UPIoT Intellisense Laboratory Scenarios

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Abstract: To improve the quality of intellisense facilities, UPIoT intellisense laboratory, the very first lab of UPIoT field, is found. The principles of laboratory including standard test, defined procedure, transparent process, shared information, open construction and international practice. Based on the principles, five main research directions are confirmed. The omnibearing performance verification of intellisense facility and performance criterion and verification of new facility are the cores of laboratory. The laboratory is the quality control basis of UPIoT.

1. Introduction

On 2019 State Grid working conference, the new era strategic target is proposed based on the integrative development trend of energy revolution and digital revolution. The strategic target is to construct world first class energy internet and "three types and two networks” enterprise [1-2]. Intellisense facilities are important basis and core of UPIoT to gather and transport energy, sense full elements of customers and equipment, and get through business [3-5]. However, the actuality of intellisense facility is far away from UPIoT demand. The main problems are as followed.

1.1 Quality Control Shortage
Because of immature technique or technical engineering issues about design, manufacture, debugging and so on, the measure accuracy, transport patency, reliability and stability of intellisense facility are poor. For new intellisense facilities, the characteristics and criterion of performance are lack. It's hard to put forward index requirement to manufactures so as to control facility quality. The states of operational intellisense facilities are out of monitor. The on-line rate, warning timeliness ratio and accuracy can't be guaranteed.

1.2 Purchasing Gist Lack
With the development of UPIoT, large numbers of intellisense facilities are to be purchased. Faced with various products, relevant departments are short of comparing gist, judging rules and usage monitor of facilities. It leads to lack of intellisense facilities purchasing gist.

1.3 Weak Ability of Data Analysis
Full types of data and facility information, including facility state, environment information, grid state and so on, are transported to master station by intellisense facilities. It's difficult to thoroughly dig out
hidden value of grid big data depends on existing data analysis ability.

2. Idea And Policy
The target of UPIoT intellisense laboratory is to strengthen source control and serve back request. The main idea of laboratory is to reinforce sensor quality control of UPIoT sense layer, to deepen multi-dimensional analysis of sensing data, and forge sensor test lab and data analysis lab. So that the laboratory can effectively support facility choice and data analysis and application, and guarantee the test result is authoritative, objective and justice. Eventually, the laboratory helps to tamp the basis of UPIoT quality control.

2.1 Forging Principle
(1) Standard test
Criterion is in advance. Against various new sensors, testing criterion is formulated term by term, so as to provide testing gist for verification.

(2) Defined procedure
Sensing facility management is defined, including commissioning registration, test and verification and function identification. The operation procedure is solidified, the management system is improved, and the compliance management of lab is enforced.

(3) Transparent process
Abide by justice, open and fair, the implement of supervision measurements including full-vision real-time monitor through testing is intensified. So as to establish the authority of verification and maintain the justice of laboratory as an independent organization.

(4) Shared information
Information collection and share, data analysis ability and tackling key technique of calculation and analysis are strengthened. Multi-dimensional analysis of sensing data including facility state, environment information and grid state is deeply launched. So that strongly support the study of sensor hardware and software.

(5) Open construction
Obey the trend of open and sharing development, and adhere to dispark, cooperation and win-win, the cooperation with social laboratories and research organizations is deepened. The laboratory innovates and studies with open mind.

(6) International practice
The information collection is enhanced. Same type international frontier laboratories are benchmarked. The gap of technique, equipment and system are seek to make up in time, improve the test and analysis abilities of laboratory.

2.2 Research Direction
(1) Access test
In addition to traditional online monitors, response to new request for new sensors and test objects is a research emphasis. The study includes technical standard formulation, detection principle definition, staff and device requirement, test environment simulating actual situation set up, and convenient usage on scene.

(2) Casual inspection
Casual inspection rules are improved, and the process management, including casual inspection plan, inspection of incoming merchandise, facility test and so on, is strengthened. So as to guarantee orderly casual inspection and justice results.

(3) Diagnosis and analysis
Based on qualitative test and contrastive analysis, various facility quality problems are dissected deeply. Thus, invitation for bids, purchase, operation and maintenance of facility are supported.

(4) Key technical problem tackling
Investments of hardware and software are increased. For hardware, the study of new sensor is
reinforced by cooperating with research institution. For software, the study of data analysis algorithm based on sensor acquisition technique is launched thoroughly. And the multi-dimensional analysis combined with operation data is boosted.

(5) After-end service
According to access test, casual inspection and operation of sensors, the performance and technical level of facility are judged impersonally to guide later supply invitation for bids and purchase. Equipment operation, maintenance and management and request analysis are undertaken, so as to further prop up business conduction.

3. Forging Content
Obey above ideas and policies, there are five main forging contents for UPIoT intellisense laboratory.

3.1 Omnibearing Performance Verification of Intellisense Facility
Performance verification system of intellisense facility is set up according to UPIoT framework. The system has 1 master station and 24 substations. The system framework is shown in figure 1.

![Figure 1. System framework](image)

The substations located at three different lab bases are integrated organically and managed uniformly by the system. The verification data are transmitted to the master station data center uniformly. In addition to data acquisition performance verification of sensors, the uniformity of communication protocol and accuracy and stability of data transmission are also verified. By
establishing micro UPIoT ecotope, real working procedure and environment of sensors can be formulated actually. The verification process and data transmission path are shown in figure 2.

![Figure 2. Verification process and data transmission path](image)

The verification objects can be divided into 4 types, primary equipment state monitor, distribution network experimental validation, environment monitor and inherent characteristic of facility. In detail, primary equipment state monitor includes oil chromatography, infrared thermography, TEV, ultrasonic PD, UHF PD, HF PD, mechanical properties of switch cabinet, leakage current of arrester, dielectric loss of capacity, grounding current of iron core, vibration and so on. Distribution network experimental validation contains fault indicator, TTU and so on. Environment monitor covers lockage, gas concentration, temperature, humidity, air pressure and so on. Inherent characteristic mainly aims at smart robot, UAV, video surveillance, smart lockset, aggregation node, access node and so on.

Test rules are formulated according to facility type. For example, because primary equipment state monitors are important and expensive, all monitors have to be verified before operation, and the operational states have to be followed. While, for environment monitors, the test rule is casual inspection due to less importance and cost and larger amount.

The Plant-wide control of intellisense facility verification is realized by the performance verification system. The control covers task management, sample registration, test object issue, performance verification, results analysis, reports present and so on. Every sample has a whole process record to display its verification schedule visually. Detail information of every link is shown in the record. The system is set up and operated according to lab approval criterion of CNAS and CMA. The operation mode and procedure of laboratory are specified, containing organization chart, staff, system document, test device and standard material management and so on. Furthermore, test data are multi-dimensional statistical analyzed and displayed by the system.
To realize transparent process, and control sample state and real-time test situation of substations, a full-vision real-time monitor system is set up. By combination of real-time test data and full-vision monitor scene, standard and transparent verification process is guaranteed, and valid data caused by human factor is excluded. What’s more, the monitor system is one of display forms of laboratory building concept, and it shows that the nature of lab is quality control.

3.2 Performance criterion and verification of new facility
Performance characteristics and property data of new sensor under actual working environment are studied. By combination of performance and application request and technology development, performance criterion of new facility is put forward. Based on the criterion, verification method, test device and corresponding standard are studied, so as to normalize verification. For example, the performance criterion of smart power well lid is accomplished, and the verification is undergoing, as shown in figure 3.

![Figure 3. Performance criterion of smart power well lid](image)

3.3 Full-life-circle performance control of intellisense facility
The data and communication interface of performance verification system are opened so that the system can be interconnected with other business platforms, such as PMS 2.0 and so on. The verification data and operational data of sensors are shared. The verification data are used to correct the operational data so as to eliminate wrong judgement about primary equipment state caused by inherent error of sensors. The sensor state is followed on time by monitoring its operational data. With data accumulation, the full-life-circle performance curve of same type facility can be excavated by big data technique. So that the performance inflection point can be pre-judged, and transfer terminal verification into state verification. For breakdown facilities, diagnosis test is present to analyze fault reason, and realize full-life-circle performance control.

3.4 Research of new sensors
According to UPIoT scenarios, high-precision, high-integration, low-consumption and miniature new intellisense facility is studied by the laboratory. For instance, several types of sensor data, such as video, infrared, PD, humiture, noise and so on can be integrated into one facility. Thus, the cost of sensor can be decreased a lot, while the sensor reliability is improved, and the data amount for multi-dimension analysis is increased by high integration. Various types of data can be acquired, and unstructured data can be preprocessed by edge computing. Abnormal pictures of substation, infrared imagery and data of micro-consumption PD sensor are processed locally, as shown in figure 4.
3.5 Multi-dimension data analysis

With the operation of laboratory, large numbers of data are accumulated, including verification data, collection data, grid operation data and so on. The value hidden behind data is excavated by advanced technology, such as big data, cloud computing and AI. For devices going to be operated, the performance and unqualified reasons are analyzed so as to provide gist for facility model selection and call for bids. For operating facilities, the operating characteristics and performance decrease inflection point are analyzed to provide data for pre-maintenance. For primary equipment state, multi-principle sense data of various time and space are analyzed to support state diagnosis.

4. Conclusion

UPIoT intellisense laboratory is the very first lab in UPIoT field domestically. The target of laboratory focuses on sense layer quality control. Through above forging content, following goals are to be realized.

(1) Omnidetecting performance of all types of intellisense facility is verified.
(2) Full-life-circle performance of intellisense facility is controlled.
(3) Performance criterion, verification method, test device and corresponding standard for new intellisense facility are present and developed.
(4) Core sensing technology is tackled. And UPIoT quality assurance system is set up.

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