A new software architecture for a distributed, modular and scalable IT infrastructure of future power system control centers

Eric Braun
Outline

- Motivation
- Requirements
- Concept
  - Backend
  - Frontend
- Prototype
- Conclusion
Motivation

- Energy Lab 2.0 as power system control center
- incoming data will be stored, analyzed, and visualized
- control electrical equipment
- big variety of applications
Motivation: Role in Energy Lab 2.0

SenSSiC (Smart Energy System Simulation and Control Center)
Motivation: Role in Energy Lab 2.0

Control, Monitoring and Visualization Center
Requirements
Requirements

Data Management
- structured data
- time series
- documents or files
- links between data
Requirements

- Data Management
  - structured data
  - time series
  - documents or files
  - links between data

```json
{
    "name": "IAI Building",
    "number": 449,
    "address": ...
    ...
}
```
Requirements

- Data Management
  - structured data
  - time series
  - documents or files
  - links between data

```json
{
    "name": "Janitza UMG 512",
    "description": "Power quality analyser",
    ...
}
```
Requirements

- Data Management
  - structured data
  - time series
  - documents or files
  - links between data

```
{
  "name": "Measurement",
  "identifier": "MMXU",
  "TotW": ...
  "Hz": ...
  ...
}
```
Requirements

- Data Management
  - structured data
  - time series
  - documents or files
  - links between data
Requirements

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  - time series
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Requirements

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  - time series
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Requirements

- **Visualization / Monitoring**
  - line / bar chart
  - maps
  - 3D visualizations

- **Analysis**
  - e.g. forecasting (electricity consumption)

- **Control**
  - e.g. electrical equipment
Requirements

- non-functional
  - high performance
  - secure system
  - easy to use applications
    (e.g. no programming knowledge needed)
Concept
Basic State-of-the-art Concept

Frontend Applications

Backend Services

Databases
How do we design such an infrastructure?

- avoid common mistakes:
  - monolith
  - custom solution for every usecase
  - desktop application as frontend
- State-of-the-art technologies
- build it for people with little IT knowledge
Monolith

- one hardware server
- one technology stack
- one codebase

+ easy scaling (replicate whole software)
+ easy development

- codebase too big
- scalability is not efficient
- updates are problematic
- deployment to server takes hours or days
Microservices

- small projects
- low coupling
- better scalability
- defined by (HTTP) interface, not by implementation
- small development teams
Custom Solution for Every Usecase

- don’t …
  - use databases with fix schemas (relational database)
    changes to the structure of the data → a lot of work
  - create microservices for different applications
- do …
  + use NoSQL databases
    e.g. MongoDB, Elasticsearch
  + create microservices based on different features
    no timeseries for electr. service BUT a generic timeseries service
Desktop Application as Frontend

- often only run on a specific platform (e.g. windows, linux, android)
- need installation

+ web frontend that can run in any modern browser
Concept: Backend
Generic Microservice Backend

- separate services for different types of data

- Time Series Service
- Master Data Service
- Digital Asset Service
Generic Microservice Backend

- additional services for more demanding applications

- Schema Service
- Link Service
- Geo Service
- Application Configuration Service
- Search Service
- Auth Service (e.g. OAuth 2)
Architectures

Applications
- Energy Management
- Demand Site Management
- Planning Tools
- Asset Management

Gateway
Concept: Frontend
Concept: Frontend

- configuration over programming
  - programming is done by the developer
  - the user only configures the rest

- all applications in the same design (e.g. Material Design)
- suitable for desktop, tablet, smartphone, etc.
Prototypes
# Prototype: Visualization

## Data Source Instances

<table>
<thead>
<tr>
<th>Name</th>
<th>Data Source</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>total</td>
<td>MMSXL_TotW</td>
<td>CONFIG PARAMETERS</td>
</tr>
</tbody>
</table>

## Template Parameters

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>color</td>
<td>#4bca21</td>
</tr>
<tr>
<td>type</td>
<td>line</td>
</tr>
<tr>
<td>label</td>
<td>10kW</td>
</tr>
<tr>
<td>showGrid</td>
<td>false</td>
</tr>
<tr>
<td>title</td>
<td>Total Real Power</td>
</tr>
</tbody>
</table>

## Data Mappings

### Data Source

<table>
<thead>
<tr>
<th>Data Slot Id</th>
<th>Data Slot Id</th>
<th>Data Slot Id</th>
</tr>
</thead>
<tbody>
<tr>
<td>mo2</td>
<td>Interval</td>
<td>Interval</td>
</tr>
<tr>
<td>mo2</td>
<td>startTimestamp</td>
<td>startTimestamp</td>
</tr>
<tr>
<td>mo2</td>
<td>values</td>
<td>values</td>
</tr>
</tbody>
</table>

**Preview**

**Total Real Power**

![Graph showing total real power over time](image)
Prototype: Analysis

Eric Braun - A new software architecture for a distributed, modular and scalable IT infrastructure of future power system control centers
Prototype: Dashboard
Summary and Outlook

summary:
- requirements for the IT infrastructure
- how to design the infrastructure
- concept of the frontend and backend
- different prototypes

future tasks:
- implementation of the whole concept
- integration of various applications for Energy Lab 2.0
Thank you for your attention!

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Sources

- Icons made by SimpleIcon, Madebyoliver, Freepik from www.flaticon.com
Scalability of Microservices

- Scalability of Microservices
- Scalability of Microservices
- Scalability of Microservices
Scalability of Microservices

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