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Research and Design about Information Interface of Demand Response Aggregation System based on the Internet Home Appliances



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I. Background

II. Analysis of the development situation of “Internet+” household appliances

III. Analysis of information interaction mode of residents’ demand response

IV. “Internet+” architecture design of demand response aggregation system

V. Aggregation interface design and example analysis of appliance cloud platform

1. BackGround

---Necessity



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Target



Energy
Policy

◆ Responsibility assessment to DSM target

Energy saving assessment for power grid enterprises

Saving index:
0.3% of the last
year maximum
electricity load



Local
Power
Shortage

◆ East China and central China' s seasonal
and periodical power shortage is still severe

Seasonal factors, grid structure, etc.

Off peak electricity:
Implement demand
response



DER* Grid-
connected

◆ In 2020, the installed capacity will reach
187 million kilowatts

Increase fluctuation of power grid load

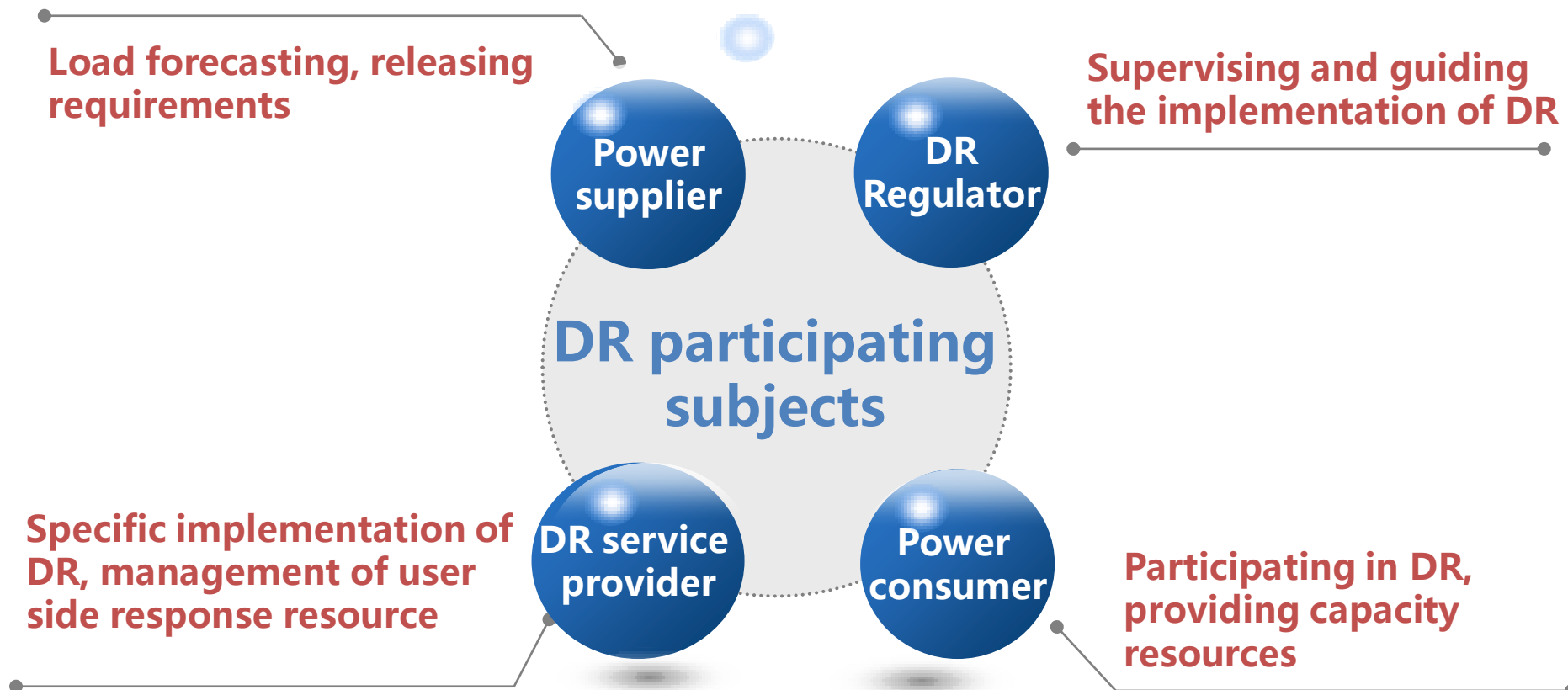
Active load adjustment :
Demand response

1. BackGround



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---DR participating subjects and relationship



1. BackGround



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---Electricity price policy

• Resident peak valley electricity price

- **Examples:** Jiangsu, Shanghai and Zhejiang.

• Industry peak valley electricity price

- **Examples:** Shanghai and Jiangsu industry peak valley.

Electricity price ratio reached 5:1

• Differential electricity price

- **Examples:** 470 high energy consuming enterprises in Hunan, on the basis of the original sales price, increase the average of about 0.01 yuan/kW.h.

• Wet price

- **Examples :** Yunnan power price fall 15% in rainy season and in dry season up 20% .



1. BackGround

---DR infrastructure construction

ESMP



●Already deployed in Beijing, Jiangsu, Shandong and other 23 provinces and cities, accessed to more than 3400 users, it can carry on the online monitoring to the user load, with the BS pattern, the mobile APP or the short message and so on contact the user to carry on the information interaction, and has initially developed the DR function module.

EVCP



●As of the end of 2014, electric car ownership 120000, built 780 charging station, charging pile 31000, a lot of charging load has a huge regulatory potential.

EIAS



●SGCC operating range involves the use of electricity households over 300 million. As of the end of 2014, 248 million smart meters had been installed. The online monitoring of data information such as user's quantity and power, is the important data base for the implementation of the DR, especially for solving the problem of user's load baseline.

1. BackGround



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---DR infrastructure construction

Intelligent Park



●Has been running in Jiangsu, Shandong, Gansu and other places, access to hundreds of companies, realize the functions of the exchange of electricity information, load monitoring, distributed energy resource coordination and management, establishing the basis for industrial enterprises to implement of DR.

Intelligent Community



●SGCC builds 28 intelligent communities in 17 provincial companies, and the South Power Grid Corp also builds intelligent communities in Guangdong, Guizhou and other places, realizing the electricity information interaction between power grid companies and residents, providing data support for the implementation of DR.

2. Analysis of the development situation of “Internet+” appliances



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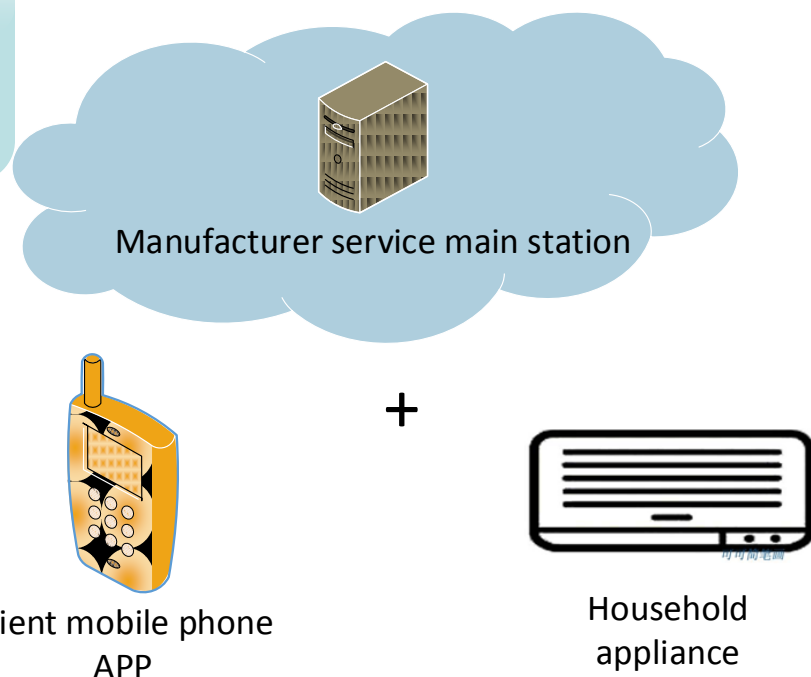
Internet appliances and cloud platform

➤ Internet appliances

Compared with traditional household appliances, they add Internet interface, therefore could access the Internet through household gateway.

➤ Internet appliance cloud platform

Appliance manufacturers provide main station of cloud service and client software, realizing communication between people and appliance, appliances as well as appliance and main station.



Using mode of Internet appliances

2. Analysis of the development situation of “Internet+” appliances



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Two interactive modes of appliances

➤ APP interaction

Interact with appliances by operating APP on a mobile phone or pad. It is suitable for users.



➤ Cloud interaction

Interact with appliances by applications of appliance cloud platform. It is suitable for service providers.



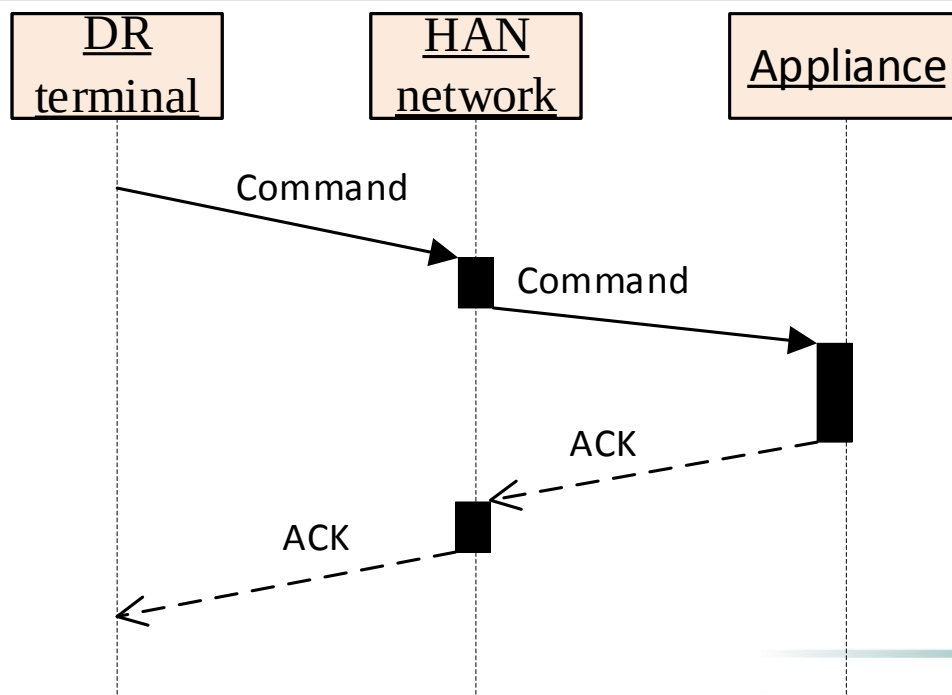
3. Analysis of information interaction mode of residents' demand response



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The converting of thought:
Home Area Network  Internet

- Traditional horizontal information exchange mode based on HAN



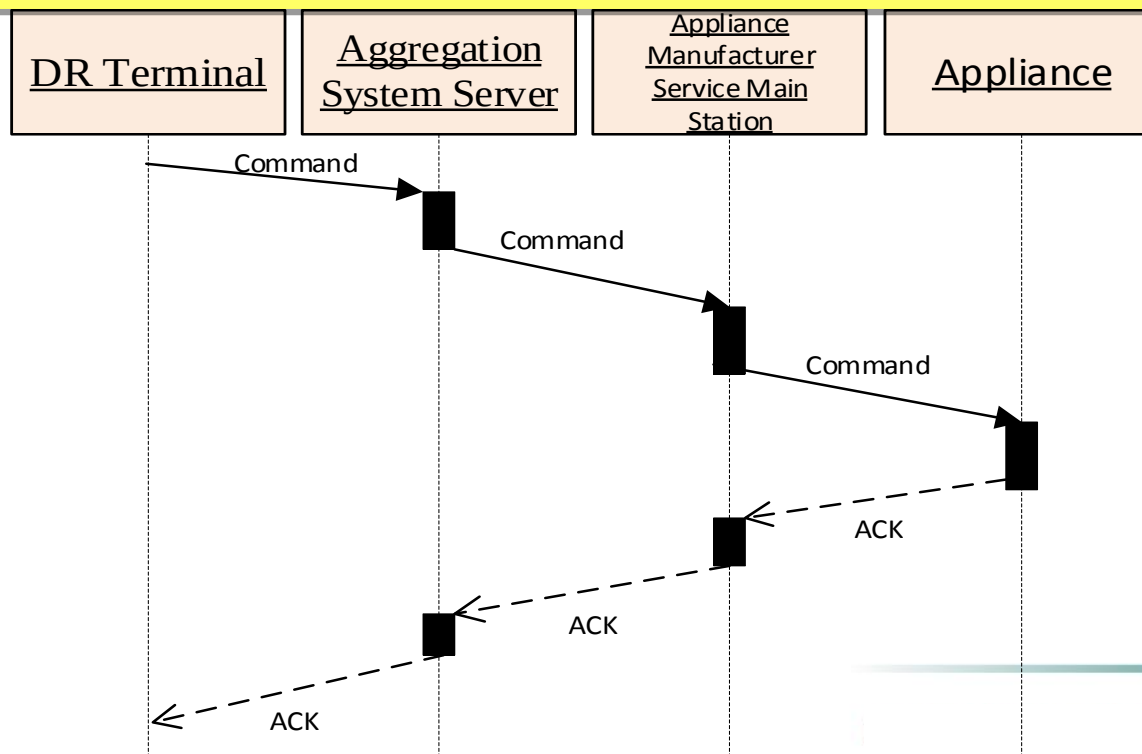
3. Analysis of information interaction mode of residents' demand response



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The converting of thought:
Home Area Network  Internet

• Vertical information exchange mode based on Internet

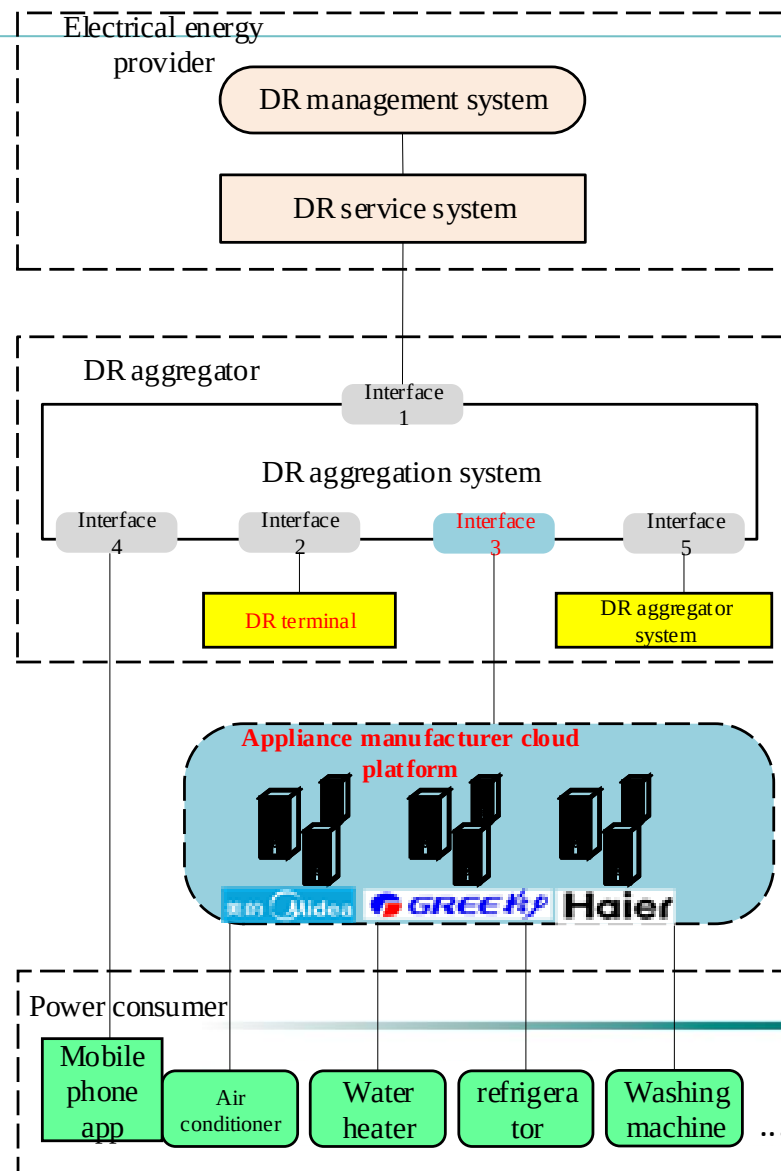


4. “Internet+” architecture design of demand response aggregation system



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- Appliance cloud platform provides efficient method of appliance data acquisition and controlling for DR aggregation system, making it possible to obtain electricity data conveniently and transmit the control command to appliances through cloud platform.
- DR terminal connects with appliance cloud platform through Internet and the aggregation system, having the ability of data acquisition and controlling. It no longer connects with appliances in HAN.

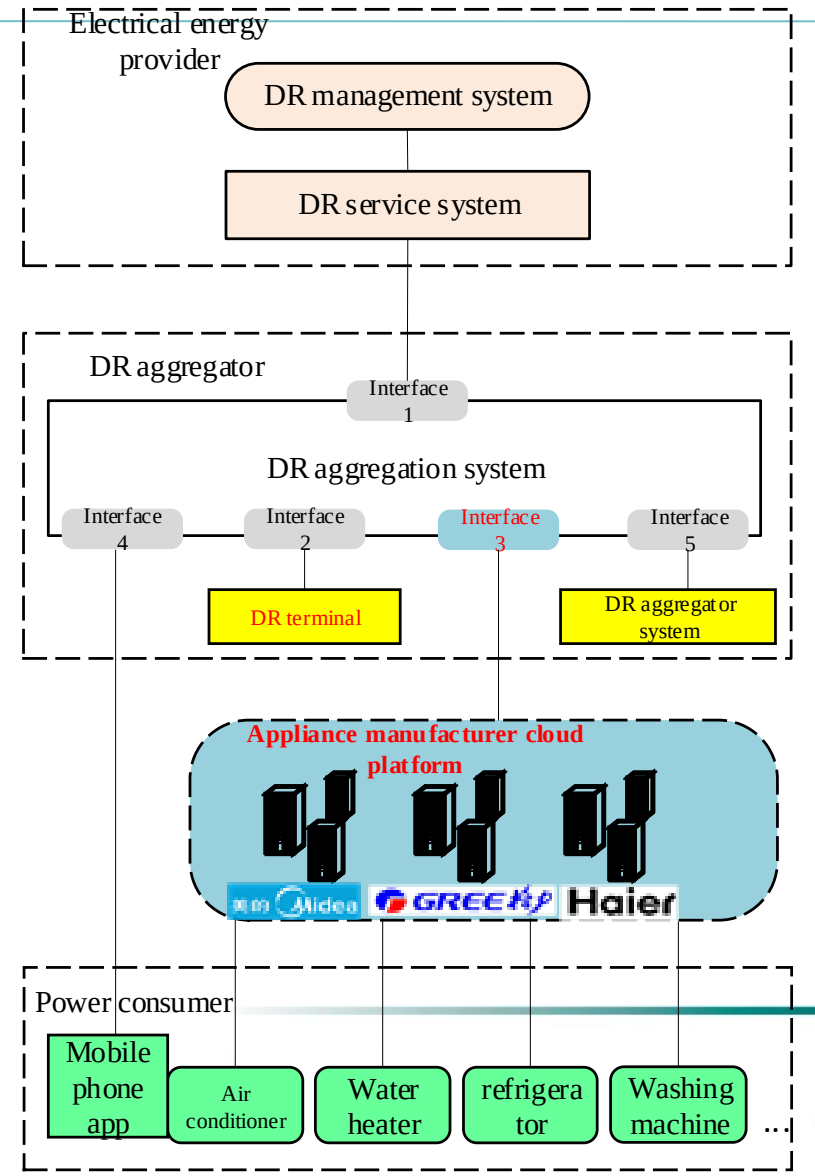


4. "Internet+" architecture design of demand response aggregation system



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- DR aggregation system connects with other aggregation systems, realizing cascade, therefore gathering and managing user load in a large scale.
- DR terminal could not only be installed in the household in the form of hardware, but it could also be transferred into virtual DR terminal and installed into Energy Management System, or integrated in the environment of aggregation systems.
- Design the mobile phone of user into the auxiliary part of DR terminal, complete the function of display and command input, and realize the system interaction of user and DR



5. Aggregation interface design and example analysis of appliance cloud platform

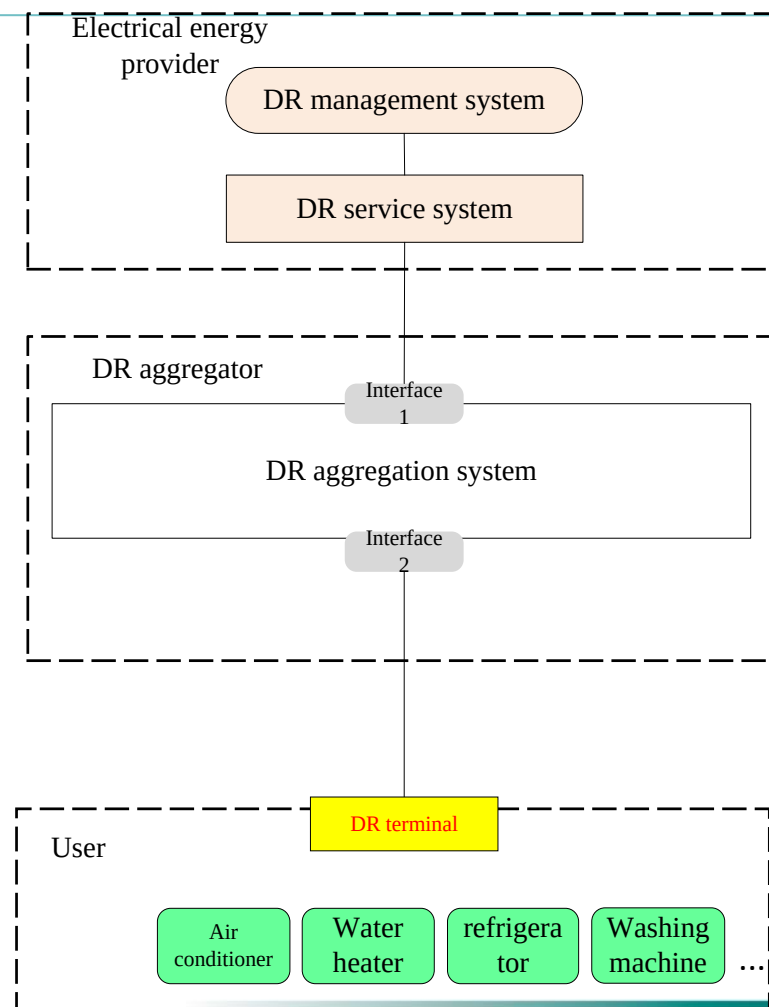


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• Design of interface concept

GB/T 32672-2016 *General technical specification of power demand response system* describes the function and location of interface. Information interfaces related to aggregation system comprises of the following two, interface 1 and interface 2.

- Interface 1 is the interactive information interface between DR service system and DR aggregation system.
- Interface 2 is the interactive information interface between DR aggregation system and DR terminal.



5. Aggregation interface design and example analysis of appliance cloud platform

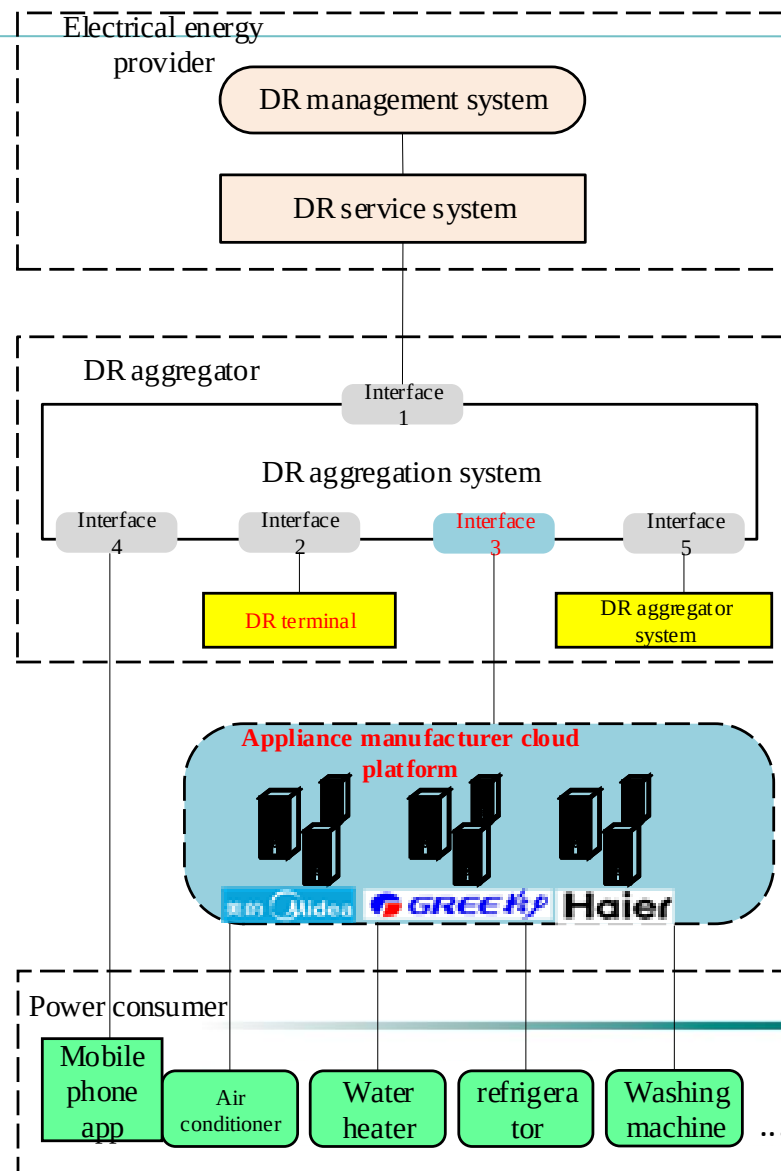


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• Design of interface concept

Added information interface

- Interface 3 is the interactive information interface between DR aggregation system and appliance cloud platform.
- Interface 4 is the interactive information interface between DR aggregation system and users' mobile phone, PAD as well as PC.
- Interface 5 is the interactive information interface between DR aggregation system and cascade of DR aggregation system.

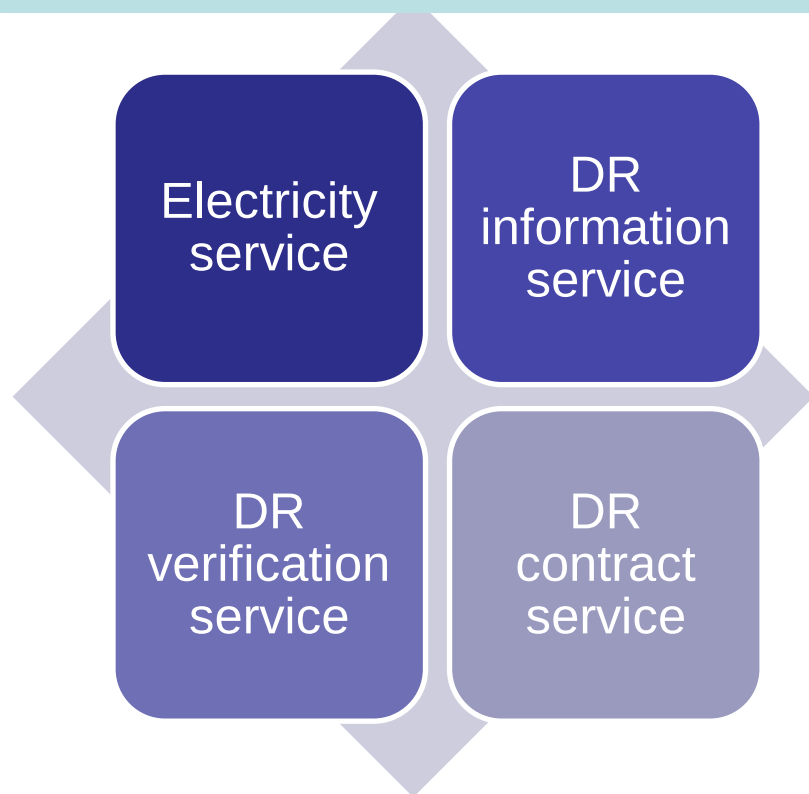


5. Aggregation interface design and example analysis of appliance cloud platform



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- Illustration of interface functions**



- Electricity service:** Electricity information and device information. Device information includes information of start-stop, operating and failures.
- DR information service:** DR peak cutting index service, DR incident service and peak demand information service.
- DR verification service:** Electrical energy providers monitor users' DR project ,observing the implementing situation and result.
- DR contract service:** Electrical energy providers and users signing a certain DR contract through network before DR implementation, having force of law.

5. Aggregation interface design and example analysis of appliance cloud platform



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- **Example analysis**

Analyzing objects: 6 pieces of appliances (water heater, washing machine, lighting equipment, air conditioner, electric cooker and electric kettle) being regarded as DR load resource.

Analyzing scene: Choose 2 application scene to implement contrast experiment, i.e. HAN network application scene and Internet application scene.

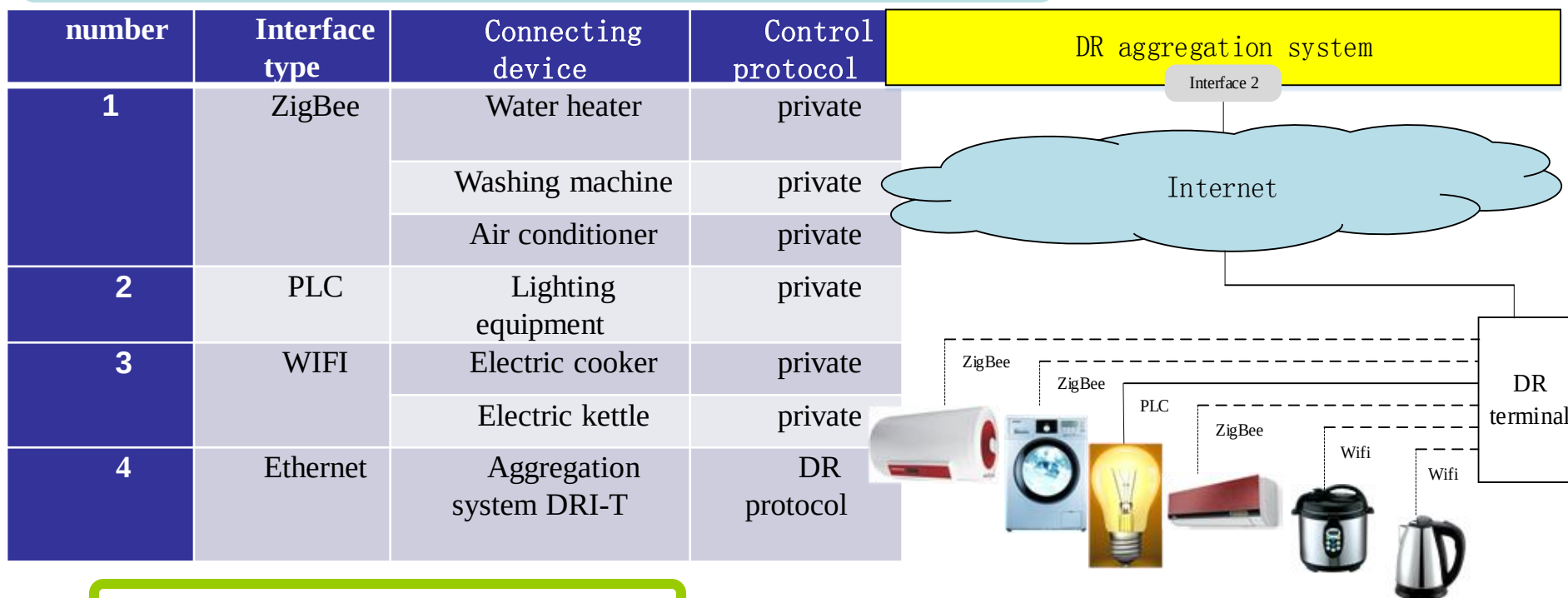
Analyzing description: The developing requirement of number, type and protocol conversion of interfaces are different. The designing complexity and realizing difficulty of terminals also have great difference.

5. Aggregation interface design and example analysis of appliance cloud platform



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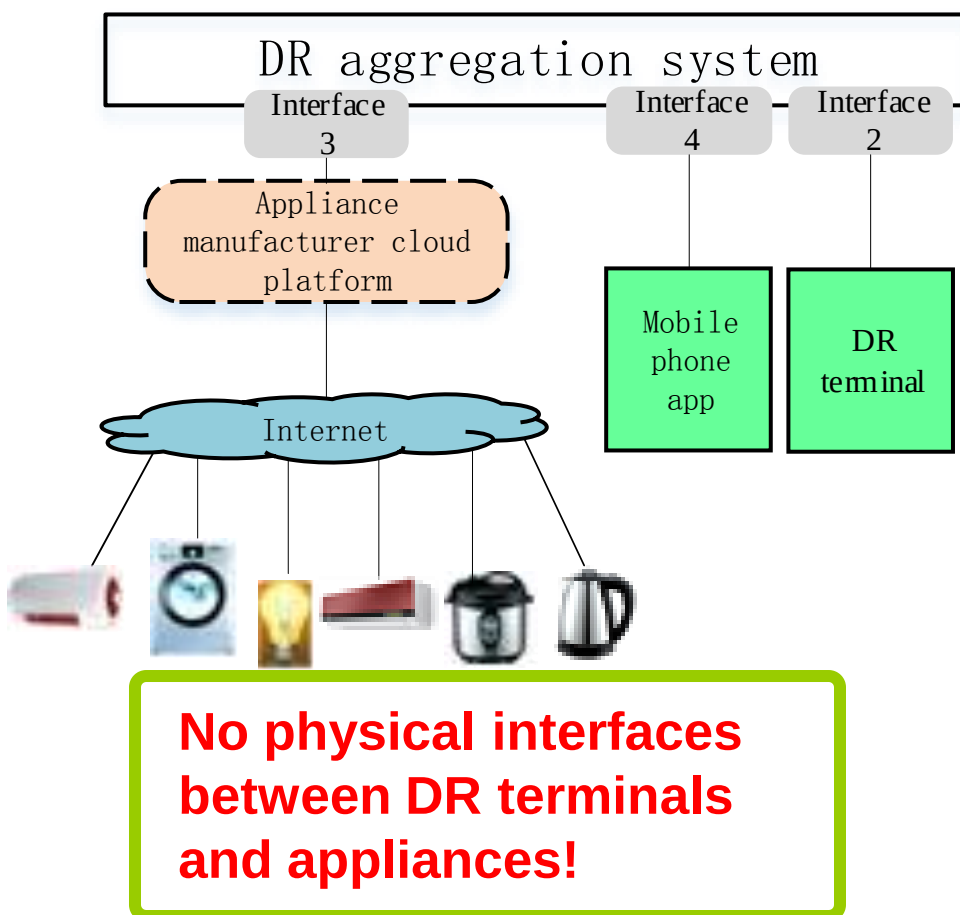
• DR terminal design of HAN interface



Too much physical interfaces between DR terminals and appliances!

5. Aggregation interface design and example analysis of appliance cloud platform

• DR terminal design of HAN interface



Internet household appliances connect to appliance cloud platform through the Internet.

- Appliance cloud platform connects to DR aggregation system through interface 3.
- There are no direct physical connections between DR terminals and appliances in the household. Only connecting to DR aggregation systems through interface 2 could realize the information acquisition and controlling of appliances.

As for a DR terminal, it only needs Ethernet interface and TCP/IP Protocol, and can form a virtual DR terminal at any Internet access point. Users can log on the virtual terminal through the corresponding platform account number, apply the virtual terminal on any Internet device(PC, mobile phone, PAD, etc.),therefore realizing the management and controlling of DR and greatly decreasing the cost of the upgrading of the DR terminals for users.



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Thank you !
