

5G Accelerate Smart Grid

China Southern Power Grid (CSG)

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Introduction of CSG

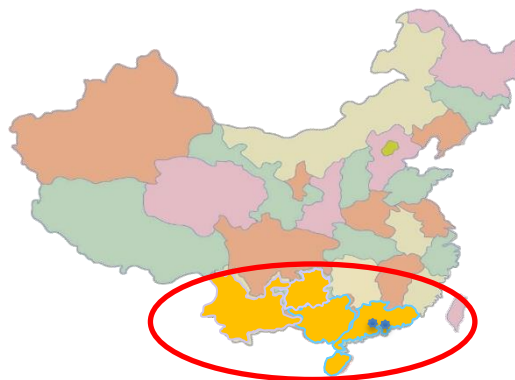
Vision

To build security, reliable, green and effective smart grid, to be leadership and respectable enterprise

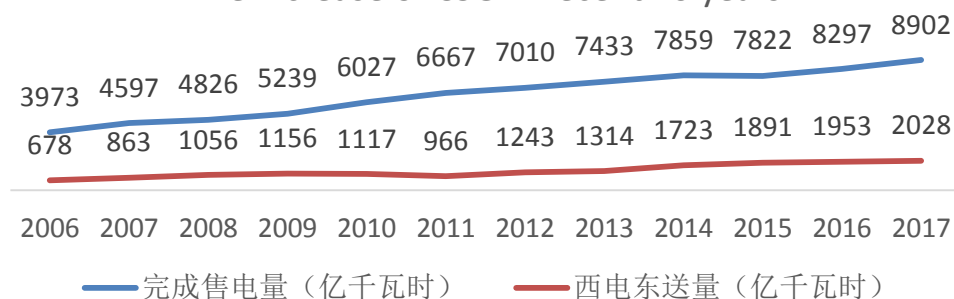
To cover 5 province of china , to supply power for 2,500 million people

Total electricity in 2017: 890 billion kWh
An average annual increase : 9.3%

Overview



The increase of CSG in recent 10 years



Global 500 , ranking 100th

Objective

Power outage: less than 1hour ; Customer satisfaction: ≥ 80 ; Green power: $\geq 50\%$;

1

**Smart grid background and challenge
to communication**

2

Typical use case for smart grid

3

Telecom solution for smart grid

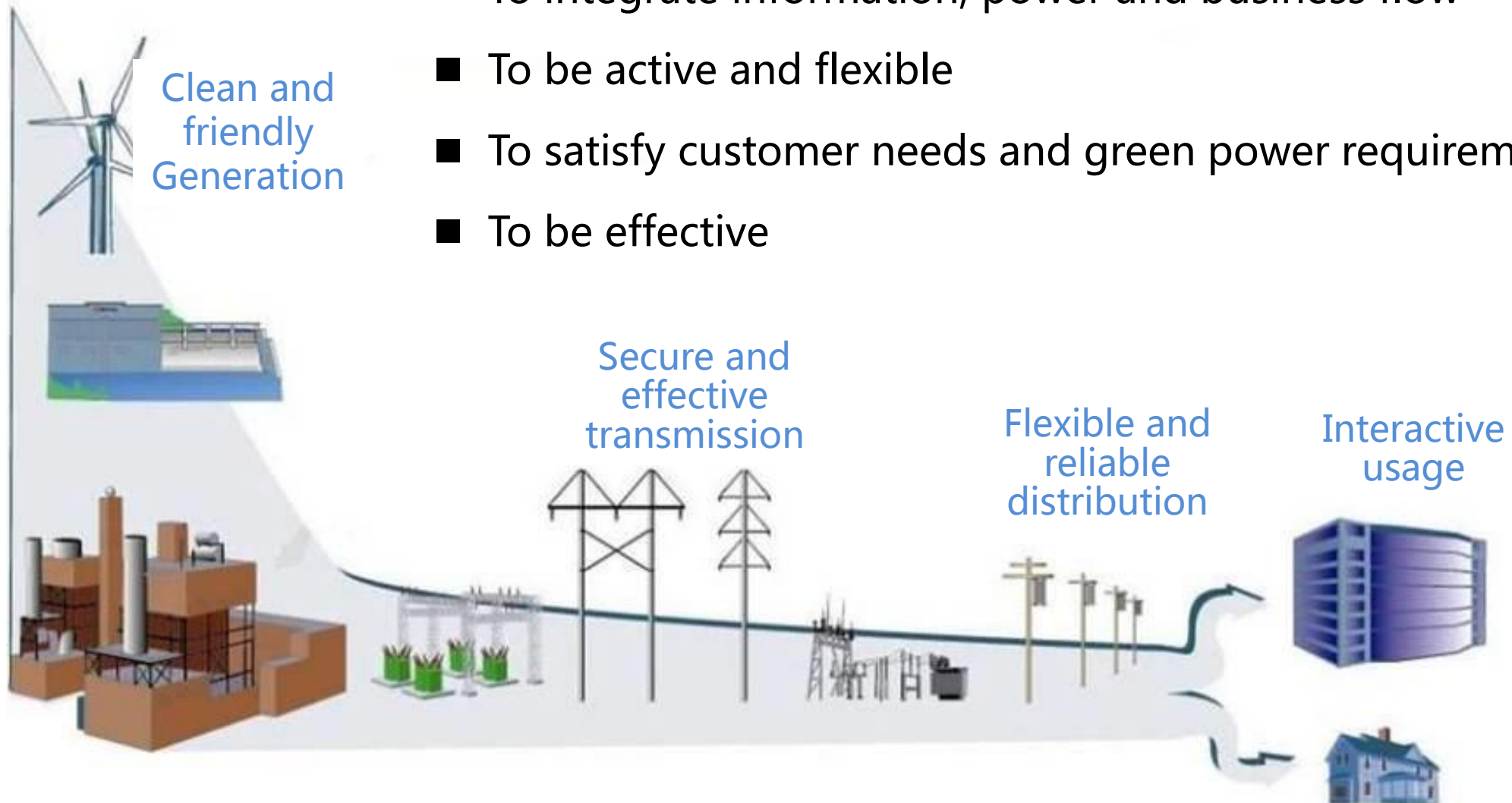
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Conclusion and outlook

1.1 Concept of smart grid

Smart grid

- To integrate information, power and business flow
- To be active and flexible
- To satisfy customer needs and green power requirements
- To be effective



1.2 Highlights of CSG

To accelerate power grid to be smarter and more effective, reliable and green

Technology

Renewable power
Micro-grid
Intelligent substation
Intelligent distribution
Information and communication
.....

Engineering

Distributed power integration
Micro grid
Active distribution
Intelligent usage
Electrical vehicles
.....

Application

Power management
dispatching automation
Demand response
Management of
electrical vehicles
.....

Achievements

■ Secure operation

- ✓ First demonstration project for $\pm 800\text{KV}$ DC transmission ;
- ✓ Highest voltage level and maximum capacity $\pm 200\text{MW}$ STATCOM

■ Reliable and smart power grid : Active distribution demonstration in Foshan and Guiyang to integrate distribution power supply

■ Various power usage : Intelligent power usage demonstration in Nanning which had achieved the interaction between smart grid and user, to measure the smart home energy efficiency etc.

■ Distribution power integration : First MW battery power station in Shenzhen,

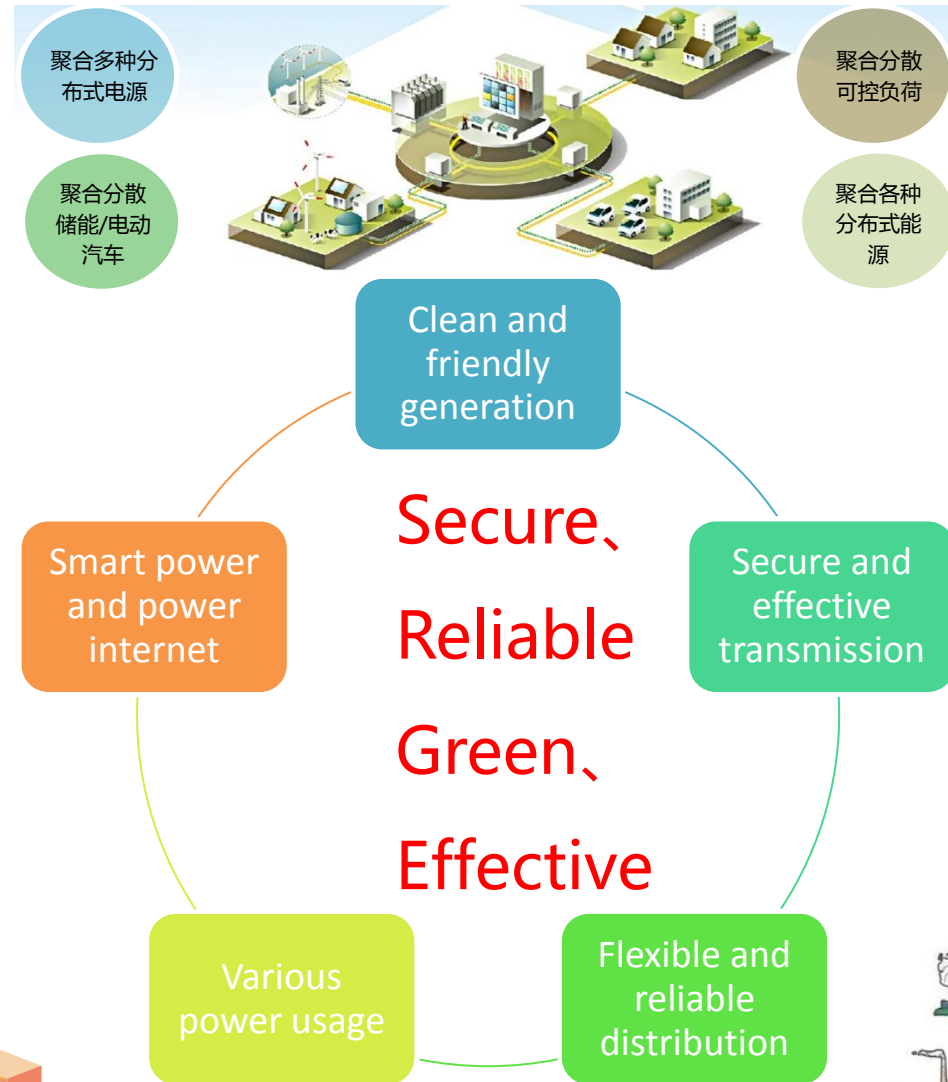
1.3 The trend of smart grid

Clean, Cooperating, Flexible, Efficient

Cooperating, Open



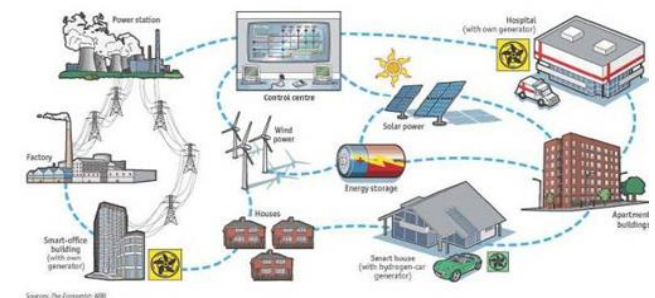
Friendly and efficient



Secure, Flexible



Economic, and opening

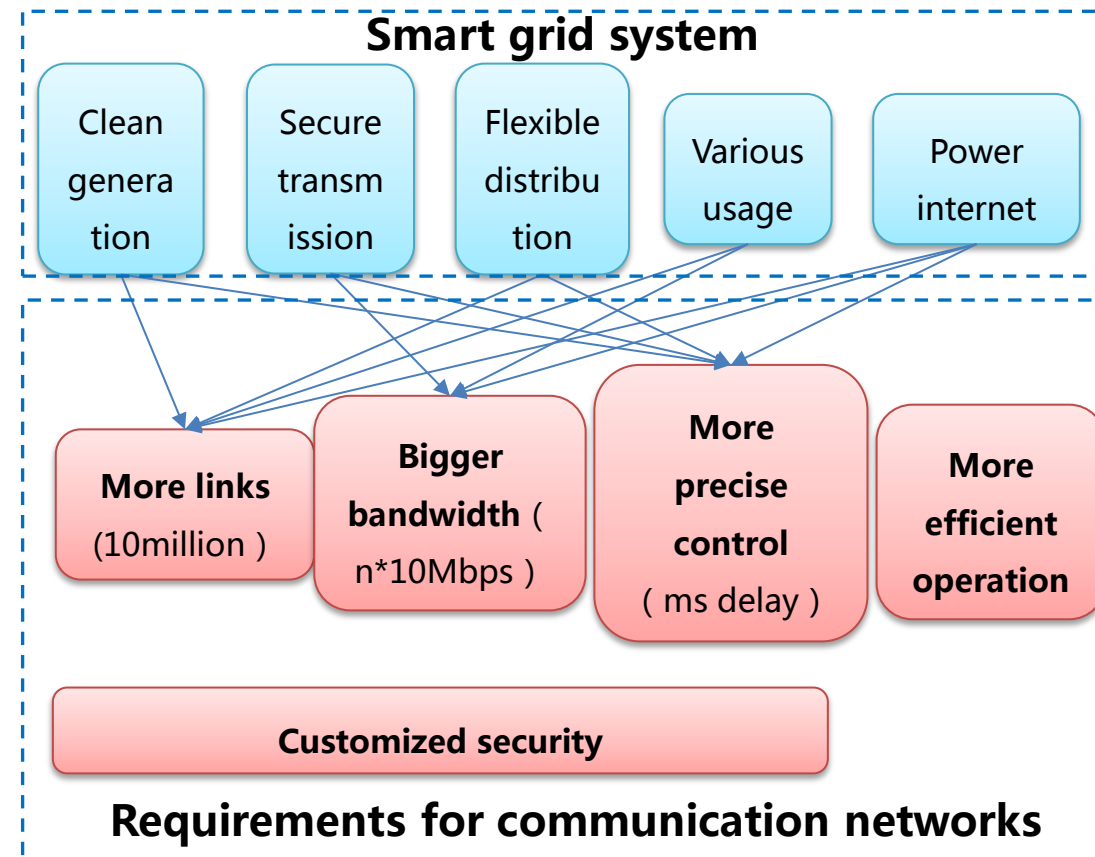


1.4 The challenge to telecommunication

- Telecommunication network is the infrastructure for smart grid which need to be transferred from passive to active



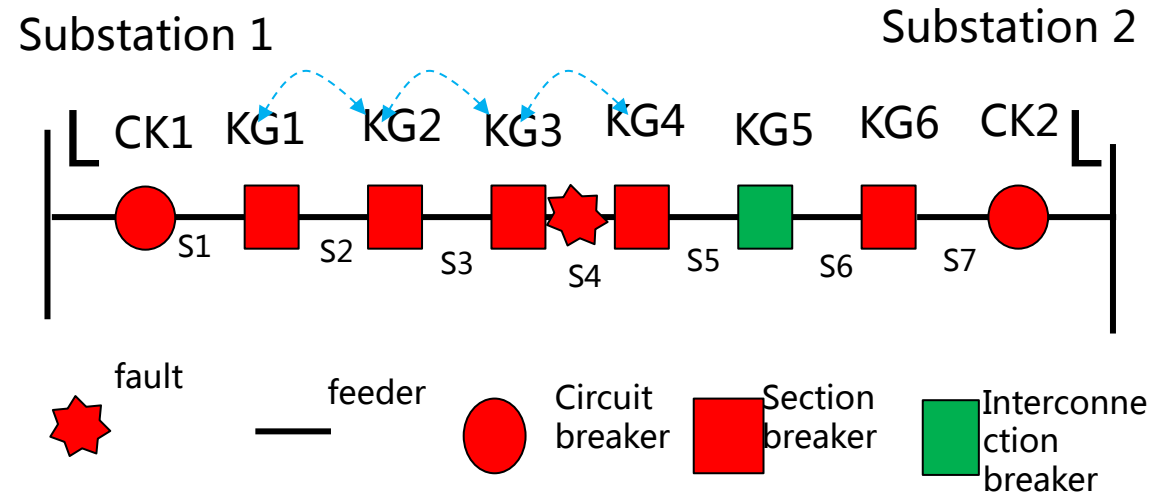
- Telecommunication network need to be **strong bearing capacity** (100M bandwidth 、 10M links 、 ms delay) , **customized security, and flexible operation**



2.1 Typical use case (low latency application)

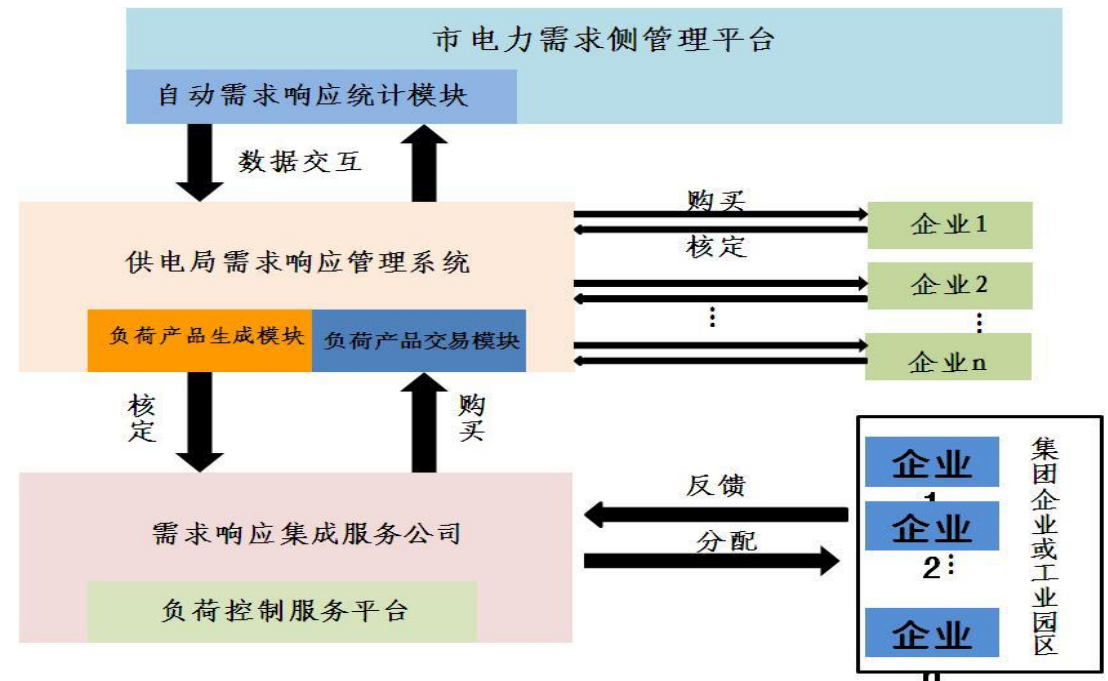
Intelligent and distributed automation

- **Introduction** : to protect feeders and isolate faults by differential protection
- **Network requirements** : latency < 10ms , bandwidth > 2Mbps , reliability 99.999%



Customer response

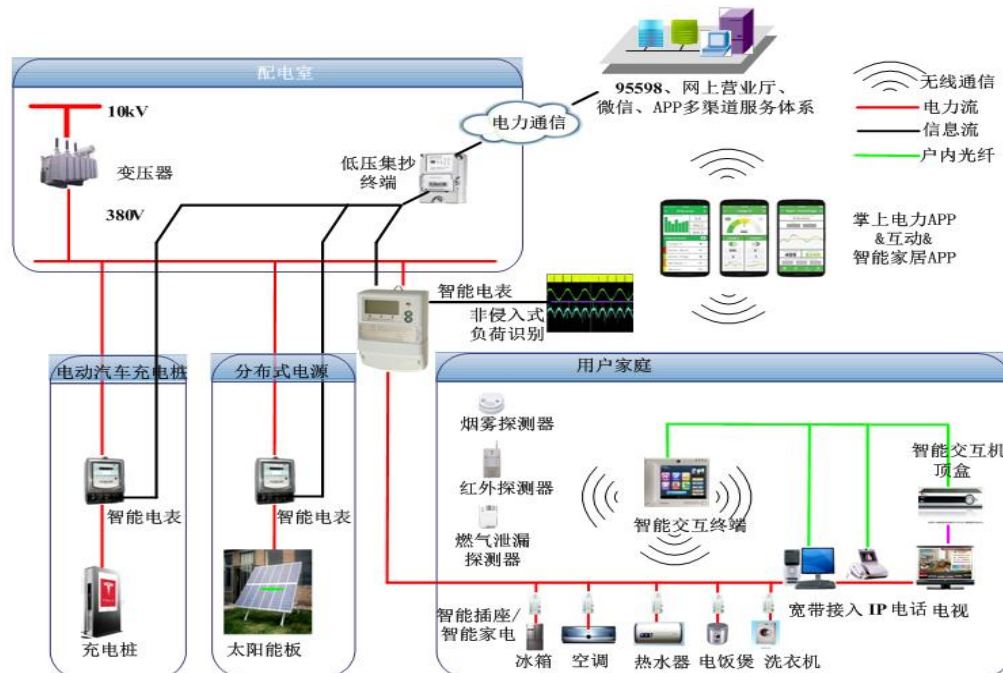
- **Introduction** : to actively adjust the customer needs to satisfy the power flow balance and ensure the power grid stable
- **Network requirements** : latency < 200ms , bandwidth < 1Mbps , reliability 99.999%



2.2 Typical use case (Massive links)

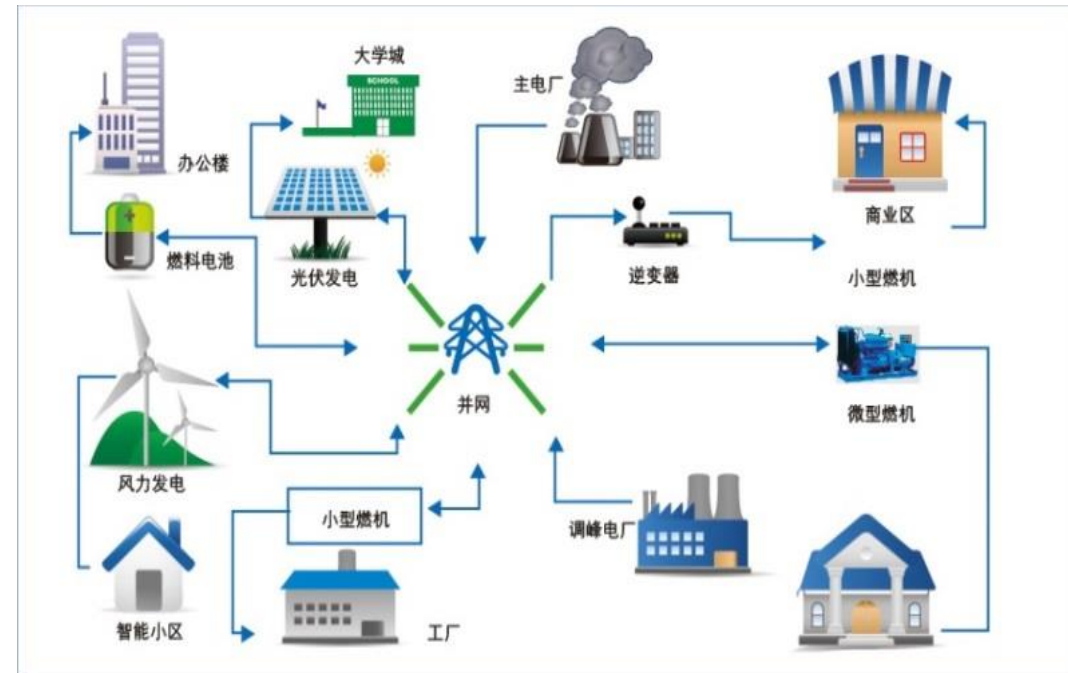
Advanced metering

- **Introduction** : based on the smart metering to collect the usage information from customer and improve the energy efficiency.
- **Network requirements** : **10M links** ,
bandwidth > 1~2Mbps , reliability 99.9%



Distributed power control

- **introduction** : to collect the data from solar, wind power, battery etc. and control the active and inactive power flow.
- **Network requirements** : **1M links** ,
bandwidth < 2Mbps



2.3 Typical use case (board bandwidth)

Video application , include robot, drone, emergency repair application etc which need to support HD video、4k , Bandwidth \geq 100Mbps , latency \leq 200ms

Inspection robot : 2~4 HD video + various sensors



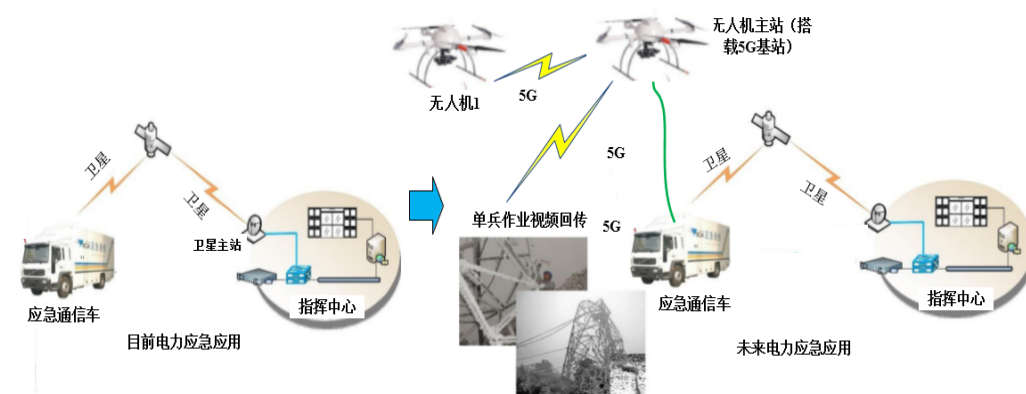
Inspection drone : range >2km , 2~4 HD video



Video monitoring : 1~8HD video + AI application



Emergency repair : Drones , 4~10 HD video , VR application



3.1 5G solution for smart grid communication

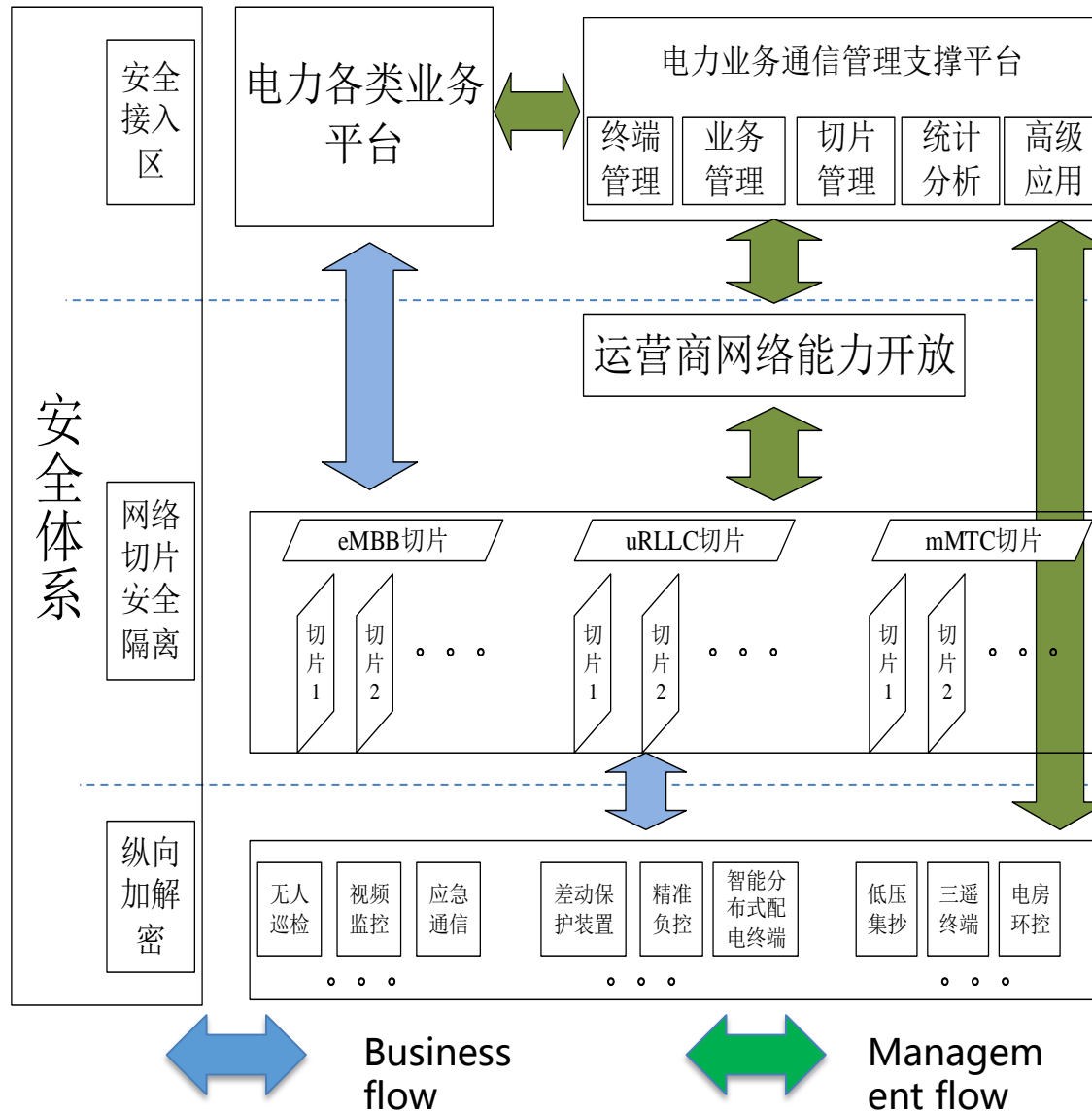
5G smart grid solution include terminal、pipe、cloud、security (4 parts)

Security : utility + telecom operator

More on pipe、terminal

Customize d security

Unified secure key system、flexible second authentication and key management



Cloud : utility

- 1、to inquire communication status, resource application etc. by communication management support platform
- 2、to manage and inquire slice by telecom operators platform

Pipe : telecom

- 1、to encapsulate the slice capability by opening platform
- 2、5G network to provide the customized slicing service

terminal : utility

- 1、by CPE or communication modules , to connect 5G networks

3.2 5G for smart Grid (terminal)

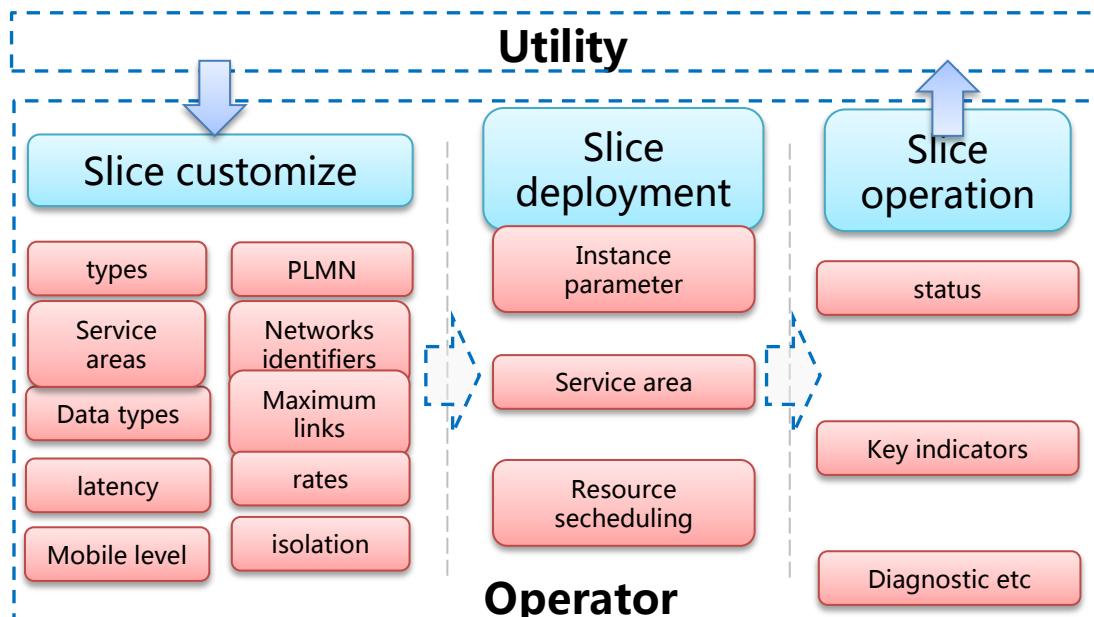
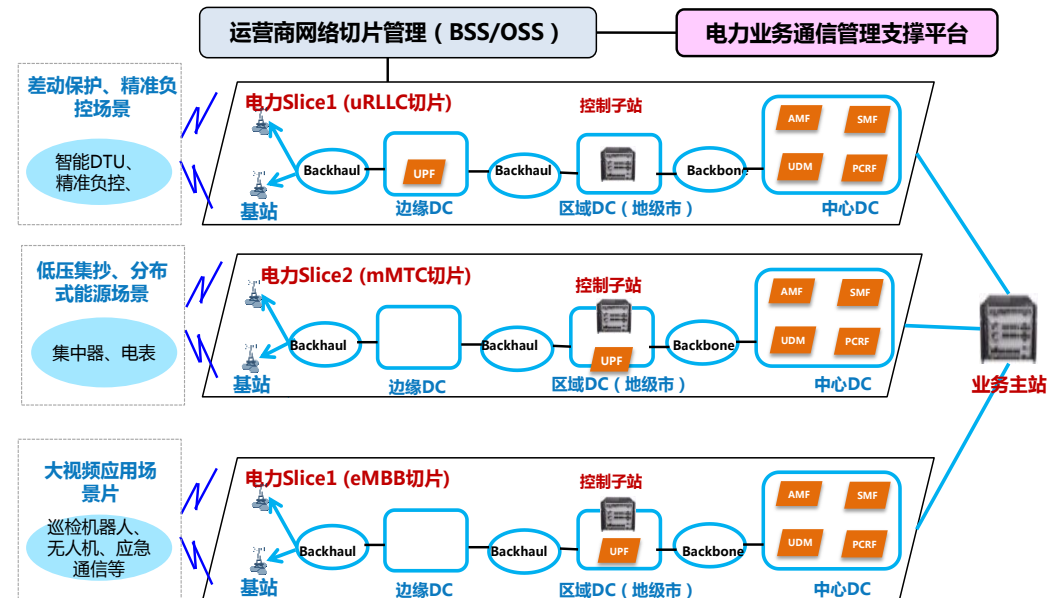
- 5G smart grid use case include eMBB、uRLLC、mMTC scenarios
- 5G terminals include two types: CPE、communication modules
 - ✓ Mainly communication module : AMI、 video etc.
 - ✓ CPE/communication co-existing : intelligent and distributed automation、 customer reponse、 distributed power control etc.

Use case	Typical electricity terminal	5G terminal	Main considerations	Slice type
Intelligent and distributed automation	DTU,FTU	CPE/embedded communication modules	-	uRLLC
Customer reponse	Load control terminal	CPE/embedded communication modules	-	uRLLC
Distributed generation control	Data collection and control termical	CPE/embedded communication modules	-	mMTC
AMI	Concentrator、 smart metering	embedded communication modules	Small size , low cost	mMTC
Inspection of substation	Inspection robot	embedded communication modules	mobile、 difficult to supply power	eMBB
Transmission line inspection	drone、 camera、 FPI	embedded communication modules	mobile、 less weight、 difficult to supply power	
Video monitoring for distribution room	HD camera	embedded communication modules	mobile、 small size	
Mobile operation	PAD, etc	embedded communication modules	Small size	
Emergency repair	drone、 helmet、 PAD etc	embedded communication modules	mobile、 small size、 less weight	

3.3 5G for smart grid (Pipe)

Solutions for smart grid slicing

- Telecom operator provide 3 types of slicing service(eMBB 、 uRLLC 、 mMTC) and to initialize multiple slicing instances for each scenarios by smart grid demands.
- Utility provide customized slicing service for different teams

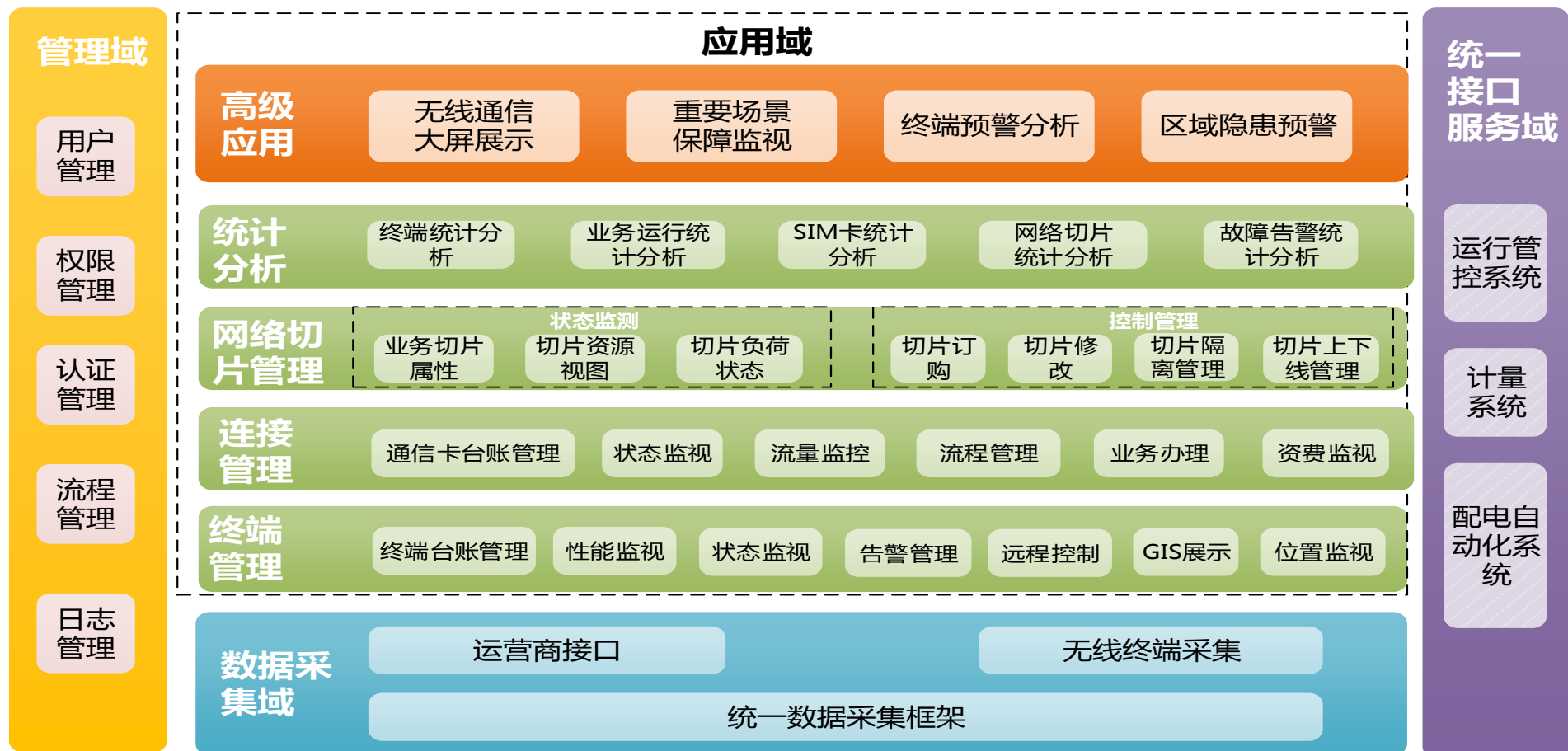


Capability opening platform solution

- Telecom operator provide slicing customization, planning, and monitoring etc. capability to utilities.
- Utility get the slicing status from telecom operators

3.4 5G for smart grid (Cloud)

- Utility communication management support platform include data collection, application, management, unified interface service domains.
- ✓ To provide abundant, diversified, flexible slicing service to utility
- ✓ To provide dig data analysis for smart grid advanced application
- ✓ To provide service for other smart grid business flow



3.5 5G for smart grid (security)

Terminal side: focus on second authentication and key management;

Pipe side: focus on end to end application isolation

Terminal security

- ✓ Flexible second authentication and key management

Air interface isolation

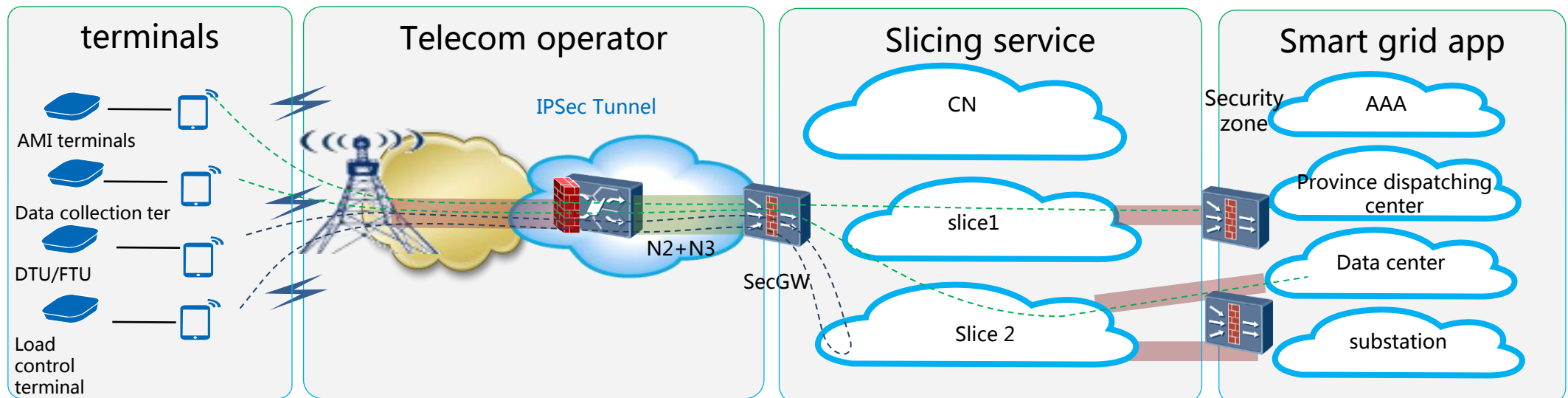
- ✓ Schedule by demands based on Time & frequency domain

Transport security

- ✓ Hard Isolation : Hard pipe based on TDM
- ✓ Soft Isolation : isolation by vlan, vpn etc.

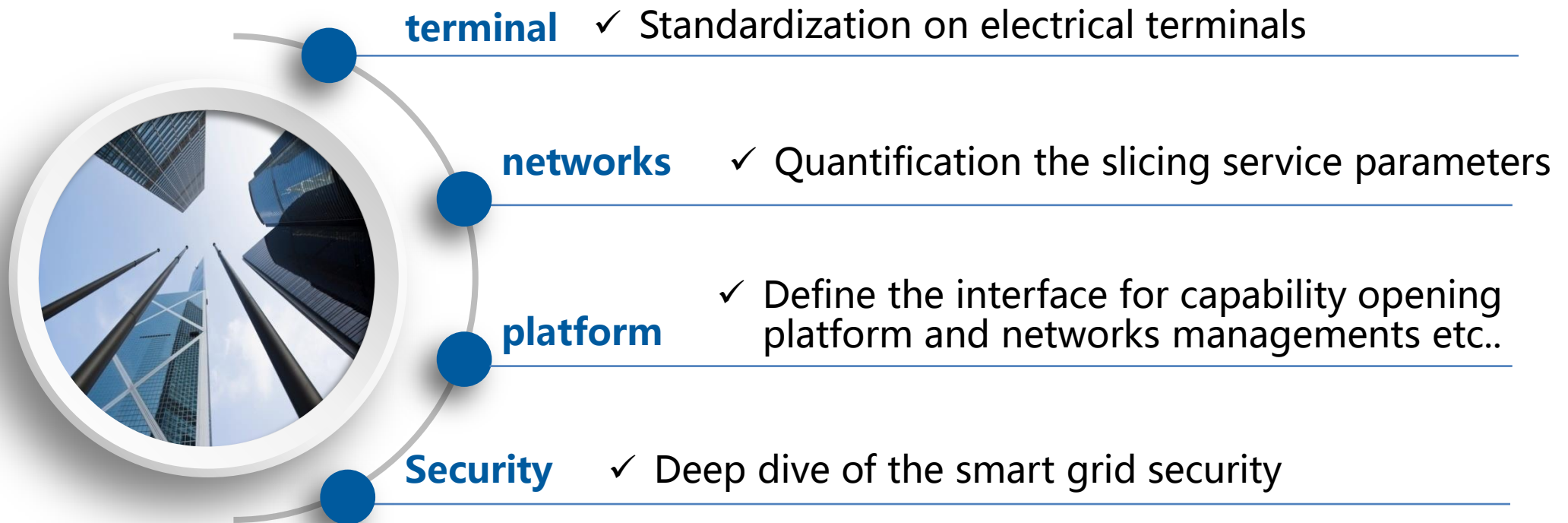
CN security

- ✓ Hard isolation : special server for utility
- ✓ Soft isolation : special virtual machine, but share the same server



4、 Conclusion and outlook

- 5G provide a better wireless solutions for smart grid which has been considered at the beginning of 5G architecture design.
- Based on 5G' s slicing service to support "private network" for smart grid
- 5G for smart grid outlook



Thanks