



Gree 5G + MEC Smart Factory Innovation



Taking advantage of the prevailing 5G and digital upgrading, we have joined hands with Gree Zhengzhou to build a 5G + smart factory that integrates 5G private network, 5G applications on production lines, and full-scenario and full-process safety production system by adhering to lean production, working out a new model of self-controllable 5G + digital transformation for the home appliance manufacturing industry. In the future, we will continue the efforts in independent innovation to make better use of technologies and tap into the potential of data, making greater contribution to the transformation from "Made in Henan" to "Intelligent manufacturing in Henan".

Wang Zhi

Deputy General Manager of China Unicom Henan Co., Ltd.

Partners



Case Overview

Gree Electric Appliances (Zhengzhou) Co., Ltd. (hereinafter referred to as "Gree Zhengzhou") has an annual production capacity of 6 million household air conditioners, 6 million compressors, and 12 million motors. It is the largest air conditioner production base in Central China, with an output of more than RMB 15 billion. There are over a hundred supporting enterprises in the surrounding areas.

Since its establishment in 2011, Gree Zhengzhou has positioned itself as a pioneer in intelligent manufacturing in Gree Group, and has set a clear goal to build a highly flexible, personalized and intelligent production model of goods and services by adhering to lean management and value creation. Taking advantage of 5G + industrial Internet, Gree Zhengzhou has partnered with China Unicom and ZTE Corporation to explore the digital transformation of discrete manufacturing.

In September 2020, the three parties carried out a pilot project regarding the integration of 5G innovative technology and industrial Internet in Gree Zhengzhou factory to explore the intelligent manufacturing applications based on 5G + MEC. In 2021, the project

made great progress and the "1+2+N+S" system architecture was successfully established, namely one 5G independent private network, 2 enterprise-level capability platforms, numerous 5G applications, and one end-to-end active security protection system for full business scenarios on the 5G industrial Internet.

Building an IoT platform and a machine vision platform at the enterprise level facilitated further tapping into the potential of data and consolidating AI capabilities. Quick deployment of applications, including 5G cloud-based scheduling AGV, 5G + VR remote guidance, 5G helmet-based safe production management system and 5G UAV patrol inspection, improved the overall operational efficiency.

In order to meet the requirements for information security across the factor premises, a defense system covering cloud, management and terminal has been built based on active defense, realising full-element and full-process protection. At the same time, as the 5G technology and manufacturing continue to mature, a virtual private network has been upgraded to an Industry 5G Core (hereinafter referred to as "i5GC") independent private network, further guaranteeing the security of enterprise applications.

1

5G independent private network

+2

enterprise-level capability platforms

+N

5G applications

+S

one end-to-end active security protection system for full business scenarios on the 5G industrial Internet

Industry Challenges

In recent years, as new urbanization accelerates and people's living standards continue to improve, the home appliance industry has witnessed rapid development. Meanwhile, due to the trend in "intelligent and customized" home appliances, shorter product life cycle and increasingly higher quality requirements, digital transformation is urgently needed for the home appliance industry.

Gree Zhengzhou faced the following challenges on the way to digital transformation:

Disconnected systems and data led to "silos"

As a typical representative of the discrete manufacturing industry, the home appliance industry generally features a large number and types of production equipment and complex production environments, which makes it difficult to collect data in the traditional network. Moreover, fragmentation and silos in the information system caused many problems, such as duplicated development, and difficulties in reducing operating costs and expanding new applications. Production managers had to switch between different systems to obtain key production data, which was time-consuming and labour-intensive.

A large number of visual quality inspection scenarios made it difficult to replicate data

In line with the core value of "pursuing highest quality", every air conditioner produced by Gree Zhengzhou must go through numerous strict quality inspection procedures. In the face of a large number of machine vision scenarios, traditional standalone deployment encountered great challenges: 1. There was limited improvement in the accuracy of traditional image processing algorithms, while AI algorithms meant greater resource investment; 2. data was difficult to be aggregated, and being "stuck" in IPCs meant their value could not be exploited; and 3. large-scale replication of data resulted in a significant increase in the cost of computing resources, operation and maintenance.

Difficulties in guaranteeing application security caused hidden dangers everywhere

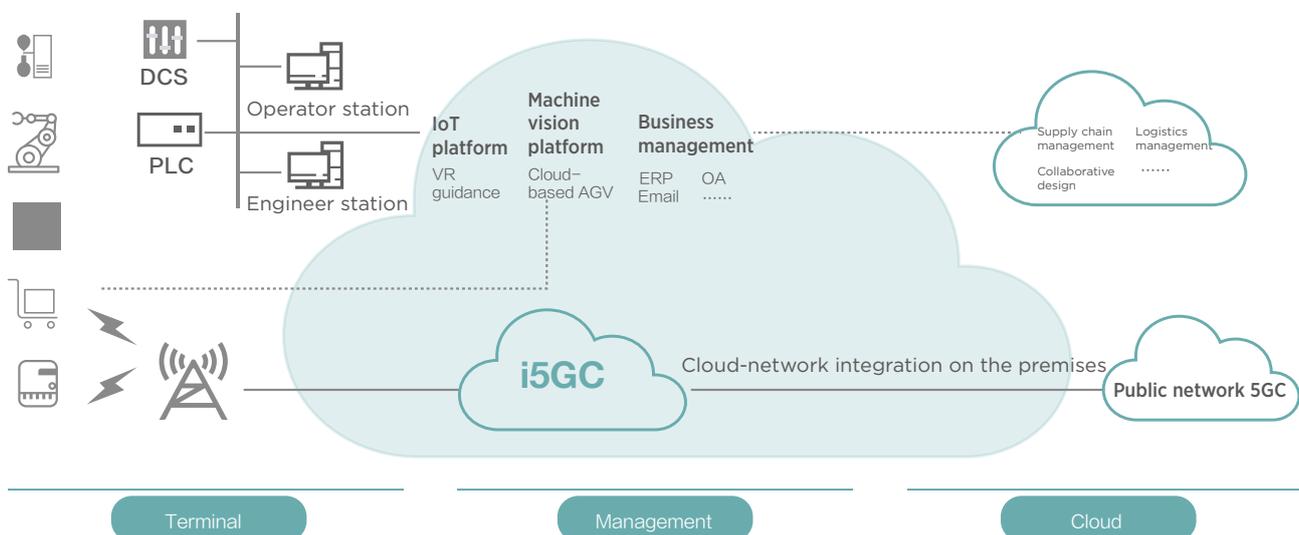
At the levels of network and system platform, the innovative application of 5G + MEC brought about protection problems for edge virtualization platforms, and security threats such as industrial control protocol vulnerabilities, intranet viruses/Trojans, and Internet DDoS attacks were ubiquitous.

At the terminal level, 5G terminals widely used in factories, such as CPE, industrial gateway, AGV, and safety helmet, also had many potential risks such as inadequate terminal security design, untimely update of patches for system vulnerabilities, weak passwords, plaintext data or simply encrypted transmission.

Solutions and Benefits

01 i5GC independent private network

By deploying an i5GC independent private network, the project used the private network for dedicated purposes and realised physical isolation on the site, giving full play to the ultra-high bandwidth/ultra-low latency of the 5G network. Two i5GCs were deployed in a pool on site for disaster recovery and backup, and loads were shared by devices to ensure high security and high reliability. i5GC supports the capacity to evolve to fixed-mobile convergence (FMC) in the future, which allows the ubiquitous access of various terminals in the industry park, and realises centralized management, operation and maintenance. In addition, i5GC may be continuously evolved and enhanced to 3GPP R16, and supports innovative features such as 5G LAN, QoS Monitoring and TSN, constantly empowering smart factories.



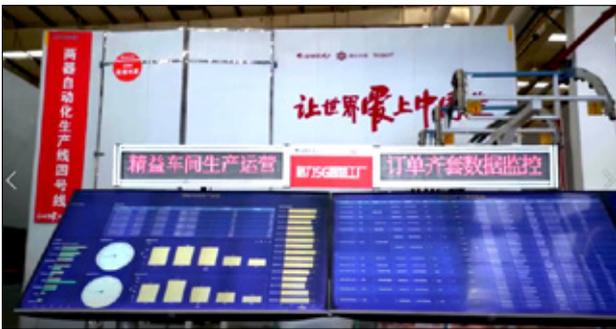


5G+ Smart Manufacturing

02 enterprise-level capability platforms

IoT platform

The enterprise-level IoT platform deployed relying on 5G + MEC edge cloud not only allow converged access of heterogeneous networks such as 4G, 5G, eMTC and NB-IoT in the workshops, but also enable connection management, device management, application enablement, operation support and other capabilities for IoT applications. This realised unified collection, management and sharing of data from different terminals, and online management and remote operation and maintenance of various types of intelligent terminals. In addition, the platform connected more than 10 existing subsystems through the northbound interfaces, truly realising data connection and becoming data-driven.



Machine vision platform

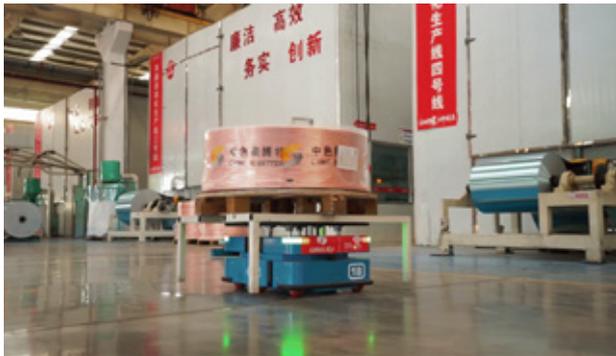
The project built a machine vision platform based on 5G + MEC for AI model training and AI inference. This not only accelerated the training of AI algorithms, but also allowed for analysis and inference of images that were centrally connected to 5G on MEC, improving the compatibility and recognition accuracy of algorithms for multiple workstation replication. As a result, the marginal deployment cost was significantly reduced, and the large-scale replication of machine vision scenarios in the workshops was accelerated. In the future, the machine vision platform will accommodate hundreds of machine vision applications across the factory, and the independent operation and maintenance of vision scenarios will be realised without adding algorithm engineers.



03 Numerous 5G innovative applications

5G cloud-based scheduling AGV

In the second evaporator and condenser workshop of Gree Zhengzhou, 5G + navigated AGVs were used to realise automatic material ordering and transportation, and independent path planning reduced the on-site deployment costs by 80% and manpower by 15 workers. 5G reduced the rate of dropped WiFi connections by 80% by resolving the problem of AP switching.



5G + AI safety helmet

The project introduced integrated smart wearables featuring positioning, perception, early warning and audio and video communication, and an integrated "cloud + terminal" management platform based on a shared IP architecture to solve problems associated with on-site safe production. It integrated perception, analysis, service, command and monitoring, and developed a new model of production safety management focusing on intelligent and fine-grained management and emphasizing both the process and the result in the "Internet+" era. 5G intelligent helmets were used by 89 workers in the second evaporator and condenser workshop.





5G patrol inspection

To meet the safety requirements of premises, 5G drones and patrol inspection robots were used to realise the real-time backhaul of 7-channel video through 5G network, providing all-around protection in every corner of the industry park.

04 S: End-to-end security protection system



In terms of platform network, 5G network security capabilities including differentiated slicing and security isolation were used to meet the requirement of keeping data inside the industry park. Intranet security measures such as dynamic firewall were used to guard against intranet viruses/Trojan horse, and platform application security measures such as cloud native security and two-factor authentication were used to ensure the security of virtual MEC. In addition, the system also provided data security capabilities for the full life cycle.

Considering the difficulty in upgrading hardware, Gree took four measures to ensure terminal security of 5G applications and data security: conducting security testing before launching terminals; using electronic fences, blacklists and whitelists for network access authentication; applying zero-trust access control for terminal access; and providing monitoring and handling of abnormal traffic.

Solutions and Benefits

With the core values of "adhering to independent innovation" and "pursuing highest quality", Gree Zhengzhou is committed to building a highly flexible production model of customized and intelligent products and services. At present, the project has achieved the periodic goals of intelligent production set by the company, realising the display of decision-making indicators on the BI platform and human interaction and digital linkage in the whole chain of product R&D, process, manufacturing and quality.

The success of the project also relied on the joint efforts of the 5G Intelligent Manufacturing, Development and Application Laboratory and 5G Empowering Industrial Internet Joint Innovation Laboratory established by the three partners in R&D and rapid output of products and solutions by accelerating technical verification, model verification and commercial application.

In the future, greater efforts will be made based on the existing achievements of the project to connect all of the equipment and apply machine vision inspection in over 100 scenarios in the factory. Moreover, as industrial Internet services such as Gree flexible production continue to develop, protection measures for Internet security and industrial control security may be adopted in the future to further protect 5G application security.

The successful project will also be replicated and promoted in other discrete manufacturing industries in Central China. At the same time, Gree Zhengzhou will continue to play a leading and exemplary role in the local industrial cluster, encouraging dozens of supporting enterprises around it to speed up digital transformation.