OpenFMB - Role of CIM in Interconnecting DER devices in the IoT

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Prepared by SEPA/SGIP OpenFMB Task Force
Presented by Terry Saxton, Xtensible Solutions
Agenda

• OpenFMB Overview
• 2016 Accomplishments
• 2017 Planning and Priorities
• OpenFMB™ Collaboration Site Resources
• OpenFMB™ Demonstration Code
• How to Participate in OpenFMB™
• Q&A
OpenFMB Overview

www.openfmb.io
OpenFMB™: The Catalyst for Interoperability

- Open Field Message Bus (OpenFMB™) is a reference architecture and framework for distributed intelligence and grid-edge interoperability
- Leverages existing standards to federate data between field devices and harmonize them with centralized systems
  - Utility industry standardized semantic models
    - IEC’s Common Information Model (CIM) used in first reference implementation
    - Harmonized CIM & IEC 61850 model to be used for second reference implementation
  - Internet of Things (IoT) publish/subscribe protocols
    - DDS: Data Distribution Service
    - MQTT: Message Queue Telemetry Transport
    - AMQP: Advanced Message Queue Protocol
- Scales operations independently, without a system-wide rollout
  - Flexible integration of renewables and storage with the existing grid
  - Accelerates ability to stack operational benefits
- OpenFMB™ RMQ.26 standard was ratified in March 2016 by the North American Energy Standards Board (NAESB)
OpenFMB™: Enhancing Grid Edge Integration

Key Observations:
1. Single-Purpose Functions
2. Proprietary & Silo’ed systems
3. Latent, Error-prone Data
4. OT/IT/Telecom Disconnected
5. No Field Interoperability!

Key Observations:
1. Multi-Purpose Functions
2. Modular & Scalable HW&SW
3. End-to-End Situational Awareness
4. OT/IT/Telecom Convergence
5. True Field Interoperability!

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OpenFMB: Federated Deterministic Exchanges

- Periodic Readings - Pub every few secs or near-real-time
- Data-Driven Events – on status change in near-real-time

Readings
- KW A/B/C
- KVAR A/B/C
- V A/B/C
- I A/B/C
- Phase Angle A/B/C
- KWh
- TimeStamp
- State of Charge

Status, Events, Alarms, & Control
- Trip / Open
- TimeStamp

PV
Battery
Security/SDN Policy Manager
Grid Edge Analytics
DER/Microgrid Optimizer

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OpenFMB™ Node Architecture

Application Layer

Field Applications

Client/Server Adapters (Modbus, DNP3, IEC 61850 GOOSE/MMS, ANSI C12, CoAP, XMPP, Others)

OpenFMB™ Interface Layer
(Data Models and Profiles, Configurations, Interaction Patterns, Security)

AMQP  DDS  MQTT  Other Pub/Sub Middleware

Layered Security Approaches
# OpenFMB Node Application Examples

## Basic measurement and event data

<table>
<thead>
<tr>
<th>Status Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power revenue measurement</td>
</tr>
<tr>
<td>Operational Power Measurement</td>
</tr>
<tr>
<td>Power Quality Measurement</td>
</tr>
<tr>
<td>Other Analog Measurement</td>
</tr>
<tr>
<td>Measurement and Status History</td>
</tr>
</tbody>
</table>

## Control

<table>
<thead>
<tr>
<th>DC/AC conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC/AC conversion</td>
</tr>
<tr>
<td>AC/DC conversion</td>
</tr>
<tr>
<td>Storage management</td>
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<tr>
<td>Real power control</td>
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<tr>
<td>Reactive power control</td>
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<tr>
<td>Switch control</td>
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<tr>
<td>Load control</td>
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<tr>
<td>Load Shedding</td>
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<tr>
<td>Alarming</td>
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<tr>
<td>Protection</td>
</tr>
</tbody>
</table>
# OpenFMB Node Application Examples
## Business Functions

<table>
<thead>
<tr>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tagging/Maintenance</td>
</tr>
<tr>
<td>Generation Forecasting</td>
</tr>
<tr>
<td>Load Forecasting</td>
</tr>
<tr>
<td>Weather Forecasting</td>
</tr>
<tr>
<td>Provide/Consume Cost info</td>
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<tr>
<td>Provide/Consume Pricing</td>
</tr>
<tr>
<td>Settlement</td>
</tr>
<tr>
<td>Scheduling</td>
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<tr>
<td>Ancillary Services</td>
</tr>
<tr>
<td>Electric Network Modeling</td>
</tr>
<tr>
<td>Calculate Network Topology</td>
</tr>
<tr>
<td>Calculate Power Flow</td>
</tr>
<tr>
<td>Volt/Var/Watt Optimization</td>
</tr>
<tr>
<td>Economic Optimization</td>
</tr>
<tr>
<td>Contingency Analysis</td>
</tr>
<tr>
<td>Islanding/Reconnecting</td>
</tr>
<tr>
<td>Black Starting</td>
</tr>
<tr>
<td>Simulation</td>
</tr>
<tr>
<td>Testing</td>
</tr>
</tbody>
</table>
Operational capabilities
OpenFMB nodes may support

• Currently some of the more complex applications, such as calculating load flow, are performed at centralized locations
• In the future, some of these applications may be distributed over multiple nodes
OpenFMB™: Framework Lifecycle

- Business Case
  - Business-driven solutions

- Use Case
  - Functional and non-functional requirements
  - Interaction and sequencing

- UML
  - Profile of applicable, existing data model

- XSD and IDL
  - Common software definitions and language

- Apps and Adapters
  - Software tools to allow actors to interoperate

- Test and Field
  - System integration and validation testing

- Maintenance
  - Updates and versioning

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OpenFMB Security Analytics Framework

- **Use-Case Planning**
- **Consistent Data Model**
- **Secure Pub/Sub**
- **Secure Transport**
- **Behavior Analysis**

**Describe**
Identifying Normal Behavior & Good Actors: Commissioning, Updating & Operating.

**Define**
Profiles, Topics, Semantics, Behavior: Operational Functions & Security Policies

**Messaging**
White-listed & Encrypted Payloads: DDS Secure on top of the UDP/IP or TCP/IP

**Transport**
Transport Layer Security (TLS) 1.2 or Plug-ins

**Security Behavior Analysis**
Intrusion Detection & Machine Learning: Domain Knowledge: Detect, Isolate, Restore
OpenFMB

Accomplishments
OpenFMB 

OpenFMB 2016 Accomplishments

• DistribuTECH OpenFMB Microgrid Demonstration
  – Over 1,100 visitors and 25 vendor partners involved

• OpenFMB ratified as a NAESB standard
  – Major Milestone for OpenFMB

• New 2016 OpenFMB Use Cases:
  – DER Circuit Segment Management
  – Circuit Segment Optimization

• Launched www.openfmb.io – a collaboration site and repository
OpenFMB Standard Spec: NAESB RMQ.26

Please contact naesb@naesb.org
First OpenFMB™ Reference Implementation:
Duke Energy Coalition at Mount Holly Microgrid

• Duke Energy completed project with 25 vendors in 18 months
• Distributech Demo in Feb 2016
• At least 2 vendors per function
• 3 dynamic use-cases:
  – Microgrid Optimization
  – Seamless Island Transition
  – Successful Reconnection
• Wired & Wireless Communication
• MQTT, DDS, AMQP
• Common Data Model (CIM: IEC 61868/70)
Second OpenFMB™ Reference Implementation in Progress: Duke Energy Rankin/Mount Holly Feeder

Planned use-cases:
- Microgrid Islanding/Reconnection
- Circuit Segment Optimization
- DER Circuit Segment Management
- PKI Management (new)
OpenFMB™
2017 Planning and Priorities
SGIP OpenFMB 2017 Priorities

• **Goal:** *Lower barriers to commercialization*
  
  – Updating open-source OpenFMB UML
    – New harmonized model based on CIM & 61850
    – New profiles for cybersecurity & mgmt services

• **SGIP OpenFMB Testing & Certification Program**
  
  – Development of conformance requirements
  – Compliance test harness at a DOE lab

• **Leverage SEPA merger to drive adoption**
  
  – 4 new utilities joined SGIP task force and initiating plans for their own OpenFMB projects with new use-cases (e.g. Volt-Var, FLISR) on top of DER circuit segment mgmt.
  – New adapters (e.g. GOOSE, SEP2.0, C37.118) being developed and to be added to github repository
OpenFMB™
Collaboration Site:
Code, Use Cases, Wiki, Blog, Community

www.openfmb.io
OpenFMB™ Collaboration Site: Code

- OpenFMB™ Developer’s Toolkit:
  - Downloadable turnkey executable file
  - Simplified example of the Microgrid Demo shown at DistribuTECH 2016 based on the NAESB OpenFMB reference implementation
  - Instructions and Wiki
Learn More & Participate

SGIP OpenFMB™ Information:
www.sgip.org/openfmb

What you can do now:
• Join SEPA/SGIP!
• Join OpenFMB™!
• Download OpenFMB Code

Contact SGIP for more information:
www.sgip.org/about-us/contact-us
CIM and IEC 61850 Harmonization in OpenFMB and Challenges Using IEC 61850 UML

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CIM and IEC 61850 Measurements
IEC 61850 UML?

• The UML used in IEC TC 57 WG 10 is for use ONLY in instantiating the copyrighted IEC 61850 standard

• Distribution and use for any other purpose is prohibited

• An alternative UML is needed for IEC 61850
Deriving the UML for IEC 61850

- NSD Files
  XML generated from IEC 61850 UML

- IEC 61850 UML
  "Artifact"
  Generated from NSD by SISCO

- IEC 61850 UML
  Standard

- CIM Users Group
Status of Usable IEC 61850 UML

- IEC: NSD files will be available for use by purchasers of the IEC 61850 standard
- IEC: Artifacts generated using NSD files do not owe royalties to IEC. Similar to a product implementing any IEC standard
- SISCO is willing to donate the IEC 61850 UML to further harmonization and more widespread use (e.g. IEC DER work)
- Problem: IEC Claims were made verbally during WG 10 meeting. SISCO cannot proceed without legal clarity on this matter.
  - Getting legal clarity is proving to be a challenge.
Thank You

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