SOLUTION BRIEF

Communications Service Providers
Multi-access Edge Computing (MEC)

Foxconn* Integrates Facial Recognition Into 5G MEC Platform

Foxconn has developed multi-access edge computing (MEC) servers based on Intel® technology with all of the necessary components—from facial recognition software to IP cameras—for smart building and smart warehouse applications.

Facial recognition technologies have become more accurate and less costly in recent years, making the technology applicable for a wide range of authorization and authentication applications. Facial recognition in enterprise applications such as building access, time clock management, or autonomous warehouse vehicles, needs both significant processing power and low latency to deliver sub-second response for these real-time applications.

To verify a person's features, facial recognition programs use frame-by-frame video analytics to review incoming video at 30 frames per second, comparing these images to a digital image stored in a database for verification. This process requires significant compute capability and high-speed networking because many applications have only seconds to process this data and communicate an approval/denial decision.

Multi-access edge computing (MEC) offers a solution for these applications that delivers scalable performance combined with fast networking and an edge or customer premises deployment model that reduces transport latency and offers appropriate responsiveness.

Foxconn Technology Group, an Intel® Network Builders partner and member of the program's Network Edge Ecosystem, has developed a family of fully integrated MEC solutions designed for applications where facial recognition is important. These solutions include Intel® processor-powered MEC servers with all of the required software, IP cameras, and networking equipment.

Foxconn's MEC Platform

The Foxconn* MEC software platform is ETSI compatible and built on an open source foundation that supports either network functions virtualization (NFV)-based virtual machines (VM) or containers. On top of this open source foundation, the company includes its own proprietary applications providing the functionality needed for specialized applications. Figure 1 shows the software used in the MEC platform, which includes:

- Wireless and Ethernet communication services
- Virtualization infrastructure management (VIM) based on OpenStack*
- KVM for virtualization
- Network acceleration utilizing Open vSwitch (OvS)* and Data Plane Development Kit (DPDK)
- Graphics acceleration via a field programmable gate array (FPGA) pass through (HDDL-F), Intel® Movidius™ Myriad™ X technology, and Intel® Visual Compute Accelerator Card

- Orchestration via ETSI* MEC platform API and the Open Network Automation Platform (ONAP)* Edge API (full ONAP integration is a planned feature)
- MEC platform service software
- MEC platform deployment software

The MEC platform also integrates the following technologies to allow for easy access to key new technologies and innovations on the hardware platform:

- FlexRAN open source software-defined RAN platform
- FlexCore open source core network reference software
- Open Network Edge Services Software (OpenNESS) reference toolkit for moving applications from the cloud to the network edge
- Intel® Distribution of OpenVINO™ toolkit for development of applications that emulate human vision

For connectivity, the MEC server can be configured with any combination of Ethernet, Wi-Fi, 4G/LTE, and 5G New Radio support, and it includes a built-in Wi-Fi router, 10 GbE switch, LTE small cell or LTE customer premises equipment (CPE) functionality, which offers the best flexibility for deployment that the end user can install the infrastructure via wireless or wireline connectivity.

On top of this foundation are enterprise attendance, access control, and smart warehouse solution software. Two key value-added components to these solutions include:

- Facial Recognition Algorithms: Foxconn offers several pre-validated third-party facial recognition algorithms and also provides pre-defined APIs for attendance management, enrollment, and stranger alarm services. This makes it easy for customers to integrate Foxconn's solution with the existing IT systems.
- Automotive Guided Vehicle (AGV): Foxconn offers AGV functionality for smart warehouse applications. Pre-defined APIs for AGV control and warehouse management simplifies the integration job for warehouse IT staff.

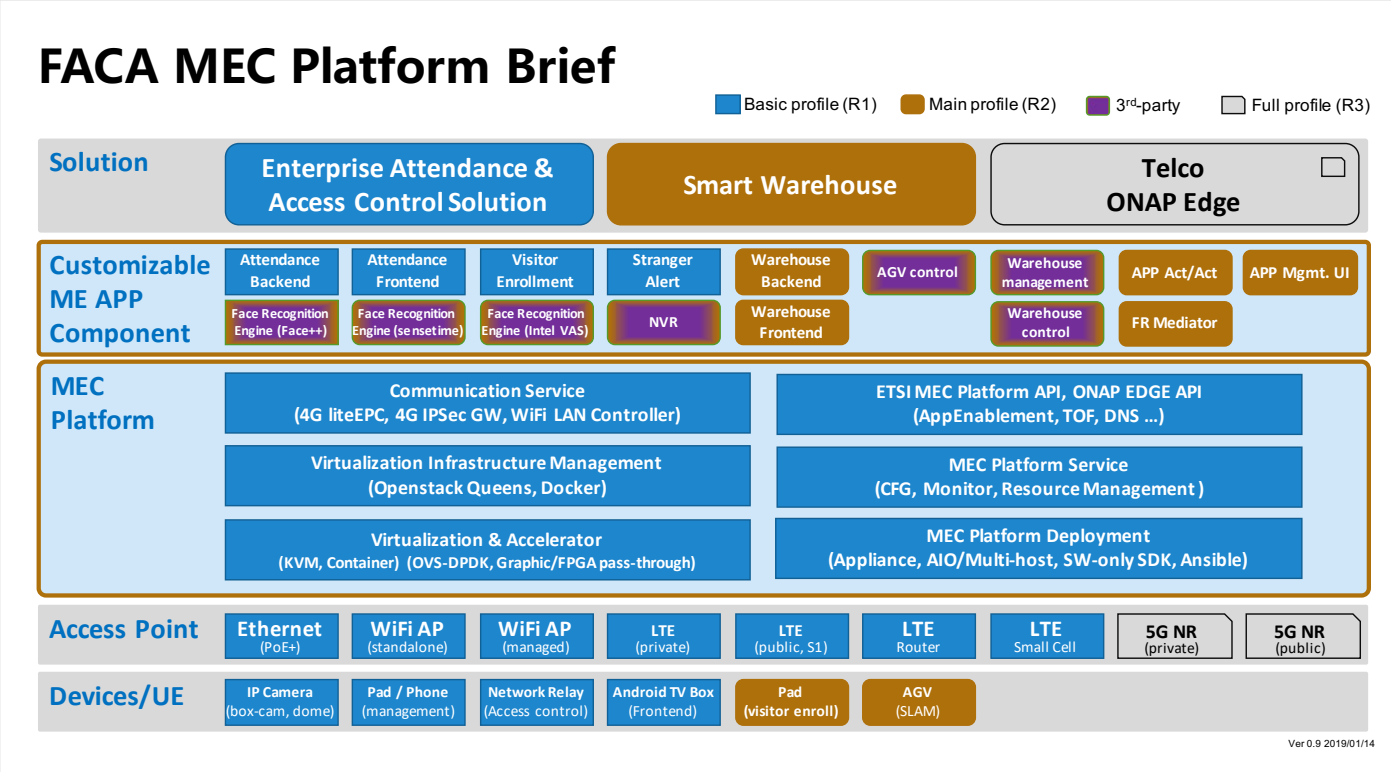

Figure 1. Block diagram of MEC solution developed by the Foxconn Advanced Communication Academy (FACA).[1]

LEVELS OF FOXCONN MEC-BASED ATTENDANCE MANAGEMENT SYSTEMS

	ENTRY	MEDIUM	HIGH
NUMBER OF CAMERA STREAMS SUPPORTED	Less than 3 video; less than 5 image	Less than 10 video; less than 15 image	Less than 15 video; 20+ image

OPTIONAL COMPONENTS	N/A	• Private LTE support • Smart building support • Smart warehouse support • Facial recognition active-active, active-backup support • Integrated OpenStack & container environment for customized IT/IoT applications	• Private LTE support • Graphics/FPGA acceleration • Smart building support • Smart warehouse support • Facial recognition active-active, active-backup support • Integrated OpenStack & container environment for customized IT/IoT/VA/AI/ML applications
CPU	Intel® Xeon® E-2100 processor x 1	Intel® Xeon® D-2183IT processor x 1	Intel® Xeon® Silver 4116 processor x 2
RAM	32 GB	64 GB (4 slots, up to 128 GB)	128 GB (24 slots, up to 3 TB)

Table 1. Components used in MEC attendance management systems that serve different customer needs.

Intel® Technology-Based Hardware Platform

Foxconn builds the MEC server hardware in scalable configurations by utilizing different Intel architecture processors for each configuration. These processors offer different performance-value points and software interoperability across the platforms. The attendance management systems outlined in Table 1 show how Foxconn's MEC systems are designed for a variety of workloads. Installations with fewer cameras will have fewer feeds, thus an Intel Xeon E-2100 processor is used. Delivering that same performance at a location utilizing up to 15 cameras requires dual Intel Xeon Silver 4116 processors for added performance.

The Intel Xeon E-2100 processors deliver essential performance for entry server, cloud, and workstation solutions with up to six cores and up to 3.8 GHz base frequency (up to 4.7 GHz with Intel® Turbo Boost Technology 2.0). They also include support for hardware-enhanced security features, including Intel® Data Protection Technology, enhanced Intel® Software Guard Extensions, and Intel® Authenticate Solution.

Intel Xeon D-2100 processors deliver data center processor architecture in a form factor optimized for cloud edge computing solutions. The CPUs bring the architectural innovations of the Intel Xeon Scalable platform to a system-on-a-chip (SoC) processor for low-power, high-density, small footprint solutions, integrating essential network, security, and acceleration capabilities.

Intel Xeon Scalable processors are Intel's leading platforms for cloud-optimized servers. With an open architecture that scales and adapts to the demands of emerging applications, the platform provides a future-ready foundation for servers that can deliver cloud economics, be highly automated and responsive, and support rapid and more secure delivery of new and enhanced services.

Other important Intel technologies include Intel® QuickAssist Technology (Intel® QAT), an accelerator for compute-intensive cryptographic and compression workloads, and Intel® Ethernet Server Adapter X710 for high-performance 10 GbE networking.

Pre-integrated IP Camera & Network Equipment

Recognizing the importance of the camera for these applications, Foxconn has also integrated IP camera into the MEC solution. The camera has special biometric technology that aids the system in identifying humans and performing key activities.

In addition to IP camera, Foxconn also offers pre-integrated Wi-Fi router, LTE Small Cell, and LTE CPE which run on both licensed and unlicensed LTE bands to connect IP cameras at locations which are difficult to deploy wired cables, such as a moving vehicle or an outdoor event.

Smart Building and Smart Warehouse Applications

While the Foxconn MEC platforms can be configured for a wide number of applications, they come designed as complete solutions for smart building facial recognition and warehouse autonomous vehicles where low-latency cloud performance is essential.

MEC-based Smart Building
Building owners are able to deploy a smart building solution using Foxconn pre-defined APIs to tie into existing backend IT systems for improved security and secure time clock initiation. IP cameras are placed at building entry points where they can scan approaching faces and confirm entry without the employee or authorized visitor having to break stride.

This allows for high levels of security with a reduced need for human guards and is more secure than employee badges, which can be lost or stolen. In addition, the building owner can add additional applications such as a stranger alarm, blacklist/whitelist management, and visitor enrollment, all of which can also be implemented utilizing Foxconn pre-defined APIs.

The cameras can also register employees as starting work or coming back from lunch and report this to the human resource management system, providing an easy way for employees to check in or check out.

MEC-based Smart Warehouse

The Foxconn smart warehouse solution facilitates a number of autonomous vehicle applications, including forklifts, inspection robots, and simultaneous localization and mapping (SLAM) AGVs (see Figure 2). The system must be in communication and control of this diverse set of vehicles across an entire warehouse in order to relay pick orders that come from the warehouse control and management systems. The enabling software is the AGV control system and the APIs that link it to warehouse management system, dashboard, and app portal.

Foxconn IP cameras are connected to an Ethernet switch for networking and power and provide the facial recognition for authorization and time clock applications, but also to aid in tracking the AGVs. Foxconn private LTE small cells are used to ensure high-bandwidth wireless connectivity across the entire warehouse for AGV communications. The flexible virtualization (VM and container) capabilities allow the warehouse owner to integrate existing warehouse applications onto the MEC platform. This not only offers an easy way to manage, maintain, and upgrade, but also can reduce the cost of infrastructure setup.

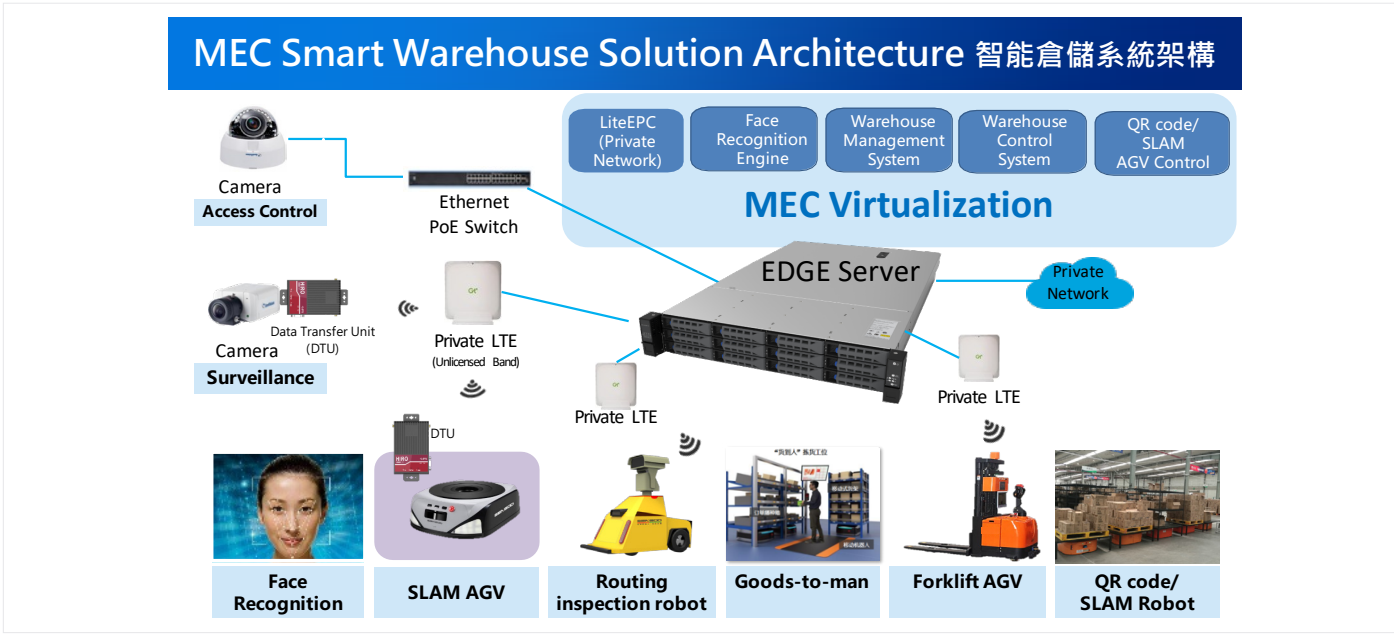

Figure 2. MEC-based smart warehouse solution architecture.[1]

Case Study: Asia Pacific Telecom (APT)* Smart Building Attendance Management System

Asia Pacific Telecom (APT)* worked with Foxconn to implement a smart building attendance management system. The system has been installed in a commercial building in Taipei for daily operation, running 300+ days with 10 live streaming cameras and active-backup design.[2]

- Predicted peak time in active MEC server. Performance: ~10 faces per second, ~60% CPU usage at peak time on a working day (see Figure 3).[2]
- Average CPU usage in active MEC server: 25% (able to schedule and execute workload in off-peak time by MEC management software).[2]
- Accuracy : >99%.[2]

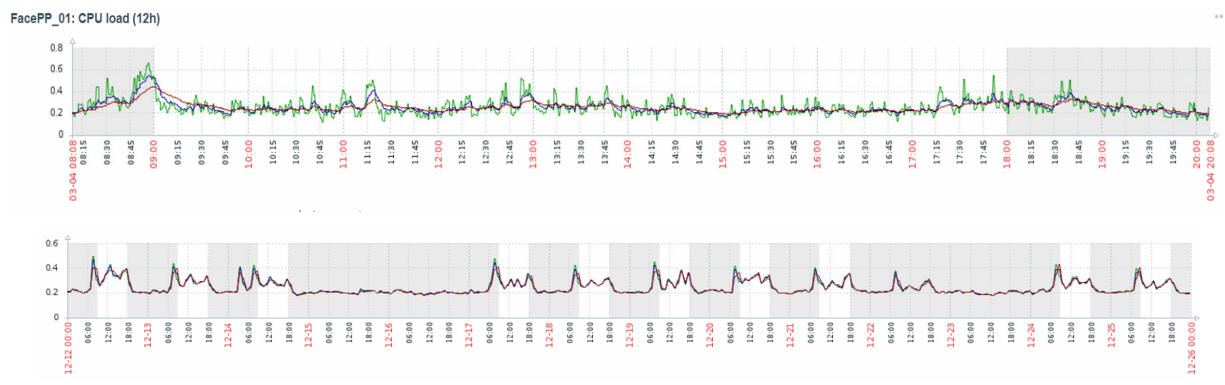

Figure 3. Daily and monthly CPU load statistics.[2]

Table 2 highlights the additional benefits seen from this implementation.

	BEFORE	AFTER
SITUATION	Pain point: Capital expenditure was too high to build a private facial recognition solution and application for a small company in a commercial building Property management agency could not open cameras to tenants due to privacy issues. Property management agency lacked know-how and resources to integrate the communication system, IOT system, and applications together to make a smart building.	Benefit: Communication service provider provides a lease model for a property owner or property management agency to build up the shared infrastructure for all tenants in the building. Provides open interfaces with security features. Communication service provider reduces the start-up cost for a small company and create the smart building ecosystem
DEPLOYMENT	All companies needed to invest individually in all infrastructure equipment	Infrastructure is shared (camera, TV, access points).

Table 2. Benefits of a communication service provider-enabled smart building attendance management system.

Conclusion

While facial recognition technology is becoming more accessible for enterprise applications, it is still complex and needs a significant amount of processing power and low-latency networking. By developing a fully integrated, high-performance MEC-based solution with specialized IP cameras, networking systems and application software, Foxconn is delivering a solution that is custom fit for smart building and smart warehouse applications. With the performance of Intel technology and Foxconn's comprehensive system integration, enterprises and communications service providers have access to the benefits of facial recognition-based applications that can integrate with existing IT systems.

About Foxconn

Foxconn Technology Group, also known as Hon Hai Precision Industry Co., Ltd., is a Taiwanese multinational electronics contract manufacturing company headquartered in Tucheng, New Taipei, Taiwan. Today, Foxconn Technology Group is a dependable partner for joint-design, joint-development, manufacturing, assembly and after-sales services to global computer, communication and consumer-electronics (3C) leaders. Aided by its legendary green manufacturing execution, uncompromising customer devotion and its award-winning proprietary business model, eCMMS, Foxconn Technology Group has built a reputation as a trusted name in contract manufacturing services. The company is the world's largest electronics contract manufacturer, and the fourth-largest information technology company by revenue.

About Intel® Network Builders

Intel Network Builders is an ecosystem of infrastructure, software, and technology vendors coming together with communications service providers and end users to accelerate the adoption of solutions based on network functions virtualization (NFV) and software defined networking (SDN) in telecommunications and data center networks. The Intel® Network Builders Edge Ecosystem is a new initiative gathering ecosystem partners with a focus on accelerating network edge solutions. As an integral part of the broader Intel Network Builders program, this initiative aims to facilitate partners' access to tested and optimized solutions for network edge and cloud environments. Learn more at http://networkbuilders.intel.com/networkedgeecosystem

[1] Figures provided courtesy of Foxconn.

[2] Tested by APT as of April 2019. APT used two servers for active/backup, each server included 64G RAM, 4TB HDD RAID-1(MIRROR), two Intel Xeon E5-2680 v4 processors, and one Intel® Ethernet Server Adapter I350 for DPDK, and Intel® NEV SDK.