White Paper of

# AsiaInfo AISWare AgileNet V4.5

AISWare AgileNet, designed by AsiaInfo Technologies, is a product portfolio of P5G with secure, reliable, and extreme-performance towards the modernization of network architecture for verticals, along with the full-stack solutions of digital intelligence on top of the network architecture.

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# AsiaInfo Technologies Limited (Stock Code: 01675.HK)

AsiaInfo Technologies Limited ("AsiaInfo Tech") started in 1993 and was successfully listed on the Main Board of the Hong Kong Exchanges and Clearing Limited on December 19, 2018. As the largest provider of telecom software products and related services in China, AsiaInfo Tech has developed industry-leading R&D capabilities with a loyal customer base.

AsiaInfo Technologies (China) Inc., as an indirect wholly-owned subsidiary of AsiaInfo Tech, is a leading software product and service provider in China, boasting extensive experience in software product development and large-scale software engineering implementation. With 30 years of deep market presence, AsiaInfo has advanced technological capabilities and numerous successful cases in 5G, cloud computing, big data, artificial intelligence, the Internet of Things (IoT), smart operations, and business and network support systems. AsiaInfo's clientele spans across industries including telecommunications, broadcasting, energy, government, transportation, finance, and postal services.

In 2022, AsiaInfo acquired iResearch Consulting Group Co., Ltd. (iResearch Consulting) and integrated it into the new brand iDigital, expanding AsiaInfo's capabilities from product development, delivery services, data operations, and system integration to consulting planning and intelligent decision-making, establishing itself as a leading provider of end-to-end capabilities in digital intelligence.

AsiaInfo is committed to empowering various industries with technologies such as 5G, AI and big data, collaboratively creating digital value with customers. AsiaInfo aims to lead in both products and services, focusing on continuous product development in the areas of data and intelligence, cloud and network, IT, and middle office products. The cloud and network products maintain international leadership, while data and intelligence products achieve domestic leadership and some international advancements. In the IT domain, AsiaInfo's products stand at the forefront within the domestic landscape.

In the future, AsiaInfo strives to become the most trusted leader in digital intelligence, leveraging its comprehensive capabilities in the field to innovate customer value and contribute to the digital transformation.

## Certificates (Part)

Capability Maturity Model Integration (CMMI) Certificate Level 5 (L5)

Cloud Managed Services Capability Assessment Certificate: Excellent Level

Digital Trusted Services - R&D Digital Governance Capability Certificate

Enterprise Credit Grade (AAA) Certificate

Information System Construction and Service Capability Assessment CS L4

ISO9001 Quality Management System Certificate

ISO20000 IT Service Management System Certificate

ISO27001 Information Security Management System Certificate

Service Certificate of Information System Security Development L2

Service Certificate of Information System Security Integration L2

## Awards (Part)

Awards from International Telecommunication Union (ITU)

Award for Science and Technology Progress of Wu Wenjun Awards

Best Network Slicing Trail at 5G World Summit

French Design Awards

Global Telecoms Awards

IDC Future Operation Leadership

iF Design Golden Award of Hannover Industrial Design Forum

Leading Artificial Intelligence Enterprise in China

Leading Enterprise of Advanced Smart City

Outstanding Catalyst Contribution to TM Forum Assets

The Best Innovation and Future Techco of TM Forum

The Best Standard Contributor of TM Forum

The Most Innovative Application of AI & Automation of FutureNet Asia

The Most Influential Enterprise in China Software Industry

Top 100 China Software Business Revenue List for consecutive years

# Contents

# 1 Executive Summary

AISWare AgileNet is a secure, reliable, and high-performance 5G dedicated network product portfolio designed for the infrastructure upgrade of vertical industries, along with a full-stack digital and intelligent solution built on top of the network infrastructure. Based on 3GPP standards and tailored to industry needs, it offers lightweight and customizable solutions, including 5G Core Network, Wireless Network, Edge Computing Platforms, Intelligent Link Product (iLink), 5G CPE, and P5G Operations Platform, meeting the demands of industries such as manufacturing, energy, transportation, and government services.

AISWare AgileNet provides end-to-end functionality from core networks to wireless access, enabling flexible adaptation to diverse network scenarios. With innovative features such as embedded computing power, 5G LAN, TSN, and RedCap, it achieves deep integration of communication and computing, delivering efficient and intelligent network solutions for industrial customers.

In terms of application scenarios, AsiaInfo's private 5G networks have been successfully deployed in industries such as smart nuclear power, smart thermal power, smart mining, smart ports, smart steel, and smart wind power, offering end-to-end services from planning and construction to operation and maintenance. For example, a private 5G network deployed in a nuclear power plant has significantly enhanced digital management through equipment monitoring, personnel positioning, and mobile office applications. In an open-pit coal mine, the private 5G network supports unmanned vehicles and remote control, optimizing operational efficiency.

AISWare AgileNet Product Portfolio has obtained certifications including MIIT network access approval, China CCC certification, and EU CE certification, and has been recognized in multiple international and domestic competitions, such as the "5G Slicing Global Best Practice Award" and the first prize in the "Bloom Cup" 5G Application Competition. These certificates and awards fully validate the product's technical strength and industry value.

Looking ahead, AsiaInfo Technologies will continue to drive industry digital transformation through its AISWare AgileNet, helping customers build efficient,

intelligent, and secure communication infrastructure and injecting new momentum into the digital economy.

# 2 Abbreviations and Term

**Table 2-1 Term Explanation**

| Abbreviation or Term | Full Name | Explanation |
|---|---|---|
| 3GPP | 3rd Generation Partnership Project | 3rd Generation Partnership Project |
| 5GC | 5G Core Network | 5G Core Network |
| MEC | Multi-access Edge Computing | Multi-access Edge Computing |
| MEP | MEC Platform | MEC Platform |
| UOMC | Unified Operation and Maintenance Center | Unified Operation and Maintenance Center |
| AMF | Access and Mobility management Function | Access and Mobility management Function |
| SMF | Session Management Function | Session Management Function |
| UPF | User Plane Function | User Plane Function |
| UDM | Unified Data Management | Unified Data Management |
| PCF | Policy Control Function | Policy Control Function |
| AUSF | Authentication Server Function | Authentication Server Function |
| NSSF | Network Slice Selection Function | Network Slice Selection Function |
| N3IWF | Non-3GPP InterWorking Function | Non-3GPP InterWorking Function |
| gNB | Next Generation NodeB | 5G Base Station |
| BBU | Baseband unit | Baseband Unit |
| EU | Extension Unit | Extension Unit |

| Abbreviation or Term | Full Name | Explanation |
|---|---|---|
| pRRU | Pico Remote Radio Unit | 5G Remote Radio Unit |
| RedCap | Reduced Capability | 5G NR Lightweight Implementation |
| SD-WAN | Software Defined WAN | Software Defined Wide Area Network |
| SRS | Sounding reference signal | 5G Uplink Reference Signal |
| MOCN | Multi-Operator Core Network | Multi-Operator Core Network |
| VoNR | Voice over NR | Voice over 5G |
| TSN | Time Sensitive Network | Time Sensitive Network |
| PDU | Protocol Data Unit | Protocol Data Unit |
| SSC | Session and Service Continuity | Session and Service Continuity |
| NFV | Network Functions Virtualization | Network Functions Virtualization |
| SLA | Service-Level Agreement | Service-Level Agreement |
| SPV | Single Point Vulnerability | Critical Sensitive Equipment |
| AGV | Automated Guided Vehicle | Automated Guided Vehicle |
| DPDK | Data Plane Development Kit | Data Plane Development Kit |
| DNS | Domain Name System | Domain Name System |
| 5G LAN | 5G Local Area Network | 5G Local Area Network |
| COTS | Commercial Off-The-Shelf | Commercial Off-The-Shelf |
| TWIF | Trusted WLAN Interworking Function | Trusted WLAN Interworking Function |

| Abbreviation or Term | Full Name | Explanation |
|---|---|---|
| N5CW | Non-5G-Capable over WLAN | Non-5G-Capable over WLAN |
| LTE FDD | Long Term Evolution with Frequency Division Duplexing | Long Term Evolution with Frequency Division Duplexing |
| ISAC² | Integration of Sensing Artificial intelligence Communication and Computing | Integration of Sensing Artificial intelligence Communication and Computing |
| TFLOPS | Tera Floating - Point Operations Per Second | Tera Floating - Point Operations Per Second |

# 3 Product Overview

## 3.1 Trends and Challenges

According to GSA data, as of September 2024, a total of 1,489 institutions and organizations across 80 countries and regions worldwide have deployed or are in the process of deploying private mobile networks using LTE/5G technology, with approximately 47% adopting 5G technology. GSMA analysis reports indicate that the global compound annual growth rate (CAGR) of private 5G networks has reached 66%.

As digital transformation accelerates, traditional enterprise networks—relying on wired networks and Wi-Fi—are facing unprecedented challenges. Increasing high-definition video traffic, the integration of mobile devices such as robots and drones, the demand for ultra-low latency, and the connection of large-scale IoT devices are placing higher demands on network flexibility, bandwidth, latency, and reliability. In contrast, expanding wired networks is difficult and costly, while Wi-Fi is limited by coverage and stability issues.

P5G offers an ideal solution to address current network challenges with its high bandwidth, low latency, and high reliability. Moving toward 5G-Advanced and 6G, the convergence of mobile communications with multi-dimensional capabilities such as computing power, AI, and sensing has become an industry consensus. In November 2023, ITU-R officially released the latest framework standard for mobile networks under IMT-2030 (6G). Within the IMT-2030 application scenario definitions, it explicitly states that future communication networks must deeply integrate AI with communications to support higher flexibility and intelligence, adapting to evolving user demands and application scenarios.

AsiaInfo, with its advanced P5G products, has successfully implemented projects in fields such as smart energy, smart mining, and intelligent manufacturing, improving data transmission speeds and network stability while providing strong support for customers' digital transformation.

## 3.2 Product Definition

AISWare AgileNet is an All-in-One product portfolio including Base Station, Core Network, Intelligent Link Product (iLink), 5G CPE, and P5G Operations Platform, with which AsiaInfo provides multi-scenario solutions for verticals along with end-to-end services of P5G planning, design, deployment, operations, and maintenance. It also supports Telco public network deployments for 5G indoor and remote coverage scenarios, etc.



**Figure 3-1 AsiaInfo's Private 5G Network Product Portfolio**

## 3.3 Product Positioning

AISWare AgileNet, designed by AsiaInfo Technologies, is a dedicated product portfolio with secure, reliable, and extreme-performance towards the modernization of network architecture for verticals, along with the full-stack solutions of digital intelligence on top of the network architecture. It also supports Telco public network deployments for 5G indoor and remote coverage scenarios, etc. Additionally, it can support public network deployment needs for operators in scenarios such as 5G indoor coverage and remote area coverage.

# 4 Product Portfolio

Figure 4-1 Product Portfolio introduces the following products:
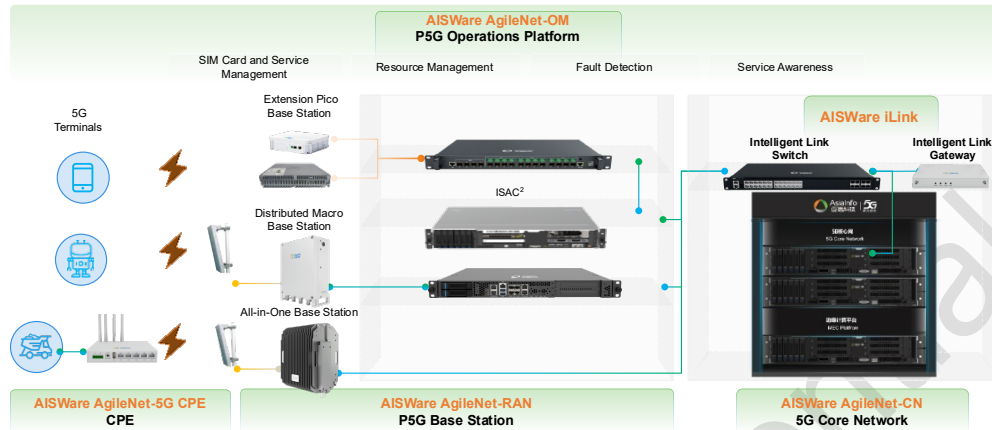


**Figure 4-1 Product Portfolio**

- AISWare AgileNet-CN: Achieve various functional controls and user plane data processing and forwarding for 4/5G networks, including key functionalities such as 5GC, EPC, IMS, and MEC.

- AISWare AgileNet-RAN: Provide 4/5G radio coverage for radio signal transmission between private networks and 4/5G terminals, including various station types such as Extension Pico Base Station, All-in-One Base Station, and Distributed Macro Base Station.

- AISWare iLink: Facilitate intelligent interconnection within and between private networks, reducing network configuration and operational complexity, including iLinkS and iLinkG.

- AISWare AgileNet-5G CPE: Convert 5G signals into Wi-Fi or wired signals to accommodate more local devices, such as cameras, vehicles, and industrial PLCs, for P5G access.

- AISWare AgileNet-OM: Implement operational, maintenance, and capability openness for Private 5G Network, reducing the usability complexity for industry customers.

# 5 Basic Functions

## 5.1 Core Network

AISWare AgileNet-CN is a lightweight private core network tailored to industry customer needs, built on the 3GPP 5G standard. It offers a complete set of functional, stable, easy-to-deploy, and customizable solutions for 5GC deployment.

The 5G core network, according to 3GPP R16, provides a full set of features, stable performance, easy deployment, and on-demand customization to meet the specific needs of industry customers.

The functionality of 4G core network is implemented by EPC, the central network component of 4G mobile communication systems. The 4G core network provides traditional capabilities such as user subscription data storage, mobility management, and data exchange, enabling users to enjoy ultra-high-speed internet access.

The IMS core network is primarily used to meet the high-definition voice and video call requirements of private network users.

The OMC offers a unified web interface for system operations, supporting the management of 5GC, EPC, IMS core network, and edge computing platform.

### 5.1.1 5G Control Plane Network Elements

3GPP defines numerous 5GC control plane network elements to meet the diverse requirements of public 5G networks. However, in the P5G scenario, network demands are relatively simple, and unnecessary network elements can lead to issues such as resource wastage and deployment challenges. Therefore, network elements need to be streamlined and consolidated. Figure 5-1 illustrates the streamlined solution of AISWare AgileNet-CN.
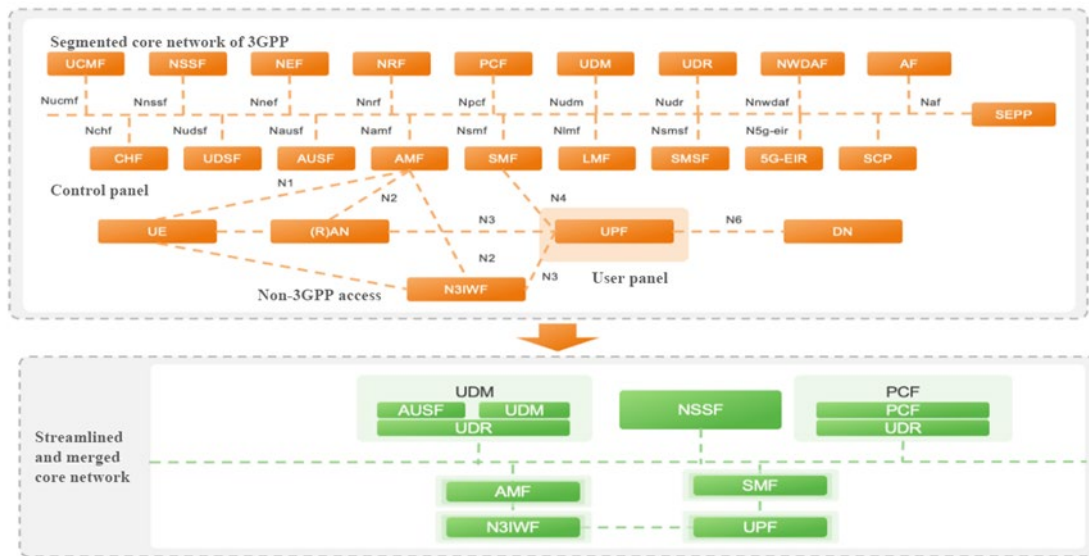
**Figure 5-1 5GC Network Element Solution**

The functionalities of AISWare AgileNet 5GC control plane elements are as follows:

**Table 5-1 Control Plane Element Functionalities**

| 5GC Network Element | Corresponding 3GPP Network Element | Feature Description |
|---|---|---|
| AMF | AMF | Handles User Equipment (UE) registration, connection, access authentication, mobility, and reachability management. Transmits Session Management (SM) messages between UE and SMF. |
| SMF | SMF | Supports interaction with the separated data plane; creates policies and flow templates based on its configuration or interaction with PCF and selects and controls UPF and SSC modes; manages session establishment, updates, and release, and maintains PDU session management, and maintains PDU session status, group management, and coordinates billing data collection and traffic control for UPF. Manages IP address allocation for UE, with DHCP, ARP proxy, or IPv6 neighbor request proxy functionality. |

| 5GC Network Element | Corresponding 3GPP Network Element | Feature Description |
|---|---|---|
| UDM | AUSF&UDM&UDR | Stores and manages user data and profiles. UDM integrates AUSF and UDR functions to support access authentication for both 3GPP and non-3GPP UEs. |
| PCF | PCF&UDR | Manages and enforces user policies, including session and mobility policies. The PCF also integrates UDR functionality. |
| NSSF | NSSF | Determines which network slice service to provide to the UE based on the NSSAI or S-NSSAI provided by the UE and decides which AMF will offer access services to the UE. |

## 5.1.2 5G User Plane Network Elements

In the 5G core network, the user plane network function is the UPF. Public network UPFs are relatively complex and expensive, which makes them unsuitable for vertical industry applications. Unnecessary features, such as content billing and roaming, should be removed. P5G industries require a low-cost, lightweight UPF.

Furthermore, different vertical industries also have various customized application needs. The P5G UPF must support necessary, tailored network element functions, such as frame routing, Ethernet sessions, and 5G LAN.

The functionalities of AISWare AgileNet 5GC user plane elements are as follows:

**Table 5-2 User Plane Element Functionalities**

| 5GC Network Element | Corresponding 3GPP Network Element | Feature Description |
|---|---|---|
| UPF | UPF | Acts as the interconnection point between RAN and DN, serving as the PDU session anchor in response to SMF requests. Handles GTP-U protocol encapsulation/decapsulation, packet |

| 5GC Network Element | Corresponding 3GPP Network Element | Feature Description |
|---|---|---|
| | | routing and forwarding, packet inspection, QoS flow mapping, and other user plane functions. Implements user plane policy rules, including gating, redirection, and traffic steering. |

## 5.1.3 4G EPC

To support industry customers' existing 4G base stations and terminals, AISWare AgileNet incorporates 4G core network EPC. Evolved Packet Core (EPC) is the core network for 4G, providing user data storage, mobility management, and data exchange, while delivering ultra-high-speed internet access. EPC features an all-IP structure, separation of control and bearer planes, and a flat network architecture, including elements like MME, SGW, PGW, HSS, and PCRF. The system supports 4G/5G interworking, enabling terminals to reselect and handover between 4G and 5G networks to ensure service continuity for private network operations.

AISWare AgileNet-CN EPC uses a control-plane and user-plane separation, offering advantages such as flexibility, performance optimization, reduced latency, fault isolation, and support for various deployment scenarios, enhancing network efficiency and reliability. The system supports converged subscriber data management across 4G SAE HSS, IMS HSS and 5G UDM, integrating the subscription management functions and interfaces of all three networks. This unified approach significantly reduces both the number of required network elements and the complexity of subscriber provisioning.

NB-IoT is a narrowband IoT technology known for its advantages such as wide coverage, massive connectivity, low power consumption, and cost-effectiveness. It has been widely adopted in enterprise 4G private networks. AsiaInfo Technologies' EPC supports the access of NB-IoT terminal devices, ensuring compatibility with a broader range of IoT application scenarios.

## 5.1.4 IMS

The VoNR solution provides ultra-clear voice and video calls with lower latency, better clarity, and improved stability in the P5G environment.

It supports terminal registration, periodic re-registration, and deregistration, keeping terminals online and maintaining status. This allows terminals to initiate and receive voice calls within the P5G network. It supports IMS multi-party conference, meeting the conference call requirements of industry customers with dedicated terminals.

It also supports IMS messaging, enabling industry SMS platforms to provide messaging capabilities to business applications—such as verification codes and group messaging for work teams—delivering more application scenarios for various industries.

The functionalities of AISWare AgileNet 5GC IMS network elements are as follows:

**Table 5-3 IMS Element Functionalities**

| IMS Network Element | Corresponding 3GPP Network Elements | Feature Description |
|---|---|---|
| CSCF | CSCF | VoNR voice/video calls; terminal access based on standard IMS; voice calls with the public network; IPSec encrypted signaling; AKAv1 authentication; IPv4/IPv6; voice call support for AMR-NB, AMR-WB, G.711, G.722, etc.; network element virtualization deployment; WEB/SNMP network management; HSS interface support (Cx interface); PCRF interface support (Rx interface). |
| MRF | MRF | Responsible for call failure-related tone services. |
| HSS | HSS | User subscription data management; authentication; user profile management; location registration management; service authorization management. |

## 5.1.5 CN OMC

The Unified Operation and Maintenance Center for Core Network (UOMC-C) possesses end-to-end centralized management capabilities for core network devices, offering a unified web interface for system O&M. It supports operational management of 5GC, EPC, IMS, and edge computing platforms. It also opens northbound interfaces for integration with higher-level network management systems to enable unified operations of the private network.

Southbound, it integrates with core network control and user plane elements, supporting access, configuration, performance, alarms, resources, topology, security, logs, backup and recovery, and signaling tracking. It also connects to the edge computing platform, supporting access, configuration, application, and rule management.

Northbound, UOMC-C uses standardized interfaces to connect with upper-level network management systems, supporting FCAPS data collection. It can integrate with OSS systems or private network operations platforms, fulfilling FCAPS/SLA monitoring needs for private network operations. It also interfaces with enterprise platforms via open APIs, supporting enterprise-specific monitoring and network operations.
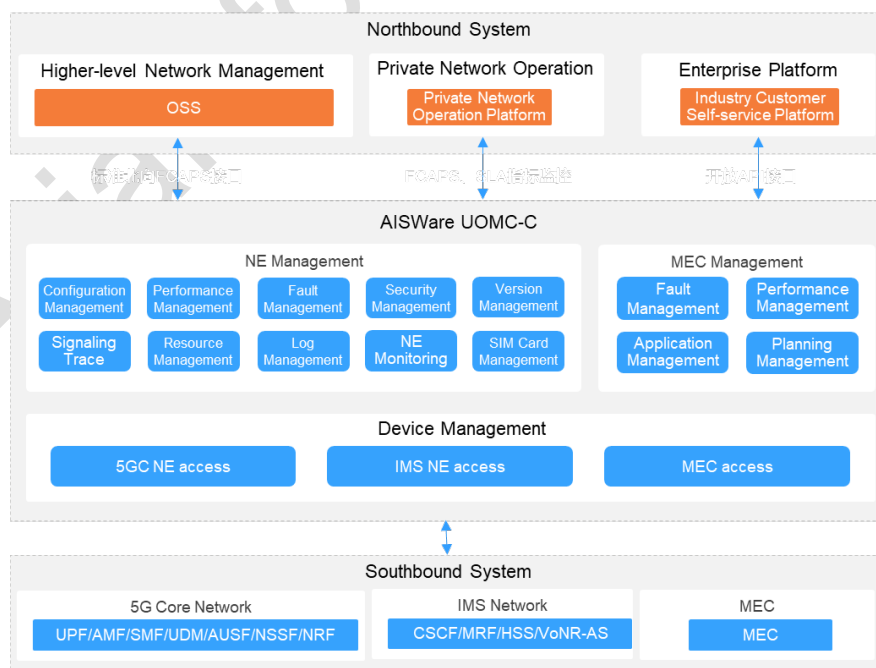


**Figure 5-2 UOMC-C Architecture**

## 5.1.6 Edge Computing Capabilities

AISWare AgileNet-MEC integrates edge IaaS, MEO, MEP, and multiple edge applications, enabling flexible network access capabilities.

The AISWare AgileNet-MEC solution supports both all-software deployment and integrated MEC appliance deployment. Built on general-purpose computing, storage, networking, and acceleration hardware, AsiaInfo's MEC product delivers lightweight Kubernetes-based IaaS capabilities, empowering cloud-native application operation, management, and orchestration.

The following diagram illustrates the architecture and key functionalities of AsiaInfo's MEC product.
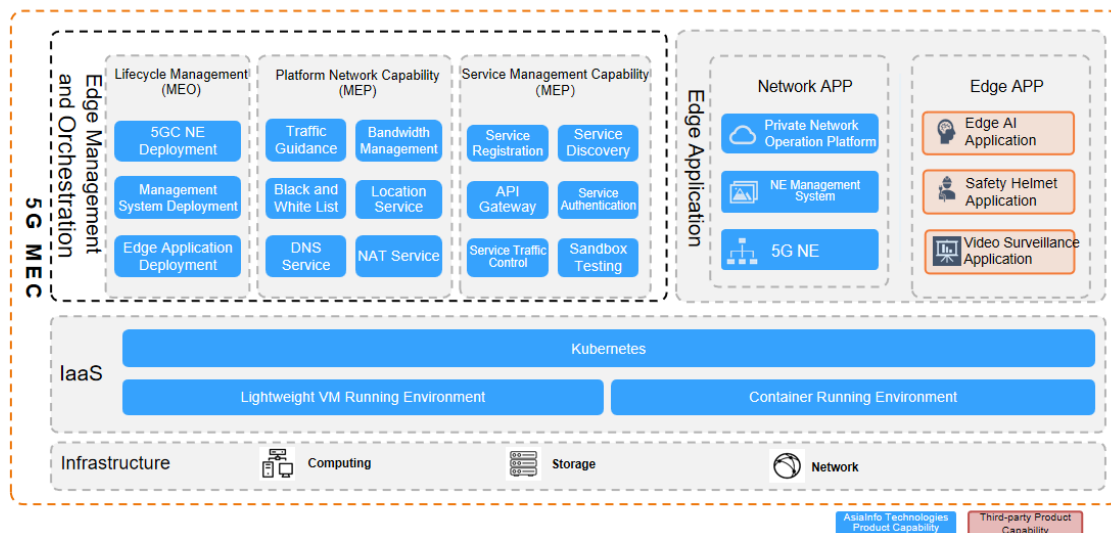


**Figure 5-3 MEC Architecture**

The MEP provides MEC application management, service management, and the management and distribution of traffic rules, DNS (Domain Name System) rule configuration. As a core capability platform, the MEP also delivers fundamental services including wireless network information service, bandwidth management, traffic steering, UE identity service, and location service.

5G MEC supports the scheduling of built-in computing resources in base stations. With the development of AI technology, base station BBU servers can now be equipped with intelligent computing power to provide AI computing services externally. The MEC product supports the management and

scheduling of base station intelligent computing resources, enabling the opening of wireless network AI computing capabilities. It also supports the lifecycle management of small and large models, implementing functions such as intelligent application upload, publishing, and deployment, thereby providing customers with more comprehensive application management services.

# 5.2 Radio Access Network

AISWare AgileNet-RAN is developed based on the 3GPP R16, including Extension Pico Base Station, All-in-One Base Station, and Distributed Macro Base Station, catering to various indoor, outdoor and underground mining scenarios.

## 5.2.1 Extension Pico Base Station

AISWare AgileNet-RAN S26/S33/S35/S49/D26 comprises BBU, EU, and pRRU.

The Extension Pico Base Station is a compact, low-power indoor distributed base station designed to provide 4/5G signal for indoor environments. Its flexible networking solution is suitable for applications such as video backhaul, industrial control, sensor data transmission, and mobile offices in indoor settings like manufacturing plants, logistics warehouses, hospitals, office buildings, and transportation hubs. The product supports multiple 5G frequency bands as well as the 1.8GHz LTE FDD band and can be selected based on the local wireless environment.

As illustrated in Figure 5-4, AISWare AgileNet-RAN S1/S2/S3/S49/D26 compromises 3 main components:

● pRRU: Responsible for amplifying and processing RF signals

● EU: Responsible for expanding and extending multiple remote radio units

● BBU: Responsible for processing baseband signals
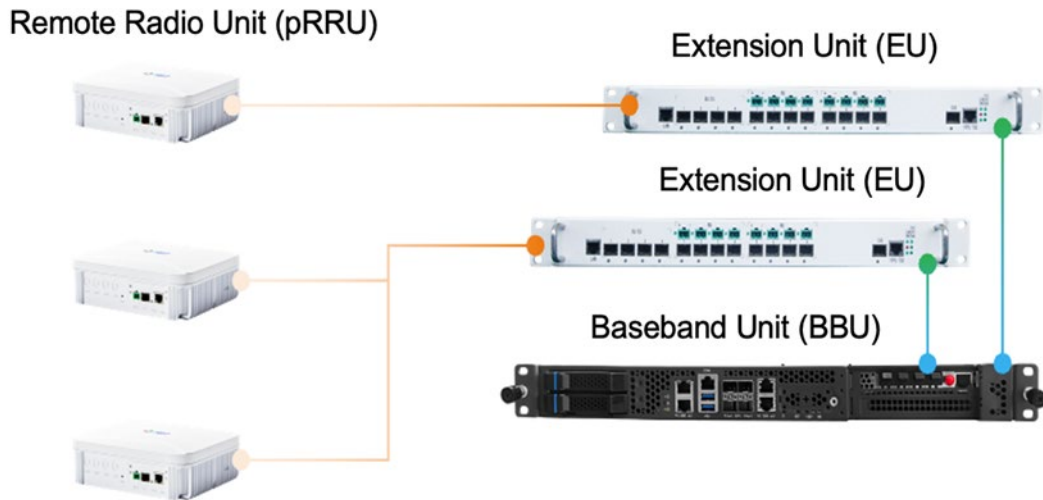
**Figure 5-4  P5G Extension Pico Base Station**

Extension Pico Base Station Features:

- Multi-Frequency Bands/ Dual-mode: Supporting multiple P5G frequency bands (2.6GHz, 3.3GHz, 3.5GHz, 4.9GHz) and LTE FDD band (1.8GHz).

- High Performance: High transmission rates, large user capacity, and low service latency.

- High Uplink Capacity: Supporting various TDD frame structures to enable high uplink speeds.

- Bluetooth Positioning: Supporting integration with Bluetooth beacons for Bluetooth terminal positioning.

- Network Slicing: Supporting radio network slicing for multi-service to facilitate radio resource allocation.

Key performance indicators of the Extension Pico Base Station are as follows:

**Table 5-4 NR Standalone pRRU Performance Indicators**

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 1 | Frequency Bands | N41: 2515~2675MHz<br>N78: 3300~3600MHz |

| No. | Parameter | Specification |
|-----|-----------|---------------|
|     |           | N79: 4800~4960MHz |
| 2   | OBW | N41/N79: 160MHz<br>N78: 300MHz |
| 3   | IBW | 100MHz/60MHz/40MHz/20MHz |
| 4   | RF Channels | 4T4R |
| 5   | Output Power | 4x0.25W |
| 6   | Error Vector Magnitude (EVM) | 256QAM: <3.5% |
| 7   | Frequency Error | ≤0.01ppm |
| 8   | ACLR | ≤-45dB |
| 9   | Spurious Emission | Comply with 3GPP standards |
| 10  | Receiver Sensitivity | Comply with 3GPP standards |
| 11  | Blocking | Comply with 3GPP standards |
| 12  | Antenna Interface | Built-in antenna or external antenna (SMA-F) |
| 13  | Power Supply Method | Powered by optoelectronic composite cable, with a distance of ≥200m |
| 14  | Power Consumption | ≤35W |
| 15  | Operating Temperature | -5~+55°C |
| 16  | Operating Humidity | 5%~95% |
| 17  | Protection Level | IP31 |
| 18  | Weight | ≤2.5kg |

| No. | Parameter | Specification |
|---|---|---|
| 19 | Product Dimensions | 219mm x 174.5mm x 62mm |
| 20 | Installation Methods | Supports installation methods such as wall-mounting and ceiling suspension |

**Table 5-5 4/5G Dual-Mode pRRU Performance Indicators**

| No. | Parameter | Specification |
|---|---|---|
| 1 | Frequency Bands | NR N41: 2515~2675MHz<br><br>LTE FDD B3: 1710MHz-1735MHz<br><br>1805MHz-1830MHz |
| 2 | OBW | NR: 160MHz<br><br>LTE FDD: 25MHz |
| 3 | IBW | NR:100MHz/60MHz/40MHz/20MHz<br><br>LTE FDD: 20/15/10/5MHz |
| 4 | RF Channels | NR: 4T4R/2T2R<br><br>LTE FDD: 2T2R |
| 5 | Output Power | NR: 4*0.25W/2*0.4W<br><br>FDD LTE: 2*0.125W |
| 6 | Error Vector Magnitude (EVM) | 256QAM: <3.5% |
| 7 | Frequency Error | ≤0.01ppm |
| 8 | ACLR | ≤-45dB |
| 9 | Spurious Emission | Comply with 3GPP standards |

| No. | Parameter | Specification |
|---|---|---|
| 10 | Receiver Sensitivity | Comply with 3GPP standards |
| 11 | Blocking | Comply with 3GPP standards |
| 12 | Antenna Interface | Built-in antenna or external antenna (SMA-F) |
| 13 | Power Supply Method | Powered by optoelectronic composite cable, with a distance of ≥200m |
| 14 | Power Consumption | 4T4R≤43W<br>2T2R≤36W |
| 15 | Operating Temperature | -5～+55℃ |
| 16 | Operating Humidity | 5%～95% |
| 17 | Protection Level | IP31 |
| 18 | Weight | ≤3kg |
| 19 | Product Dimensions | 219mmX174.5mmX62mm |
| 20 | Installation Methods | Supports installation methods such as wall-mounting and ceiling suspension |

**Table 5-6 EU Performance Indicators**

| No. | Parameter | Specification |
|---|---|---|
| 1 | Power Capacity | 8×40W, with each remote power port providing 40W |

| No. | Parameter | Specification |
|---|---|---|
| 2 | Main/Expansion Unit Side Transmission Interface | 4x10Gbps (eCPRI protocol) |
| 3 | Remote Unit Side Transmission Interface | 8x10Gbps (CPRI protocol) |
| 4 | Networking Topology | Star topology |
| 5 | Cascading Capability | Level 2 |
| 6 | Remote Capability | 200 meters via hybrid fiber optic and electrical cable |
| 7 | Clock Synchronization | Supports clock synchronization extraction from the main unit interface; supports GPS or BD dual-mode operation with automatic switching |
| 8 | Input Voltage | 220V AC (176V ~ 264V) for AC power module |
| 9 | Output Voltage | -48V DC (-40V ~ -57V) for DC power module |
| 10 | Power Consumption (W) | ≤55W (static) |
| 11 | Operating Temperature | -20~55℃ |
| 12 | Operating Humidity | 5%~95% |
| 13 | Enclosure Protection | IP31 |
| 14 | Noise Level | <40dBA |

**Table 5-7 BBU Performance Indicators**

| No. | Parameter | Specification |
|---|---|---|
| 1 | Dimensions | 410mm x 410mm x 44mm |
| 2 | Weight | Approximately 7.5kg |

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 3 | Power Supply | AC 220V/DC -48V |
| 4 | Enclosure Protection | IP20, suitable for indoor environments |
| 5 | Installation Method | Standard rack-mounted |
| 6 | Cooling Method | Air cooling |
| 7 | Operating Temperature | -5°C~+55°C |
| 8 | Power Consumption | 350W |
| 9 | Cell Capacity | 4 cells x 4T4R |
| 10 | RRC Connected Users | 1200 per cell |
| 11 | RRC Active Users | 400 per cell |

## 5.2.2 All-in-One Base Station

AISWare AgileNet-RAN A07/A21 integrates the 5G BBU and RRU for seamless 5G NR access, offering a compact, reliable radio network solution, as shown in Figure 5-5. The AISWare AgileNet-RAN-A07 model supports 700MHz, while the A21 model supports 2.1GHz. AISWare AgileNet-RAN-BA7 is a specialized base station model designed to provide 5G coverage in mine tunnels, meeting intrinsic safety requirements. It supports the 700MHz frequency band.

**Figure 5-5 P5G All-in-One Base Station**

The high-power All-in-One Base Station features a small form factor, easy installation, and is ideal for private network deployments that require extensive 5G coverage, such as in smart mines, power plants, and suburban/rural areas. The Intrinsically Safe All-in-One Base Station is designed for low-power applications in mine tunnels, meeting stringent safety requirements including explosion-proof standards.

Key features of the All-in-One Base Station:

● Easy deployment, flexible backhaul, low power consumption, and reduced maintenance costs, easing construction and O&M pressures

● Robust environmental adaptability, with resistance to vibration, salt spray, and sandstorms. The system is stable, secure, and reliable.

● Supports both private and public network sharing, with MOCN compatibility

● Built on proprietary protocol stacks and system software for stability and security

● Flexible clock synchronization options, supporting GPS/Beidou/ 1588V2

● Complies with mine intrinsic safety and explosion-proof requirements.

The following tables introduce key performance indicators of AISWare AgileNet-RAN A07:

**Table 5-8 AISWare AgileNet-RAN A07 Specifications**

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 1 | Power Consumption | 300W |
| 2 | Timing Source | GPS/BD/1588v2 |
| 3 | External Power Supply Voltage | AC: 220V |
| 4 | Interfaces | 1* Gigabit Ethernet Optical Port, 1* Gigabit Ethernet Port, 1* Power Input Port, 1* GPS Antenna Port, 2* RF Main Antenna Ports |
| 5 | Indicators | Power, Operation, Alarm |
| 6 | Basic Functions | Supports system internal switching with NG/Xn interfaces; supports MOCN; supports VONR |
| 7 | Number of Cells | 1 |
| 8 | RRC Connected Users | 200 per cell |
| 9 | RRC Active Users | 100 per cell |
| 10 | Antenna Channels | 2T2R |
| 11 | Transmit Power | 40W per channel |
| 12 | Downlink Peak Rate | 300Mbps@30MHz (under ideal conditions) |
| 13 | Uplink Peak Rate | 150Mbps@30MHz (under ideal conditions) |
| 14 | Operating Temperature | -40~+55℃ |

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 15 | Operating Humidity | 5%~95% |
| 16 | Dimensions (mm) | 402*328*195.2 (including maximum connector dimensions)<br><br>382*285*195.2 (effective dimensions) |
| 17 | Weight (kg) | 18 |
| 18 | Volume (L) | 21 |

**Table 5-9 AISWare AgileNet-RAN-A07 RF Specifications**

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 1 | Operating Frequency | N28 (Uplink: 703~748 MHz; Downlink: 758~803MHz) |
| 2 | Duplex Mode | FDD |
| 3 | Output Power Accuracy | -40℃~+15℃: +/-2dB;<br><br>+15℃~+30℃: +/-2dB;<br><br>+30℃~+55℃: +/-2dB |
| 4 | Carrier Bandwidth | 5G NR:15/30MHz |
| 5 | Subcarrier Spacing | 15KHz/30KHz |
| 6 | EVM | ""QPSK:<18.5%, 16QAM:<13.5%, 64QAM:<5%, 256QAM:<3.5%"" |
| 7 | ACLR | <-45dBc |
| 8 | Frequency Error | <0.05ppm |
| 9 | RF Power Configuration Range | >10dB |

| No. | Parameter | Specification |
|---|---|---|
| 10 | In-band Spurious | TS 38.104&&TS 38.141 6.6.4.2.2.1 Category B |
| 11 | Spurious Emission | TS 38.104&&TS 38.141 6.6.5.2.1 Category B |
| 12 | Sensitivity | -97dBm@room temp<br>-95dBm@over temp |
| 13 | RSSI Measurement Accuracy | +/-3dB@-55dBm~-77dBm |

The following tables introduce key performance indicators of AISWare AgileNet-RAN A21.

**Table 5-10 AISWare AgileNet-RAN A21 Specifications**

| No. | Parameter | Specification |
|---|---|---|
| 1 | Power Consumption | <350W |
| 2 | Timing Source | GPS/BD/1588v2 |
| 3 | External Power Supply Voltage | AC: 220V |
| 4 | Interfaces | 2* 10G Optical Ports, 1* Power Input Port, 1* GPS Antenna Port, 2* RF Main Antenna Ports |
| 5 | Indicators | Power, Transmission Link, Fiber Interface |
| 6 | Basic Functions | Supports system internal switching with NG/Xn interfaces; supports MOCN; supports VONR |
| 7 | Number of Cells | 1 |
| 8 | RRC Connected Users | 200 per cell |
| 9 | RRC Active Users | 100 per cell |

| No. | Parameter | Specification |
|---|---|---|
| 10 | Antenna Channels | 2T2R |
| 11 | Transmit Power | 40W per channel |
| 12 | Downlink Peak Rate | 400Mbps @40MHz 256QAM 2 Streams 1 DMRS |
| 13 | Uplink Peak Rate | 200Mbps @40MHz 256QAM 1 Streams 1 DMRS |
| 14 | Operating Temperature | -40~+55℃ |
| 15 | Operating Humidity | 5%~95% |
| 16 | Dimensions (mm) | 402*328*195.2 (including maximum connector dimensions)<br>382*285*195.2 (effective dimensions) |
| 17 | Weight (kg) | <18 |
| 18 | Volume (L) | <21 |

**Table 5-11 AISWare AgileNet-RAN A21 RF Specifications**

| No. | Parameter | Specification |
|---|---|---|
| 1 | Operating Frequency | N1 (Uplink: 1920~1975 MHz; Downlink: 2110~2165MHz) |
| 2 | Duplex Mode | FDD |
| 3 | Output Power Accuracy | Within ±1.5dB of rated transmission power for RRU over entire temperature range |
| 4 | Carrier Bandwidth | 5G<br>NR:10MHz/15MHz/20MHz/30MHz/40MHz |
| 5 | Subcarrier Spacing | 15KHz |

| No. | Parameter | Specification |
|---|---|---|
| 6 | EVM | EVM is less than 3.5% when using 256QAM modulation and transmitting at maximum power |
| 7 | ACLR | <-45dBc |
| 8 | Frequency Error | ±(0.05 ppm + 12 Hz) |
| 9 | RF Power Configuration Range | >20dB |
| 10 | In-band Spurious | TS 38.141 6.6.4.2.2.1 Category B |
| 11 | Spurious Emission | TS 38.141 6.6.5.2.1 Category B |
| 12 | Sensitivity | -97dBm@room temp<br>-95dBm@over temp |
| 13 | RSSI Measurement Accuracy | +/-3dB@-55dBm~-77dBm |

**Table 5-12 AISWare AgileNet-RAN-BA7 Specifications**

| No. | Parameter | Specification |
|---|---|---|
| 1 | Operating Frequency | N28 (Uplink: 703~748 MHz; Downlink: 758~803MHz) |
| 2 | Duplex Mode | FDD |
| 3 | Sector Capacity | Supports 1 × 2T2R sector (can be split into 2 × 1TR to expand capacity) |
| 4 | Number of Users per Sector | Each sector supports 128 RRC connected users, 64 active users |
| 5 | | 20MHz bandwidth: downlink 205Mbps, uplink 84Mbps<br>30MHz bandwidth: downlink 310Mbps, uplink 127Mbps |

| No. | Parameter | Specification |
|---|---|---|
| | Peak Rate | |
| 6 | Maximum Transmission Power | 2 channels, each channel 250mW |
| 7 | Synchronization Method | Supports IEEE1588v2 time synchronization |
| 8 | Dimensions (L×W×H) | 300mm*200mm*81mm；<br><br>Without mounting ears |
| 9 | Optical Port | 2 × 10G ports, supports base station cascading |
| 10 | Weight | ＜5kg |
| 11 | Coverage | When a single base station is split into 2 × 1TR for use, each pointing in a fixed direction, coverage distance is 800m (with 10dBi antenna gain), supports voice and data services |
| 12 | Power Supply | 2 × DC 12V power inputs, voltage tolerance ±10%, max current 1.8A |
| 13 | Antenna | External antenna connection |
| 14 | Operating Temperature | Long-term operating temperature: -40°C to +50°C |
| 15 | Operating Humidity | 10%～95% |

## 5.2.3 Distributed Macro Base Stations

AISWare AgileNet-RAN M35/M49 combines the BBU and RRU, connected via optical fiber. The BBU can be co-located with core network equipment or deployed separately, linking to the remote RRU via optical fiber, enabling flexible networking for reliable 5G coverage in outdoor private network scenarios.

Key features of the Distributed Macro Base Station:

● Easy deployment, flexible networking, and low maintenance costs, reducing construction and operational pressures

● Distributed deployment with fiber-optic connection between BBU and RRU, minimizing RF cable loss

● Supports 4-stream downlink and 2-stream uplink per cell, enhancing system capacity and user experience



**Figure 5-6 RRU&BBU**

Table 5-13 and Table 5-14 introduce key performance indicators of AISWare AgileNet-RAN M35.

**Table 5-13 AISWare AgileNet-RAN M35 BBU Specifications**

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 1 | Size | 438mm x 400mm x 44mm |

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 2 | Weight | ~6.5kg |
| 3 | Power Supply | AC 220V/DC -48V |
| 4 | Chassis Protection | IP20, suitable for indoor environments |
| 5 | Installation Method | Standard rack |
| 6 | Cooling Method | Air cooling |
| 7 | Operating Temperature | -5°C to +55°C |
| 8 | Power Consumption | <350W |
| 9 | Number of Cells | 2 cells x 4T4R |
| 10 | RRC Connected Users | 1200 per cell |
| 11 | RRC Active Users | 400 per cell |

**Table 5-14 AISWare AgileNet-RAN M35 RRU Specifications**

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 1 | Operating Frequency | N78: 3400~3600MHz |
| 2 | OBW | OBW: 200MHz |
| 3 | IBW | IBW: 60/80/100MHz |
| 4 | RF Channels | 4T4R |
| 5 | Output Power | 4*40W |
| 6 | Error Vector Magnitude | 256QAM:<3.5% |
| 7 | Frequency Error | ≤0.01ppm |
| 8 | ACLR | ≤-45dBc |

| No. | Parameter | Specification |
|---|---|---|
| 9 | Spurious Emission | Comply with 3GPP standards |
| 10 | Receiver Sensitivity | Comply with 3GPP standards |
| 11 | Blocking | Comply with 3GPP standards |
| 12 | Electric Downtilt Antenna | AISG 2.0 |
| 13 | Power Supply | Supports DC -48V (-40.5V to -58.5V) |
| 14 | Power Consumption | <420W |
| 15 | Operating Temperature | -40~+55°C |
| 16 | Operating Humidity | 5%~100% |
| 17 | Protection | IP65 |
| 18 | Weight | 10kg |
| 19 | Volume | 10L |
| 20 | Lightning Protection | Meets the requirements of YD/T 2324-2011 |

The following tables introduce key performance indicators of AISWare AgileNet-RAN M49.

**Table 5-15 AISWare AgileNet-RAN M49 BBU Specifications**

| No. | Parameter | Specification |
|---|---|---|
| 1 | Size | 438mm x 400mm x 44mm |
| 2 | Weight | Approximately 6.5kg |
| 3 | Power Supply | AC 220V/DC -48V |
| 4 | Chassis Protection | IP20, suitable for indoor environments |

| No. | Parameter | Specification |
|---|---|---|
| 5 | Installation Method | Standard rack |
| 6 | Cooling Method | Air cooling |
| 7 | Operating Temperature | -5℃~+55℃ |
| 8 | Power Consumption | <350W |
| 9 | Number of Cells | 2cells x 4T4R |
| 10 | RRC Connected Users | 1200 per cell |
| 11 | RRC Active Users | 400 per cell |

**Table 5-16 AISWare AgileNet-RAN M49 RRU Specifications**

| No. | Parameter | Specification |
|---|---|---|
| 1 | Operating Frequency | N79: 4800~5000MHz |
| 2 | OBW | OBW: 200MHz |
| 3 | IBW | IBW: 60/80/100MHz |
| 4 | RF Channels | 4T4R |
| 5 | Output Power | 4*20W |
| 6 | Error Vector Magnitude | 256QAM:<3.5% |
| 7 | Frequency Error | ≤0.01ppm |
| 8 | ACLR | <-45dBc |
| 9 | Spurious Emission | Comply with 3GPP standards |
| 10 | Receiver Sensitivity | Comply with 3GPP standards |

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 11 | Blocking | Comply with 3GPP standards |
| 12 | Electric Downtilt Antenna | AISG 2.0 |
| 13 | Power Supply | Supports DC -48V (-40.5V to -58.5V) |
| 14 | Power Consumption | <310W |
| 15 | Operating Temperature | -40~+55°C |
| 16 | Operating Humidity | 5%~100% |
| 17 | Protection | IP65 |
| 18 | Weight | 10kg |
| 19 | Volume | 10L |
| 20 | Lightning Protection | Meets the requirements of YD/T 2324-2011 |

## 5.2.4 ISAC$^2$ Base Station

AISWare AgileNet-RAN-ISAC$^2$ integrates edge intelligent computing and wireless sensing capabilities, enabling flexible combinations to support AI applications and target recognition at the user edge. The baseband unit (BBU) supports mainstream AI accelerator cards, delivering edge intelligence services such as large model inference. The radio units (pRRU/RRU) provide sensing capabilities for both indoor and outdoor environments. During deployment, the BBU can be co-located with the core network or deployed independently, connected via optical fiber to remote radio units, enabling flexible networking and seamless, reliable 5G coverage for outdoor private network scenarios.

Key Features of the ISAC$^2$ Base Station:

● Dynamically optimizes network performance and enhances spectrum efficiency using AI/ML and intelligent computing hardware.

- Transforms RAN infrastructure into AI computing nodes, fostering an open ecosystem and creating new business opportunities for operators.

- Integrates AI with RAN processes to maximize infrastructure utilization.



**Figure 5-7 ISAC$^2$ Base Station**

The following table outlines the key performance indicators of the AISWare AgileNet-RAN-ISAC² product.

**Table 5-17 ISAC$^2$ Base Station Specifications**

| No. | Parameter | Specification |
|---|---|---|
| 1 | BBU Intelligent Memory | Single BBU supports 48GB intelligent memory |
| 2 | BBU Computing Power | INT8: 240 TFLOPS, FP16: 120 TFLOPS |
| 3 | Detection Range | Indoor detection range: ±6m; Outdoor: 240–500m |
| 4 | Doppler Accuracy | 0.08 m/s (outdoor) |

| 5 | Distance Resolution | 7.5cm–105cm |
|---|---|---|
| 6 | Capacity | Up to 400 RRC connected active users per cell |
| 7 | Peak Rate | Uplink ≥ 750 Mbps, Downlink ≥ 230 Mbps (per small cell) |
| 8 | CAPS Users | Under 100 MHz bandwidth, CAPS attempts ≥ 60 users, with success rate ≥ 99% |
| 9 | VoNR Users | 100 MHz bandwidth, supports HD VoNR voice (24.4 kbps), up to 200 users |

## 5.2.5 RAN OMC

The Unified Operation and Maintenance Center for Radio Network (UOMC-R) provides centralized management of radio base stations and a unified web-based O&M system. It supports AISWare AgileNet-RAN S1/S2/S3/S49, S4/A21, and third-party base stations that comply with mobile interface standards. The UOMC-R integrates northbound interfaces with higher-level network management systems, ensuring unified monitoring and management of private networks.

On the southbound side, the UOMC-R provides functionalities such as access, configuration, performance monitoring, alarms, resource management, security, logging, MR measurements, and signaling tracking for base stations.

On the northbound side, the UOMC-R interfaces with higher-level network management or private network operations platform to meet the FCAPS/SLA standards. It also integrates with enterprise platforms through open APIs to address specific operational needs.
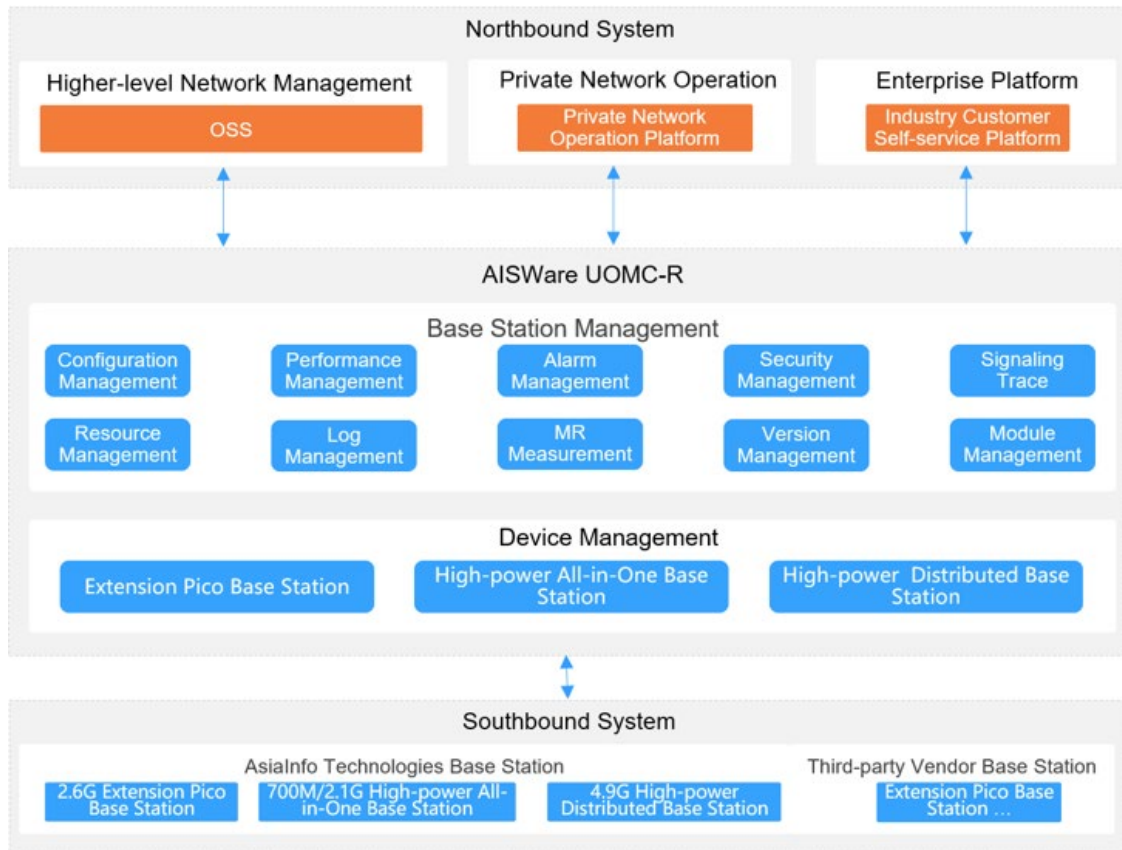
**Figure 5-8 UOMC Architecture**

# 5.3 Intelligent Link

## 5.3.1 Intelligent Link Switch

AISWare iLinkS offers three versions—Standard, Advanced, and Professional, Intrinsically Safe—tailored to various P5G interoperability needs.

Key features include:

- High Reliability: Modular power supplies with field-replacement capability, 2+2 backup, intelligent fan speed control, and real-time monitoring of chipset temperature, power, and fan status

- Comprehensive Security: User, switch, and network-level security policies; IPv4/IPv6 ACLs that match Layer 2, 3, and 4 information in a single rule

- Rich QoS Management: Supports SDN via open APIs, simplifying network management and maintenance

- SDN Architecture: Supports SDN via open API, significantly simplifies network management and maintenance

- Energy Efficiency: Intelligent fan speed control and real-time power consumption monitoring to reduce operational costs and improve energy efficiency

- Data Center Features: Supports priority-based flow control, MLAG for cross-device aggregation, and overlay tunnel technologies like VXLAN and NVGRE



**Figure 5-9 AISWare iLinkS (Standard Version)**

**Table 5-18 AISWare iLinkS (Standard Version) Specifications**

| No. | Parameter | Specification |
| --- | --- | --- |
| 1 | Switching Capacity | 208 Gbps |
| 2 | Packet Forwarding Rate | 155 Mpps |
| 3 | Ports | 24*10/100/1000Mb Base-T, 8*10GbE SFP+ |
| 4 | System Security | AAA, ACL, ARP detection, IP source protection, port security, VLAN security, CPU traffic limit, anti-DDoS attack, link flapping detection, etc. |
| 5 | Maximum MLAG Groups | 63 |
| 6 | VLAN Division | Based on port, MAC, subnet, protocol |
| 7 | Tunnels | VxLAN, GRE, NVGRE, GENEVE |
| 8 | PTP | IEEE 1588 |
| 9 | VxLAN | Supports distributed gateway, dual-active access<br>Supports modification of outer header DSCP<br>Supports modification of inner header Ethertype<br>Supports BGP EVPN<br>Supports horizontal segmentation |

| No. | Parameter | Specification |
|---|---|---|
| 10 | QoS | 10 hardware queues per port<br>Supports multi-level scheduling congestion protection mechanisms<br>Queue scheduling algorithms for traffic shaping<br>Intelligent bandwidth monitoring for ingress and egress directions |
| 11 | Fans | 2 units, intelligent speed control |
| 12 | Serial Port | 1*RJ45 |
| 13 | Management Port | 1*RJ45 out-of-band management port |
| 14 | USB | 1*standard USB port |
| 15 | Power Supply | Dual power supply, hot-swappable |
| 16 | Input Voltage | AC<br>Operating Voltage: 100 ~ 240V; 50/60Hz<br>Maximum Voltage: 90 ~ 264V; 47~63Hz<br>DC<br>Maximum Voltage Range: -48 ~ -60V |
| 17 | Maximum Power Consumption | 55W |
| 18 | Operating Temperature | 0 to 45 $^{\circ}$C |
| 19 | Storage Temperature | -40 to 70 $^{\circ}$C |
| 20 | Relative Humidity | 0 to 95% |
| 21 | Dimensions | 4.4 x 44.2 x 24.5 cm |
| 22 | Weight | 3.50KG |

**Figure 5-10 AISWare iLinkS (Advanced Version)**

**Table 5-19 AISWare iLinkS (Advanced Version) Specifications**

| No. | Parameter | Specification |
|---|---|---|
| 1 | Switching Capacity | 1.44 Tbps |
| 2 | Packet Forwarding Rate | 1071.4 Mpps |
| 3 | Ports | 48*10GbE SFP+, 6*40GbE QSFP+ |
| 4 | System Security | AAA, ACL, ARP detection, IP source protection, port security, VLAN security, CPU traffic limit, anti-DDoS attack, link flapping detection, etc. |
| 5 | Maximum MLAG Groups | 63 |
| 6 | VLAN Division | Based on port, MAC, subnet, protocol |
| 7 | Tunnels | VxLAN, GRE, NVGRE, GENEVE |
| 8 | PTP | IEEE 1588 |
| 9 | VxLAN | Supports distributed gateway, dual-active access<br>Supports modification of outer header DSCP<br>Supports modification of inner header Ethertype<br>Supports BGP EVPN<br>Supports horizontal segmentation |
| 10 | QoS | 10 hardware queues per port<br>Supports multi-level scheduling congestion protection mechanisms<br>Queue scheduling algorithms for traffic shaping<br>Intelligent bandwidth monitoring for ingress and egress directions |
| 11 | Fans | 4 units, supports 2+2 backup and intelligent speed control, hot-swappable |
| 12 | Serial Port | 1*RJ45 |
| 13 | Management Port | 1*RJ45 out-of-band management port |
| 14 | USB | 1*standard USB port |
| 15 | Power Supply | Dual power supply, hot-swappable |
| 16 | Input Voltage | AC<br>Operating Voltage: 100 ~ 240V; 50/60Hz<br>Maximum Voltage: 90 ~ 264V; 47~63Hz<br>DC<br>Maximum Voltage Range: -40 ~ -72V |

| No. | Parameter | Specification |
|---|---|---|
| 17 | Maximum Power Consumption | 145W |
| 18 | Operating Temperature | 0 to 45 °C |
| 19 | Storage Temperature | -40 to 70 °C |
| 20 | Relative Humidity | 0 to 95% |
| 21 | Dimensions | 4.4 x 44.2 x 45.1 cm |
| 22 | Weight | 8.15KG |

**Figure 5-11 AISWare iLinkS (Professional Version)**

**Table 5-20 AISWare iLinkS (Professional Version) Specifications**

| No. | Parameter | Specification |
|---|---|---|
| 1 | Switching Capacity | 4 Tbps |
| 2 | Packet Forwarding Rate | 2976 Mpps |
| 3 | Ports | 8*25GbE SFP28, 8*100GbE QSFP28 |
| 4 | System Security | AAA, ACL, ARP detection, IP source protection, port security, VLAN security, CPU traffic limit, anti-DDoS attack, link flapping detection, etc. |
| 5 | Maximum MLAG Groups | 63 |
| 6 | VLAN Division | Based on port, MAC, subnet, protocol |
| 7 | Tunnels | VxLAN, GRE, NVGRE, GENEVE |
| 8 | PTP | IEEE 1588 |
| 9 | VxLAN | Supports distributed gateway, dual-active access Supports modification of outer header DSCP Supports modification of inner header Ethertype Supports BGP EVPN Supports horizontal segmentation |
| 10 | QoS | 10 hardware queues per port Supports multi-level scheduling congestion protection mechanisms Queue scheduling algorithms for traffic shaping Intelligent bandwidth monitoring for ingress and egress directions |

| No. | Parameter | Specification |
|---|---|---|
| 11 | Fans | 4 units, supports 2+2 backup and intelligent speed control, hot-swappable |
| 12 | Serial Port | 1*RJ45 |
| 13 | Management Port | 1*RJ45 out-of-band management port |
| 14 | USB | 1*standard USB port |
| 15 | Power Supply | Dual power supply, hot-swappable |
| 16 | Input Voltage | AC<br>Operating Voltage: 100 ~ 240V; 50/60Hz<br>Maximum Voltage: 90 ~ 264V; 47~63Hz<br>DC<br>Maximum Voltage Range: -40 ~ -72V |
| 17 | Maximum Power Consumption | 160W |
| 18 | Operating Temperature | 0 to 45 $^{o}$C |
| 19 | Storage Temperature | -40 to 70 $^{o}$C |
| 20 | Relative Humidity | 0 to 95% |
| 21 | Dimensions | 4.4 x 44.2 x 45.1 cm |
| 22 | Weight | 8.85KG |



**Figure 5-12 AISWare iLinkS (Intrinsically Safe)**

**Table 5-21 AISWare iLinkS (Intrinsically Safe) Specifications**

| No. | Parameter | Specification |
|---|---|---|
| 1 | Switching Capacity | 128Gbps |
| 2 | Packet Forwarding Rate | 83 Mpps |
| 3 | Ports | 8x1GE Combo, 4*10GE SFP+ |
| 4 | System Security | Supports port rate limiting, storm control, port aggregation, and flow control; supports ACL for filtering L2-L7 data; supports SP and WRR queue scheduling. |
| 5 | VLAN Division | Supports VLAN |
| 6 | Tunnels | VxLAN, GRE, NVGRE, GENEVE |
| 7 | PTP | IEEE 1588 |

| No. | Parameter | Specification |
|---|---|---|
| 8 | Routing | Supports RIPv1/v2, RIPng, OSPFv1/v2, and static routing protocols. |
| 9 | Management&Maintenance | Supports Console, Telnet, and WEB-based management and RMON. supports SNMPv1/v2c and centralized management via MaxView; supports FTP and TFTP for file transfer and software upgrades. supports power failure alarm, power alarm, port alarm, and loop storm alarm. supports port mirroring, Syslog, LLDP, RTC, SNTPv4 IP. Supports DHCP server/relay/client |
| 10 | Fans | Fanless cooling with aluminum alloy single-rib chassis design |
| 11 | Power Supply | Dual power supply |
| 12 | Input Voltage | DC12/24V |
| 13 | Maximum Power Consumption | 20W |
| 14 | Operating Temperature | -40°C~+70°C |
| 15 | Storage Temperature | -40°C~+85°C |
| 16 | Relative Humidity | 5%~95% |
| 17 | Dimensions | 185mm×63mm×135mm |
| 18 | Weight | Approx. 1Kg |

## 5.3.2 Intelligent Link Switch Management

AISWare iLinkS-Manager provides unified management, O&M, and configuration of iLink Switches and third-party devices, enabling rapid online connectivity and simplifying network operations.

The architecture of AISWare iLinkS-Manager is illustrated in Figure 5-12. It supports southbound protocols such as SNMP, NETCONF, REST, and Telemetry for data collection and access. The system offers capabilities for resource management, alarm analysis, performance monitoring, QoS configuration, and one-click network provisioning, optimizing O&M efficiency.
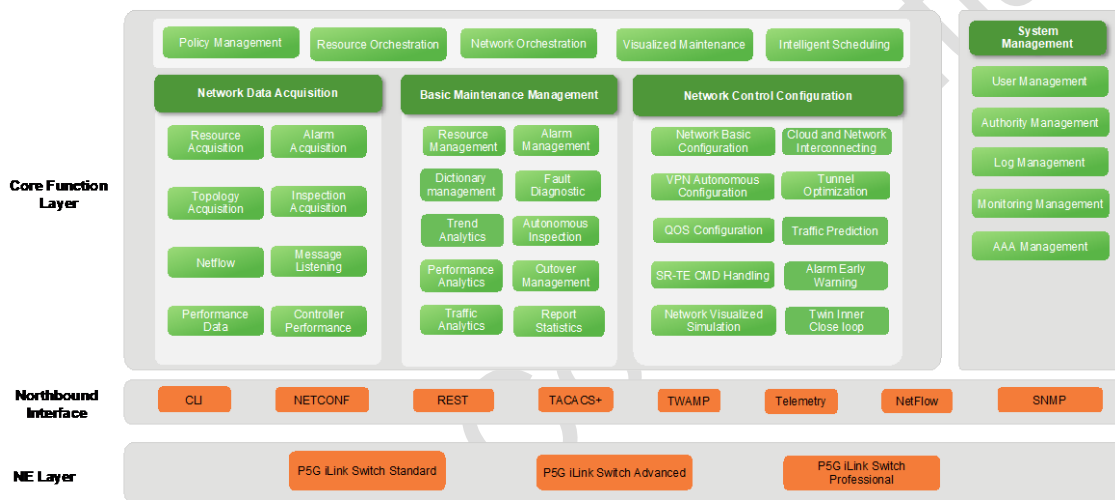


**Figure 5-13 AISWare iLinkS-Manager Architecture**

## 5.3.3 Intelligent Link Gateway

AISWare iLinkG offers three device models—Small Branch, Medium Branch, and Small Aggregation—designed for various P5G scenarios.

Key features include:

- Graphical Orchestration: Visual resource management and configuration delivery, simplifying service provisioning

- Intelligent Routing: Real-time link monitoring and intelligent switching based on latency, jitter, and other parameters to ensure SLA compliance

- Status Visibility: Real-time network element and tunnel monitoring, with automatic alarm detection and classification to aid network diagnostics and simplify O&M

- Multi-Tenant Isolation: Complete tenant data isolation using multi-tenant IPSec VPN capabilities, enabling differentiated forwarding

- Secure and Flexible: Dual WAN port protection and failover, end-to-end data encryption, and flexible radio access (including LTE/5G)

- Hierarchical Permissions: Configurable account permissions for isolating administrators, distributors, and customers



**Figure 5-14 AISWare iLinkG (Small Branch)**

**Table 5-22 AISWare iLinkG (Small Branch) Specifications**

| No. | Parameter | Specification |
|---|---|---|
| 1 | CPU | 2 cores |
| 2 | Memory | 2GB |
| 3 | Storage | 32GB |
| 4 | Virtualization | Supported |
| 5 | SDN/NFV | DPDK, OVS, VPP, OpenStack agent |
| 6 | IPSec Hardware Encryption | Supported |
| 7 | Network Ports | 5*GbE |
| 8 | LTE/5G | Optional |
| 9 | WIFI | Optional |
| 10 | VPN | IPSec, VxLAN, PPTP, L2TP, GRE, OpenVPN, VxLAN over IPSec, SRv6 |
| 11 | QoS | Supports flow classification, flow marking, flow policy, CAR, Shaping, congestion avoidance, congestion management, queue scheduling technologies including WRED, PQ, CQ, WFQ |
| 12 | USB | 1*USB3.0 |
| 13 | Antenna | LTE:2, 5G:4, WIFI:2 |
| 14 | Operating Environment | Indoor |
| 15 | Operating Temperature | -10°C to 45°C |
| 16 | Storage Temperature | -40°C to 70°C |
| 17 | Dimensions | 173mm*115mm*30mm |
| 18 | Power Supply | DC 12V 3A |
| 19 | Weight | 0.7kg |

**Figure 5-15 AISWare iLinkG (Medium Branch)**

**Table 5-23 AISWare iLinkG (Medium Branch) Specification**

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 1 | CPU | 4 core |
| 2 | Memory | 4GB |
| 3 | Storage | 32GB |
| 4 | Virtualization | Supported |
| 5 | SDN/NFV | DPDK, OVS, VPP, OpenStack agent |
| 6 | IPSec Hardware Encryption | Supported |
| 7 | Network Ports | 5*GbE |
| 8 | LTE/5G | Optional |
| 9 | WIFI | Optional |
| 10 | VPN | IPSec, VxLAN, PPTP, L2TP, GRE, OpenVPN, VxLAN over IPSec, SRv6 |
| 11 | QoS | Supports flow classification, flow marking, flow policy, CAR, Shaping, congestion avoidance, congestion management, queue scheduling technologies including WRED, PQ, CQ, WFQ |
| 12 | USB | 1*USB3.0 |
| 13 | Antenna | LTE:2, 5G:4, WIFI:2 |
| 14 | Operating Environment | Indoor |
| 15 | Operating Temperature | 0°C to 55°C |
| 16 | Storage Temperature | -20°C to 70°C |
| 17 | Dimensions | 270mm*180mm*33.5mm |
| 18 | Power Supply | DC 12V 3A |
| 19 | Weight | 1.6kg |



**Figure 5-16 AISWare iLinkG (Small Aggregation)**

**Table 5-24 AISWare iLinkG (Small Aggregation) Specifications**

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 1 | CPU | 8 core |
| 2 | Memory | 16G |
| 3 | Storage | 32GB |

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 4 | Virtualization | Supported |
| 5 | SDN/NFV | DPDK, OVS, VPP, OpenStack agent |
| 6 | IPSec Hardware Encryption | Supported |
| 7 | Network Ports | 2 combo ports, 4*GbE Ethernet ports |
| 8 | LTE/5G | NA |
| 9 | WIFI | NA |
| 10 | VPN | IPSec, VxLAN, PPTP, L2TP, GRE, OpenVPN, VxLAN over IPSec, SRv6 |
| 11 | QoS | Supports flow classification, flow marking, flow policy, CAR, Shaping, congestion avoidance, congestion management, queue scheduling technologies including WRED, PQ, CQ, WFQ |
| 12 | USB | 2*USB2.0 |
| 13 | Antenna | NA |
| 14 | Operating Environment | Indoor |
| 15 | Operating Temperature | 0°C to 50°C |
| 16 | Storage Temperature | -20°C to 70°C |
| 17 | Dimensions | 212mm*179mm*44.5mm |
| 18 | Power Supply | DC 12V 5A |
| 19 | Weight | 1.16kg |

## 5.3.4 Intelligent Link Gateway Management

AISWare iLinkG-Manager centralizes the management of gateway devices, enabling unified configuration deployment across multiple sites. The platform supports zero-touch configuration, offering features like topology and traffic visualization, intelligent routing, and template configuration.

As shown in Figure 5-17, AISWare iLinkG-Manager supports southbound protocols such as SNMP, REST, and OVSDB for data collection and access, providing management of gateway resources, alarms, performance, visual configuration, and tunnel management for efficient O&M.
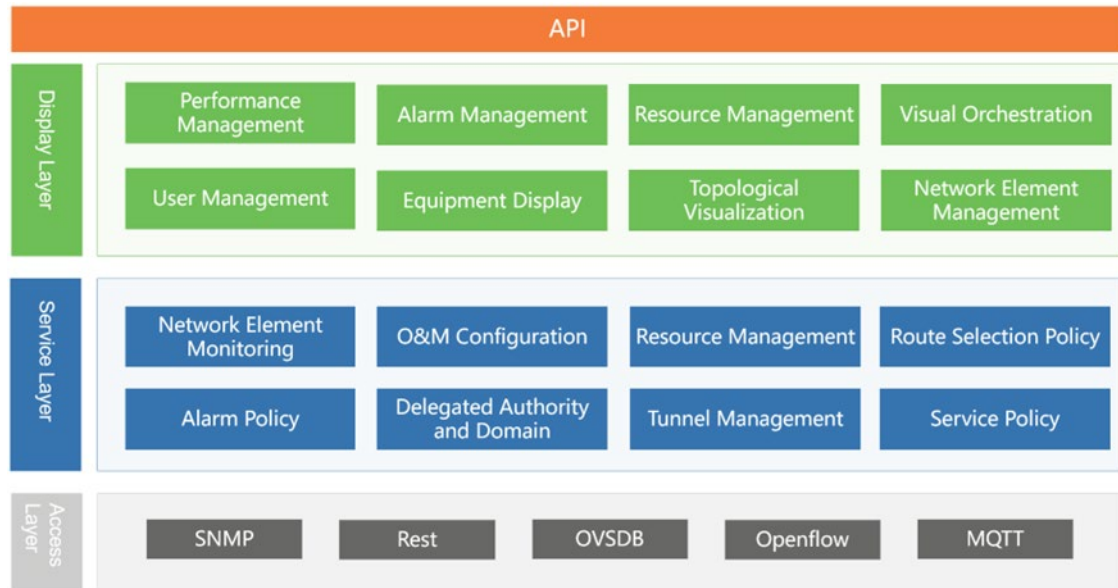
**Figure 5-17 AISWare iLinkG-Manager Architecture**

## 5.4 5G CPE

AISWare AgileNet-5G CPE provides secure and flexible access for various industry terminals to P5G, with standard, high-power, and industrial-grade versions. It supports integration and data transmission for Wi-Fi, wired, and IoT terminals.

Key Features of 5G CPE:

- 5G LAN: Offers flexible and secure Layer-2 interoperability capabilities

- Dual-Transmission with Selective Reception: Provides dual 5G links or a hybrid 5G + wired dual-link to enhance network reliability.

- High Transmission Power: Extends wireless coverage, suitable for harsh environments

- Quality Probes: Collects and reports real-time terminal data, operational metrics, and events

- Terminal Security and Traffic Control: Ensures secure access and traffic management with core network UPF

- Universal Terminal Access: Supports Wi-Fi, wired, and IoT connections

- Industrial-Grade: With wide temperature tolerance, dust and water resistance, and TSN support



**Figure 5-18 AISWare AgileNet-5G CPE (Standard Version)**

**Table 5-25 5G CPE (Standard Version) Specifications**

| No. | Parameter | Specification |
|---|---|---|
| 1 | 5G Frequency Bands | n1/n2/n3/n5/n7/n8/n20/n28/n41/n66/n71/n77/n78/n79 |
| 2 | 5G Antenna | 4*4 MIMO |
| 3 | WIFI Antenna | 2*2 MIMO |
| 4 | Ports | 1*WAN/4*LAN (10/1000/1000Mbps) |
| 5 | Serial Ports | 1*RS232, 1*RS485 |
| 6 | Network Protocols | PPTP, L2TP, IPSEC VPN, TCP, UDP, DHCP, HTTP, DDNS, TR-069, GRE, HTTPS, SSH, Open VPN, SNMP, etc. |
| 7 | 5G Bandwidth | Downlink up to 2.1 Gbps, Uplink up to 900 Mbps |
| 8 | Transmit Power | 23dBm ± 2dB |
| 9 | Wi-Fi Frequency Bands | 2.4G/5GHz Dual-band |
| 10 | SIM | 2 SIM card slots |
| 11 | GNSS | GPS, GLONASS, Beidou, Galileo (optional) |
| 12 | Power Supply Range | DC Input: +6/2.5A ~ 36V/0.5A |
| 13 | Operating Temperature | -30$^{o}$C ~ +70ºC |
| 14 | Storage Temperature | -35$^{o}$C ~ +75ºC |
| 15 | Humidity | 5% ~ 95% |
| 16 | Power Consumption | ≤5.64W |
| 17 | Protection Level | IP30 |
| 18 | Dimensions | 155mm*105mm*25mm |
| 19 | Installation Method | Desktop or rail mount |

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 20 | Weight | 225g |
| 21 | 5G LAN | Supported |



**Figure 5-19 AISWare AgileNet-5G CPE (High-Power Version)**

**Table 5-26 AISWare AgileNet-5G CPE (High-Power Version) Specifications**

| No. | Parameter | Specification |
|-----|-----------|---------------|
| 1 | 5G Frequency Bands | n1/n2/n3/n5/n7/n8/n12/n13/n14/n18/n20/n25/n26/n28/n29/n30/n38/n40/n41/n48/n66/n70/n71/n75/n76/n77/n78/n79 |
| 2 | 5G Antenna | 4*4 MIMO |
| 3 | WIFI Antenna | 2*2 MIMO |
| 4 | Ports | 1*WAN/LAN 2.5G, 1* LAN (10/1000/1000Mbps) |
| 5 | Serial Ports | 1*RS232,1*RS485 |
| 6 | Network Protocols | PPTP, L2TP, IPSEC VPN, TCP,UDP, DHCP, HTTP, DDNS, TR-069, GRE, HTTPS, SSH, Open VPN, SNMP, etc. |
| 7 | 5G Bandwidth | 1Gbps |
| 8 | Transmit Power | 37dBm |
| 9 | Wi-Fi Frequency Bands | 2.4G/5GHz Dual-band |
| 10 | SIM | 2 SIM card slots |
| 11 | GNSS | GPS, GLONASS, Beidou, Galileo |
| 12 | Power Supply Range | DC 12~36V |
| 13 | Operating Temperature | -40°C ~ +70°C |
| 14 | Storage Temperature | -40°C ~ +85°C |
| 15 | Humidity | 5% ~ 95% |
| 16 | Power Consumption | <24W |
| 17 | Protection Level | IP67 |
| 18 | Dimensions | 259 x 178 x 48 (mm) |
| 19 | Installation Method | Pole mount |
| 20 | Weight | 2KG |
| 21 | 5G LAN | Supported |

| No. | Parameter | Specification |
|---|---|---|
| 22 | Frequency/PCI Lock | Supported |



**Figure 5-20 AISWare AgileNet-5G CPE (Industrial-Enhanced Version)**

**Table 5-27 AISWare AgileNet-5G CPE (Industrial-Enhanced Version) Specifications**

| No. | Parameter | Specification |
|---|---|---|
| 1 | 5G Frequency Bands | n1/n2/n3/n5/n7/n8/n12/n13/n14/n18/n20/n25/n26/n28/n29/n30/n38/n40/n41/n48/n66/n70/n71/n75/n76/n77/n78/n79 |
| 2 | 5G Antenna | 4*4 MIMO |
| 3 | WIFI Antenna | 2*2 MIMO |
| 4 | Ports | 1*WAN/LAN 2.5G, 1* LAN (10/1000/1000Mbps) |
| 5 | Serial Ports | 1*RS232,1*RS485 |
| 6 | Network Protocols | PPTP, L2TP, IPSEC VPN, TCP, UDP, DHCP, HTTP, DDNS, TR-069, GRE, HTTPS, SSH, Open VPN, SNMP, etc. |
| 7 | 5G Bandwidth | 1Gbps |
| 8 | Transmit Power | 37dBm |
| 9 | Wi-Fi Frequency Bands | 2.4G/5GHz Dual-band |
| 10 | SIM | 2 SIM card slots |
| 11 | GNSS | GPS, GLONASS, Beidou, Galileo |
| 12 | Power Supply Range | DC 12~36V |
| 13 | Operating Temperature | -40°C ~ +70°C |
| 14 | Storage Temperature | -40°C ~ +85°C |
| 15 | Humidity | 5% ~ 95% |
| 16 | Power Consumption | <24W |
| 17 | Protection Level | IP67 |
| 18 | Dimensions | 259 x 178 x 48 (mm) |
| 19 | Installation Method | Pole mount |
| 20 | Weight | 2KG |
| 21 | 5G LAN | Supported |
| 22 | Industrial Grade Features | Wide temperature range, dustproof, waterproof, TSN, anti-corrosion |

## 5.5 Operations Platform

AISWare AgileNet-OM is built on private network infrastructure and offers differentiated network provisioning and service operations for industry customers. It supports end-to-end self-operation and intelligent O&M for vertical industries, driving 5G+ digital operations. Key features include:

- SIM Card Management: Manages the lifecycle of P5G IoT SIM cards, tracks traffic consumption, and monitors IP addresses, empowering refined and digital operations in industrial parks

- Device Management: Manages and monitors P5G and smart service devices, integrates with industry ecosystems, and deploys probes for edge data collection

- Centralized Management: One-stop provisioning for private networks, member sign-ups, industrial 5G LAN group agreements, and TSN policy configuration, enabling seamless IoT service activation

- Application Management: Coordinates deployment of edge applications within private networks, facilitating nearby deployment and load balancing

- Network Monitoring: Enables comprehensive monitoring of private networks, network slices, and DNNs, along with topology reconstruction, offering insights into network quality

- Service Monitoring: Delivers end-to-end connection analysis and awareness tailored to typical ToB business scenarios built on network monitoring

- Fault Detection: Uses AI algorithms with probe, test, performance, and alarm data to automatically detect service faults and degradation trends, trace root causes, and simplify O&M

- Inspection and Testing: Uses self-developed probes to verify connectivity and proactively measure service quality, supporting fault segmentation and quality assurance in 5G private networks

- Security Authentication: Enhances access security through CPE-level device control and DN-AAA-based service authentication
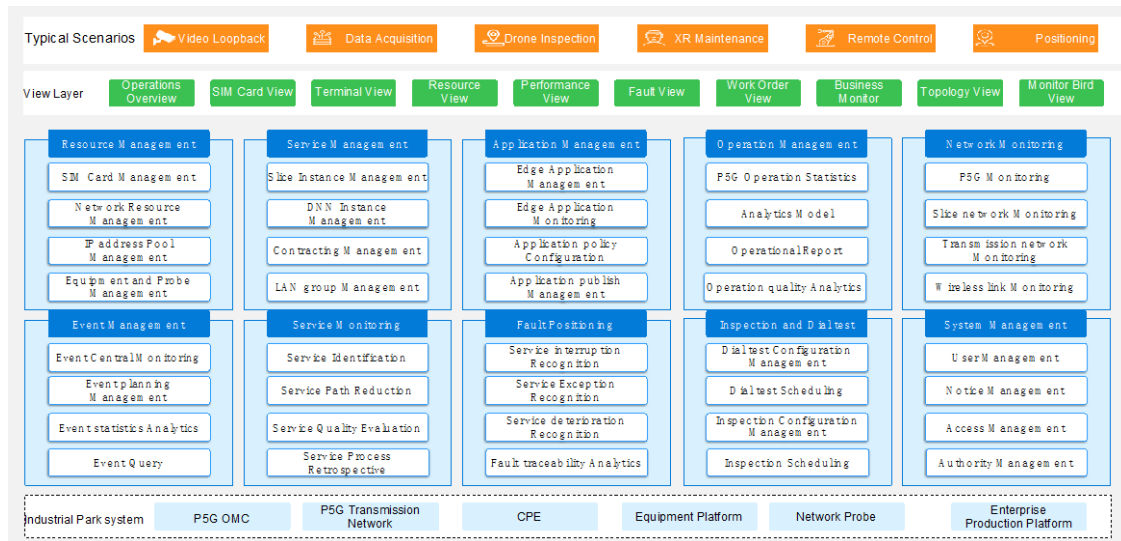
**Figure 5-21 AISWare AgileNet-OM Architecture**

# 6 Featured Functions

## 6.1 Integrated AI, Communication and Computing

AISWare AgileNet Integrated AI, Communication and Computing enhances the functions of 5G BBU and 5G MEC without altering the existing 5G network architecture or core capabilities. It enables native computing and intelligence within the network, delivering converged communication, computing, and intelligence capabilities through unified 5G network, as shown in Figure 6-1.
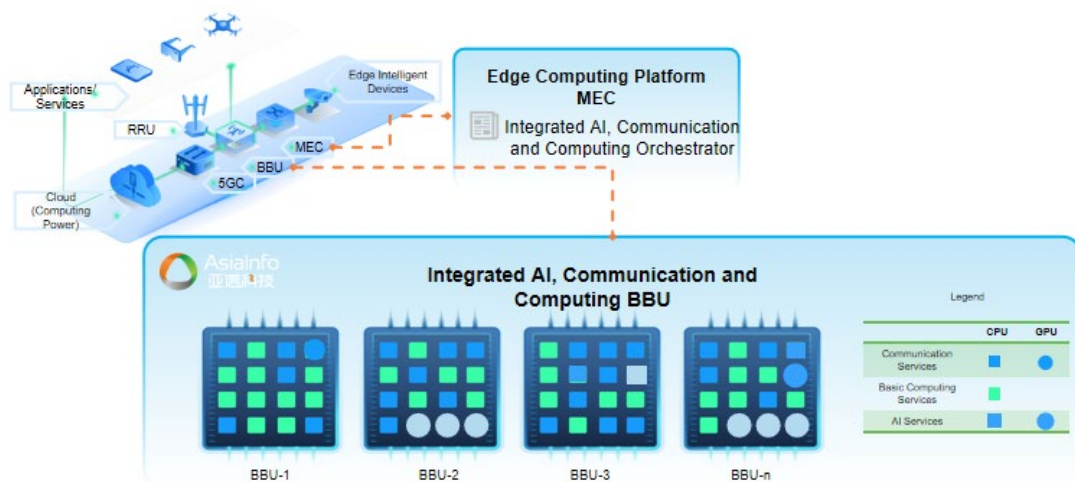


**Figure 6-1 Integrated AI, Communication and Computing**

AISWare AgileNet-CNN abstracts and virtualizes the CPU and GPU of 5G BBU, transforming it into communication and computing abilities to support communication and basic computing and AI services. It also includes a computing scheduling and orchestration decision-maker to pool the computing power of the 5G BBU in the radio network, achieving integrated scheduling and orchestration of computing applications and resources.

The 3 core values of Integrated AI, Communication and Computing are:

- Reducing Investment: Compared to traditional solutions that require dedicated base stations and specialized computing boards or servers, the integrated AI, communication and computing adopts COTS (Commercial

Off-The-Shelf) hardware, eliminating the need for additional investment costs.

- Enhancing Resources: Transforming the idle communication capability of Computing Native 5G base stations into computing capability, utilizing time-division multiplexing to improve resource utilization and enhance resources

- Improving Capabilities: The Computing Native 5G base station provides not only basic functions but also general computing features, running multi-industry application services

By intelligently scheduling network resources, the Integrated AI, Communication and Computing feature successfully converts the idle 5G computing power into additional computing resources for use in edge applications, without compromising communication performance. This enhances resource utilization efficiency and expands the service capabilities of wireless networks.

## 6.2 5G LAN

AISWare AgileNet-CN supports 5G LAN services, providing LAN-like services to radio users over a 5G network. Terminals within the same LAN group can communicate one-to-one or one-to-many, regardless of their geographic locations, while users in different LAN groups are isolated from each other.
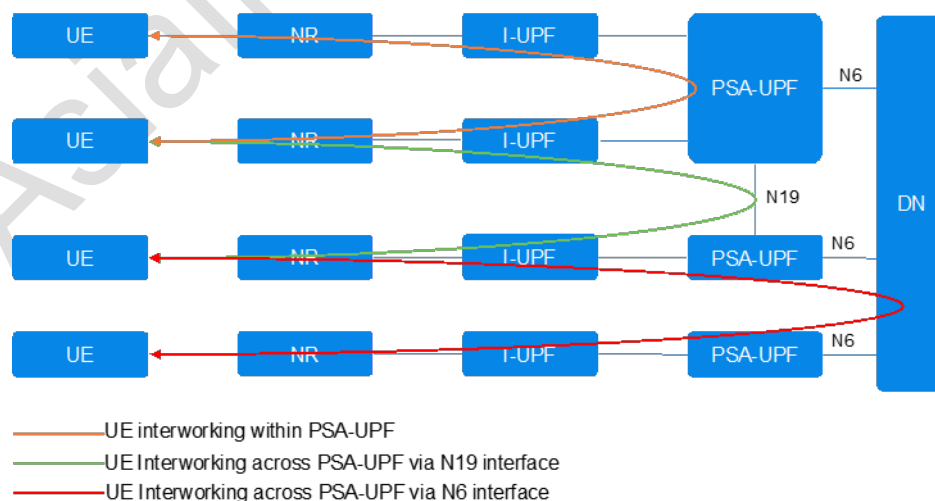


**Figure 6-2 5G LAN**

5G LAN provides a convenient interconnection for 5G industrial terminals, especially devices requiring Layer 2 communication like PLCs, with the following advantages:

- Direct Interconnection: Users within the same 5G LAN form a local network, enabling direct communication with each other

- Spatial Scalability: 5G LAN users can be located in different places, not confined to the same building. Members can even be in different cities

- Mobility: Users moving to different areas can maintain 5G LAN connectivity and communication

- Security: Different 5G LAN groups are isolated from each other, achieving a similar effect to VLAN isolation

- Flexible LAN Formation: Users can flexibly join 5G LAN groups to enable rapid 5G LAN setup

- Layer 2 Forwarding: 5G LAN supports both layer 2 and layer 3 data forwarding. Layer 2 forwarding meets multiple requirements of protocol operating

Based on existing slice member subscriptions, the private network operation platform enables interconnection of intelligent devices within a 5G LAN. It supports 5G LAN group management, differentiated network policy configurations for VN LAN and general LAN groups (including PDU session types, DNN info, and QoS settings), and group member subscription management—covering subscription, un-subscription, and member updates. It configures LAN group policies and identifies MAC addresses via the UPF interface of the core network.

By integrating 5G LAN with TSN and other technologies, it ensures high reliability and low latency for industrial users while supporting mobility.

## 6.3 VoNR

Based on AISWare AgileNet-CN IMS, users can make flexible voice calls in P5G campus, including voice intercommunication between mobile terminals, between mobile and fixed telephone terminals, and between the private and public networks, all under legal and compliant conditions.
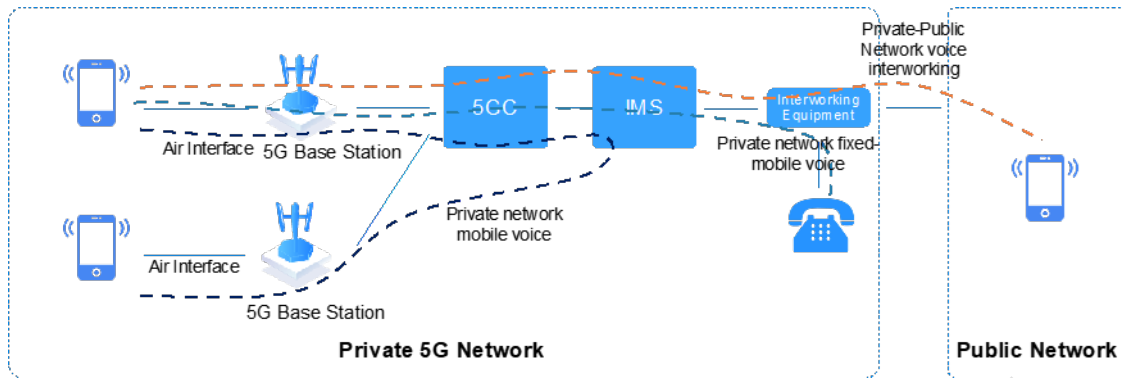
**Figure 6-3 Flexible Voice Call Capability**

## 6.4 MOCN

AISWare AgileNet-CN and AISWare AgileNet-support the MOCN feature. This enables the deployment of P5G and public networks sharing base stations in industry deployment scenarios. This network configuration assigns different PLMNs to private and public networks, allowing P5G users and public network users to access different core networks through the same base station. This ensures the security of private network data while providing network coverage to public network users in remote areas.

## 6.5 Secure Access for Wi-Fi Devices

As 5G network deployment accelerates, commercial terminals are also being upgraded to support 5G. However, in the current stage, many industry customers—such as factories and campuses—still rely heavily on existing Wi-Fi devices and networks. While introducing 5G, these legacy Wi-Fi networks can be integrated with the 5G network to form a unified system. Through the TWIF network element, trusted non-3GPP terminals can access the network, minimizing the need for extensive hardware upgrades or modifications to existing infrastructure. This enables unified access authentication, security policies, and routing management, achieving resource reuse, simplified management, and enhanced security.
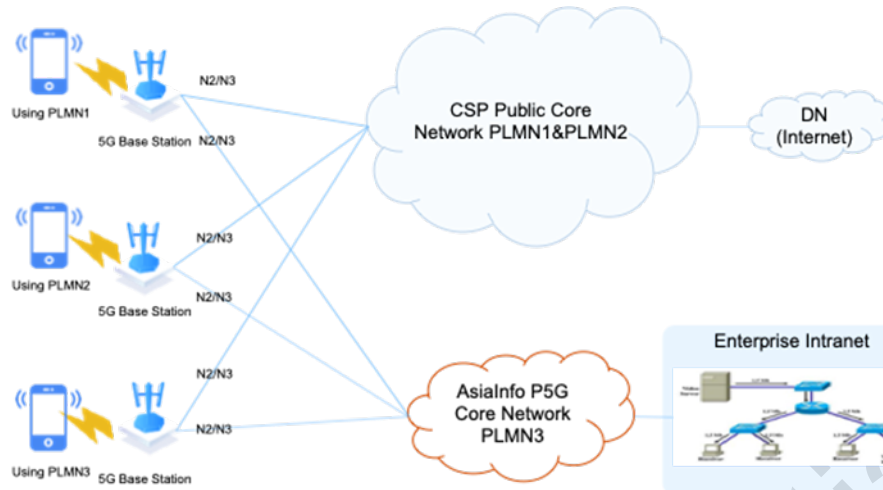
**Figure 6-4 Shared Base Station Network**

As shown in the figure below, Wi-Fi devices securely access the 5G network via TWIF.
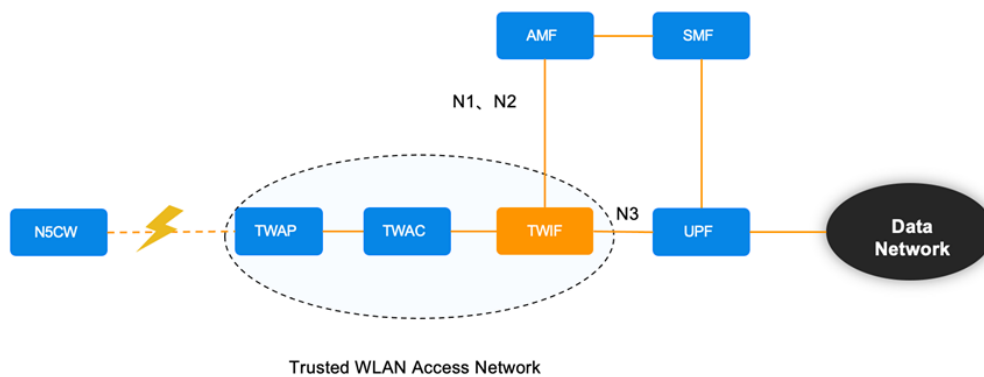


**Figure 6-5 Trusted WLAN Access Network**

The TWIF (Trusted WLAN Interworking Function) network element converts traditional interfaces with TWAP and TWAC into N1, N2, and N3 interfaces compatible with the 5G core network, enabling seamless integration.

- Acts on behalf of N5CW terminals (Non-5G-Capable over WLAN – trusted devices in legacy WLANs that do not support direct 5G access) to complete authentication and registration within the 3GPP system.
- Acts on behalf of N5CW terminals to complete IP address allocation and session establishment within the 3GPP system.
- Establishes and maintains GTP-U tunnels with the UPF.
- Supports IP-based routing and forwarding.
- Supports Layer 2 packet forwarding in industrial scenarios.

## 6.6 MEC Integrated Sensing, AI and Communication Scheduling Function

With the advancement of AI technology, BBU servers are increasingly equipped with intelligent computing capabilities to provide AI services externally. Building on its native computing power, AsiaInfo introduces intelligent computing resource management and scheduling units for base stations, along with lifecycle management for both large and small AI models. This enables more comprehensive application management services for customers.
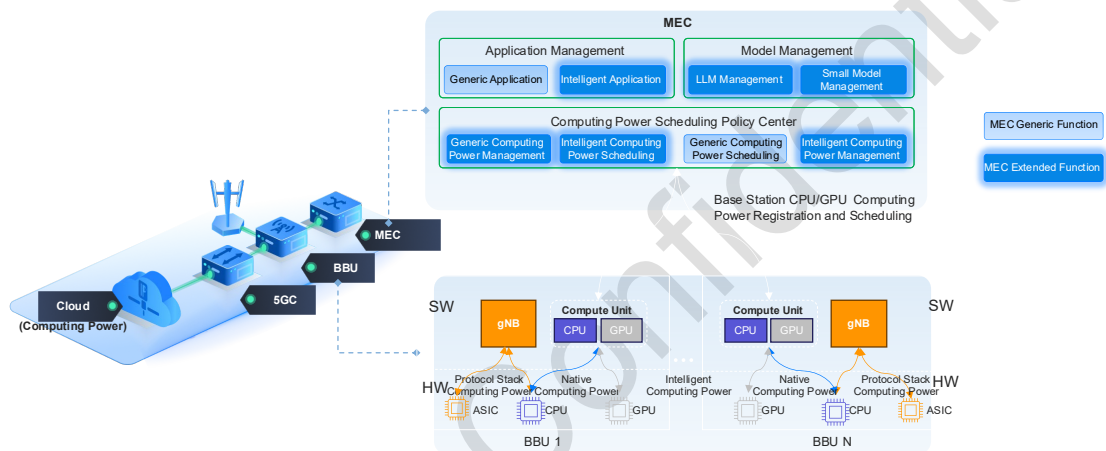


**Figure 6-6 MEC Integrated Sensing, AI and Communication Scheduling Function**

MEC Integrated Sensing, AI and Communication Scheduling includes a Computing Power Scheduling Decision Center, Application Management Center, and Model Management Center.

- Computing Power Scheduling Decision: Enables intelligent management and scheduling of base stations, supporting dynamic registration, deregistration, and scheduling of intelligent computing units.

- Model Management Center: Manages both large and small models, covering lifecycle management, upload and deployment of models, and authorization management of models for applications.

- Application Management Center: Handles the upload, release, and deployment of intelligent applications.

## 6.7 5G Network Slicing

As a fundamental 5G technology, 5G Network Slicing constructs multiple dedicated, isolated, and guaranteed logical networks on a physical 5G network architecture to meet users' personalized network capability needs.

AISWare AgileNet offers native support for slicing, providing end-to-end slicing capabilities with full automation for slice activation and SLA monitoring.

## 6.8 One-Click Deployment

AISWare iLinkS-Manager offers product configuration templates based on service scenarios, applicable to both AISWare iLinkS and third-party private network switches. These templates enable scenario-based pre-configurations, where users can input configuration parameters and set default values. The system supports bulk deployment, facilitating rapid network interconnection and second-level network setup for enterprise customers.
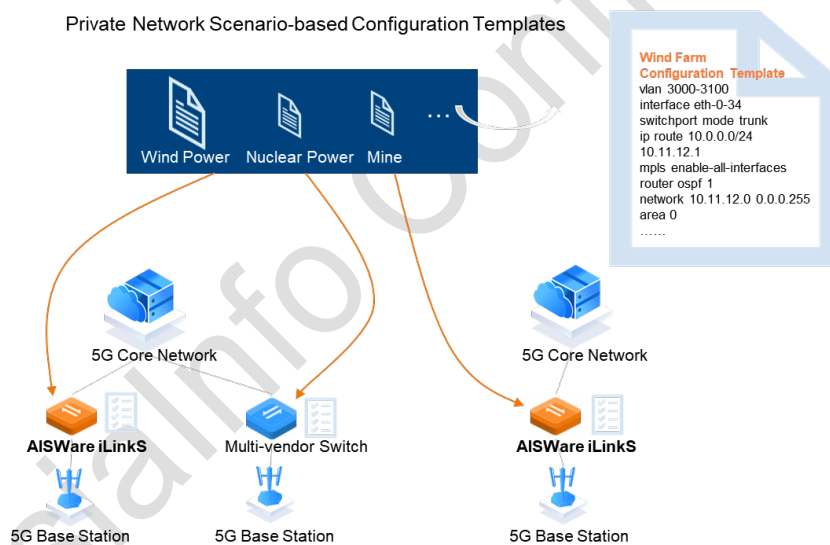


**Figure 6-7 One-Click Deployment**

The one-click deployment simplifies configuration by enabling users to select managed devices for unified SSH login. Once the configuration template is completed, AISWare iLinkS-Manager converts it into proprietary configuration commands for the selected device model, automating the deployment process.

# 6.9 RedCap

5G defines application scenarios for eMBB, uRLLC, and mMTC, corresponding to Broadband IoT, Mission-Critical IoT, and Massive IoT. While these scenarios address high-speed, low-latency, and low-speed IoT needs, they overlook medium-demand IoT applications. RedCap is a cellular IoT solution introduced to fill this gap, offering a tailored solution for moderate network connection requirements.
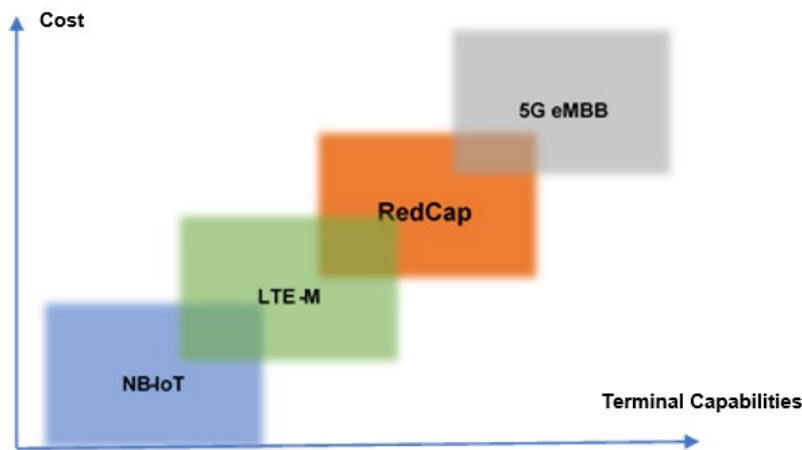


**Figure 6-8 RedCap Positioning**

Advantages of RedCap:

- Introduced in 3GPP R17, Tailored NR terminal capabilities to better meet medium network connection needs

- Combines 5G advantages such as millimeter wave, network slicing, and 5G positioning, offering improved IoT services over LTE IoT

- Reduces terminal costs

Applicable Scenarios: Wearable devices, industrial radio sensors, surveillance cameras, and other medium-demand IoT applications.
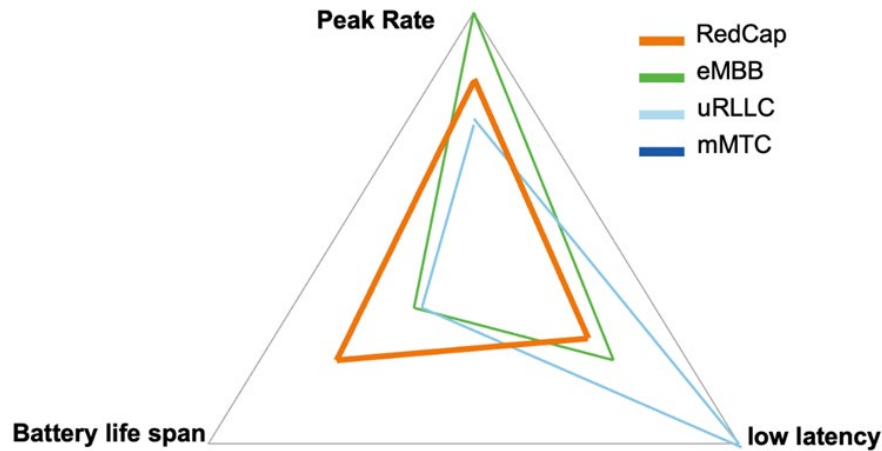
**Figure 6-9 RedCap**

# 6.10 5G NR Relay Backhaul

During the P5G construction in remote areas, the deployment of base stations is constrained by wired transmission infrastructure. 5G NR Relay Backhaul supports flexible deployment of small cells across the frequency band in areas where optical fibers are scarce, enabling coverage in edge or isolated gaps, and enhancing the 5G network capacity and coverage performance.

5G NR Relay Backhaul is based on CPE. The CN UPF can forward and parse data from base stations at different levels. Compared to other radio relay backhaul technologies, 5G NR Relay Backhaul possesses the following advantages:

● Simple Networking: Existing base stations can connect to the CPE via wired connection for data backhaul.

● Low Cost: The commercialization of CPE is mature

Applicable Scenarios:

● Remote areas and offshore platforms where fiber deployment is challenging.

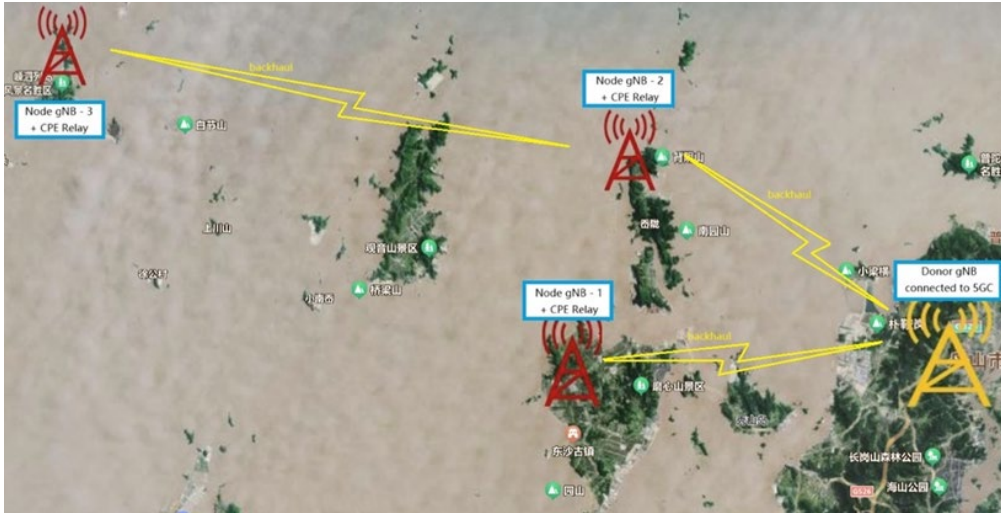● Emergency support and temporary capacity expansion.

**Figure 6-10   5G Relay Scenario**

# 6.11 Time-Sensitive Network

Time-Sensitive Network (TSN) is a set of protocols designed to enable deterministic low-latency communication over inherently non-deterministic Ethernet networks. Developed by the TSN working group within IEEE 802.1, TSN introduces deterministic mechanisms for data transmission in standard Ethernet, enhancing its determinism and reliability to ensure real-time, reliable data transfer.

Industrial control, a core part of industry, demands high network performance, including low latency, low jitter, and high reliability. TSN meets these requirements with its features, making it essential for industrial internet OT domains. Traditional TSN operates on wired networks, which can be costly and inflexible.

Thanks to 5G network slicing and time synchronization mechanisms, AsiaInfo's P5G products can provide deterministic ultra-low-latency transmission for time-sensitive applications, such as industrial control and vehicle-to-everything (V2X) coordination.

Therefore, the integration of 5G and TSN offers deterministic transmission guarantees for service applications.

## 6.12 5G Indoor-Outdoor Integrated High-Precision Positioning

Positioning is one of the key functions of a P5G network, especially in industries such as wind power and nuclear power, which require high-precision positioning in both indoor and outdoor environments. It supports the positioning and trajectory tracking of personnel and equipment during operations and maintenance. By using MDT GPS data for outdoor positioning and SRS-based positioning for indoor environments, continuous and integrated positioning of end users can be achieved, enabling functions such as trajectory prediction. The related positioning information can be further transmitted back to the P5G network operations platform, enabling external empowerment.
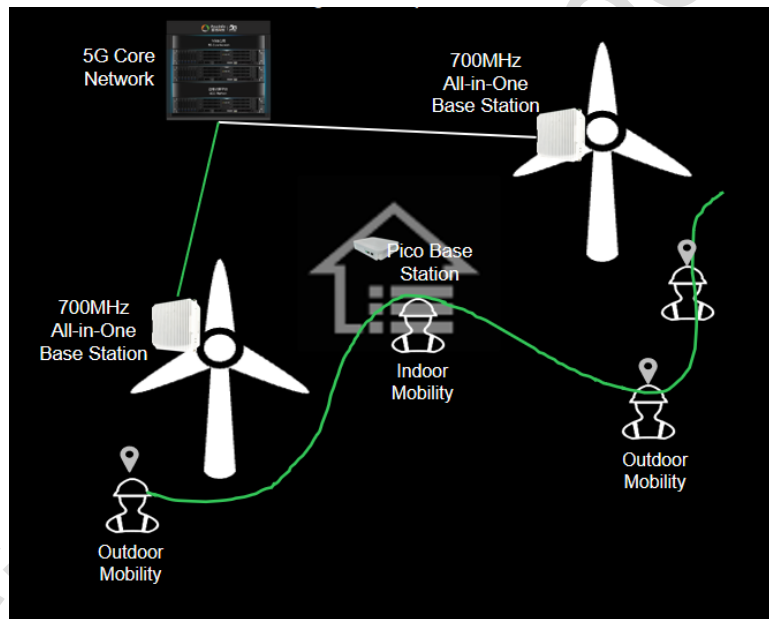


**Figure 6-11 5G Indoor-Outdoor Integrated High-Precision Positioning**

## 6.13 Intrinsically Safe Base Station

Safety in production is the foremost concern in coal mine intelligence. High methane and coal dust levels in underground environments pose explosion risks to electrical equipment, which also faces spatial constraints for installation. The Intrinsically Safe All-in-One 5G Pico Base Station Module is a low-power deep-coverage 5G product developed by AsiaInfo, customized for underground mine tunnel deployment. It can be integrated into intrinsically safe

All-in-One 5G substations by vendors certified with coal mine safety qualifications. Once integrated, the substation enables 5G network capacity coverage within underground mining tunnels. The module is designed using a domestically developed 5G baseband SoC chip and integrates baseband processing, low-power RF processing, and switching modules. It features low power consumption, compact size, light weight, easy installation, and simple maintenance.



**Figure 6-12 Intrinsically Safe Base Station**

# 6.14 Bluetooth High-Precision Positioning

In a specific P5G scenario, integrating Bluetooth beacon positioning technology enhances indoor target positioning with faster data transmission and stable connections. This integration improves the responsiveness and reliability of positioning services, benefiting industries with precise indoor navigation, asset management, and personnel tracking. In large hospitals, P5G and Bluetooth beacon enable accurate tracking of medical equipment, optimizing resource allocation and enhancing medical service efficiency.

The 5G base station RRU connects to the Bluetooth gateway via Ethernet, with Bluetooth beacons linked to the gateway via RS485 bus. Beacon data is aggregated and forwarded to the BBU through the Bluetooth gateway.

Bluetooth terminals continuously emit reference signals. Upon detection, beacons send signal strength information to the BBU. The BBU calculates the terminal's position using positioning algorithms and sends this location information to the private network operations management platform for graphical representation.
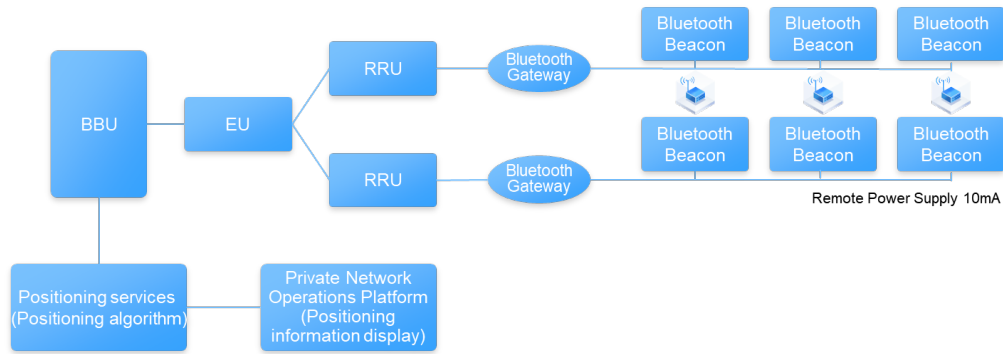
**Figure 6-13 Bluetooth High-Precision Positioning Process**

# 6.15 Application-Level Security Management

AISWare Intelligent Link Gateway implements basic firewall capabilities such as packet filtering and application detection. It routes network traffic from small branches and mobile office PCs through lightweight terminals to local aggregation devices or PoP points for security inspection, enabling unified security management. The gateway is capable of differentiating and targeted analyzing key services, providing application-level security management, as shown in the following figure.

The Intelligent Link Gateway also supports the aggregation of comprehensive security capabilities in the cloud, ensuring unified security for branch internet access, networking, and centralized management.
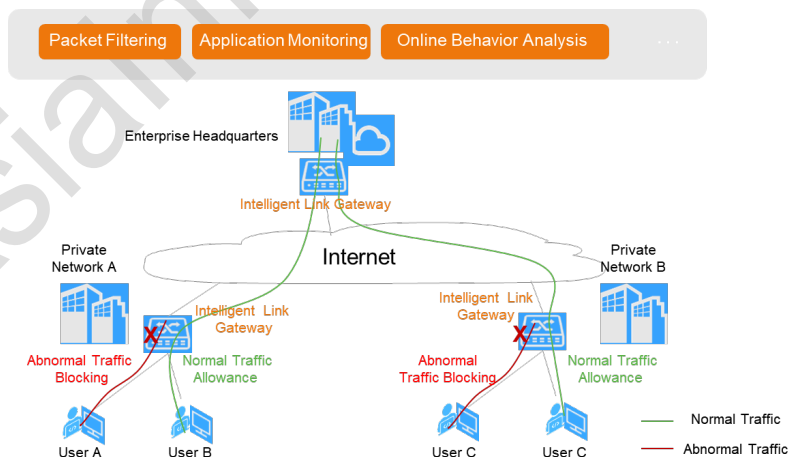


**Figure 6-14 Intelligent Link Gateway Application-Level Security Management**

## 6.16 Dual Fed and Selective Receiving

By enhancing 5G CPE products to support multi-scenario dual link 5G wireless and 5G + wired Dual Fed and Selective Receiving solutions, a highly reliable P5G network can be achieved to meet the requirements of uninterrupted service and stable latency for industrial control and similar applications.

● The 5G CPE performs dual transmission of data, while the aggregation gateway performs selective reception, ensuring reliable data transmission.

● For dual 5G wireless links, the 5G CPE uses dual SIMs to connect to two separate base stations, with the aggregation gateway handling dual 5G link transmission and selective reception.

● For 5G wireless + wired dual links, the 5G CPE connects to a base station via wireless and to a fiber link via its WAN port, enabling dual transmission and selective reception.
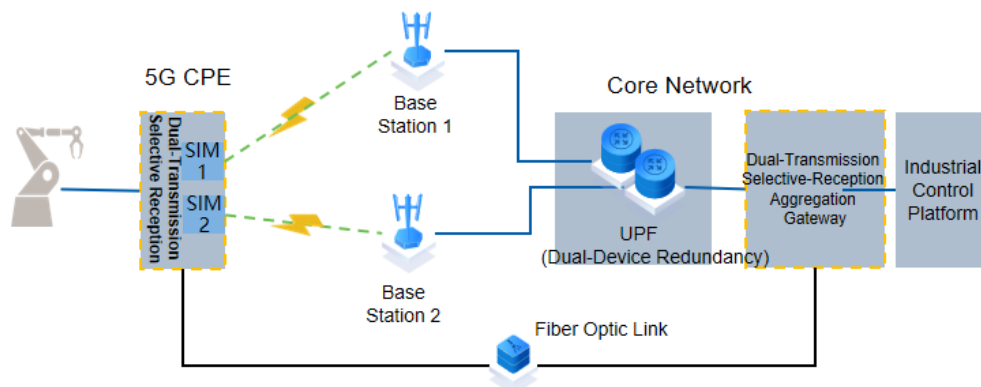


**Figure 6-15 Dual Fed and Selective Receiving**

## 6.17 Service Sensing

The P5G Network Operations Platform, built on proprietary network edge probes, enables service detection and monitoring across campus-specific scenarios--such as video surveillance, PLC industrial control, IoT, and internet applications. This supports scenario-based monitoring of terminal connections, service path restoration, and service quality analysis and evaluation.
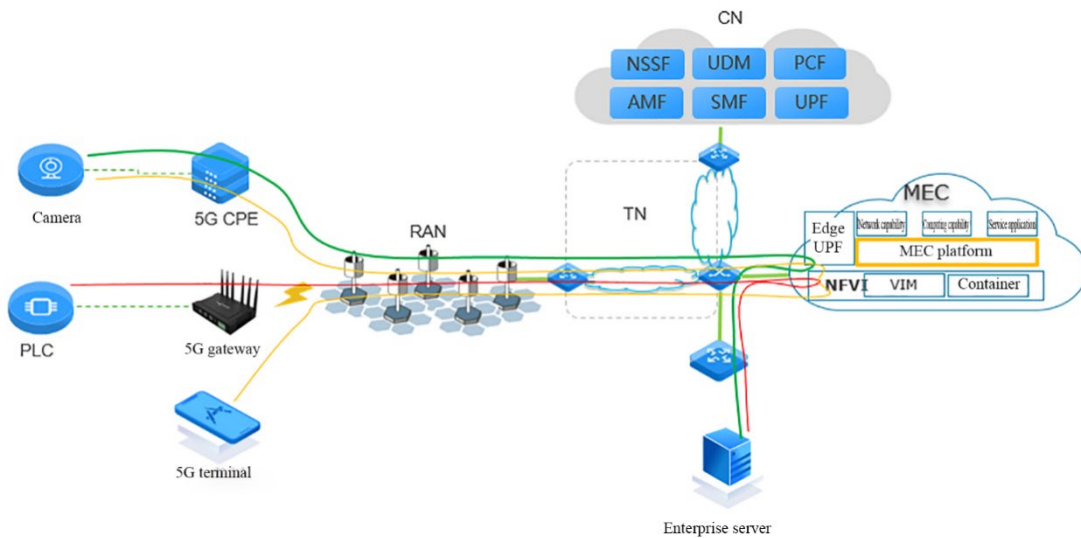
**Figure 6-16 Service Awareness**

Key capabilities of service awareness include:

- Proprietary Network Edge Probes

  - Supports packet collection and deep analysis for interfaces such as N3, N4, N9, S1-u, and S5/S8-u

  - Supports protocol analysis for DNS, HTTP, HTTPS, FTP, RTSP, S7, and more

- Scenario-Based Service Monitoring

  - Provides service-centric, scenario-based monitoring from the customers' perspective, offering monitoring capabilities to each service session within its specific context.

- Service Path Reconstruction

  - Reconstructs the service topology by linking signaling plane, user plane, and service plane data

- Service Quality Analysis and Evaluation

  - Offers monitoring of connection-based experience indicators and service quality analysis and evaluation

## 6.18 Service Dial Testing Management

The AISWare AgileNet-OM employs proprietary edge probes and terminal module probes to implement key service tests, ensuring network node connectivity detection and proactive service quality measurement. This provides active quality monitoring and service fault detection tools. The figure below illustrates the collection of key network indicators and fault detection capabilities, including:

● N6-side Testing: Suitable for centralized monitoring scenarios without requiring CPE software/hardware probes, enabling the collection of key network indicators.

● N3-side Testing: Suitable for fault detection and latency delimitation in 5G base stations campus, UPF, and 5GC.

● Node Connectivity Detection: Periodically initiates connectivity monitoring for nodes, providing real-time node availability status.

● Proactive Service Quality Measurement: Automatically detects service paths using daily DPI data, initiates simulation tests, and measures latency, rate, and jitter. Provides proactive monitoring data for real-time service quality assessment.

● Automatic Path Node Learning: Uses Trace technology to actively discover each node in packet forwarding, automatically identifying unknown business nodes and supplementing the business path with node information.
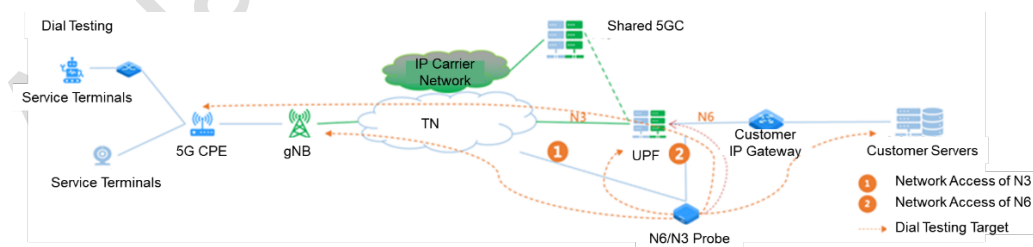


**Figure 6-17 Probe Testing Management**

● N6 Interface Testing: Uses independent probes to customize the campus device topology based on specific network connection scenarios, such as campus application servers, UPF, and terminals, and conducts segmented, targeted network layer testing.

- N3 Interface Testing: Assigns RAN VPN addresses to the probes, enabling testing for the 5G base station campus, UPF addresses, and 5GC addresses.

## 6.19 Fault Diagnostics

When a service fault occurs in a private network, it is often difficult for network maintenance personnel to quickly identify the fault or detect that the service is degrading. Even if the issue is identified, due to the involvement of many components, complex protocols, and specialized knowledge, it is challenging to pinpoint the root cause. The figure below illustrates how the AISWare AgileNet-OM, using AI-based fault isolation and localization algorithms, combines probe data, testing data, network performance metrics, and network alarm data to automatically identify faults and degradation. It also performs automatic fault trace analysis, reducing the complexity of O&M.
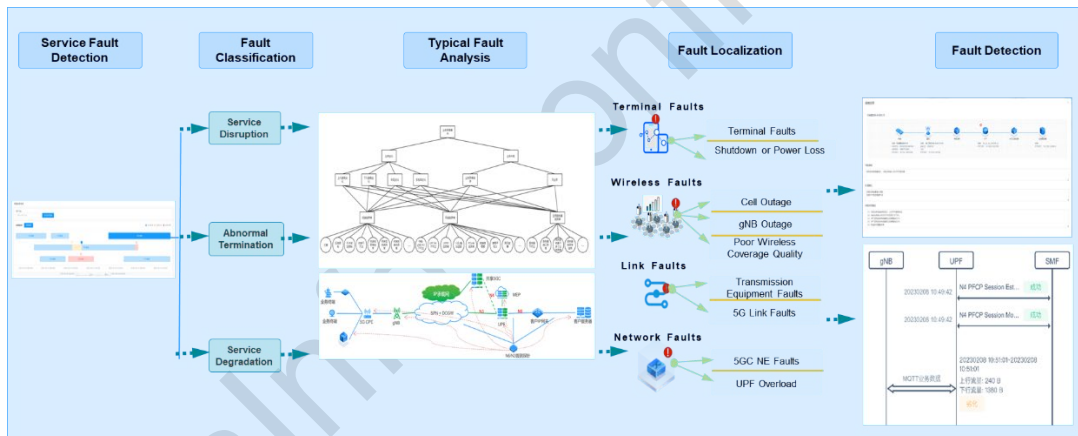


**Figure 6-18 Fault Diagnostics**

- Fault Detection: Through comprehensive analysis of multi-dimensional data, it can automatically identify interruption, abnormal termination, and service degradation.

- Fault Analysis: Utilizing fault isolation and localization algorithms based on expert experience, it can perform fault boundary analysis.

- Fault Localization: By combining fault isolation algorithms and testing technology, it can analyze the root cause and trace of the fault.

## 6.20 Terminal Module Probe

The P5G Operations Platform focuses on 5G+ full connectivity scenarios and actively collaborates with downstream industry terminal module manufacturers in segmented sectors such as electricity, government services, and manufacturing. This collaboration aims to establish unified standards for terminal module probes, conduct verification of critical services, and promote large-scale deployment. The following figure illustrates the self-developed industry module soft probe, which collects cellular basic data (module ID, model, device, and mobile identifiers), operational data (cell status, cell IDs, signal quality, throughput, etc.), and events (power on/off, SIM card removal, etc.), along with terminal location data based on positioning chips. This enables 5G terminal quality detection, service testing, and monitoring of terminal location distribution, facilitating the quality monitoring of P5G terminals and the digital operation of private network.
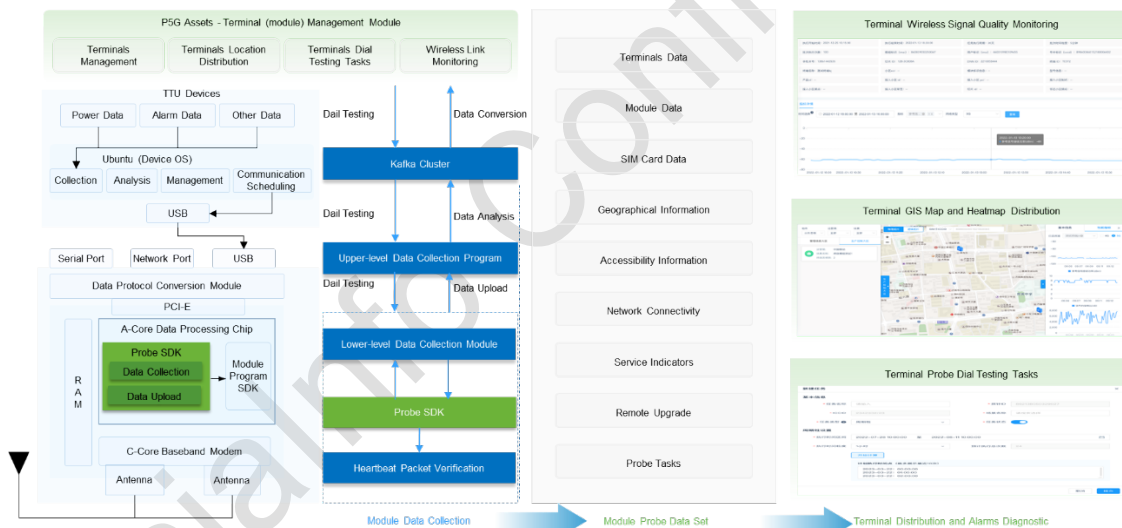


**Figure 6-19 Terminal Module Probe**

Currently, AISWare AgileNet-OM, in collaboration with major module manufacturers, has achieved large-scale deployment across various industries such as electricity, government services, and manufacturing, enabling effective monitoring of network quality at the edge.

● For New Devices: AsiaInfo provides a module probe SDK, which is centrally managed by downstream module manufacturers to handle SDK integration and file configuration for new device terminals.

- For Legacy Devices: For the upgrade of existing terminals with the same specifications, the module manufacturer leads the upgrade process. AsiaInfo provides support as needed.

# 7 Unique Advantages

AsiaInfo's P5G products have unique advantages in the following five aspects: industry-specific capabilities, flexible networking, ISAC$^2$, simplified O&M, and being domestic, independent, and controllable.

## 7.1 Advanced and Open Technology

- Wilder Coverage, Higher Rate, Lower Latency

- More flexible spectrum utilization

- Seamless Mobility

- Enhanced Security

- Open architecture supporting ORAN

- Intelligence-driven with AI RAN support

## 7.2 Full-Stack Product Portfolio

- Integrated 4G/5G Core Network (Hardware and Software)

- Multi-mode integrated 4G/5G base stations

- Simplified multi-vendor integration

## 7.3 Industry-Specific Capabilities

- Radiation Resistance, Extreme Temperature Tolerance, Salt Spray Resistance, Intrinsically Safe, Explosion Resistance

- 5G LAN, TSN, 5G Relay, Dual Fed and Selective Receiving

- Over 300 P5G deployments with full lifecycle expertise, including China's largest private 5G network for CNNC

## 7.4 Cost Efficiency and Fully Controllable

- Total TCO (CAPEX+OPEX, example of a Small Campus Private Network) reduced by 36% compared to industry standards

- Full controllable over core chips, components, boards, and operating systems

- Fully certified with MIIT, CE, CCC, OTIC, and successfully validated in China Mobile and China Broadnet centralized procurement tests

## 7.5 Innovating Private Network Evolution

- World's first integrated AI, communication and computing base station with embedded Qwen LLM, jointly released with AliCloud

- ISAC base station empowering the low-altitude economy

- Next-gen Agentic architecture RAN & Core Network

- Globally recognized: Omdia P5G Quadrant Challenger, Gartner Magic Quadrant Leader in Telco AI, ABI Research Top 7 Core Network Vendor, GTI Award Winner for Market Impact & Business Value.

# 8 Scenario Solutions

AISWare AgileNet includes typical application scenarios for smart nuclear power, smart thermal power, smart mining, smart ports, smart steel, and P5G operations.

## 8.1 Smart Nuclear Power

AISWare AgileNet has already been deployed in the nuclear power industry. Below is an introduction to a typical use case.

### 8.1.1 P5G Scenario for Smart Nuclear Power

In response to energy conservation, environmental protection, and emission reduction, countries are accelerating the development of nuclear energy. Nuclear power is the focus of China's power structure adjustments, and the investment scale will greatly surpass that of conventional power plants. Nuclear power companies have already planned for the construction of smart nuclear power, using IoT technology to establish a data collection network for power plant systems and equipment, enhancing the digital monitoring level of plant conditions. They are also building wireless networks to support the digitalization, mobility, and end-to-end tracking of O&M processes. The strong technical and industrial capabilities of P5G make it the preferred choice for nuclear power companies.



**Figure 8-1 P5G Scenario for Smart Nuclear Power**

## 8.1.2 Service Requirements for Smart Nuclear Power

P5G empowers the digital transformation and upgrading of nuclear power plants. The key needs within a nuclear power plant include equipment/material, site/environment, work activity, and personnel safety management.

Single Point Vulnerability (SPV) devices are those where a failure of a single device could lead to shut down, stoppage, reduced output, or significant power fluctuation of the plant. SPV device management is a key requirement for nuclear power operations on the P5G. For example, a nuclear plant experienced six unplanned shutdowns in a single year due to equipment failures, highlighting deficiencies in equipment management. By leveraging P5G for continuous monitoring, data collection, and early warning of SPV devices, as well as tracking and monitoring radiation sources and hazardous chemicals, nuclear power companies can significantly improve their management capabilities and enhance safety assurance.

In the smart nuclear power scenario, the P5G requirements can generally be divided into three categories: video surveillance, personnel and equipment management, and mobile office.

● Video surveillance services mainly include the following:

■ Monitoring of tool and equipment usage, behavior supervision, and safety witnessing

■ Monitoring of radiation sources and hazardous chemicals

■ Real-time monitoring of key work sites, temporary construction areas, and accident sites

■ Access management for critical and sensitive areas

**Table 8-1 Network Requirements of Video Surveillance**

| Application Scenario | Network Requirements | | | |
|---|---|---|---|---|
| Video Surveillance | Uplink Speed | Downlink Speed | Transmission Delay | Number of Connections |
| | ≥50 Mbps | No special requirements | ≤50 ms | ≥100 |

- Personnel and equipment management services mainly include the following:

  - Personnel positioning, headcount tracking, and traffic monitoring

  - Data collection and early warning for SPV devices or other critical system equipment

  - Traceability of the movement and flow of radioactive sources and hazardous chemicals

  - Radiation monitoring network, real-time transmission of on-site radiation level data

  - Simplified O&M for widely distributed system equipment such as lighting, cabinet fans, fire alarm sensors, and fire doors

**Table 8-2 Network Requirements for Personnel and Equipment Management**

| Application Scenario | Network Requirements | | | |
|---|---|---|---|---|
| Personnel and Equipment Management | Uplink Speed | Downlink Speed | Transmission Delay | Number of Connections |
| | ≥10 Mbps | ≥10 Mbps | ≤200 ms | ≥2000 |

- Mobile office services mainly include the following:

  - Operation Inspection: Inspectors use the wireless network to record real-time issues and defects, upload photos, videos (real-time communication), inspection data, and document conditions such as leaks, spills, or drips

  - Operational Tasks: Facilitates remote monitoring of operations, electronic records of operational tasks, and digitized mobile applications for procedures, schematics, and tickets

  - Mobile Maintenance: Use of mobile terminals to handle ticketing, ticket transfers, and witness quality and safety control points

**Table 8-3 Network Requirements for Mobile Office**

| Application Scenario | Network Requirements | | | |
|---|---|---|---|---|
| Mobile Office | Uplink Speed | Downlink Speed | Transmission Delay | Number of Connections |
| | ≥10 Mbps | ≥50 Mbps | ≤100 ms | ≥500 |

## 8.1.3 P5G Solution for Smart Nuclear Power

The Smart Nuclear P5G is divided into production and front-of-plant zones to meet stringent safety requirements:

Production Zone: Covering areas like the nuclear island, conventional island, BOP, and emergency command centers. This zone employs a standalone P5G with a localized core, using a physically isolated network setup. It connects to the private network via secure network devices.

Front-of-Plant Zone: Encompassing offices and maintenance buildings, this zone utilizes hybrid P5G, offloading data within the nuclear facility perimeter without leaving the campus. The signaling is linked to the carrier's core network and connected to the nuclear network through an MEC setup.

Due to the unique wireless environment in nuclear facilities, P5G design must account for electromagnetic compatibility and signal shielding within nuclear islands. Wireless systems within these buildings use low-power, multi-base station distributed architectures to control base station power and minimize electromagnetic interference from stations and mobile devices on sensitive electrical and instrumentation equipment.

For extensive coverage outside the nuclear island, high-power macro base stations can be installed at elevated locations on the plant buildings. This approach expands coverage, lowers equipment and design costs, and reduces construction workload.

For underground areas and weak-signal zones within the conventional island and various BOP sub-units where staff are stationed, on duty, or conducting inspections, additional coverage can be added to eliminate blind spots.

- Production Area 5G Network Design

As shown in Figure 8-2, the 5G network design for the production area adopts a dedicated private network solution, building an independent P5G.
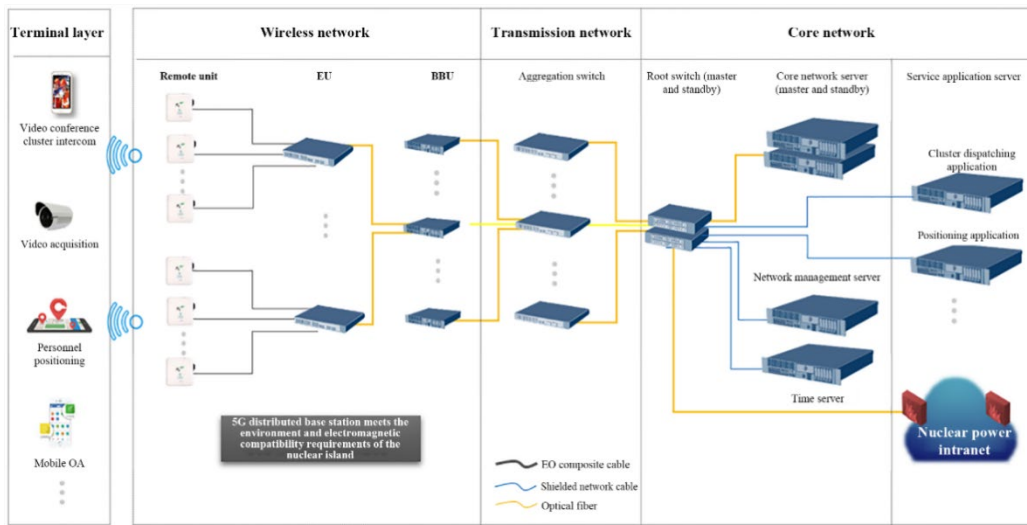


**Figure 8-2 5G Network Design for the Production Area**

5G Core Network: A lightweight 5G core network is deployed with a primary and backup setup or in a POOL mode to provide disaster recovery. Dual power supply is provided. The network integrates as needed with cluster dispatch and positioning systems to enable scheduling and indoor positioning services. Core network servers, network management servers, and application servers are housed in the office building within the front area.

Transmission Network: Aggregation switches connect multiple BBUs, consolidating into a primary-backup root switch setup.

5G Radio Network: Distributed base stations are deployed in all rooms within the nuclear island, while macro base stations provide wide-area coverage outside.

● Nuclear Island: All rooms are equipped with pRRU or passive antennas, with passive antennas used in the orange and red zones, and pRRU used in the yellow, green, and white zones. All EU and BBU are deployed in the yellow, green, and white zones. All wireless equipment must pass electromagnetic compatibility (EMC) testing.

● Conventional Island & BOP: High-power RRUs are deployed in elevated and open areas for wide-area coverage. In hard-to-cover areas, such as

underground PX pump rooms, EUs, and pRRUs are used for supplementary coverage.

- Front-of-Plant Area 5G Network Design

As shown in Figure 8-3, the front area utilizes a dedicated network overlay via slicing and UPF/MEC deployment to construct a hybrid P5G.
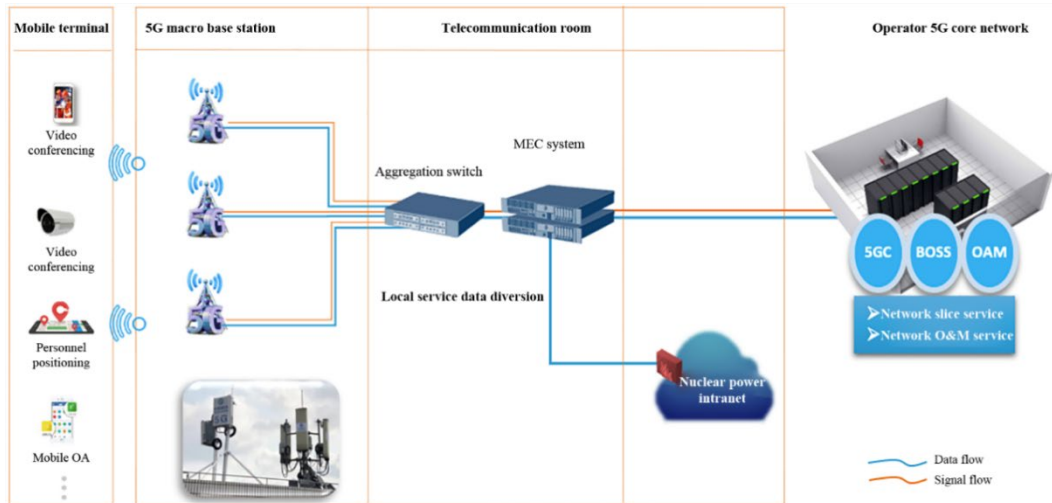


**Figure 8-3 5G Network Design for the Front-of-Plant Area**

5G Core Network: To meet the plant's security requirements by keeping control data within the site, the UPF is deployed onsite in the plant's data center along with an MEC. User devices in the front area can only access the MEC via signals from base stations within the site, necessitating a dedicated TA for on-site wireless coverage. A whitelist and blacklist are configured in the core network to restrict MEC access only to devices within this TA.

Transmission Network: The connection between onsite base stations and the UPF must be controlled to ensure that data paths for specific terminals in the front area remain within the site.

5G Radio Network: A macro base station is designated for the front area, operating on public network frequencies and located within the site boundaries. This area is assigned a specific TA to ensure that terminals connecting through this TA and subscribed to specific slices and DNNs are directed to the onsite MEC system for traffic management.

## 8.2 Smart Thermal Power

### 8.2.1 P5G Scenario for Smart Thermal Power



**Figure 8-4 Smart Thermal Power Scenario**

In building the Smart Thermal Power P5G, the "Four-Unit Centralized Control" (centralized control of four generator units) approach is fully utilized to optimize design and drive innovation from the source. This approach aligns with the smart power enterprise structure, which adheres to the "Two Platforms (Intelligent Power Generation ICS and Smart Management IMS) and Three Networks (Production Control Network, Management Information Network, and Industrial Wireless Network)" framework, establishing an integrated control system.

### 8.2.2 Service Requirements for Smart Thermal Power

Traditional thermal power plants suffer from low levels of automation and intelligence, facing issues such as reliance on makeshift office setups during major overhauls, substantial labor and resource consumption, inefficient offline inspections, and safety risks for personnel. As shown in Figure 8-5 Service Requirements for Smart Thermal Power, the Smart Thermal Power P5G enables new intelligent applications, such as video security, AR displays, personnel tracking, and drone inspections, significantly enhancing automation and addressing the current challenges within thermal power plants.
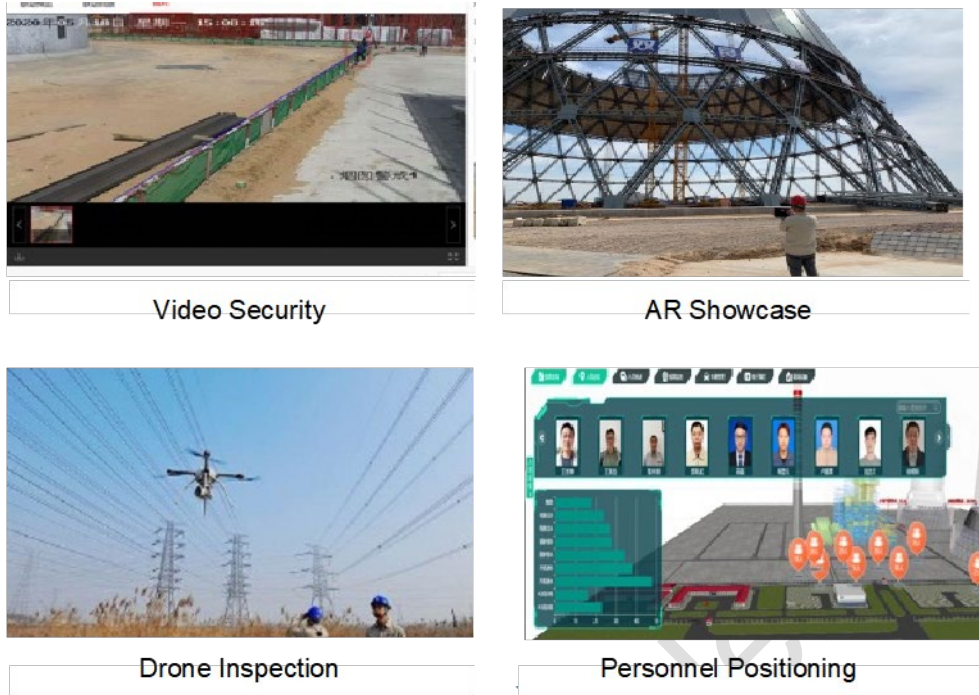
**Figure 8-5   Service Requirements for Smart Thermal Power**

Table 8-4 Video Backhaul Requirements outlines the network requirements for applications in smart thermal power plants, including video backhaul, AR displays, and location management.

**Table 8-4 Video Backhaul Requirements**

| Application Scenario | Network Requirements | | |
|---|---|---|---|
| Video Surveillance, Drone Inspection | Uplink Speed | Downlink Speed | Transmission Delay |
| | ≥40 Mbps | No special requirements | ≤100 ms |

**Table 8-5 AR Display Requirements**

| Application Scenario | Network Requirements | | | |
|---|---|---|---|---|
| AR Display | Uplink Bandwidth | Downlink Bandwidth | Transmission Delay | Coverage Area |
| | ≥500 Mbps | No special requirements | ≤100 ms | Plant Building |

**Table 8-6 Personnel Location Requirements**

| Application Scenario | Network Requirements | | | | |
|---|---|---|---|---|---|
| Personnel Location | Uplink Bandwidth | Downlink Bandwidth | Transmission Delay | Number of Connections | Coverage Area |
| | No special requirements | No special requirements | ≤100 ms | >1000 | Production Line |

## 8.2.3 P5G Solution for Smart Thermal Power

The informatization requirements for smart thermal power plants call for a P5G that ensures physical isolation to guarantee information security. The P5G solution for thermal power must focus on two critical aspects: electromagnetic compatibility (EMC) safety and network information security.

● EMC Safety

Within a thermal power plant, electromagnetic-sensitive instrumentation and control equipment must be safeguarded from interference caused by the wireless network. Network equipment must also maintain stable operation within the plant's electromagnetic environment to support safe and sound plant operations. The wireless communication network system must comply with IEC 61000 or GJB151B series EMC standards, ensuring safe, reliable operation across all areas without impacting other plant systems.

● Network Information Security

The wireless P5G for thermal power plants must adhere to security protocols specified for monitoring systems, including relevant requirements from the Power Monitoring System Security Protection Scheme to secure plant data. This includes using dedicated communication systems or proprietary protocols, isolating the network from unauthorized access, and ensuring both wired and wireless connections are isolated from external networks, thus securing data transmission.

The smart thermal power plant P5G employs SA architecture, building an entirely new 5G network with four main components: core network, radio access network, application platform, and access terminals, all managed by

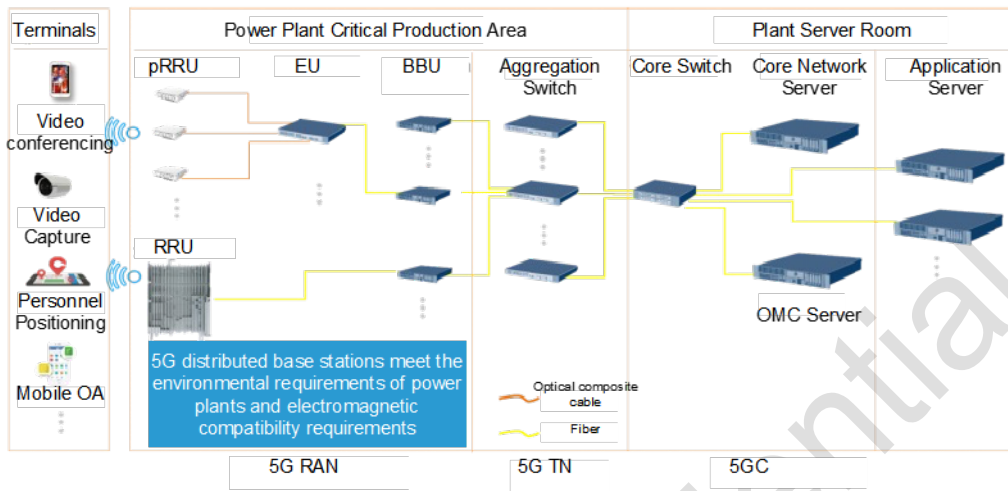a unified network management system. This setup offers high bandwidth, reliability, performance, and security.



**Figure 8-6 Smart Thermal Power Plant P5G Architecture**

The P5G adopts a flat architecture, with wireless base stations connected to the core switch via 10G optical fiber transmission. The transmission layer uses full 10Gbps access with reserved expansion ports.

For outdoor coverage in the plant, high-power base stations are used, while extension Pico base stations provide coverage in indoor areas to eliminate blind spots.

The P5G exchanges data with the plant's private network via secure isolation devices, maintaining complete physical separation from the public network. Onsite 5G connections are authenticated through dedicated SIM cards to ensure user identity uniqueness and authenticity. Additionally, the P5G operations platform monitors user behavior to maintain a secure network environment.

# 8.3 Smart Mining

## 8.3.1 P5G Scenario for Smart Mining

The mining industry is one of the most important energy sources for both daily life and industrial production, and it is a vital part of the real economy. At present, the mining sector is at a critical point of transformation. The low cost, high reliability, enhanced security, and industry-specific customization features

of P5G offer irreplaceable advantages in the manufacturing sector. They can support multiple production and operational scenarios, helping enterprises improve efficiency, reduce costs, and foster innovation and development.



**Figure 8-7   Open-pit Mining Application Scenario**

## 8.3.2 Service Requirements for Smart Mining

Most mines are in remote areas with poor network coverage, and they have numerous personnel and vehicles, but limited management capabilities. The key challenges faced by customers include:

Incomplete Network Coverage: Open-pit mines are in remote locations where communication networks and power infrastructure are hard to build. Communication coverage is expensive, and internal communication still relies on landlines and broadcasting, with a critical need for full-capability communication systems.

Low Management Efficiency: Many workers and vehicles are spread across vast areas, making it difficult to monitor people and vehicles in real time. It is challenging to track contractor personnel locations, monitor work progress, and ensure compliance with safety regulations.

Emergency Response Challenges: Safety is the top priority in mining operations. In emergencies, it's difficult to quickly implement a coordinated

response because the location of personnel is unknown, severely affecting rescue efforts.

Inspection Quality Control: The mining area is vast with long transportation routes and harsh working conditions. It is difficult to plan effective inspection routes and teams and ensure the standardization and quality of inspections.

China aims to establish an intelligent mining system by 2035, with most medium- to large-sized mines achieving full intelligence. The main service requirements for smart mining include the following four aspects:

1.  Intelligent Goal: Mines aim to build intelligent mining, transportation, and production in line with the Industrial Internet requirements, reducing safety incidents and improving work efficiency. The goal is to create green mines and increase resource utilization.

2.  Production Visibility: Real-time perception of production processes, enabling visibility, control, and management. Intelligent positioning of personnel and vehicles.

3.  Minimized Workforce and Automation: Achieving remote mining, driving, and inspection through robotics, eliminating unsafe and inefficient practices in mining.

4.  Intelligent O&M and Unified Management: Business quality visibility, network management, and security control with remote operation capabilities.

## 8.3.3 P5G Solution for Smart Mining

For mining operations, AsiaInfo provides a fully localized, standalone P5G. This solution offers high bandwidth, low latency, and large-scale machine communication capabilities, while also meeting stringent security requirements. Using high-power, low frequency 5G integrated base stations, the network covers all roads and work areas within the mine. This approach meets the demands for low-cost, wide coverage, outdoor adaptability, and easy installation. With integrated base stations, data can be transmitted directly to the core network without edge facilities, reducing costs for mining customers.
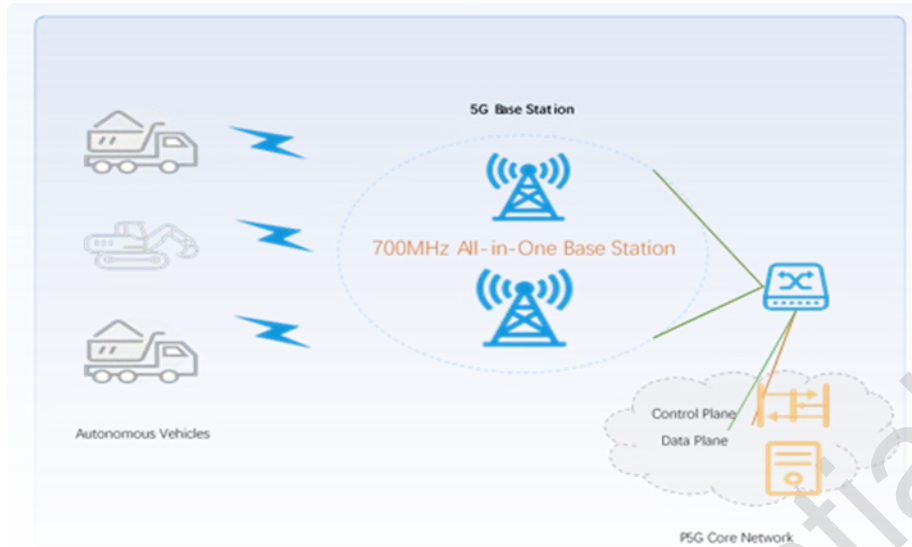
**Figure 8-8 P5G Solution for Mining Industry**

## 8.4 Smart Ports

P5G is also widely applied in smart ports. The following explains P5G applications in ports and service requirements.

### 8.4.1 P5G Scenario for Smart Ports

5G facilitates digital transformation across industries, enhancing productivity and efficiency. Ports, with both industrial and transport functions, have a strong demand for smart, automated operations. Port operations include vertical transportation, horizontal transportation, and comprehensive security monitoring.

Leveraging 5G's high bandwidth, low latency, and massive IoT capabilities, ports can integrate 5G with remote crane control, unmanned container trucks, AGV dispatch, and intelligent security monitoring. This improves automation and smart operations at port terminals, creating eco-friendly, efficient smart ports.

As shown in Figure 8-9 Remote Control of Port Machinery, remote crane control within the vertical transport system covers large port machinery like quay cranes and gantry cranes. Quay cranes handle ship-to-shore container movement, while gantry cranes handle container loading, unloading, and sorting.

**Figure 8-9 Remote Control of Port Machinery**

## 8.4.2 Service Requirements for Smart Ports

Traditional port equipment operations require on-site, high-altitude manual work, which leads to harsh working conditions and high labor costs. Consequently, there is an urgent need for remote control solutions at ports. Some retrofitted ports use fiber or Wi-Fi networks for video backhaul and control signal delivery.

However, fiber backhaul comes with high infrastructure costs and requires maintenance or replacement that can lead to downtime. Wi-Fi backhaul, on the other hand, suffers from limited bandwidth and poor stability. With 5G's high bandwidth, the network can support HD video backhaul from quay and gantry crane cameras. The low latency of 5G ensures real-time control signal responsiveness, while P5G offers flexible network configurations that keep production data within the port and enable data isolation.

Table 8-7 outlines the network requirements for remote control of port machinery.

**Table 8-7 Remote Control Requirements for Port Machinery**

| Application Scenario | Network Requirements | | | |
|---|---|---|---|---|
| Remote Control of Port Machinery | Uplink Speed | Downlink Speed | Transmission Delay | Reliability |
| | ≥30 Mbps | ≥100 Mbps | ≤18ms | ≥99.9% |

The port's horizontal transport system mainly consists of unmanned container trucks and AGVs for moving containers between quay cranes and container yards (designated areas where containers are stacked). Figure 8-10 illustrates the scheduling of unmanned trucks and AGVs.



**Figure 8-10 Unmanned Container Trucks and AGV**

Ports are densely populated industrial zones, where container truck drivers are prone to fatigue, posing safety risks. Currently, automated ports primarily rely on sensor- and camera-based smart container trucks and AGVs guided by geomagnetic systems. These systems use LTE-U private networks for remote vehicle dispatch. However, smart trucks are limited by the sensitivity of onboard sensors, and the high-cost, fixed-route geomagnetic guidance system lacks flexibility. 5G-based autonomous driving technology addresses these challenges by providing high-precision positioning and ultra-low-latency, reliable data transmission for sensor information.

Table 8-8 lists the 5G network requirements for unmanned truck and AGV scheduling.

**Table 8-8   Requirements for Unmanned Truck and AGV Scheduling**

| Application Scenario | Network Requirements | | | |
|---|---|---|---|---|
| Autonomous Container Truck and AGV Scheduling | Uplink Speed | Downlink Speed | Transmission Delay | Reliability |
| | ≥30 Mbps | No special requirements | ≤20ms | ≥99.9% |

The port's security monitoring system primarily uses cameras and drones to oversee port safety, inspect equipment and facilities, and patrol the coastline. Figure 8-11 illustrates common setups for intelligent security monitoring.
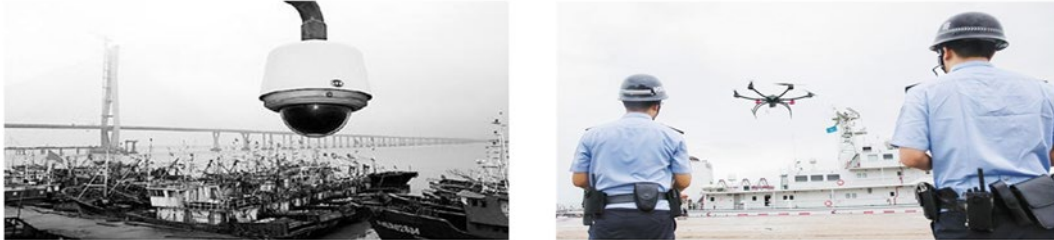


**Figure 8-11 Smart Security Monitoring**

Real-time monitoring is essential to build efficient, automated ports, covering all aspects of operations, including personnel, vehicles, ships, cargo, and production workflows. The system integrates ground and aerial surveillance via drones and on-ground cameras, significantly reducing manual oversight.

Current Wi-Fi solutions for port security have drawbacks, such as surveillance blind spots, limited capacity, and low stability. In contrast, the P5G combines 5G with AR/VR, high-definition cameras, and drone inspections, providing complete coverage and real-time visual monitoring across the port.

Table 8-9 outlines the network requirements for intelligent security monitoring. Key network metrics include:

**Table 8-9 Network Requirements for Intelligent Security Monitoring**

| Application Scenario | Network Requirements | | | |
|---|---|---|---|---|
| Intelligent Security Monitoring | Uplink Speed | Downlink Speed | Transmission Delay | Number of Connections |
| | ≥40 Mbps | No special requirements | ≤100ms | ≥50 |

## 8.4.3 P5G Solution for Smart Ports

Figure 8-12 presents a P5G solution for a smart port. This hybrid P5G leverages existing carrier 5G infrastructure, using a "UPF local breakout with MEC" configuration to establish a P5G.
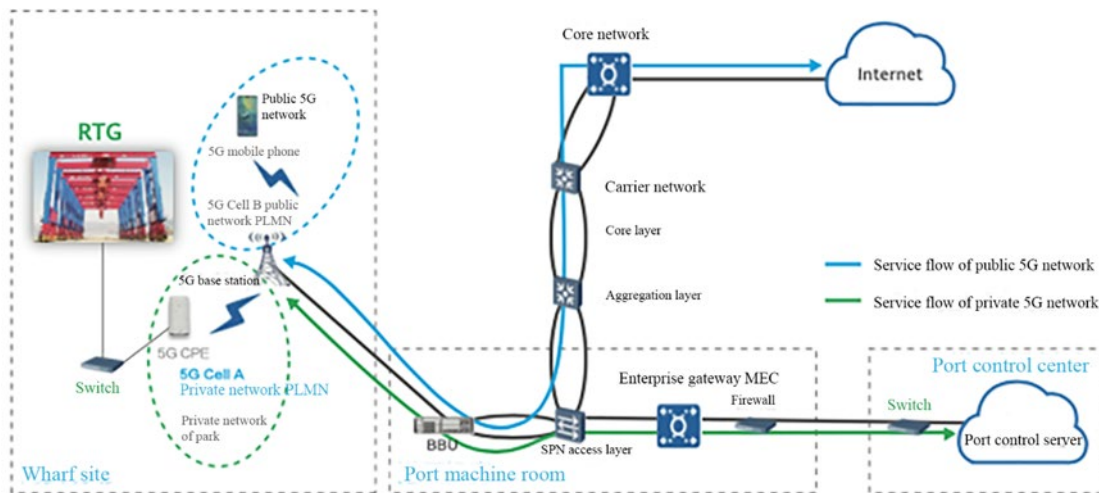
**Figure 8-12 P5G Solution for Smart Ports**

At the dock, telco's public base stations are used, with both the 5G public PLMN and the private 5G PLMN enabled simultaneously. Regular mobile users connect to the 5G public network, while dedicated port system devices connect to the private 5G network, ensuring logical separation between the two.

In the port's data center, the port's 5G core network UPF and MEC system are deployed to split the network traffic. Public data is routed to the internet, while private network data is directed to the port control center, ensuring both security and performance for the port's private 5G network.

# 8.5 Smart Steel

P5G can enhance the digitalization and intelligence of the steel industry, addressing corresponding business challenges.

## 8.5.1 P5G Scenario for Smart Steel

The steel industry is one of the most complex and high-risk sectors in industrial manufacturing. The new capabilities provided by 5G networks can significantly reduce operational risks and enhance the industry's intelligence level.

In steel production, six main applications—unmanned overhead cranes, ultra-HD security surveillance, machine vision for quality inspection, slag-handling robots, drone inspections, and AR-assisted remote support—rely on P5G for reliable communication. These applications together form a comprehensive

smart steel solution. Figure 8-13 illustrates various scenarios for smart steel applications.
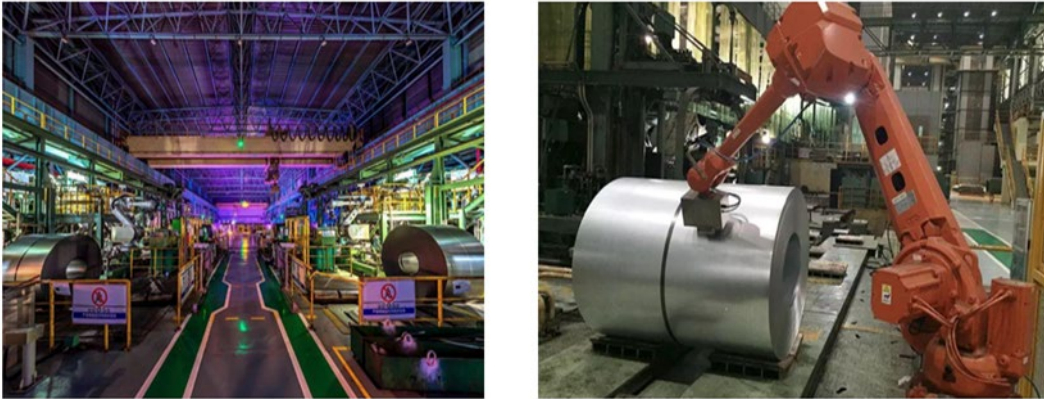


**Figure 8-13 P5G Scenario for Smart Steel**

## 8.5.2 Service Requirements for Smart Steel

Network performance requirements in the steel industry can be generally grouped into two categories: low-latency requirements, such as for slag-handling robots and PLC controls, and high uplink bandwidth requirements, such as for machine vision and quality inspections.

Unmanned overhead cranes require low-latency PLC remote control, with latency not exceeding 50ms. Telcos also need multi-angle HD video from a first-person perspective to ensure precise and real-time remote control. Table 8-10 lists the network requirements for unmanned crane operations.

**Table 8-10 Network Requirements for Unmanned Cranes**

| Application Scenario | | Network Requirements | | | | |
|---|---|---|---|---|---|---|
| 5G Unmanned Overhead Cranes | Functions | Uplink Bandwidth | Downlink Bandwidth | Transmission Delay | Reliability | Coverage Area |
| | Control Signal Transmission | ≥1Mbps | No special requirements | ≤50ms | ≥99.99% | Production Line |

| Application Scenario | | Network Requirements | | | | |
|---|---|---|---|---|---|---|
| | High-definition Video Transmission | ≥50Mbps | No special requirements | ≤50ms | ≥99.99% | Production Line |

In visual machine quality inspection, fast transmission of control signals requires latency under 20ms, while high-resolution image uploads need uplink bandwidth above 100 Mbps. Table 8-11 outlines the network requirements for visual machine quality inspection.

**Table 8-11 Network Requirements for Visual Machine Quality Inspection**

| Application Scenario | | Network Requirements | | | | |
|---|---|---|---|---|---|---|
| | Functions | Uplink Bandwidth | Downlink Bandwidth | Transmission Delay | Reliability | Coverage Area |
| Machine Vision Quality Inspection | Control Signal Transmission | ≥1Mbps | No special requirements | ≤20ms | ≥99.99% | Production Line |
| | High-definition Video Transmission | ≥100Mbps | ≥20Mbps | ≤100ms | ≥99.99% | Production Line |

In equipment maintenance scenarios, AR technology helps address the shortage of technical experts and the high travel costs for on-site support, significantly improving equipment repair efficiency. Table 8-12 outlines the network requirements for remote AR assistance.

**Table 8-12  Network Requirements for AR Remote Assistance**

| Application Scenario | Network Requirements | | | | | |
|---|---|---|---|---|---|---|
| 5G AR Remote Assistance | Function | Uplink Bandwidth | Downlink Bandwidth | Transmission Delay | Reliability | Coverage Area |
| | Video Backhaul | ≥500Mbps | No special requirements | ≤100ms | ≥99.99% | Production Line |

## 8.5.3 P5G Solution for Smart Steel

Figure 8-14 presents a P5G solution for smart steel, featuring a hybrid P5G with UPF localization and MEC deployment.

On the wireless side, a detailed network design is required, considering the specific bandwidth and uplink requirements as well as the signal interference and high penetration loss typical of steel industry workshops. This includes careful planning of base station locations, types of base station equipment, and frequency selection to ensure optimal coverage and performance.

On the core network side, if user data needs to remain on-site, the UPF can be deployed directly within the facility. Depending on operational needs, such as support for both low-latency and high-uplink bandwidth services, end-to-end 5G network slices can be created, with each slice configured to meet specific performance requirements.

Given the high network reliability requirements in industrial steel production, spare parts such as MEC servers, CPE, and AR routers should be maintained within the facility to ensure quick replacements when needed.
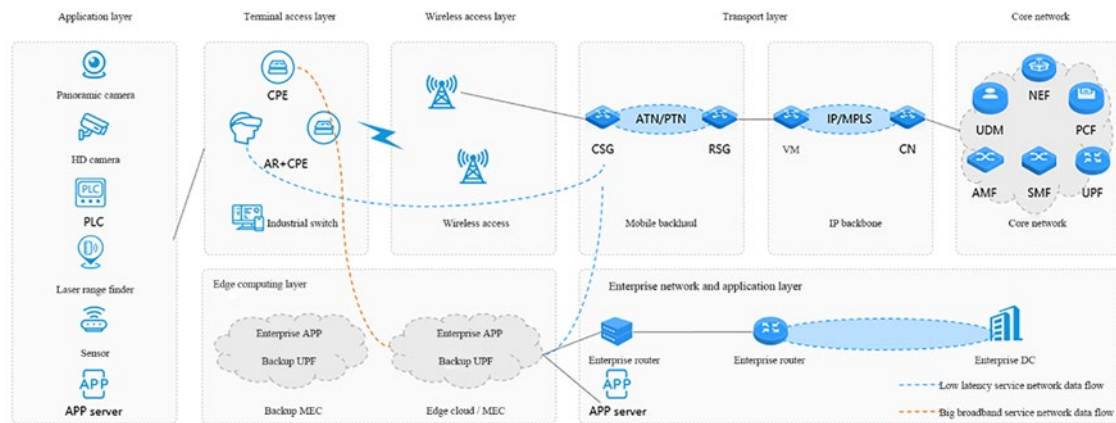
**Figure 8-14 P5G Solution for Smart Steel**

## 8.6 Smart Wind Power

### 8.6.1 P5G Scenario for Smart Wind Power

Smart wind power refers to the use of advanced information technologies to intelligently manage and control the design, construction, operation, and maintenance of wind farms. By integrating and analyzing large amounts of data from both inside and outside the wind farm, it optimizes the operational efficiency and energy output of the wind farm, reduces O&M costs, and improves the reliability and economy of wind power.

The application of 5G technology enables more precise remote monitoring and control of wind farms, improving automation and response speeds. For example, 5G can support real-time data collection and transmission from numerous sensors and smart devices within the wind farm. This allows O&M personnel to access up-to-date operational and environmental data from wind turbines, enabling accurate fault diagnosis and maintenance.

### 8.6.2 Service Requirements for Smart Wind Power

Wind farms are typically located in remote, difficult-to-access areas with harsh environments, making maintenance and troubleshooting challenging when issues arise. The main service requirements for smart wind power include:

Instant Communication: A P5G enables staff to communicate instantly through voice calls, messaging, and other real-time channels.

5G-Based Operations Management: Key requirements include integration with operational systems for task guidance, real-time location tracking of personnel and vehicles, and remote expert or operations guidance.

5G-Based Turbine Maintenance and Inspection: Includes visual inspection guidance, live video guidance for maintenance, and other forms of remote, real-time support.

**Table 8-13 5G Requirements for Remote Expert Guidance**

| Application Scenario | Network Requirements | | | | | |
|---|---|---|---|---|---|---|
| 5G Remote Expert Guidance | Function | Uplink Bandwidth | Downlink Bandwidth | Transmission Delay | Reliability | Coverage Area |
| | Video Backhaul | ≥500Mbps | No special requirements | ≤100ms | ≥99.99% | Around the Wind Turbine |

## 8.6.3 P5G Solution for Smart Wind Power

For smart wind power applications, AsiaInfo's overall P5G solution includes a wireless 5G base station system, optical fiber transmission system, switches, core network, firewall system, and more. It ensures comprehensive 5G network deployment and coverage across the entire wind farm, providing 24/7 uninterrupted communication, data transmission, and other services. Additionally, P5G supports communication tools for on-site staff and management tools for external personnel operations.

Figure 8-15 provides a typical P5G solution for smart wind power. In this setup, the core network is optimized with four core elements localized onsite, and the wireless network uses 700MHz integrated base stations, meeting energy security standards. The use of the 700MHz frequency leverages its low signal loss and high coverage capacity, resolving the challenge of wide-area coverage around the wind farm.
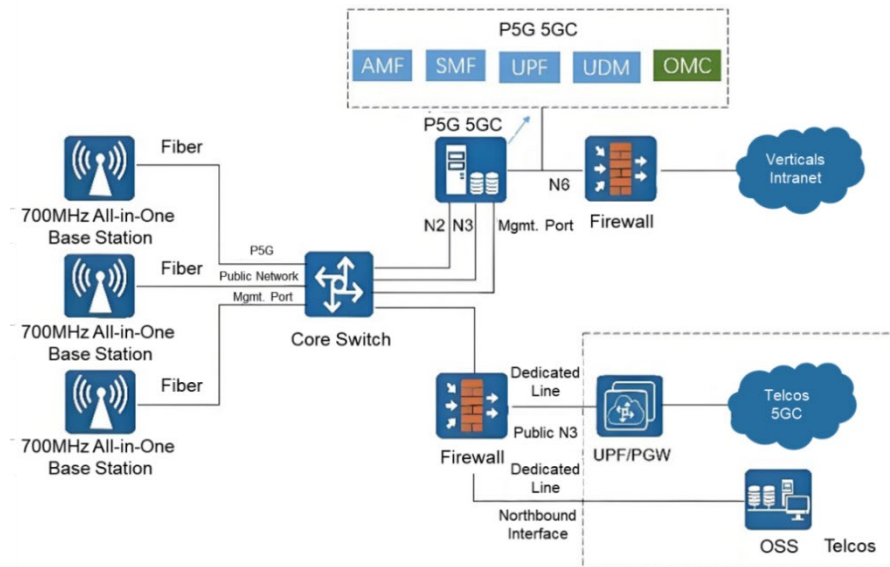
**Figure 8-15 P5G Solution for Smart Wind Power**

# 8.7 P5G Operations

## 8.7.1 P5G Scenario for Operations

For industry-specific P5G scenarios, the integration of 5G with vertical industry applications becomes a new growth engine. Built on CT, this solution deeply integrates IT and OT technologies, achieving differentiated network support, coordinated edge equipment management, network quality monitoring, and replicable low-cost, standardized solutions. This setup enables advanced factories characterized by extensive connectivity, optimal data utilization, and efficient deployment of innovative applications, driving productivity and sustainability in operations.
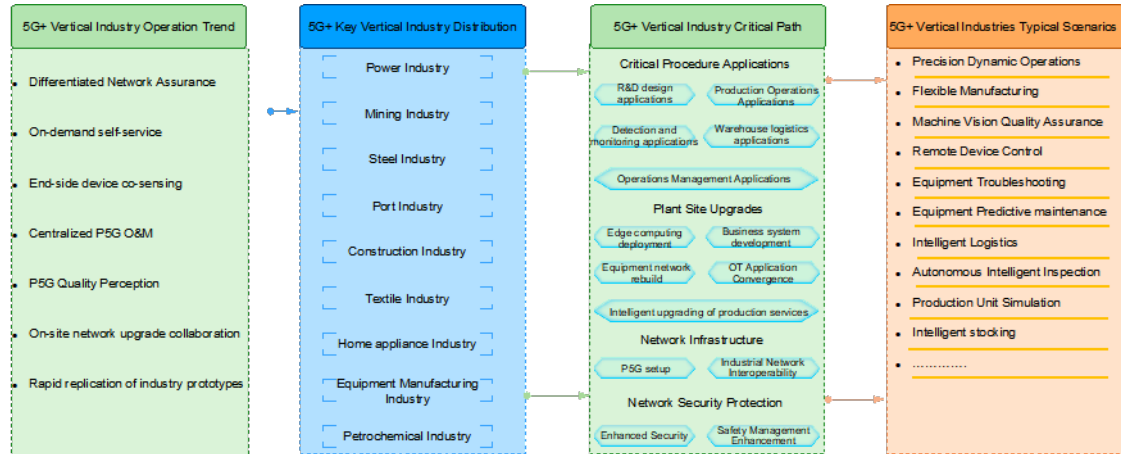
**Figure 8-16 5G+Key Operation Scenarios of Verticals**

## 8.7.2 Service Requirements for P5G Operations

Digital transformation in vertical industries is moving beyond peripheral support to deeply integrate with core production processes, enabling close coordination with onsite equipment. The adoption of 5G addresses previous network limitations by enhancing scenario-based monitoring, activating industrial-grade operations, and offering flexible, on-demand deployment for industry-specific needs, expanding the 5G+ industry ecosystem.

To meet the fragmented, specialized, and customized demands of vertical industries, an integrated operations platform is essential. This platform enables flexible, on-demand deployments and coordination, driven by scenario-based applications, allowing rapid, low-cost replication of 5G+ model deployments across industry use cases.
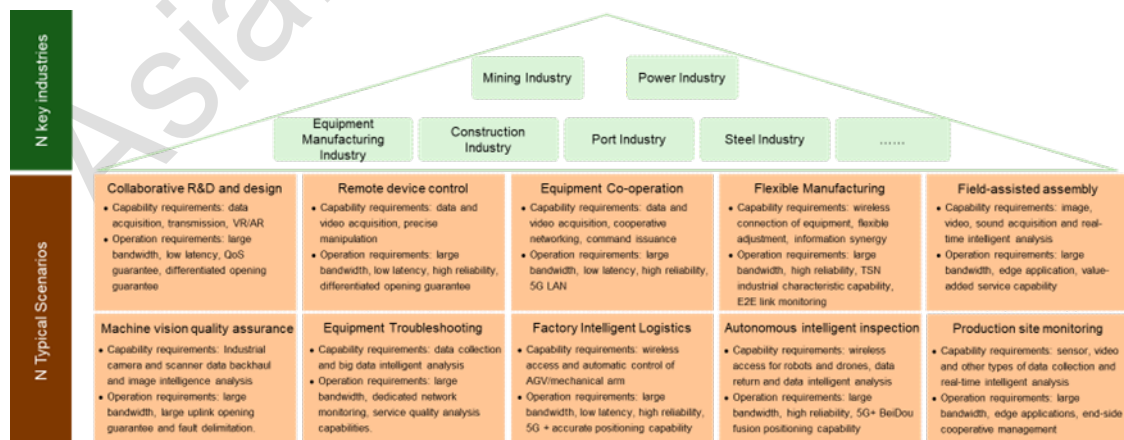


**Figure 8-17   Network Requirements for Vertical Industries**

### 8.7.3 P5G Operations Solution

P5G is built on a standalone 5G architecture tailored for the campus, connecting seamlessly with the OMC platform and production systems to enable unified network operation and intelligent maintenance monitoring.
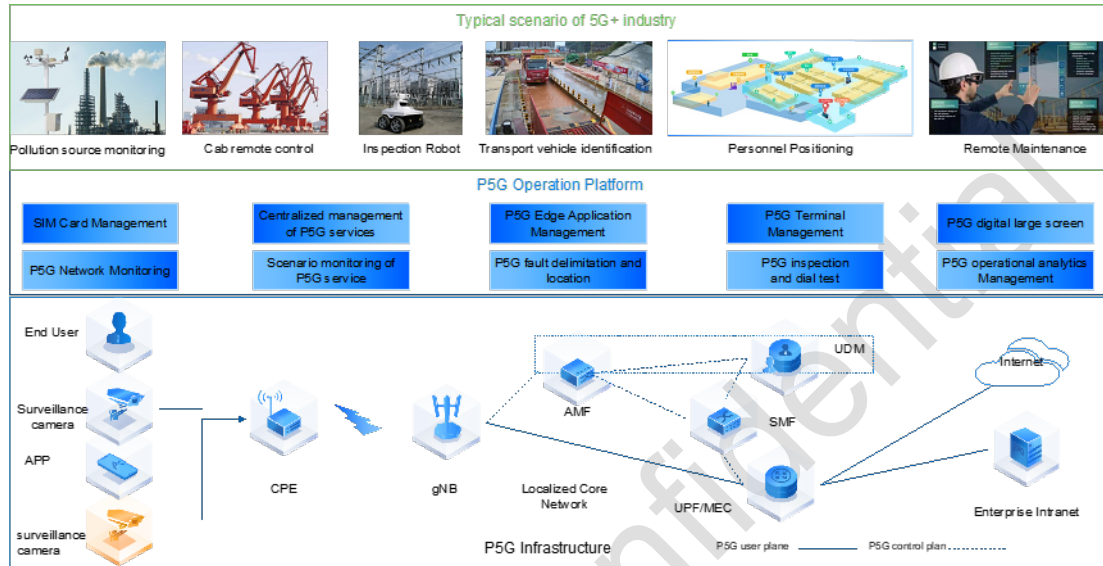


**Figure 8-18 Overall P5G Operation Solution**

P5G operations widely integrate with basic network devices to enable SIM card self-management, network monitoring, business scenario monitoring, and fault diagnostics under an independent network architecture. This reduces the usage barrier for industry customers. Core functions include:

- SIM Card Management: In an independent network, it integrates with SIM card providers and the core network management system to enable SIM card activation and lifecycle management, achieving autonomous SIM card management within the campus.

- Centralized Business Monitoring: Provides network slicing, 5G LAN, TSN, secondary authentication, and other scenario-based, differentiated, and refined management capabilities for industry-specific functions.

- Edge Application Management: Opens edge application marketplace, supports deployment, monitoring, and value-added services for edge applications. Based on edge PaaS and AI algorithms, it enables

configuration and personalized expansion of edge sub-applications to meet diverse business innovation needs.

- Device Management: Manages smart terminals and modules for private networks, including terminal information management, scene-specific configuration, and geographical distribution management.

- Digital Dashboard: Meets customers' needs for digital monitoring of core business and key equipment. Offers customizable, flexible dashboards to enhance digital monitoring effectiveness.

- Network Monitoring: Provides end-to-end network monitoring for private networks, slice networks, DNNs, etc. Visualizes the network topology for wireless, transport, and core networks, allowing customers to intuitively check and analyze network quality.

- Business Scenario Monitoring: Builds on network monitoring to enable end-to-end connection analysis and awareness for typical ToB business scenarios. Use network probe packet analysis in collaboration with module software probes and application probes to trace business transactions end-to-end and perform business quality analysis for various protocol scenarios based on specific use cases.

- Fault Detection: Supports fault isolation and display for issues like business connection interruption, abnormal termination, and degraded connections. Uses diagnostic tools like dial tests for root cause analysis and fault tracing.

- Inspection and Testing: For centralized monitoring scenarios, supports N3 and N6 interface testing management to collect key network metrics and perform fault isolation and latency testing.

- Operation Analysis and Management: Analyzes and compiles operational data, focusing on core business metrics, key business data reports, and a network quality overview.

# 9 Use Cases

AsiaInfo's P5G product provides Telcos and customers with a full-stack, end-to-end P5G solution and services, supporting agile networks for personalized applications and driving industry digital transformation.

## 9.1 P5G for a Nuclear Power Plant

AsiaInfo's P5G product has been successfully deployed in multiple nuclear power plants. The following details are the project requirements, solution, and effects.

### 9.1.1 Customer Requirements

The nuclear power plant's goal is to use IoT technology to establish a data collection network for plant systems and equipment, enhancing digital monitoring capabilities for plant status. Additionally, the wireless network aims to support operational and maintenance digitization, mobility, and end-to-end process tracking. Specific network requirements to support plant operations are outlined in Table 9-1.

**Table 9-1  Service Requirements for Smart Nuclear Power Applications**

| No. | Category | Service Requirements |
|---|---|---|
| 1 | Equipment/Materials Management Improvement | Continuous Monitoring of SPV Equipment or Other Critical Equipment |
| 2 | | Data Collection for SPV Equipment or Other Critical Equipment |
| 3 | | Data Alerting for SPV Equipment or Other Critical Equipment |
| 4 | | Radiation Source and Hazardous Chemical Monitoring |
| 5 | | Radiation Source and Hazardous Chemical Movement Tracking |

| No. | Category | Service Requirements |
|---|---|---|
| 6 | | Simplified Maintenance Solutions for Street Lights, Lighting, Cabinet Fans, Fire Alarm Sensors, Fire Doors |
| 7 | | Access Control Management for Critical Sensitive Areas |
| 8 | | Continuous Monitoring of Key Environmental Parameters |
| 9 | | Collection of Critical Environmental Data |
| 10 | | Early Warning for Critical Environmental Data |
| 11 | | Electronic Fencing for Important Equipment and Areas |
| 12 | | High-Risk Worksite Area Alerts |
| 13 | | Work Time Alerts for High-Risk Worksites |
| 14 | Site/Environment Improvement | Monitoring of Critical Worksites, Temporary Construction Sites, and Accident Zones |
| 15 | | Construction of Unattended Factory Buildings |
| 16 | | Monitoring of Manhole Covers, Leak Detection, and Parking Space Management |
| 17 | | Establishment of Radiation Monitoring Network for Real-Time Transmission of Radiation Levels and Worker Dose Data |
| 18 | | Hotspot Location Entry Prevention Alerts |
| 19 | | Accurate Personnel Location, Headcount, and Flow Monitoring |
| 20 | Work Activity Management Improvement | Real-Time Issue and Defect Reporting by Inspection Personnel |
| 21 | | Uploading of Photos, Videos, Inspection Data, and Leak Detection by Inspection Personnel |

| No. | Category | Service Requirements |
|-----|----------|---------------------|
| 22 | | Automated Planning of Inspection Plans, Routes, and Tasks for Effective Management |
| 23 | | Unmanned Inspections in Remote Areas |
| 24 | | Remote Monitoring of Operations |
| 25 | | Reducing Human Errors in On-Site Operations |
| 26 | | Digitalized and Mobile Operation Procedures, Diagrams, and Tickets |
| 27 | | Mobile Maintenance |
| 28 | | Multimedia Scheduling |
| 29 | | Instant Messaging |
| 30 | | Emergency Response |
| 31 | | On-Site Delivery within the Plant |
| 32 | | Warehouse Management |
| 33 | | Tool Tracking Management |
| 34 | | On-Site Location of Fixed Assets and Search for Lost Equipment |
| 35 | | Inspection Safety |
| 36 | | Operational Safety |
| 37 | Personnel Safety Management Improvement | Radiation Safety |
| 38 | | PPE Compliance Monitoring |
| 39 | | Behavior Monitoring |

| No. | Category | Service Requirements |
|-----|----------|---------------------|
| 40 | | Safety Witnessing |
| 41 | | Security Enhancements |

## 9.1.2 Solution and Effects

P5G for the nuclear plant is deployed using an independent private network for the production area and a hybrid private network for the front area, ensuring full 5G coverage. Figure 9-1 shows the overall P5G solution for the nuclear power plant.
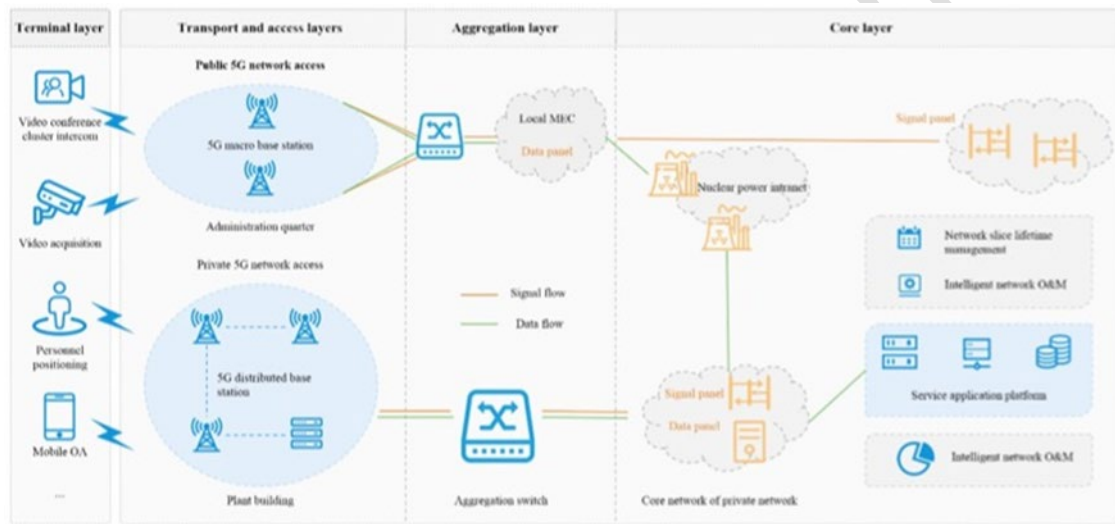


**Figure 9-1 P5G Solution for a Nuclear Plant**

The P5G for this nuclear power plant features the following:

- Key Requirements: Supports safety production, efficient maintenance, radiation protection, human error management, and online training and exams.

- Network Security: The production area's P5G follows level 3 information security protection standards, while the front plant area's hybrid network (with local MEC) follows level 2 security standards.

- Electromagnetic Compatibility: Equipment meets strict EMC standards to avoid interference with other plant systems, such as DCS and safety instruments.

The P5G operations platform for nuclear power establishes targeted business operations and network management capabilities, enabling slice activation, SIM card self-management, integrated operations, equipment integration, personnel tracking, and unified voice under an independent network setup. This platform continuously supports the development of new intelligent applications, empowering the digital transformation of nuclear power plants. Key functionalities are illustrated in Figure 9-2.
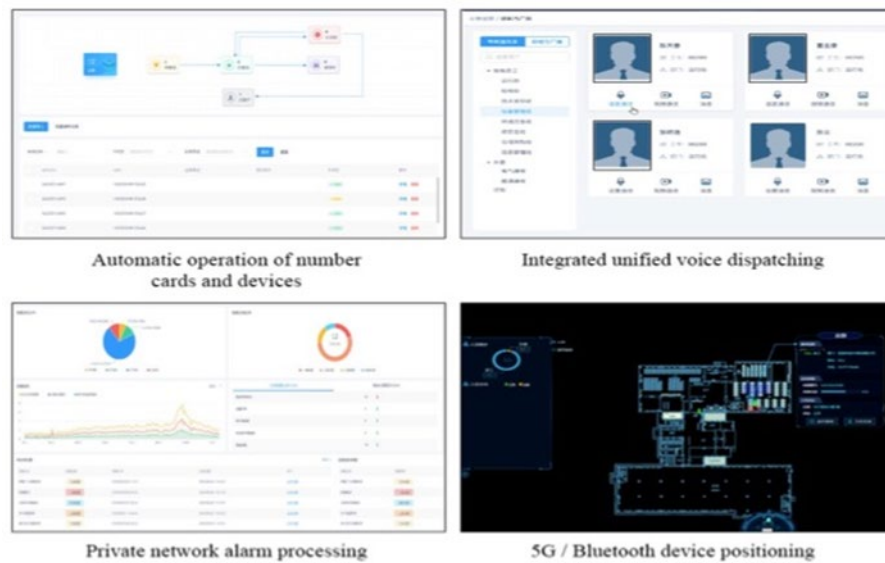


Automatic operation of number cards and devices

Integrated unified voice dispatching

Private network alarm processing

5G / Bluetooth device positioning

**Figure 9-2 Main Functions of P5G Operations Platform**

AsiaInfo's P5G solution offers substantial economic benefits to nuclear power customers. Estimated benefits per nuclear unit include:

● Centralized 5G communication coordination: Reduces setup time for temporary communication systems during major overhauls, minimizes traditional communication methods like broadcast paging or fixed-line calls, lowering operational costs by approximately $1,500,000 annually.

● Electronic ticket system: Cuts down on labor hours and paper usage, reducing costs by around $3,000,000 annually.

● Intelligent inspection system: Enables real-time data transmission to the backend, mobile work for personnel, and minimizes manual data recording, organization, and analysis, leading to an estimated annual savings of $500,000.

- Additional smart systems for O&M: Generates savings of approximately $7,500,000 or more annually by supporting enhanced digital tools for plant operation and repairs.

Implementing the P5G strengthens the nuclear power sector's digital operations, laying a foundation for digitalized, mobile-enabled, and comprehensively tracked O&M.

## 9.2 P5G for a Thermal Power Plant

AsiaInfo's P5G has been successfully deployed in the thermal power industry. The following is a typical use case.

### 9.2.1 Customer Requirements

A thermal power plant serves as both a green thermal power demonstration and an intelligent thermal power benchmark. See Figure 9-3 for an overview of the thermal power plant's P5G project.



**Figure 9-3   P5G Project for a Thermal Power Plant**

As the first intelligent benchmark plant developed by the group, the project leverages the "Four-Unit, One-Control "(integrated control of four generator units) approach to optimize design and drive innovation from the outset. Following the "Two Platforms (Intelligent Generation ICS, Intelligent Management IMS) and Three Networks (Production Control Network, Management Information Network, and Industrial Wireless Network) "standard

framework, it builds an integrated control system according to unified requirements across the infrastructure, platform, application, and interaction layers. The wireless P5G, as a critical part of the infrastructure layer, provides network support for mobile applications, personnel tracking, drones, AR, and other intelligent tools across the plant.

Supported by 5G, the project also applies technologies like ubiquitous sensing, digital twin, big data, cloud computing, and artificial intelligence to develop a full life-cycle intelligent plant ecosystem with features such as self-analysis, self-diagnosis, self-management, self-optimization, self-recovery, self-learning, and self-improvement.

With the high performance, security, and reliability of the P5G, the project will provide an intelligent network guarantee for safe plant operations. The project adopts a "unified planning, phased implementation "approach, with smart engineering during the infrastructure phase. During operations, the goal is to achieve higher labor productivity, first reaching "unmanned inspections and fewer operators "and ultimately aiming for "minimal operators and minimal management ".

## 9.2.2 Solution and Effects

To meet safety standards, a localized full-core P5G is being deployed for comprehensive plant-wide coverage, ensuring reliable and stable 5G signal quality, especially in key construction and production areas. This network supports the plant's needs from construction through operational phases, accommodating high-definition video streaming, big data collection, AR/VR remote assistance, intelligent inspection robots, and drones for data transfer.

The P5G solution for this thermal power plant shown in Figure 9-4 includes:

A complete access solution designed to support ICS 2.0, enabling smart plant operations.

Wireless 5G coverage with core network localization, forming a telecom-grade, high-bandwidth, low-latency network without external boundaries within the plant.

A 5G mobile application cluster that supports on-site mobile tasks with a foundational IaaS platform, data backup, third-level security, and a business release zone.

Minimal-boundary integration with the production network via optical isolation for 5G communication with ICS systems in production Area 1.

A private network operations platform that unifies all boundaries and infrastructure management, simplifying maintenance.
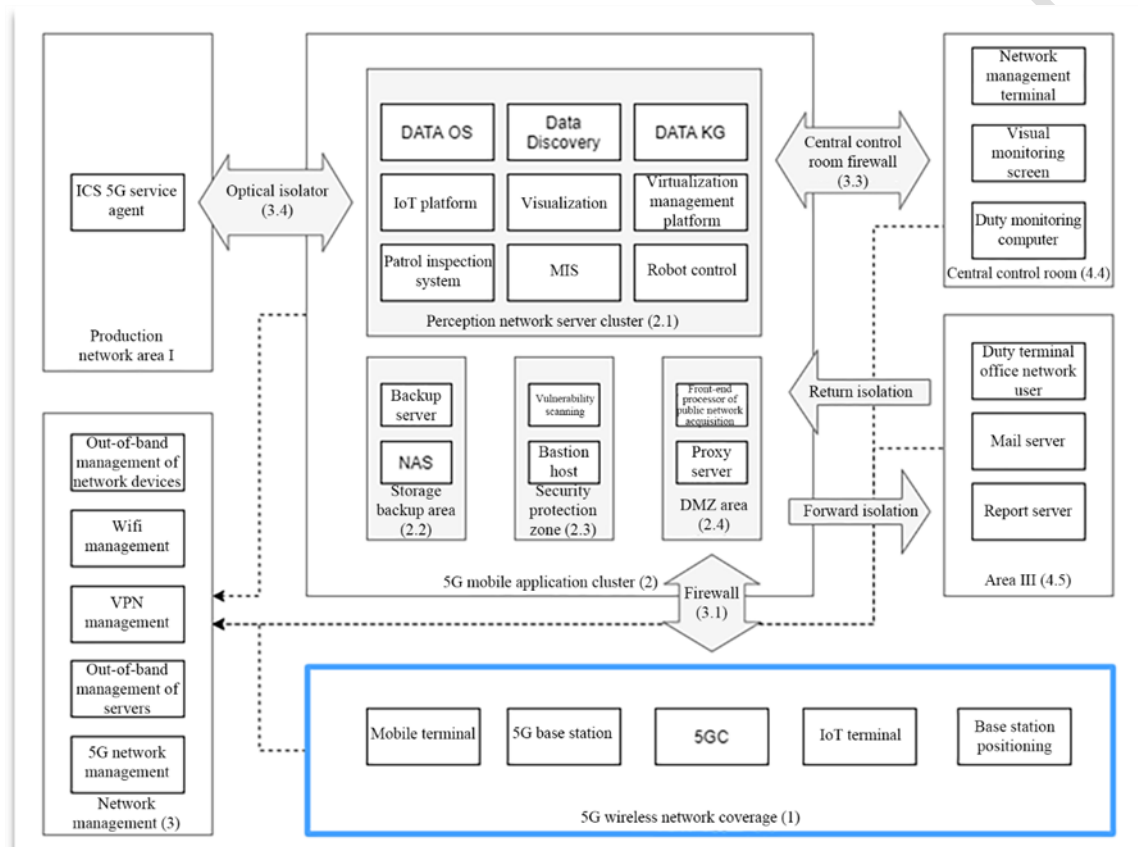


**Figure 9-4   P5G Solution for a Thermal Power Plant**

# 9.3 A P5G for a Large Open-Pit Coal Mine

AsiaInfo's P5G has been successfully deployed in a large open-pit coal mine. The following details are the use case.

## 9.3.1 Customer Requirements

P5G has been deployed within the closed-off areas of an open-pit coal mine in Xinjiang, supporting unmanned trucks and remote excavator control. This

mine, as a model demonstration site, highlights the strategic importance of the P5G project.

The primary customer requirement is to enable industrial wireless network applications for equipment management throughout the mine site. With full industrial wireless coverage, the mine can facilitate unmanned vehicle operations, drone inspections, conveyor belt inspection robots, video monitoring, rapid retrieval of equipment data, and remote diagnostics. The 5G network security access control system enables secure integration with the mine's production network through MEC platform devices. With full 5G coverage, engineering vehicles on-site are equipped with onboard devices that support real-time video, voice communication, and real-time messaging. Unmanned driving, a key beneficiary of 5G connectivity, depends on this robust network, enhancing high-precision navigation and remote-control applications.

## 9.3.2 Solution and Effects

The P5G Smart Mining project in Xinjiang uses a 5G wireless system with a core network, two 700 MHz high-power integrated base stations, and supporting infrastructure. The system includes 5G base stations, fiber-optic transmission, switches, core network, and firewall systems, covering the entire mining area with 5G wireless network. This provides 24/7 communication and data transmission services, along with P5G real-time communication tools and external personnel management.

This solution enables high-speed data communication and intelligent control. By sending control commands via the P5G, it supports the upload and integration of vehicle data, boosting the operational efficiency of autonomous vehicle convoys. The innovative integration of autonomous transport systems with digital twin optimizes mining operations, smart scheduling, and monitoring.

With autonomous driving fully implemented across the mine, transportation efficiency will increase by over 10%, fuel consumption reduced by 10%, and operating costs cut by 10%.

**Figure 9-5 P5G for a Large Open-pit Coal Mine in Xinjiang**

# 9.4 P5G for a Wind Farm

## 9.4.1 Customer Requirements

A national energy group's wind farm, located in Guangning, Zhaoqing—known as the "Bamboo Town "—spans over 7 square kilometers and employs 15 large wind turbines. While the public network primarily covers residential areas, the wind farm experiences weak coverage, and many turbine operations lack timely communication through the telco's network. The challenging mountainous terrain and adverse weather conditions here also increase the risks of high-altitude falls, electric shocks, lightning strikes, and fires. Emergency communication is limited between turbine platforms and access roads. It also faces high costs for independent O&M, with a lack of skilled workers, experts, and external professional teams. And management challenges arise due to insufficient remote support. Additionally, there are no tools and smart solutions for managing external workers. During emergency events, it is difficult to quickly obtain on-site information, communicate, make decisions, and guide operations.
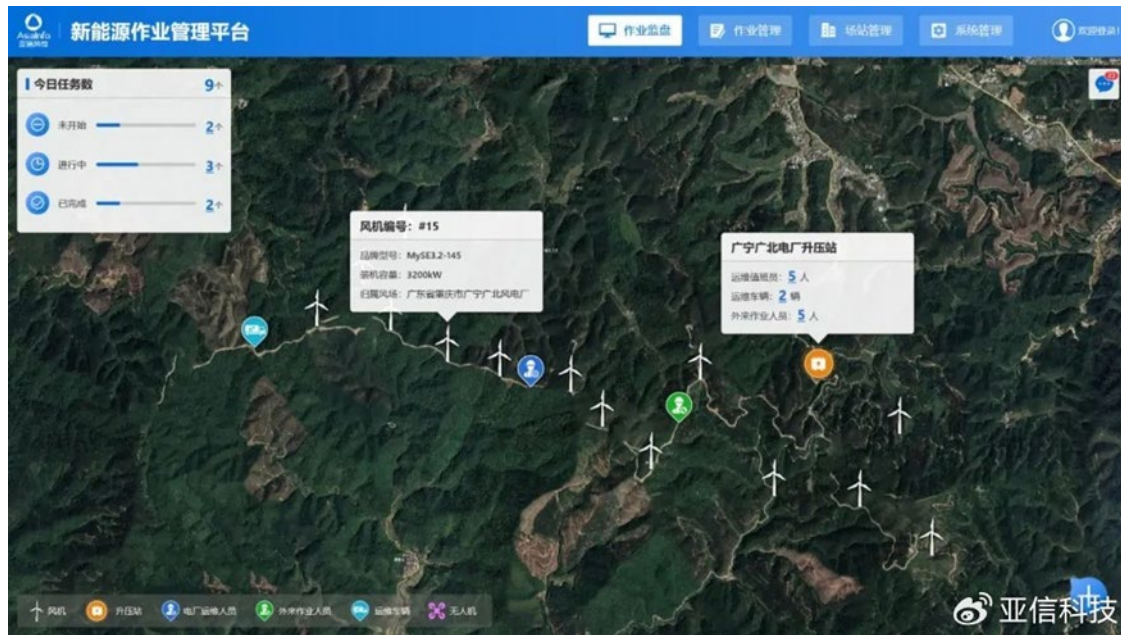
**Figure 9-6 A Smart Wind Farm in Guangdong**

## 9.4.2 Solution and Effects

In this project, AsiaInfo's self-developed P5G core network provides a decoupled hardware and software solution, fully cloud-deployed with elastic scalability. It integrates edge computing, AI-driven O&M, traffic security offloading, and open network capabilities, forming the foundation for 5G smart applications like drone inspections, tower-climbing robots, vibration monitoring, blade crack analysis, and lightning strike warnings. This enables the digitalization and intelligence of production and operational management at the wind farm. AsiaInfo also developed China's first 700MHz All-in-One base station for the wind power industry, ensuring power security. It successfully demonstrates that this frequency offers low propagation loss and wide coverage in the mobile communications. The solution pioneers the use of P5G in wind power, integrating edge data collection, operation monitoring, safety management, and remote diagnostics with a professional network management platform and a 24/7 customer support SLA to ensure stable network operation.

AsiaInfo's P5G, developed in collaboration with Telcos and a new energy company, stands out for its localized deployment of all network elements, offering top-level security. The solution is deeply integrated with the wind farm's operations, including personnel access, work process management, and

closed-loop management. During the network deployment, the project leverages the existing communication infrastructure and optical fiber resources at the wind farm, significantly reducing transmission network costs. By installing the turbines, the base station minimizes overall cost, delivering a cost-effective solution. This P5G enables a range of smart applications, including edge data collection, operation monitoring, safety management, and remote diagnostics. It supports technologies like drone inspections, tower-climbing robots, vibration monitoring, blade crack analysis, and lightning strike warnings, driving the digitalization and intelligence of the wind farm's production and operational management.



**Figure 9-7 Deployment of Smart Wind Power**

## 9.5 P5G Operations for an Enterprise

AsiaInfo's P5G operations platform has been commercially deployed in multiple provincial-level power companies. The following provides a detailed overview of its P5G Scenario.

### 9.5.1 Customer Requirements

The development of new power systems is characterized by ""massive terminal access, frequent information exchange, and control extending to the edges."" This creates new demands for the flexibility of grid communications, business support capabilities, security isolation, and overall operations. The high-speed, low-latency, high-reliability, and massive connectivity features of 5G align perfectly with the needs of new power system services. It ensures reliable communication in the final phase and expands the scope and capability of monitoring and control in modern power systems.

## 9.5.2 Solution and Effects

The smart power P5G operations platform integrates the three major telecom networks, enabling collaborative governance and comprehensive support for all power-related services. It facilitates online service management, network panoramic monitoring, and real-time terminal control, enhancing network capacity and driving smarter, more refined grid management.
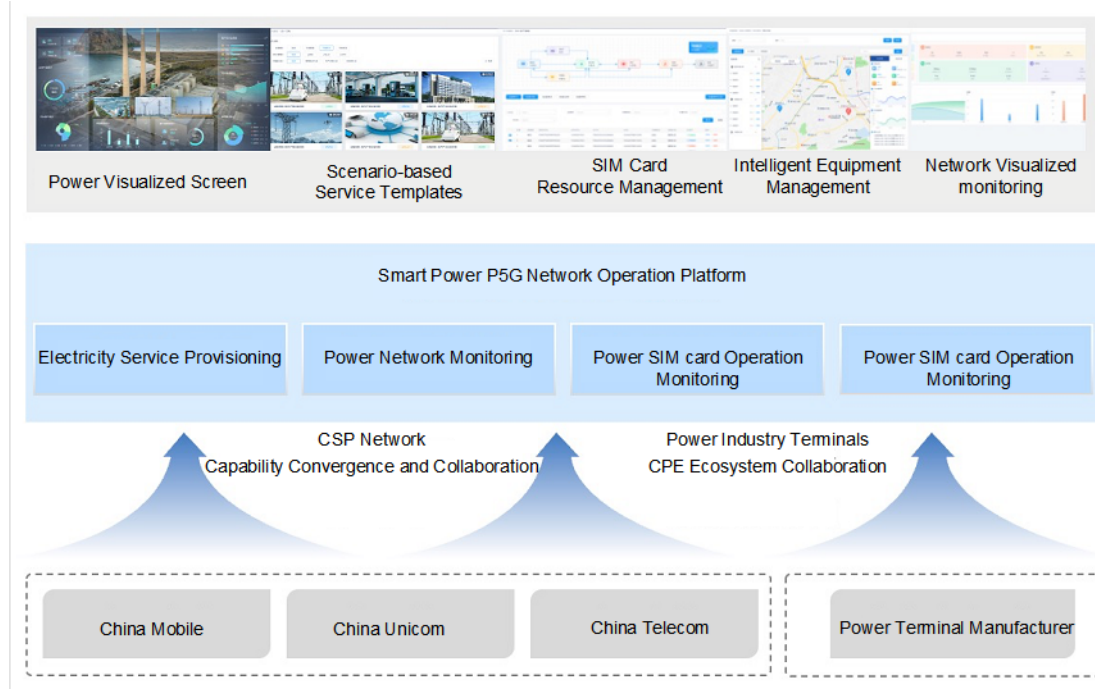


**Figure 9-8 P5G Operations Platform Architecture for a Smart Power**

Providing 5G network coverage and differentiated operational capabilities for information management and production zones in the power sector, the solution establishes plug-and-play business templates and centralized monitoring for the key stages of generation, transmission, transformation, distribution, and consumption.

- Generation: Through 5G network slicing and wireless access, power dispatch centers gain unified control over power plants. This solution overcomes limitations in remote or distributed power plants lacking fiber coverage and provides cost-effective alternatives to expensive new cable installations, enabling pervasive terminal connectivity.

- Transmission: Using 5G network slicing with a BeiDou ground augmentation system, this solution supports drone inspections of power

lines and real-time HD video monitoring. It enables high-definition live video transmission and online fault detection, enhancing the efficiency and intelligence of transmission line inspections.

- Transformation: Power-specific 5G robotic and AR/MR inspection applications facilitate HD video feedback and real-time collaboration with remote experts. This improves the accuracy, safety, and efficiency of substation inspections, advancing intelligent maintenance.

- Distribution: By integrating 5G with distribution automation and differential protection, this solution demonstrates 5G's high reliability and low latency for fast command dispatch, precise fault detection, and grid-to-load interaction, enhancing operational management and supply reliability.

- Consumption: Leveraging 5G's capacity for large-scale connectivity and high bandwidth, solutions such as "5G + energy data collection" and "5G + EV charging stations" improve the cost-effectiveness and security of service connections, support rapid deployments, enable high-frequency data collection, and enhance customer energy service and management quality.

- Consumption: Through dynamic monitoring of onsite equipment, structures, staff, and visitors, along with real-time personnel tracking, this solution ensures workplace safety and project progress monitoring.

- In smart power applications, the P5G network operations platform provides standardized, planned, and collaborative three-network integration based on virtual and hybrid networking.

- For power business scenarios, customized 5G slice templates and DNN activation capabilities are tailored to service requirements like latency, jitter, connectivity, isolation, uplink/downlink, and bandwidth, thereby enabling unified and secure network management.

- Through dedicated public networks and flexible slicing for different business scenarios, the platform supports massive device connections, provides intelligent device management, and promotes safe production.

- Covering generation, transmission, transformation, distribution, and consumption, it supports major scenarios like distributed photovoltaic power, automated distribution, and drone inspection, along with online SIM

card application, on-demand procurement, lifecycle management, real-time monitoring, usage analysis, and refined operations. This facilitates optimized SIM resource allocation and reduced 5G SIM costs, achieving online, precise management of power.

● By enabling the integration of network across the three main Telcos, it supports network overview, visualization, and closed-loop ticket coordination, facilitating rapid network fault detection and end-to-end service quality monitoring.

A power company has adopted AsiaInfo's P5G product portfolio, in collaboration with the three major Telcos, to establish China's first wide-area P5G Operations Platform.



Launch of the nationwide first provincial 5G power demonstration network    Publishing Network Platform Operation Benchmark-Power Private Network Operation Platform

**Figure 9-9 Launch of a Private Network**

# 10 Certificates and Awards

AISWare AgileNet has received a network access license from the Ministry of Industry and Information Technology (MIIT). Along with numerous other certificates and honors, it validates the capabilities, network performance, and security of the P5G products, laying a solid foundation for large-scale commercial deployment.

## 10.1 Product Certification

### 10.1.1 MIIT Network Access License

As shown in the figure below, AISWare AgileNet — including base stations, core networks, switches, and CPEs — have passed the MIIT network access tests and have obtained network access licenses.



**Figure 10-1 MIIT Network Access License**

### 10.1.2 China CCC Certification

AISWare AgileNet-5G CPE has obtained CCC certification by the China Quality Certification Center.

**Figure 10-2 CCC Certification**

## 10.1.3 EU CE Certification

AISWare AgileNet-CN and AISWare AgileNet-RAN have obtained EU CE certification.



**Figure 10-3 EU CE Certification**

# 10.2 Awards

## 10.2.1 5G World

AsiaInfo was awarded the ""Best Network Slicing Trial"" by 5GWorld in recognition of its outstanding contributions to slicing in both Telcos and industry applications. Figure 10-7 shows AsiaInfo's ""Best Network Slicing Trial"" award.

**Figure 10-4 ""Best Network Slicing Trial""**

## 10.2.2 Bloom Cup

As shown in Figure 10-5, AsiaInfo, together with its partners, won the first prize in the 5th ""Bloom Cup"" 5G Application Competition for its ""Smart Nuclear Power P5G Project,"" and the first prize in the Energy and Non-ferrous Metals Category in the National Finals of the 7th ""Bloom Cup"" 5G Application Competition for its "" 700MHz Band P5G Project for a Smart Wind Farm"".



**Figure 10-5 The 1st Prize of the 5th ""Bloom Cup"" 5G Application Competition**

### 10.2.3 NetworkX

Network X (formerly BBWF) is one of the most important events in the global mobile communications industry. The event brings together over 1,500 Telcos, vendors, industry organizations, governments, and media professionals from around the world. It focuses on five key themes: fiber optics, Wi-Fi, optical transmission, mobile networks, and mobile services, aiming to explore industry challenges and the latest trends.

AsiaInfo, together with its partners, won the "Best Service for Enterprises "at the Network X for their "700MHz P5G Solution for the Wind Power Industry," highlighting the innovative application and commercial value of AISWare AgileNet in the wind power sector and its high international recognition.



**Figure 10-6 Network X "Best Service or Solution for Enterprises "**

### 10.2.4 CAA

In 2023, AsiaInfo's project "Key Technologies and Applications of Computing Native Network" was awarded The First Prize of Scientific and Technological Progress Award by Chinese Association of Automation (CAA).

**Figure 10-7 The First Prize of Scientific and Technological Progress Award**

## 10.2.5 CCF

The same year, AsiaInfo received The Second Prize of Technological Advancement from China Computer Federation (CCF) for the innovative P5G solution at a thermal power plant.



**Figure 10-8 The Second Prize of Technological Advancement**

## 10.2.6 GTI Awards

During MWC25 Barcelona (the 2025 Mobile World Congress in Barcelona), AISWare AgileNet, with its outstanding product capabilities and extensive industry applications, won the GTI Awards for "Market Development & Business Value Award," marking significant international recognition of AsiaInfo AISWare AgileNet in technological innovation, industry application, and commercial value.



**Figure 10-9 2025 GTI Awards "Market Development & Business Value Award"**

# 10.2.7 Omdia Report

The globally renowned technology research and advisory firm Omdia, in its Omdia Market Radar: E2E Private 5G Networks Vendors 2025 report, evaluated leading private 5G vendors worldwide. Nine suppliers were selected for this prestigious assessment. AsiaInfo Technology was positioned in the "Challenger" quadrant alongside Samsung, Celona, and QCT. The "Leader" quadrant included Nokia, Ericsson, ZTE, HPE, and Huawei. AsiaInfo's AISWare AgileNet distinguished itself through its AI native architecture, open and decoupled design, integrated hardware and software capabilities, and tailored support for vertical industries' connectivity and intelligent automation requirements. Its proven commercial deployments across critical sectors including nuclear power, thermal power, wind energy, photovoltaics, mining, and chemicals further reinforced its market position. This recognition affirms AsiaInfo's role as an innovation leader and trusted provider of 5G and 5G Advanced private network technologies and solutions with significant industry impact and commercial value.
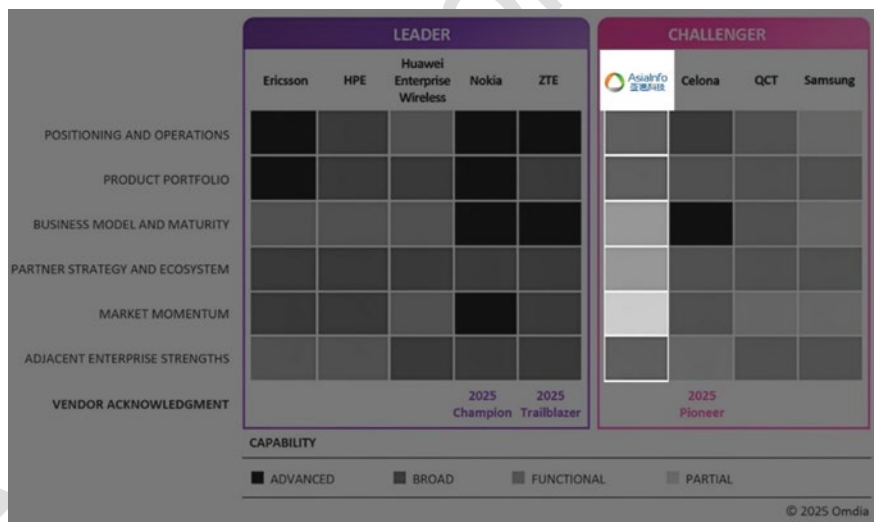


**Figure 10-10 2025 Omdia Market Radar**

# 11 Contact Us

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# Thank you

Customer Value Innovator & Digital Transformation Promoter with Full-Stack Data Intelligence Capabilities