国家电网公司
STATE GRID
CORPORATION OF CHINA

Life-cycle Quality Monitoring of Smart Meter and "Internet Plus Metering" Platform based on Big Data

Metering Department
China Electric Power Research Institute
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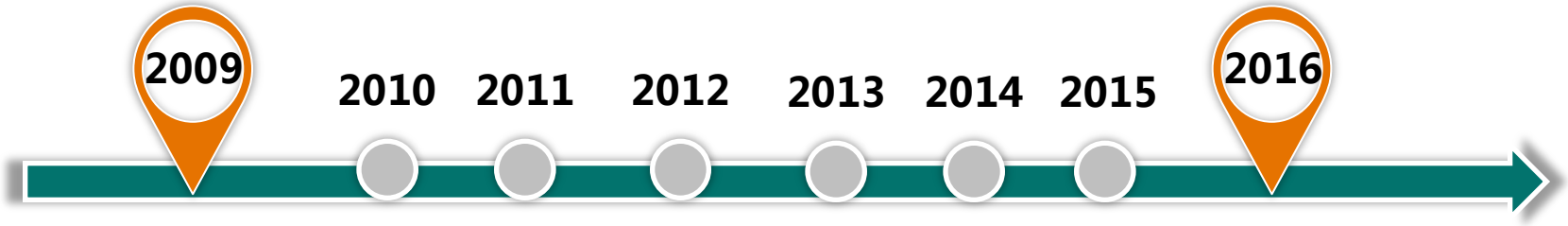
1. Life-cycle Quality Monitoring

Background



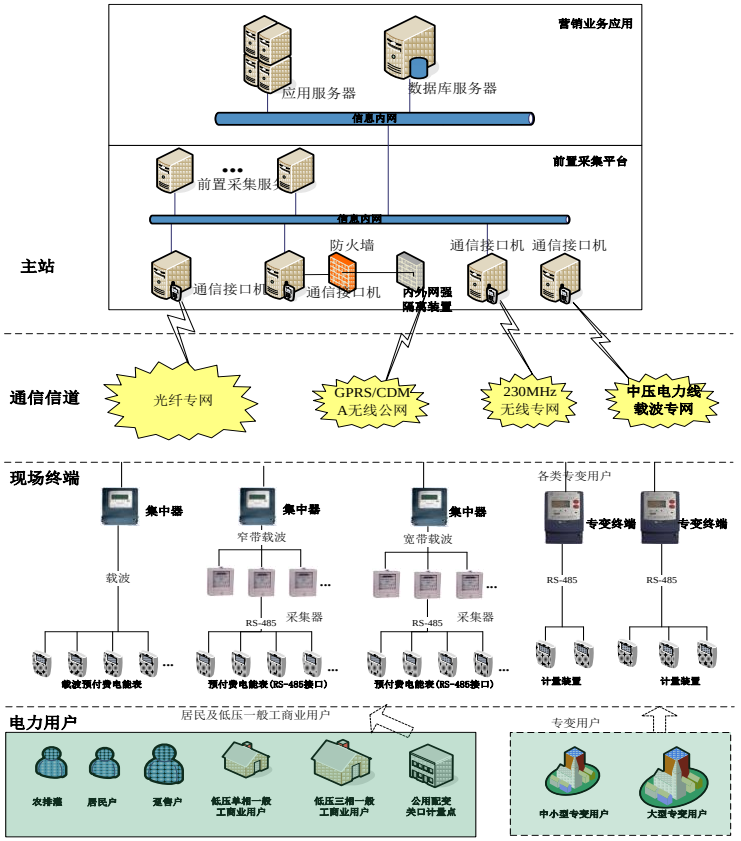
SGCC have been establishing the AMI system since 2009.

Data Concentrator
11.93 million

Smart Meter
370 million

Coverage Rate
87.30%

Success Rate
98.55%



1. Life-cycle Quality Monitoring

Achievement

Intelligent Calibration Workshop

Testing ability:
70 million
Automated rate:
90%

Testing worker:
30% lower
Testing efficiency:
10 times higher

The intelligent calibration workshop for measuring instruments is comprehensively constructed by technologies such as IOT, industrial robot, intelligent sensor and intelligent control. It is able to realize the automatic verification of electric energy meter and mutual inductor.

1. Life-cycle Quality Monitoring

Achievement

Measurement Dispatch System (MDS)

The overall vertical management and real-time control system of measurement business and data is comprehensively constructed by technologies such as precise perception, visualized monitoring and whole-perspective dynamic simulation.

1. Life-cycle Quality Monitoring

Smart meter

Life-cycle quality monitoring information tables of all procedures

Procurement

Demand amount
Actual amount
Bidding batch
Contract execution
Contract breach

Arrival

Full-inspection
Sample-inspection
Return
Exchange
…etc

Verification

Routine test
Casual test
Malfunction
…etc

Storage

Stock amount
Turnover amount
Meter age
Delivery Info
…etc

Installation

Installation time
Installation duration
Installation type
…etc

Operation

On-site test
Operating amount
Running fault
Operation age
…etc

Remove

Remove reason
Remove amount
Remove age
…etc

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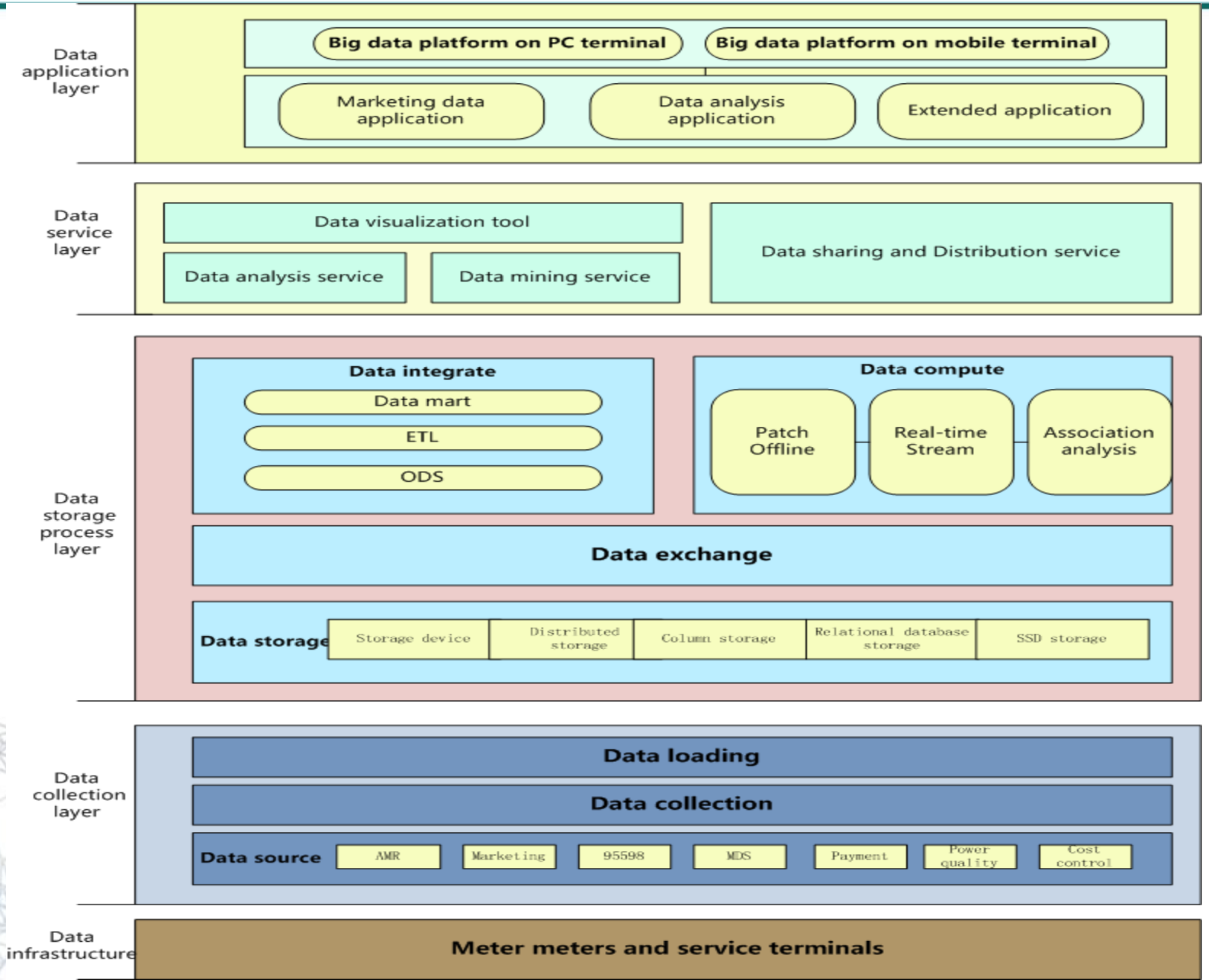
Infrastructure



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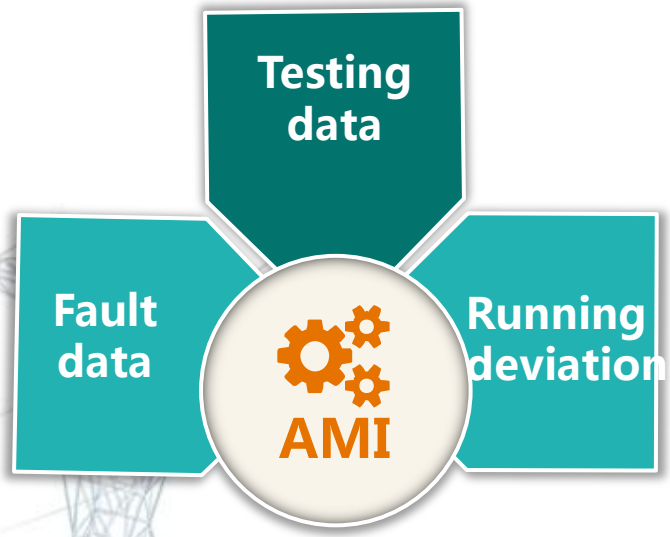
Available data scale:
500TB

Increment per year:
100TB



Testing data analysis

(1) Testing equipment usage
(2) Testing item completion
(3) Testing quality

Fault data analysis

(1) Fault distribution
(2) Fault rate evaluation

Running deviation analysis

least square method

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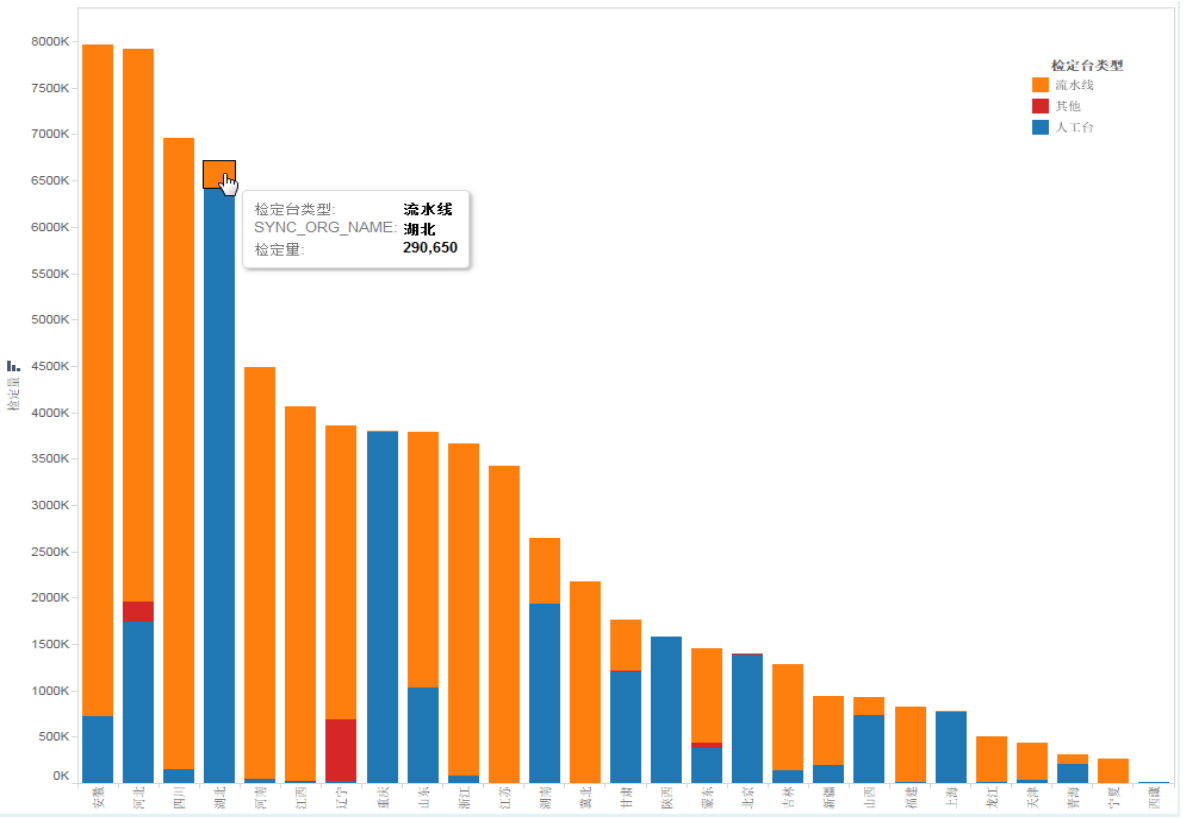
Example

Testing data analysis

Testing equipment usage



Up to 2015,

24 provinces implement pipeline in testing items.

17 provinces implement pipeline in 50% testing items.

4 provinces implement pipeline in 100% testing items.

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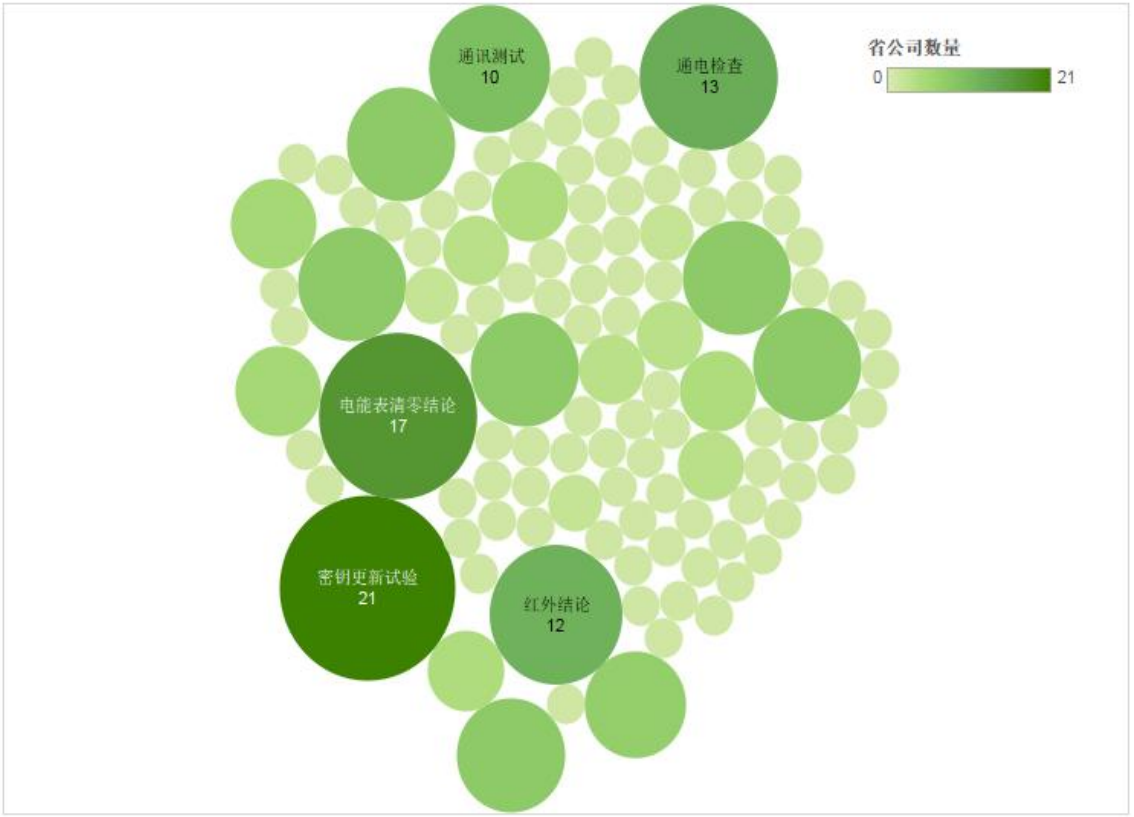
Example

Testing data analysis

Testing item completion



Besides of 7 necessary testing items,

50% provinces also implement some unnecessary testing items such as: security key updating , data clear, power connection check, infrared function.

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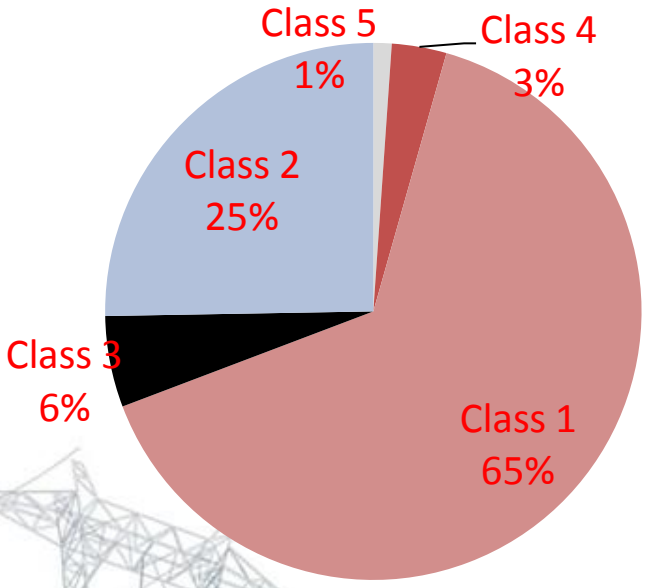
Example

Testing data analysis

Testing quality



91 suppliers are classified as 5 kinds by K-means algorithm on the basis of passing rate on 7 necessary testing items.

Class 1:High passing rate on every item.
Superior supplier.

Class 2: Relative high passing rate on every test.
Good supplier.

Class 3: Low passing rate on appearance test.

Class 4:Low passing rate on initiate test .
Component quality should be promoted.

Class 5: Low passing rate on 4 testing items .

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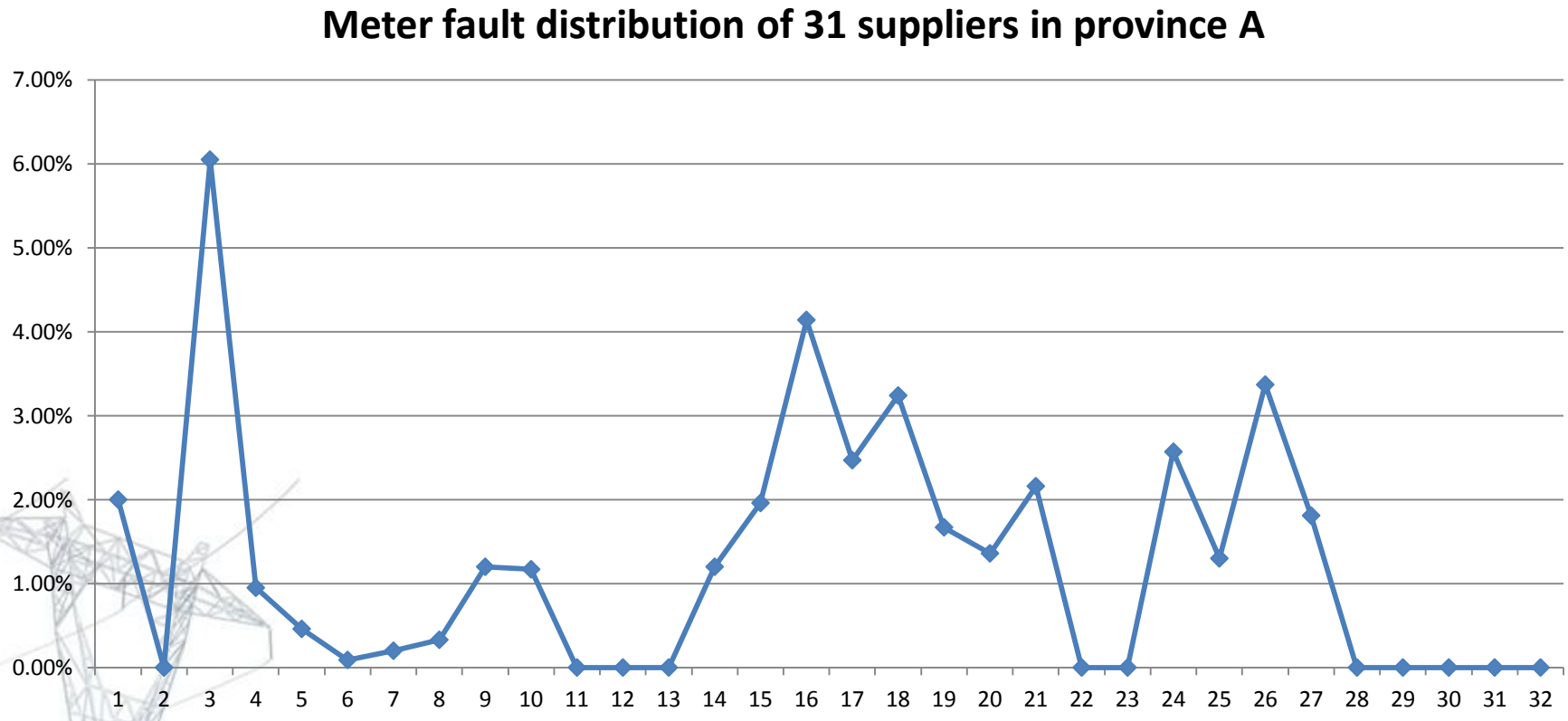
Example

Fault data analysis

Fault distribution



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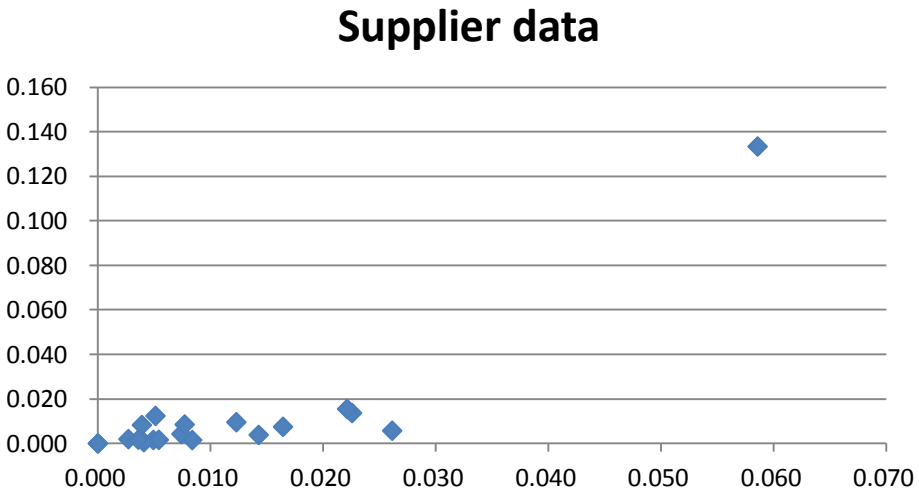
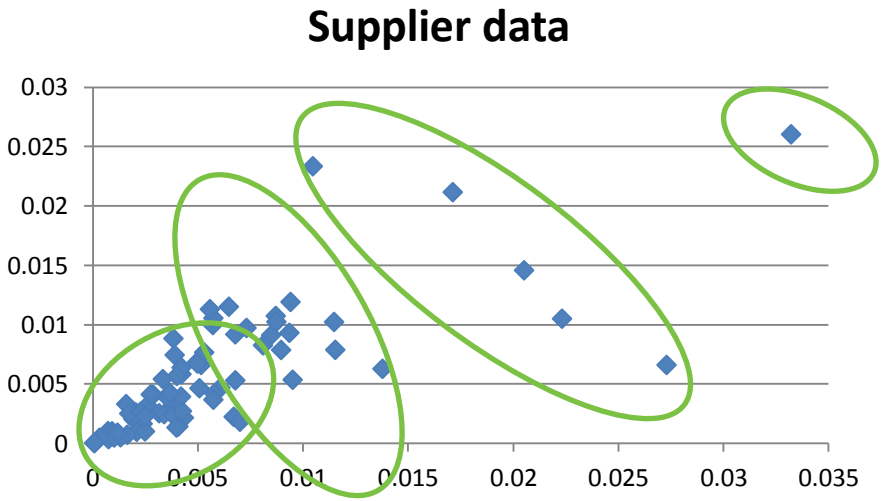
Example

Fault data analysis

Fault rate evaluation





Suppliers are classified as 4 kinds by K-means algorithm on the basis of fault rate of all on-site meters.

Class 1: Lowest mean and variance . Superior supplier.

Class 2: Relative lower mean and variance . Good supplier.

Class 3: Relative higher mean and variance.

Class 4: Highest mean and variance..

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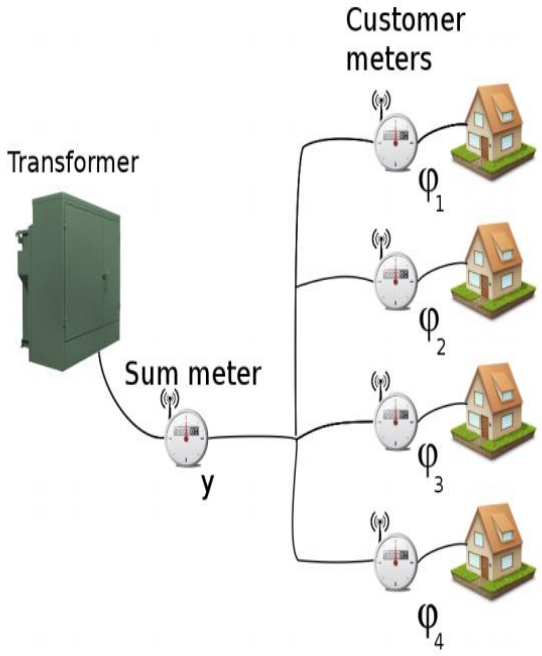
Example

Running deviation analysis

Topological structure



Multiple linear regression model

$$y(i) = \sum_j (1 + \xi_j)\phi_j(i)$$

$$y(i) = \sum_j \theta_j \phi_j(i).$$

$$y(i) = \sum_j \theta_j \phi_j(i) + \theta_0.$$

θ_0 ： Line Loss

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Example

Running deviation analysis

Multiple linear regression model $y(i) = \sum_j \theta_j \phi_j(i) + \theta_0.$

which j: meter serial number，θ: error parameter of meter

Matrix Expression:

$$\begin{bmatrix} y(1) \\ y(2) \\ \vdots \\ y(n) \end{bmatrix} = \begin{bmatrix} 1 & \phi_1(1) & \phi_2(1) & \dots & \phi_j(1) \\ 1 & \phi_1(2) & \phi_2(2) & \dots & \phi_j(2) \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & \phi_1(n) & \phi_2(n) & \dots & \phi_j(n) \end{bmatrix} \begin{bmatrix} \theta_0 \\ \theta_1 \\ \theta_2 \\ \vdots \\ \theta_j \end{bmatrix}$$

$$\theta = \arg\min \left\{ \sum_{i=1}^{n} [y(i) - y(i)_{Truth})]^2 \right\}$$

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Display

Display of testing data analysis

Characteristic

1. Deviation distribution of certified meter displayed with “Heat Map”.
2. Relations between suppliers and defective items displayed with “Chorus Map”.
3. Crosswise comparison on efficiency and pass percent of testing device displayed with “Tree Map”.

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Display

Display of fault data analysis

Characteristic

1 Trend of fault over time displayed with “Histogram Map”.

2. Relations between fault and abnormality displayed with “Hyetograph”.

3. Fault distribution of suppliers displayed with “Scatter diagram”.

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Display

The "Internet plus" idea is utilized to build the smart interactive service website, the "Power on Palm" app and self-service terminal. The social people livelihood service level could be promoted by convenient service such as real-time inquiry and remote recharge.

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Thank you