The 3rd generation Smart Meter Development Strategy of KEPCO

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ABSTRACT
Conventional smart meter has been developed basically focusing on functions for metering and AMI projects. The 3rd generation smart meter is a progressive technology that changes paradigm of customer management and smart meter operation innovatively by converging ICT and metering technologies. It is expected that the proposed technology can reduce smart meter production cost and improve the quality of customer service through research and development of three models; Multi Optional Smart Meter, AC·DC Smart Meter, The Smart Meter using Usim.

INTRODUCTION
The smart meter technology has been continuously developed with advancement of Smart-grid and AMI Projects. KEPCO firstly introduced electronic meters for power demand management in the 1990's, and after that KEPCO has diversified the functions of electronic meters such as Bi-directional metering, power quality management, etc.

However, conventional smart meters have focused on services for supplier (power utility) such as tariff scheme adjustment and demand management, not for customers. That is the reason why customers have not given preference to smart meters.

On the basis of convergence between ICT and metering technology, it is possible to provide various innovative services beneficial to customers. KEPCO has been developing "The 3rd generation Smart Meter" considering diverse power consumption pattern and extensibility of business field.

Table 1. Development of Smart Meter

<table>
<thead>
<tr>
<th>1G('90s)</th>
<th>2G('11~'15)</th>
<th>3G('16~)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic</td>
<td>Multi-function</td>
<td>Intelligent</td>
</tr>
<tr>
<td>WH, TOU, PF, Peak</td>
<td>RTP, Bi-directional, Diagnosis, PQ etc</td>
<td>Multi Optional AC-DC combination USIM Type</td>
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</tbody>
</table>

MULTI OPTIONAL SMART METER
The specification and production cost of smart meter vary considerably according to the type of tariff and service that would be applied to the customers.

It is enough for small-capacity customer such as households to apply basic functions for example active power and TOU, while various functions, for instance bi-directional metering and power quality measurement, would be required for large-capacity customers such as factories and large buildings. In addition prepaid meter is needed in the case of prepaid tariff.

Multi-optional Smart Meter refers the technology to customize smart meter according to customer type and power consumption pattern, and the first commercialized model that was applied to meter was function-added meter of Osaki (Japanese enterprise) which metering, communication, open-close sections are separated.

Multi Optional Smart Meter, inspired by Motorola's assembly smart phones, could be assembled and customized as occasion demands such as rate system, security, prepayment, etc.

It can be applied to both hardware (pre-payment, latch-switch, etc) and software (price policy, measurement option, etc)

Smart meter is module-type product in which optional assembling is possible, and it is planned to develop it as open-hardware type in order to add or modify functions according to variable condition in the future.
Table 2. MULTI OPTION SMART METER Module Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Functions</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Functions</td>
<td>▪ Metering/Measuring</td>
<td>▪ Receiving end active/reactive power, Peak, Power factor, AMR, Fault detection</td>
</tr>
<tr>
<td>S/W Module</td>
<td>▪ Tariff Scheme ▪ Metering ▪ Measuring ▪ Self-diagnosis ▪ O&amp;M</td>
<td>▪ TOU, CPP, RTP, OPP, etc ▪ Apparent power, Bi-direction, Receiving-direction, Lagging/leading reactive power ▪ Higher order harmonics, Sag/Swell, Average voltage/current, Frequency ▪ Wrong-wiring, Electronic seal, Over-current detection, Magnetic field detection ▪ Remote setting (rates, metering, measuring, self-diagnostics, etc)</td>
</tr>
<tr>
<td>H/W Module</td>
<td>▪ Tariff Scheme ▪ Load Switching ▪ Product Life Warranty</td>
<td>▪ Prepaid tariff (Keypad, AMI type, etc) ▪ Latch R/Y, Remote On/Off operation, Initial charging ▪ 10 years, 15 years, 20 years</td>
</tr>
<tr>
<td>Communication Module</td>
<td>▪ Comm. Method ▪ Integrated Metering</td>
<td>▪ Wire (PLC), Wireless (CDMA, RF, ZigBee, Wi-fi, etc) ▪ Metering module such as water, gas, heating (DLMS, etc)</td>
</tr>
</tbody>
</table>

One of the main advantages of the multi optional smart meters is sectional replacement in case of functional failure of the smart meter.

**AC/DC COMBINATION SMART METER**

Failures by defect elements such as LCD, CPU, memory occupy about 80% of total failures of electronic meters. In other words, DC parts that consist of combinations of electronic elements have much higher probability of causing failures than AC parts that consist of physical structures.

Table 3. Failure types of electronic meters in 2013

<table>
<thead>
<tr>
<th>Failure Types</th>
<th>Times</th>
<th>Proportion</th>
<th>Cause of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCD Fault</td>
<td>4,776</td>
<td>59%</td>
<td>CPU/Power element defect, soldering defect</td>
</tr>
<tr>
<td>Metering Info. Fault</td>
<td>1,047</td>
<td>13%</td>
<td>CPU defect, memory defect</td>
</tr>
<tr>
<td>Malfunction</td>
<td>567</td>
<td>7%</td>
<td>CPU defect, connector defect, soldering defect</td>
</tr>
<tr>
<td>Comm. Fault / Others</td>
<td>1,658</td>
<td>21%</td>
<td>Modem defect, connector defect, exterior defect</td>
</tr>
<tr>
<td>Total</td>
<td>8,048</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

It is important to reduce fundamental causes of failure to enhance the quality of smart meters. However, it is necessary to establish strategy to follow smart meter technology that is being continuously developed according to needs of power utility and demand of customers.

AC/DC combined smart meter has independent power circuits to make possible partial replacement of failure part in order not to replace whole power circuit.

AC/DC smart meter has basically the same principle with MULTI OPTION smart meter, and could be more advanced model than socket-type electronic meter that is utilized in North America and Europe.

It consists of 3 parts, AC Module (power transformer, smoothing circuit, etc), DC module (CPU, LCD, etc) and case (terminal, line).
THE SMART METER USING USIM (USER IDENTIFICATION)

Current customer management scheme is based on address of each customer. That means even though a customer moves into a new house, he would use the same meter that the previous resident had used.

Interim payment is made through telephone during about 1,900 thousands of customer transfer every year, and it could be a reason of electric rate dispute between customers.

USIM-installed smart meter is a security-enhanced advanced-concept smart meter that changes customer management scheme from address-oriented to user-oriented to resolve problems that are stated above.

Smart meters can automatically recognize customers by using USIM card and measuring power usage. USIM card is issued by power utility and it holds individual information and authentication certificate.

USIM-installed smart meter recognizes and records individual information and certificate of customer when USIM card is inserted, and eliminates related information of customer when USIM card is removed.

Overall operation system of USIM-installed smart meter is represented in Figure 4.
CONCLUSION
The 3rd generation smart meter “Multi Optional Smart Meter, AC/DC Smart Meter, The Smart Meter using Usim” is a progressive technology that changes smart meter operation paradigm innovatively converging ICT and metering technologies, and it is expected that it can reduce smart meter production cost and operation cost, and enhance the quality of customer service.

KEPCO has been continuously working on development of the 3rd generation smart meters for two years, and a related pilot project is planned in 2016.

REFERENCES
