

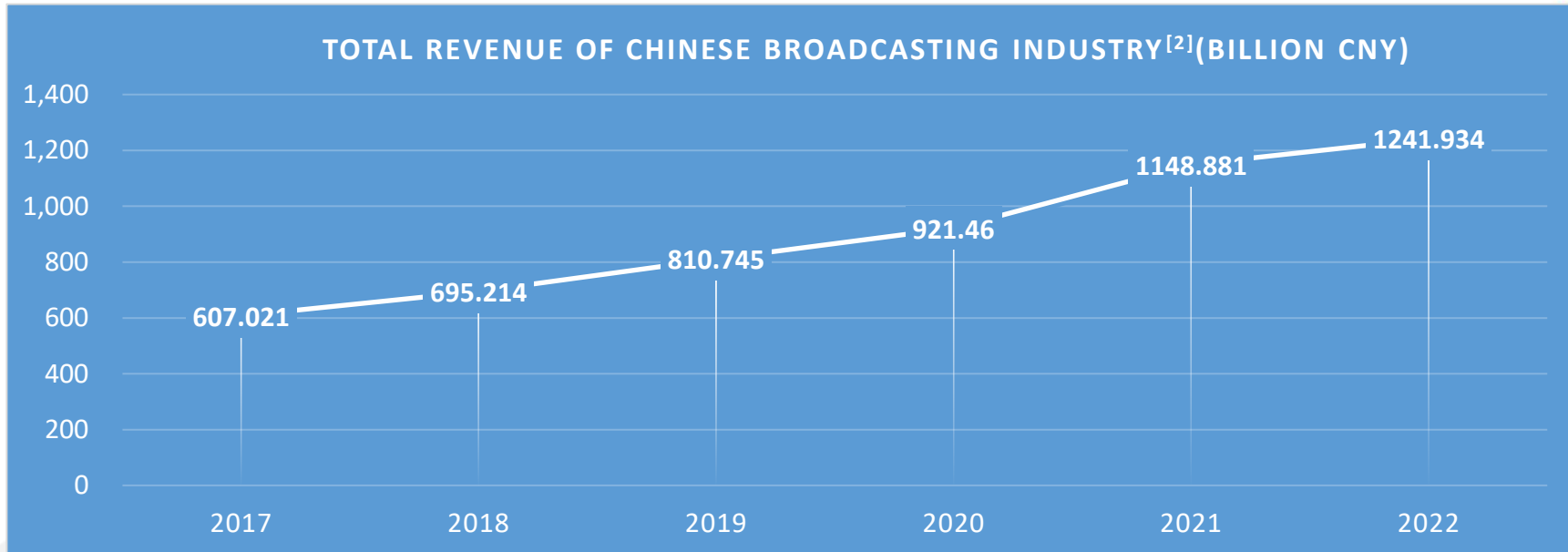
Innovative technologies for new broadcasting services and applications: 5G and beyond

Dr. Luyu Zhao

May 10th, 2023

Current situation of broadcasting service in China

- Number of Cable Digital TV family Users : 199 million^[1]
- Population coverage of radio programs : 99.6%^[1]
- Population coverage of television programs : 99.8%^[1]



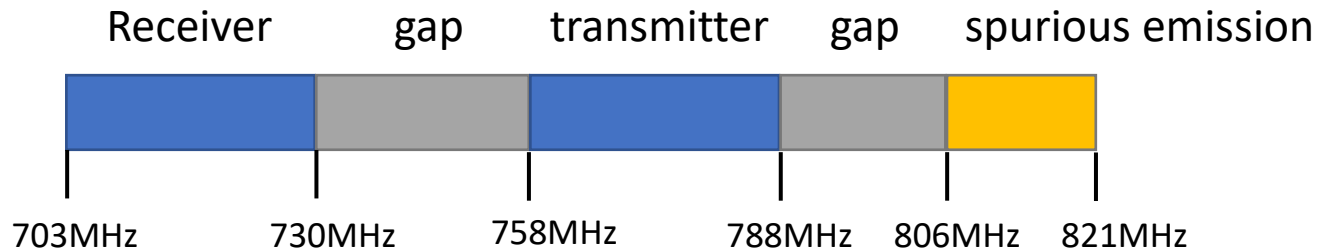
[1] Statistical Communique of the People's Republic of China on National Economic and Social Development in 2022

[2] Statistical Communique of the National radio and Television Industry in 2022

Adjustment of frequency spectrum of broadcasting service

- 702-798MHz frequency band is removed from broadcasting service to 5G mobile communication
- 703-743/758-798MHz frequency bands are used by FDD mobile communication system
- The television channels in 702-798MHz frequency band are migrated to lower frequency bands.
- Some lower frequency bands used after migration: 187MHz, 482MHz, 554MHz, 634MHz, 690MHz.

5G 700MHz base station frequency bands



5G 700MHz+4.9GHz base station



Radius of coverage(single base station)/km

	Urban area	Countryside
700MHz	1.34	4.66
2.6GHz	0.82	2.03
3.5GHz	0.72	1.85
4.9GHz	0.61	1.55

Global Satellite Constellation Communication System in China

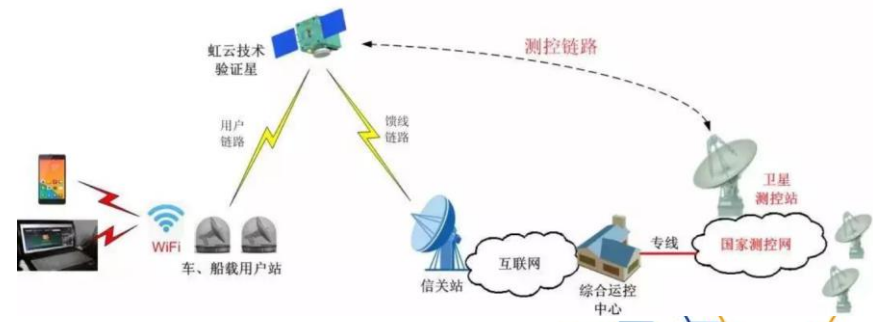


Global distribution and number of low- and medium-orbit communication satellites



Functional diagram of Hongyan Constellation System
虹云技术验证系统架构图

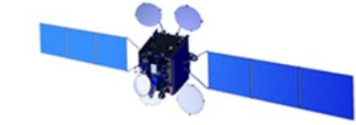
Hongyan Global Satellite Constellation Communication System, is a global low-orbit satellite communication system being built by China. It is composed of more than 300 low-orbit satellites and data service processing centers to realize Internet access anywhere in the world. The second phase is expected to be completed in 2025.



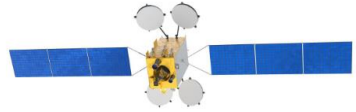
The HongYun project is one of the five major commercial space projects of China Aerospace Science and Technology Corporation (CASC), with 156 satellites planned to be launched. And the HongYun verification satellite has completed all functional and performance tests and successfully realized typical Internet services such as web browsing, video chatting and HD video on demand.

In April 2020, the satellite Internet was formally incorporated into the national strategy of new infrastructure construction.

3 Ka-band satellites owned by China



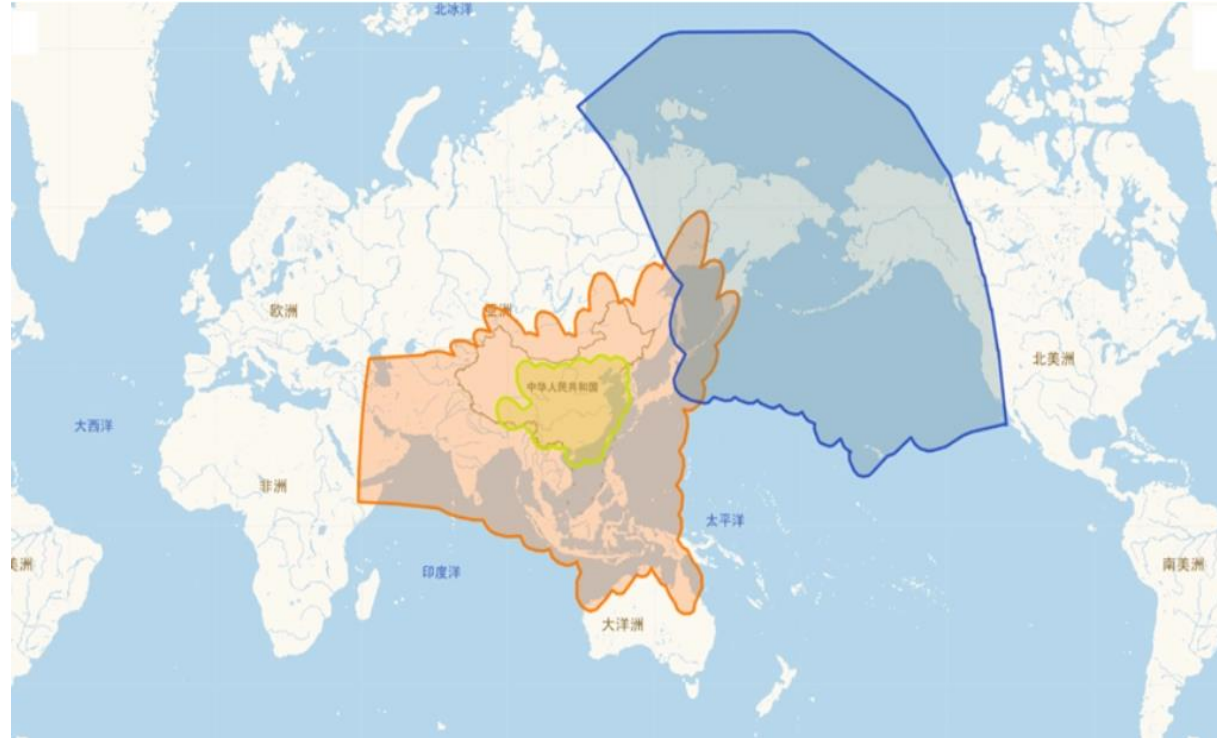
CHINASAT 16



CHINASAT 19



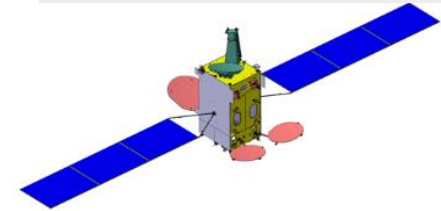
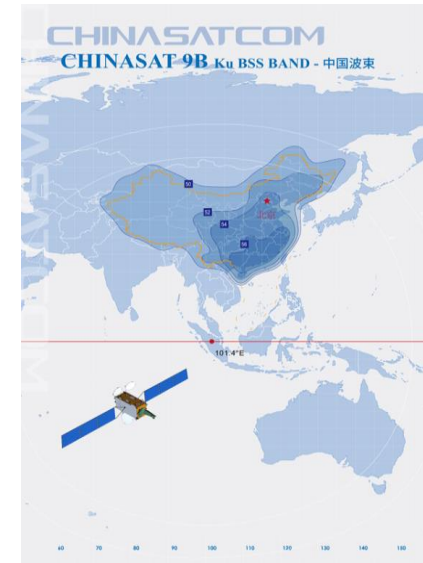
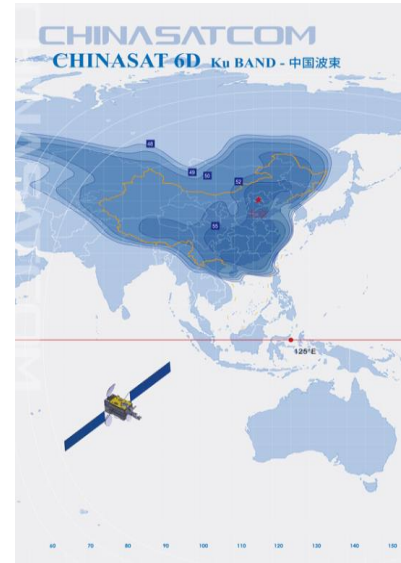
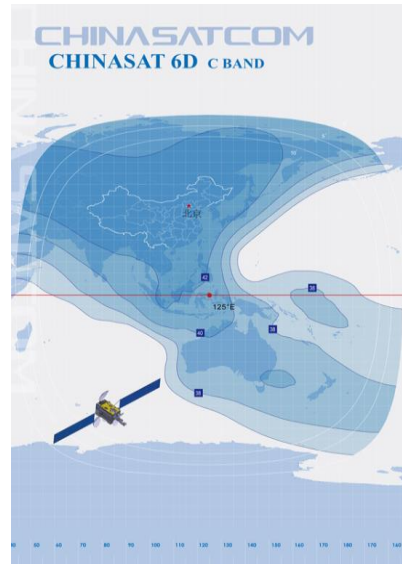
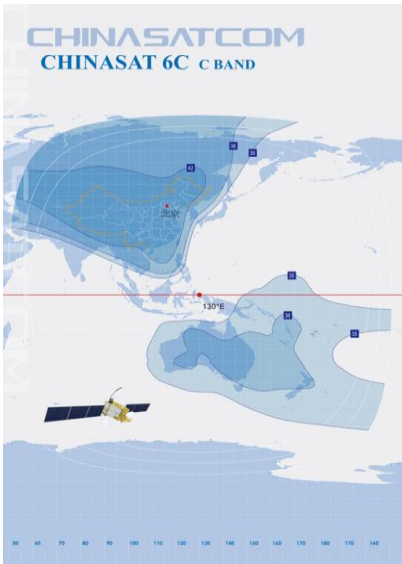
CHINASAT 26



China's Eleventh Five-Year Plan has proposed the development of Ka-band satellite broadcasting business, and has already launched "CHINASAT 16", "CHINASAT 19" and "CHINASAT 26" three Ka-band satellites. China is actively carrying out the demonstration of the third generation of high-throughput satellites with a capacity of over 300Gbp.

CHINASAT 16 (green range) mainly covers the densely populated areas and most of the southeast coast of China. CHINASAT 19 (blue range) mainly covers the China-US route and serves the aviation Internet. CHINASAT 26 (red range) mainly covers all of China and its surrounding areas and waters, parts of East, Southeast and South Asia, and parts of the Pacific and Indian Oceans, etc.

China's main TV satellites: CHINASAT 6A, CHINASAT 6B, CHINASAT 6C, CHINASAT 6D, ASIASAT 7, APSTAR 5, CHINASAT 9. China's broadcast television live satellite platform has transmitted 30 sets of high-definition television programs.



CHINASAT 6C

- Design and manufacture: CASC
- Satellite platform: Dongfanghong IV platform
- Stabilization mode: Three-axis stabilization
- Polarization mode: linear polarization
- Orbital position: 130°E

CHINASAT 6C satellite was launched on March 10, 2019, using the Dongfanghong IV satellite platform. The satellite is designed with 25 **C-band** transponders, covering China and the surrounding areas, Australia, New Zealand and other South Pacific regions, and will provide sufficient quality satellite resources to guarantee the development of ultra-high definition services such as 4K/8K.

CHINASAT 6D

- Design and manufacture: CASC
- Satellite platform: Dongfanghong IV enhanced platform
- Stabilization mode: Three-axis stabilization
- Polarization mode: dual linear polarization
- Orbital position: 125°E

Launched on April 15, 2022, CHINASAT 6D is a new generation of geosynchronous orbit communication satellite, providing **C-band and Ku-band** transponder commercial services, It can meet the demand of 4K and other high-definition video transmission, and is the core guarantee force for the safe transmission of Chinese satellite broadcasting and TV programs.

CHINASAT 9B

- Design and manufacture: CASC
- Satellite platform: Dongfanghong IV enhanced platform
- Stabilization mode: Three-axis stabilization
- Polarization mode: circular polarization
- Orbital position: 101.4°E

Launched on September 9, 2021. The CHINASAT 9B will operate in geosynchronous orbit and will be used for live broadcast television, supporting 4K and 8K HD video program transmission in Ku band. The satellite is capable of providing high-quality live transmission services for large-scale sports events such as the Beijing 2022 Winter Olympic Games.

Development dynamics of digital terrestrial television(DTT) in China

《全国地面数字电视广播频率规划》

2020: National digital terrestrial television broadcasting frequency planning

国家广播电视总局关于进一步

2022: Opinions of the National Radio and Television Administration on Further Accelerating the Development of HD/UHD Television

From: National Radio and Television Administration

2022

Since July 1, 2022, the new Cable and Satellite TV channels should be HD/UHD channels, and the new Satellite TV STB should be HD/UHD smart STB.

2023

From January 1, 2023, IPTV and Cable TV new STB should be UHD STB.

2025

By the end of 2025, significant increase in penetration of HD/UHD STB and basically shut down IPTV SD channel signals.

HD/UHD DTT puts higher demands on terminal device
Such as TV, STB, PC, Cellphone, Tablet, VR/AR etc.



HUAWEI 4K UHD TV

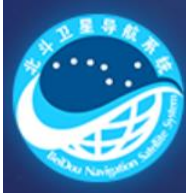


HUAWEI P60 Pro

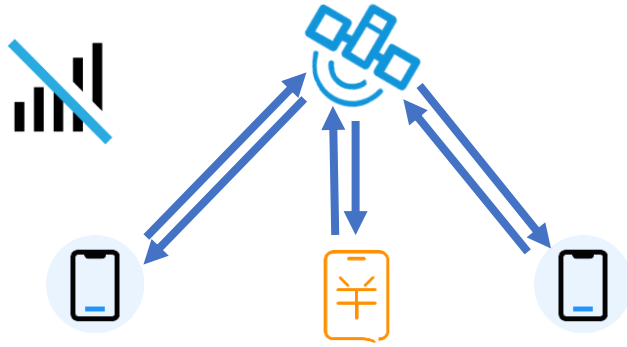


Tencent OTT Box 5Pro

4K
ULTRA HD



The Regional Short Message Communication (RSMC) power by The BeiDou Navigation Satellite System (BDS)



Service Overview:

The **Regional Short Message Communication (RSMC)** Service is provided through the L-band and S-band signals of the three GEO satellites in the BDS-3 nominal constellation.

Service Volume:

BDS can provide the RSMC service to users in China and its surrounding areas in the scope of 10°N~55°N, 75°E~135°E, on the surface of the Earth and its near-earth areas extending within 1,000 kilometers above the Earth surface

Additional Applications Examples:

1) Emergency Communications

In February 2023, Wilderness photographer using HUAWEI Mate 50 to send a satellite distress text message successfully rescued.

2) Digital RMB Payments

The Digital Currency Research Institute of the People's Bank of China also applies RSMC to digital currency wallet payments, enabling remote control in an offline state and improving the security of digital currency wallet terminals

Reference: BeiDou Navigation Satellite System Open Service Performance Standard (Version 3.0)
CN 114186990 A

SIS Interface Characteristics	User Transmitted Signal	User Received Signal
Frequency	1610.0 MHz - 1626.5MHz (L band)	2483.5 MHz - 2500MHz (S band)
Modulation	DSSS, BPSK	DSSS, BPSK

Chinese telecommunication companies have already released several terminal products in 2023 that support satellite communication:

Huawei has unveiled its new P60 series flagship smartphone range featuring communications technology linked to China's BeiDou Satellite, meaning users can send and receive messages without a terrestrial signal. ZTE also unveiled its industry-first 5G secure phone that supports satellite communications

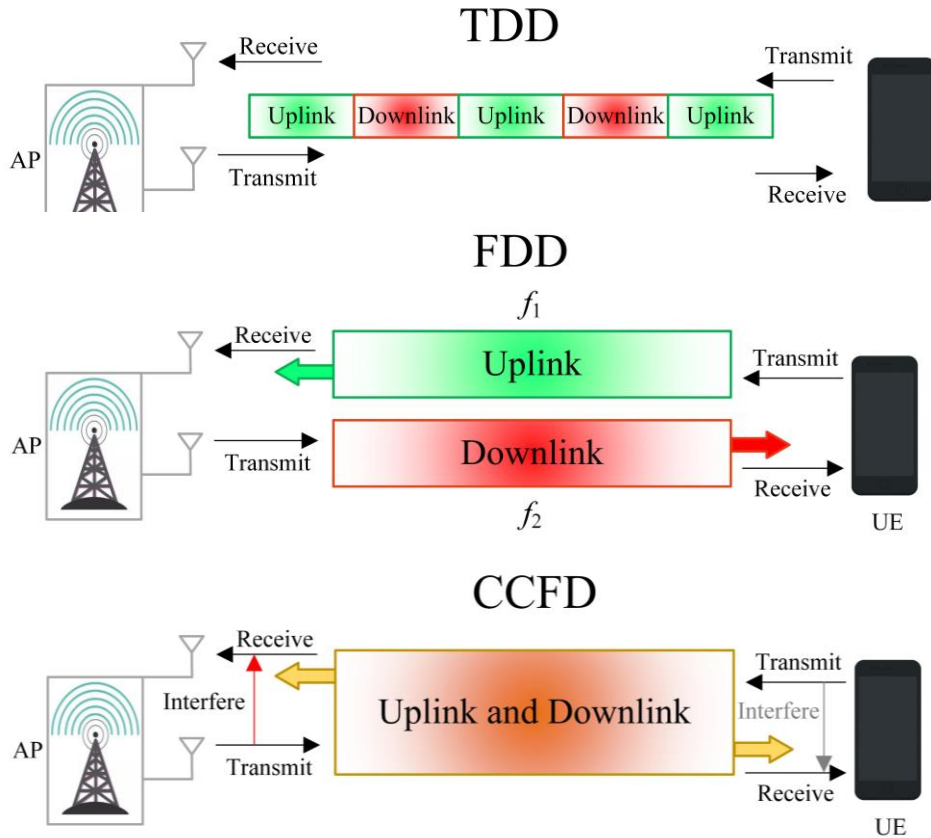


ZTE Axon 50 Ultra

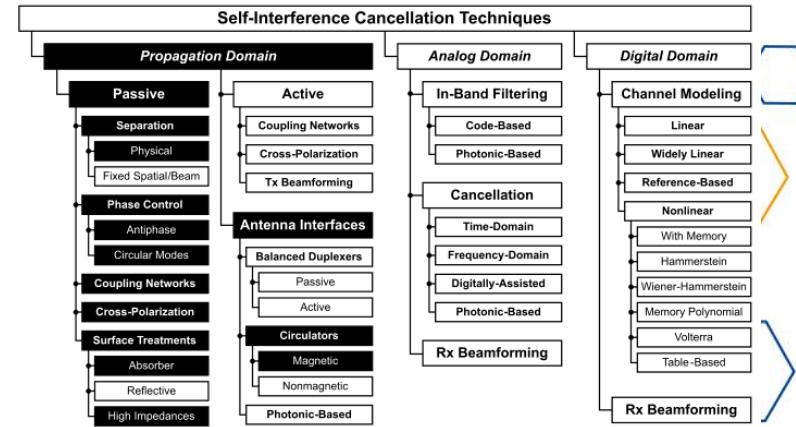
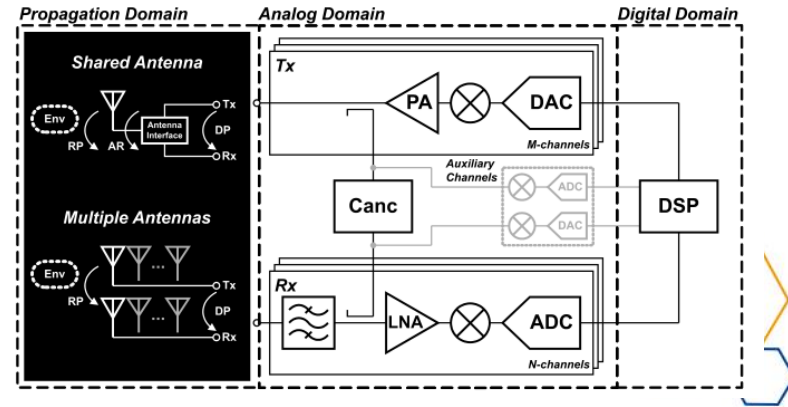


HUAWEI Mate X3

Co-time Co-frequency Full-Duplex (CCFD)



Comparison of CCFD and FDD/TDD methods



Self-Interference Cancellation (SIC) technology

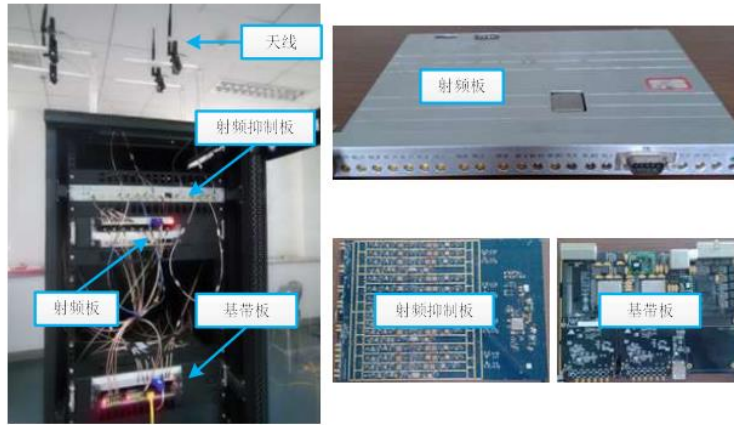
Contains propagation domain, analog domain and digital domain:

- The propagation domain containing various passive and active antenna techniques;
- The analog domain contains in-band filtering, various offset methods and analog receive beamforming;
- The digital domain contains a variety of channel modeling and digital receive beam formation methods.

Experiments by Chinese companies and universities on full-duplex technology



University of Electronic Science and Technology of China



2T2R LTE prototype



Outfield experiment



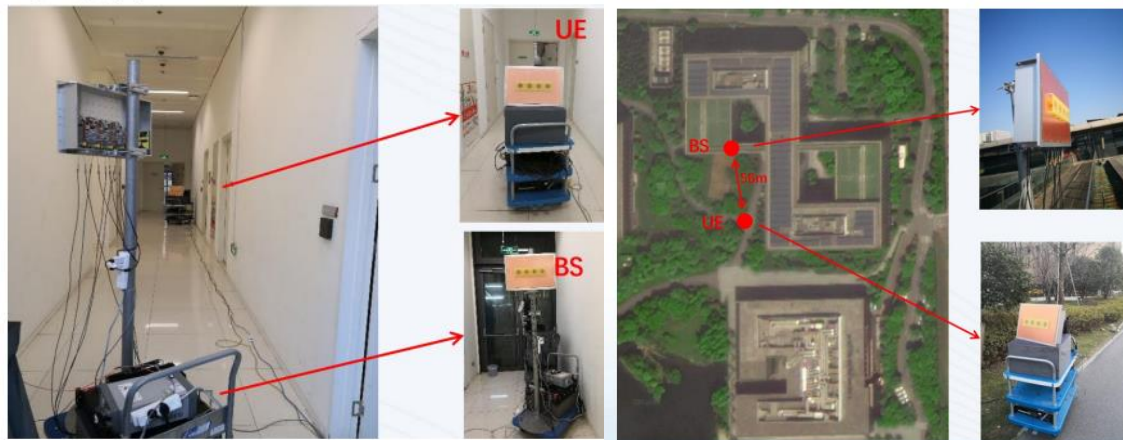
- A full-duplex 2T2R MIMO prototype is developed to verify the full-duplex transmission of LTE signal.
- The suppression of self-interference is achieved through three parts: the separation of the transmitting and receiving antennas, the design of the RF suppression board at the front end of the receiver, and the digital suppression algorithm running in the baseband board.
- The experimental results show that the self-interference is suppressed by a total of 115 dB. In full-duplex mode, the data rate between the two mobile stations reached 200 Mbps, compared to 110 Mbps in half-duplex mode, which means that the system managed to increase LTE throughput by 80%.

Huawei full-duplex prototype validation



4T4R prototype

In the antenna platform, the dual-polarized dipole linear antenna array is used, the isolation of self-transmitting and self-receiving antenna can reach 60dB. RF devices are integrated with 60dB high isolation antennas to achieve an overall 100M, >75dB SIC performance. In addition, digital cancellation can achieve 35dB SIC performance.



Indoor testing

Outdoor testing

Indoor testing are conducted in a 15m × 1.8m × 3m space, and the achievable throughput gains are 86%, 62%, and 39% for 1, 2, and 4 MIMO streams, respectively.

In outdoor testing, the straight-line distance is 56m (25m vertically and 50m horizontally), and the achievable throughput gains are 67% and 32% for 1 and 2 MIMO streams, respectively.

Thank You!

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