CAICT 中国信息通信研究院
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Study on Power Feeding System for 5G Network

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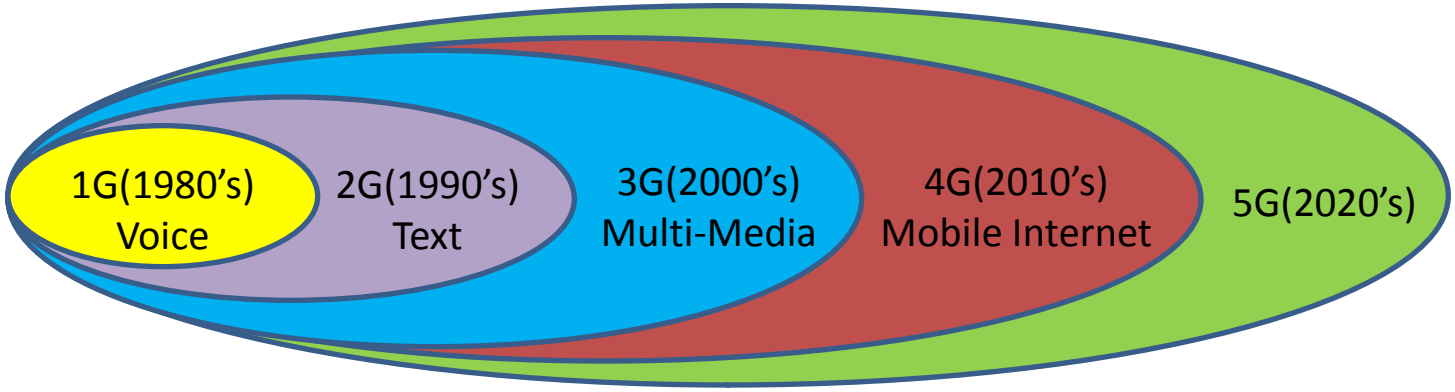
Development of communication technology

Since the 1980s, global wireless communications have undergone changes from 1G to 4G per 10-year cycle.



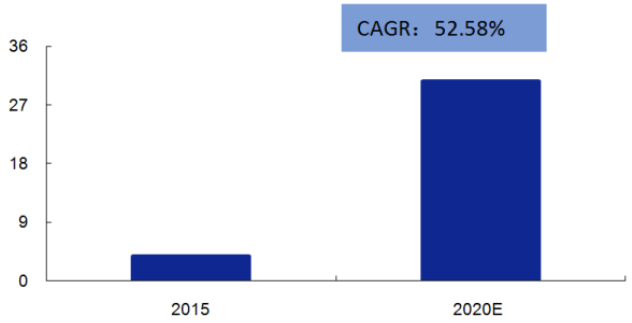
In 1984, 1G wireless communication based on simulated cellular technology appeared.

In 1990, 2G's mainstream technology standard GSM and CDMAOne were released , entered the era of digital communication.

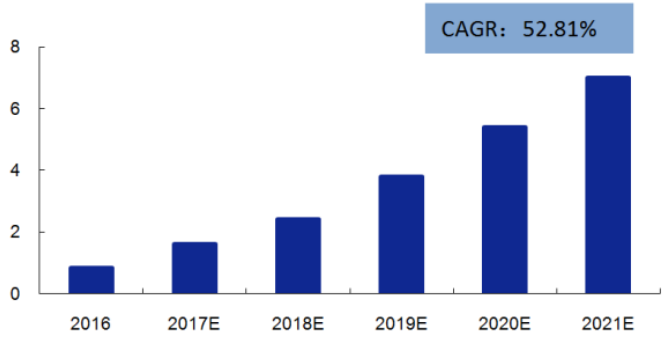
In 2000, the International Telecommunication Union (ITU) identified WCDMA, CDMA2000, TD-SCDMA and WiMAX as the four mainstream wireless interface standards for 3G.

In 2010, the 4G technology under the two systems of TDD-LTE and FDD-LTE became mature and commercially available.

The rapid growth of mobile Internet traffic brings new demands to the 5G

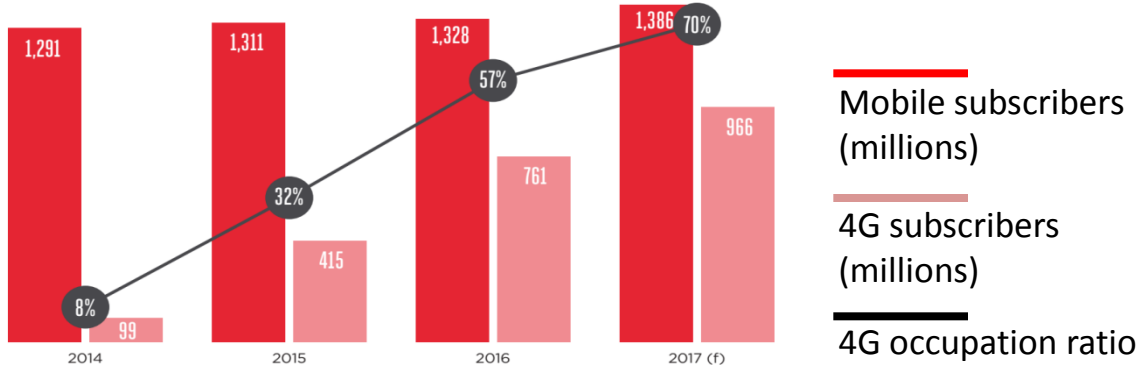


Global Mobile Internet Traffic Forecast (EB/per month)



China Mobile Internet Traffic Forecast (GB/per person per month)

- ✓ The annual compound average growth rate(CAGR) of global mobile data traffic reach 52.58% in 2015-2020.
- ✓ The CAGR of China Mobile Internet traffic will reach 52.81% in 2016-2021.

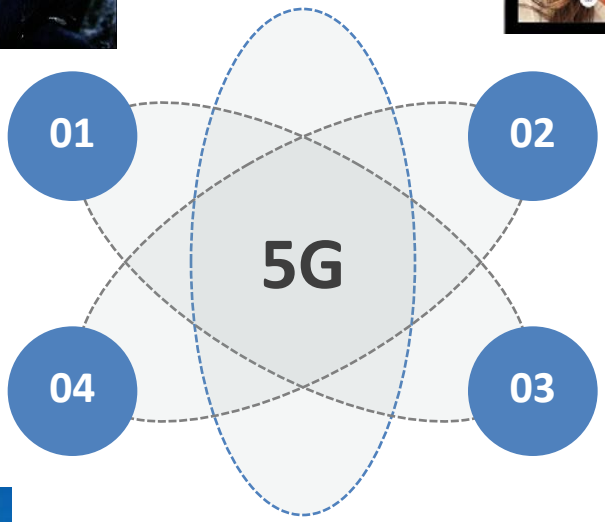


- ✓ Experience in the 4G era shows that with the advent of new technologies, the number of users will increase significantly.
- ✓ For 5G, the existing telecommunications industry infrastructure can no longer meet the demand, 5G will also be the era of infrastructure innovation.

Key challenges and application scenarios

High net speed

100Mbps - 1Gbps



High traffic density

Tbps / km2

Connection density

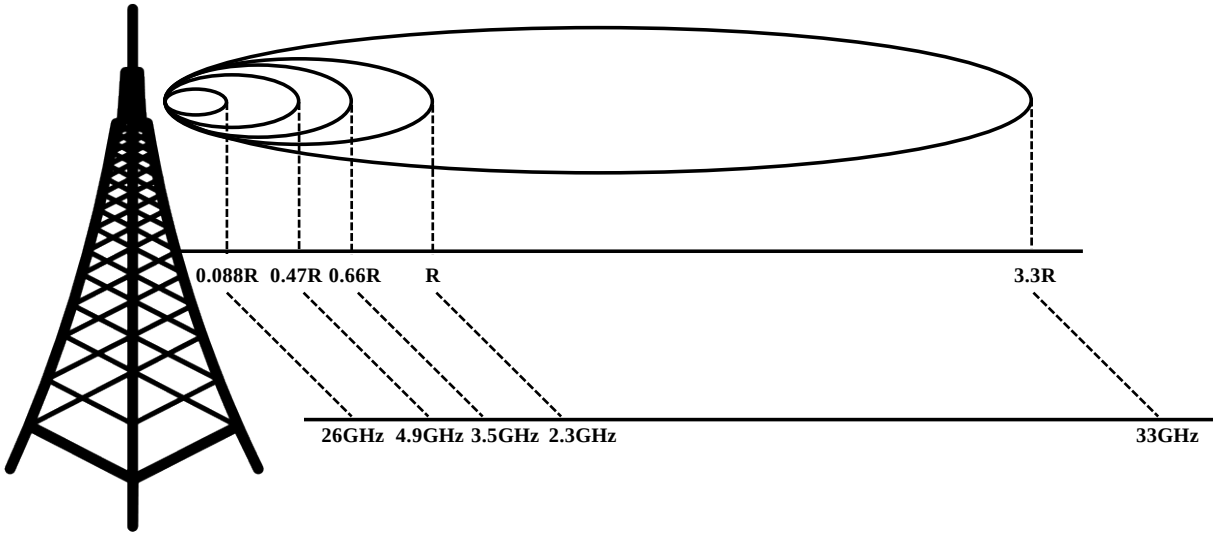
million / km2

Low delay

milliseconds

In order to cope with the continued growth of mobile data traffic, the connection of massive devices into the network, and the emergence of various new business and application scenarios, the application of the 5G will came into being.

Development trend of 5G base stations

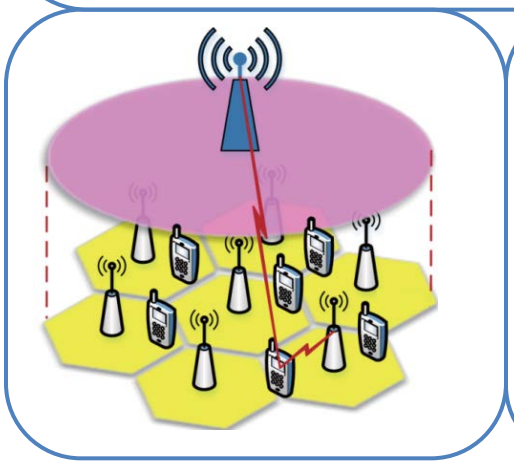


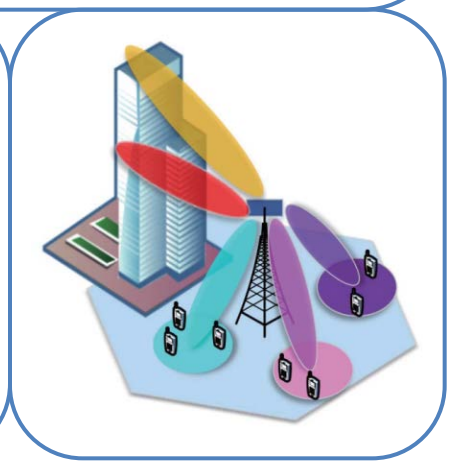
- ✓ According to the principle of mobile communication, the **transmission distance and frequency of the signal are inversely proportional** when the power ratio of receiving and transmitting is constant.
- ✓ The frequencies of 4G base stations are generally from **2.3GHz to 2.6GHz**, and the frequencies of 5G high-frequency base stations are above **28GHz.**

Frequency	2.3GHz	3.5GHz	4.9GHz	26GHz	29GHz
Coverage Radius	R	0.66R	0.47R	0.088R	0.079R

- ✓ **The radius of coverage area** of 5G high-frequency base stations will be ***less than one-tenth*** of that of 4G base stations, and the coverage area of 5G high-frequency base stations will be ***less than one percent*** of that of 4G base stations.

Development trend of 5G base stations





In the 4G era, a base station covers hundreds of meters, but a 5G base station may cover only 20 to 40 meters, which makes the cost too high

The deployment of macro base stations is difficult and the site resources are not easy to obtain.

Therefore, in 5G networks, high-frequency resources will no longer use macro base stations, micro-cells become the mainstream, and the small base stations will be used as the basic unit for ultra-intensive networking, that is, small base stations dense deployment.

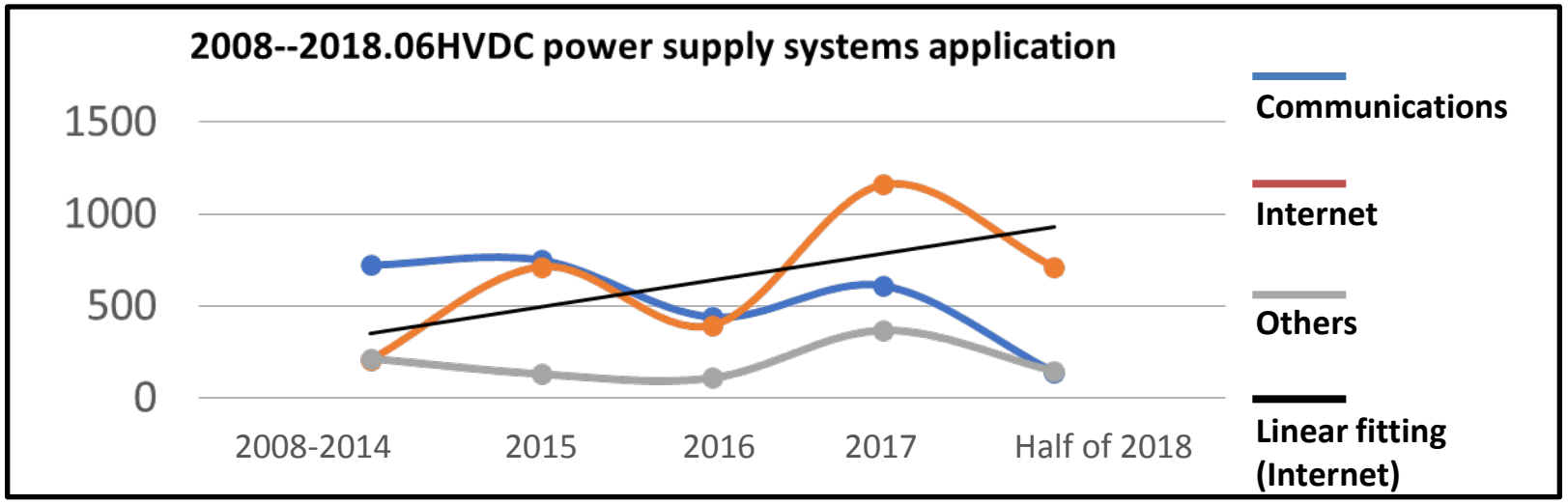
In the future, the most likely deployment mode for 5G base station construction will be :

low-frequency wide area coverage (macro base station) + high-frequency deep coverage (micro base station).

High Voltage Direct Current (HVDC) power supply

HVDC systems are mainly used in telecommunication rooms and data centers, not in the Base station. With the increase of power density and voltage drops on the power transmission line in macro base, it is recommended to use HVDC system for the 5G network.

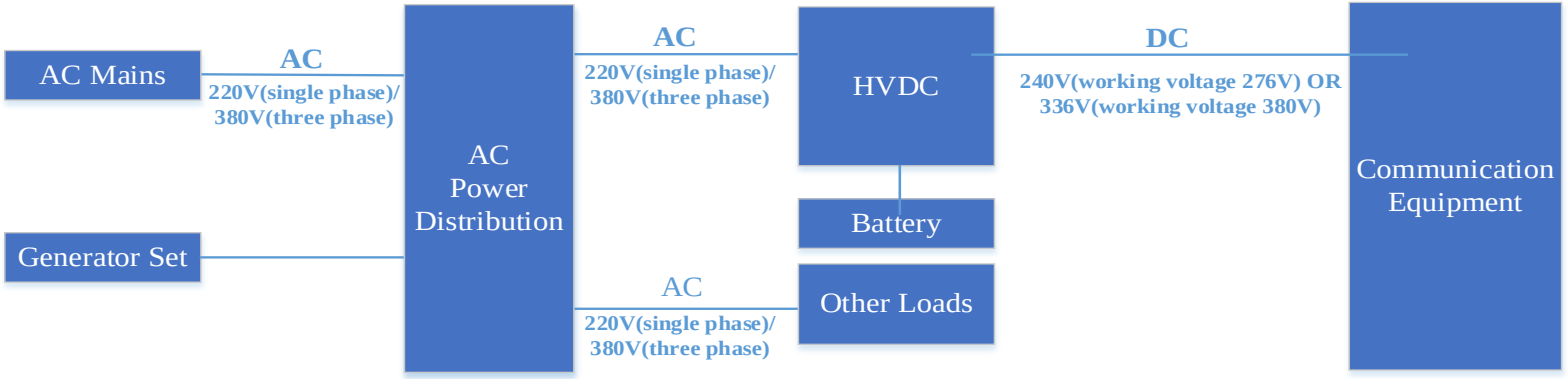
Till the first half of 2018, 6807 HVDC power supply systems have been put into practical use only in the information and communication industry, and the total power supply capacity has reached 6.5million A.



Efficiency of HVDC system and module from main communication equipment manufacturers in China

	A	B	C	D	E	F
SYSTEM	95.96%	95.72%	95.49%	95.45%	95.21%	95.56%
MODULE	96.18%	95.80%	95.68%	95.50%	95.47%	95.62%

High Voltage Direct Current (HVDC) power supply



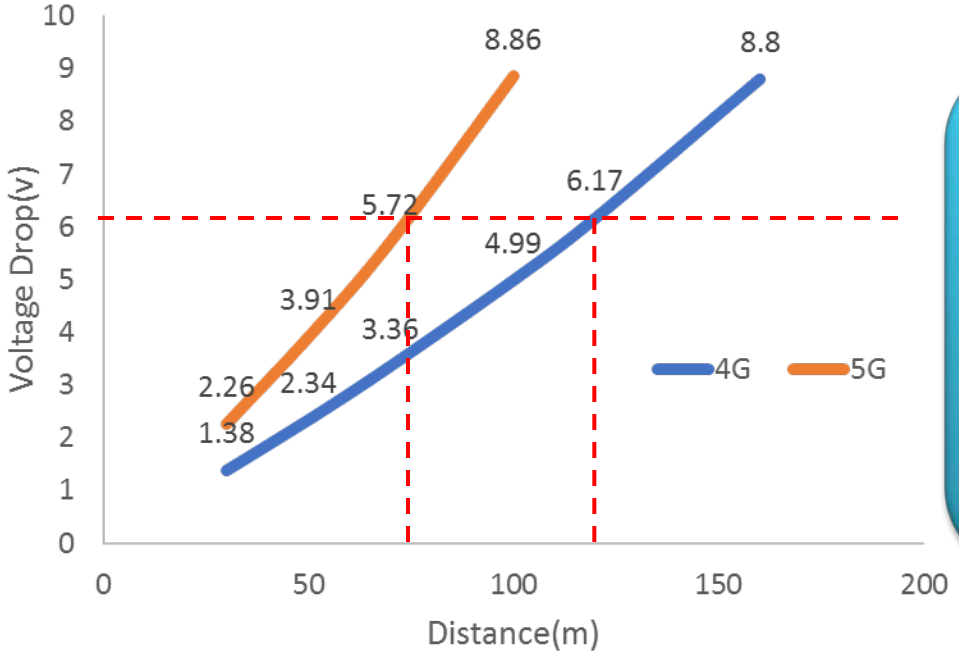
- ✓ ***Requirements to ICT equipment Power Supply Unit (PSU) and supporting facilities.***
- ✓ ***Protections of HVDC system lines in outdoor conditions***
- ✓ ***Increased requirements for maintenance staff***
- ✓ ***Compatibility issues with existing -48V DC power supply systems***

No.	Rated voltage	Working voltage	Voltage range of HVDC system	Voltage range at ICT equipment
1	240V	276V	200V～288V	192V～288V
2	336V	380V	280V～400V	260V～400V

Increasing the voltage with DC/DC converters based on -48V system scheme

Voltage drop of different power supply distance in battery discharge state

Gen	power(W)	30m	50m	70m	100m	120m	160m	200m
4G	350	1.38	2.34	3.36	4.99	6.17	8.8	—
5G	1500	2.26	3.91	5.72	8.86	—	—	—



- ✓ Most of the current situation in -48V system, the output low voltage protection value is set about -42V.
- ✓ It means that if the voltage drop is more than 6V, the ICT equipment will be protected.
- ✓ It can be seen that when the length more than 120m in the 4G system and the length more than 70m in the 5G system, the ICT equipment will be off because the low voltage protection of the power supply system.

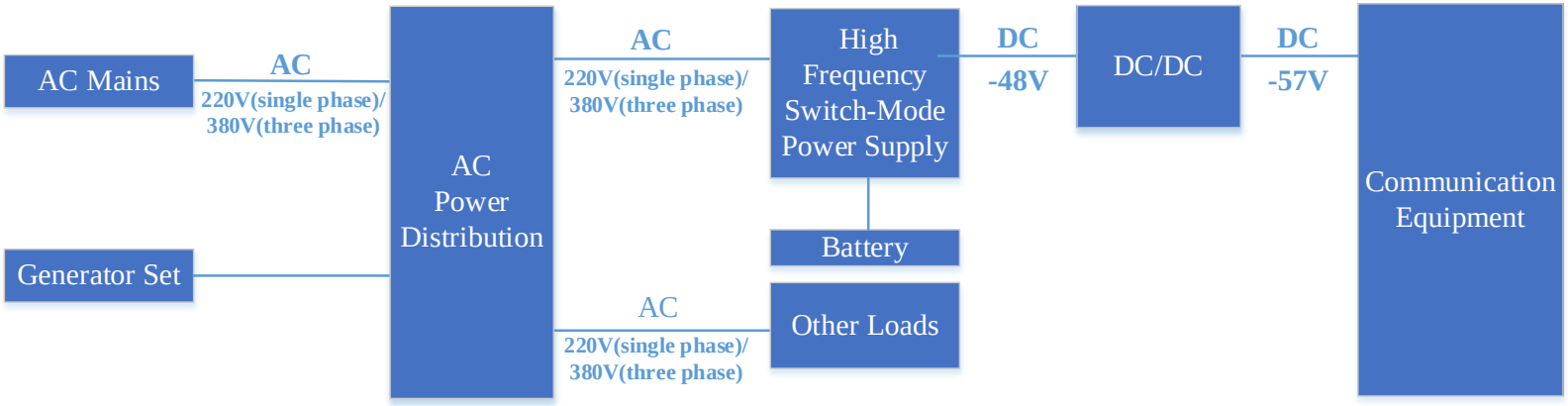
Transmission line loss with different power supply under grid power supply

Voltage level	Gen	Power(W)	30m	50m	70m	100m	150m	160m	200m
48V	4G	1050	2%	4%	6%	9%	12%	17%	——
48V	5G	1500	4%	6%	9%	15%	——	——	——

The Sectional area of the 4G power supply cable is calculated by 6mm2

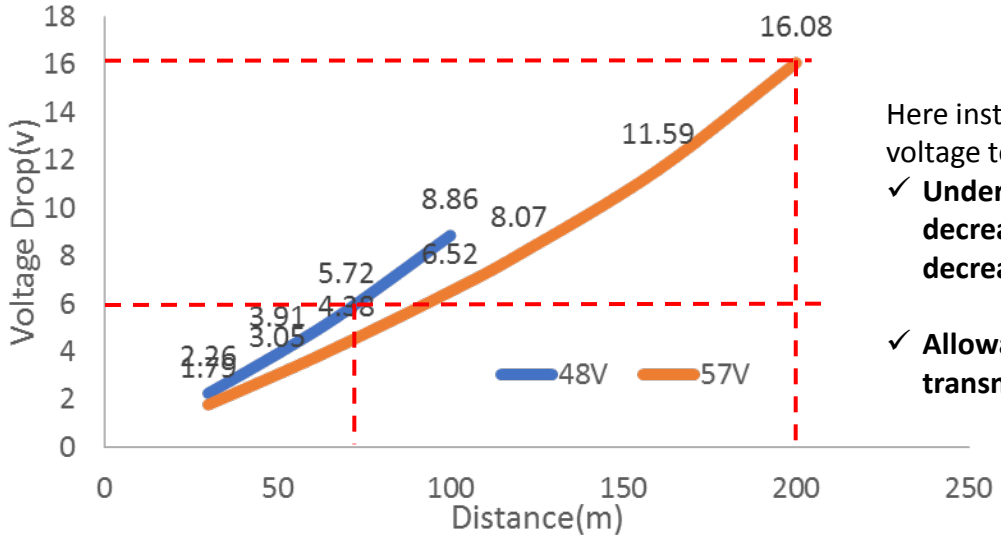
The Sectional area of the 5G power supply cable is calculated by 16mm2.

Increasing the voltage with DC/DC converters based on -48V system scheme



Voltage drop of different power supply distance in battery discharge state

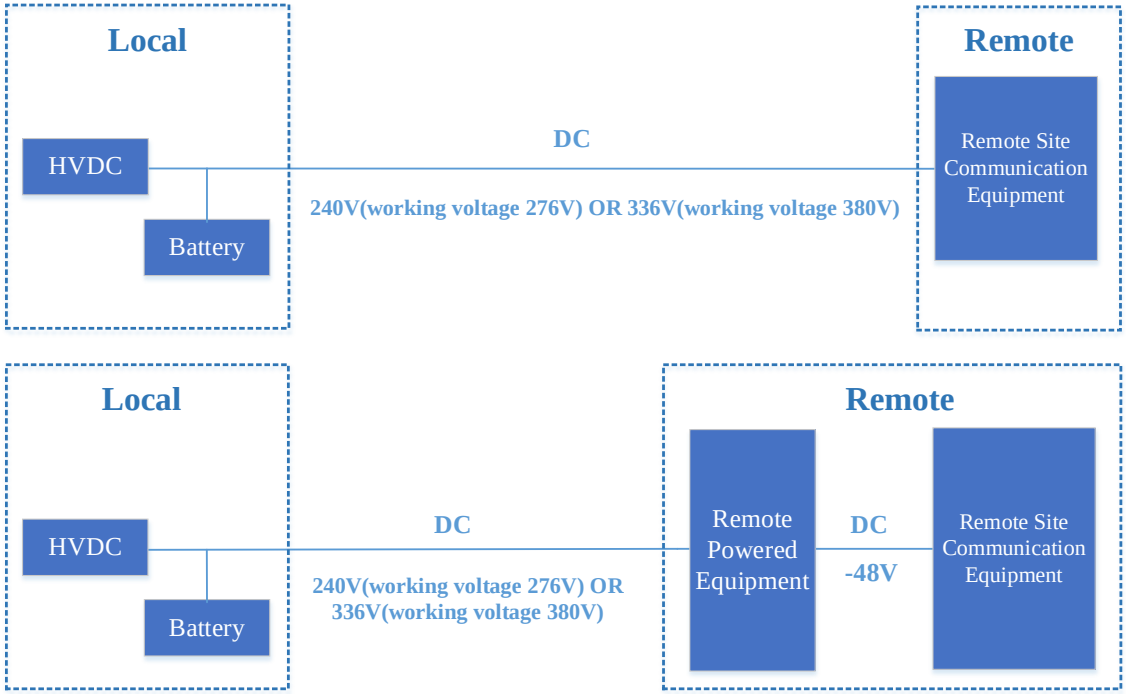
Voltage level	Gen	Power(W)	30m	50m	70m	100m	120m	160m	200m
48V	5G	1500	2.26	3.91	5.72	8.86	——	——	——
57V	5G	1500	1.79	3.05	4.38	6.52	8.07	11.59	16.08



Here installed a DC/DC converter to increase the system voltage to 57V or 60V.

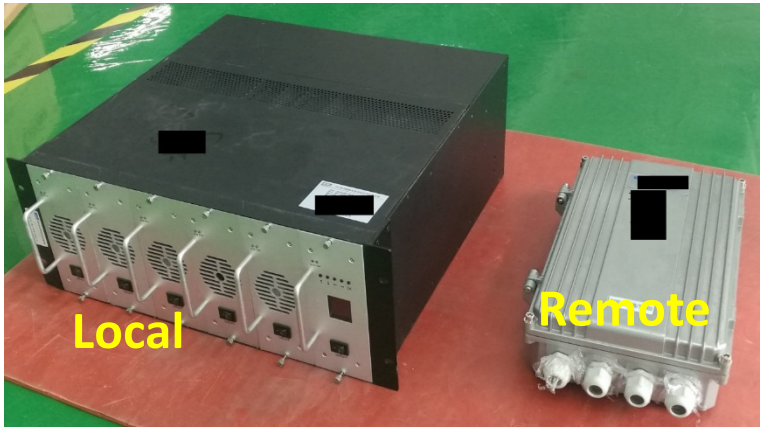
- ✓ **Under the same power, the loss on the transmission line decreases and the voltage drop within the unit distance decreases due to the increase of voltage.**
- ✓ **Allowable pressure drop increased from 6V to 16V, and transmission distance increased from 70m to 200m.**

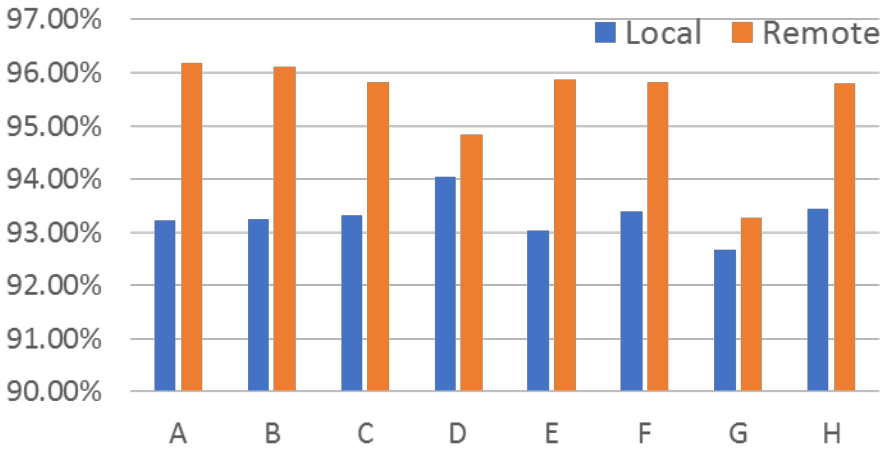
Remote power supply scheme



HVDC scheme which is already used in the data center and telecommunication center is suitable in the 5G network in huge macro base stations to solve the voltage drops and high power needs.

In micro base stations cases, we can use a remote power supply scheme so as to decrease the maintenance work difficulty.





Standards on the 5G power supply system

ITU-T Recommendation under study L.5G powering

Power Feeding Structures	Backup Solutions	Safety Requirements	The Environmental Condition

1) 5G Network general descriptions, cells coverage, and impact on powering strategy, type of 5G network and feeding solutions

2) Powering solution divided into local powering, remote powering and share infrastructures in three different cases and there will be very technical specifications.

3) Energy efficiency, dependability, reliability, maintenance, energy control monitoring and environmental aspects will be studied

China Communications Standards Association(CCSA)

《Research on the power supply and cooling technology for the 5g base station》

Power feeding solution	Energy storage solution	Cooling technology of 5G base station

1) Application principles of power feeding and cooling system
2) Configuration of power supply and cooling system structure
3) Selection of key components of power supply and cooling system
4) Performance of power supply and cooling system
5) Economic evaluation of power supply and cooling systems
6) Foreseeable risks and preventive measures for power supply and cooling systems

Thank you !