements of full life cycle such as application identity authentication, application mirroring security and application termination security.
- Service platform layer: Generally, it provides edge computing connection, middleware service and service opening capabilities. Therefore, the security service provides the capability of service access security and data security within this scope. It needs to consider and provide the security networking capability, and introduce technologies such as virtual firewall. At the connection layer, typical problems such as traffic offload policy security and interface security are solved.
- Infrastructure layer: In the edge computing scenario, the infrastructure capabilities of VMs and containers should be considered at the same time. Both the demands for application development towards cloud native development and the lightweight consideration of edge scenarios are considered. Therefore, in addition to the

traditional security of OpenStack, the introduction of cloud native K8S at the virtual layer should solve the corresponding security requirements, including the typical problems of container runtime security.

- Physical facility layer: As the physical location of edge computing may be in remote equipment rooms, physical devices should provide security solutions in terms of physical equipment security and equipment I/O security. The physical interfaces of the server include local serial port, local debugging port, and USB port. The port function should be disabled to prevent malicious attackers from accessing and damaging the network. In addition, the IEEE802.1X protocol is used to authenticate the connected customer's physical network equipment to prevent it from being connected to illegal and insecure network equipment.

2.6 MEC O&M

Breakthroughs in edge computing, network slicing, and cloud native technologies are supporting operators to achieve unprecedented operation flexibility and a larger expansion of the service field, bringing exponential increase in O&M management complexity.

MEC O&M focuses on application management, resource management, and capability openness.

1. Application Management

NFVO/VNFM is responsible for UPF/MEP deployment, and MEPM is responsible for MEC service management. Unified service deployment, application management, and monitoring are provided to meet operators' requirements for centralized and efficient maintenance and rapid on-demand service deployment.

MEC applications need to be deployed in a differentiated manner. Edge cloud applications fall into two categories: Carrier-grade and third party APP. Carrier-grade APPs are tested through carrier network access and deployed with a mature MANO system. Generally, the third party APP does not pass the network access test of the carrier, and provides simplified deployment.

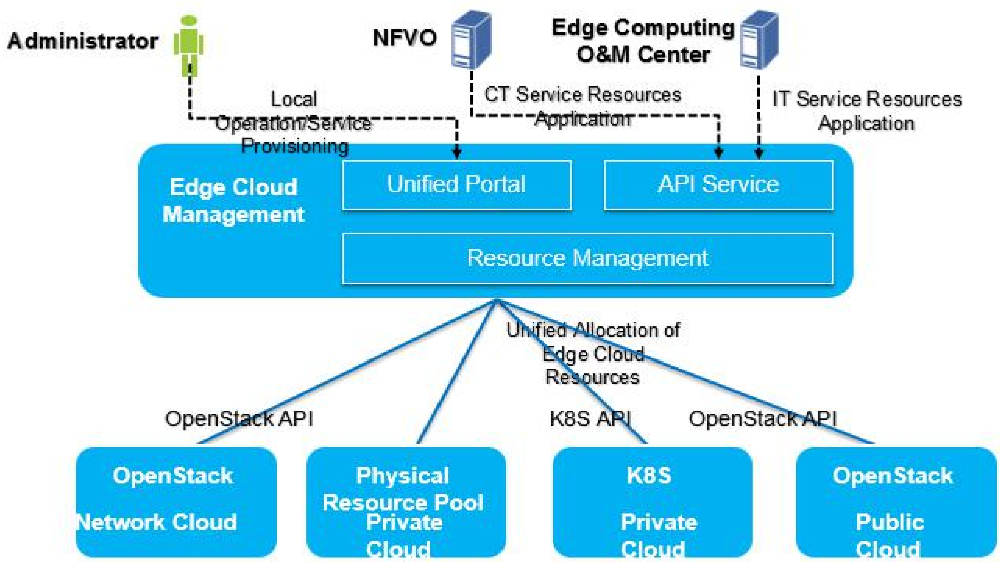
- Carrier-grade APP deployment: The deployment content, which includes 5G UPF and MEP and forms end-to-end network services with regional 4/5G, is deployed by the carrier's regional integrated NFVO.

- Third party APP deployment: The APP provided by the enterprise and industry is introduced to MEAO/MEPM to implement MEC service deployment and orchestration management.

2. Resource Management

Edge cloud features broad distribution and multiple nodes, and different resource pools adopt different hardware devices. Meanwhile, 3rd party application IaaS and PaaS are deployed in diversified mode. The multi-VIM management function should be provided to be responsible for making unified management and monitoring of the MEC resource pool.

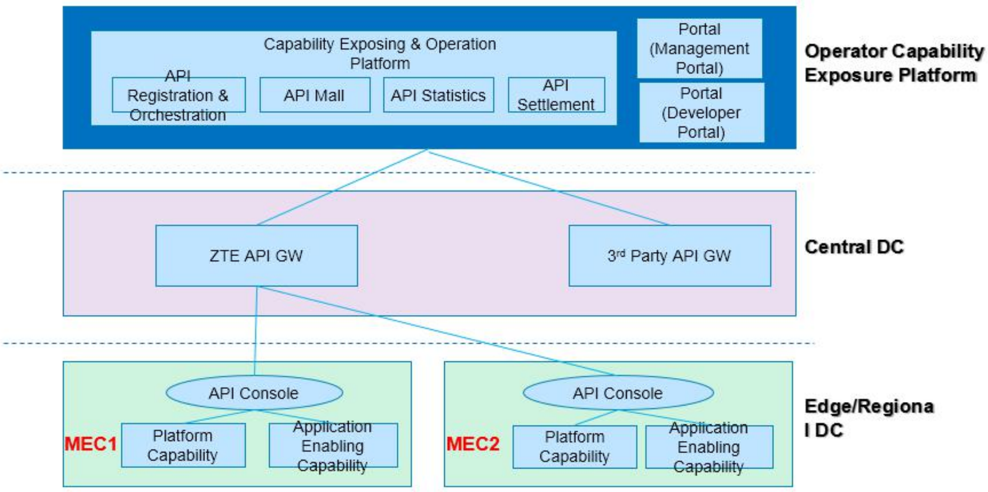
Figure 2-4 Unified Management and Monitoring of the MEC Resource Pool



3. Capability Exposing

With the development of the edge cloud ecosphere, vertical industries have increasingly high requirements for edge cloud capability exposure. Capability exposure of the edge cloud becomes an important key point in MEC O&M. On the one hand, the platform resources, edge network capabilities and special functions are exposed to the third party application, so that the third party application can obtain differentiated network services according to its service requirements, and use and charge on demand to improve user satisfaction in service use. On the other hand, the third party provides statistics and settlement of APP life cycle management, product management, subscription relationship management and API invocation to the third party, so that the third party can have the right and capability of flexible self-operation and further construct an open ecological operation of edge computing application.

Figure 2-5 MEC Capability Exposure Management



3 Probe into MEC Industry Application Scenarios

ZTE actively promotes the application of MEC industry scenarios, and has now explored the "1+4" scene mode.

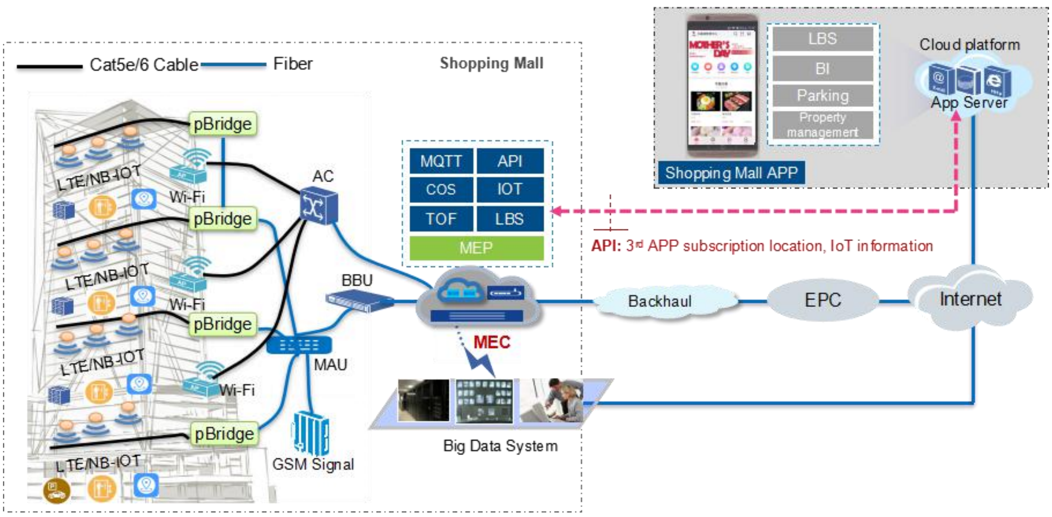
- “1” refers to the wireless services of operators, such as high-precision indoor positioning, wireless network information service capabilities, wireless intelligent network optimization, ORAN applications, and video TCP acceleration services.
- “4” refers to four major industry application fields including big video, smart manufacturing, smart grid, and Internet of Vehicles.

3.1 Indoor Positioning

Location information is the online identity of a real object. It is placed in the three-dimensional coordinate system of a virtual space to implement interconnection between the real world and the virtual space. However, the most fundamental problem of Scene-IoT is to solve the problem of the location of people and objects in scenarios. However, isolated user location data is of limited value, and the commercial value of information can be fully expanded only through user location-based connections between people, objects, and data.

Through multiple access modes, the MEC edge service platform provides high-precision indoor positioning services for smart storage and logistics, intelligent manufacturing, emergency rescue, personnel asset management, and service robots. For the retail industry, the system provides low-precision grid-level positioning and location information to record the activity tracks and areas of each customer. If the system is analyzed based on other big data, such as consumption data, residence time, and behavior habits, a disruptive change is generated for the industry. More accurate marketing will result in more effective delivery, more accurate pre-judgment analysis, and high-efficiency trading.

Figure 3- 1 Hybrid Indoor Positioning Solution Based on the MEC

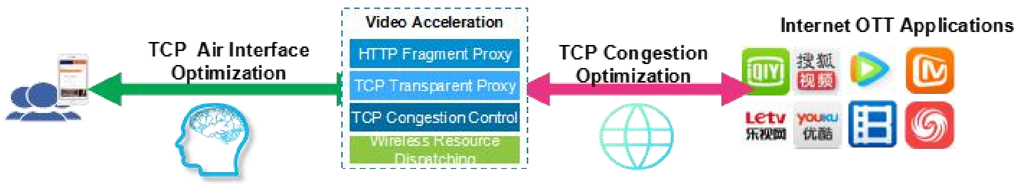


As shown in Figure 3.1, ZTE is committed to building a smart mall solution based on the MEC edge service platform. It integrates multiple positioning technologies such as indoor base station, Wi-Fi and NB-IoT, and provides 5m high-precision positioning. In addition, it can implement coordination management through the MEC-based IoT management platform such as geomagnetic field, fire nozzle and fire alarm. In addition, by relying on the MEC platform, the capabilities of indoor location service are exposed to the third party applications and the big data platform in the shopping mall, to provide users with such service applications as indoor navigation and smart parking, and to the property management service applications for the owner. Through the location capability wholesale distribution, the effective data of indoor location and big data are extracted, analyzed and calculated, and the most valuable results are obtained.

3.2 TCPO

The TCP protocol is widely used in mobile data networks, including common webpage browsing and download services. The TCP considers that packet loss is caused by network congestion, which reduces the packet sending rate and eases network congestion. When the transmission network includes wireless transmission, packet loss is probably caused by the fluctuation of the wireless environment and the movement of terminals, and is not caused by transmission congestion. If the sending rate is reduced, the TCP transmission rate is degraded seriously.

Figure 3-1 TCPO



This procedure describes how to deploy the TCP proxy service on an MEC device close to a base station to optimize uplink and downlink data services. On the one hand, the TCP proxy provides buffer and fast ACK for the downlink data packets sent by the server, thus shortening the loopback latency and preventing random fluctuation of the wireless network from affecting server-side packet transmission, shortening the slow-start process and speeding up downlink data transmission. The system simulates the response TCP ACK to uplink TCP packets to speed up the uplink data transmission by reducing the loopback latency.

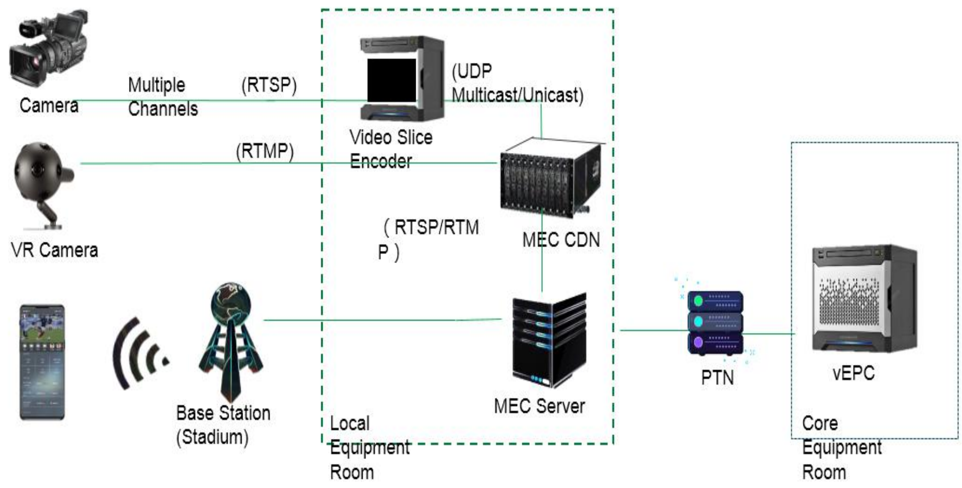
On the other hand, the TCP proxy acts as a server to send buffered packets to UEs to provide flow control and retransmission, and accelerate downlink data transmission and ensure reliability. When uplink TCP packets are forwarded to the server, flow control is made based on the receiving window and retransmits lost packets to ensure reliable uplink data transmission.

Through TCP optimization in the MEC location, both the server speed-down problem caused by packet loss and the radio environment information can be solved. TCP optimization can be achieved to an extreme degree, and collaboration can be achieved between multiple sites.

3.3 Big Video

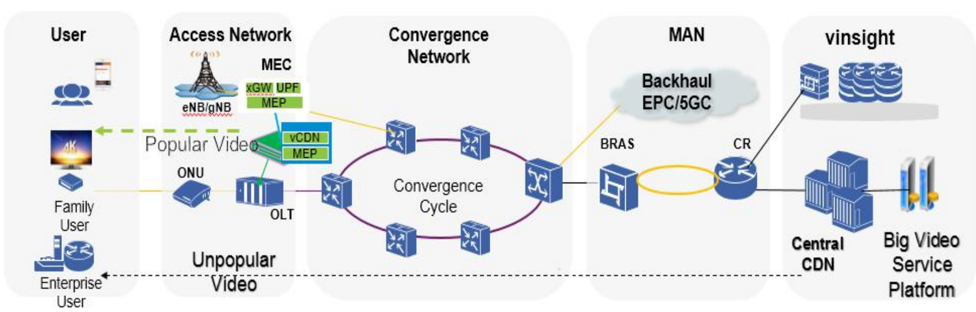
Big video services include 4K/8K LiveTV&VOD, VR LiveTV&VOD, VR game, AR and video surveillance, which pose challenges of large bandwidth and low latency to the 5G network. MEC is an important part of the 5G big video service solution. Figure 3.3 shows a typical MEC solution for live video broadcast. Multiple cameras and VR cameras are deployed inside the venue to shoot from different angles. Video is combined through a video splice encoder. MEC CDN transcodes video to provide services directly to users in the venue. This avoids processing at the cloud end, reduces live broadcast latency and provides better live broadcast experience.

Figure 3- 2 5G Stadium Video LiveTV Solution



For the video on demand (VOD) service, it can save backbone and convergence network traffic through MEC CDN, reduce the transmission latency of the video service, and improve the user experience of the video VOD service. As shown in Figure 3.4, the CDN distribution system of the carrier or OTT manufacturer further deploys the edge nodes of the CDN to the mobile network or access equipment room according to the service requirements. Wireless users are distributed through the MEC distribution module, and fixed network users are distributed through the OLT distribution module. Together with the CDN dispatching mechanism, the video traffic of the users within the coverage of MEC CDN is introduced to the edge CDN node. Service access speed can be improved.

Figure 3- 3 Solution of Deploying MEC CDN to the Edge

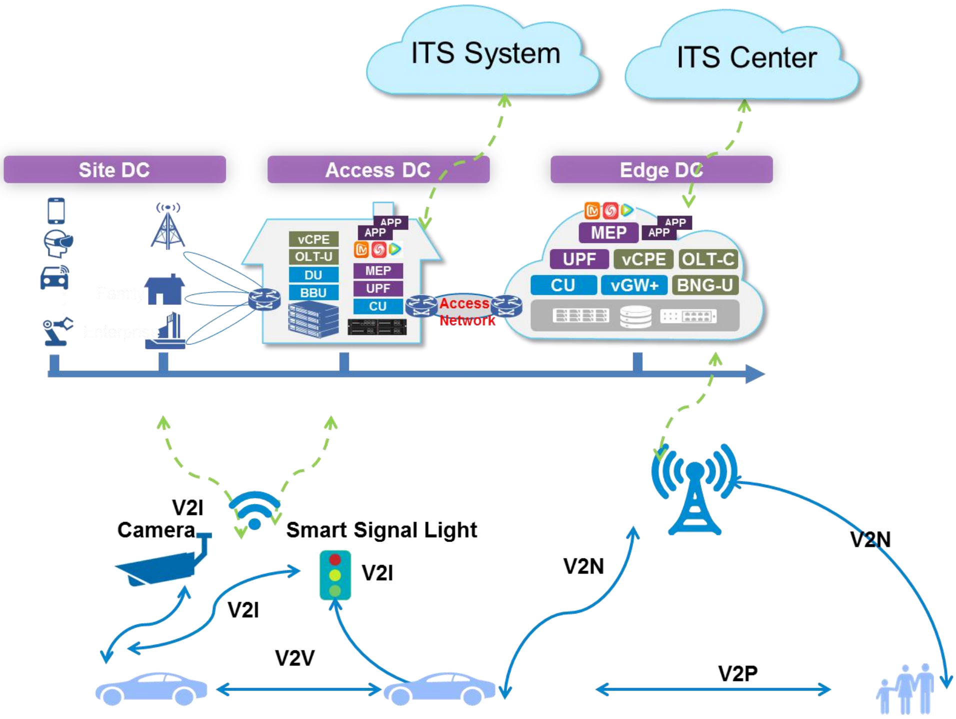


VR games involve interaction with users, and require higher latency. The MEC solution further deploys the game servers to the edge towards users, greatly improving user experience in VR games. For the video monitoring service, the MEC solution can be used to process videos locally, saving the leasing cost of large-bandwidth leased lines.

3.4 IoV

Due to the complexity of IoV services and strict requirements for latency, MEC is an important part of IoV solutions. On the one hand, the MEC can be flexibly deployed so that cloud-end services can be deployed closer to the user side and end-to-end latency can be reduced. On the other hand, MEC can be configured with abundant heterogeneous computing capabilities to meet the requirement for a great amount of AI computing in the Internet of Vehicles (IoV) service, reduce the dependence on the intelligent single-vehicle technology, implement vehicle-road coordination, and share computing resources on the road side (cloud and edge cloud).

Figure 3- 2 Realizing V2X Applications Based on the MEC Platform



Internet of Vehicles (IoV) applications deployed on the MEC are divided into security, efficiency, and information services:

Safety scenarios such as cross-road collision warning, early warning for pedestrian blind spot monitoring, early warning for dangerous driving and regulation violation, and cooperative control such as cooperative change of lane, variable lane control and automatic parking;

Efficiency scenarios: Typical efficiency scenarios include traffic speed guidance based on traffic lights, high-precision map distribution, and enhanced navigation guidance. Information services, such as AR navigation and OTA.

As the standards for the southbound interfaces between MEC and road-side sensing devices, transportation facilities, and networks, and northbound application API interfaces are defined and evolved, the Internet of Vehicles (IoV) applications based on MEC will be more extensive and more open.

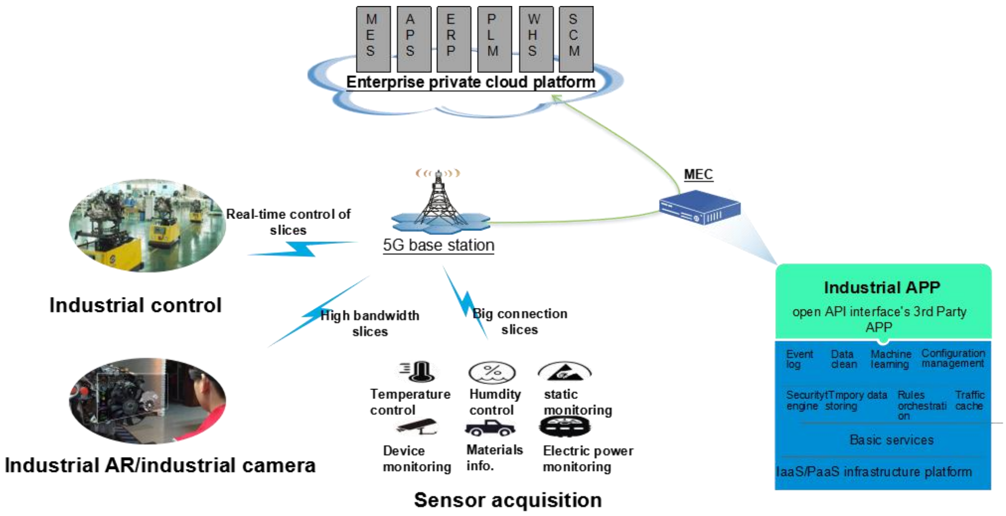
3.5 Industry Control

Currently, wireless technologies in the industrial field are mainly used for collection of equipment and product information, non-real-time control, and in-factory informatization. Due to the deficiency in reliability, data transmission rate, coverage distance and mobility, wireless technologies in the current industrial field have not been widely applied, and wireless communication accounts for only about 6%. With the development and maturity of 5G technologies, especially its special features such as low latency, high reliability, and high bandwidth, wireless technologies make it possible to apply wireless technologies to new industrial applications such as real-time control, remote maintenance and control, and industrial HD image processing. In addition, 5G lays the foundation for flexible production lines and workshops in the future, and opens for future development of industrial wireless technologies.

In the future, more wireless connections will appear in factory workshops, which will improve the network architecture of factory workshops, effectively improve the level of networked collaborative manufacturing and management, improve quality and efficiency in factory workshops, and maintain full connections in the entire product lifecycle. The network architecture is mainly reflected in real-time control, industrial wear, machine vision, and wired replacement of high-density access.

Combined with 5G network and the MEC platform, the 5G network can implement real-time analysis and processing of machine and device-related production data in the industry age of 4.0, implement production automation, and improve production efficiency. Without the need to bypass the traditional core network, the MEC platform can locally process and feed back collected data in real time. This is equivalent to providing industry users with MEC-based wireless quasi-dedicated networks, featuring high reliability, high security, short latency, and high bandwidth. With the continuous development of services, MEC edge computing provides industrial applications such as AGV scheduling control, industrial AR-assisted preventive maintenance and assembly, real-time control of on-site devices, remote maintenance and control, and industrial HD image processing.

Figure 3-4 Industry Control Based on the MEC



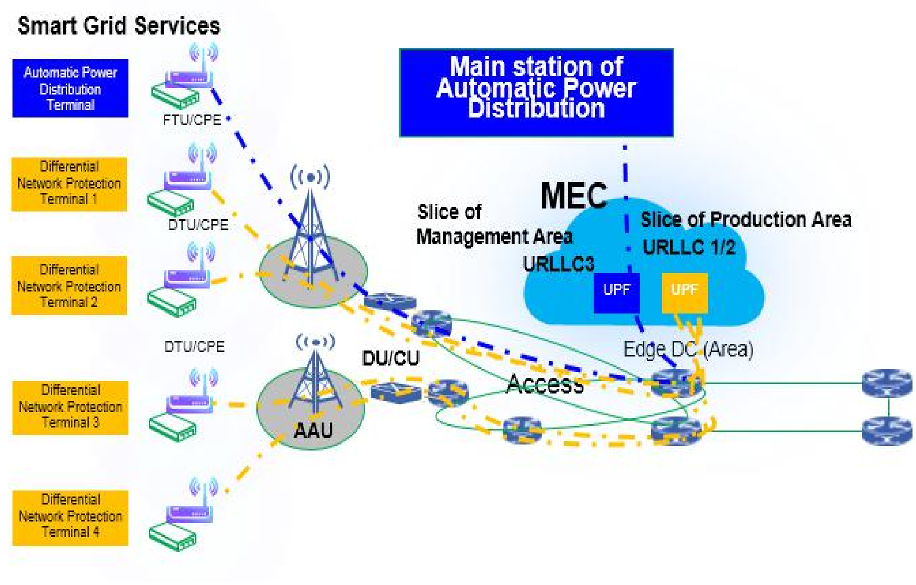
3.6 Power

As one of the important infrastructure supporting the development of the smart grid, the power communication network provides a secure, reliable, and efficient information access and transmission channel for the smart grid. In the smart grid era, a large number of new energy and smart electrical appliances are popularized, and power users continuously improve the power quality. This poses great challenges to the control and management of the power grid, especially the urban distribution grid. Many new service scenarios have clear requirements for network latency, bandwidth, and reliability.

For the low-latency service, the power distribution automation service is used as an example. The power distribution automation collects and monitors the real-time status of the power distribution line through the power distribution automation terminal DTU, and sends the information to the main station of the power distribution automation. The main station performs comprehensive analysis and processing according to the DTU information of the feeder line or all nodes in the network. The adjacent DTUs communicate with each other, and the information is determined or processed through distributed analysis. In this way, power supply can be determined, isolated, located, and restored for faulty lines or devices to ensure power supply reliability. The end-to-end transmission latency of this service must be less than 12ms. In this service scenario, the

UPF is deployed to the edge to ensure the low latency and high reliability of network transmission in the UPF+MEC mode.

Figure 3-5 Deployment of UPF to the Edge Supporting Power uRLLC Services



Let us set operation, maintenance and repair as the example of high bandwidth services. As one of the core business units of power grid enterprises, O&M plays an important role in guaranteeing the safety and health of power grid equipment and supporting the safe operation of the large power grid. AR/VR-based intelligent patrol inspection, training and remote guide can be applied in the substation and power distribution room. On-site personnel can wear intelligent devices and display substation equipment and data information through VR and AR technologies. Based on the 5G high-bandwidth feature, the smart O&M system and smart wearable devices can be interconnected to each other. The device structure, documents, and on-site information can be seen on the screen to further assist preventive maintenance personnel in their work and improve operation efficiency. In this service scenario, MEC, together with 5G, can implement local unloading and analysis of video streams.

4 ZTE MEC Industry Ecosystem and Vision

ZTE is always committed to providing assistance for operators in digital transformation, helping them transform traditional mobile networks into intelligent networks, and providing more personalized services for different types of consumers at the network edge. ZTE has worked closely with global operators to verify MEC solutions and pilot existing networks. In addition, ZTE has developed more than 200 industrial customers and more than 100 strategic partners to jointly build a win-win MEC environment for 5G networks, and accelerate the digital-to-commercial transformation of thousands of industries.

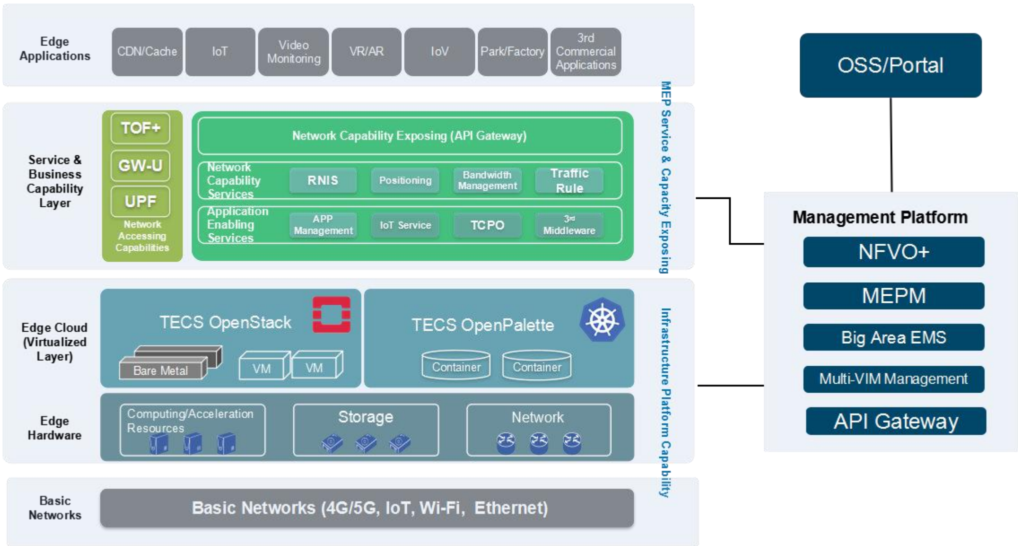
The birth and emergence of an emerging technology and ecosystem requires the strong support of the business model. In the future, the industry has unlimited expectations and expectations for various application scenarios of the edge service platform. To realize the target, you need to work together with the entire industry chain. ZTE will work together with more industry partners to explore the cooperation mode of edge computing and build a 5G network edge ecosystem to promote the flourishing of edge services.

Although the business model of edge computing is still in the process of exploration, with the joint efforts of the industry chain, not only a large number of "cost-saving" edge applications will emerge in the future, but also a large number of "open source" services will be born, achieving a win-win situation for equipment manufacturers, operators, and service providers.

5 ZTE Common Edge Solution Description

The ZTE Common Edge solution includes an MEP capability exposing platform, a lightweight edge cloud, a full range of edge-oriented servers, and edge acceleration.

Figure 5- 1　ZTE Common Edge Solution Architecture



ZTE's Common Edge solution focuses on 4C:

- **Capability: Exposing platform for the joint construction of an ecosystem**
  - Network capability exposing: More than 100 kinds of edge network information and capabilities such as LBS (high-precision location service), RNIS (Radio network information service), TCPO (TCP optimization service) and VO (video optimization service) are exposed to the external, accelerating service innovation.
  - Application enabling: The solution provides video identification services, low latency video services, IoT equipment management services, and support integrating third party services.
- **Connection: Multiple models and fixed/mobile convergence**
  - Oriented to full connection: The solution integrates access of wireless network and fixed network, supporting multiple systems such as 4G/5G/WiFi.
- **Cloud: Cloudified deployment and unified O&M**
  - Through in-depth integration of OpenStack and Kubernetes, the solution provides operators with a unified edge cloud view, and a mature resource management system involving unified computing, unified network, unified storage and unified security, improving management efficiency and improving

resource utilization.

– Precise management components are jointly deployed with compute nodes. Lightweight edge cloud can save management resources by 60%.

– The AI-based MEC unified cloud management platform provides unified management of central DC and edge cloud to implement non-attendance and automatic O&M of edge cloud.

- **Compute: Dedicated hardware and heterogonous acceleration**

  – Embedded hardware: IT BBU hardware V9200, TITAN Series C600 are provided for no extra space. The MEC card for site DC is embedded in TITAN C600, providing close to user deployment and zero footprint.

  – Edge-oriented MEC servers: ZTE provides E5430 450-mm short chassis server and easy front wiring design and maintenance for small edge DC space, meeting the requirement of edge hardware acceleration and expansion.

  – Edge acceleration: Flexible hardware acceleration (GPU and FPGA) meets AI, image processing and video processing.