TRANSFORMATIVE IoT
B E Y O N D   C O N N E C T I V I T Y

Haier: Optimising Manufacturing performance through 5G, Edge Computing and Machine Vision Proof of Concept Case Study

INTRODUCTION

GSMA, China Mobile, Huawei and Haier have completed a proof of concept encompassing the deployment of edge computing, 5G and machine vision into Haier's manufacturing environment. Haier is the world's largest white goods manufacturer and a Fortune 500 company.

Machine Vision is an intensive computing task that needs dedicated resources and complex application support to achieve meaningful data from the analysis of a still or moving image. In a fast paced commercial environment, there is an almost constant flow of images that are required to be analysed in order to implement corrective actions. This means that data processing capabilities needs to be placed close to the recording camera in order to minimise latency and achieve near real-time results.

Production quality is of utmost importance to Haier. Stainless steel refrigerators are at the top of their range, but due to the nature of stainless steel, can suffer imperfections through scratching and denting during the course of the production process. Therefore, Haier manually check every refrigerator that comes from the production line for defects in the stainless steel, which can be a time-consuming task.

Using Machine Vision to accomplish this task means that a more thorough quality assurance process can be undertaken, with less risk of defects being missed by manual checking. The use of edge computing and 5G means that near-real time analysis takes place so refrigerators can be returned to the production line almost instantly.
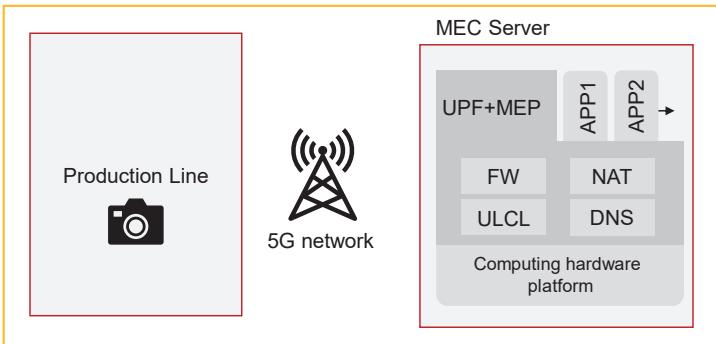
Haier

MACHINE VISION BASED ON MEC*
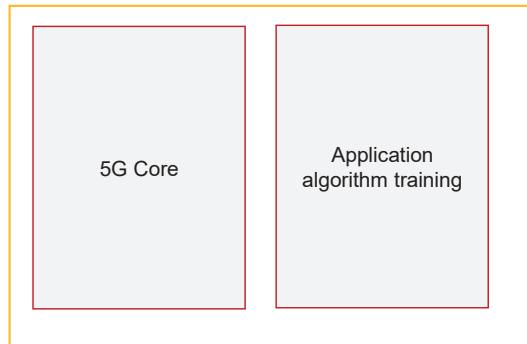
Huawei & China Mobile implemented a 5G connected MEC architecture inside the Haier factory to enable high-volume image processing with minimal latency to ensure no delays to the production line. The edge server is used to host the machine vision application from Mstar and all data processing is conducted within the production facility.

The Huawei MEC Platform (MEP) works to dynamically allocate and adjust available resources so that the machine vision application is able to operate at maximum efficiency the whole time and the data processing workload on the server can be efficiently managed. Additionally, MEP sends data analytics reports to end users so that appropriate tracking can occur.

5G enables efficient MEC deployments as the user plane and control plane functions (UPF) can be separated. In this use case, it means that 5G network functions could be moved closer to the production line, resulting in much reduced latency and improved reliability of data packet delivery. The MEC infrastructure includes both UPF and MEP deployed on one server, meaning the deployment is further simplified and space requirements for hosting are greatly reduced.

*MEC Platform = Mobile Edge Computing Platform

Before the live production environment could be initiated, the machine vision algorithm first needed to be trained. By collecting sample images, the machine vision application could be 'trained' to identify anomalies in images from the real-time production environment. Once trained, the adapted algorithm could be uploaded into the MEC architecture. As more images are processed by the application, the accuracy of the algorithm hunting for anomalies improves.

HAIER'S ROBOTIC ARM

The Haier factory has mounted a 500W industrial camera onto a robotic arm, with high intensity lighting, which is able to scan the refrigerators as they come off the production line. By using the trained algorithm, the local application is able to identify any damage to the refrigerators exterior that requires replacement. Small scratches and dents which may be missed by the human eye can be easily identified.

THE KEY ROLE OF 5G

The 5G network is required to transfer the large images produced by the industrial camera whilst maintaining low latency. The network requirements are in the order of 42Mbit/s upstream with image analysis completed in around 200-300ms. This means that a 5G network is the only realistic network that can

handle this volume of data whilst maintaining low latency and the ability to operate within a small footprint inside the factory production line.

PARTNERS AND ROLES:

A number of partners have worked together to enable this new machine vision service. By working together, a better, integrated service has been developed and deployed from which every partner benefits.


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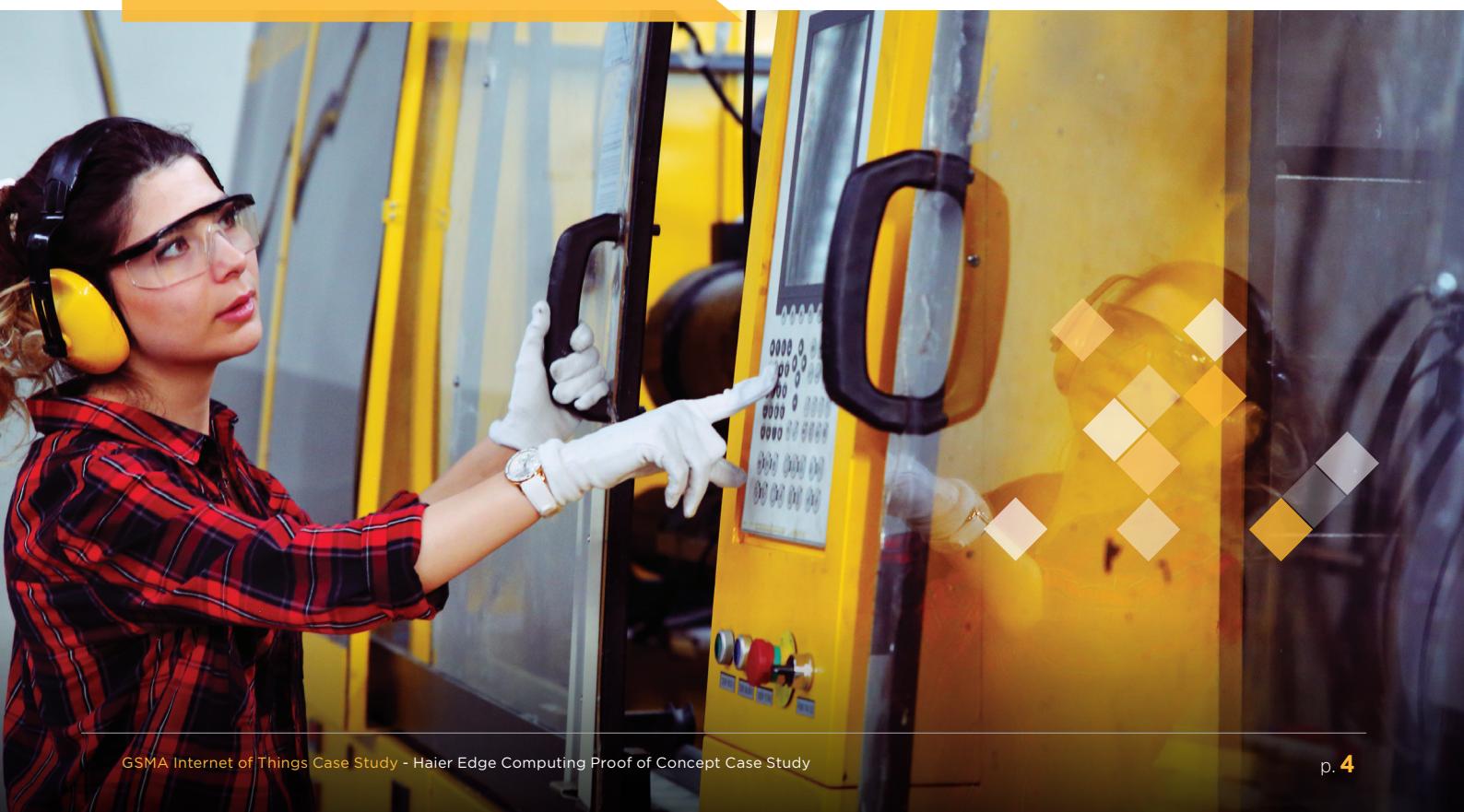
China Mobile	System provider, integrating 5G system and MEC system
Huawei	MEC platform and hardware installation
MStar	Machine vision application provider
Haier	Installation and management of robotics
GSMA	Project management

OUTCOMES

A number of benefits have been recorded through the duration of the proof of concept.

1   Improved implementation times. The 5G MEC infrastructure was installed and implemented in the Haier plant in only 1.5 days, compared to up to 35 days for legacy systems. This is due in part to extensive algorithm training conducted off site. Additionally, the MEC infrastructure includes an integrated HPF and MEP design, which makes the configuration and setup extremely simple. This meant a time saving of over 100 man-days which would otherwise have been spent setting up and testing the 5G MEC machine vision system on site.

2   Reduced space and resources required, compared to legacy solutions. The 5G MEC infrastructure is able to operate in a confined space close to the production line, due to the integration of UPF and MEP in a single server, and localised telecommunications equipment. This means that the infrastructure can be installed in a variety of configurations for a variety of use cases whilst maintaining close proximity to the industrial equipment to be monitored, ensuring low latency.

3   Improved product quality monitoring. The machine vision infrastructure has improved the overall product quality of refrigerators on the production line, as more defects can be accurately detected. This in turn results in fewer product returns and increased customer satisfaction.

About the GSMA

The GSMA represents the interests of mobile operators worldwide, uniting more than 750 operators and nearly 400 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces the industry-leading MWC events held annually in Barcelona, Los Angeles and Shanghai, as well as the Mobile 360 Series of regional conferences.

For more information, please visit the GSMA corporate website at www.gsma.com.

Follow the GSMA on Twitter: @GSMA.

About the GSMA Beyond Connectivity campaign

Delivering seamless IoT connectivity has been a crucial element in helping operators to launch new services such as low power wide area (LPWA) networks, using NB-IoT and LTE-M technologies and create added value and sustainable growth. Now leading IoT operators are building on this and their reputation as trusted industry partners by delivering value added services beyond connectivity.

These end-to-end solutions include services across big data, machine learning, analytics, edge computing and distributed ledger technologies. They are delivering substantial benefits to customers such as increased productivity, reduced costs and automated business processes as well as driving innovative new products and services, new lines of business and new business models. Services beyond connectivity are transforming businesses and industries.

www.gsma.com/BeyondConnectivity

About China Mobile IoT Company

China Mobile IoT Company Limited is a wholly owned subsidiary of China Mobile. Based on the overall strategy of China Mobile, China Mobile IoT Company aims to become the supporter of IoT business services, the provider of IoT chips & modules and the promoter of IoT products & applications. In practice, China Mobile IoT focuses on operating IoT private networks, designing IoT chips and modules, smart vehicle applications, smart home applications and wearables, development and operation of the IoT card connection management platform OneLink and the IoT open platform OneNET, delivering IoT solutions.

Overall this makes a comprehensive architecture known as "Cloud-Pipeline-Device". The China Mobile IoT Company collaborates with China Mobile provincial and professional companies to provide the community with the most advanced IoT technologies. Following the philosophy of openness, cooperation and sharing, China Mobile IoT strives to become a China based, leading global IoT Companywhich promotes IoT applications in various industries.

About Haier

Haier Smart Home Co., Ltd (also known as Haier) is a leading global household appliance manufacturer headquartered in Qingdao, China. Haier Smart Home designs, manufactures and sells a wide range of household appliances including refrigerators, freezers, washing machines, air-conditioners, water heaters, kitchen appliances and small household appliances, with a comprehensive offering of smart household appliances. In addition, Haier Smart Home operates a logistics business focused on the distribution of large format items across China. Founded in the 1980's, Haier Smart Home listed on the Shanghai Stock Exchange in 1993 (SSE: 600690). Haier Smart Home has successfully expanded its global footprint in recent years with the acquisition of GE Appliances, General Electric's household appliances business, in 2016 and the transfer of Haier Group's overseas white goods business to Haier in 2015. Since 2015, Haier Smart Home has also managed and operated the New Zealand luxury household appliances brand Fisher & Paykel in trust for Haier Group and in April 2018 the Group entered into a share purchase agreement to acquire all shares of Haier NZ, the holding company of Fisher & Paykel, from Haier Group. Haier's overseas expansion has significantly broadened its

global R&D, production and marketing networks, enabling it to implement a successful localisation strategy around the design, manufacturing and sales in overseas markets. As a result, Haier Smart Home has become a global enterprise with a portfolio of leading household appliance brands to meet the diverse needs of customers in more than 100 countries world-wide. In the year ended 31 December 2017, Haier Smart Home generated 42.3% of its total revenue outside China.

About Huawei

Founded in 1987, Huawei is a leading global provider of information and communications technology (ICT) infrastructure and smart devices. We are committed to bringing digital to every person, home and organization for a fully connected, intelligent world. We have nearly 194,000 employees, and we operate in more than 170 countries and regions, serving more than three billion people around the world.

Huawei's end-to-end portfolio of products, solutions and services are both competitive and secure. Through open collaboration with ecosystem partners, we create lasting value for our customers, working to empower people, enrich home life, and inspire innovation in organizations of all shapes and sizes. At Huawei, innovation focuses on customer needs. We invest heavily in basic research, concentrating on technological breakthroughs that drive the world forward.