5G + MEC Boost Green, Digital, and Intelligent Transformation of Masteel

The 5G private network now witnesses in-depth integration with Masteel's high-quality industrial intranet. With leading end-to-end solutions featuring high reliability and low latency, the 5G private network goes deep into Masteel's key production processes by leveraging collaborative innovation of 5G, AI, edge computing, cloud, and other technologies, achieving intelligent equipment interconnection, intelligent production, intelligent operation, and automatic operation and maintenance. In the future, Masteel will continue to tap into 5G values, pursue integrated innovation, focus on key applications, and converge industrial ecosystems to boost Masteel's green, digital, and intelligent transformation and promote the best practices across the iron and steel industry.

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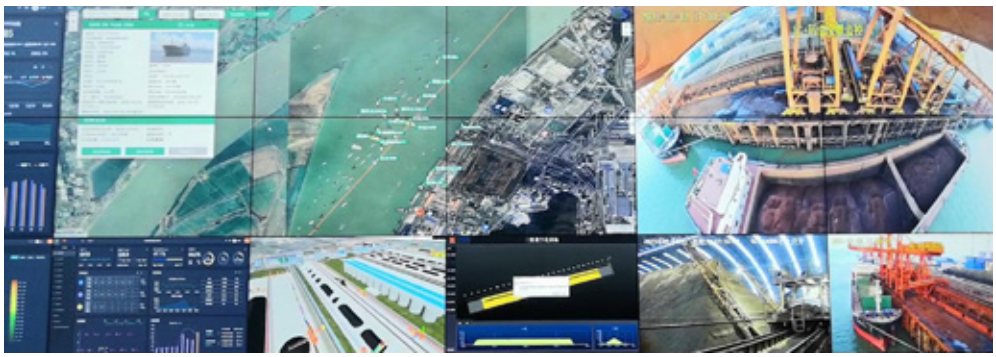
Case Overview

Masteel Harbour Raw Material Factory is located in the northwest of Maanshan City adjacent to the Yangtze River, covering a total area of about 1.15 million square meters. The factory is primarily responsible for receiving, storing, processing, and delivering the raw materials needed for production by the six blast furnaces and five sintering machines of Masteel. The factory records an annual output of 10.1 million tons, being a "granary" of Masteel's iron-making raw materials. The factory covers a large area, and has nearly 100 large mobile machines, cloth vehicles, and tripper cars, with more than 1,000 discrete video surveillance points. Its equipment is connected via 427 belts totalling around 70 kilometres in length. Considering the complicated operating conditions and difficult deployment of communication systems, a 5G private network that is highly reliable, less costly, and easy to maintain is urgently needed to address challenges including mobile network deployment, flexible manufacturing, and green production.

Masteel, PHIMA Intelligence Technology, China Unicom, and Huawei jointly deployed nineteen 5G SA sites in the raw material factory and one set of MEC (UPF + MEP) system in Masteel's data centre for in-depth integration of the 5G private network with Masteel's high-quality industrial intranet. Additionally, Masteel has also piloted 5G + unmanned stacker-reclaimers, a 5G + 3D digital material factory, intelligent inspections of belt conveyors, 5G + AI production behaviour supervision, 5G + intelligent video cruise, and a 5G + AR intelligent operation and maintenance demonstration project, replacing 52 industrial Wi-Fi systems, with the investment cut by 30% and the overall utilisation rate across the factory increased by 20%. These efforts have translated into a manpower cut of 36 persons in the early stage and 200 persons in the later stage, saving CNY 8 million per year. As a result, the factory achieves intelligent equipment interconnection, intelligent production, intelligent operation, and automatic operation and maintenance, setting a benchmark for 5G application in the process industry.



Industry Challenges

The iron and steel manufacturing process features a long process, many production steps, complex production techniques, a long supply chain, and a wide variety of manufacturing facilities, being a typical hybrid manufacturing process. Modern iron and steel manufacturing has highly automated process and production line equipment. However, this has also introduced challenges including high costs for equipment maintenance, high invisibility of industrial knowledge, increasingly personalised demands from downstream sectors, growing pressure for environmental protection, a low level of intelligence, and serious brain drain. As a result, the industry has a strong demand for digital transformation and upgrading to cut costs and increase efficiency. This is primarily embodied in the following aspects.

Excessive production capacity, unbalanced supply and demand, and high pressure for energy conservation and emission reduction: The excessive investment in the iron and steel industry during the 13th Five-Year Plan period has led to a concentrated release of production capacity, driving up the capacity to a level beyond the demand. Companies failed to quickly identify market demands due to the less optimal allocation of supply and demand information in the industry, leading to imbalanced supply and demand. Meanwhile, as the field with the highest carbon emissions in the manufacturing industry, the iron and steel industry is under high pressure for emission reduction, and urgently needs the support of the Industrial Internet for digital transformation.

Data standard deficiency, data isolation, and stove-piped systems: Steel factory equipment features many types and scenarios, leading to data silos, data fragmentation, and network diversification, with standalone systems and data, compromising utilisation efficiency of data and restricting the transformation and upgrading to Industry 4.0.

Poor operating environment, labour-intensive production processes, and serious brain-drain: The environment of many posts at iron and steel production sites harbour production safety risks such as high labour intensity, much dust, and high temperature hazards. Many production operations such as manual quality inspections still rely on personal experience, which is less efficient. Meanwhile, such posts are less attractive to human resources, resulting in recruitment difficulty.

High requirements for wireless network connection and network security and stability: Most of the production intranets in steel companies use optical fibres and Wi-Fi connection. Optical fibres are neither suitable for mobile scenarios nor conducive to flexible manufacturing due to their lossy nature and costly maintenance. Steel mills are dominated by the steel frame structure, which highlights serious electromagnetic and multi-way interference, while high reliability, stability, and low latency are required for some control-type businesses.

Leveraging the enhanced mobile broadband, low latency, and massive connectivity of 5G networks, as well as collaborative innovation of technologies such as AI, AR, and edge computing, 5G solutions help steel mills achieve digital transformation and upgrading with less manpower input and unmanned and intelligent operation.

Solutions and Benefits

01 5G + 3D digital material factory

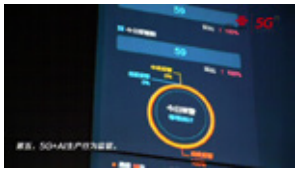
Previously, the stacking and reclaiming positions, heights, lengths, and widths of the stock piles and strips depended on individual observations and operation plans were revised based on the operator's experience and personal judgments on stockyard conditions. Single raw material management methods and low utilisation rate of the factory exist. To address this issue, the existing operational mode should be changed by deploying 3D scanners on mobile machines to get 3D scanning data of stock piles in real time. However, deploying wired optical fibres on mobile machines is complicated, with a large amount of 3D point cloud data and a significant delay during Wi-Fi communication, making it impossible to timely and accurately obtain the stock pile information.

In the 5G solutions, the massive amount of point cloud data scanned by 3D scanners is sent back to the data centre over the 5G network for 3D modelling and computing of stock piles and strips, enabling real-time stocktaking and operation plan development. After project implementation, the stockyards can be managed in a fine-grained manner to elevate the production efficiency by 20%.

02 5G + unmanned stackers-reclaimers

All stockyards are covered with sheds and closed during environmental protection upgrading and transformation. However, the serious vibration and much dust during stacker and reclaimer motions result in the harsh operating environment in the sheds. Remote/unmanned driving of the stackers and reclaimers is required to improve the operating environment. In the traditional mode, optical fibres are used for remote transmission of video signals and control signals, and optical fibre reels are placed on the rotating discs of the stackers and reclaimers to move, lay, and pick optical fibres. Nevertheless, optical fibres are prone to interruption which can affect normal production, complicate maintenance, and increase the cost.

5G+ Smart Manufacturing



Now with the 3D model data, intelligent sensing equipment, and high-definition video technologies of the digital stockyards, real-time communication between the machine-borne control systems and the remote intelligent decision-making systems can be realised leveraging the low latency of 5G networks, enabling inter-system coordination and unmanned operation of stackers and reclaimers.

This scenario requires precise control of production equipment and is demanding on the service latency (usually less than 20 ms). The 5G access and MEC local offloading ensure the smooth operation of remote/unmanned driving. Combined with the network slicing technology, the solution can meet the networking needs for remote/unmanned driving, realise flexible, independent sliced network resources, and guarantee network quality and safety of use.

03 5G + intelligent cruise

The material factory has a total of 427 sealing-tape machines, resulting in complexity for managing them. In the event of any equipment faults, it becomes difficult to find the video of the faulty equipment among the massive video signals. When the tapes of different material flows need to be started sequentially, it is necessary to get multiple video signals accordingly to monitor the start-up process.

High-definition videos can be sent back utilizing the high-bandwidth feature of 5G networks. Based on the specific process chain information as well as the electrical fault and alarm messages of the equipment, operators can quickly locate the faulty points and automatically identify the monitoring camera of the equipment to project the image on the large screen or send it to the terminal of the maintenance personnel. The 5G solutions also support video cruise and monitoring of the specific production process following customizable routes.

By deploying application capabilities such as map sharing, route planning, and scheduling management, the 5G solutions can enable remote cruise control and scheduling while sending back data such as real-time high-definition images, equipment information, and environmental information over the 5G network. The edge cloud uses video transcoding and decoding and AI inference among other functions to pre-process video data and then transmits it to the central cloud. The central AI system conducts in-depth analysis of the collected data to identify any abnormality in the equipment or environment in the cruise area.

04 5G + AI intelligent supervision of production behaviours

Managers may find it impossible to always supervise and issue reminders on the production behaviours of personnel in scenarios that feature a large area of field operation and scattered operation sites.

The enhanced mobile broadband of 5G supports transmission of 4K high-definition videos of the operation sites in real time. Coupled with the AIplatform, 5G solutions can help analyse production behaviours intelligently and take pictures of and issue real-time alarms on any violations. This can prevent accidents caused by misbehaviours and avoid major personal injury and equipment loss caused by accidents.

With the 5G network traffic to data businesses well managed, one or more recognition algorithms can be configured for video streams or video files as needed by using functional modules such as AI algorithm libraries of atomic capabilities, intelligent analysis of videos, and face management in conjunction. The outputs include the automatically captured event photos, event descriptions, and time of occurrence, achieving 5G + intelligent supervision of production behaviours in the real sense.

05 5G + AR intelligent operation and maintenance

Previously, operation and maintenance personnel manually recorded equipment operation and maintenance details in form of text on paper or on an electronic platform as daily routines. For complex equipment, it was necessary to invite experts to the site to offer guidance on a regular or temporary basis. However, this approach highlights low maintenance efficiency and poor information sharing.

In current practices, 5G + AR glasses are used to record the spot check details of each component and perform analysis. In a complex industrial environment, experts provide real-time guidance through text, images, real-time annotations, and other spatial annotation means to enable real-time interactions from the first person point of view and multi-participant, multi-site collaboration. This can quickly locate the issues and share solutions in real time via cloud-based interactions and remote diagnosis.

The automatic offloading of business data on the edge cloud network, as well as the automatic deployment and transcoding, rendering, and splicing capabilities of AR applications lay a network foundation for 5G + AR intelligent operation and maintenance and remote collaboration, supporting AR space annotations, multi-user high-definition audio and video communication, and document sharing among other functions, with the technical support costs dramatically reduced.

06 5G + intelligent maintenance and inspection of sealing-tape machines

Sealing-tape machines are prone to motor or reducer failures, belt misalignments, slip, tearing, and other issues during production and operation due to the complex operating environment, the long transportation distance, and the large transportation volume. What's worse, the lack of effective detection and monitoring methods can lead to consequences ranging from lowered production efficiency to severe accidents.

To address the above issues, we have utilised smart sensors and 5G network technologies to improve the detection methods on equipment operational statuses, established a real-time digital model for equipment to manage equipment in a visualised manner, utilised an intelligent analysis model for rapid and intelligent diagnosis of faults, and conducted a systematic digital health assessment to ensure safe operation of the system. In addition, we have also analysed and evaluated equipment health statuses based on historical data and machine learning algorithms and models to implement predictive maintenance. Meanwhile, we have set up an intelligent maintenance and inspection system including file management, spare part management, and equipment maintenance functions to remotely carry out operation, maintenance, and monitoring in an information-based and intelligent approach.

For the purpose of 5G-based intelligent maintenance and inspection of sealing-tape machines, we collect real-time data on motors, reducers, and tapes via the 5G network, upload the data periodically, and perform state estimation and situational awareness after intelligent, algorithm-based analysis. The results are then sent to the operation and maintenance personnel to predict the equipment status and take measures in advance against any tape faults and safety risks.

Summary and Next-steps

The 5G pilot application in the raw material factory has proved that the 5G network can well eliminate the pain points of wireless communication such as wired optical cables and Wi-Fi connections. The organic convergence of the 5G private network and Masteel's industrial intranets has connected up the company's CT, OT, and IT systems, enabling deterministic communication with less jitter, a low latency, and high uplink speed. This ensures the high availability of Masteel's industrial production network and helps the company achieve "centralised control and operation, machine-powered operation, remote operation and maintenance, and online services". Thanks to the 5G solutions, the eight types of problems during steel production have been effectively solved, namely poor operating environment, complex network deployment, excessive operators, low work efficiency, high operation and maintenance costs, high labour intensity, difficult operation and maintenance evaluations, and limited supervisory measures. As a result, wireless network services featuring enhanced mobile broadband, low latency, and high reliability become available for industrial sites to empower Masteel's smart manufacturing.

With the joint exploration by the three parties, the capabilities of 5GtoB business modelling, network planning and design, business modelling, and integrated services for business scenarios including video surveillance, remote control, and unmanned driving in the steel industry have been accumulated to tap into the needs in different application scenarios.

5G integration with industrial applications requires the participation of ecological partners to incubate new applications and accelerate 5G integration into R&D and design, production and manufacturing, fault operation and maintenance, logistics and transportation, and safety management among other links. In view of industrial characteristics, we can further build a "5G + Industrial Internet" industrial ecosystem with the upstream and downstream of the industrial chain coordinating with each other to promote infrastructure construction to the lower end and develop industrial application scenarios for the upper end.

Next steps

1. Explore more value-creation scenarios: Make collaborative innovation of 5G, AI, edge computing, cloud computing, and other technologies, go deep into production processes, explore value-creation applications such as 5G + AI intelligent coal blending, 5G data acquisition and predictive maintenance, and electronic fences to improve quality and efficiency, and promote automated, unmanned, green, digital and intelligent transformation and upgrading in multiple links and processes.

2. Incubate innovative solutions: Gradually verify and launch advanced solutions that are applicable to the iron and steel industry, such as reliable core network schemes, the dual-transmit and selective-receive mode, and 5G LAN to ensure network connectivity even in case of Internet disconnection, so as to improve the reliability of 5G private networks and facilitate networked operation and maintenance.

3. Build an application enabling platform: Build an integrated automatic operation, maintenance, and management platform targeting networks, terminals, and businesses to achieve terminal device management, real-time business process monitoring, fault alarming, and positioning and boundary setting, for the purposes of further solidifying assets, accumulating capabilities, and accelerating business incubation and launch.

4. Promote scaled replication in the industry: Develop and improve standard 5G private network solution baselines and end-to-end products targeting iron and steel application scenarios, open up capabilities, and promote scaled replication and industrial upgrading of the capabilities within Magang (Group) Holding Co., Ltd.