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# Smart Meter and Distribution Data Integration and Practices

**China Electric Power Research Institute**

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**Putrajaya, Malaysia, IERE Workshop**

**Nov 21, 2017**

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# 1. SGCC Distribution System

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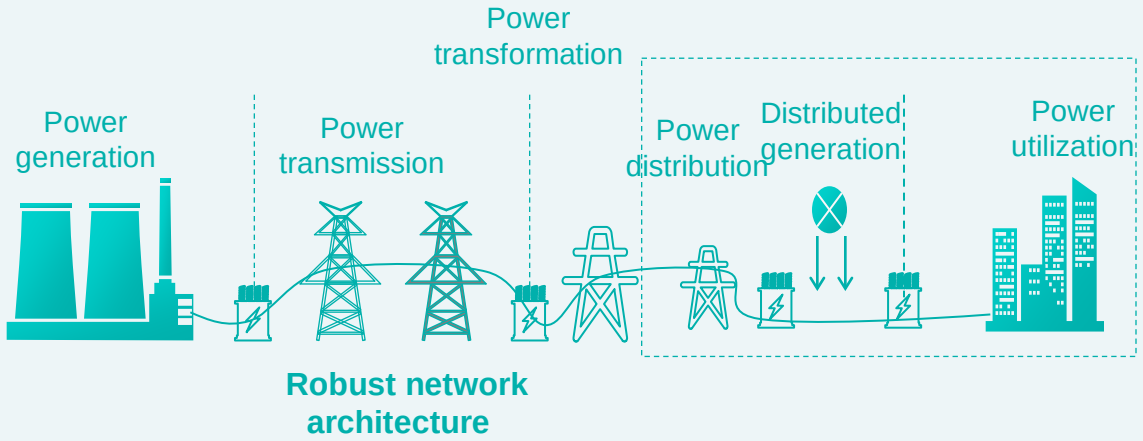
## Overview

The power distribution network plays an important role in the power grid. The State Grid Corporation of China (SGCC) attaches great importance to construction and development of the power distribution network, proactively promotes construction of power distribution network, enhances intelligence of the power distribution network, strengthen management of the power distribution network, and continuously improves the reliability of power supply.



# 1. SGCC Distribution System

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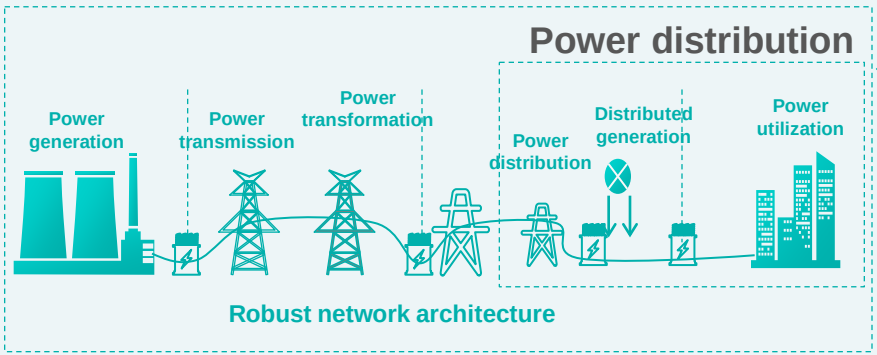
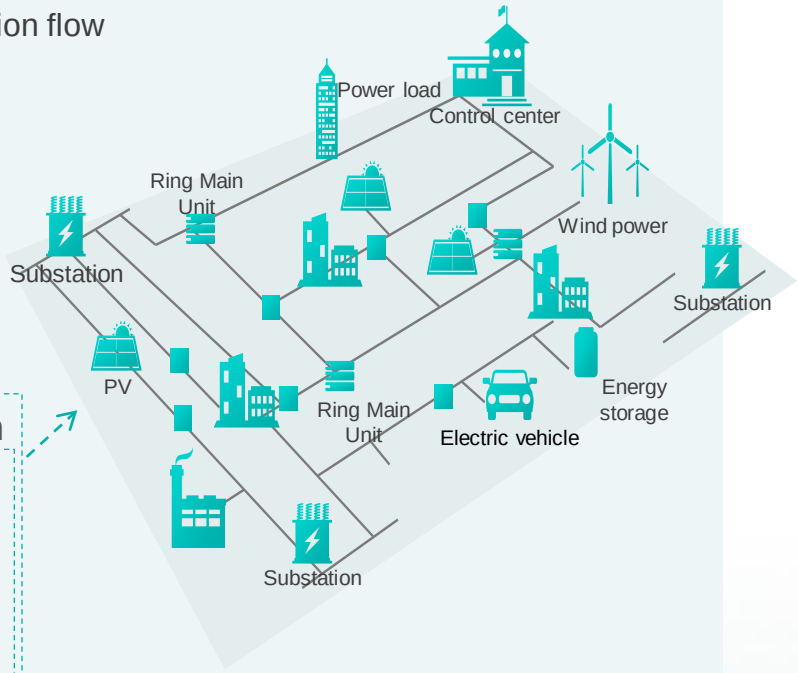
## Overview

### Characteristics of the power distribution network:

- Large scale, complex structure, and wide coverage
- High integration of the information system and physical system
- Convergence of bi-directional energy flow and information flow



# 1. SGCC Distribution System

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## Overview

By the end of 2016, SGCC has 293,000 power distribution lines of 6 kV to 20 kV, spanning over 3.657 million km, including aerial lines covering 3.169 million km and cable lines covering 488,000 km. There are a total of 4.075 million distribution transformers with the total capacity of 1.09 billion kVA, and 3.488 million switches including 738,000 pole-mounted switches.

| Project | Line Length (km) | Transformer Capacity (MVA) | Quantity (Set) |
|---|---|---|---|
| Urban | 689,715 | 466,385 | 2,280,634 |
| Rural | 2,967,623 | 623,216 | 1,207,699 |
| Total | 3,657,337 | 1,089,601 | 3,488,333 |

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# 2. Industry Situation & Trends

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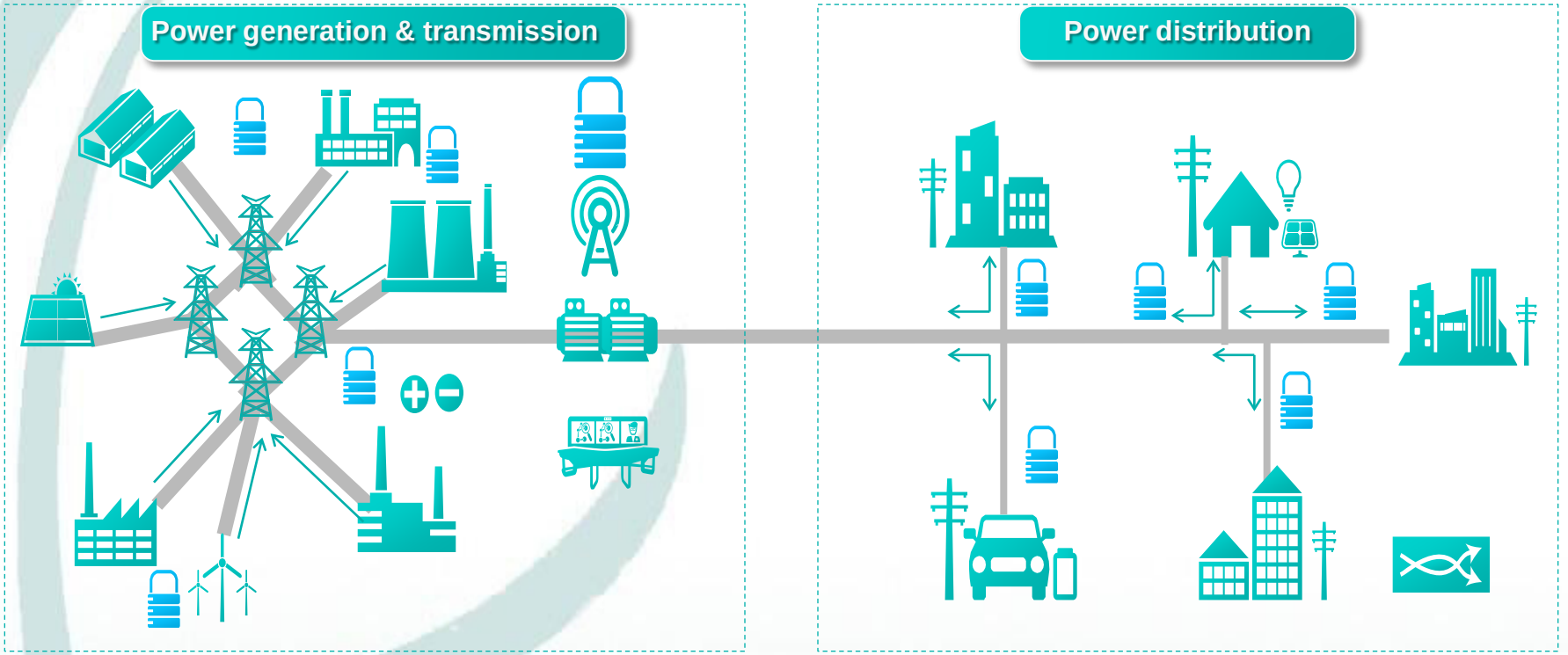
## Integrated grid




Source: EPRI

# 2. Industry Situation & Trends

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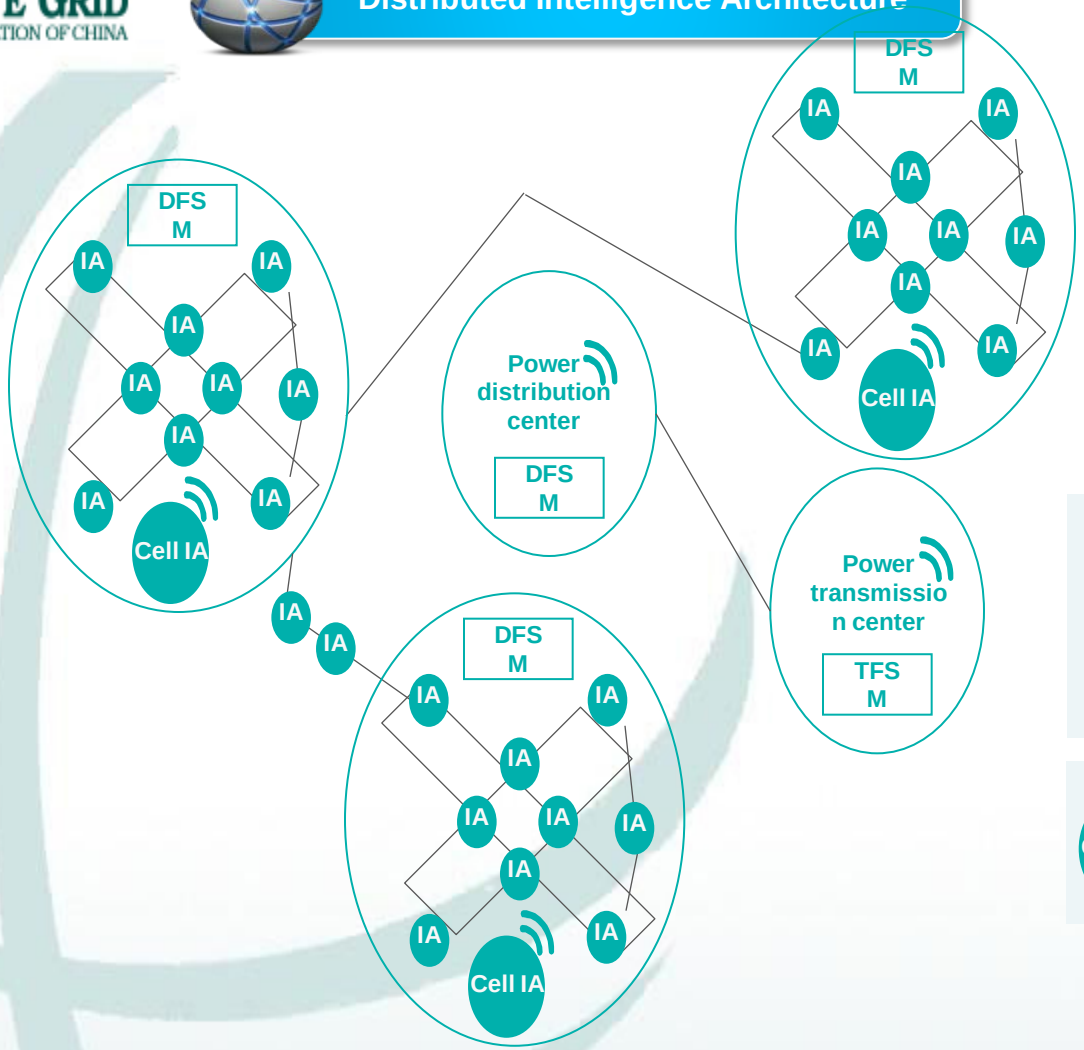
## Distributed Intelligence Architecture



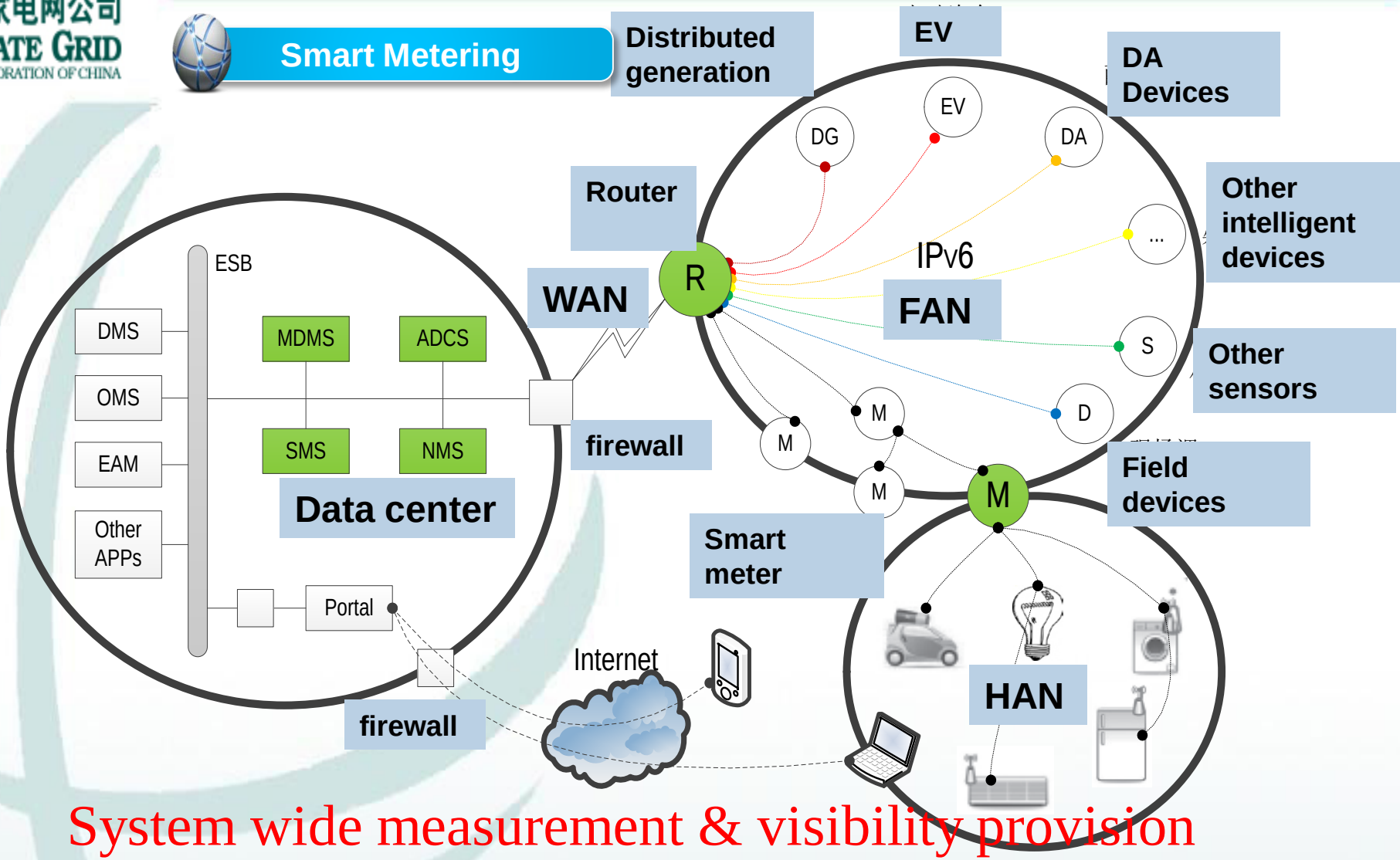

- Edge computing
- Sensors and AI
- Cloud edge coordinated operation

IA Basic intelligent agent that can send and receive signals, including power generation protection, distributed power generation, energy storage unit (ESU), power distribution scheduling with distributed power, and check-in machines

Cell IA DFSM Intelligent agent of power distribution

Source: EPRI

# 2. Industry Situation & Trends




System wide measurement & visibility provision

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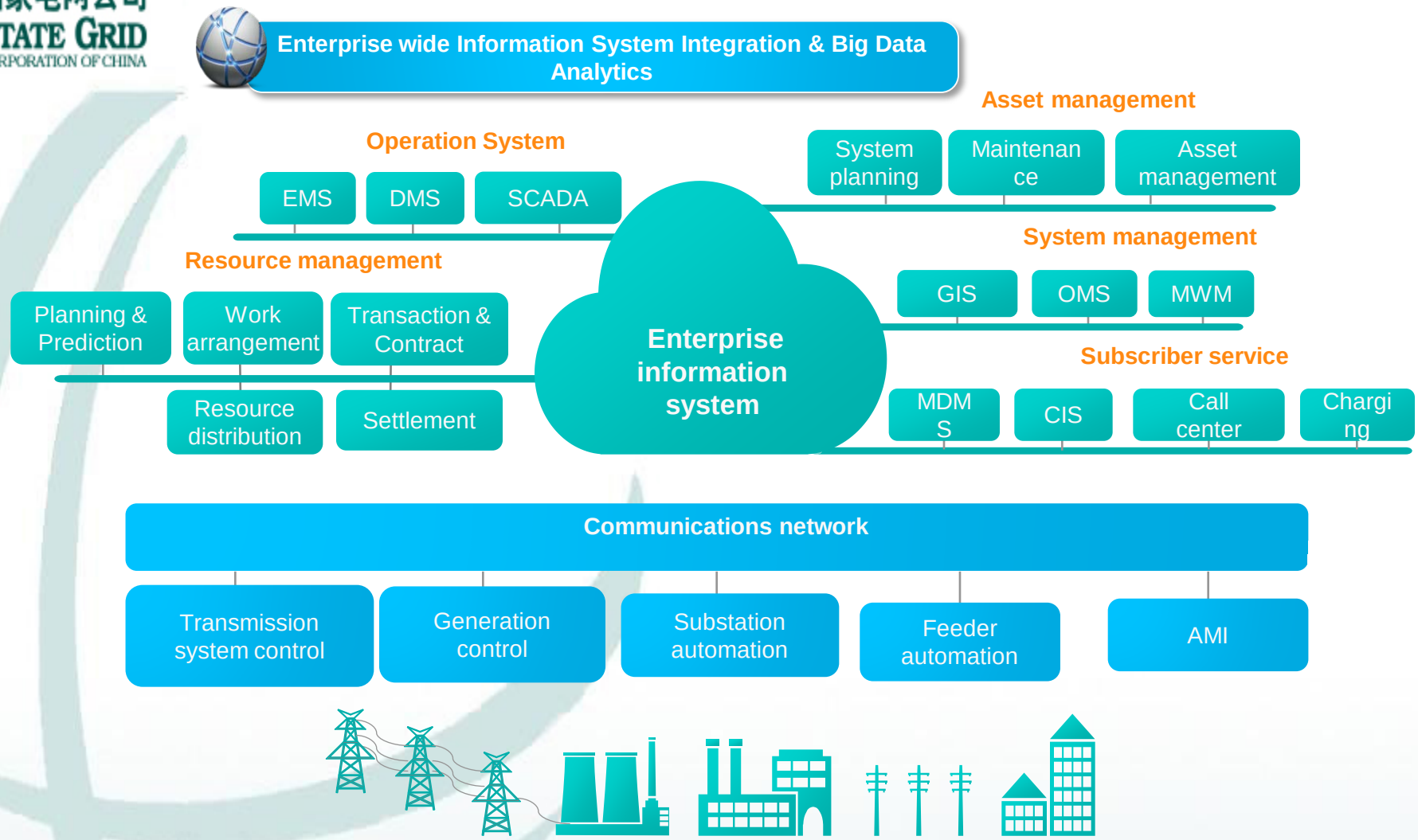

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# 3. Metering & Distribution Data Integration

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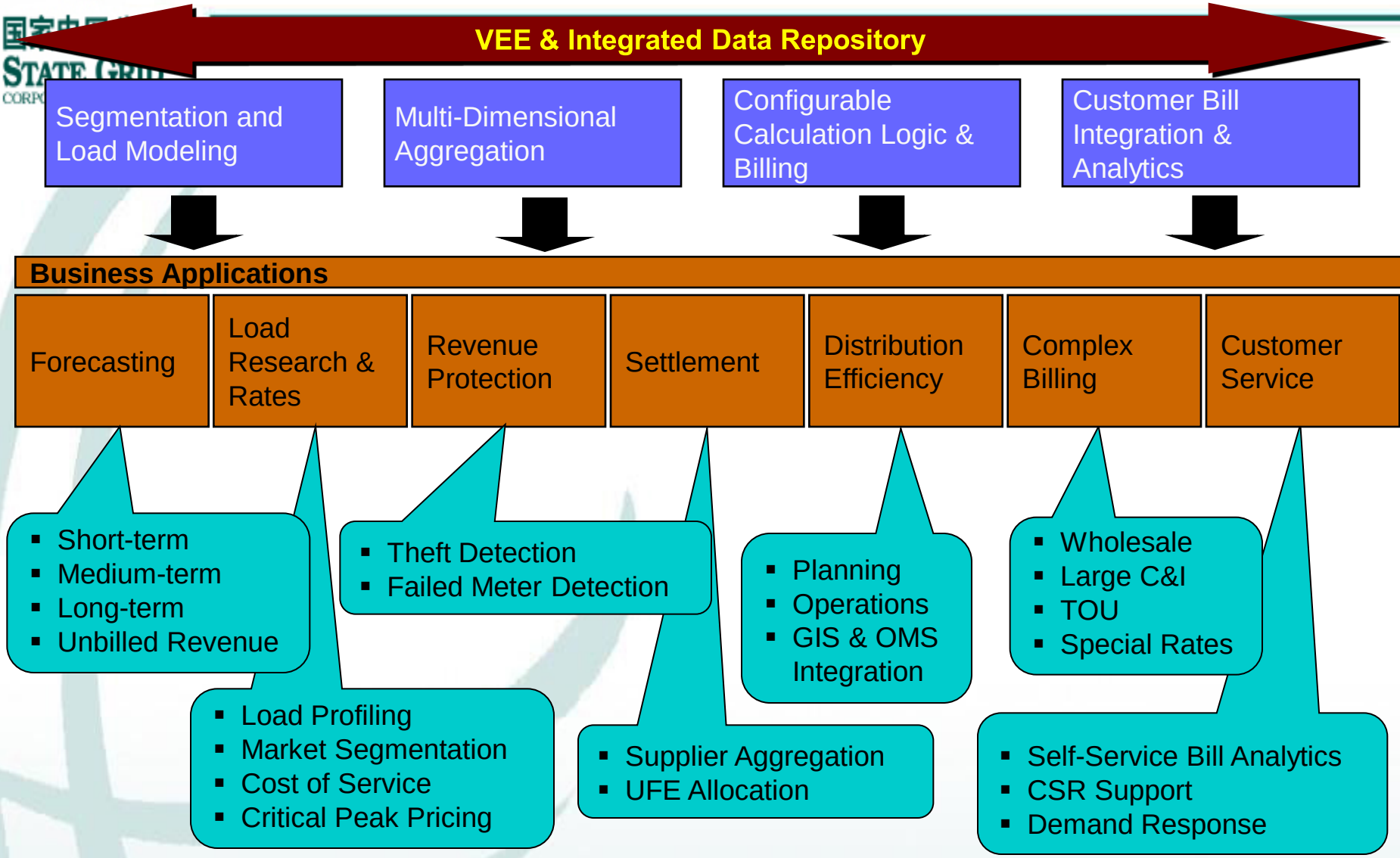
## Beyond Metering

- Smart meter
  - Smart grid sensor at end of distribution network
  - Connection point of customer and power company
  - Enabling technologies

**Smart Metering + D-SCADA**


# 3. Metering & Distribution Data Integration



# •3. Metering & Distribution Data Integration

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## Data Analytics

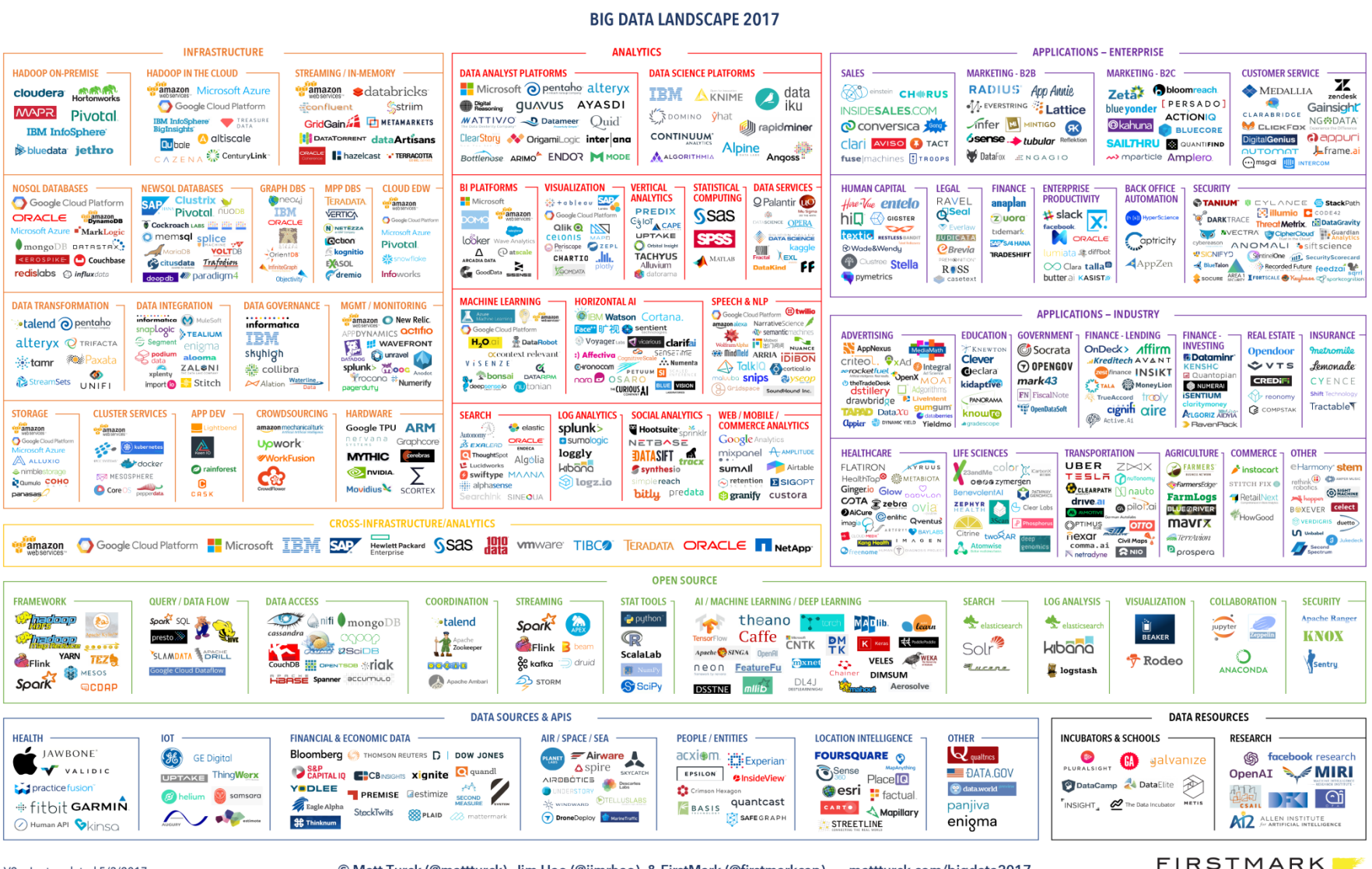
### By target:

- Customer analytics
  - ✓ Meter data analysis; demand correspondence; customer types
- Asset Optimization Analytics
  - ✓ Substation management; transformer management
- Grid Optimization Analytics
  - ✓ Energy quality management; distribution management; fault management; transmission management

### By characteristics

- Descriptive analytics: analysis of past information, explanation of past scenarios
- Predictive analytics: analysis of the future
- Prescriptive analytics: recommended optimization programs

# •3. Metering & Distribution Data Integration



# •3. Metering & Distribution Data Integration

- **Distribution network topology model**
  - **Auto-generate secondary network branch parameters**
  - **System topology and connectivity verification**
  - **Device phase detection**
- **Overload detection**
  - **Guide transformer and asset upgrade**
  - **Overvoltage detection**
- **Nontechnical loss detection**
  - **Energy theft detection**
  - **Abnormal meter detection**

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# 4. Data Analytics & Applications

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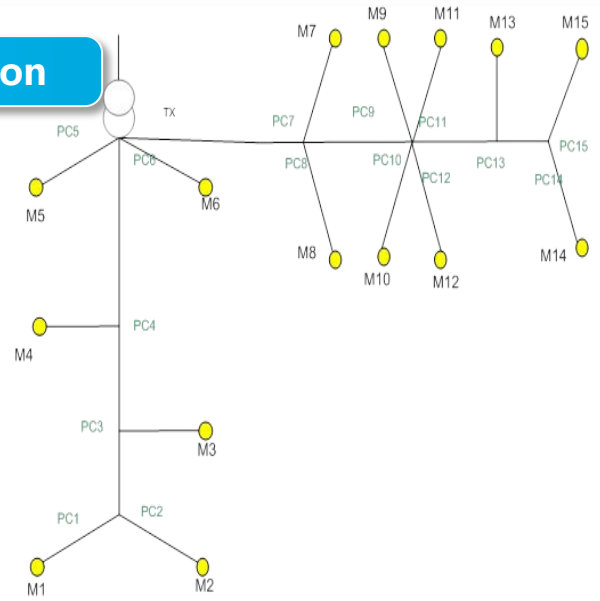
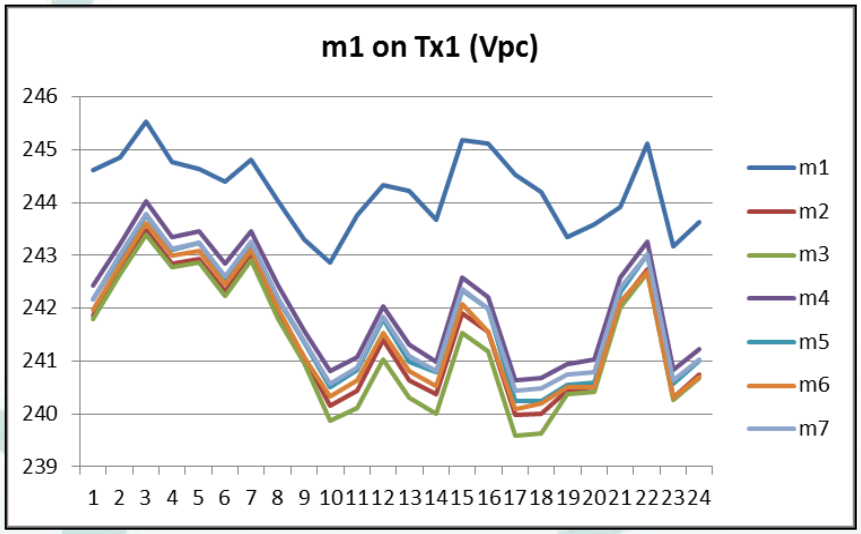
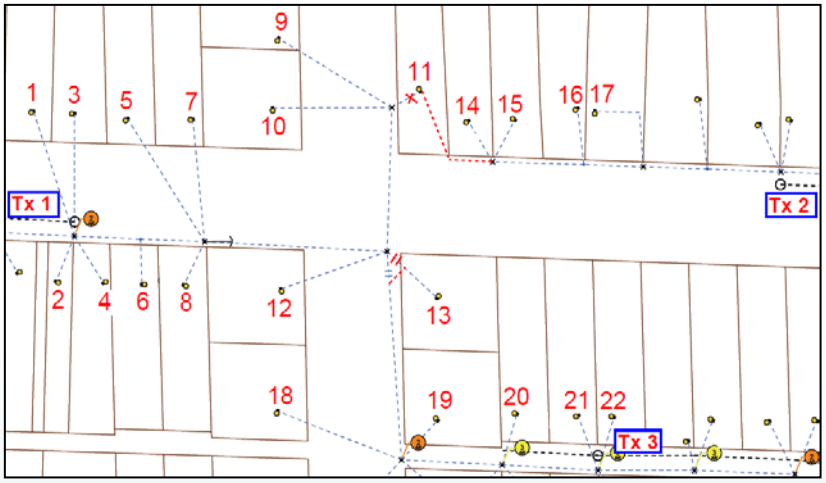
## Network topology generation & verification

- **Based on meter， GIS， & SCADA data analysis**
- **Meter-transformer-feeder connectivity**
- **Transformer & feeder phase**



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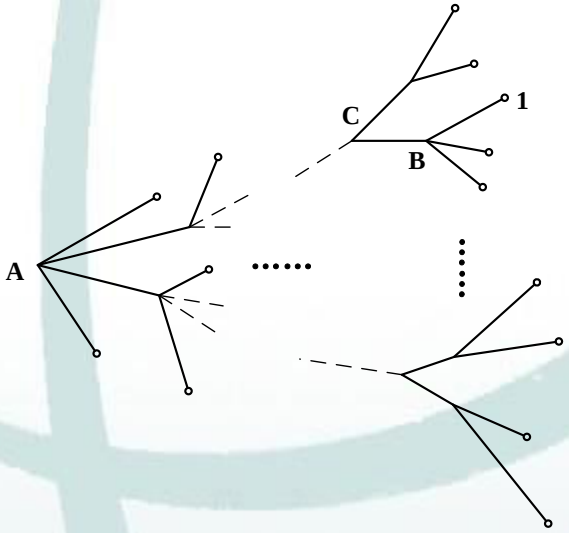
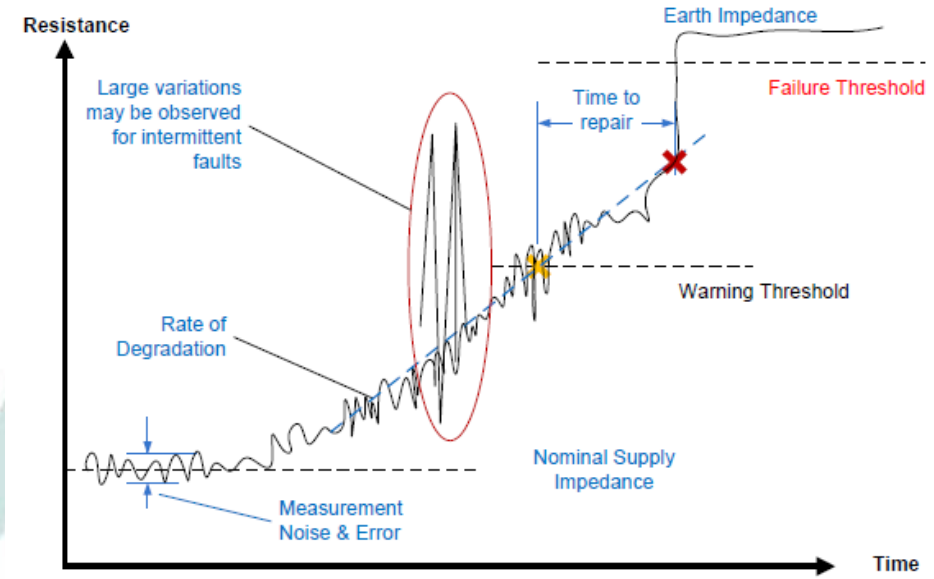
## Secondary circuit parameter generation

- Using smart meter interval data and GIS to calculate branch impedance (R+jX)
- Circuit and device condition monitoring
- Assisting asset management



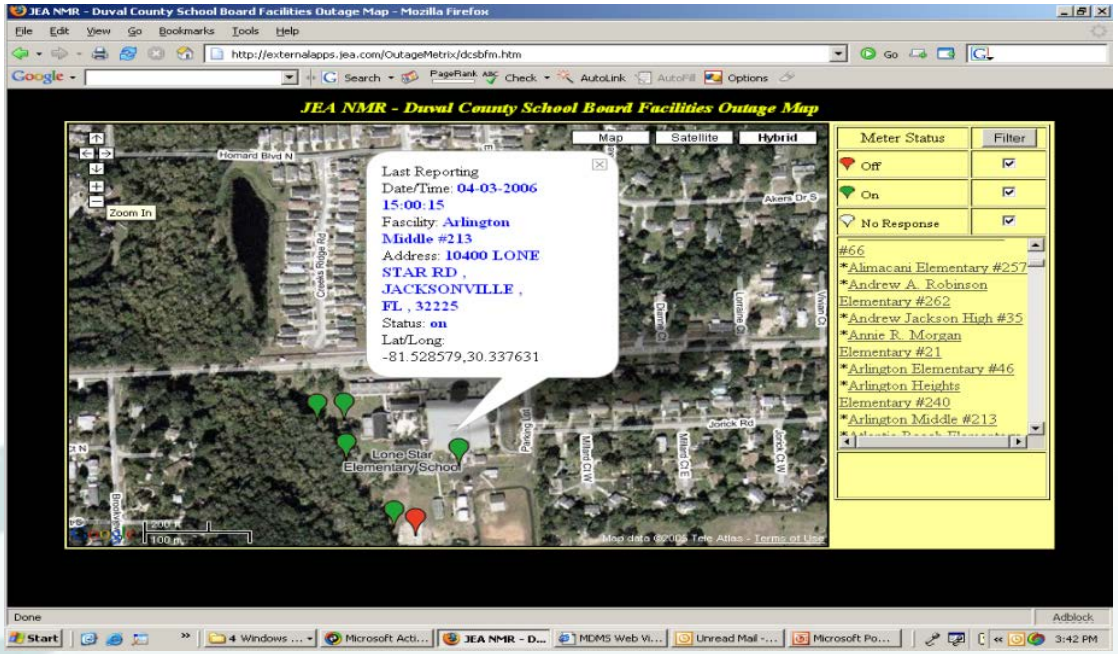




Source: Jemena

# 4. Data Analytics & Applications

## Outage response & restoration

- Last gasp/first breath
- On-demand read
- Customer call verification



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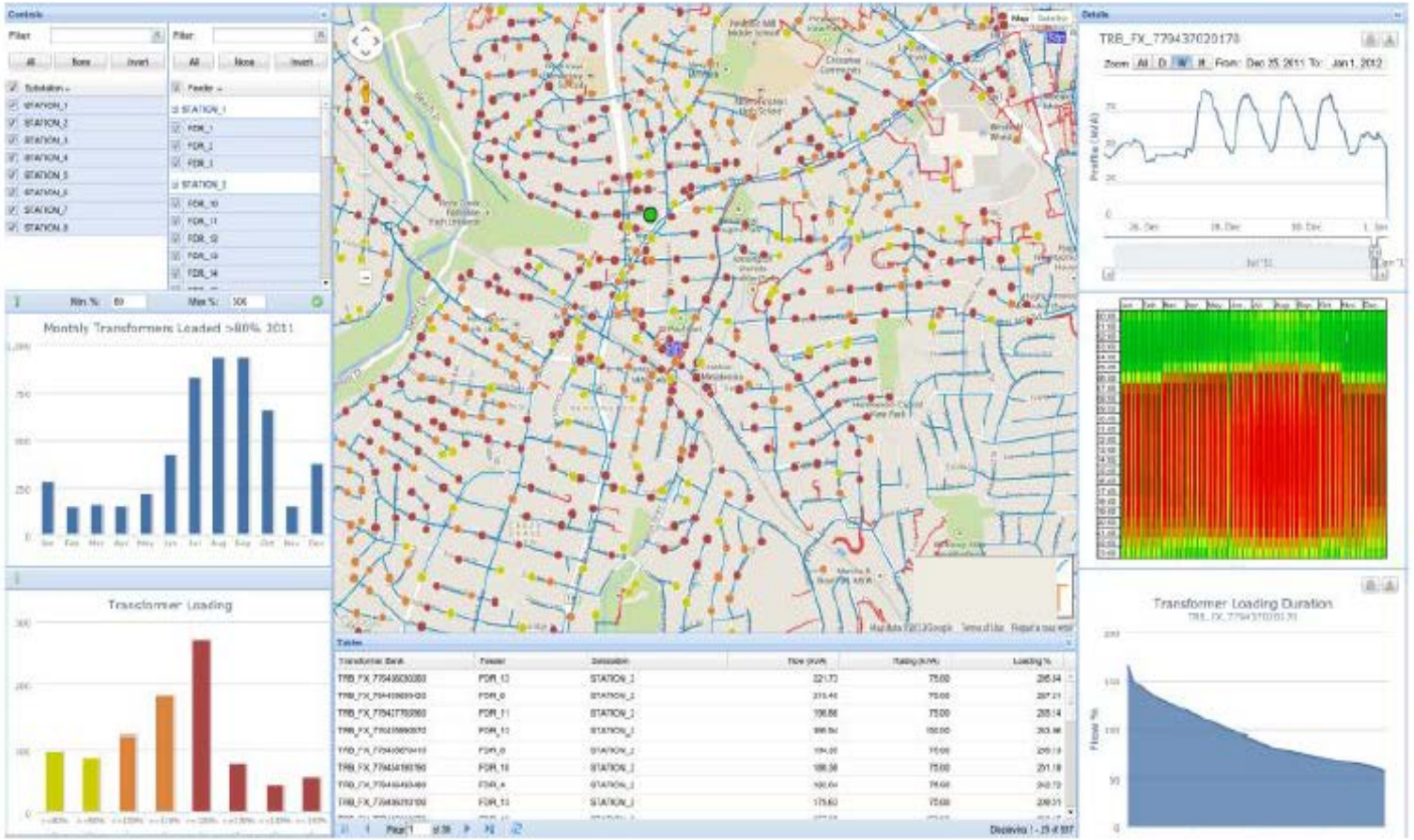
## Voltage and transformer load monitoring



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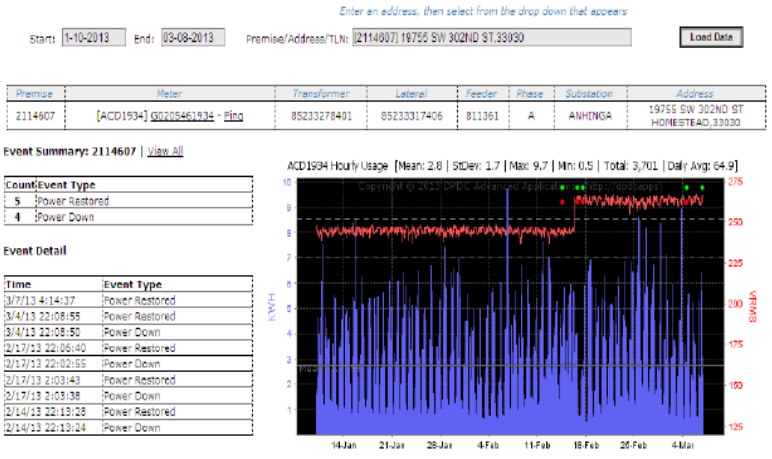
## Device fault prediction

- Transformer failure early prediction

**Using voltage information, FPL can proactively identify and replace transformers before they cause an outage**

**FPL is analyzing the history of each high-voltage transformer to identify the root cause**

### High-voltage Transformer Example




### High-voltage Transformer Replacement Program

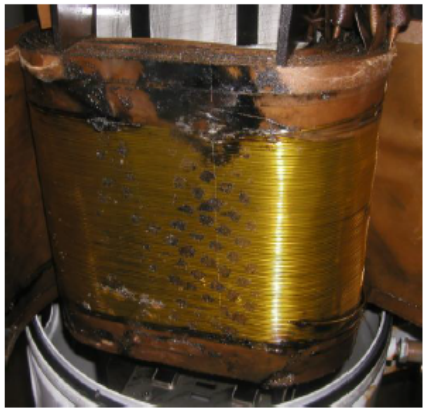
high-voltage transformers
tified in November of 2012

igh-voltage transformers
ently in the system

replaced since January

eting replacement of units
voltage above 252

ority of the units identified
more than 15 years old



Damage to primary winding of high-voltage transformer identified through smart meters

**Scheduled replacements reduce outage times by more than 93 minutes**

Source: FPL

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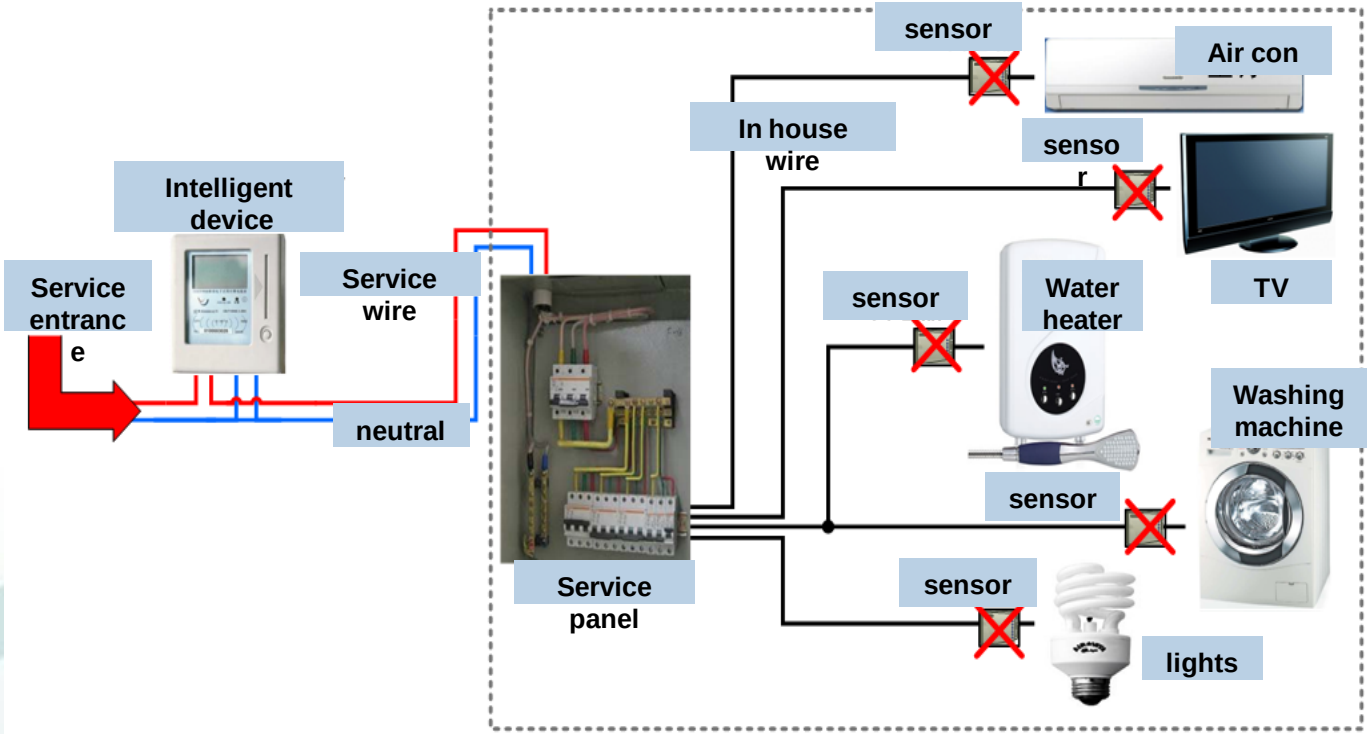
## Non-intrusive load monitoring

- Load modelling
- PQ monitoring and source identification
- Device condition monitoring
- EV and DG connection identification



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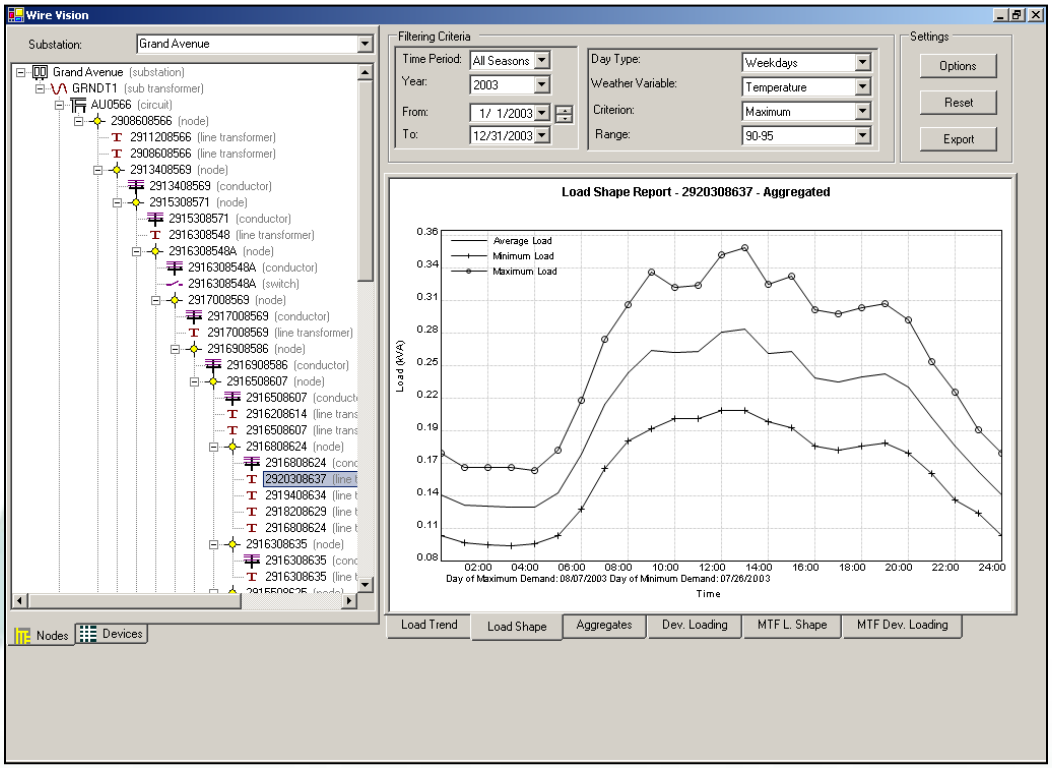
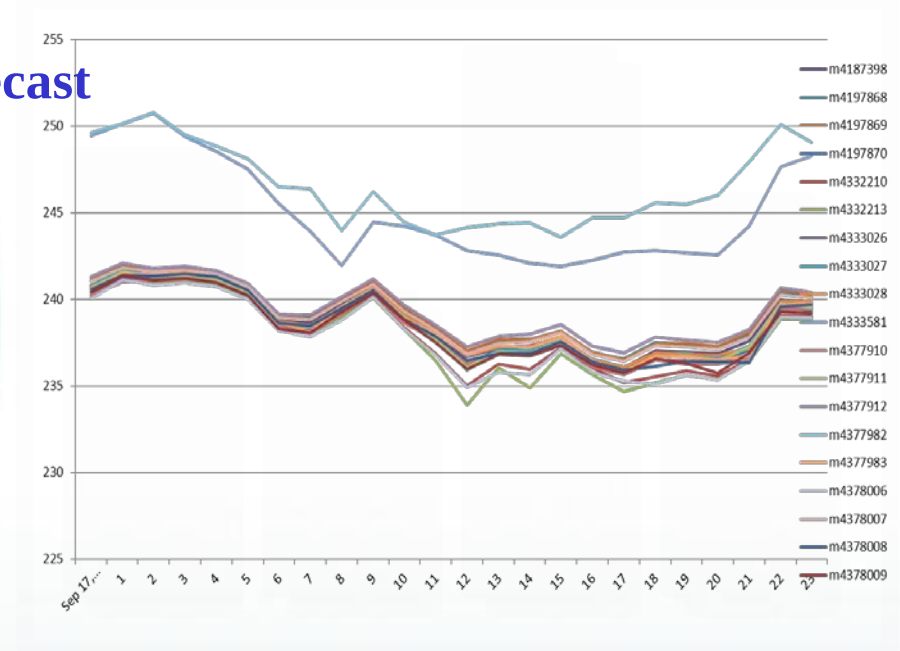
## Virtual metering to derive load profiles for any system point

- Optimize system improvement & capital investment
- Improve load balance and asset utilization
- System risk assessment
- Extreme weather response planning and resource allocation



# 4. Data Analytics & Applications

- **Combine GIS and grid measurements**
  - **Distribution station estimation**
  - **Loss analysis**
  - **Spatial load forecast**
  - **etc**



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# Thank You !