中日友好医院
CHINA-JAPAN FRIENDSHIP HOSPITAL

China 5G Health Progress & Future Promotion

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National telemedicine and connected healthcare center

National telemedicine management and training center, National Health Commission

National primary-care telemedicine development directory center, National Health Commission

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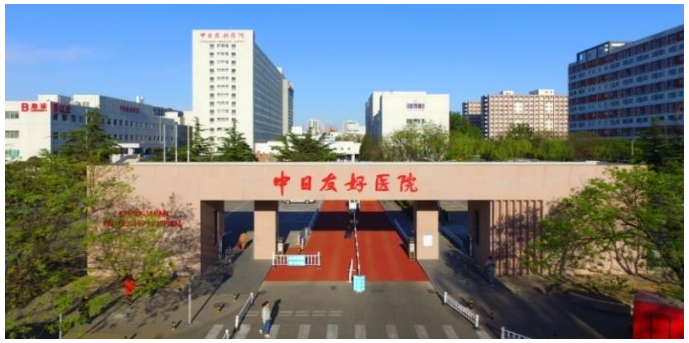
China-Japan Friendship Hospital: the Pace Maker of "Internet + Healthcare"

- 1998: Ministry of Health's first pilot: Telemedicine Center
- 2012: **National Telemedicine Management and Training Center**
- 2018: **National Telemedicine and connected Healthcare Center**
- 2018: **National Primary Telemedicine Development Directory Center**
- 2020: National Tele-consultation Platform for Covid-19 severe patients
- 2020: National Telemedicine Platform for Medical senior-care cooperation.
- 2021: China-Japan Friendship e-Hospital



“Internet + Healthcare” has been Applied into Various Telemedicine Services

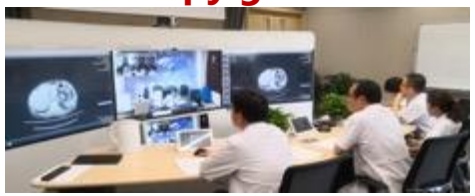
Realiable Connections, high throughput, low latency,
Strong compute capability, broad connection, fixed + mobile networks

Teleconsultation

Multi-disciplinary consultation

Remote teaching & ward round by experts

Radiation therapy guidance



China – Kazakhstan joint consultation

Tele-diagnosis

Teleconsultation

Tele-diagnosis

Tele-Ultrasound

Tele- ECG

Cloud Based Test analysis

Online-healthcare

Online follow-up visits

E-Prescription

Medicine Delivery to homes

Medicine delivery to nursing houses

Smart Hospital based on AI + 5G

AI applications

Smart Medicine	For Doctors More efficient	EMR based data exchanged AI，CDSS，robots etc.
Smart Assistant	For Patients More Convenient	Informatics 、 self management Appointment online 、 results presenting、 Payment、 drug delivery
Smart Management	For Managers More Precised	performance、 cast，resources Equipment 、 supplies, etc.

5G advantages match requirements for digital healthcare

- ✓ Increasingly connected
- ✓ Increasingly mobile

- ✓ Ubiquity
- ✓ Convenience
- ✓ Mobility
- ✓ Stability
- ✓ Safety

Equipment Upgrade

Business Innovation

Technology Innovation

As networks become a bottleneck, new technologies are required

- ✓ High-throughput data sharing
- ✓ A large number of devices are Connected concurrently
- ✓ Long interaction delay

High Throughput eMBB

- Massive data transmission
- HD video interaction
- Real-time data query on the cloud

Low latency URLLC

- No frame freezing or packet loss
- Latency < 20 ms
- Onsite interaction without waiting

Multiple connections mMTC

- Terminal/Sensor cluster access
- Multi-scenario and multi-terminal
- Multi-point concurrency and
- multiple audiences

5G Healthcare Initiated as New Infrastructure

Healthcare Quality and patient safety require high standards and powers of 5G network

- China Mobile Inc. + China-Japan Friendship Hospital
  - Joint with 100+hospitals
- 5G + telemedicine networks
  - Nation-Province-City-County-Town-Village Telemedicine Collaboration System

- Real-time video communication: HD video
- Large-volume data transmission: 1-2 Gb/case
- Cloud computing:
  - 3D imaging real-time two-way interaction
- Multi-source information collection: healthcare IoT
- Information security dedicated channel

National telemedicine and connected healthcare center leading the 5G health practice

- ✓ **Nation wild telemedicine cooperation network：**
  - 5400+ hospitals； 32000+ Physicians
- ✓ **Full brands 5G, full covering on key areas**
- ✓ **Connected to 200+ hospitals on 5G**
  - Telemedicine
  - Dermatoscope + AI
  - Digital stethoscope + AI
  - B- Ultrasonics + AI
  - Tele-Pathology

Problem: Inconsistent network communication performance between hospitals

- The performance of base stations is inconsistent after deployment
  - Engineering personnel rework and equipment replacement: time-consuming and costly
- The backbone network is not unified
- Big difference between the uplink and downlink data rates

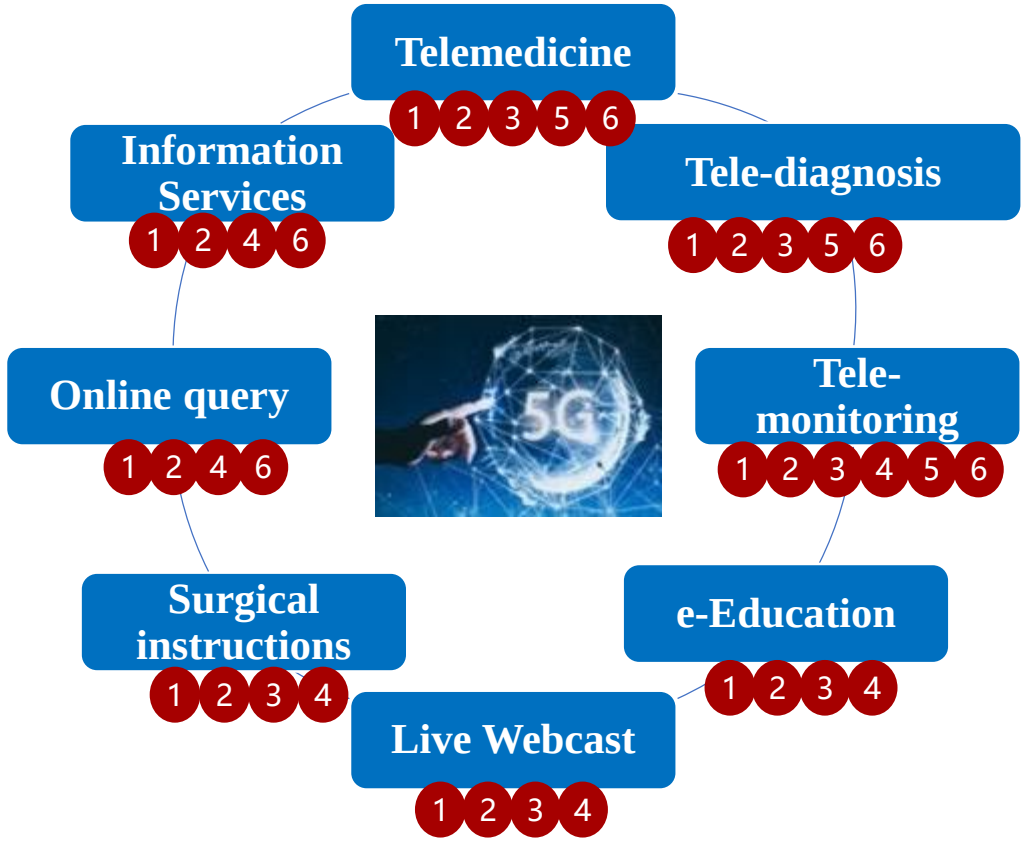
Networking standards and performance standards must be unified during network construction

Bottleneck of 5G communication between hospitals affects the efficiency and experience of telemedicine.

HD signal transmission is impaired: impaired video quality , poor reliability, unstable latency

The 5G network standard is proposed based on the requirements of medical quality control & patient safety

No.	Network capability
①	determinism
②	High throughput
③	Low latency
④	Large connection
⑤	Compute capability
⑥	Safety assurance



- ✓ **Initial installation**: Unify standards, reduce equipment costs, and improve efficiency and quality.
- ✓ **Application scenario**: Ensure communication quality, reduce medical accidents, and maintain patient safety.
- ✓ **Industrial manufacturing**: Comply with industry characteristics and technical requirements and reduce the error rate.

5G Network Architecture of the China-Japan Friendship Hospital

PDA

5G Cloud Diagnosis Room

Digital Auscultation

Remote Combined Ultrasound Diagnosis

Inside

5G

5G RRU

RHUB

BBU

5G DIS
Indoor coverage system

Pre-hospital first aid

5G AAU

Outside

Wireless

There are 20 buildings in the hospital. The 5G LampSite solution is used for indoor coverage, including consultation rooms, wards, operating rooms, teaching buildings, offices, and garages. The total area is 154,46 million square meters. 5G AAUs are used outdoors.

IP RAN

SPN

NRF NSSF SMF AMF UPF VIM

Beijing Unicom Core Network

Internet

UPFI APP APP MEP VIM

Beijing Shared MEC

Applications

The current applications are Teleconsultation_5G cloud consultation room, mobile nursing, digital auscultation, and Tele-ultrasound.

Transmission

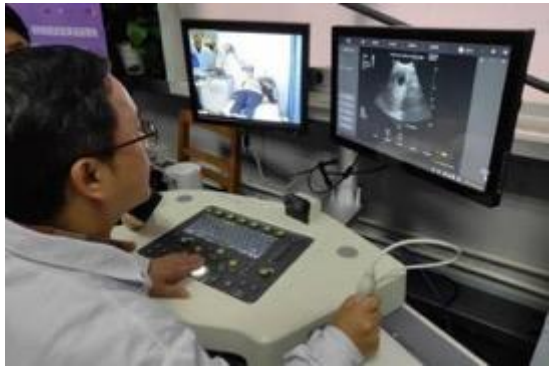
The RGW is connected to the access ring of the 5G SPN transmission network. Dual VPNs are configured on the transmission device SPN.

Shared core network

The MEC provides a traffic distribution and open platform. Different tenants are logically isolated, meeting the requirements for fast rollout and deployment of third-party applications.

The standard research has received extensive support and participation from hospitals

- **Organize experts in hospitals demonstration application**
  - Telemedicine application test in 200+ hospitals
  - 8 telemedicine application categories
  - Provide basic requirements for 5G network construction in hospitals
  - Output the network requirements for eight categories of clinical applications
- **Organize CAICT, Huawei, and three telecom carriers**
- **Practice model, technical argumentation, refining standard parameters**



The 5G healthcare industry ecosystem has taken shape

First batch of 5G medical terminals (24 models of 7 categories)

No.	Application Category	Typical Application
1	Mobile Machines	mobile disinfecting service robot
2		Mobile Logistics Service Robot
3		Nuclear Medicine ward inspection service robot
4		guided navigation service robot
5	Wireless monitoring	Data acquisition and control of bedside ventilator
6		
7		Data acquisition and control of bedside monitor
		Defibrillator data acquisition
8	Mobile PDA Class	Mobile Care PDA
9		Inventory of drugs, consumables and other equipment PDA
10	Mobile carts	Mobile nursing information cart
11		Mobile ward inspection information cart
12		Mobile bedside consultation video cart
13	Ultrasound	portable ultrasound
14		Tele-ultrasound
15	Telemedicine	Teleconsultation
16		Remote surgical teaching
17		remote visit
18		Remote ward round
19		digital auscultation
20	Logistics Management	Video security
21		Device Asset Location Management
22		Building energy consumption monitoring and collection
23		Building environment data monitoring and collection

Teleconsultation

CT Telediagnosis

Tele Ultrasound

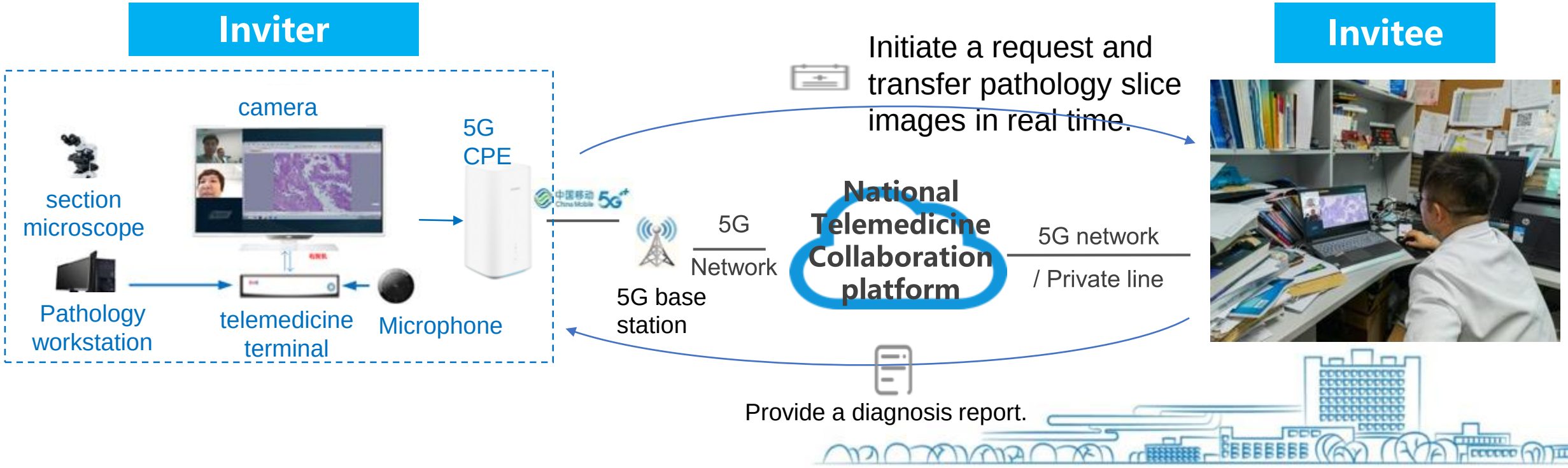
ECG Tele monitoring

Cloud detection and analysis

5G smart ward check

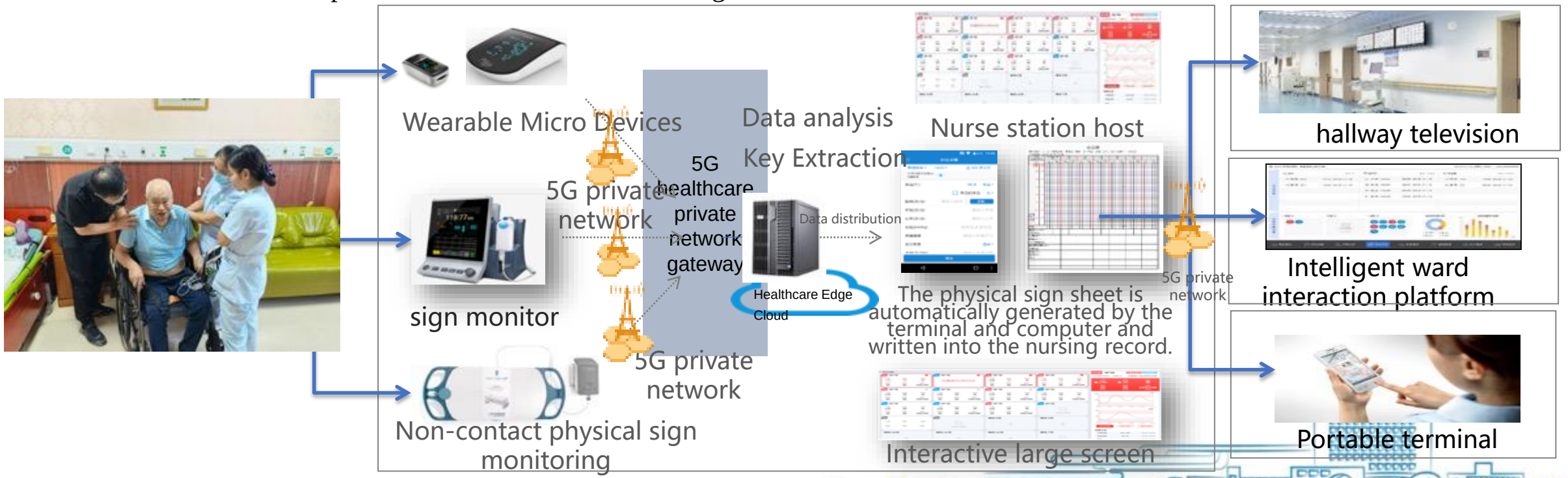
5G+4K: Real-Time Synchronous Pathology telediagnosis

- 5G+ Pathology Telediagnosis: Mobile
- 5G+4K: Rapid frozen and real-time synchronous film reading during operation, 30-minute diagnosis report
  - Low latency: 30 ms



5G dynamic monitoring

- Ambulatory monitoring: 12-lead ECG, blood pressure, blood oxygen, and respiration
- 5G Transmission of Monitoring Data to Telemedicine Monitoring Platform
  - Mobility, no packet loss
- The platform uses AI to analyze abnormal information in real time. After manual confirmation, the platform reminds the relevant department of the hospital where the patient resides in real time.
  - Critical value alarm not delayed
- It is convenient for patients to realize home monitoring.



5G treatment: Ultrasound-guided minimally invasive surgeries

Acupotomology for pain treatment

- **Surgical demonstration training**
- **Real-time online directory during surgeries**

5G module terminals + mobile video carts

- **Sharing special treatment technologies with primary hospitals**
- **Effective local treatment for patients**

- HD video: Synchronous dual streams
  - HD dynamic ultrasound imaging: Remotely synchronous visuals
  - Remote, real-time communication + outdoor communication
- Low latency: (< 10 ms)
  - Remote, real-time observation of anatomical structure and depth
- Mobility: Video carts
  - Easy to move and change angles
  - Reducing wires in the treatment room

5G-based, digital, intelligent auscultation applications at primary hospitals

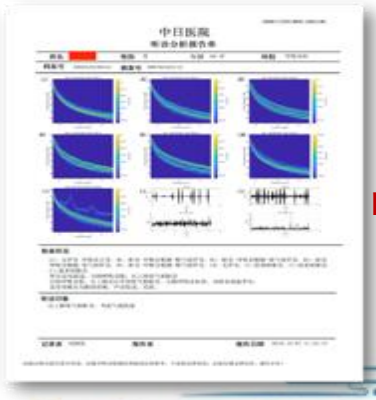
direct ear listening
Subjective listening sound
Human ear: 20 Hz to 20000 Hz

digital auscultation sensor
recording sound wave
AI: 0 to 50,000 Hz

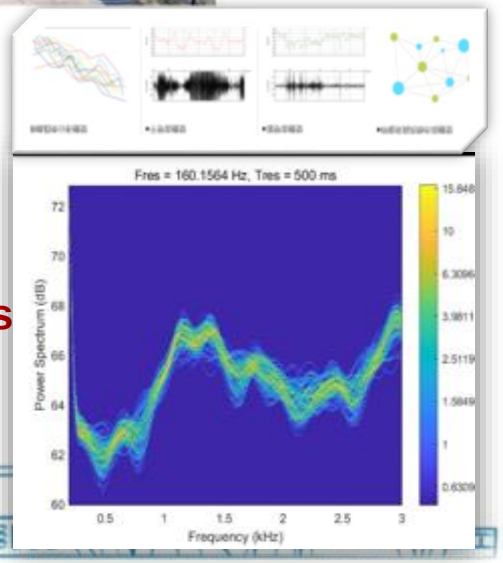
Assisted medical teams in combating COVID-19 in Wuhan
Helped doctors hear the lung sounds of patients infected with COVID-19 for the first time

Advantages of digital intelligent stethoscopes

- ✓ **Early detection:** Collection of wider range of sounds enables early detection of small lesions
- ✓ **Objective records:** promote unified diagnosis and quantified research
- ✓ **Data sharing:** facilitates remote expert consultation and follow-up visits online
- ✓ **Intelligent analysis:** helps doctors at primary hospitals learn anytime and anywhere
- ✓ **Economic and convenient:** suitable for chronic disease management at primary hospitals



Visualized result reports



National Health Commission – National 5G Medical Applications Standards

Standardization of 5G networks in hospitals

- ✓ 5G networking solution standardization
- ✓ Demand-driven terminal modules
- ✓ Edge Computing Node Deployment Specifications

- ➢ **Technology Performance Matching Applications**
- ➢ **Support Healthcare Quality Control**
- ➢ **Preventing Patient Safety Risks**

- ■ Saving construction and maintenance costs
- ■ Unify quality and performance and eliminate the effect of bottleneck
- ■ Unified user experience and improved usage
- ■ **In line with International standard: mutual recognition and benchmarking of China-EU standards**

1 **Standards for wireless access networks**

2 **Standards for terminals**

3 **Standards for MEC**

5G+ medical practice has received extensive attention and support from the industries

- September 2019
- **5G determinative network industry alliance formed**
- **Vice-President**

- October 2019, more than 100 industry members jointly released the Standard Radio Access Network (RAN) .
- **Dozens of media reports over 3,000**

- November 2019
- GSMA has **included this case in the << 5G Vertical Industry Application Cases in China >>** and promoted it globally as an good example

- January 2020
- **Hosted the first national workshop on 5G modules in healthcare**
- **The first 32 medical equipment manufacturers in China participated in the discussion.**

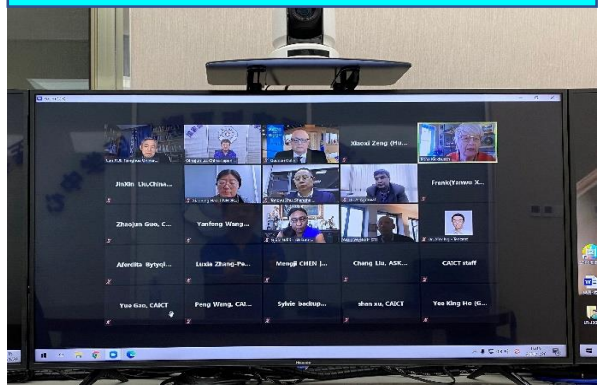
- June 2020
- Huawei HAS Analyst Conference
- Four measures for the large-scale development of 5G smart healthcare
- Interviewed by the Observer, the video has more than 110,000 hits.

It has caused great reverberation at domestic and international conferences

2020.11 MBBF Conference Keynote Report

2021.2.23 Shanghai GIO Roundtable

2021.2 WHO Digital Health Conference



2021.3.Beijing Satellite TV "I'm a doctor"

2021.3 People's Daily-Health "Health Policy"

2021.10 CCTV-1 Telemedicine

2021.10 CCTV-2 E-Hospital

GSMA: GLOMO Award

- GLOMO Award: Global System for Mobile Communications Association (GSMA),
  - Global Communications Congress, Barcelona, June.30, 2021
- Best Innovation for Fight COVID-19 Pandemic Response& Recovery
  - 5G Telemedicine Solution for COVID-19

GLOMO award from GSMA

Advantages of 5G Customized Private Networks

Major Key Points Addressed

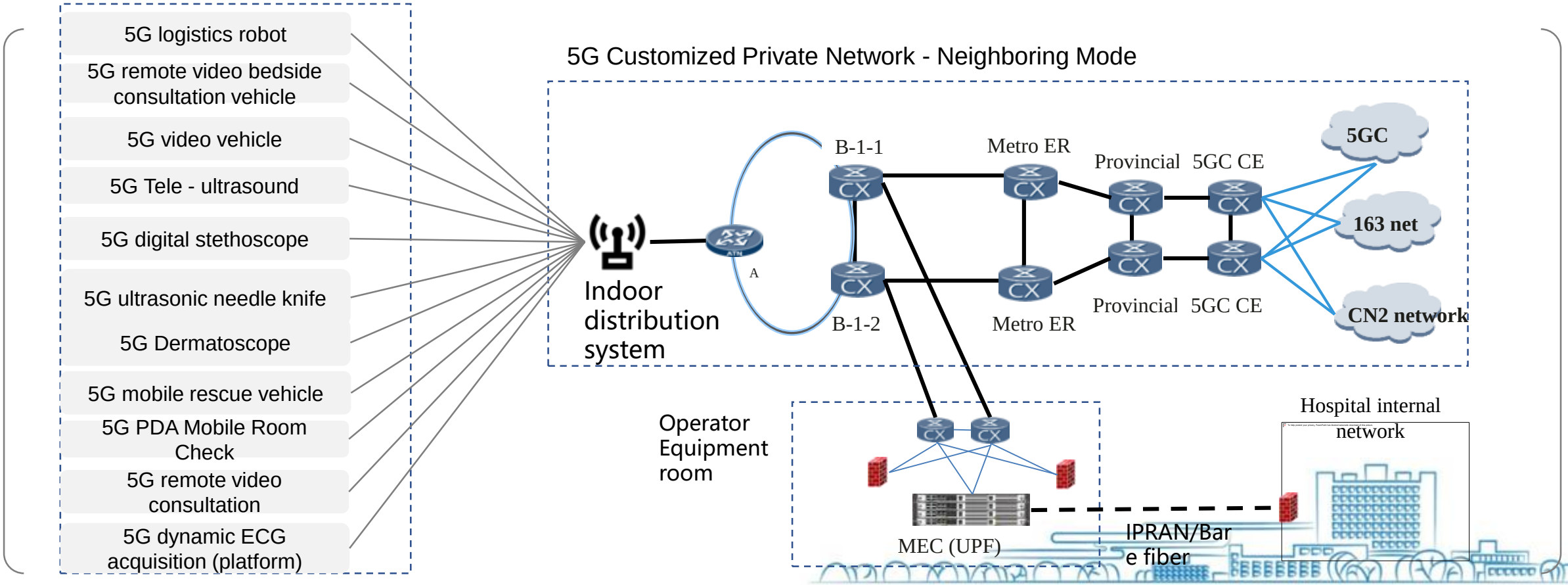
- Data transmission slow & backhaul not real-time.
- Wi-Fi connections are prone to interference, handovers, and coverage are insufficient.
- Medical data security in hospitals.

5G Customized Private Network Solution

Build customized 5G private network for hospitals. Use technologies such as multi-frequency collaboration, carrier aggregation, super uplink, edge node, and radio resource reservation to provide dedicated network services that feature enhanced bandwidth, low latency, and local data offloading.

Values

- Local processing, cloud-edge collaboration, and more efficient communication in the hospital.
- Internal data is inside the hospital, which is more secure.



Interconnection between medical devices and 5G communication modules

Commercial use of 5G modules, cost control

Device ready and integrated 5G applications from ecosystem partners

Medical equipment

WAN/LAN RJ45

Serial port UART

USB2.0/3.0

Wi-Fi

External communication module

5G

5G+MEC

Hospitals IT system

Phase 1: External 5G Module

Phase 2: Built-in 5G module

M.2 Package

LGA encapsulation

What MEC Can Do for Healthcare

Connection	■ Wi-Fi connection vs. wireless cellular base station connection
Computing Power	■ Cloud Computing Capability vs. Local MEC Computing
Security	■ Physical Isolation vs MEC Intelligent Security ■ Crypto machine and encrypted transmission

边缘计算

- ✓How to network the edge cloud?
- ✓How to deploy cloud-edge collaboration?
- ✓How to design the AI system?
- ✓How to establish an operation model?

5G Smart Healthcare Architecture

Applications

Telemedicine

Teleconsultation

medical teaching

Telemonitoring

Collaborative office

Executive meeting

Hospital Collaboration

Digital Hospital

Hospital operation management

Clinical diagnosis and treatment

Regional health

Disease Control

Electronic medical record sharing

Drug management

Platform

Telemedicine platform

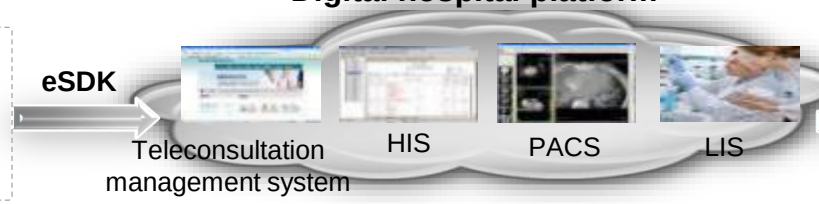
Media and Access

Management platform

Recording

eSDK

Digital hospital platform


Teleconsultation management system

HIS

PACS

LIS

Data collection

Regional Health Platform

Medical record sharing

Disease Control

Drug management

Network

Internal healthcare 5G private network

Telemedicine 5G private network

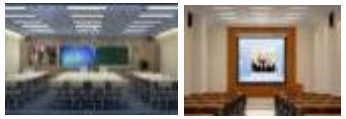
5G dedicated network for emergency treatment

Terminal

Comprehensive consultation center

Expert consultation room

Reception Room


medical demonstration classroom

Medical cart

Desktop consultation terminal

PC

Mobile Phone/PAD

5G Network Construction Needs to Meet Requirements of Smart Hospitals

Network infrastructure construction | System and platform construction | Application system convergence

1 network
2 users

doctor & patient use one 5G network by logical isolation

3
Basic applications

- Smart healthcare system
- Smart management system
- Smart service system

4
Basic platforms

- Hospital MEC platform
- Hospital Big Data platform
- Internet + healthcare platform
- Medical IoT platform

N
Practices

- Outpatient and emergency department, ward, ICU, operating room, nursing, pharmacy, laboratory.
- Telemedicine and online follow-up
  Combination of family medical care and medical care
  medical consortium
- Manage decision-making and resource allocation
  Health insurance, commercial insurance, and financial services
- Medical O&M and supply security
- Patient service and drug delivery
  Information query and medical treatment guidance
- Social services: poverty alleviation, disease prevention, rescue, popular science
- ...

5G development should integrat into medicine actual need

- 5G health had been well widely recognized and practiced since the 5G telecom licensed in China.
- 5G had emerged excellent supporting power to both Digital Health and Smart Medicine.
- Cost-effective 5G application models should be conducted under the STANDARD Guideline, since the Technical Stability and Maturity would affect the healthcare quality and safety.
- 5G Health Applicational Standard Guideline would be the most urgent and important procedures for 5G promotion in future.

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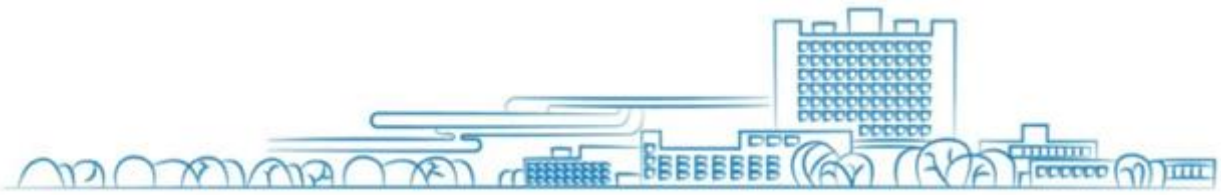
Feel free to offer suggestions
Thank you!