

COMMUNICATIONS TECHNICAL STANDARDS INFRASTRUCTURE OF SMART GRID

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Communications platform is supporting the building of strong and Smart Grid platform and an important means of public. Communications system supports the Smart Grid of the power generation, transmission, substations, distribution, customer service, power dispatch, six links, and information platform for normal operation. Support the Smart Grid communications standard system is the communications technology standards in accordance with the composition of its inherent logic, integrity and openness in science and organic whole. The standards system is to ensure interoperability, to lead the direction of technology development technology base. The equipment/system life cycle of power network and communications network relations has analyzed. The reliable influence model of power network and communications network relations has constructed. Through research the support Smart Grid's communications standard frame setup procedure, the communications standard renewal iteration feedback mechanism, the communications standard appraisal system. The Smart Grid's communications standard system frame has given.

INTRODUCTION

Along with economical development, society's progress, technical and informationization level enhancement as well as global resources and environment question day by day prominent, depends upon the present information technology and the communications, will develop the Smart Grid positively, the adaptation in the future the sustainable development request, will promote the clean energy large-scale development use, will realize the low-carbon economy, has become the international electric power development the reality choice [1-6].

The Smart Grid needs to realize between the power grid each composition unit as well as subsystem's elevation information sharing, but the existing technical standard is formulates independently by the different organization or the technical committee, the respective definition's connection is inconsistent, easy to cause between the system not to be able to be compatible.

The Smart Grid technical standard is to achieve the Smart Grid development targets, carries on the coordinated unification to Smart Grid various domains, guaranteed the interoperability proposed technical stipulation or technology standard. The Smart Grid technical standard system has the Smart Grid standard according to its inner link composition the logic, the integrity and the open science organic whole.

The standard system may the equipment manufacturer which, system integration business, the electrical network development organization constructs for the participation Smart Grid provide the technical guidance, guaranteed the Smart Grid constructs quality and progress. The standard system may the effective guarantee Smart Grid's energy system, the information system and the electrical power system, power consumer's interoperability. The standard system is unifies the Smart Grid to know that to eagerly anticipate the Smart Grid development direction the technology base. The technical standard is taking on the industrial mainstream technology carrier strong character.

The Smart Grid involves the scope to be widespread; therefore the latent standard domain is huge and complex. But, the Smart Grid technical standard cannot each time make a fresh start from zero, cannot duplicate each kind of same discovery and expensive wrong [1]. Already had each kind mature standard and the best practices, may use very easily advances the Smart Grid's deployment. Therefore, embarks from the demand and the standards, the display, combs, screens and compiles the existing related standard and the practice is essential.

The communications platform is the public platform which and the important means the support Smart Grid constructs, the penetration and the service electricity generation, the electric transmission, the power transformation, the power distribution, the customer service, the dispatch and so on six links and the information platform [3-6]. The Smart Grid's construction proposed a higher demand to the communications platform. Therefore the establishment support Smart Grid's communications standard system frame is essential. In the existing related standard and the practice, the support Smart Grid's communications standard system will involve many domestic and foreign standardization organizations. The representative overseas organization has International Telecommunication Union telecommunication standards bureau (ITU-T), International Telecommunication Union radio communication agency (ITU-R), European Telecommunications Standard Association (ETSI), internet project work team (IETF), American telecommunication industry solution alliance (ATIS), the international big electrical network conference electric power information and communications specialized committee (CIGRE SC D2), International Standardization Organization (ISO), international electrician committee (IEC), the American electricity and electronic Engineer association (IEEE), US National standards Association (ANSI) [7-14].

The support Smart Grid's communication China standard possibly involves scope including national standards, profession standard and enterprise standard. And national standards including national standards (GB), engineering

construction national standards (GBJ), country recommended limit (GB/T), country instruction standard (GB/Z); Profession standard including communications profession standard (YD), communications standard class fitness report (YDB), communications standard referential technical paper (YDC), electric power profession compulsion standard (DL), electric power profession recommended limit (DL/T) and so on [15-18].

POWER NETWORK AND COMMUNICATIONS NETWORK

Equipment/system life cycle relations between power network and communications network

In the electric power profession each kind of property's operation service life is as follows, the machinery/construction class property is from 40 to 70 years, the electricity class property is from 20 to 30 years, the communications facility class property is from 8 to 10 years, the information equipment class property is from 4 to 5 years [3-6]. In the service life aspect, in the electric power profession each kind of property generation gap difference is huge.

Moreover, according to "a mole of law", microprocessor's performance every other 18 months enhances one time, but a price fall time; Computer performance which can buy with a US dollar institute, every other 18 month doubles; On the integrated circuit chip integrates the electric circuit number, every other 18 months doubles. Along with Smart Grid's advancement, after informationization, digitization, automation, the property life will reduce gradually, renewal's cycle will speed up.

Looking from the electric power profession each kind of property's operation service life angle, the corresponding Smart Grid 1 generation the electricity class property operation service life cycle, needs to construct 2 to 4 generation of communications system successively. If plans the communications system construction according to 2 generations, then how the 1st generation of key point is through the foundation technology improvement reliable safeguard network and physical facility survivability, how does the 2nd generation of key point is use based on the game theory virtual organization theory, provides one kind of integration message communication ability, constructs the distributional virtual system.

Reliable influence model between power network and communications network

Power network and communications network performance mutual influence, therefore, it is necessary to study the mutual influence model. The establishment support Smart Grid's communications standard system frame, constructs the Smart Grid reliability is as follows to the communications network reliable influence model. The Smart Grid reliability proposed to the communications network reliability requests high. The supposition power network reliable indicator system

is A , the communications network reliable indicator system is B , then the power network reliable indicator system and the communications network reliable indicator system's relations may express are,

$$B_{rs} = T_{rm} A_{mn} H_{ns}$$

And, the electrical network reliable indicator system is

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & a_{m3} & a_{mn} \end{bmatrix}$$

The communications network reliable indicator system is

$$B = \begin{bmatrix} b_{11} & b_{12} & \dots & b_{1s} \\ b_{21} & b_{22} & \dots & b_{2s} \\ \dots & \dots & \dots & \dots \\ b_{r1} & b_{r2} & \dots & b_{rs} \end{bmatrix}$$

The transfer matrix is

$$H = \begin{bmatrix} h_{11} & h_{12} & \dots & h_{1s} \\ h_{21} & h_{22} & \dots & h_{2s} \\ \dots & \dots & \dots & \dots \\ h_{n1} & h_{n2} & \dots & h_{ns} \end{bmatrix}$$

$$T = \begin{bmatrix} t_{11} & t_{12} & \dots & t_{1m} \\ t_{21} & t_{22} & \dots & t_{2m} \\ \dots & \dots & \dots & \dots \\ t_{r1} & t_{r2} & \dots & t_{rm} \end{bmatrix}$$

Standard match

The communications platform is the public platform which and the important means the support Smart Grid constructs, the penetration and the service electricity generation, the electric transmission, the power transformation, the power distribution, the customer service, the dispatch and so on six links and the information platform.

The support Smart Grid's communications standard system has the communications standard according to its inner link composition the logic, the integrity and the open science organic whole. The support Smart Grid's communications standard system guarantees the interoperability, eagerly anticipates the technological development direction the technology base.

The Smart Grid standard system and the communications network standard system must match, and the renewal iteration needs the coordination.

ELECTRIC POWER COMMUNICATIONS NETWORK STANDARD SYSTEM FRAME ESTABLISHMENT

Electric power communications standard system setup procedure

The support Smart Grid's communications technology, the standard frame setup procedure may summarize for Figure 1. Along with the rolls, iterates and approaches the flow the advancement, the technological innovation and the practice, will have more and more new standards.

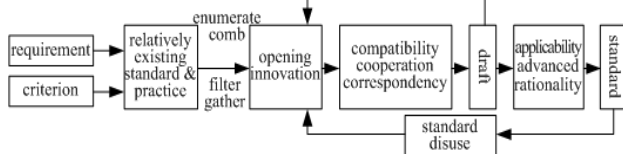


Fig. 1 Standard frame setup procedure of the support Smart Grid's communications technology

Supports the Chinese Smart Grid's communications standard system mainly to include the security and the environmental protection standard, the foundation and the synthesis standard (including technical standard, management standard and working standard), the engineering construction standard (including reconnaissance, design, construction and installment, acceptance test standard), the operation and the inspection standard, the equipment and the material standard. May divide according to the standard regulatory document is: Compulsion standard, recommended limit and standardization guidance technical paper. Its pyramid structure sees Figure 2.

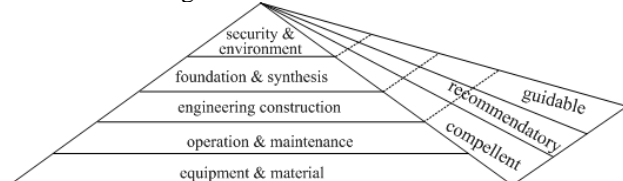


Fig. 2 Pyramid structure of communication standards of Smart grid

The standard compilation needs to follow the fundamental rule: essential requirements, unified, standard coordination, serviceable, planed and patent processing. Take the sense of purpose, the performance and may the confirmation as principles, determines the support Smart Grid's communications product standard content.

Communications standard renewal iteration feedback mechanism

According to foundation and synthesis, engineering construction (including design, transformation, approval, test), operation and overhaul, equipment and material, security and environmental protection and so on intrinsic logical relation, support Smart Grid's communications standard system, its intrinsic renewal folds the belt feedback mechanism to see the chart.

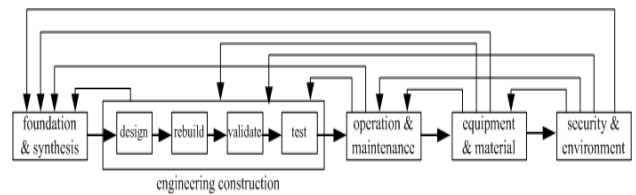


Fig. 3 Support Smart Grid's communications standard frame renewal iteration feedback schematic drawing

Communications standard appraisal system

The communications standard system needs to establish the appraisal mechanism can support the Smart Grid well.

Constructs the Chinese characteristic the Smart Grid, each aspect needs the coordinated development, maintains balanced. The following relative plot has enumerated 8 aspects which the communications standard system needs to balance. It is namely openness, compatibility, interoperability, cooperativity, security, economy, efficiency, logicity. For example, openness and the security must balance are coordinated the proper attention to both, avoids mutually contradictory.

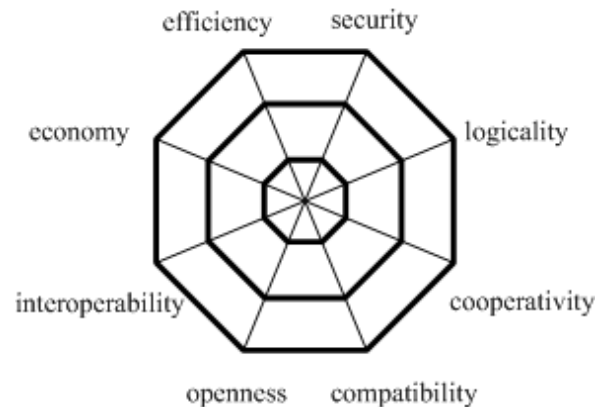


Fig.4 Smart Grid communication standard frame needs each aspect coordinated development maintains balanced

Communications technology standards frame

Through system analysis domestic and oversea communication standard present situation, in the display combs in the foundation which, screening compiles, proposed the support Smart Grid's communications standard frame model, see figure 5.

The support Smart Grid constructs the communications platform may divide into the transport layer, carrying layer and service layer. The transport layer consists mainly of transmission network composition. The carrying layer consists mainly of backbone, metropolitan and access networks composition. The access network may include wired and the wireless communication way. The service layer is mainly composed of the communication service platform and the service control system. The transport layer and carrying layer constitute communication foundation network. Communications service network consists mainly of service layer formed.

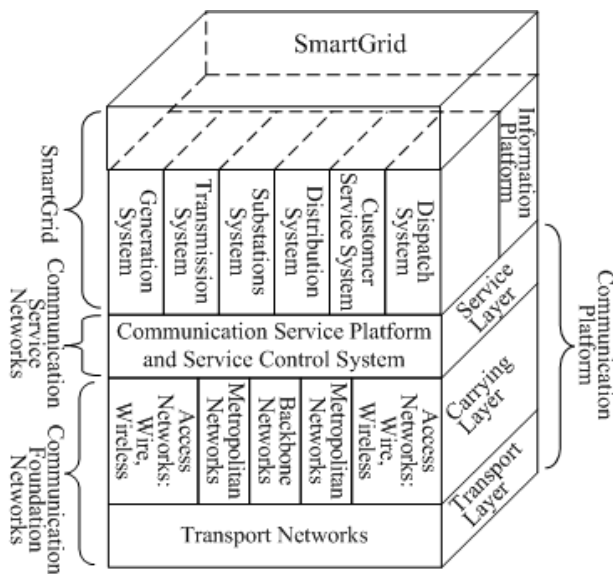


Fig.5 Standardization conceptual model of Smart grid communications technology standards frame

The communications platform support and the service Smart Grid, manifests specifically in supporting and the service electricity generation, the electric transmission, the power transformation, the power distribution, the customer service, the dispatch and so on six links and the information platform.

The related core standard example, see Table 1.

Table 1 The example of related core standards

	service network		foundation network	
ITU	G.9960	G.703 G.8011	G.811 G.812 G.813	G.823 G.651 G.652
IEC	62351	61850 Suite	61588	60794
IETF		RFC 2460	SNMP	
IEEE	P1901	802Family	1588v2	
NIST	7628			

CONCLUSION

The establishment support Smart Grid communications standard frame is essential.

Looking from the electric power profession each kind of property's operation service life angle, the corresponding Smart Grid 1 generation service life cycle, needs to construct 2 to 4 generations of communications system successively. Therefore, the support Smart Grid's communications standard system's renewal iteration, must each kind of property service life match with the Smart Grid.

The Smart Grid reliability proposed to the communications network reliability requests high. The Smart Grid standard system and the communications network standard system must match, and the renewal iteration needs the coordination.

Supports the Chinese Smart Grid's communications

standard system mainly to include the security and the environmental protection standard, the foundation and the synthesis standard (including technical standard, management standard and working standard), the engineering construction standard (including reconnaissance, design, construction and installment, acceptance test standard), the operation and the inspection standard, the equipment and the material standard. May divide according to the standard regulatory document is: Compulsion standard, recommended limit and standardization guidance technical paper.

The following relative plot has enumerated 8 aspects which the communications standard system needs to balance. It is namely openness, compatibility, interoperability, cooperativity, logicity, security, economy, efficiency. For example, openness and the security must balance are coordinated the proper attention to both, avoids mutually contradictory. Proposed Smart Grid communications specialized standardization conceptual model including transport layer, carrying layer and service layer.

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