Technical Article

A New Mobile Edge Computing Architecture for 5G Using Innovative Industrial Cloud Computing Platforms from ADLINK



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The Mobile Edge Computing (MEC) initiative can improve user experience and save bandwidth resources, as well as provide endless possibilities for service innovation at the network edge. These benefits are achieved by moving computing power to the mobile edge node and providing third-party application integration at the network edge.



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1. Introduction

The deployment of 4G networks and the number of 4G mobile users are both increasing rapidly. At the same time social networking applications and online-to-offline (O2O) commerce have recently experienced vigorous growth and consumed most of the available 4G bandwidth. Telecom operators worldwide are facing a common crisis as business investment and mobile traffic continue to grow, while mobile carrier network is becoming pipelined, reducing the average revenue per user (ARPU). To address this problem, international standards organizations for telecommunications have been taking action. To prevent the mobile carrier network from becoming pipelined, they are investigating how to increase the bandwidth value by bonding the carrier network with the mobile Internet and the Internet of Things (IoT) more deeply. 5G mobile networking technology will not only provide more flexible deployment, but will also produce a win-win scenario for mobile users and telecom operators in order to achieve sustainable business growth.

The Mobile Edge Computing (MEC) initiative by the European Telecommunications Standard Institute (ETSI) is such a network architecture that is based on the evolution to 5G and comprehensively fuses the mobile access network with Internet services. MEC can improve user experience and save bandwidth resources, as well as provide endless possibilities for service innovation at the network edge. These benefits are achieved by moving computing power to the mobile edge node and providing third-party application integration at the network edge. The seamless integration of mobile networks and mobile applications will provide a powerful weapon for meeting the challenges from various over-the-top (OTT) content providers. The following are some of innovative services that can be achieved through MEC.

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Distance measurements are carried out on the MEC server using data collected from base stations. Precise positioning and tracking of mobile devices is achieved based on location algorithms, allowing location-related business services to be provided to mobile users.

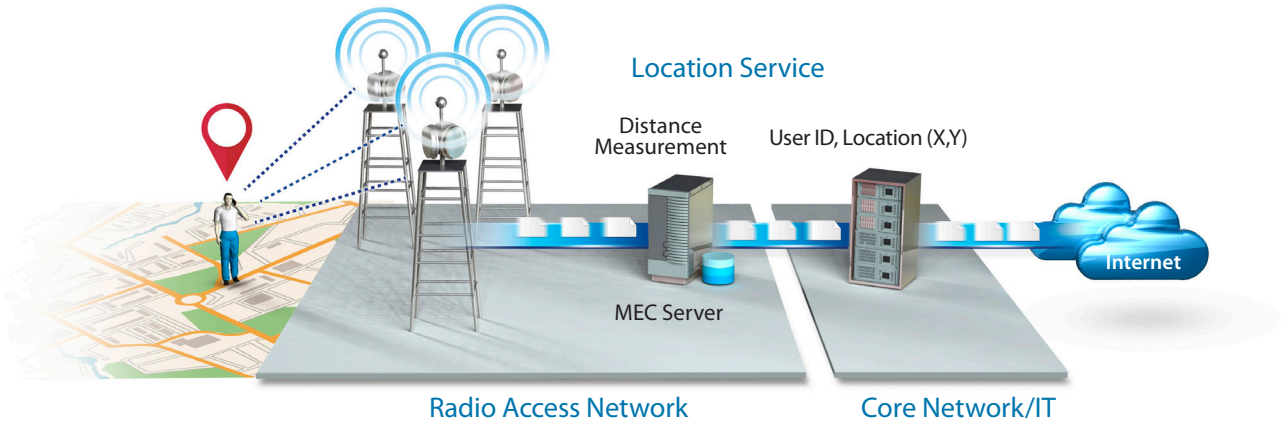


Figure 1, Location services based on MEC positioning

Video streams captured from mobile devices are analyzed on MEC servers and an event notification is sent to a preset terminal when a predetermined event is detected using intelligent video analytics. The targeted applications include public safety, IoT, and smart cities.

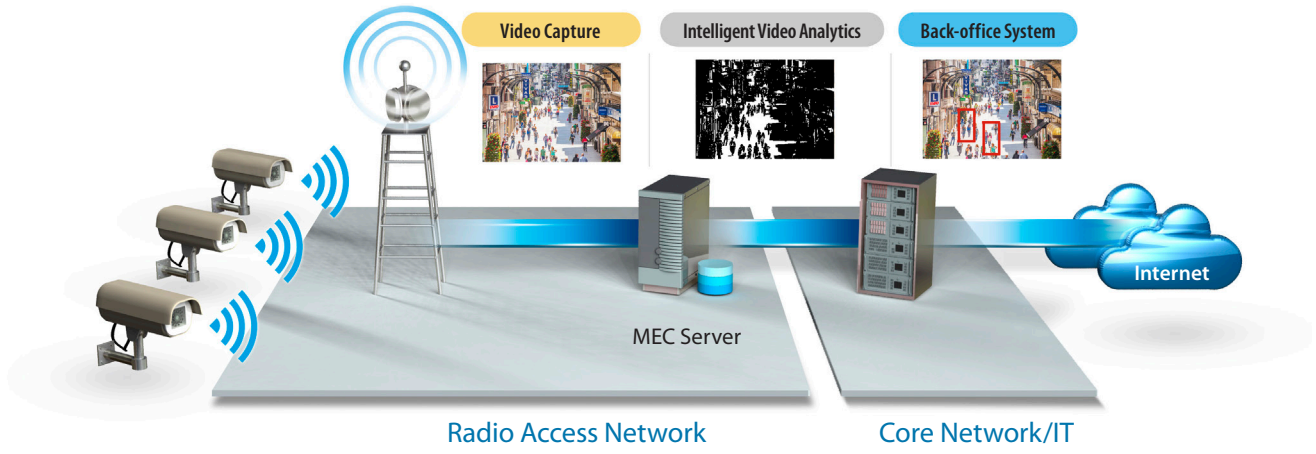


Figure 2, Intelligent video analytics on MEC servers

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Real-time communications between a radio access network (RAN) and a mobile user are evaluated on an MEC server (e.g. for cellular load and link quality), allowing for dynamic optimization of video content delivered to the device. For example, high-quality video with high bit rate is streamed to the mobile user when network conditions are good, and lower-quality video with lower bit rate is streamed when network conditions are bad in order to guarantee a smooth viewing experience.

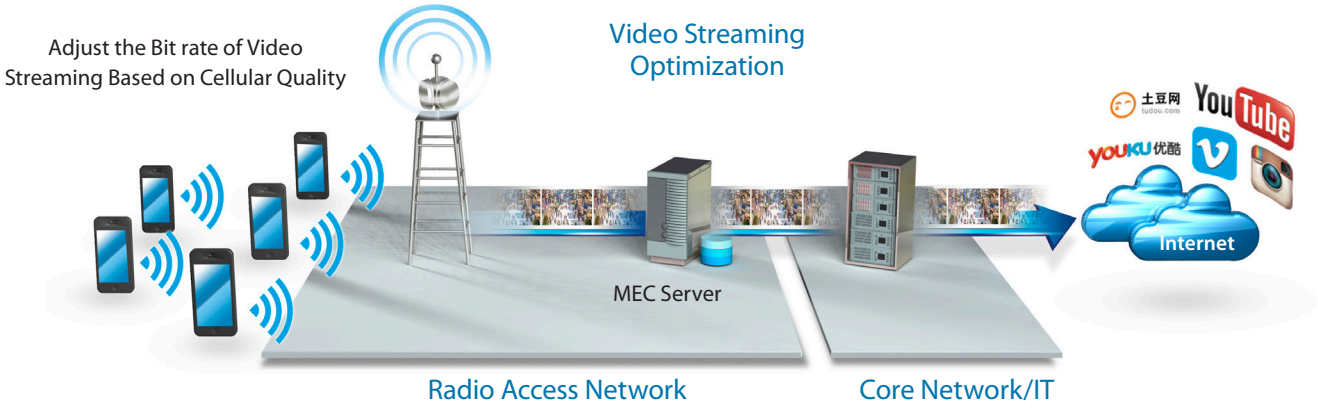


Figure 3, Dynamic video streaming optimization on MEC servers

Frequently accessed content such as news websites, trending video content and popular pages on shopping websites are cached on the MEC server. When this content is requested by a subsequent mobile user, the cached versions are delivered, greatly reducing download time and improving the user experience. Additionally, network transmission costs on the backbone are also decreased.

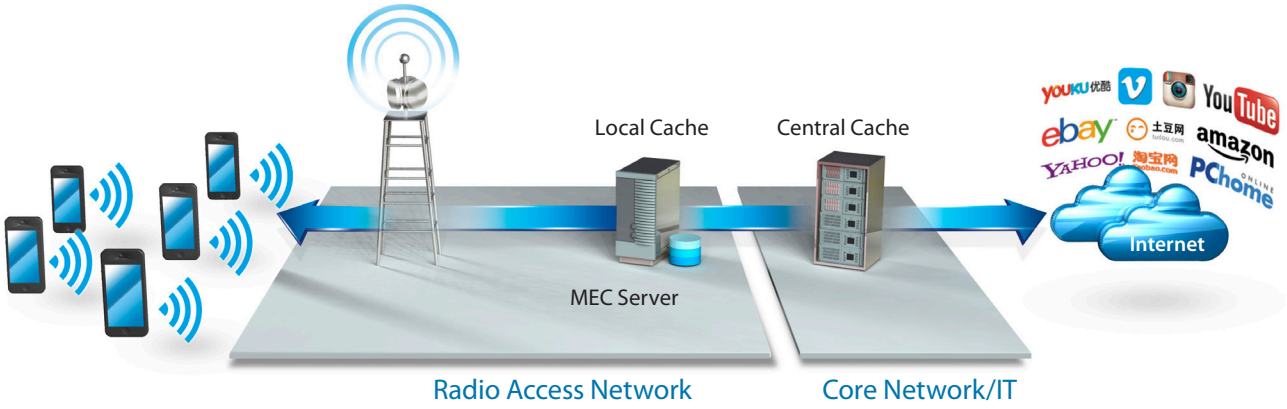


Figure 4, Content caching for download acceleration by MEC servers

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2. 5G Radio Access Network Infrastructure



5G networks will not only provide higher bandwidth, but also support more flexible deployment in order to accommodate different operating environments. As of the transition to 5G approaches, the two competing architectures, Centralized/Cloud Radio Access Network (C-RAN) and Distributed Radio Access Network (D-RAN), are receiving more and more attention.

C-RAN

C-RAN architecture consists of three parts: a distributed wireless network comprised of a remote radio Unit (RRU) and antennas, a high-bandwidth and low-latency optical transport network, and a centralized baseband unit (BBU) pool consisting of general purpose processors with Network Function Virtualization (NFV) support. The optical transport network connects the RRU and BBU. Multiple BBUs in the BBU pool are connected together through high-bandwidth switches with Software Defined Network (SDN) support. By using NFV and SDN in combination, resource sharing and dynamic scheduling in the BBU pool can be achieved to increase spectrum utilization efficiency. Compared to the traditional RAN architecture, C-RAN eliminates the constraint that the RRU and BBU must be deployed close to each other and also centralizes the BBU of various base stations into a single district tandem office. The application of C-RAN will reduce the construction and maintenance costs of telecom rooms and increase spectral efficiency through collaboration methods and virtualization technologies.

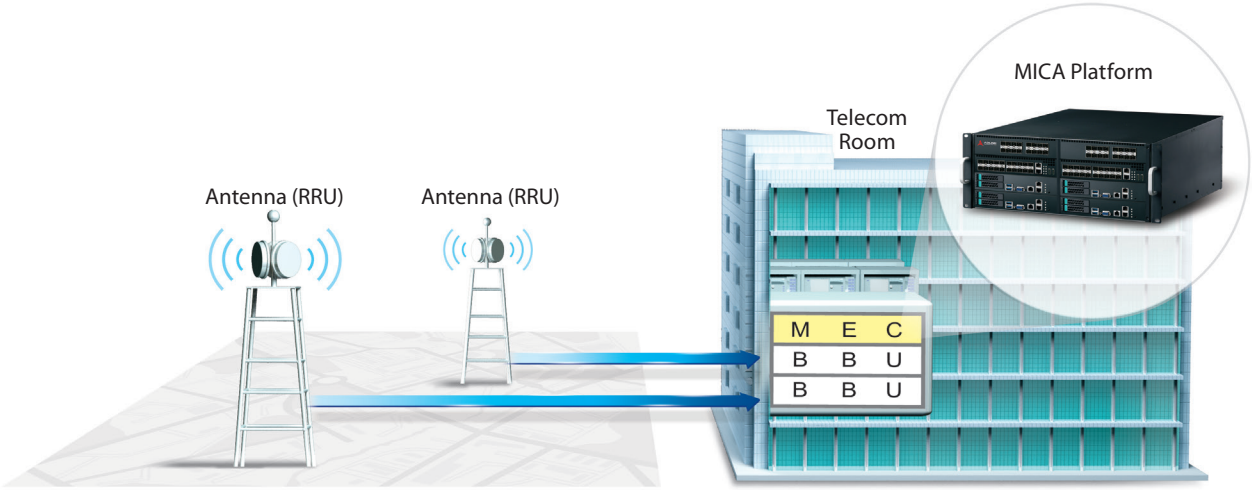


Figure 5, Centralized Radio Access Network (C-RAN)

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D-RAN

The RRU and BBU still coexist within a base station in D-RAN. The development direction of D-RAN is miniaturization, and it strives for a completely outdoor deployment without the need for a machine room. Thanks to the advancements in semiconductor technology, all the components of a base station, including RRU and BBU, can now be made small enough to achieve a completely outdoor deployment. Concurrently, the advancements in communications technology have eliminated the resource sharing limitation between different base stations, which makes it possible to achieve collaboration and resource sharing among neighboring base stations. D-RAN provides many advantages for deep coverage and rapid deployment, and is especially suitable for the deployment of applications related to geographical location and the IoT.

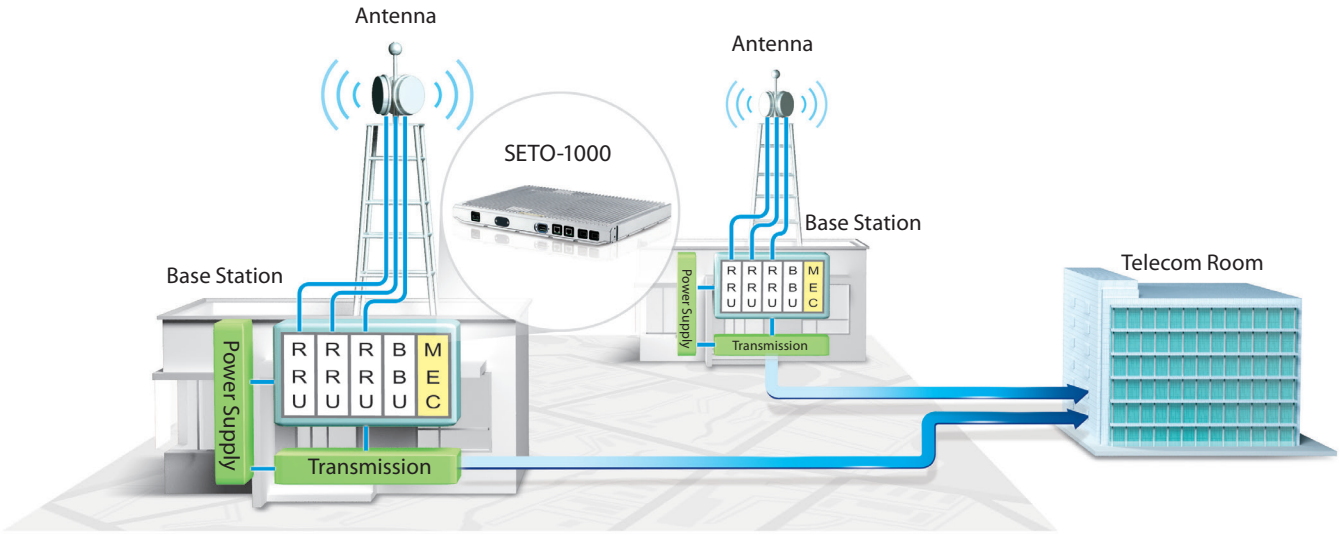


Figure 6, Distributed Radio Access Network (D-RAN)

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3. MEC Server Requirements



Whether C-RAN or D-RAN deployment mode is adopted for 5G networks, MEC will definitely be introduced into the network to open up more opportunities for application innovation. When cloud computing and cloud storage is moved to the network edge, a high performance, low latency, high bandwidth, and carrier grade service environment that is in close proximity to the mobile user is created, which will help accelerate download speeds of content, services and applications, and provide a better customer experience to the mobile user. The main characteristics of MEC servers are listed below, most of them originating from data center technologies, but some meeting higher requirements than usually required by data centers, such as high availability and hot-swapping.

Network Function Virtualization

NFV technology can help transform the traditional base station into a multifunction computing platform, thereby providing a powerful tool for MEC servers to cultivate a new generation of wireless applications at the network edge. Transforming the hardware computing infrastructure into a virtualized computing platform will make it easier to deploy various wireless applications on the platform. Additionally, because proprietary network hardware platforms are replaced by virtualized network appliances, network functions can be deployed where required more easily and quickly. With NFV, computing and storage can be allocated dynamically on demand, achieving optimal device utilization.



Software Defined Network

SDN technology separates the control plane and forwarding plane and can be used to increase the data flow manageability of MEC servers. By using NFV and SDN in combination, network resources can be allocated as required to achieve a flexible network deployment with more precise control of Quality of Service (QoS) on traffic flow, improving end-to-end user experience and achieving high-efficiency network operation.

Edge Computing and Storage

In order to support a rich set of applications, 5G networks require more computing and storage resources to be deployed at the network edge. C-RAN deployment requires a MEC server to have characteristics similar to that of one used in an IT data center. But compared with a traditional data center server, it also has some additional requirements in order to provide the required carrier-grade service availability, including main computing and switching nodes with hot-swap support, and main communication links with backups for failover. D-RAN requires the complete outdoors deployment mode is taken into account. Because the MEC server will work in a harsh environment, it must have the characteristics of heat resistance, cold resistance, waterproof, and dust prevention.

Energy Efficiency

In order to have energy-efficient 5G networks, processors with higher efficiency and dynamic performance scalability based on real-time computing loads will be used in MEC servers in order to reduce power consumption. During idle time, the MEC server will support service hot-migration to centralize the computing load in order to power off idle computing nodes, effectively reducing energy consumption for a more environmentally-friendly network.

Bandwidth and Connectivity

Compared to traditional data center servers, the MEC servers deployed at the mobile edge will not only provide higher bandwidth, but also a richer set of network interface types, including 1/10 GbE copper/optical and 40GbE optical. MEC servers will also meet requirements for link redundancy and low-latency transmission.

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4. ADLINK Solutions for MEC

Compared with the deployment mode of traditional base stations, both C-RAN and D-RAN can reduce the required number of telecom rooms, and increase spectral efficiency. To provide the required deployment flexibility and high performance for 5G mobile edge computing, ADLINK provides not only Modular Industrial Cloud Architecture (hereafter referred to as “MICA”) platforms for C-RAN deployment that offer high-density computing resources, but also the rugged SETO-1000 server for D-RAN deployment that can endure the extreme conditions of harsh outdoor environments.



The driving ambition behind MICA platforms is to introduce the latest technologies of IT data centers into industrial telecom computing. The name implies the main characteristics of the platform: modular design, industrial carrier-grade features, and cloud-oriented design.

MICA adopts an innovative modular design, allowing the customer to select different functional modules based on specific application requirements to build a a highly tailored computing platform. ADLINK provides a range of the most commonly-used compute, switch, storage and IO modules for customers to choose from. The compute slots of MICA platforms have a hybrid design, allowing customers to mix and match between 1/4 and 1/2 slot width compute nodes in order to scale the number of independent systems in the platform as required by the application. Because of MICA's open architecture, customers can design their own modules to meet their particular requirements, or provide ADLINK with a module specification within the MICA framework to design and manufacture. MICA platforms connect the high-speed PCIe bus of the compute node to the backplane, providing maximum flexibility to specify a customized functional module. In addition, MICA platforms are available in 2U, 4U and 10U form factors in order to meet the different computing capacity requirements at different stages of a project.

MICA adopts industrial-grade design. In addition to adopting Intel's latest high-performance low-power consumption Xeon processors to provide a high-density computing performance, a more flexible application extension, as well as better energy efficiency for mobile edge computing, MICA designs also factor in particular requirements of telecom equipment. For example, in order to meet the “five nines” availability required by most telecom services, all MICA compute, switch and storage modules are designed to support redundancy and hot-plugging. MICA IO modules support advanced LAN bypass features and users can control the power-on/off bypass mode of each network IO card independently via BIOS setting or IPMI command. To deal with the high bandwidth requirements of future 5G networks, each MICA compute node can support dual 64G bandwidth to two redundant switch modules. Higher bandwidth requirements can

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be achieved through expansion IO cards, allowing a single compute module to support up to 480G communication links. In conjunction with the Intel® Data Plane Developer Kit (DPDK) and Open vSwitch (OVS), the computing power and IO capabilities of a compute module can be maximized in order to achieve high-density IO processing.

MICA is designed for industrial cloud computing. In addition to adopting the latest Intel processor technologies, such as multi-core, hyper-thread, and VT-x, to provide sufficient support for virtualization, MICA also integrates a wide range of the latest hardware acceleration technologies to boost the processing of network packets and video streams. For SDN, MICA switch modules use larger TCAM tables to implement L2/L3/L4 fast forwarding using OpenFlow. For NFV, MICA switch modules and network cards support hardware-accelerated processing for NVGRE and VXLAN tunnel protocols. For video processing, the MICA compute nodes utilize the Intel® Quick Sync Video functionality integrated in the Intel® processor to implement hardware-assisted video encoding/decoding and analytics. For packet processing, MICA compute nodes are able to implement load balancing and packet filtering via network cards without taking computing resources from the main processor. In addition, customers can optionally select an expansion card with Intel® QuickAssist Technology to implement data encryption/decryption or compression/decompression via hardware. The integration of dedicated hardware processing units not only speeds up the processing of arithmetic-intensive application tasks, but also relieves the burden on the main processor in handling these tasks, achieving more efficient usage of computing resources.

Table 1, MICA platforms and their suitable applications

MICA Platforms	Main Characteristics	Suitable Applications
MCS-2080	2U, supports hardware-based video processing, up to 16 systems, dual redundant switches	Video transcoding, video analytics, WebRTC conferencing
CSA-7200	2U, high performance processor, supports up to 8 IO expansion cards, supports advanced LAN bypass feature	Deep packet inspection, network traffic monitoring, network security, content caching service, location service, rich media social networking, video delivery optimization
CSA-7400	4U, hybrid installation of dual Xeon® E5 and dual Xeon® E3 compute modules, high bandwidth and low latency switching, supports hot-swapping and energy saving	
Other Products	Customized computing platforms suitable for dedicated applications through a flexible combination of compute, switch, IO and customized modules	

SETO-1000: High Performance Server for Edge Computing with Intel® Xeon® Processor E5-2400 v2

The ADLINK SETO-1000 high performance server for edge computing can operate in a temperature range of -40 °C to +55 °C with self-heating main components for safe start-up in ultra-low temperature environments. The SETO-1000 has an IP65 rating for dust and liquids and is also resistant to shock and vibration, making it an ideal computing device for deployment in extreme outdoor environments. Furthermore, SETO-1000 has a fanless design and features high speed connectors (fiber or copper) with ingress protection from inclement conditions. Being robust and reliable for reduced maintenance costs, the SETO-1000 is ideally implemented as an MEC server to perform content caching, thus reducing the required transmission bandwidth, and decreasing transmission delay. Simultaneously, high performance computing and storage capacity can be provided for third-party application development, providing differentiated services for mobile users.

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Industry-Oriented Application Ready Intelligent Platforms

ADLINK's goal is to build Application Ready Intelligent Platforms (ARiPs) for 5G cloud computing, and provide the SDN/NFV and other software infrastructures required for mobile edge computing. When constructing edge computing services based on MICA platforms or the SETO-1000, customers need not be concerned about low level supporting software, and can focus on the development of more high level value-added applications.

To compliment MICA platforms and SETO-1000 hardware, ADLINK provides MediaManager software for network video processing and PacketManager software for packet processing. MediaManager is provided to help develop end-to-end video applications and supports audio/video de-multiplexing, RTP stream receiving/sending, video composition, application prototyping for video on demand, video conferencing and video analytics. It also demonstrates how to take full advantage of the GPU hardware acceleration capabilities to develop video server applications. PacketManager is provided to handle network packet processing in addition to traditional L2/L3 protocol stacks. It can also implement flow-based forwarding strategy, load balancing, encryption/decryption and compression/decompression of packet payloads.

MICA platforms and the SETO-1000 not only provide NFV and SDN hardware support, but also integrate mainstream open source and third-party NFV/SDN software, thus reducing the NFV/SDN implementation effort required by customers. For SDN support, ADLINK integrates Intel® DPDK OVS on MICA platforms and SETO-1000, and will provide OpenFlow support for all switch nodes in the near future. For NFV support, ADLINK integrates Wind River Titanium Server and provides VMware virtualization certification for compute nodes. ADLINK ARiPs allow customers to leverage open-source software such as OpenStack, as well as enabling them to obtain carrier-grade NFV services more easily.

In addition to basic software infrastructures, ADLINK MICA platforms and SETO-1000 also support out-of-band system management that conforms to the IPMI 2.0 specification. Customers can monitor the operating status of compute nodes remotely and can execute remote reset/shutdown/startup. Furthermore, the power consumption of compute nodes can be accessed and a variety of power saving policies can be executed via the IPMI interface to achieve maximum energy efficiency.

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5. Conclusion



In combination with ADLINK ARiP software, mobile equipment providers can construct the next generation of telecom applications more quickly and stay ahead of the curve in the increasingly competitive telecom industry.

The benefits of the 5G network will not only be reflected in faster download speeds, but will also come in the form of new customer-centric mobile applications. The Mobile Edge Computing architecture that has emerged from the demands of the next generation of mobile networks will use the RAN to provide the network and cloud computing functions at the mobile edge and will create a high performance, low latency and high bandwidth service environment close to mobile users to accelerate the downloading of content, services and applications, allowing them to experience a better network service. MICA platforms and the SETO-1000 rugged outdoor server from ADLINK meet the requirements of both data center and telecom computing. They provide the building blocks for a feature-rich industrial cloud computing environment through their innovative architectural and industrial designs. In combination with ADLINK ARiP software, mobile equipment providers can construct the next generation of telecom applications more quickly and stay ahead of the curve in the increasingly competitive telecom industry.

About ADLINK

ADLINK Technology is enabling The Internet of Things (IoT) with innovative embedded computing solutions for edge devices, intelligent gateways and cloud services. ADLINK's products are application-ready for industrial automation, communications, medical, defense, transportation, and infotainment industries. Their product range includes motherboards, blades, chassis, modules, and systems based on industry standard form factors, as well as an extensive line of test & measurement products and smart touch computers, displays and handhelds that support the global transition to always connected systems. Many products are Extreme Rugged™, supporting extended temperature ranges, shock and vibration.

ADLINK Technology is a Premier Member of The Intel® Internet of Things Solutions Alliance, one of the world's most recognized and trusted technology ecosystems. Members of The Intel® Internet of Things Solutions Alliance include leading solution and service providers from a broad range of industries, who provide the hardware, software, firmware, tools, and systems integration that developers need to take a leading role in the rise of intelligent systems.

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