

# The Practice of TCL's 5G Deterministic Network Application

## — The Practice and Communication on Industrial 5G Promotion with China and EU



TCL



中国移动



HUAWEI

FORWARDX



凌犀  
LINGXI

China Mobile Guangdong Company

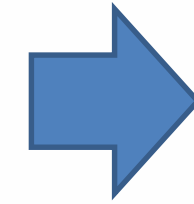
TCL Group Company TCL King

ForwardX Robotics Co., Ltd.

China Mobile Internet of Things Inc

HUAWEI TECHNOLOGIES CO., LTD

LINXI Things Inc (Guangdong)



- 1、 The Brief Introduction of TCL**
- 2、 Enterprise Painpoints**
- 3、 Solutions and Application Deployment Based on 5G Deterministic Network**
- 4、 Suggestions for 5G Development**

## TCL Industrial Intelligent Terminal -Global Manufacturing Layout



- **Tonly Electronics Manufacturing Base**

Huizhou,Beihai,Vietnam

◆ Annual production capacity:**33 million units**

- **Television Manufacturing Base**

Huizhou,Chengdu,Neimenggu,Poland,Vietnam,Mexico,Brazil,  
Pakistan,India

◆ Global color TV production capacity:  
**46 million units**

- **Air Conditioning Manufacturing Base**

Zhongshan,Huizhou,Wuhan,Jiujiang,Indo  
nesia,Brazil and so on

◆ Global Air Conditioning production capacity:  
**17 million units**

- **Washing Machines and Refrigerators Manufacturing Base**

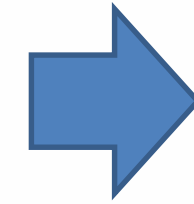
Hefei Ice Washing Park plans production capacity:8 million units

- ◆ The first-phase production capacity:**4.5 million units has been achieved**
- ◆ The planning production capacity of the second-phase: **3.5 million units**

- **Mobile Phone Manufacturing Base**

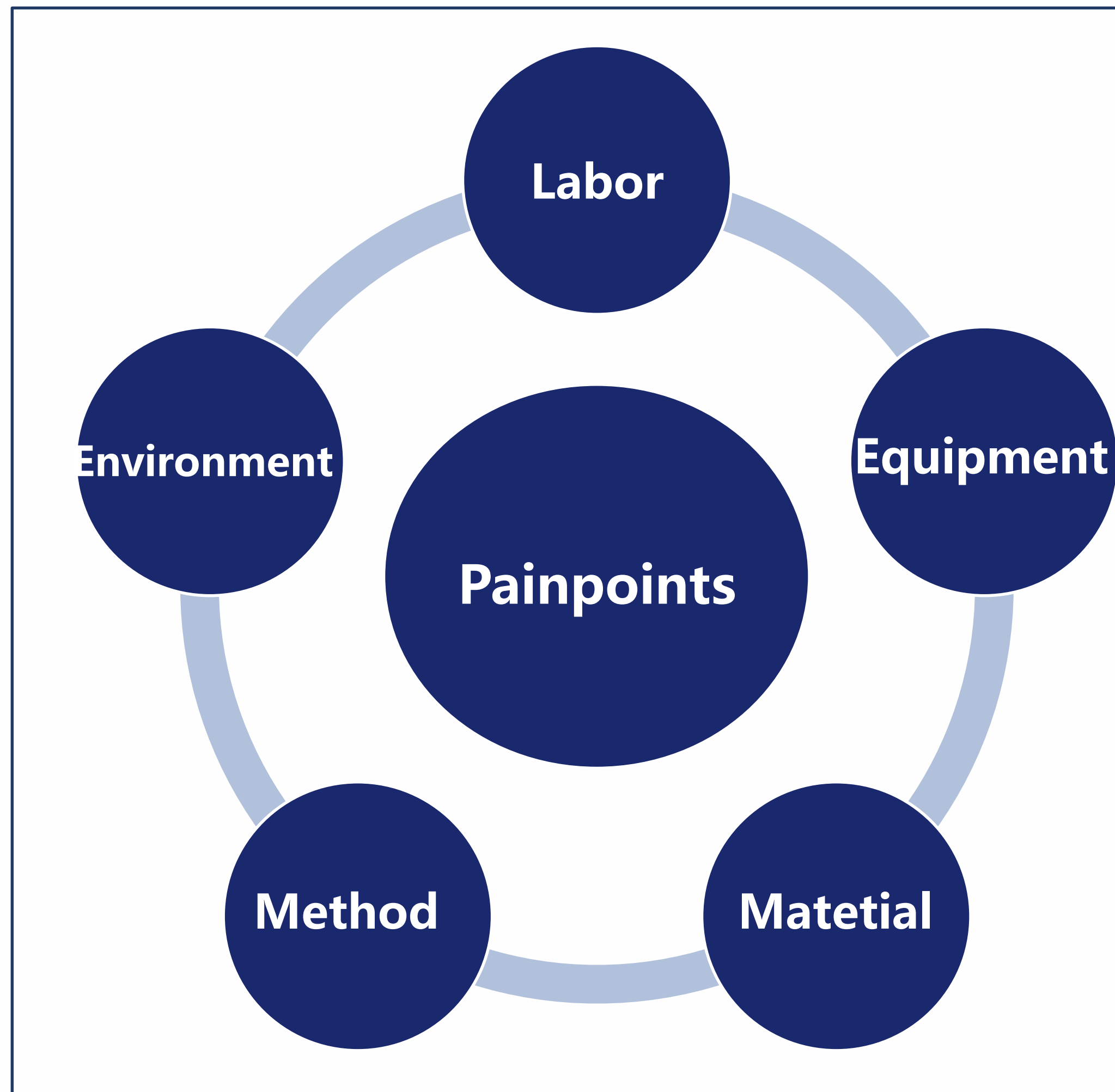
Huizhou:the biggest,unitary manufacturing base

◆ The overall annual production capacity reaches **120 million units**



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# Enterprise Painpoints



**Labor**

◆The labor cost of manufacturing industry rises, it is difficult to recruit workers, the mobility is large, the knowledge structure is not ideal.  
**Need: AI machine vision to support intellectualization and aid decision making**

**Equipment**

◆Automation equipment is accounted for a large proportion, production conversion, preventive maintenance, upgrade iteration, remote operation are becoming difficult.  
**Need: Preventive maintenance under massive connection, soft instead of rigid, stable and reliable 5G network**

**Material**

◆Multi-variety small batch ,multi-batch material supply are wrong,missing,mixed.Cost waste of picking, sending, moving, cross - floor handling.Mixing people and cars is difficult  
**Need: JIT one-flow unmanned trans-regional transport, intelligent storage (material management, remote control)**

**Method**

◆Personnel operation guidance and operation standard monitoring can not meet the requirements of flexible manufacturing and remote guidance  
**Need:V-SOP for automatic placement, real-time job monitoring, remote teaching and other auxiliary operations**

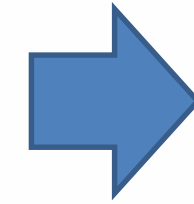
**Environment**

◆If security of electrostatic,cleanliness,temperature depends on manual work,it is easy to leak and delay  
**Need:real-time monitoring of the environment**

**Cluster Coordination**

◆ecological chain collaboration is difficult(production line replication, data security, product quality control are difficult)  
**Need: cross-regional ecological coordination, management replication**

The seven applications of 5G deterministic networks need to be implemented: real-time monitoring, machine vision, remote control, material management, auxiliary jobs, mass connectivity, and product lifecycle management



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We are working together to promote and accelerate the process of industrial Internet with the demonstration effect of full factors of production, and build a 5G+ industrial Internet demonstration park with leading technology, industry recognition, high replication and promotion.

March 12, 2019

June 6, 2019

August 20, 2019

September 27, 2019

October 15, 2019

March 15, 2020

September 20, 2020

TCL and China Mobile reached a strategic consensus on 5G during the Two Sessions

5G licensing on the same day opened the industrial park indoor and outdoor 5G base stations

First won 5G+ Industrial Internet Demonstration Park in the province"

Leaders of Municipal Industry and Information Technology Bureau, TCL China Mobile and Huawei **signed a strategic cooperation agreement** on 5G + Industrial Internet was signed

**First Won** in the Second National "Bloom Cup" 5G Application Innovation Competition

Unmanned workshop operation based on 5G integration of "human + machine + material + vehicle + field"

**Second won** in the 3rd National Bloom Cup 5G Application Innovation Competition. **First Won** of National Smart Park Competition;



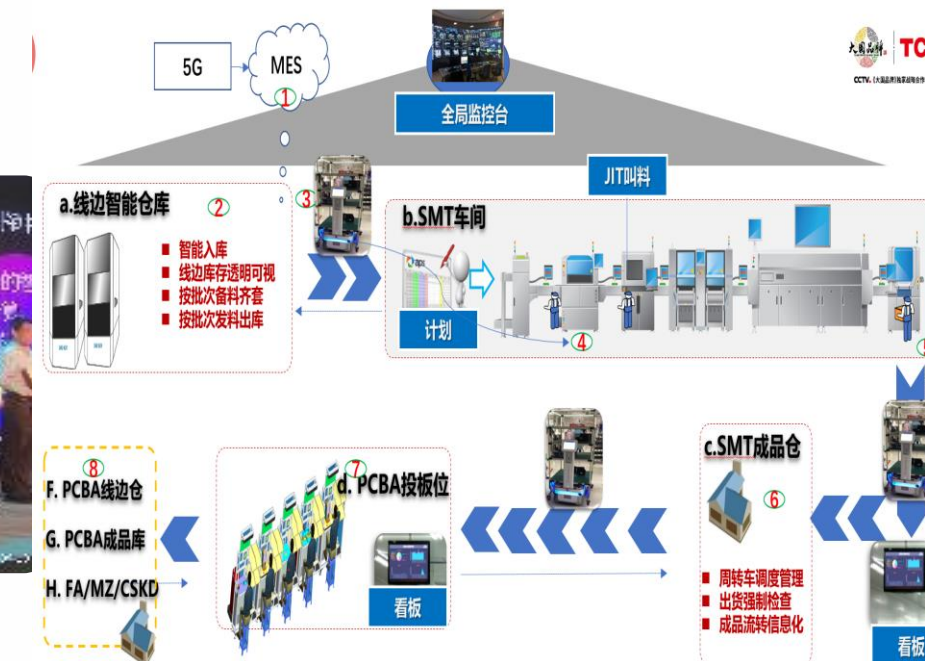
Smart factory 5G base station opened and tested



The first batch of 5G+ Industrial Internet Demonstration Park was awarded licenses



Ministry of Industry and Information Technology Bloom Cup Awarded National First Prize



Intelligent workshop put into operation

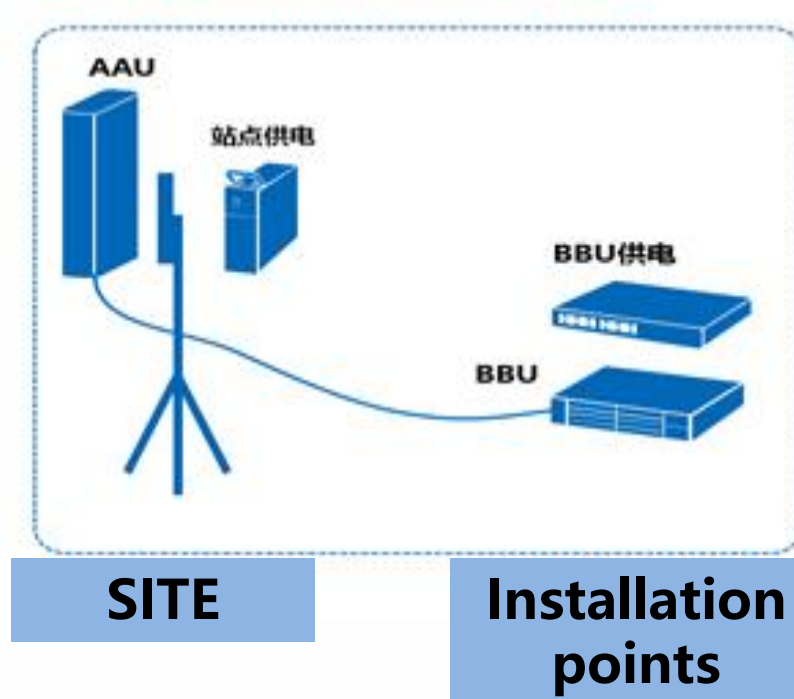
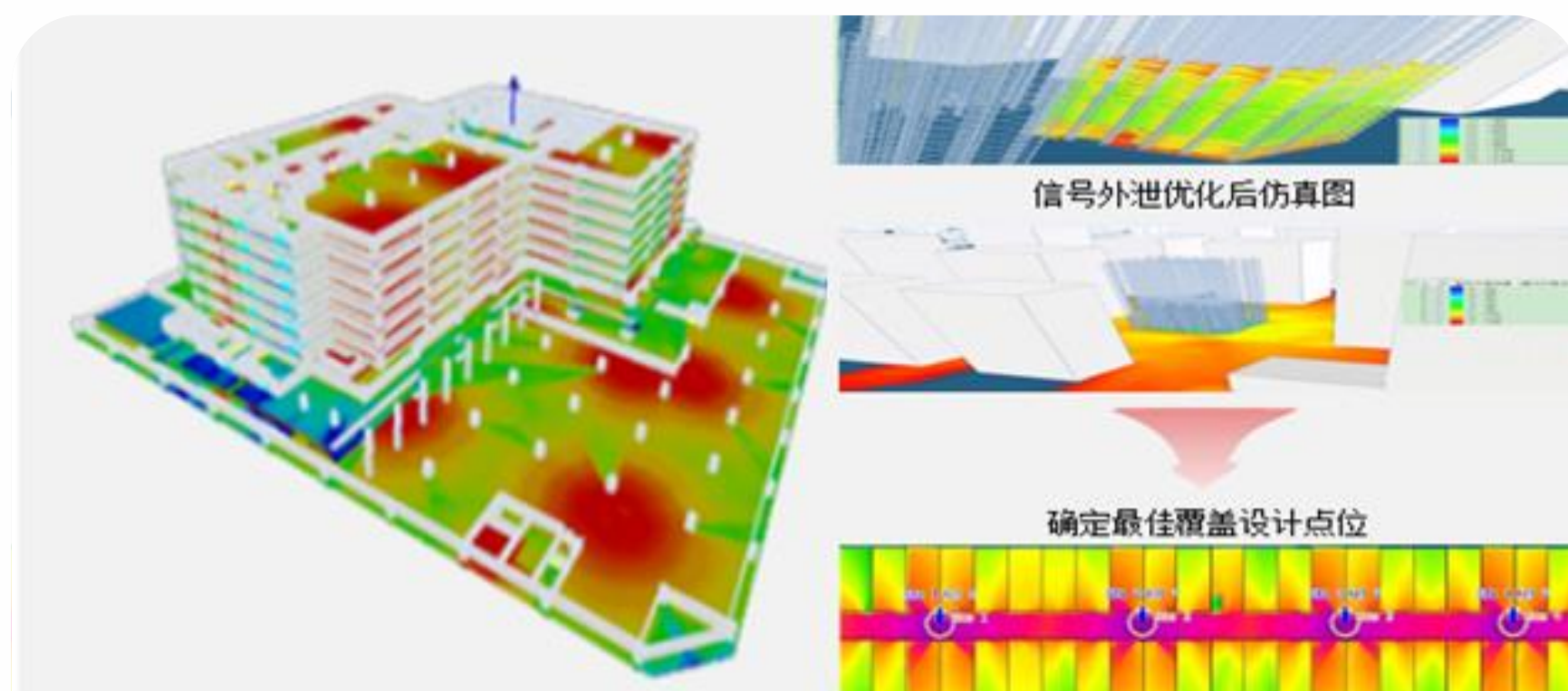


Guangdong 5G+ Industrial Internet Application Demonstration signed contract

Combining with the development of 5G technology, we will continue to internalize core capabilities in three steps to create high-value, typical application demonstration

## STEP 1: June 2019

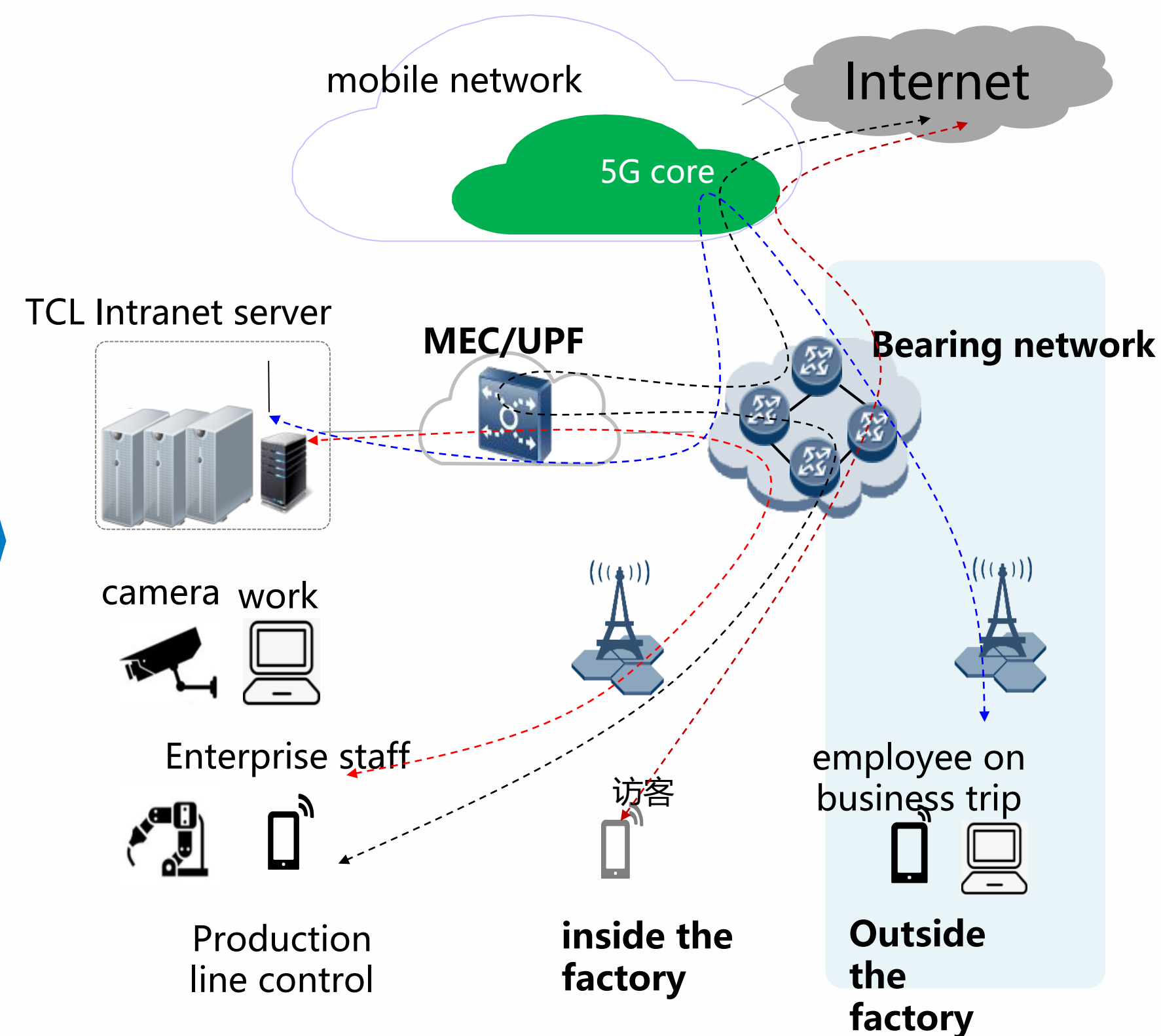
Based on industrial environment, realize 5G network indoor and outdoor collaborative coverage, build a highly reliable **5G Industrial Intranet**



Collaborative planning and 5G network deployment

## STEP 2: October 2019

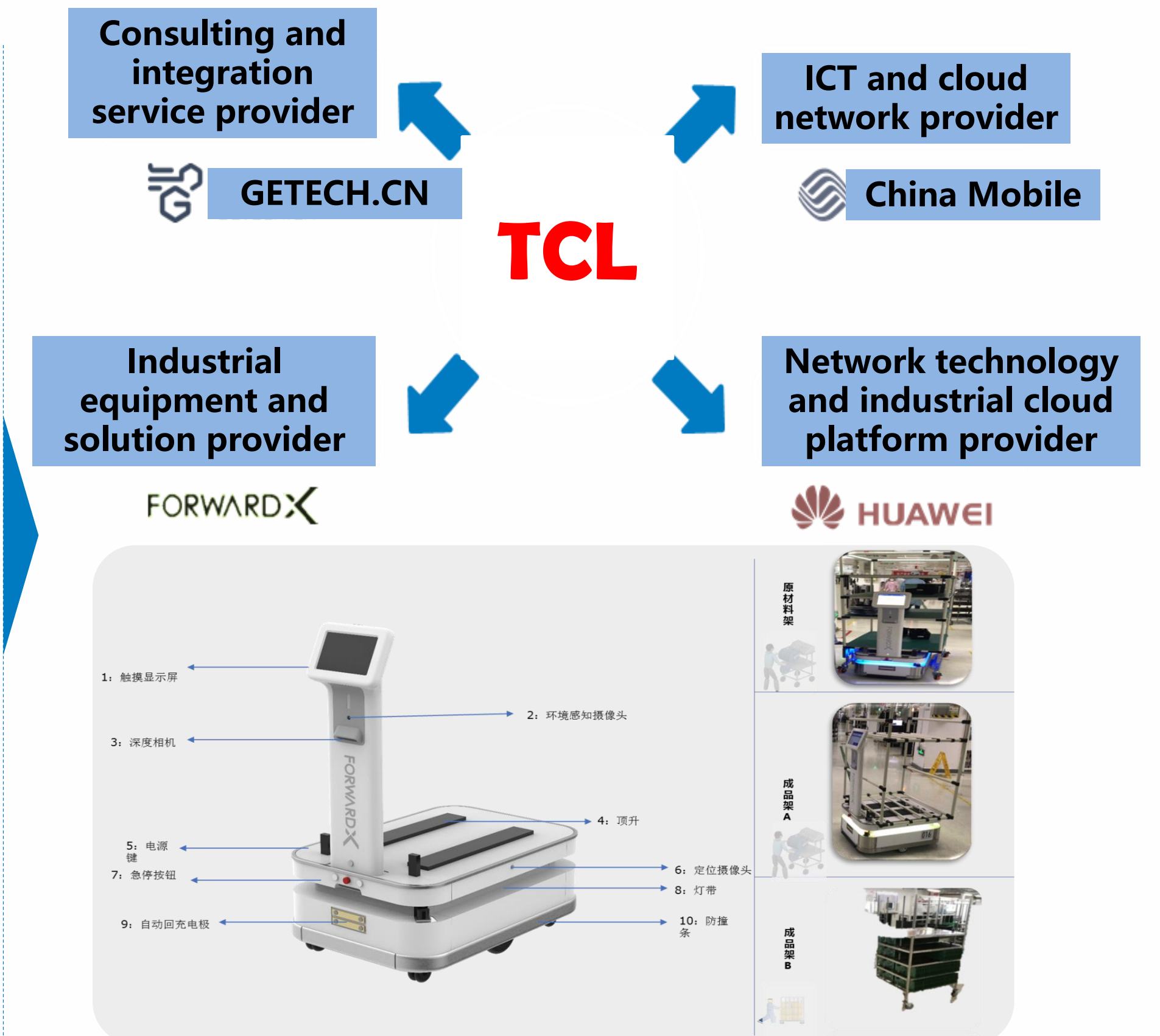
Build the overall architecture of "Industrial Internet + Enterprise Private Cloud + Edge Cloud + Function Cloud"



Through DNN access, flexible networking in the park is realized

## STEP 3: March 2020

Depende on the Edge computing, build an **integrated ecosystem**, Implement high-value industrial demonstration application



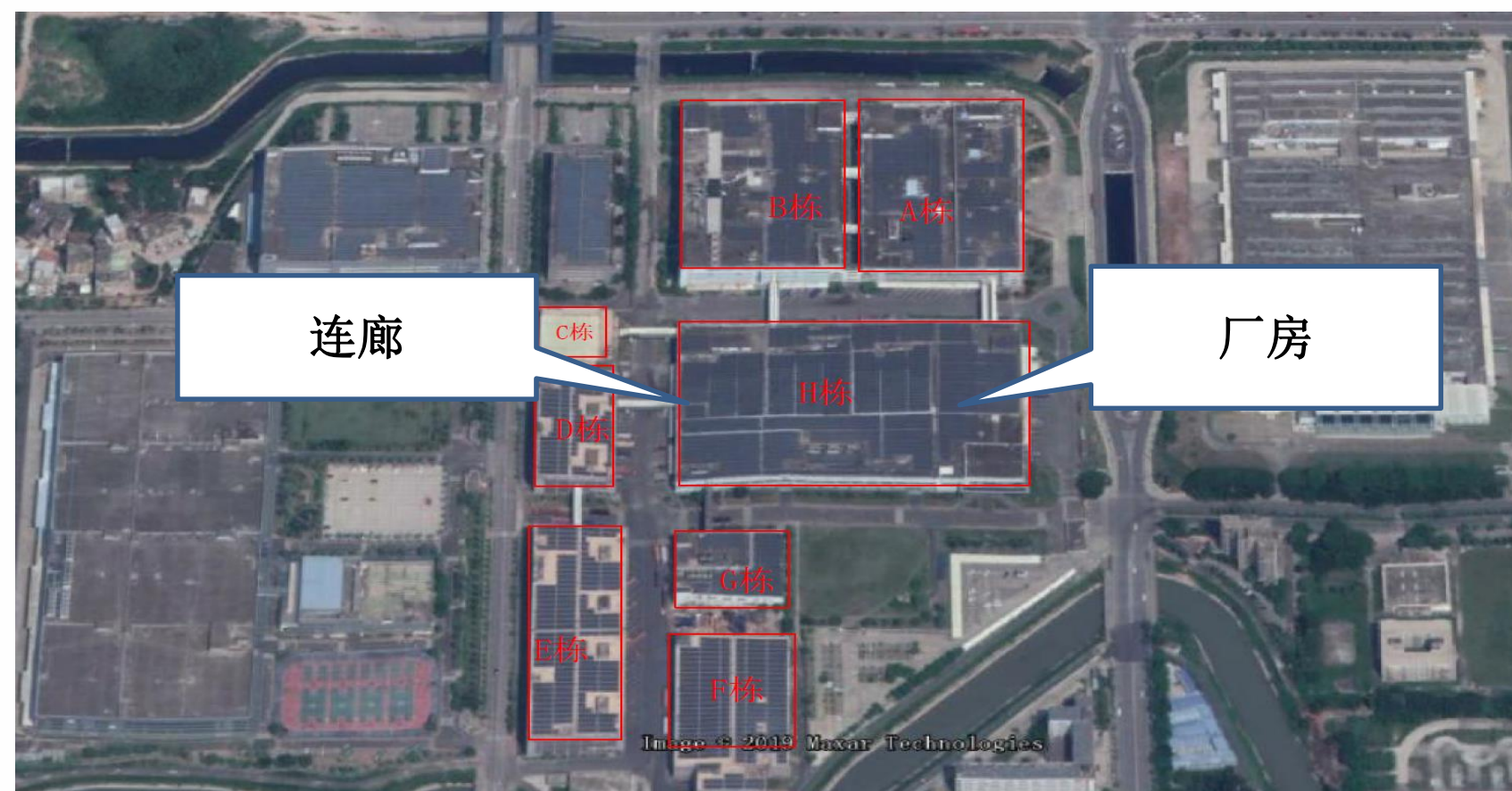
Cultivate ecology and build an ecosystem of cloud + platform + application



## STEP 1: Wireless network: Combined with the application requirements of the factory, formulating 5G private network plan and building a high-standard 5G private network

### Research Needs

Facing the industrial environment, investigate the site fine, research the covers of demand area



Requirements identification, research equipment requirements` coverage area

### Site Designs

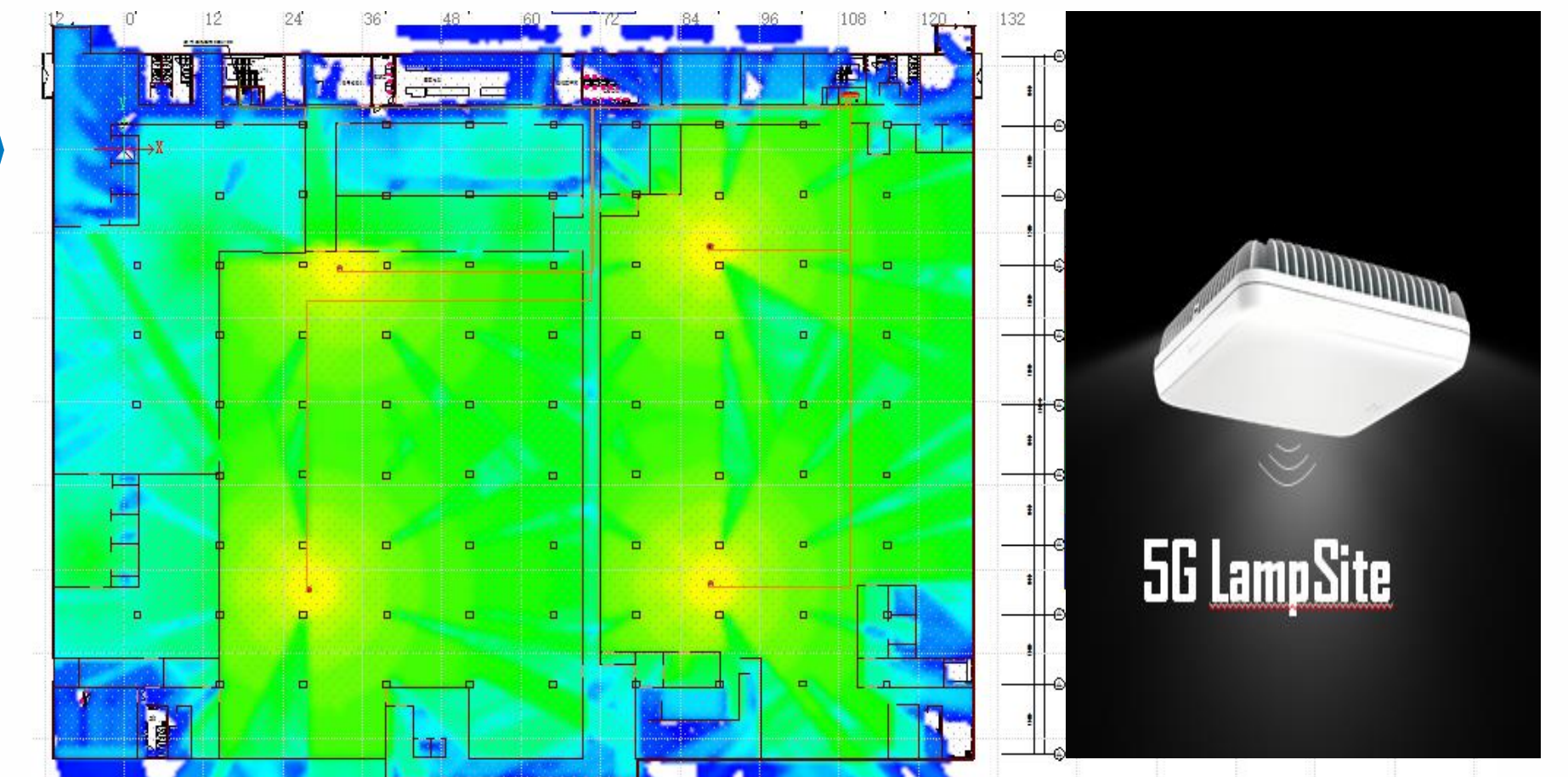
Adjusting measures to local conditions, flexible deployment, so that the machinery and equipment in the complex industrial environment have complete coverage



Scene design, To achieve flexible network deployment in the park

### Special Optimization

Modeling and simulation to guide PRRU position planning, repeated optimization and adjustment to ensure the overall test route

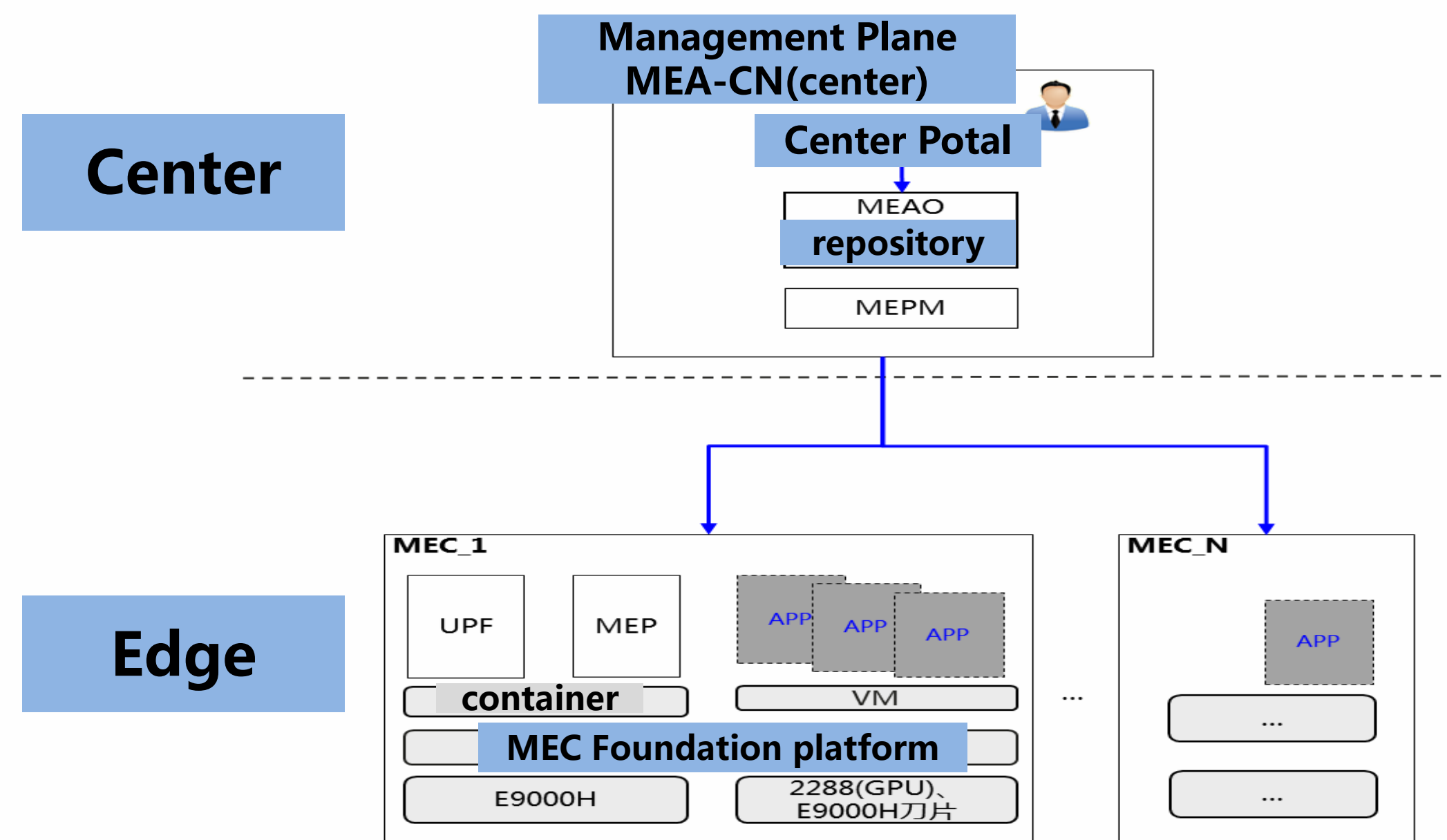


Performance optimization, to create a typical ,high-quality networkhigh-quality

For the wireless part, have constructed 53 PRRU, compared with traditional 2C scenario, put into **2 times more investment**. By means of dozens of optimization and equipment adjustment, coverage effect is improved obviously, signal strength increased from -105dBm to -85dBm, download speed > **900Mbps**, upload speed > **110Mbps**, 5G deterministic network deployment for factory scenarios has completed.

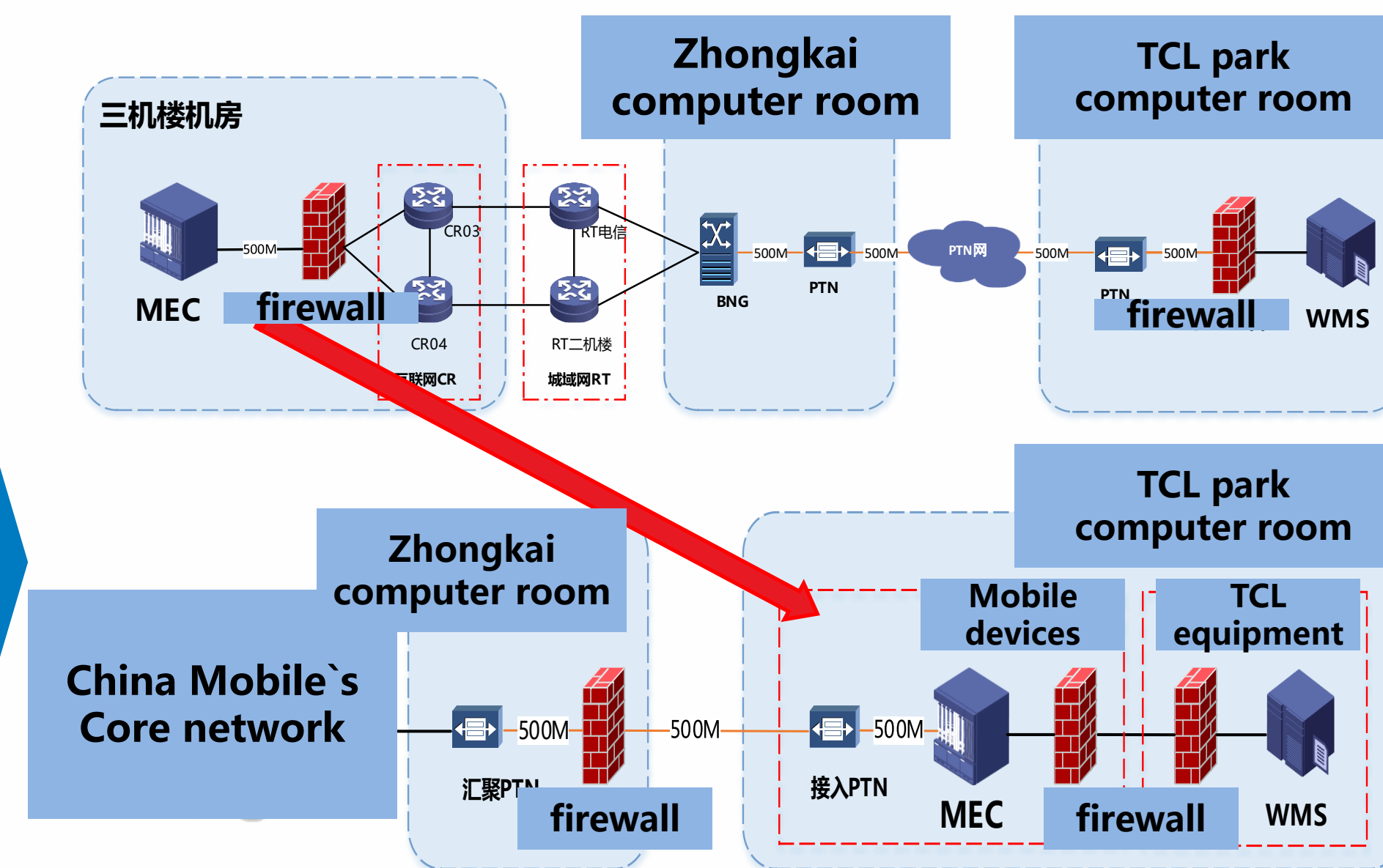
## STEP 2: Edge Computing: Deploy edge computing server in China mobile computer room, with Zero Code loaded in AMR APP

### MEC simulation environment testing



Huawei provides a test platform for industrial APP deployment, deployment guidance for enterprise upper edge cloud, and trial operation environment. Industrial APP developers can use this platform to carry out pre-deployment tests, and realize digital twinning and production process simulation tests.

### Marginalized deployment policy validation

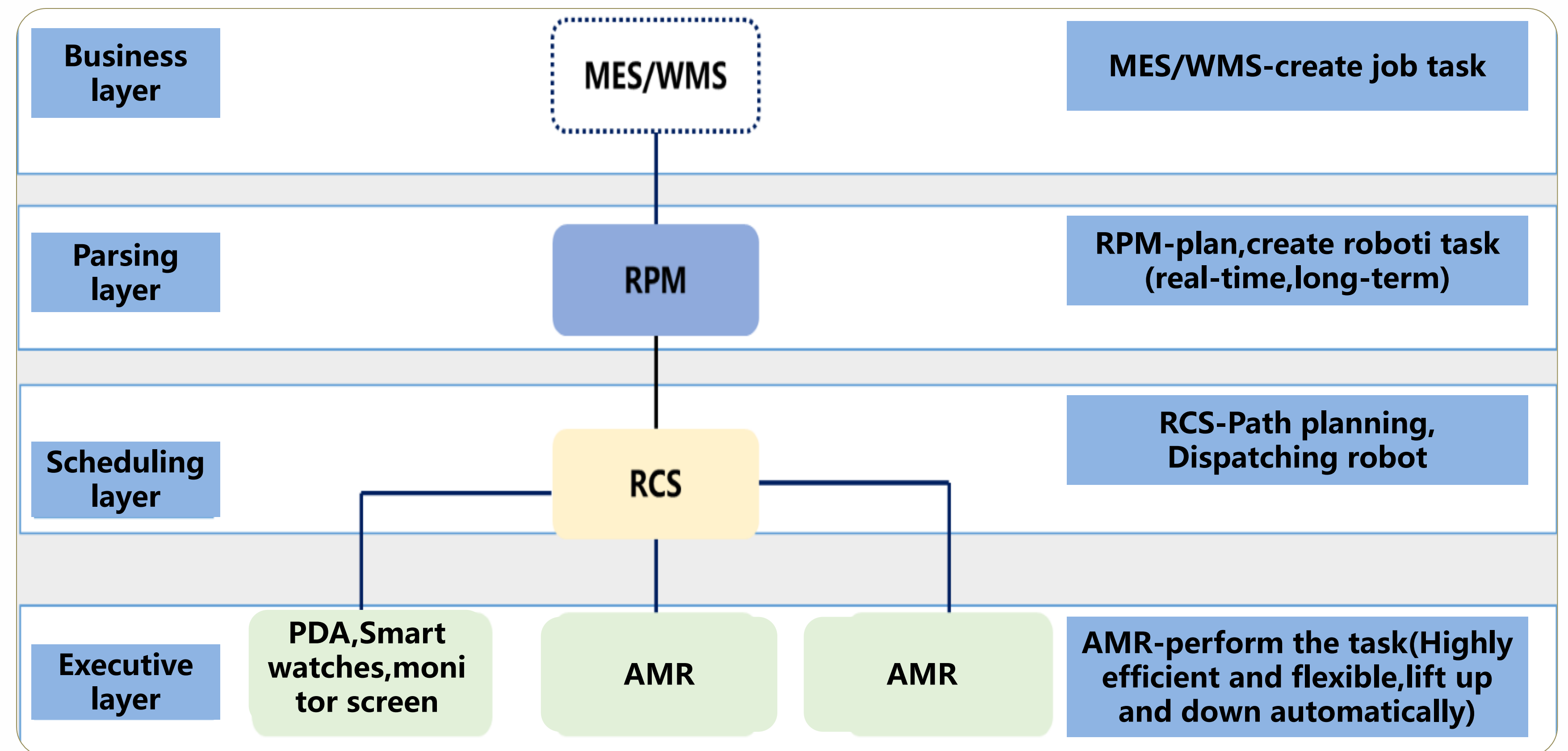
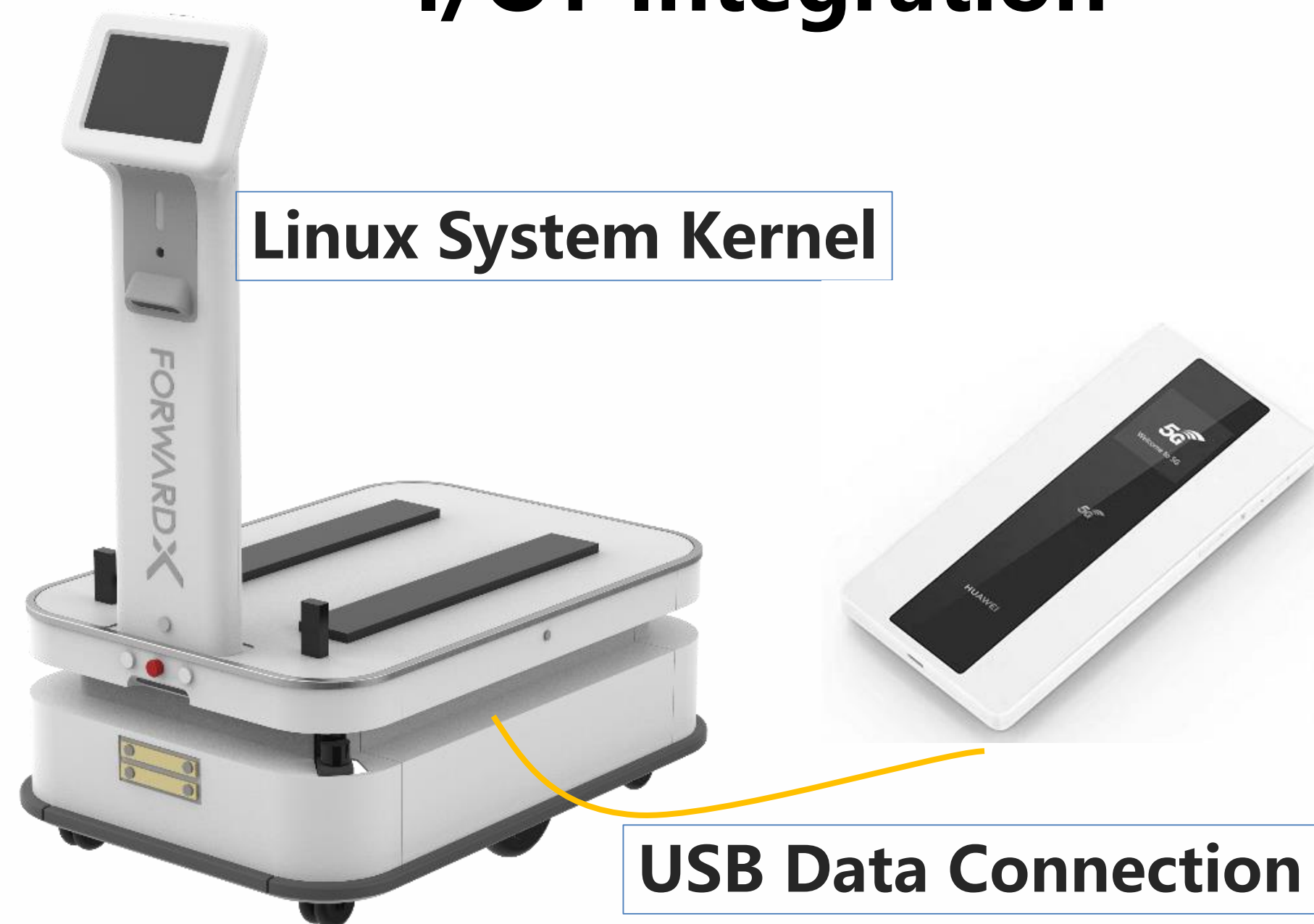


The current MEC deployment method and performance test have a delay of 13-17 milliseconds, which can meet the operational requirements of AMR intelligent car. However, in order to improve the speed of vehicle collaborative scheduling, the end-to-end delay is required to be controlled at 20ms, and the delay left for 5G network is only 10ms, which must be lowered to the park.

## STEP 3: System integration: Intelligent vehicle transformation and MES interface transformation

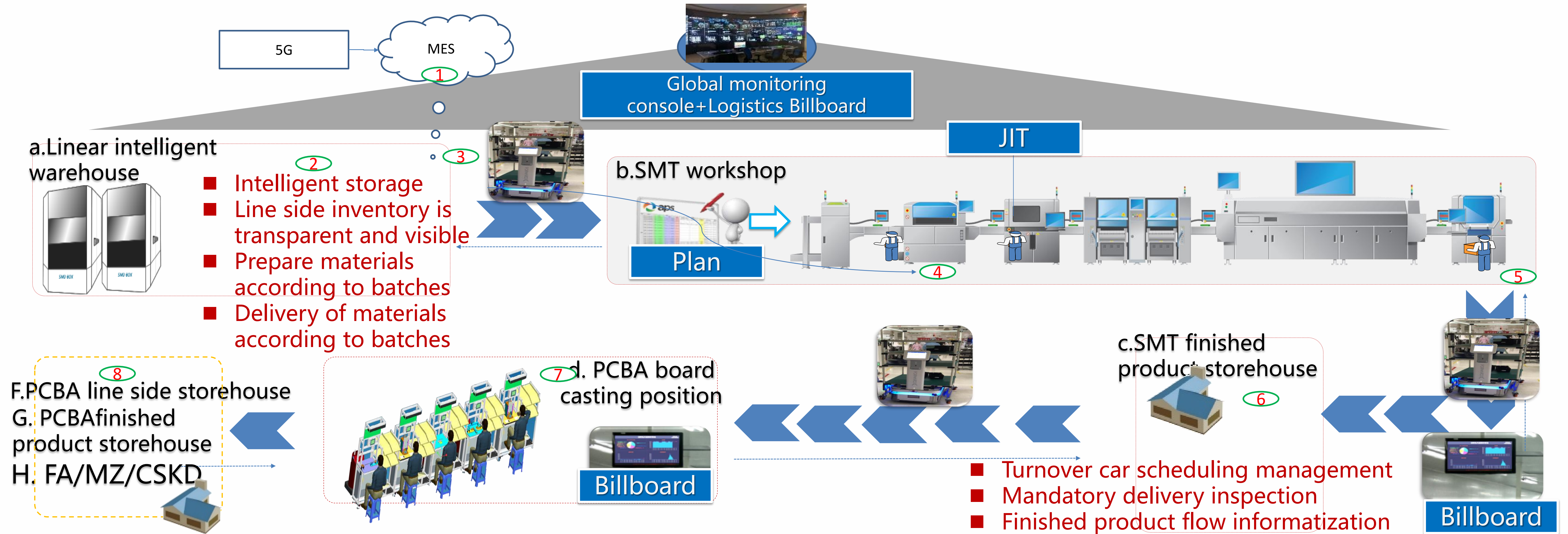
The integration of WMS, MES and robot scheduling system makes the information flow completely connected. With the support of 5G and robots, the automation of material management and distribution is realized, the process is optimized, the transmission link is reduced, the efficiency is improved and the error rate of human is reduced. At present, there are 20 vehicles running in the factory, which improves the efficiency of logistics and transportation.

### I/OT Integration



At present, the 5G transformation of AMR intelligent logistics vehicle is using Linux system kernel to develop USB data transmission mode for 5G carry-on, so that AMR intelligent vehicle can connect with 5G carry-on in the car and carry out data transmission through 5G signal. But USB communication can not meet the low delay control requirements, still need to adopt module integration plan.

## Intelligent logistics project construction achievements of movement factory



Build 5G cloud +MES tube + edge computing + end (equipment +AMR + material + site + people) integrated collaborative unmanned factory; Free people's feet, hands and part of the brain to achieve MES production plan which can depend on one-button drive unmanned manufacturing.

# Deployment of 5G deterministic network applications: Next step

## Collaborate with R&D and manufacturing to build 5G+ digital twin color TV assembly line

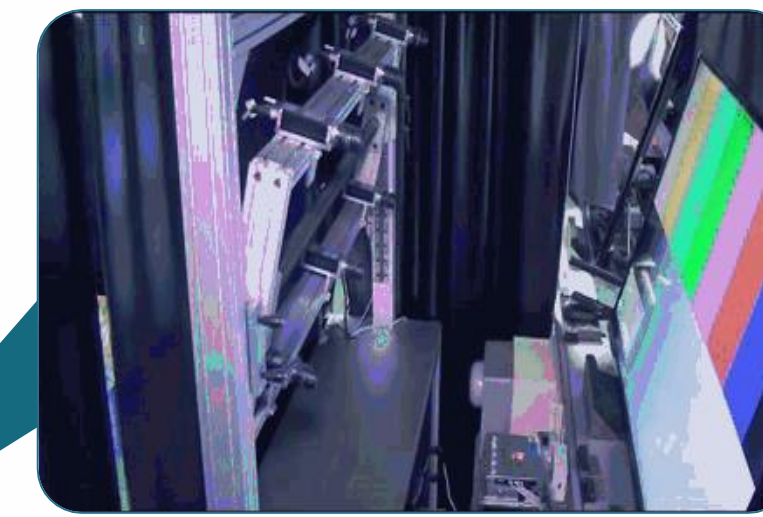
High precision flexible production line cloud control  
(Dispensing machine/OpenCell/screw machine)



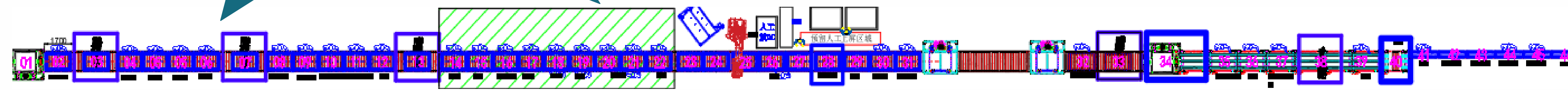
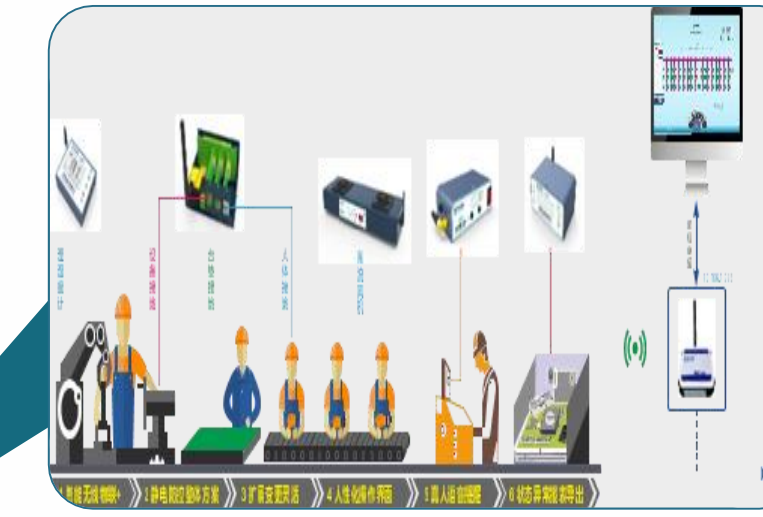
ESOP, intelligent operation monitoring



Visual inspection of panel defects  
Automatic detection of module, internal process inspection,  
automatic pressure resistance  
, automatic image sound detection, automatic detection of  
LOGO, boot automatic detection,  
Appearance automatic detection, automatic shooting  
equipment, art automatic detection (stickers/labels, etc.)



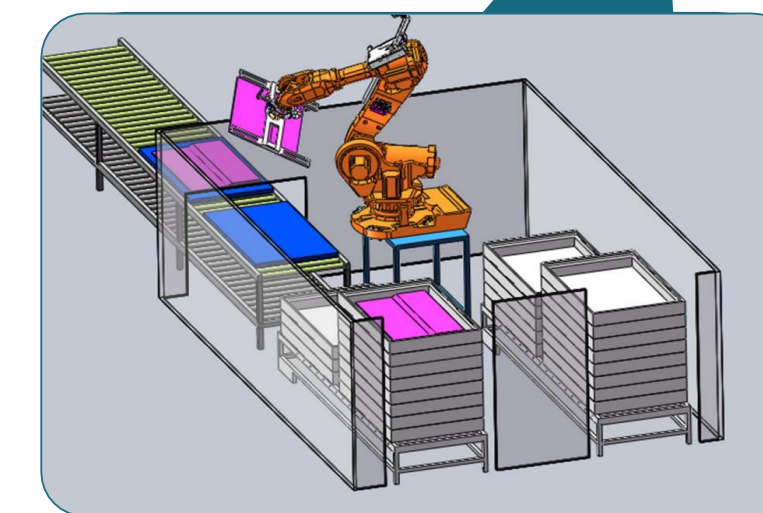
NB-IoT ESD, cleanliness monitoring



Scenarios of intelligent production line application	Uplink bandwidth (mbps)	Downlink bandwidth (mbps)	Latency(ms)	Jitter(ms)	Number of terminal (set)
High precision,flexible production line cloud control	12	2	18	2	6
Production line with AMR intelligent logistics cooperation	20	2	15	5	12
Visual inspection of color TV panel defects	100	2	50	20	4
Visual inspection of SMT patch process	100	2	50	20	3
Online ESD, cleanliness monitoring	2	2	100	20	20
ESOP video, job video intelligent monitoring	8	20	100	20	10
AR remote operation and maintenance and inspection	20	20	50	10	2



AR remote operation and inspection



High precision flexible production line cloud control (upright machine/packing/stacking)



AMR intelligent logistics collaboration

Practice the 7 applications of 5G deterministic networks: real-time monitoring, machine vision, remote control, material management, auxiliary jobs, mass connectivity, and product lifecycle management

# Deployment of 5G deterministic network applications: Next step

Based on 5G LAN virtual private network, We will promote coordination among industrial clusters

Give full play to the advantages of industrial clusters, copy production lines quickly, Initiate SMT patch process outsourcing and final assembly foundry, **moving forward quality control technology**

### 1 Flexible production lines replicate quickly

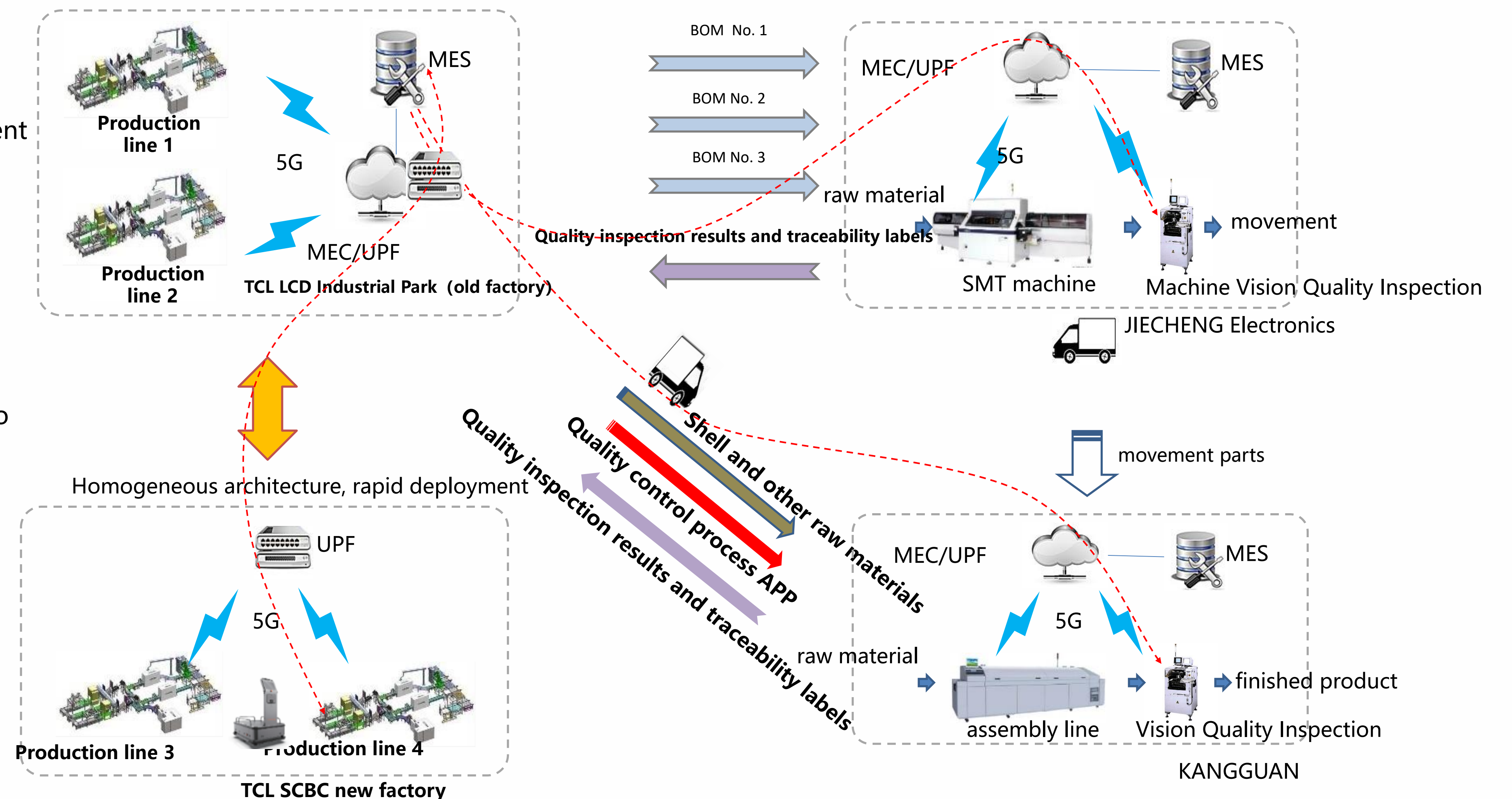
The standardized 5G+ edge computing network environment provides a unified architecture, shortens the time of business testing and deployment, and accelerates the deployment of new overseas electronic production lines.

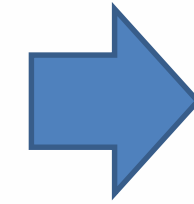
### 2 Source monitoring of patch process

Transfer forward the patch process quality inspection link to the OEM factory to trace the source of the test results, and avoid the inspection of the movement board when it is in the factory to avoid the loss of overseas assembly.

### 3 Move the core technology of screen picking forward to the foundry

Deploy the quality inspection process APP to the foundry in a safe and confidential manner to monitor in real time to ensure the quality and keep the core technology confidential between factories.



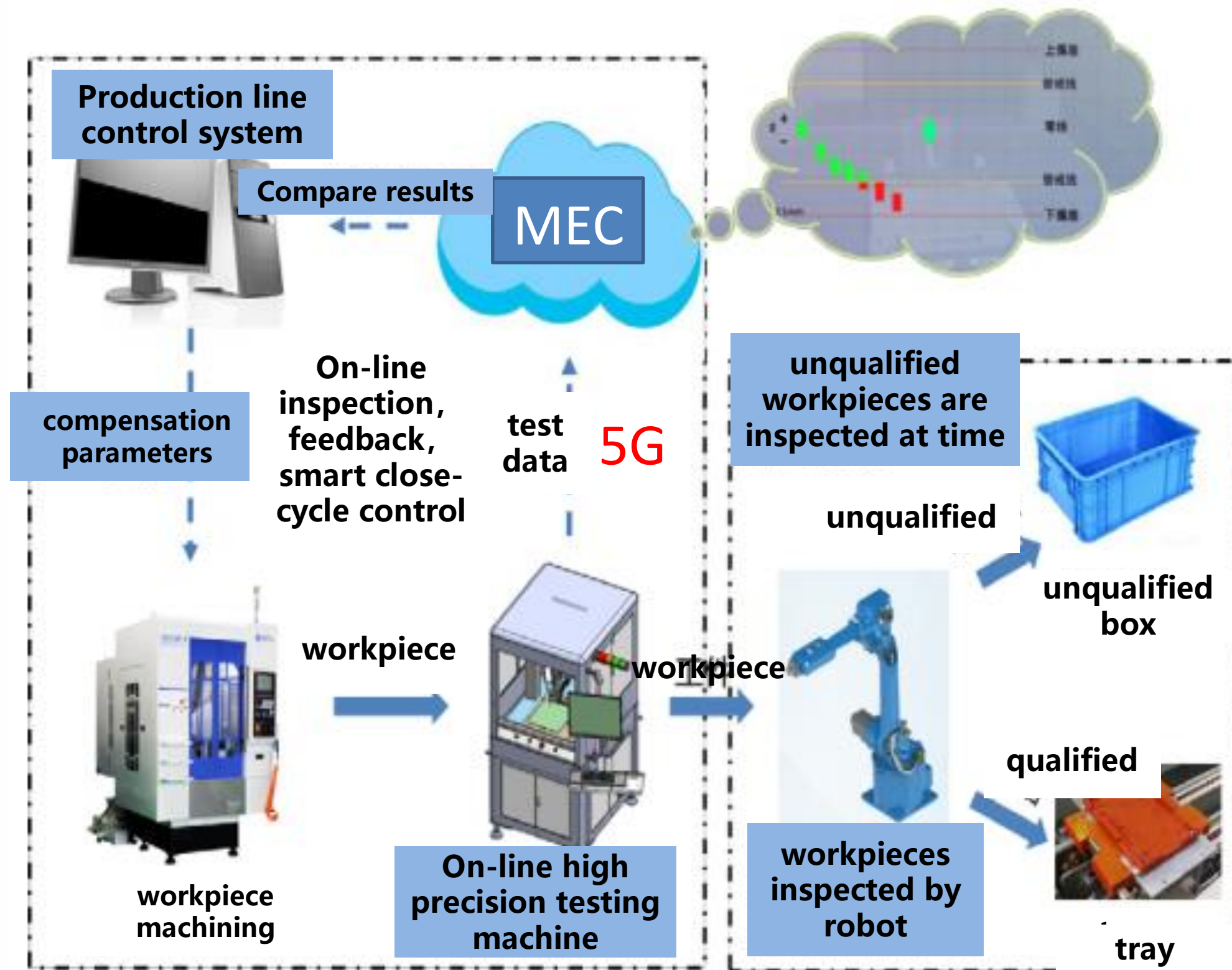


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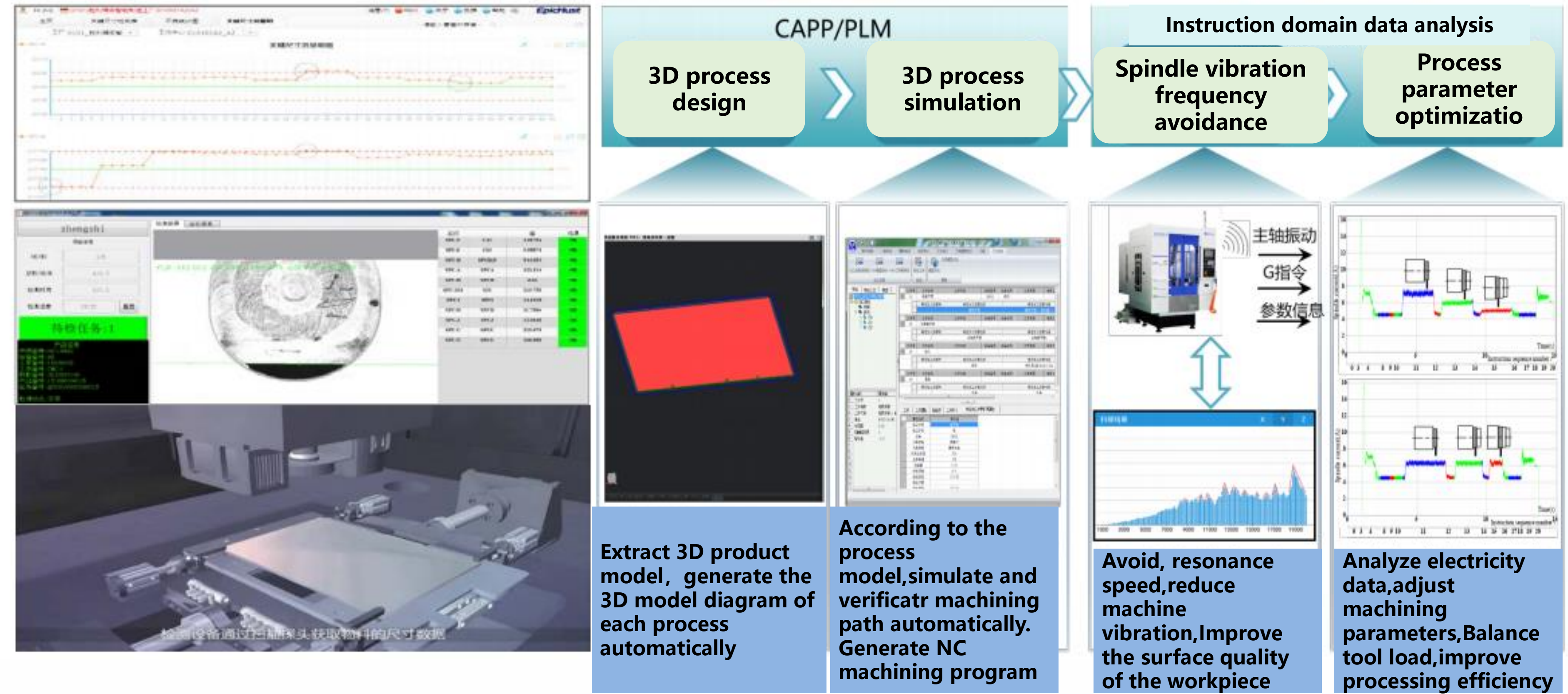
# Low Latency Requirements of 5G Deterministic Network in Intelligent Manufacturing Scenarios

□ The low latency scenario of quality control and process optimization is realized based on 5G LAN virtual private network

## 1、Surface defect detection and automatic sorting based on machine vision



## 2、Autonomous process optimization based on accurate measurement of machine vision



## 3、Feasibility of Whole Area Wireless Replacement for fieldbus in 5G Deterministic Network

- ◆ Wireless SCADA
- ◆ Wireless DCS
- ◆ Wireless PLC

- ✓ Short latency, 0-1ms, 1-100ms, 01-10s
- ✓ High reliability, Wireless packet loss rate < 0.0001
- ✓ High stability, TSN's network jitter is 0

The cloud-based controller is partially feasible in DCS and PLC system



**□ For technical management departments and alliances:**

- ✓ 1、 Accumulate business requirements, abstract and summarize requirements, discuss and promote the development of technology.
- ✓ 2、 Accumulate cooperation resources and form an overall solution library.
- ✓ 3、 Strengthen policies to lead the application of 5G smart terminals, promote commercialization through large-scale standardization, and then activate the industry by reducing costs.

**□ For 5G carriers:**

- ✓ 1、 Explore and cultivate new business cooperation models, provide multiple flexible combination package models, modularize the needs of different customers, and provide flexible combinations according to their needs.
- ✓ 2、 Integrate eco-systems, practice mature commercial solutions.
- ✓ 3、 Simplify the deployment and application of industrial APP, and enable quick launch of industrial APPs by innovation models such as rent on demand.

# We will jointly build the "5G+ Smart Factory" Industrial Internet Demonstration Park



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