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ZTE GLOBAL 5G INTELLIGENT MANUFACTURING BASE

"The "Intelligent Manufacturing Powered by 5G" project at ZTE Corporation Binjiang site uses 5G + industrial Internet technologies widely to address the pain points during production, which significantly improves the level of intelligent operation at the site, and helps ZTE deliver better 5G system and equipment to global users faster. It is also a great demonstration. All efforts to build a promising Binjiang will ultimately pay off!

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Partners ZTE中兴 中国电信 CHINA TELECOM

Case Overview

ZTE Global 5G Intelligent Manufacturing Base is a factory built by ZTE with an investment of over CNY 20 billion since 2018 to meet ZTE's needs for the manufacturing of ICT electronic equipment. Since its official production commenced in March 2020, it has followed a five-year plan for development spanning from "Digital Binjiang" to "Intelligent Binjiang", and to "Ultimate Binjiang". Firstly, it focussed on reducing costs and increasing efficiency to explore typical 5G applications. Secondly, it started integration of Information Technology (IT) with Operational Technology (OT) between 2021 to 2022 to speed up full automation and intelligent manufacturing. Last but not least, it expects to optimize production and operation to the optimal extent to establish a dark factory. Based on a deterministic 5G precision network, two distributed precision cloud platforms ("industrial intelligent manufacturing" and "smart park"), as well as business best practices adopted in many scenarios, 5G and industrial Internet capabilities have been extensively integrated to realise the application of 5G in all elements and scenarios at Binjiang. 5G is used to promote intelligent and digital transformations of OT to achieve intelligent equipment, digital manufacturing, and intelligent operation.

The base has witnessed rapid development of 5G innovation. With the support of 5G applications for cost reduction and efficiency improvement, the annual output in 2021 exceeded CNY 30 billion at 50% more than the established target, which is a strong proof of the value of the combination of 5G and intelligent manufacturing for the industry. It also joined hands with China Telecom to build a 5G industrial Internet application supermarket to speed up the promotion of successful new infrastructure projects at Binjiang site with the aim to incentivise enterprises to embrace 5G and explore innovations with 5G enterprise private network and business model to be able to drive the development of the industry.

Intelligent operation

Digital manufacturing

Intelligent equipment

5G+ Smart Manufacturing

Industry Challenges

Due to highly integrated nature of SBCs in 5G base stations and their complex production processes, coupled with the impact of external uncertainties, challenges such as the large production volume, disconnected enterprise IT systems and inadequate manpower all have become increasingly prominent. There was an urgent need to accelerate reform and innovation to build a flexible factory featuring automated and intelligent manufacturing to enhance competitive advantage and improve production efficiency.

At the same time, as the integration of 5G and industrial Internet continues, many new technical challenges also emerged. Therefore, it was necessary to leverage experiences in breaking data silos existed across production lines and premises from pilot projects of digital transformation at factory scale. This would help drive improvements in elementary capacity and innovative capability for the integration of 5G and industries.

Faced with the challenges presented in the industry and itself, ZTE Corporation made it clear that the Binjiang 5G factory would be built as a benchmark for digital factory in China's electronics manufacturing sector, and an leading example internationally that aligned with the overall development strategy and technical strength of the Corporation to achieve a lean, automated, and IT-driven operation. Specifically, the focus on informatization was targeted at breaking data silos by the innovative integration of 5G and industrial Internet to quickly respond to internal and external changes, and to ultimately achieve optimized production and management. At the same time, the ZTE Corporation, as a professional in both 5G network and manufacturing, promotes the digital transformation of the industry at ZTE Global 5G Intelligent Manufacturing Base.

Solutions and Benefits

ZTE Global 5G Intelligent Manufacturing Base developed an industry benchmark integrating cloud, network and industry which was built on the elementary architecture of an industry-oriented industrial private network, two self-developed platforms (collaborative manufacturing cloud platform, and premise management and control platform), and many replicable usage scenarios. The project planned for more than 60 innovative 5G + industrial applications in 16 categories that covered all aspects of production and operation, and hoped to continue upgrading the traditional offline management to online intelligent management.

01 One 5G virtual enterprise private network based on 5G + MEC

As of December 2021, with support from China Telecom Nanjing, ZTE Global 5G Intelligent Manufacturing Base had built a total of 10 outdoor macro base stations and 751 indoor distribution nodes covering the entire factory premises. Four sets of MEC were deployed across the factory, two of which served the Binjiang 5G manufacturing base/factory for mutual disaster recovery; while the other two sets provided local data traffic offloading for other manufacturing companies in the park.

Based on this, the 5G virtual enterprise private network designed for "Internet +" collaborative manufacturing incorporates 5G slicing and edge computing to cater for the business, connectivity, computing, security and other cloud-network driven needs of ZTE Binjiang factory and other enterprises in the Binjiang Development Zone. ZTE Corporation and China Telecom continue to optimize 5G industrial private network capabilities to meet the deterministic network requirements in intelligent manufacturing scenarios, such as defining different 5QI templates for low-altitude coverage and SLA requirements for 2B services or using PRB resource reservation. The scenarios meet the business requirements of high reliability and low latency, the management needs of visibility, governance and control, and the security requirements of keeping data on premise.

Industrial application requirements

Machine vision inspection

Auxiliary video backhaul

Space guiding and positioning

Production equipment control

OEE data collection

High reliability 99.999%

Large bandwidth Uplink rate at 1 Gbps

Low latency < 10 ms

High safety Local guarantee

Ultimate Reliability

Equipment-level enhancement:
Redundant power supply for single-board computers
NE-level enhancement: Hot standby for core network, RRU ring network, transmission ring network
Link-level enhancement: MCS enhancement, keep-alive mode for link disconnection, data replication
Network-level enhancement: Active and standby CPE, wireless dual connectivity, E2E dual sessions

Ultimate Performance

Resource guarantee: Priority scheduling, PRB slicing, EdgeQoS
Uplink enhancement: SuperMIMO, 3U1D, CA
Ultra-low latency: No scheduling, mini-slot
Deterministic latency: TSN

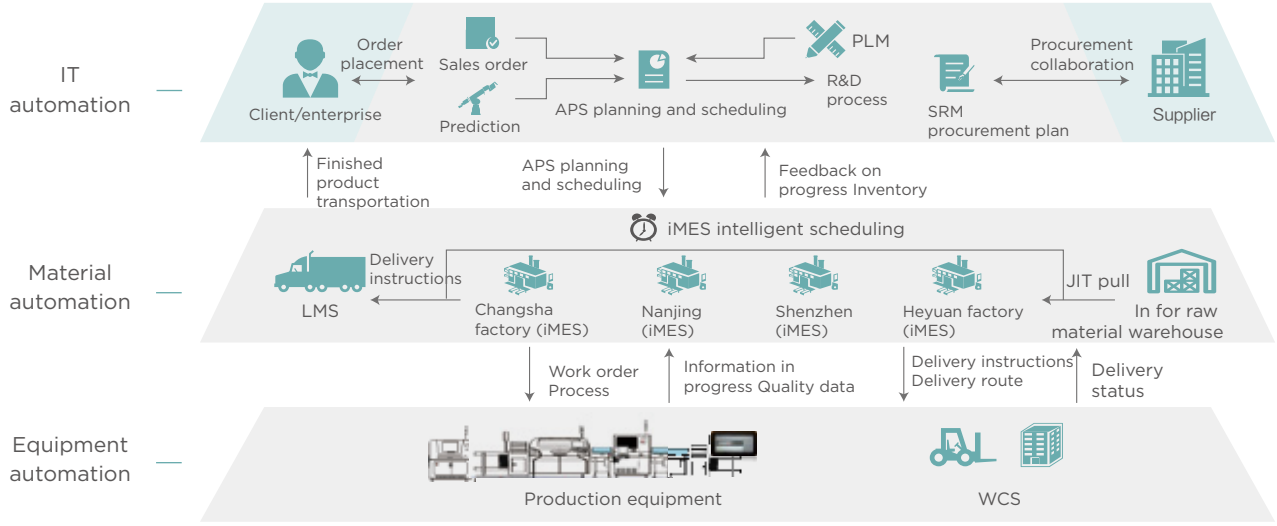
Ultimate Safety

Local guarantee: NodeEngine, i5GC
Slice isolation: End-to-end soft and hard slicing
PNI-NPN: NPN CAG
Security authentication: Access authentication, security encryption, secondary service authentication

02 Two core cloud platforms

ZTE built two core cloud platforms at Binjiang 5G factory: the iMES intelligent manufacturing cloud platform and industrial IoT cloud platform.

ZTE's self-developed iMES collaborative manufacturing cloud platform for the electronics industry supports productions of SBCs, standard components, whole units, as well as outsourcing management in the communication and consumer electronics industries. It also supports hierarchical deployment, which can be divided into group operation layer and factory execution layer. The group's operation layer supports multi-factory operation, unified scheduling of production tasks, unified allocation of production resources, operation dashboard, and intelligent manufacturing operation; the factory execution layer connects the factory plans and master production plan, aligns contract details and consolidate information between plans and actual productions, to accomplish service-oriented process management, order planning, material delivery, production and quality management, that are all improvements towards digital manufacturing.



At the same time, ZTE's self-developed industrial IoT cloud platform based on its digital twin technology achieves the intelligent interconnection of equipment, real-time data collection and processing, and automated analysis of working condition protocols, that enables efficient data sharing and eliminates data silos to form a data pool. It also provide data and application support to industrial apps such as digital twin and predictive maintenance of production lines and premises, factory vehicle management, energy consumption monitoring and analysis. Building on the vMAX big data engine and accumulated production data, this platform could also be gradually applied to quality tracking and intelligent decision-making for production lines, which contributes to the creation of a smart brain for the factory and the subsequent transformation into a smart factory with improved efficiency for the factory's production as well as its operation and management.

03 Numerous industrial scenarios that can be promoted

Enabled by the full 5G coverage across production lines and factory premises, Binjiang 5G factory has rationalised the end-to-end process of production management, completed the planning for 5G connection across the entire factory, and implemented by step 5G applications in different scenarios based on their readiness level and ROI.

No	Application Category	Typical Applications
1	5G-based intelligent data collection	Collection of SMT data, assembly line data, automation equipment data, etc.
2	5G cloud-based AGV applications	Visual SLAM cloud-based AGV, cloud-based forklift
3	5G- and cloud-based robot control	Cloud-based PLC on-site control, robotic arm control
4	5G-based mobile production management	5G PDA task assignment and production monitoring, contactless infrared temperature measurement and screening, industrial wearable dashboard equipment, etc.
5	360-degree panoramic surveillance	Production site inspection and monitoring with Giraffe robot
6	5G-based industrial AR	Remote SBC maintenance guidance, XR training
7	5G- and cloud-based machine vision	AAU thermal pad, thermal paste, thermal silicone grease, screw quality inspection, SMT machine vision-guided robotic arm stack
8	5G video surveillance	5G video surveillance across production lines and factory premises
9	5G logistics tracking	Whole-process tracking of goods

5G+ Smart Manufacturing

No	Application Category	Typical Applications
10	5G-based indoor positioning	Precise positioning of production tools and personnel
11	XR multi-player collaboration	Product design consultations, product demonstrations, etc.
12	Energy efficiency management	Energy saving management, demand forecasting, energy efficiency metering, power distribution monitoring, etc.
13	Environmental monitoring	Monitoring of water quality, noise, air quality, workshop dust, etc.; digital twin in the industry park
14	5G robots	5G handling robot, 5G patrol robot, etc.
15	5G-based digital twin for production lines	Digital twin for collaborative manufacturing
16	Unmanned driving	Unmanned commuter minibus, unmanned sweeper, vehicle-road coordination for inter-plant handling

By of the end of October 2021, the Binjiang 5G factory had implemented more than 30 5G convergence application scenarios and deployed more than 400 5G industry terminals (and more being planned), with the peak real-time enterprise offloading data reaching 4 Gbps. After more than a year of exploration, three trends stood out from application: (1) flexible combinations of applications increase production efficiency and reduce labour costs from multiple dimensions while improving product quality. (2) applications should be coordinated across different stages of the process. For example, AGV is applied in many scenarios connecting all delivery and turnover gaps throughout the production process to enable factory-level end-to-end unmanned transport; (3) applications should be adapted from core processes into greater reuse in other processes to reduce marginal cost of deployment and provide more flexibility for faster deployment of innovative applications. Below are some representative and innovative application scenarios for further sharing.

Jack-up 5G-powered AGVs operating in the SBC area

1 Factory intelligent logistics based on 5G cloud-based AGV

There are more than 40 AGVs in the demonstration plant at the ZTE Global 5G Intelligent Manufacturing Base and a total of more than 70 5G-powered AGVs in the factory. These AGVs automatically deliver materials in batches and in real time, carrying nearly all material handling tasks throughout material turnovers and delivering a designated amount of materials to workers at designated locations at specified time.

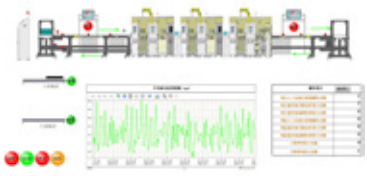
ZTE's self-developed industrial 5G-navigated AGV uses combination of laser and vision for navigation positioning, and can be scheduled by the cloud iMES and AGV scheduling system in real time in a unified manner via the 5G network. In addition, it can render cloud-based maps from the MEC, and coordinate with inventories near production lines, JIT improvement system, and smart warehousing to improve logistical efficiencies in the streamlined factory. With 5G's low latency and high reliability features, industrial 5G-navigation AGVs receive more stable network connection than WiFi-powered ones, and can render cloud-based maps from the MEC, which resulted in 20% efficiency increase in cargo turnover, 15% reduction in site construction cost, 100% manpower savings, and a reduction of more than CNY 2 million in labour costs.

Assistance of 5G + cloud-based machine vision in the precise positioning for robotic arm lamination

2 Multiple applications of machine vision based on 5G + MEC

Machine vision has a number of applications such as AOI, quality inspection, and guided processing in the production lines at Binjiang factory. The integrated 5G + POL network is deployed along the production site for industrial camera or laser scanner access. High-definition product images are taken in real time and transmitted to the general-purpose machine vision platform deployed on the MEC, which are then spliced, recognised and processed in the edge computing centre. This way, existing production lines can be quickly transformed to improve the efficiency of machine vision recognition, reduce labour costs, and improve product quality.

The introduction of 5G and MEC makes the end-to-end industrial machine vision system more flexible, convenient and scalable. They allow computing capacity required by multi-point machine vision applications in the factory to be flexibly allocated and coordinated using GPU virtualization. At the same time, deep learning and re-training can be performed on the 5G and MEC machine vision platform to optimise AI algorithms' accuracy to further improve recognition quality and efficiency.



5G + cloud-based machine vision for the quality inspection of AAU filter screw/adapter column

3 Flexible manufacturing based on 5G cloud-based PLC control

Working with its partners, ZTE was the first to launch the production line ready 5G cloud-based PLC on the test production lines for small base station at Binjiang Intelligent Manufacturing Base. The control logic of the PLC runs on the MEC side and the IO module is deployed on site that form a cloud-based PLC solution that is able to replace multiple traditional hardware PLCs. With extensive tuning of the 5G network and leveraging technologies such as NodeEngine and MCS enhancement, the solution can maintain the 5G network's latency down to less than 12 ms, and reduce fault rate to no more than two per month. Free from the limits on traditional PLC hardware, programming environment and interface protocols, 5G cloud-based

Remote SBC maintenance guidance

Remote inspection of production lines

VR panoramic view/HD surveillance

Giraffe robot in production lines/ unmanned patrol on factory premises

PLC supports cloud-based graphical programming, unified control, offline simulation, multiple protocol support, and more flexible expansion to make the production lines more intelligent and flexible. Compared with traditional hardware PLCs, the 5G cloud-based PLC improves efficiency for operation and maintenance and reduces the turnaround time for production line changes by more than 20%.

4 Remote equipment control, on-site auxiliary assembly and unmanned intelligent patrol inspection based on 5G and ultra-high-definition video

A 5G network with large bandwidth enables wireless transmission of ultra-high-definition videos to mobile terminals that enables remote management of production processes and the industry park facilities.

Precise, remote and real-time control of industrial equipment in production facilities is achieved in the control centre using panoramic HD videos from the production environment and data from various types of terminals in real time through the 5G network. In ZTE Global 5G Intelligent Manufacturing Base, ZTE released its first 5G robot specially designed to resolve problems in production lines and conduct patrol inspections. Using the 5G network and ultra-high-definition conferencing system, production experts could view the live production environment and control robot's arms remotely in real-time. This improves sharing capacity of experts and reduces problem resolution time by more than three times.

On-site data such as images, videos and audio are transmitted in real time via the 5G network to help on-site operators to carry out assembly and maintenance of complex or delicate equipment. The remote expert guidance system powered by 5G and 4K ultra-high-definition videos connects front-line operators with cloud-based knowledge library and remote experts in real time to access guidance on the maintenance of SBCs, which effectively improves communication efficiency and maintenance accuracy. The remote expert guidance system significantly reduces amount of business travel by 30% and lowers the maintenance response time from magnitude of "days" to "hours".

Mobile and intelligent security devices such as patrol inspection robots or drones are connected to the 5G network to replace personnel inspectors. Binjiang Park launched 5G inspection robots and 5G drones to replace personnel patrols, and with the optimization of 5G network coverage in high-altitude and open environment, that can send real-time video and other related data back to the industry park management platform through the 5G network. A single device can complete a equivalent of 3-4 people's workload. Through intelligent analysis on the cloud and real-time early warning, these devices could improve operation and management capabilities of the industry park.

Summary and Next-steps

With 5G + industrial Internet, ZTE was able to upgrade processes and management capabilities of its global 5G intelligent manufacturing base's production processes and industry park management, that led to improved levels of automation, intelligence and flexible manufacturing. It increased quality and efficiency on the factory floor, rationalised costs, and enhanced output. At present, Binjiang's smart manufacturing best practices has brought significant benefits to the company in cost reduction, quality improvement and efficiency increase: 80% decrease in the missed inspection rate of assembly quality, 46% reduction in the defective rate of key processes, 28% cut in the production line personnel, and 20% shorter production line adjustment cycle. At the same time, the willingness to better utilise 5G to create more innovations in the working level has skyrocketed. In the future, we will continue to innovate and optimise our solutions to increase both scale and depth and develop more black factories with 5G as the driving force and technical enabler, with the aim to increase its share of total factory capacity from 26.1% to more than 80%.

One of the purposes and significance of building ZTE's global 5G intelligent manufacturing base is to explore application scenarios that can truly improve quality, reduce costs and increase efficiency through its own exploration in the capabilities of 5G + industrial Internet, so as to promote the implementation of 5G for enterprise business and thus showcase the real value of 5G + Industrial Internet. As of November 2021, Binjiang factory has welcomed more than 500 enterprises and institutions totalling more than 10,000 visits, showcasing its flagship role to demosntrate 5G+ industrial Internet. Building on the implementation results from Binjiang factory, ZTE has started to deploy 100+ 5G innovative application scenarios for 60+ clients with significant social impact.

Next, we will act swiftly to replicate Binjiang's successful practices in other factories, while to also accelerate the integration vertically into different application scenarios. We hope to improve application scenarios used in ZTE's global 5G intelligent manufacturing base, and at the same time use these experiences to empower a wide ecosystem of industries to digitalise and transform intelligently.

Through the Binjiang Industrial Internet Innovation Centre, we provide an environment for partners to conduct R&D of industrial applications as well as testing at ZTE's Nanjing factory to facilitate greater development of the industrial ecosystem. Over the past two years, our success in the digital transformation of industrial enterprises at Binjiang factory can be shared and used by other stakeholders and our partners. Our knowledge and learnings in connectivity assurance, extracting data value, and ecosystem partnerships. We may establish a prosperous and healthy ecosystem with our industry partners, so that everyone could benefit from 5G-powered digital transformation and safeguard the healthy development of 5G and industrial Internet.