Plug-in Electric Vehicle Battery Sensor Interface in a Smart Grid Network for Electricity Billing

Presented by Deniz Gurkan
Co-authors: Sofia Shahid and Karthik Ram Narumanchi
University of Houston, USA
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Motivation

Cloud

Plug-in Electric Vehicle

SNMP Manager

SNMP request Manager \(\rightarrow\) Agent (Get, Get\_Next, Set)

SNMP response Agent \(\rightarrow\) Manager (Trap, Get)

SMART GRID NETWORK

Electric Utility Provider

External Charging Location

SNMP Manager

Home Charging

SNMP Manager/Agent

Battery Charging Station

Plug-in Electric Vehicle

PEV

Electric Vehicle

SNMP Manager/Agent

Home Charging

SNMP Manager/Agent
OUTLINE

- Anticipated Billing Problem
- Organizational Model
- SNMP Architecture
- Management Information Base (MIB)
- Exchange of Information
- Conclusion
FUTURE USE OF THE SMART GRID

- We propose a Simple Network Management Protocol (SNMP) management information base (MIB) for a Plug-in electric vehicle (PEV).
- It utilizes charge-level sensors to intelligently bill electricity usage per subscriber independent of the location of the charging.
- We propose the design of a sensor information exchange that would identify and collect data from a PEV at a charging station and make this data accessible to the utility company.
Organizational Model of PEV Management System
The managed element has an SNMP process running and is called an agent.

The manager uses data collected by the agent towards intelligent billing according to the consumed power by the PEV charging.

The intermediate layer is acting as both an agent and a manager.

MIB resides on all the network management components but Management Data Base (MDB) resides only on the manager.
SNMP Architecture

SNMP Manager
  \arrow{SNMP message}
  \arrow{Trap}

SNMP Agent
  \arrow{Get/Set}

MIB

SNMP Agent
  \arrow{Get/Set}

MIB
Loaded Mib Modules

internet

private enterprises

pevMib

customerAccountInfo

- customerName
- customerId

vehicleInfo

- vehicleMake
- vehicleIdNumber

batteryInfo

- batteryStatus
- batteryCharge
- batteryChargingDuration
- batteryChargingRate

- timeOfCharging
  - peakHours
  - offPeakHours
CHARGING MODEL
<table>
<thead>
<tr>
<th>Component</th>
<th>Proposed Connection</th>
<th>Optional Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charging Station</td>
<td>Zigbee</td>
<td>USB, Ethernet, RS232, 802.11</td>
</tr>
<tr>
<td>Battery Charger</td>
<td>CAN-BUS</td>
<td>USB, RS232, Ethernet, 802.11</td>
</tr>
<tr>
<td>Battery Management System</td>
<td>Proposed CAN-bus</td>
<td>USB, RS232, Ethernet, 802.11</td>
</tr>
</tbody>
</table>
## Sensors Used in PEV

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Measured Quantity</th>
<th>Data Communication Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delphi</td>
<td>Voltage, Current, and Temperature</td>
<td>Local Interconnect Network (LIN) OR Controller Area Network (CAN)</td>
</tr>
<tr>
<td>Hella Intelligent Battery Sensors</td>
<td>Voltage, Current, and Temperature</td>
<td>Bus capability for LIN</td>
</tr>
</tbody>
</table>
Sequence of Events - I

1. PEV is first charged at the home charging station where the subscriber has a permanent address registered by the electricity provider.

   customerAccountInfo
   customerName
   customerId

2. `pevMIB` is stored with the customer account info and the `batteryInfo` (unique id).

3. When the subscriber connects the PEV at an external charging location such as work or shopping mall, the utility provider is notified with the `pevMIB` and the battery charge sensor data.

   internet
   private
   enterprises
   `pevMIB`
   customerAccountInfo

   batteryInfo
   batteryStatus
   batteryCharge
   batteryChargingDuration
   batteryChargingRate
4. Depending on the charge status (full, or needs charge), the subscriber will be billed (charged for the consumption, or credited for the stored energy transfer to the smart grid).

5. Smart grid network handles all authorization transactions through SNMP messages that identify the subscriber.

6. Battery status sensor measurements are logged into the subscriber account at the utility provider database.
Dynamic nature of the smart grid poses a challenge to manage subscriber functions effectively. We addressed this problem by designing MIB for PEV that collects electricity usage information of the subscribers using SNMP protocol.

Our approach provides the flexibility to the subscribers to connect to any charging interface and for utility to identify and bill them accordingly.
Questions