Interaction between Home Energy Management and Smart Appliances

Status and overview

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Josef Baumeister, Gerhard Fuchs,
BSH Hausgeraete GmbH
What are we facing today?
Efficient usage of energy ….. management of my Appliances …. today……

My device

My area of responsibility….  

….. my scattered Home Network!
Wouldn't it be great to have a system that manages all my stuff?
... either home- or cloud based?
How to ensure interoperability with all these manufacturer specific implementations?
.... mapping it in the cloud?
complex algorithms are necessary to ensure optimal resource usage

and every manufacturer defines it for his own use

... implication on mappings?
Why not defining a set of interoperable messages, common profiles etc.…
Interoperability means:

• Common functionalities manufacturer independent

• For main features

• Common agreement with all manufacturer

Interoperability does not mean:

• Common algorithms on how to manage intelligent!
We base our work on the Common Architecture Model, developed by the Smart Grid Coordination Group (European Mandate M490).

* e.g. HBES device, smart appliances, storage, generator, domestic charger for EV, complex display
We are defining a set of Smart Premises Interoperable Neutral Messages (SPINE)
where the Neutral Information can be exchanged via mappings to domain specific protocols
Our process
We base our process on the SGAM Model, developed by the Smart Grid Coordination Group (European Mandate M490).
1. User Stories and Use Cases – (referenced to IEC 62746-2 Use Cases and Requirements)

<table>
<thead>
<tr>
<th>User Story</th>
<th>Use Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer wants to set Basic Settings of Appliance</td>
<td>The Customer wants to get the dishes ready until 8am tomorrow</td>
</tr>
<tr>
<td>Customer wants to dim all lamps in the house</td>
<td>The user likes to use his Electro Vehicle at 3:00pm again</td>
</tr>
<tr>
<td>The Customer wants to get remote help, if the washing machine works improper</td>
<td>The user allows the Customer Energy Manager to reduce the energy consumption of his freezer in a defined range for a specific time, if the grid recognizes (severe) stability issues</td>
</tr>
<tr>
<td>The user likes to use the own decentralized energy (e.g. PV)</td>
<td>The Customer wants to feed PV energy into own battery pack if too much power available</td>
</tr>
<tr>
<td>The user likes to limit own energy consumption up to a defined limit</td>
<td>The Customer wants to sell own decentralized energy (e.g. PV) to Smart Grid</td>
</tr>
<tr>
<td>Grid related Emergency Situations (Blackout prevention)</td>
<td></td>
</tr>
</tbody>
</table>

**Use Case: The user likes to get the laundry ready until 8:00pm**
- The user prepares the washing machine
- Fills clothes
- Selects washing program
- Pre-selects the end time (e.g. 8:00pm)
- Starts washing program

**Use Case: The washing machine now informs the CEM about**
- The start of the new program
- The pre-selected end time
- The pre selected incentive program (if not already stored)
- The expected energy consumption profile with duration and (e.g. time related specific) power consumption

**Use Case: The CEM calculates the operation plan and takes into account**
- The selected incentive program e.g.
- Tariff Information
- PV forecast
- Expected energy consumption other Smart Devices
- Expected energy consumption of the requesting Smart Device

**Use Case: The CEM sends the calculated start time to the Smart Device**
- The Smart Device starts the cycle
- Based on the calculated start time
- Based on an updated start time
2. Information to be exchanged and Sequence Diagrams
3. Data Model descriptions

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3. Data Model descriptions

<table>
<thead>
<tr>
<th>Element name</th>
<th>Data range</th>
<th>M/O/NV/C</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>suiteId</td>
<td>M</td>
<td></td>
<td>SHALL be present and set to “SmartEnergyManagementPs”.</td>
</tr>
<tr>
<td>suiteDataGroup</td>
<td>M</td>
<td></td>
<td>SHALL always be present and state “smartEnergyManagementPs_Information”.</td>
</tr>
<tr>
<td>PowerConstraint</td>
<td>PowerLevels comprises P1,...,Pn in case of discrete power levels (Continuously=false)</td>
<td>O</td>
<td>List of data group (0..unbounded)</td>
</tr>
<tr>
<td>PowerSequence</td>
<td>powerSequenceDescriptionData</td>
<td>M</td>
<td>General descriptions on the power sequence. SHALL be present.</td>
</tr>
<tr>
<td>PowerSequence</td>
<td>xs:unsignedInt</td>
<td>M</td>
<td>SHALL state an endpoint-wide unique sequence identifier.</td>
</tr>
<tr>
<td>PowerSequence</td>
<td>xs:string (1..60 characters)</td>
<td>O</td>
<td>If used, should state a textual description for this power sequence.</td>
</tr>
<tr>
<td>PowerSequence</td>
<td>Enumeration: see Annex A - Units</td>
<td>O</td>
<td>For electric power, the element powerUnit SHALL be omitted and kW SHALL be assumed as unit for the value implicitly. For any other power type, the unit SHALL be stated explicitly.</td>
</tr>
</tbody>
</table>
```
4. Neutral Messages, Corresponding XSDs and XML/JSON

<table>
<thead>
<tr>
<th>Message name</th>
<th>suiteDataGroup name</th>
<th>M/O</th>
<th>Direction</th>
<th>Valid classifier</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>powerSequences information</td>
<td>smartEnergyManagementPs_Information</td>
<td>M/Out</td>
<td>reply, notify</td>
<td></td>
<td>Informs or updates a client about a forecast (fixed or with flexibilities).</td>
</tr>
<tr>
<td>powerSequences information request</td>
<td>smartEnergyManagementPs_InformationRequest</td>
<td>M In</td>
<td>read</td>
<td></td>
<td>Requests current information from a server.</td>
</tr>
<tr>
<td>powerSequences configuration call</td>
<td>smartEnergyManagementPs_ConfigurationCall</td>
<td>M Out</td>
<td>call</td>
<td></td>
<td>Informs the client that the server’s power sequences need to be (re-)scheduled.</td>
</tr>
<tr>
<td>powerSequences configuration</td>
<td>smartEnergyManagementPs_Configuration</td>
<td>M In</td>
<td>write</td>
<td></td>
<td>Is used to write a new configuration to a server.</td>
</tr>
<tr>
<td>powerSequences state request</td>
<td>smartEnergyManagementPs_StateRequest</td>
<td>M In</td>
<td>read</td>
<td></td>
<td>Requests current power sequence states from a server.</td>
</tr>
</tbody>
</table>

Diagram: Neutral Messages and XSD/JSON Structures

- eebus.powerSequencesStateChangeState
- eebus.powerSequencesStateListData
- eebus.powerSequencesStateListDataRead
- eebus.powerSequencesStateListDataReadSequence
- eebus.powerSequencesStateListDataCapabilities
- eebus.powerSequencesStateListDataCapabilitiesRead
- eebus.powerSequenceSchedule
- eebus.powerSequenceScheduleListData
- eebus.powerSequenceScheduleListDataRead
- eebus.powerSequenceScheduleListDataReadSequence
- eebus.powerSequenceScheduleListDataCapabilities
- eebus.powerSequenceScheduleListDataCapabilitiesRead
- eebus.powerSequenceScheduleConstraints
- eebus.powerSequenceScheduleConstraintsListData
- eebus.powerSequenceScheduleConstraintsListDataRead
- eebus.powerSequenceScheduleConstraintsListDataCapabilities
- eebus.powerSequenceScheduleConstraintsListDataCapabilitiesRead
Status: Relevant documents, we have already finished or we are working on:

- IEC 62746-2
- prEN 50631-1-x
- prEN 50491-12
- prEN 50631-1-x
  - EEBus & E@h Data Model
- prEN 50491-12
- prEN 50631-1-x
  - EEBus & E@h messages
- prEN 50631-4 mappings
  - SHIP&OIC Protocol
  - Alljoyn
  - Echonet lite
  - Other (upcoming) protocols

User Stories & Use Cases

Information to be exchanged

Neutral set of data model

Protocol specific Mappings - XSDs

Connectivity Protocol

Transport Protocol
Next steps to enlarge the footprint of this approach
Who is involved in Smart Home & Smart Grid standardization?
Excerpt of relevant Standardization bodies

- **Association bodies**
- **Standardization bodies**

supported

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**International**

- IEC TC57 WG21
- IEC TC23 WG12
- ISO/IEC JTC1/SC25
- IEC TC59 WG15

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**US**

- SGIP
- ZigBee SEP 2.0
- ASHRAE

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**Europe**

- CLC/TC57 mirror
- CLC/TC205 WG18
- CECEXD TF SG
- CLC/TC59x WG7

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**Germany**

- DKE 952
- DKE NeLDE
- DKE Inhome
- DKE Use Cases
- DKE 1711.x
- ZVEI TF SG

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* may not be complete
How to ensure Interoperability if lot’s of different consortia are developing new proprietary solutions?
Based on European Commission project Common Ontology (DG-Connect and DG-Energy)

- Alignment of Data Model and Messages
- Common support of International Standards
- Energy related messages in 2015

Our Intention - to achieve an overall EU-wide connectivity approach!

DG Connect project: Common Ontology

Innovative EBUS
SAREF: a DG-Connect driven project, a first step to achieve a common Smart Appliance ontology.