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5G Smart Port Solution

China Mobile International

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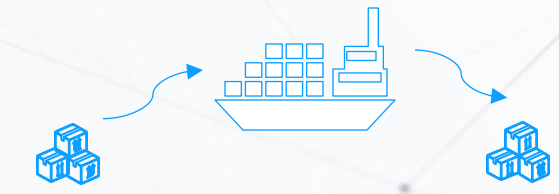
Contents

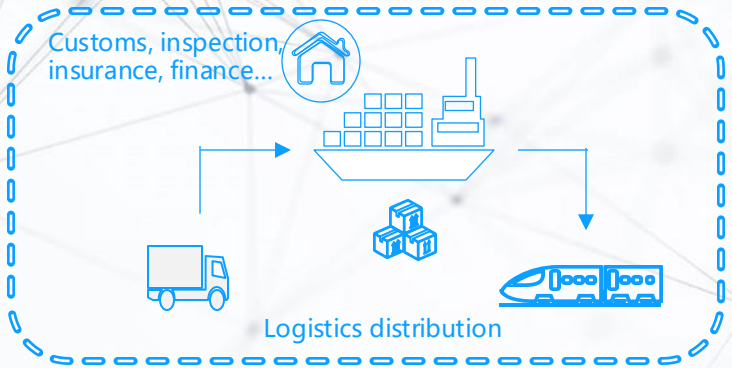
Smart Port Evolution and Corresponding Requirements

Traditional Port



- Operation and Storage of marine cargo

Modern Port

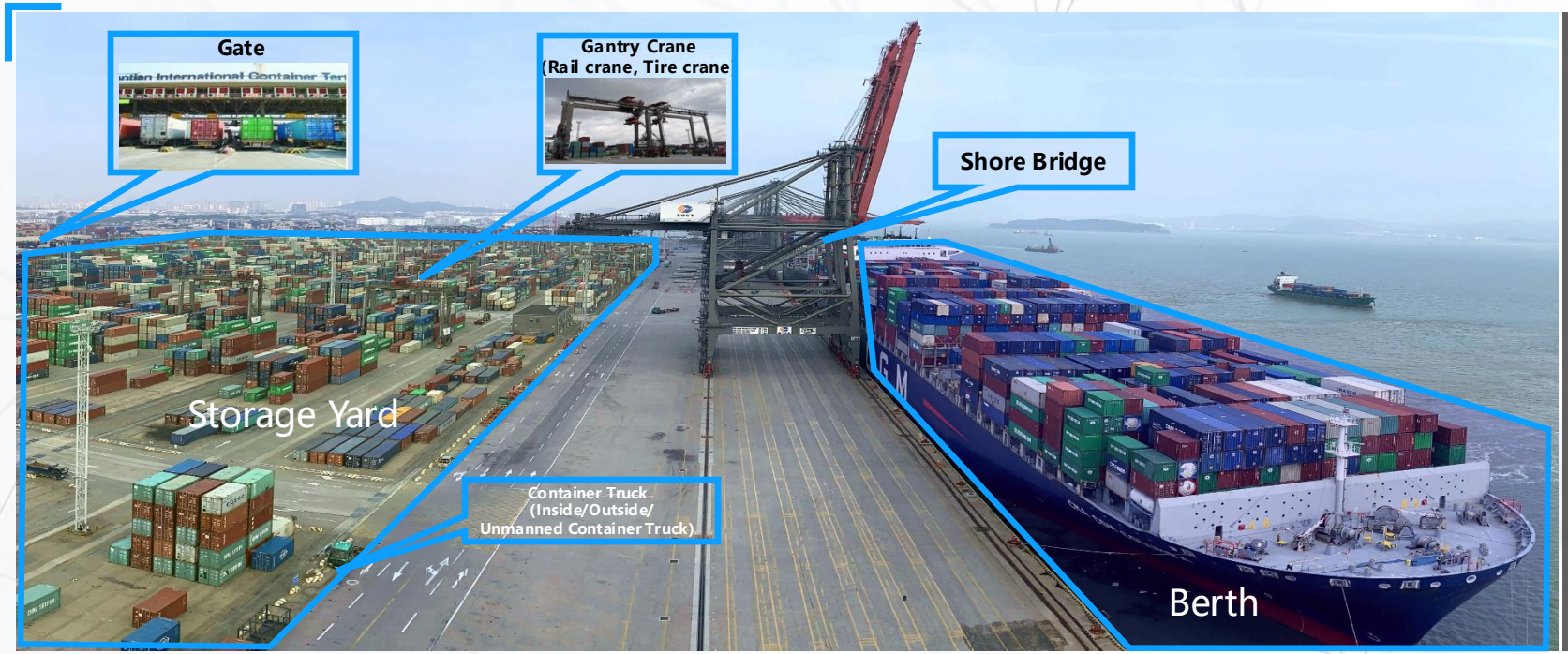


- The port has gradually evolved into a trade center and a logistics center
- Provide comprehensive services such as goods distribution and trade information services
- Gradually integrate railway, road and other freight resources to provide door-to-door services

Smart Port

- Production refinement and agility
- It has the characteristics of high informatization and networking
- Provide flexible services to meet personalized needs
- Environmental protection, green and low carbon
- Form port ecology and port city integration
- Sustainable development

Port Overview and Operation Process Introduction



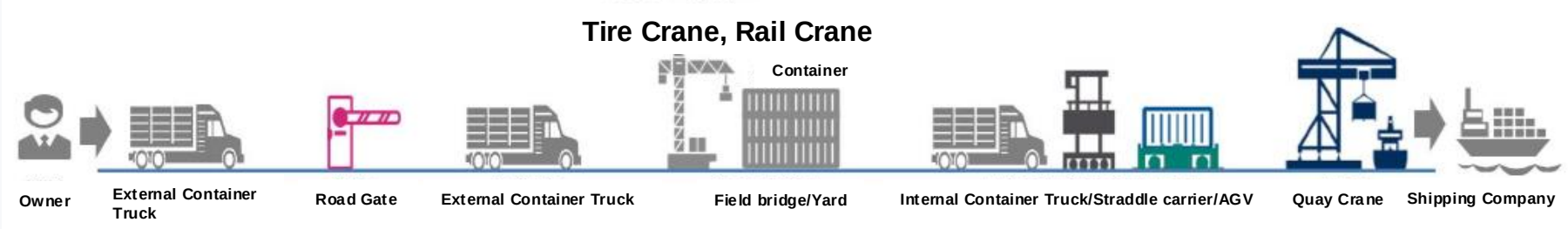
Main port machinery transportation means (container terminal in the figure above and bulk cargo terminal in the figure below)


Shore bridge crane | Rail crane | Tire crane


AGV | Container Truck | Straddle carrier


Ship loader | Portal crane | Bucket wheel

Container Port Workflow (Example - one way)



① Cargo owner's container entry/exit customs gate (external container truck, horizontal transportation)

② Yard bridge (Rail crane/Tire crane) unloading / loading to truck (vertical transportation)

③ Truck / AGV / straddle truck transport the goods to the storage yard (horizontal transportation)

④ Ship to shore, loading / unloading by shore bridge (vertical transportation)

Various Port Services and Corresponding Requirements for Smart

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Analysis of Challenges by Traditional Ports

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Vertical Transport Operation

Less Operation Supervision

High Operation Intensity

Difficult for RTGs maintenance

Difficult to recruit and employ people

External Truck Operation Process

Gate easy to be blocked

More personnel investment

High Cost for Maintenance

High probability of mistake

Port Container Tally Operation

Heavy workload

RF Limited scope

Low work efficiency

Poor environment and mistake prone

High Energy Consumption Equipment Increasing

RTG High Energy Consumption

Mains power instability

Non-Green Energy

Difficult manual operation and maintenance

Port Communication System Problems

Difficult Cable routing

Optical fiber easily damaged

Long construction period

Difficult monitoring and maintenance

Port Informatization Decision Scheduling

Data not cross connected

Data updated not timely

Indicator not visible

Inconsistent command

Two Wheel Drive of The Construction of Smart Port

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Trend Orientation

Smart Port construction is an effective means to accelerate port transformation and upgrading, enable innovation and become a first-class port with sustainable development, which has become the consensus of the industry

Smart Port

Technological Innovation:
Automatic driving, AI, big data, Intelligent tally, intelligent gate, automatic wharf, intelligent robot

Port management innovation:
visible business indicators
Visual Intelligent Operation Center

Port security: port control
One network joint control and one-stop service

Technical Orientation

5G | Video | Cloud Computing | Big Data | IoT | AI

Innovative technology has become the cornerstone of digital transformation of Smart Port

Construction Target of Smart Port

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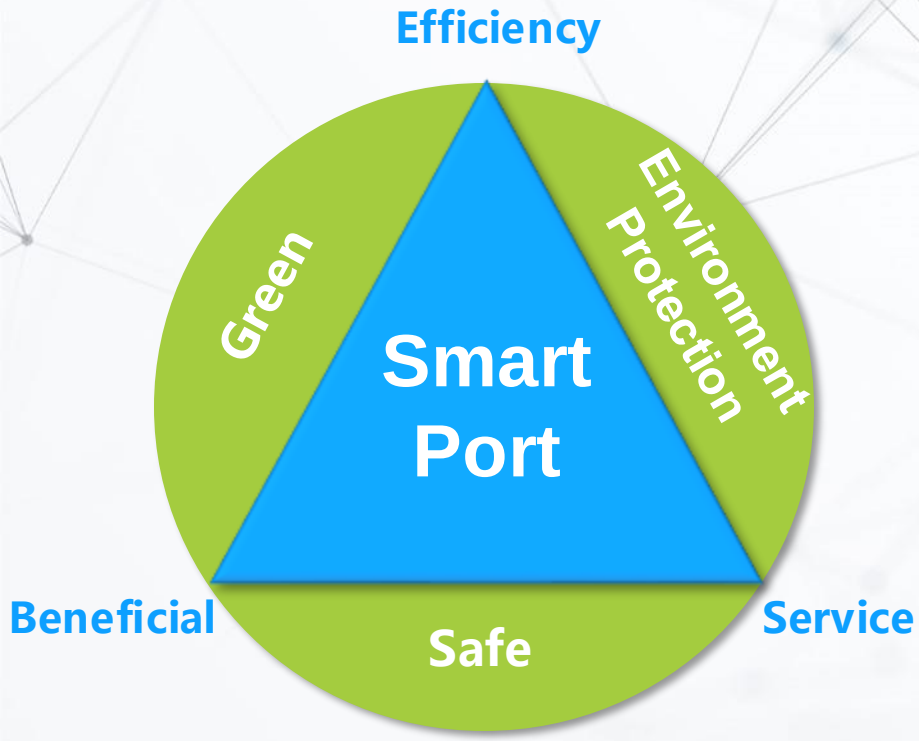
Build a Smart Port with "Efficiency, Beneficial and Service" that ships enjoy their navigation and goods flow smoothly



Efficiency

Optimize the allocation of port machinery resources, make intelligent auxiliary decisions for production service, improve operation efficiency, reduce cost and increase efficiency

Beneficial

We will give priority to efficiency, work in multiple ways, improve operating profits and enterprise competitiveness, and strive to promote all-round and high-quality development

Service

Take customer service as the center, take the port as the hub, provide flexible services, and create an ultimate and convenient customer experience

System Components of Smart Port

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Comprehensive monitoring, coordination, command and dispatching

Multi party coordination of port production service, pilotage and port operation ships

Linkage Command

Efficient handling of emergencies

Intermodal Transport

Building a hub from point to area

IOC

Port Big Data

Port Big IoT | **Port Big Video**

Whole process "Visualization and Collaboration"

Aggregate port ecology

Build a "Smart Platform"

Cloud, big data, video

Digital "Cornerstone"

5G Mobile Network + IOT

Hub

Wharf Yard Storage

Park

Shore bridge and suspension bridge Container CCTV

Object

People Cargo Vehicle Ship

Cloud

Cloud Data Center

Network

5G Private Network

5G 5G

Terminal

UAV Mobile Terminal Camera Robot

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Smart Port Overall Solution Architecture

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Build "1+1+N+1" Network, Cloud, Application and Center End-to-End Solution

Display Layer

1 Center

Intelligent Operation Centre

Intelligent Operation Centre

Situational Awareness | Auxiliary Decision | Linkage Command | ... ...

Application Layer

N Smart Applications

5G Remote Crane | 5G Smart Tally | 5G Smart Campus | 5G Push To Talk | 5G UAV Solution | 5G Green Energy | Welcome/ Inspection Robot | ... ...

Platform Layer

Smart Port Management Platform

Video Platform | AI Platform | IoT Platform | Converged Communication | GIS Platform | BIM | Blockchain Platform | ...

PaaS Services (Middleware/API Gateway/Big Data/Micro-Service/etc.)

1 Cloud

Cloud Base (Server/Storage/Data Centre/Cloud Connection)

Operation | Identity authentication | Security | Maintenance | Auxiliary operation

Network Layer

1 Network

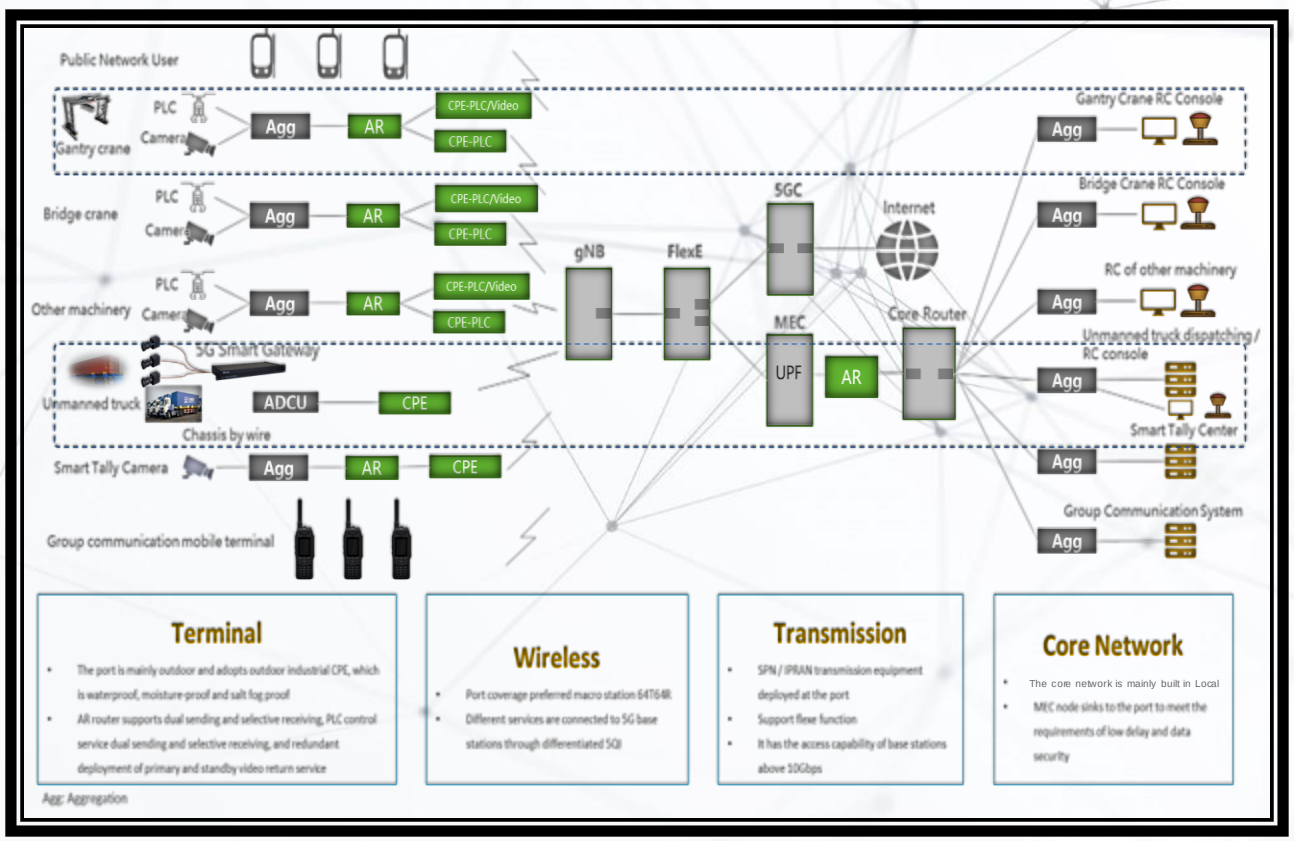
Private 5G Network

Access Network Side Service Assurance System

Core Network Side Service Assurance System

Device Layer

Network | 5G Private Network Combined with Smart Port Service Scenario



5G Private Network can realize full coverage of the port area and reduce the cost of remote-control transformation

Compared with the current optical fiber remote control scheme, the advantages of 5G are reflected in the comprehensive ability of industrial chain, network coverage, network performance and so on

Related Content	Fiber	5G Network
One-Time Cost	High transformation cost	**Low transformation cost**
Hidden cost	• Cable loss • 1-2 years replacement • Trenching and burying fiber has a long cycle and affects production	Undertaken by the operator
Performance	Excellent	5G uRLLC Slicing、MEC support continuous optimization
Mobility	Poor	Full cover

Requirements for network in the remote-control : **large bandwidth** (demand for multi-channel HD video transmission), **low delay** and **stability** (PLC control signal transmission)

Key Capabilities

① Design consulting operation

② Design, Consultation and Operation of China Mobile's current network simulation tool

③ More Than 1000+ Private network Case

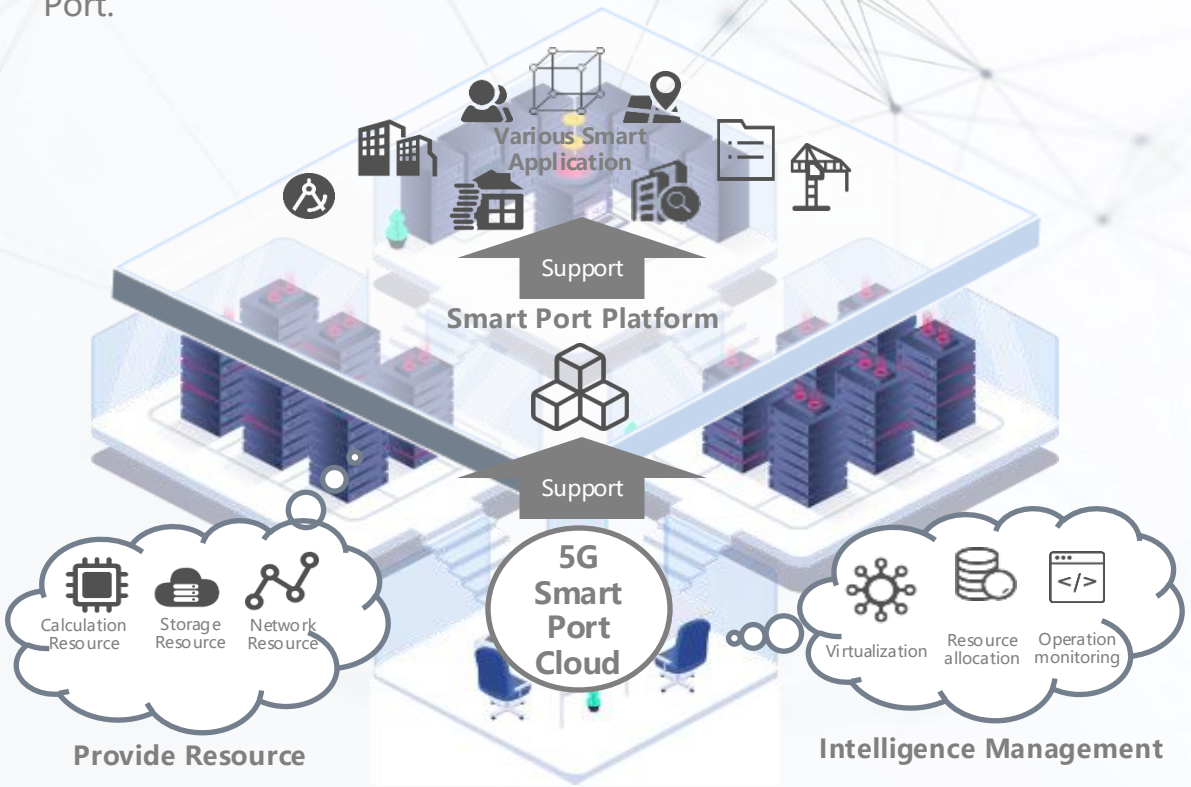
④ More Than 500+ Network Expert

Cloud Platform | Port Cloud Architecture

Build 5G Smart Port Cloud Base, including **Server Computing Resources**, **Storage Resources** and **Network Services**.

Build 5G Smart Port Cloud Base

To match the resource demands of 5G Smart Port for high-performance service capabilities such as Big data, AI, IoT, GIS and Video analysis, provide sufficient storage, computing and network information resources, carry all kinds of Smart Port applications, and support the construction of 5G Smart Port.



Improve Cloud Resource Architecture and Service Content

5G Smart Port Portal

PaaS

API Gateway | Micro-Service | Middle-ware | Container | Big Data/Data Warehouse

IaaS

Cloud Maintenance Center | Cloud Operation Management

Cloud Resource Management

Calculation Resource Pool | Storage Resource Pool | Network Resource Pool

Resource Expansion Capacity to meet the needs of long-term sustainable development in the future

Big Data | AI | GIS

IoT | Video Analysis | Communication

Smart Applications | Network Management and Smart Service operation

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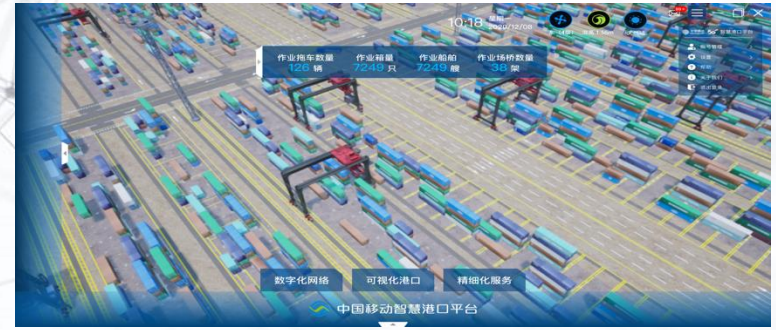
In the direction of "**Digital Network Management and Smart Service operation**" for the Smart Port Platform, presents real operation scenarios such as port communication and perception network, loading, unloading, transportation, production and operation.

The platform supports access to the port's original business system and can be flexibly customized.

Panoramic view of the port

Production and Operation Data Display



Port Equipment Management

Port Traffic Status Display

Smart Port Network Management Platform

- Wireless Network Monitoring
- Service Quality Monitoring
- IoT Card Management
- ...

Smart Port Traffic Management Sub-Platform

Port traffic supervision

- Port Vehicle Supervision
- Port personnel supervision
- Regulatory rule management

Traffic Information Analysis

- Entity status statistics
- Traffic flow statistics
- Traffic efficiency analysis

Smart Port Big Data Service

- Port Operation Management
- Intelligent analysis and decision-making
- Port data governance
- ...

Smart Applications | Remote Control Crane

Rail Crane and Tire Crane are the two most widely used large-scale lifting and loading equipment in ports, It is an important medium for realizing vertical container transportation. 5G port machinery remote control system provides the following functions:

(1)Remote Control of Port Machinery : remotely operate the lifting, cart, trolley and other mechanisms of port machinery to complete remote loading and unloading of containers;

(2) Crane Monitoring : Real-time monitoring of port machinery operating status information, with data collection, analysis, management, and fault diagnosis functions.

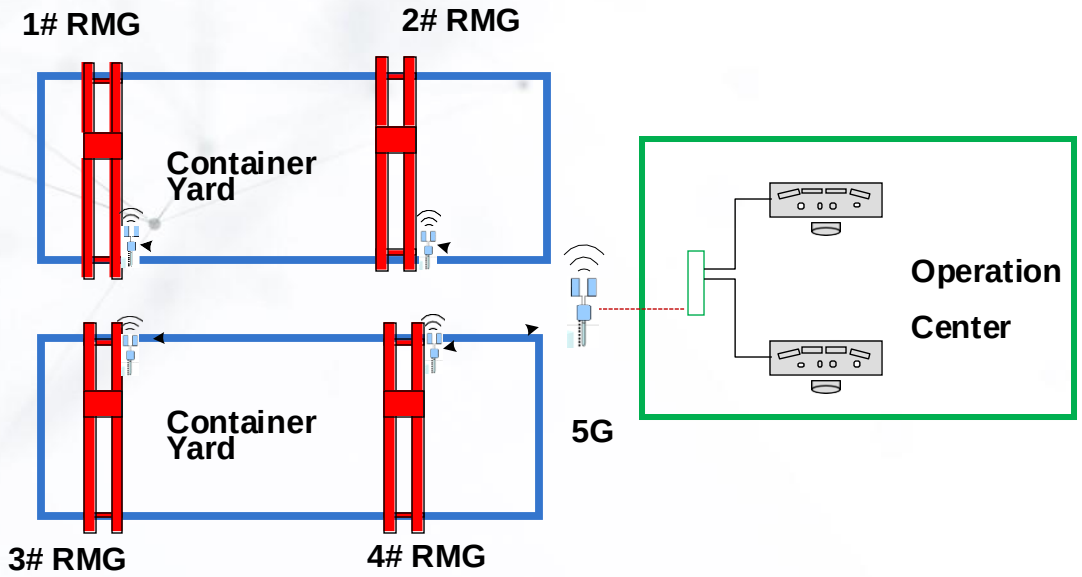
RTG

- 8 large tyres cound walk through container yard without optical cable;
- RTG remote control retrofit based on 5G has already been put into scaleable promotion stage.

RMG

- RMG usually works in a certain area with optical cable;
- ARMG has been run in many terminals, ARMG based on 5G is on the stage of small-scale tests.

System Structure:



Smart Applications | Remote Control Crane

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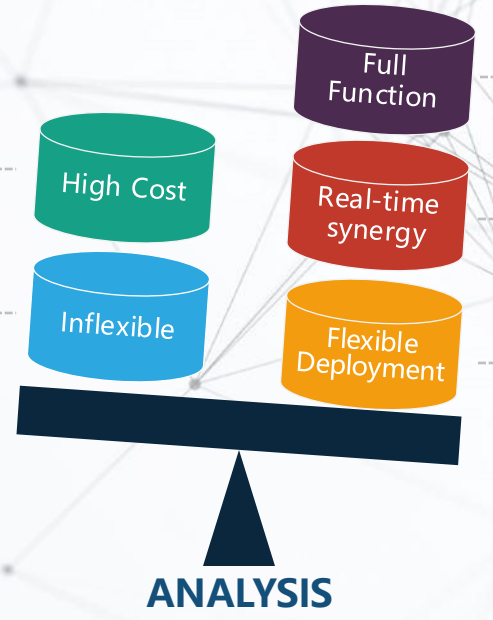
Fiber Solution vs 5G Solution



Monitor and manage business in multiple dimensions with the help of 5G network, video, sensor and control technology

difficult to deploy, the optical fiber is easy to be old and broken, and the overall TCO remains high

Real-time synergy with the terminal operation system (TOS), enabling remote container loading and unloading operations

There are limitations such as inability to flexibly transition, and some scenes cannot be covered

Using 5G wireless network, there is no line constraint, covering almost the whole scene

Advantages of 5G Solutions

(1) 5G industry private network: Based on multi-band 5G network capabilities, it provides low-latency, large-bandwidth, and highly reliable network services;

(2) Centimeter-level high-precision positioning: Provide centimeter-level cart positioning and automatic deviation correction services based on GPS;

(3) Low-latency transmission of job video: Provide ultra-low-latency HD video system to improve interactive experience;

(4) Port-specific control system: Cooperate with industry leaders to provide industry-leading intelligent control software, automatic operation control subsystem, remote manual operation subsystem and safety protection subsystem.

Benefit Efficiency Analysis

(1) Change from one person and one crane to **four** cranes operated by one person

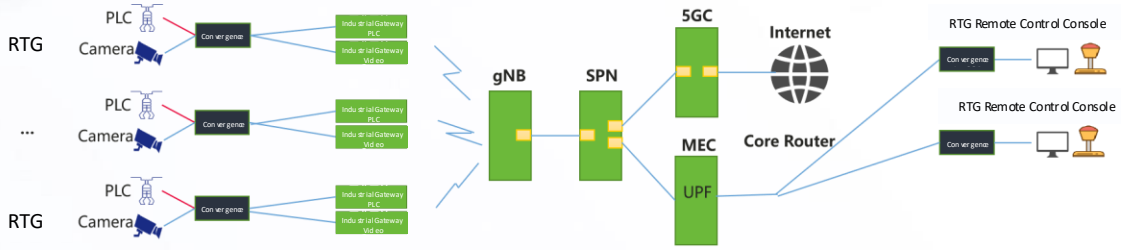
(2) Increase efficiency by **30%+,** and the safety **risk is 0**

(3) Annual saving of **600,000 RMB**: one crane and one driver on average, annual cost of 200,000 and safety cost of several

Machinery Remote Control System Components

Machinery Remote Control System includes **5G Terminal, 5G Network, Cloud Platform and Application:**

- **5G Terminal:** 5G network access and basic data collection;
- **5G Network:** Provide the E2E communication tunnel ;
- **Cloud Platform:** Service Management, Synergy and Operational Quality Control ;
- **Application:** Remote Control Center, On-Board Automation System and Yard Automation System.



Smart Applications | Horizontal Transportation

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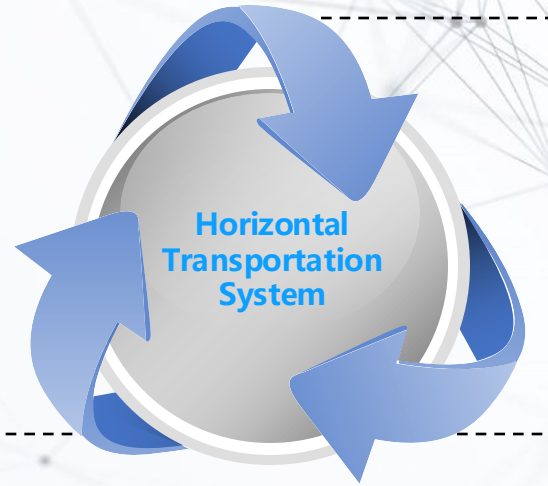
The 5G unmanned horizontal transportation system deploys sensors such as cameras and radars on the internal trucks, integrates the use of 5G + high-precision positioning + vehicle-road coordination and other technologies, and cooperates with efficient and accurate algorithms to enable the trucks autonomous driving, global awareness and global policy control.

System Architecture

Build an E2E vehicle-road collaboration network to realize the fusion perception, collaborative computing and instant communication of autonomous vehicles

Fusion Perception

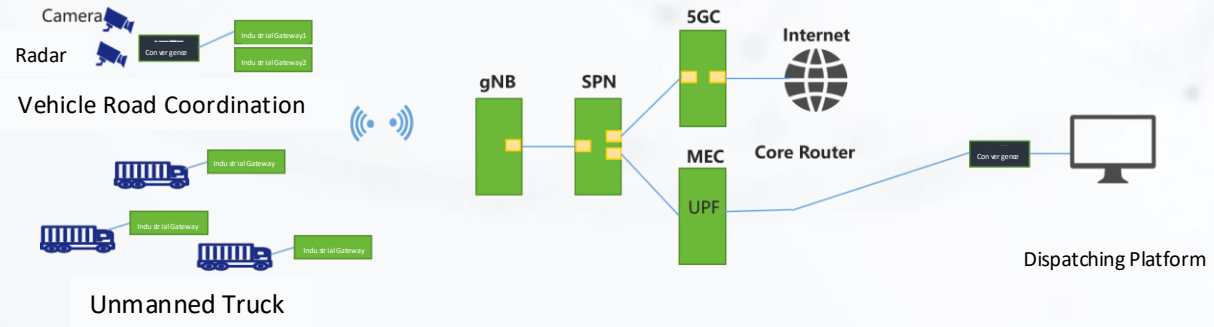


Autonomous Driving

Relying on 5G, C-V2X, MEC and other technologies, the unmanned horizontal transportation system is capable of intelligent driving by modifying existing internal trucks or deploying new ones

Smart Scheduling

Realize intelligent vehicle scheduling



Main Functions

Autonomous Driving

By deploying video, radar, 5G communication, edge computing servers and other equipment, and loading core algorithms for decision-making and control, L4 autonomous driving is realized

Global Awareness

Improve the safety of autonomous driving through collaborative perception, collaborative decision-making, and collaborative control

Global Policy Control

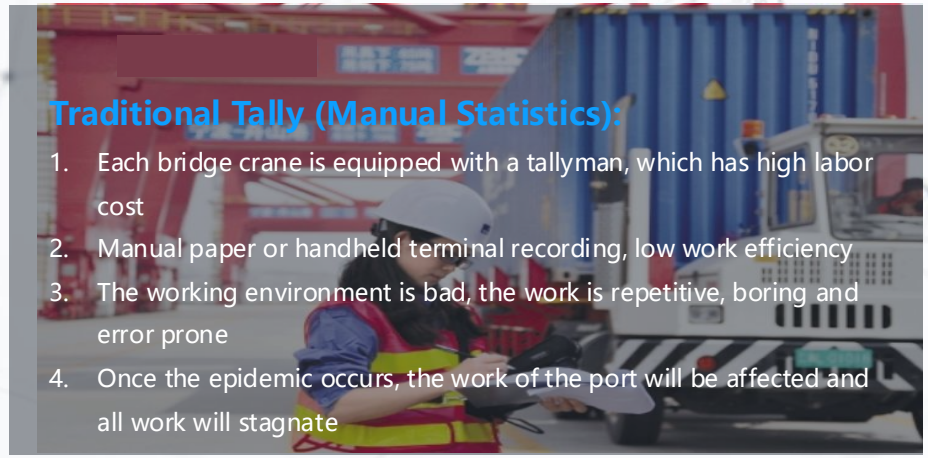
By configuring the core algorithm of path planning, action decision-making, and whole-process scheduling, the intelligent scheduling of the card is realized.

Benefit Efficiency Analysis

- It can support the fleet's continuous real ship **operation for more than 24 hours** at a time; Average operation efficiency **26move / hour**
- Each automatic driving truck will **save at least 450,000 RBM/year** of labor cost
- New energy with **66% reduction of carbon** emission by single vehicle

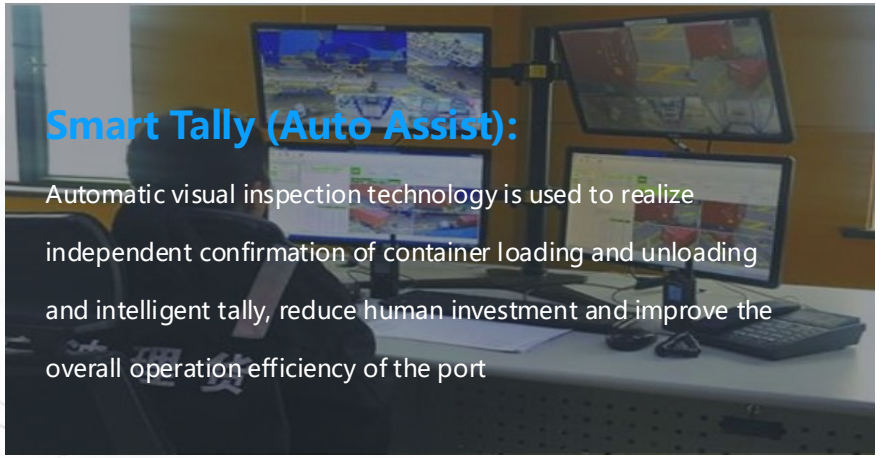
Smart Applications | Smart Tally

By deploying high-definition ball machines at shore bridge, yard bridge and gate, and using edge cloud + AI visual analysis technology, collect container video / image information in real time and conduct automatic identification and analysis, to realize automatic data verification of container number automatic identification, box damage identification, lead seal, bay position, trailer number and other information collection, to realize intelligent cargo tally of port containers.



Traditional Tally (Manual Statistics):

1. Each bridge crane is equipped with a tallyman, which has high labor cost
2. Manual paper or handheld terminal recording, low work efficiency
3. The working environment is bad, the work is repetitive, boring and error prone
4. Once the epidemic occurs, the work of the port will be affected and all work will stagnate

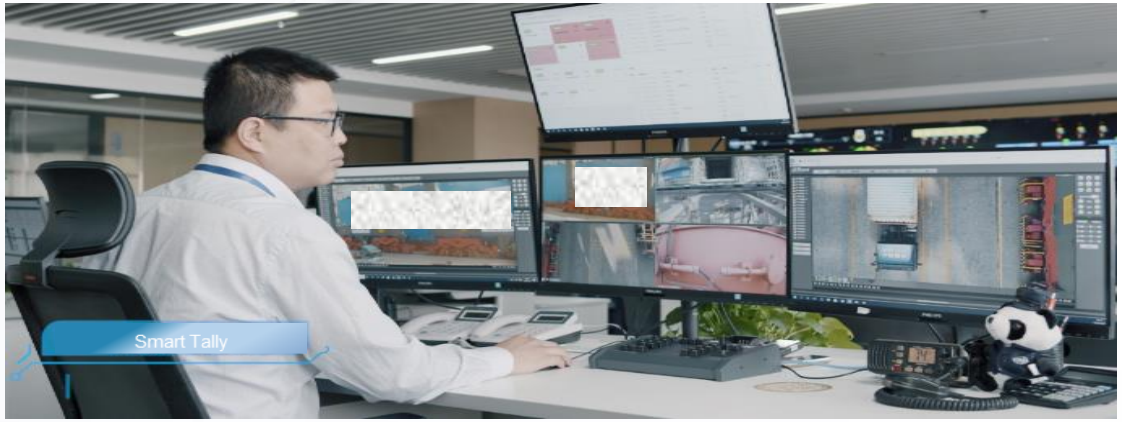


Smart Tally (Auto Assist):

Automatic visual inspection technology is used to realize independent confirmation of container loading and unloading and intelligent tally, reduce human investment and improve the overall operation efficiency of the port

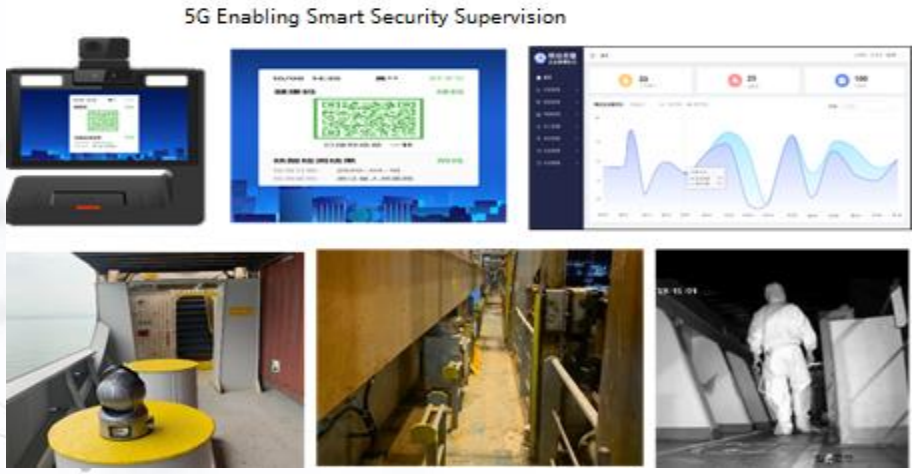
【Project Implementation Values】

Together with X technology in G City H Port 5G+ Intelligent tally project, the accuracy of container number identification is 95% and the manpower is reduced by 50%+, Efficiency increased by 200%



Smart Applications | Smart Security

Through 5G IoT terminal, visitors can be quickly identified by brushing their ID card; The ship's living quarters were supervised, and the contact between local staff and foreigners was flexibly and effectively monitored through 5G mobile cameras, which help the smart fight against the epidemic.



【Project Implementation Values】

Combined with the flexibly deployed monitoring, UAV patrol inspection and HD video capabilities, a three-dimensional cloud prevention and control system for Smart port is constructed


Ground Patrol Inspection


UAV Inspection


Port Machinery Access


Monitoring Alarm


Intrusion Alarm

Smart Applications | Communication

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Integrate the **IoT, AI, Cloud computing, Big data, Edge computing** and other new technologies, create the integration of services and capabilities, build a new 5G "And Talk", and provide **unlimited distance intercom, multimedia communication, visual scheduling of Video + location** and other services.

PTT Device


PTT


APP


Platform

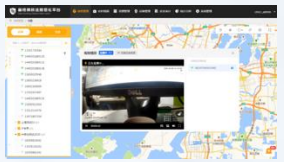
Voice

Visualisation

PTT Video Device


Recorder


APP


Platform


Inquiry Centre


Video Centre

Video + Audio

Visual Monitoring

Deployment

Core Function

• 3 Basic Functions

Audio
- Noise-cancelling
- Smart command
- Audio transcription

Video
- 4K Video
- Video editing
- Video storage

Location
- Precise position
- Navigation
- Tracking

• 2 Add-on Functions

Big data
- A/V Analysis
- Data Visualisation
- A/V Retrieval

AI Application
- Staff Distribution
- Vehicle Distribution
- ID Identification

A/V: Audio/Video

Smart Applications | Auto Driving Truck

Demands: The port transportation market is about 10 billion dollars a year. Once auto-driving truck is commercially used at the terminal, the port operation company can greatly reduce the truck drivers or security officers, so labor cost can be greatly reduced every year.

Solutions: Based on 5G, high-precision positioning & navigation, V2X network and automatic driving, we can realize unmanned driving, remote driving, trunk perception and strategy making.

AGV

- AGV generally uses magnetic nail navigation in port, for example, more than 60,000 magnetic nails were laid in Shanghai Yangshan port phase IV.
- The cost of AGV is high, with 5-6 million Yuan each.

Straddle Carrier

- Straddle trucks are equipped with mechanism slings. They can shuttle between the wharf and yard, directly load / unload and transport containers.
- Add radar, camera and automatic driving technology to realize unmanned driving.

Auto Driving Trunk

- Auto driving truck does not need too much terminal reconstruction， so it's more suitable for old terminals. Roadside equipment can significantly accelerate reliability.
- The cost of ADT is low, with 1.5-2 million CNY each

Smart Applications | Energy Management

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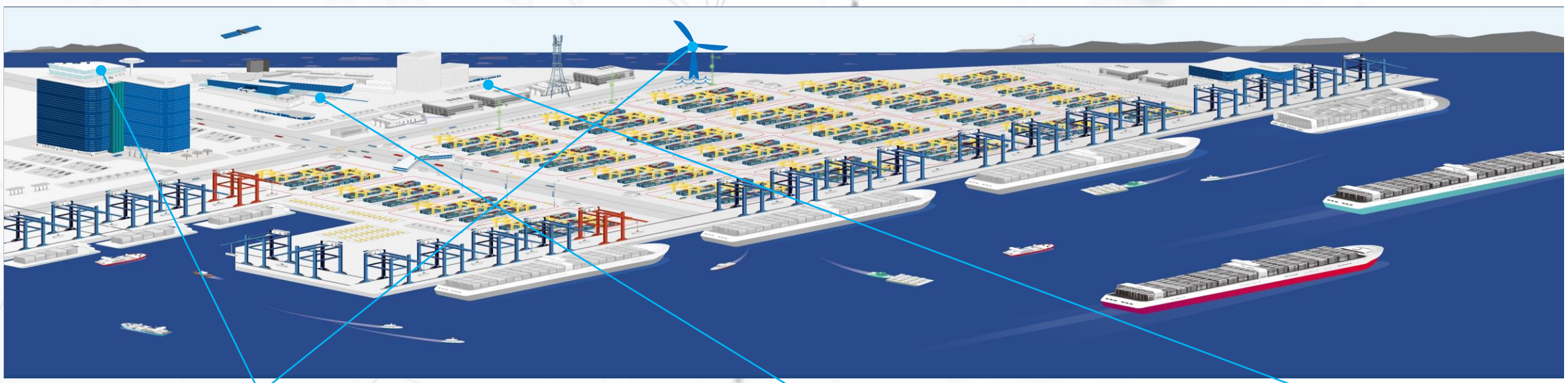


Clean Energy such as Photovoltaic /Wind Power

1. Intelligent photovoltaic controller
2. Distributed data acquisition
3. Operation and maintenance management system
4. Intelligent photovoltaic optimizer
5. Intelligent wind controller

5G Integrated Energy Storage System

1. Intelligent series energy storage
2. Intelligent energy storage controller
3. DC distribution cabinet
4. Operation and maintenance management system
5. Distributed data acquisition
6. Intelligent box transformer

Data Center Energy

1. Preset modularization scheme for data center
2. Temperature control system: temperature control refrigeration system of data center
3. Power system: power supply and distribution module of data center, including UPS, lithium battery and distribution cabinet
4. Operation and maintenance management system

Smart Applications | Port Lighting

The 5G Smart Lamp-pole solution provides a comprehensive port management platform, provides visual, knowable and controllable management services, and improves the efficiency of port management; Through the comprehensive management of policy dimming, realize the green site of port energy conservation and carbon reduction.

Traditional Port Sodium Lamp:

1. Sodium lamp has short service life and high maintenance cost
2. Manual start and stop management, waste of resources in some time periods
3. Daily manual inspection is time-consuming and laborious

Smart Lamp-pole of 5G Technology :

1. The sodium lamp is changed to LED lamp for strategic control, and the second energy saving is 60%
2. Policy dimming to further save energy
3. Automatic deployment of the whole network equipment, remote unified visual management, and reduce the operation and maintenance cost
4. The erection of micro macro 5G base station realizes the simple deployment of multiple services

【 Project Implementation Values 】

Minimalist O&M

Integrated management

Simplified Deployment

Micro macro 5G Base Station

Intelligent Deployment

CCTV

Pedestrian sensor

Environment sensor

Intelligent lighting

One-key alarm sending

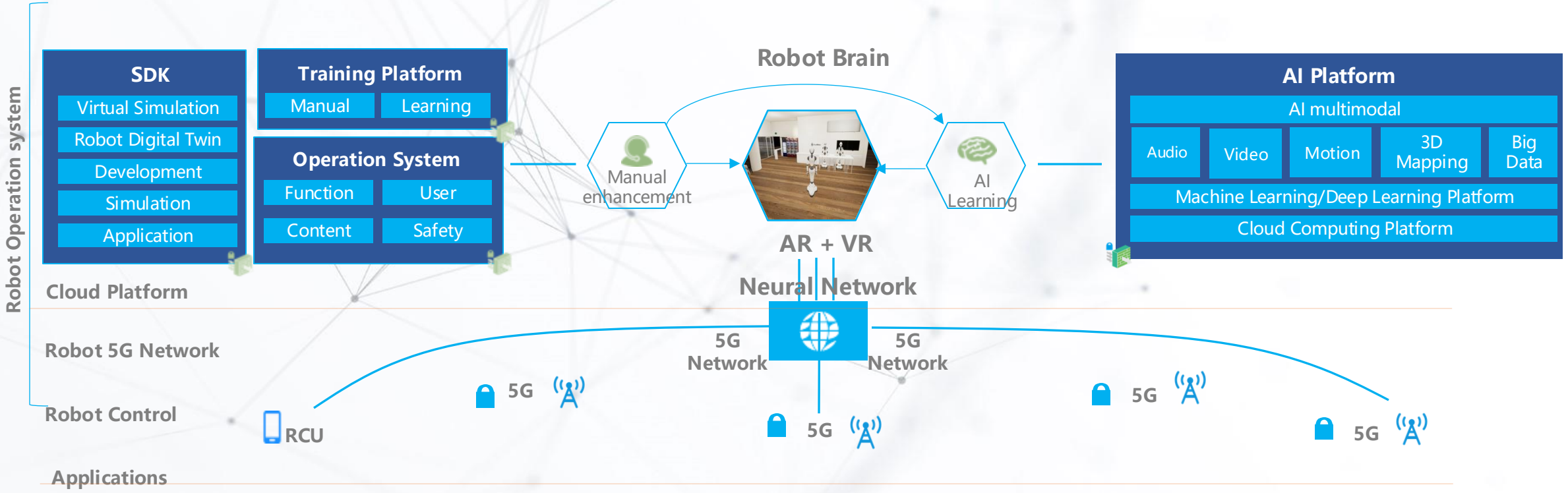
Integrated Construction

IoT Box

Intelligent Distribution Warehouse

Smart Applications | Robot

- 5G Greeting robot used in main reception or passenger terminals.
- 5G Surveillance robot.
- 5G Delivery robot.



Greeting Robot

Surveillance Robot

Delivery Robot

Smart Applications | Site inspection

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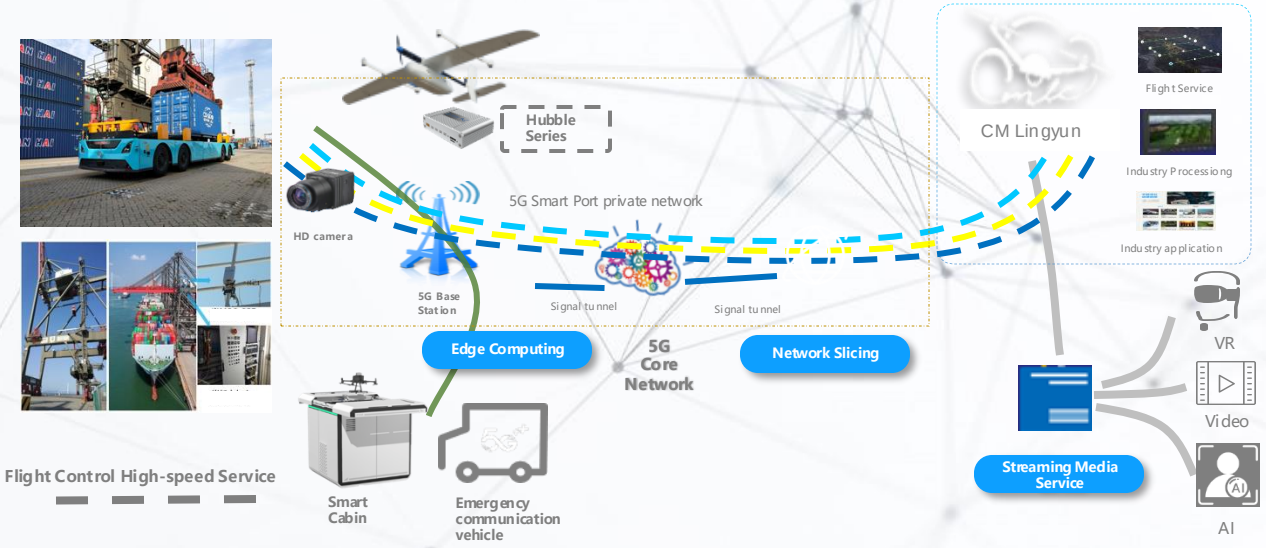
Use **5G private** network to replace the traditional UAV self-built communication and control link (C2 link).Through the platform over the horizon remote flight control, **real-time data acquisition, real-time return** and **real-time analysis** are realized, which is used for patrol inspection scenario applications in ports.

Solution Architecture



China Mobile Lingyun 5G network connected UAV management platform

Partial Function Display

Cases

Fujian Ningde nuclear power intelligent inspection project

Sichuan Xichang forest fire prevention

In July 2021, it officially won the bid for the inspection project of China Harbor and Hong Kong. Customize the aircraft + load scheme based on China Mobile Lingyun platform and hubble-1 for customers. Provide patrol inspection and data acquisition services for the construction site of Kwai Chung port in Hong Kong. It is **the first commercial order of 5G Internet connected UAV in Hong Kong** Special Administrative Region.

Center | Intelligent Operation Centre(IOC)

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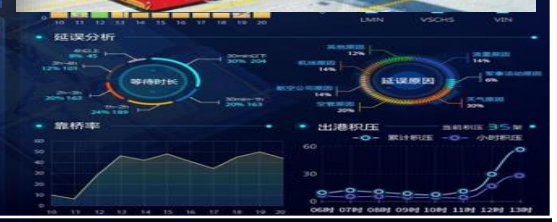
Real-time Port Operation Monitoring

- Monitoring cargo, vehicles and container operation status, improve the port management.
- Enhance port resource allocation, improve operation efficiency.

Enhance Port Capabilities

- Big data analysis to assist port operations and decision makings.
- Investment predictions.



Comprehensive Service Status

Cargo KPI | Container KPI | Vehicle KPI | Benefit KPI | Auxiliary KPI

Key KPI forecast

Throughput | Resources | Maintenance | Personnel

Coordinated/Emergency Command

On-site management | Event management | Emergency management

Operation Process

Data and Open API Platform

Operation process	Data Association	ETL/Deep Learning
Data Cleaning	Data Analysis	Data Fitting

Data management

Basic Data: Access | Personnel | Geographic | Employee | Credit

Professional Data: Main Data Base | Operation | IoT Data | .....

Operation Data | Application Data | Internet Data | Sensor Data

Resource Service

Big Data Platform

- -Crane Data
- -Campus Data
- -Drone Data
- -PTT Data
- -Green Site Data
- -Robot Data
- -TOS System Data
- -CMS System Data
- -etc.

3Rd Party API

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Implementation Case | 5G Smart Port Construction Practice

China Mobile International

China Mobile joined hands with Shenzhen Mawan port, Zhejiang Ningbo port, Shanghai Yangshan Port, Xiamen ocean terminal and other **Group Level 5G Leading Demonstration Projects**; Nine provincial-level leading demonstration projects have been carried out in Qingdao, Shandong, Tianjin, Qinhuangdao, Hebei and other places, and pilot projects such as remote control of port machinery and automatic driving of intelligent truck have been preliminarily realized.

Shenzhen Mawan Port

- **The Group Level** 5G leading demonstration project won the **First Prize** of the third "blooming Cup";
- Complete 5G+ MEC tire crane video and control signaling transmission;
- Complete the unmanned truck test based on high-precision positioning and vehicle road cooperation.

Ningbo Port Meishan Wharf

- **Group Level** 5G leading demonstration project won the **third national prize** of the third **"blooming Cup"**;
- The World's First Port 5G gantry crane remote control application in normal operation;
- 6 sets of 5G gantry cranes are subject to normalization test and service durability test.

Xiamen Ocean Gate Terminal

The First 5G All Scenarios Application Smart Port in China

- **Group Level** 5G Leading Demonstration Project to realize **full scene 5G service demonstration**;
- Deploy the industry's first 5G Smart Port Platform.

Shanghai Yangshan Port Phase III Guandong Wharf
(Group Level)

- Remote control of port tire crane
- Autopilot truck

Tangshan Port
(Group Level)

- 5G Autopilot truck pilot run

Huaian Port
(Group Level)

- 5G HD video surveillance
- 5G informatization demonstration hall

Tianjin Port
(Province Level)

- High-definition Video and control signal return of port terminal tire crane

Qingdao Port
(Province Level)

- Port 5G Remote operation
- Smart Tally

Beibuwan Port
(Province Level)

- Bridge crane video return
- Auto patrol inspection
- PLC status return

Qinhuangdao Port
(Province Level)

- 5G Network Construction
- Application planning of 5G bulk cargo terminal

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Implementation Case | XiaMen Ocean Gate Terminal Wharf

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Pain Point

1. **Gantry Crane has high labor cost and harsh environment:**
   Operators work in three shifts, with long working hours at height, high risk factor, difficult recruitment and continuous growth of labor cost

2. **Low tally efficiency and easy to make mistakes:**
   The tallyman works in the open air for 12 hours under the bridge crane and beside the driveway, with high labor intensity, potential safety hazards, low efficiency and high cost.

3. **Truck transportation management is difficult:**
   The lack of accurate and high-precision positioning management, scheduling and monitoring of internal and external container trucks is an urgent problem for port operation enterprises.

4. **The safety management in the port area is difficult:**
   Due to the wide area of the port area, it is difficult for inspectors to find violations and accidents at the first time, the reaction speed is slow, and there are potential safety hazards.

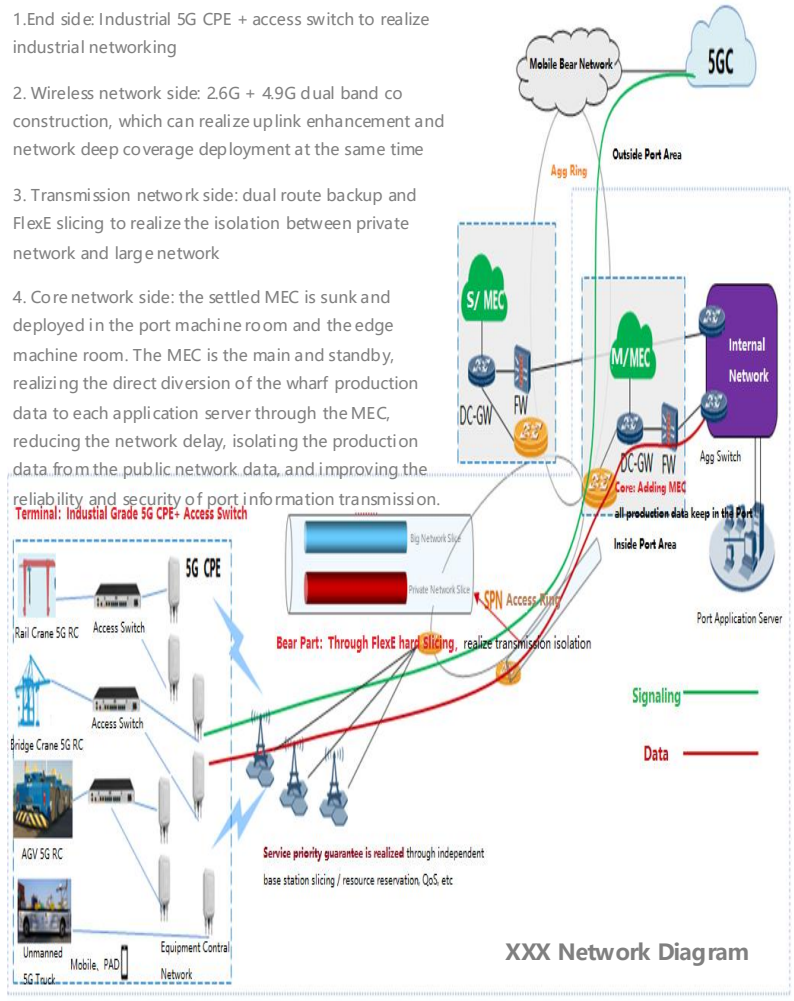
Solution

1.End side: Industrial 5G CPE + access switch to realize industrial networking

2. Wireless network side: 2.6G + 4.9G dual band co construction, which can realize uplink enhancement and network deep coverage deployment at the same time

3. Transmission network side: dual route backup and FlexE slicing to realize the isolation between private network and large network

4. Core network side: the settled MEC is sunk and deployed in the port machine room and the edge machine room. The MEC is the main and standby, realizing the direct diversion of the wharf production data to each application server through the MEC, reducing the network delay, isolating the production data from the public network data, and improving the reliability and security of port information transmission.



Benefit

5G Smart Tally

The identification accuracy of container number is **95%**

5G AGV Cluster Management

Ship loading and unloading increased **by 12.98%** year-on-year

5G RC of Rail Crane

Remote control can improve operation efficiency and reduce cost

5G RC of tire crane

Operation efficiency: **+260%**
labor cost: **-70%**

5G Driverless Container Truck

Labor cost: **- 50%**, operation efficiency: **+ 40%**

Driver Behavior Management

It realizes the intelligent analysis, recording and alarm of the behavior of transport vehicle drivers, and greatly improves the **efficiency and safety** of wharf transportation

Based on 5G+ MEC, **5G Gantry crane, Tire crane, Rail Crane Remote Control, 5G Smart tally, 5G driverless Container truck, 5G driver behavior** and other service scenarios have been realized in XiaMen Ocean Gate Terminal Wharf

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THANK YOU!