Introducing CIM grid model to TSO processes
Briefly presenting the presenters

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Lead architect of IBM’s ELVIS solution, which won Fingrid’s competitive solution request. Today he leads the ELVIS integration teams, bringing the ELVIS solution to life.

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Power System Planning Expert at Fingrid Oyj
Has been working with ELVIS project since 2008, from the requirement definition phase, and is Fingrid team lead of ELVIS simulation grid model and calculations part.
Agenda

• Introduction to Fingrid
• Background, Drivers of the ELVIS Project
• High Level System Architecture
• Focus on Main Integration Points:
  – Maximo <-> ArcGIS
  – ArcGIS <-> ODMS
• Architectural Principle
• Current System Usage
• The Future of ELVIS
Fingrid is the Finnish transmission system operator (TSO)

We are responsible for the functioning of the entire power system in Finland. We keep the transmission grid in a good condition and construct it on the basis of the needs of the electricity market.

We transmit electricity continuously from electricity generating companies to distribution network companies and industrial companies. 75% of the electricity in Finland is transmitted in our grid.

We take care of the cross-border connections of electricity transmission. There are direct connections to Finland from Russia, Sweden, Norway and Estonia.

We promote the functioning of the electricity market by keeping the transmission connections between various countries in working order.

Fingrid Oyj’s grid assets:
- 14,300 km of transmission lines and cables
- 113 substations
- 67 power transformers, with total capacity of 21,000 MVA
- 935 MW of reserve power capacity
ELVIS high level objectives

• Increasing operative efficiency
  – Increasing proactivity in calculations, monitoring and maintenance
• Single source for power system information
  – Improving information access and usability within stakeholders
• Adding cost aspect to operation and power system components
  – Enhanced business planning through cost operational analytics
• Platform for further system development with modern solutions
  – Mobile solutions and data analysis to support Asset Management and Power system operations

A more efficient tool for Fingrid's asset and operation management by replacing existing tailor-made grid information systems by integrated best-of-breed standard software products

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Process Coverage

Project Management
3 - 2nd level processes
App. 50 UC’s

Grid & Asset Modeling
6 - 2nd level processes
App. 75 UC’s

Grid and Asset Calculations
4 - 2nd level processes
App. 40 UC’s

Relay Modeling and Calculations
6 - 2nd level processes
App. 75 UC’s

Electrical Grid Modeling and Calculations
2 - 2nd level processes
App. 15 UC’s

Workorder and Maintenance
7 - 2nd level processes
App. 40 UC’s

RoW, Growth Clearance, Land Use and Permits
3 - 2nd level processes
App. 20 UC’s

Outage Management
3 - 2nd level processes
App. 60 UC’s

Switching Planning and Disturbance Management
7 - 2nd level processes
App. 80 UC’s

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## Solution package – functionalities/processes covered by products

<table>
<thead>
<tr>
<th>Product</th>
<th>Features</th>
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<tbody>
<tr>
<td>Elvis</td>
<td><strong>Asset Management</strong></td>
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<tr>
<td></td>
<td>- Creation, management and ownership of asset hierarchy data.</td>
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<td>- Creation and management of work orders, resources and contracts.</td>
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<td>- Asset and work order history repository.</td>
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<td>- Out-of-the-box integration between Maximo and ESRI/Syclo/Primavera</td>
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<td>IBM Maximo</td>
<td><strong>GIS</strong></td>
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<td>- Creation, management and ownership of grid topology data.</td>
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<td></td>
<td>- Scenario management.</td>
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<td>- Flow of way tools and growth clearance.</td>
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<tr>
<td>ESRI ArcGIS</td>
<td><strong>Planning &amp; Analytics</strong></td>
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<td></td>
<td>- Siemens PTI PSS/E</td>
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<tr>
<td></td>
<td>- What-if scenarios</td>
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<td></td>
<td>- Impact analysis</td>
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<td></td>
<td>- Trend analysis</td>
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<td></td>
<td>- Electrical calculations</td>
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<tr>
<td>Primavera</td>
<td><strong>Project Management</strong></td>
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<td>- Project and portfolio management.</td>
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<td>Syclo SMART</td>
<td><strong>Mobile</strong></td>
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<td></td>
<td>- Provides mobile access to selected areas of Maximo</td>
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<tr>
<td>Siemens PTI</td>
<td><strong>IPS EPIS</strong></td>
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<tr>
<td></td>
<td>- Determination of particular relay settings for specific relay type</td>
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<td>- to accomplish specific characteristics</td>
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<td><strong>Relay Management</strong></td>
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<tr>
<td>Electrocon</td>
<td><strong>Relay Calculation</strong></td>
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<td>- Primary &amp; Secondary Relay Calculations</td>
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### Project Scope
- System Implementation based on standard packages
- Configuration, Customization, Integration of packages on solution, Integration to external systems
- Data Migration
- Test, Deployment, Training
- HW Delivery and Installation
- Application Support and Maintenance

### Drivers for package selection
- Fully (and pre-)integrated solution that fulfils the Fingrid requirements for Asset Management and Grid Design while being characterized by:
  - Delivery through standard packages with limited customization
  - Selected packages ensure a high degree of flexibility and ease of configurability that will enable Fingrid to adjust the solution to the business needs.
The foundation for Asset Management - provide great tools for the AM specialists

- OSIsoft PI AF & ProcessBook
- OSIsoft PI Real-time & data storage
- SCADA
- Both realtime and historical measurements (status, analog)

- ESRI ArcGIS GIS
- IBM Maximo Asset Management
- Primavera Adapter
- Oracle Primavera Project Management
- Siemens PSS®ODMS Grid modeling
- Siemens PSS®E Grid Calculation
- IPS Relex Relay Management
- Electron CAPE Relay simulation
- Maximo Spatial
- Maximo Spatial
- SAP Work Manager

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CIM16 widely adapted, where applicable. At the same time, the nature of the individual component must be respected.
Critical Points of Integration

Maximo

Unversioned hierarchical model of logical locations and physical assets

ArcGIS

Versioned geospatial representation of grid elements, master of grid connectivity

ODMS

Versioned grid model of grid connectivity and electrical characteristics
ArcGIS<-->Maximo – Maximo’s Three Fundamental Concepts

Work Orders, modelling what needs to be done: scheduling, contracts, project management, etc

Locations, which are logical functions of the grid, structured hierarchically

Assets, the physical devices fulfilling those functions.
ArcGIS<-->Maximo Integration – Main Separation of Responsibilities

- The split of responsibilities between ArcGIS and Maximo are captured by the CIM PowerSystemResource-to-Asset relationship.
- Maximo does not model network connectivity.
- Rather, Maximo structures its locations hierarchically, which maps directly to ArcGIS (CIM) containment.
ArcGIS<--->Maximo Integration – Data Flows

Data exchanged via web services, Features mapping to Locations, selected Asset attributes returned

Maximo Spatial "Map Tab" through ArcGIS REST services, providing geospatial context of Locations

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ArcGIS

ODMS

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Versioned geospatial representation of grid elements, master of grid connectivity

Versioned grid model of grid connectivity and electrical characteristics
GIS→ODMS – CIM Mapping

- The GIS Powergrid model is a CIM adaption, but must still first and foremost serve as a GIS network model. By contrast, ODMS is a pure CIM-based system.
- Thus, mapping of the connectivity model is a necessity. Particular complex details include:
  - Mapping of switches from a point feature into a two-terminal device.
  - The necessity of creating abstract elements (Terminals and some ConnectivityNodes) out of a more crude model.
GIS→ODMS – Integrating of Two Versioned Systems

• Choice of degree of freedom – users are allowed to make mistakes.

• An ArcGIS version is selected, along with a compare project residing in ODMS. The diff between these two are loaded.

• Commissioning of projected versions into base model synchronized through business processes.
GIS→ODMS – Bridging Node/Breaker and Bus/Branch Models

- ODMS functions as the bridge between the node/breaker operational model and the bus/branch planning model.
- The mapping is bi-directional. The backwards mapping is used to represent calculation results in ArcGIS and Maximo.

**ESRI GIS**
- Internal ESRI GIS Grid Representation
- ESRI GIS CN-based CIM Export
- Transient CIM Grid Representation

**ODMS**
- ODMS CN-based CIM Import
- Persisted CN-based CIM Model
- ODMS Topological Processing
- ODMS TN-based Representation
Central Grid Model Management Supporting All Processes

• Master current grid model originates from GIS
• Nameplate electrical values are synchronised from asset registry
• Grid model is transformed to CIM model and imported to CIM network model database
• The network model is updated with some simulation specific data
• The central network model can be used in different programs
  – PSS/O, PSS/E, CAPE
• and for different purposes
  – power flow calculation, state estimation, contingency analysis, short circuit calculation, dynamic simulation
Grid model maintenance in Fingrid in 2015

- Asset information and hierarchy (Maximo)
- Geographical information system and asset topology (ArcGIS)
- Grid topology and values from other TSO:s & NSO:s
- Enterprise grid model management (ODMS CIM database)
  - Present grid
  - Projects and scenarios
  - Load-, generation-, and voltage profiles
  - Rating profiles
  - Links to measurements
- Measurement and status information, EMS (XA and PI)
- Energy measurements from connection points (LTJ)
- Protection planning (CAPE/IPS)
- System analysis (PSSE/CAPE/Maximo)
- Long term system planning (PSSE)
- Operations planning (ODMS/PSSE)
- Fault location calculation (PSSE/Maximo)

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ELVIS will bring Fingrid new things

- **Common accurate grid model**
  - Common grid model which is synchronized with asset management, operations planning, long term planning and network protection analysis.
  - All switchgear modeled with real and accurate description of components in the grid. Lot's of additional information about the grid model.

- **Better utilization of saved measuring data**
  - Accurate planning grid model linked to real time status and metering data.
  - Preparing of calculation model is easy by using status and metering data from the past.

- **Better visualization of data, grid status and results**
  - Attributes for grid components available through the map.
  - Visualization of real time power and voltage measurements using colours on grid model or map.

- **Common model about the future**
  - Common database about future projects where schedules are in sync through the systems.
  - Easy to build different scenarios.
Real time visualization capabilities

Relative load of transmission lines

Angle of voltage

Voltages
Further development planned to fulfil ENTSO-E CGMES needs

- planned grid outages automatically to network model
- planned powerplant outages automatically to network model
- forecasted load and generation automatically to network model
Thank you! Questions?