Flexible Data Maintenance
for CIM based Control Systems

Ingo Goldak
SIEMENS
# Flexible Data Maintenance for CIM based Control Systems

## Agenda

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Flexible Data Maintenance for CIM based Control Systems

CIM Basics

Highlights: Common Information Model (CIM)

- The Data Model is based on the IEC 61968/61970 Common Information Model (CIM) supporting the Import/Export formats like XDF, RDF, SVG, based on the W3C standard XML
  - Allows easy enterprise integration and data exchange between Control Centers and Applications of different suppliers
  - Is the base for vertical & horizontal integration

Communication Architecture of the Future
Flexible Data Maintenance for CIM based Control Systems

CIM Basics

Spectrum PowerCC’s IMM is designed for full IT-Integration

The Common Information Model CIM IEC 61970 is:

- The basis for the emerging inter-system interface architecture IEC 61968
- The basis for the Application Program Interface IEC 61970
- The control system data model harmonizing with substation communication based on IEC 61850
- Spectrum PowerCC provides more than a CIM „translation interface“

The PowerCC data model is CIM!

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Objectives:

- Standardized description of Power System Networks
- Cost / time reduction when upgrading an EMS system

Concept:

- Object oriented description

- Each power system object has a type and each type consists of attributes and links (associations)
  - each attribute has a unique name and a data type which may be restricted by enumerations and constraints
  - each link has a unique name and target type

- Power System Objects are described as instances of a particular type
Flexible Data Maintenance for CIM based Control Systems

CIM Basics

Areas covered by CIM

Power system assets:

- Generators
- Transformers
- Lines
- Switches

Topology:

- Nodes

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CIM Basics

Areas not covered by CIM

SCADA:
- Alarming
- Supervisory control

Visualization:
- single line diagrams
- dynamic colors / symbols

Communication:
- RTU protocols
- IEC 60870-6 (TASE.2 / ICCP)

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CIM Basics

Example of a Power Transformer Modeling in CIM
## Flexible Data Maintenance for CIM based Control Systems

### CIM Basics

<table>
<thead>
<tr>
<th>General Attributes</th>
<th>Value</th>
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<tbody>
<tr>
<td>Adaptive Forecast Flag</td>
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<td>Alias Name</td>
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<td>Area of Responsibility Id</td>
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<td>Breaker Type</td>
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<td>Continuous Rating</td>
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<tr>
<td>Control Enable</td>
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<tr>
<td>Current Flow</td>
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<td>DMS Flag</td>
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</tr>
<tr>
<td>Disconnects two Voltage Levels</td>
<td>False</td>
</tr>
<tr>
<td>Display Order</td>
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</tr>
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<td>Exchange Name</td>
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<td>Fault Level Rating</td>
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<td>Flow Breaker Flag</td>
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<td>In Transit Time</td>
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<tr>
<td>Message Configuration</td>
<td>E Message</td>
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<tr>
<td>NA Flag</td>
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<tr>
<td>Network Mapping Sense</td>
<td>1 - Map with normal sense of status</td>
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<tr>
<td>Nominal kV</td>
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<td>Normal Open</td>
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<td>Phases</td>
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<td>Local Name</td>
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<td>Reference Terminal</td>
<td>Terminal</td>
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<tr>
<td>Reliability Index Zone</td>
<td>Zone 1</td>
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<tr>
<td>Switch on Count</td>
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Flexible Data Maintenance for CIM based Control Systems
The Tool IMM – “Information Model Management”

- Interactive Graphic Editor
- Topology derivation
- Automatic display construction
- Interactive type editor

Data exchange between different systems of multiple suppliers

Data migration

CIM-based Data Model

System & Process-objects

Remote CC & Multi-Site

Applications

Field resources

Archive

System Management
Flexible Data Maintenance for CIM based Control Systems

The Tool IMM – “Information Model Management”

Functional Overview

- Common Information Model CIM
- Job Management
- Fully graphic-oriented data editing
- Workflow oriented and Wizard-based technologies
- Syntactic and generic data validations
- Import/Export
- On-line Activation
- Reports

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Flexible Data Maintenance for CIM based Control Systems

The Tool IMM – “Information Model Management”

Engineering Process

Engineering Phases

System Configuration
- Hardware
  - Network
  - Servers
- Software
  - 3rd PP (Oracle...)
  - Spectrum PowerCC SW
  - Mapping to HW
- System
  - System-Wide Settings
  - User Administration

Customization
- Definition of new
  - Instances
  - Attributes
  - Associations
  - Graphic Objects

Data Entry
- Import/Export
  - XDF/RDF File
  - SVG File
- Editing
  - Instances
  - Links
  - Network Diagrams

Tailoring System Delivery
Adapting Data adding Project Specials
Day to Day Activities
Flexible Data Maintenance for CIM based Control Systems
The Tool IMM – “Information Model Management”

User Interface Framework

- Web-Enabled, accessible via MS Internet Explorer
- Multi-screen and multi-window data entry sessions

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Flexible Data Maintenance for CIM based Control Systems
The Tool IMM – “Information Model Management”

Security Concept

• IMM multilevel security service is part of the overall Spectrum PowerCC security strategy
  – User authorization
  – User access rights
  – Security permissions
  – Instance Level Access Rights (ILAR)

• IMM maintains an audit record of all changes made to type and instance data
Flexible Data Maintenance for CIM based Control Systems
The Tool IMM – “Information Model Management”

Instance Level Access Rights (ILAR)

- ILAR controls users access to data instances
  - Instances are assigned to companies through ownership and/or operatorship
  - Each instance can be assigned to more than one company (e.g. shared ownership)

- Company rights
  - VIEW (any company)
  - MODIFY (company which has operatorship rights)
  - MODIFY&ASSIGN NEW RIGHTS (company which has ownership rights)

- Clear responsibilities and rights within the whole data model
- Ensures data integrity within hierarchical models
- Conflicts within model merge processes can be easily detected

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For model data the industry standard data formats XDF and RDF are supported

- Bulk data and incremental updates

For worldmaps and GIS data the industry standard SVG Graphic Exchange Data format is available

- It makes use of the SVG standard xml format, as the language for describing the characteristics of graphical objects in schematic diagrams
- It builds on CIM-XML model data exchange format by referring graphical objects to domain objects
- It does not enforce using the same style of object representation in both the sender and receiver system

Highlight: Import / Export based on W3C standard XML
Flexible Data Maintenance for CIM based Control Systems
The Tool IMM – “Information Model Management”

Highlights

- Object Oriented engineering system with IEC compliant implementation of power system data model (CIM - IEC Standard 61970)
- With the CIM data model IMM supports the future standards of horizontal and vertical integration within Spectrum PowerCC
- Web-Enabled User Interface
- IMM provides a consistent view for maintaining all engineering data tasks including graphical data
- Data maintenance without influencing Spectrum PowerCC realtime operation

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Flexible Data Maintenance for CIM based Control Systems

IMM Generic Data Model

1. CIM Basics
   - Objectives and Concept
   - Areas covered by the Common Information Model (CIM)
   - Areas not covered by the Common Information Model (CIM)

2. The Tool IMM - Information Model Management
   - Overview
   - Generic Data Model
   - Job Concept
   - Interfaces

3. IMM Generic Data Model
   - Overview
   - CIM Definitions
   - Additional Definitions
   - Graphics

4. Model Maintenance Challenges
   - Multi-User Environment
   - Transfer to Realtime System

5. IMM Interfaces
   - PowerCC Control Center
   - Foreign Control Centers
   - SOA Environment

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Object Data Model

**Standard Object Types**
- Standard delivery with the product
- Based on CIM standard definition

**Application Specific Object Types**
- Dependent on industry sector and division
- Provides all the required additional object types (templates)

**Customer-entered Objects (Instances)**
- Are entered by the user during the data input phase and describe the user process (networks, power stations, etc.)
- Based on prepared object types (templates)
- All the data points build on it (instances)
- Are further maintained by the user

**Examples:**
- Standard Object Types: generator, transformer, line
- Application Specific Object Types: server, displays, alarming, communication
- Customer-entered Objects (Instances): Customer generator West-A, Customer transformer XY, Customer display of substation B
Flexible Data Maintenance for CIM based Control Systems
IMM Generic Data Model

Graphics Editor

- Fully integrated Graphics Editor
  - MS Windows look and feel
  - Worldmap concept with a 32 layer drawing pane for vector-oriented display design
  - Zooming and decluttering
Flexible Data Maintenance for CIM based Control Systems
IMM Generic Data Model

Graphics Editor (continued)

• Fully integrated Graphic Editor
  – Data model network topology can be derived from the network diagrams
  – Technological Copy / Paste of objects, graphical and source data is maintained together
  – Extensive clipart library and template library for all areas
  – Best usability for data input by workflow-oriented and Wizard-based technologies

⇒ Simplified graphical data entry
Flexible Data Maintenance for CIM based Control Systems
IMM Generic Data Model

Graphics Editor (continued)

- Technological Editing
  ➔ Drag&Drop from Graphical object library
  ➔ Enter parameters, e.g. substation name, busbar name

- Technological Editing
  ➔ Select existing station/feeder
  ➔ Copy and Paste
Flexible Data Maintenance for CIM based Control Systems
IMM Generic Data Model

Graphics Editor (continued)

• Technological Editing

  ➔ Select graphical objects which should be connected

  ➔ Connect

• Graphical Interface should always be the primary interface to graphical & technological editing

  ➔ Better User Experience based on better performance (WYSIWYG)

  ➔ Increased engineering performance
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**Flexible Data Maintenance for CIM based Control Systems**

**IMM Job Management**
Flexible Data Maintenance for CIM based Control Systems
IMM Job Management

**Engineering Process**

**Engineering Phases**

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**Tailoring System Delivery**

**Adapting Data adding Project Specials**

**Day to Day Activities**
Flexible Data Maintenance for CIM based Control Systems
IMM Job Management

Highlights: Job Management

• Job Management allows multiple and simultaneous data modifications without any impact on the runtime system
  – Job Interlocks prevents multiple users from editing the same data
  – Automatic change detection generates Change Log files describing all changes
  – Activation of a job transfers the changed data to the run-time system and notifies those applications affected by the change
  – A clearly laid out Job History bookkeeping (e.g. job creation, job activation, undo) is available

• Two flavors of Job’s exists
  – Lock Jobs
  – Time Based Model Jobs (optional)

➤ Quick, easy and secure data maintenance
➤ No interrupt of process control during on-line activation and undo function

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Flexible Data Maintenance for CIM based Control Systems
IMM Job Management

- Extensive Data Validation before start of activation in on-line system
  - Syntactic and generic data validations, which can be extended by user-defined constraints
  
  ➔ Quick, easy and secure data maintenance

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Flexible Data Maintenance for CIM based Control Systems

IMM Job Management

- User ORANGE creates a Job and extends the current data model
  - He sees his changes and the current data model

- User PINK creates a Job and modifies the current data model
  - He sees his changes and the current data model
  - User ORANGE does not see changes made by User PINK and vice versa

- User ORANGE activates his Job
  - His changes are now in the current data model
  - User PINK does now see the changes made by User ORANGE

- User ORANGE deletes his Job

- Data Model changes within Job’s

- Current Data Model
Flexible Data Maintenance for CIM based Control Systems
IMM Job Management

- User PINK is still working on his Job
- User GREEN creates a Job and tries to modify Instances User PINK has already modified
  - He is able to create a Job and sees the current data model
  - Instances already modified within the User’s PINK job are locked and cannot be modified by him
- User PINK activates and deletes his Job
  - His changes are now in the current data model
  - User Green does now see the changes made by User PINK
- User GREEN is now able to modify Instances formerly modified by User PINK
- Data Model changes within Job’s
- Current Data Model
Flexible Data Maintenance for CIM based Control Systems
IMM Job Management

Time Based Models - Benefits

• Time based models add the ability to reflect the evolutionary nature of work
  – Time based models allow more flexibility in scheduling data changes to reflect scheduling of projects
  – Impact of delays or re-scheduling of projects can be managed more effectively

• Time based models allow for maintaining a history of data changes
  – Models can be archived for forensic analysis
  – Historical views of the data/model are possible
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IMM Job Management

Time Based Models – Past, Present, Future

• **Present**
  - Present day’s model serves as a base case

• **Future**
  - User selects a date in the future
  - System selects all Jobs that are scheduled to go into service on/before the selected date
  - User de-selects Jobs that may be delayed
  - System selects model of today as the base case, and adds all Jobs to for the model as it will appear on the future date

• **Past**
  - Models that go into production are archived
  - User can select a date in the past
  - All changes from the present to the past date are “undone” to create the model as it was on the selected date
Flexible Data Maintenance for CIM based Control Systems

IMM Job Management

- Current Data Model (NOW)
- Data Model changes within Jobs
- Job’s scheduled for June 1st
  - Users PINK and ORANGE do have scheduled Jobs for the same date
  - No basic difference to Lock Jobs
- Job’s scheduled for June 15th
  - User YELLOW does have a scheduled Job after Jobs for June 1st
    - He sees also the changes from Users PINK and ORANGE
- Job’s scheduled for June 28th
  - User GREEN does have a scheduled Job after Jobs for June 15th
    - He sees all changes from Users with scheduled dates before
    - Conflicts are presented by the system, solving is up to the User
- Job’s scheduled for July 4th
  - User BLUE does have a scheduled Job after Jobs for June 28th
    - He sees all changes from Users with scheduled dates before
    - Conflicts by User YELLOW and GREEN are not presented, he sees the last scheduled change
- Current Data Model (NOW)
Flexible Data Maintenance for CIM based Control Systems
IMM Job Management

- Past Models are VIEW ONLY
  - No Change of History
Flexible Data Maintenance for CIM based Control Systems

IMM Job Management

- Changes can be re-scheduled to an earlier date
- Changes can be re-scheduled to a later date

- Validation is performed during re-schedule requests to enforce model persistency

Example: June 11\(^{th}\) project modifies data being created during May 22\(^{nd}\) project
Lock Jobs and Time Based Model

- Example: a new substation is put into operation in several phases
  - first phase: few lines and one transformer
  - second phase: additional lines and second transformer
Flexible Data Maintenance for CIM based Control Systems
IMM Job Management

Lock Jobs and Time Based Model

- Lock Jobs
  - phase two extension can only be put into a job if phase one is already completed (job is activated and finalized/deleted)
Flexible Data Maintenance for CIM based Control Systems
IMM Job Management

Lock Jobs and Time Based Model

- Time Based Model
  - phase two extension can be put into a job as soon as the job of phase one contains the necessary basics (e.g. substation)
Flexible Data Maintenance for CIM based Control Systems
IMM Job Management

Highlights

• Job-based data maintenance without influencing PowerCC realtime operation

• Job management enables you to work on different engineering tasks at the same time without conflicts

• IMM is the right tool for quick and faultless input and maintenance of your data

• No interrupt of process control during on-line activation and Undo-function
# Flexible Data Maintenance for CIM based Control Systems

## IMM Interfaces

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Flexible Data Maintenance for CIM based Control Systems
IMM Interfaces

Import / Export based on Excel (Examples)

- Excel Import / Export
- XDF Import / Export

SIEMENS
Flexible Data Maintenance for CIM based Control Systems

IMM Interfaces

IMM within Foreign Systems

Control Center

- IMM can be used with every foreign system
  - Data model according CIM
  - Data exchange based on XDF and CIM RDF Export / Import
  - Gateway provided by foreign systems translates CIM into proprietary formats
  - Data activation is handled by foreign system according to its specifications
Flexible Data Maintenance for CIM based Control Systems

**IMM Interfaces**

**Enterprise Service Bus (ESB) – SOAP Event and Messages**

- **Outage Scheduler**
  - Load Forecast
- **Short Term Generation Scheduling**
  - OEP
  - HCM
  - TM
- **Bilateral Transaction**
  - OS
  - LF
  - CDS
  - PDG
  - OEP
  - HCM
  - TM

**High Speed Bus (HSB)**

- **OS**
  - SOA-Adapter
- **LF**
  - SOA-Adapter
- **CDS**
  - SOA-Adapter
- **PDG**
  - SOA-Adapter
- **OEP**
  - SOA-Adapter
- **HCM**
  - SOA-Adapter
- **TM**
  - SOA-Adapter
- **IS&R**
  - SOA-Adapter
- **SCADA**
  - SOA-Adapter
- **AGC/LFC**
  - SOA-Adapter
- **TNA**
  - SOA-Adapter
- **OTS**
  - SOA-Adapter
- **IS&R**
  - SOA-Adapter
- **SCADA**
  - SOA-Adapter
- **AGC/LFC**
  - SOA-Adapter
- **OEP**
  - SOA-Adapter
- **HCM**
  - SOA-Adapter
- **TM**
  - SOA-Adapter

**Spectrum PowerCC Advanced (SCADA/EMS)**

- **IMM**
  - HSB-Adapter
  - SOA-Adapter
- **TNA**
  - HSB-Adapter
  - SOA-Adapter
- **OTS**
  - HSB-Adapter
  - SOA-Adapter
- **IS&R**
  - HSB-Adapter
  - SOA-Adapter
- **SCADA**
  - HSB-Adapter
  - SOA-Adapter
- **AGC/LFC**
  - HSB-Adapter
  - SOA-Adapter
- **OEP**
  - HSB-Adapter
  - SOA-Adapter
- **HCM**
  - HSB-Adapter
  - SOA-Adapter
- **TM**
  - HSB-Adapter
  - SOA-Adapter
- **OS**
  - SOA-Adapter
  - HSB-Adapter
- **LF**
  - SOA-Adapter
  - HSB-Adapter
- **CDS**
  - SOA-Adapter
  - HSB-Adapter
- **PDG**
  - SOA-Adapter
  - HSB-Adapter
- **OEP**
  - SOA-Adapter
  - HSB-Adapter
- **HCM**
  - SOA-Adapter
  - HSB-Adapter
- **TM**
  - SOA-Adapter
  - HSB-Adapter

**Engineering Model and Data (CIM)**

- Information Exchange Model (CME)

**Operations**

- Real Time Data Collection and Processing

- Long Term Scheduling

**Bilateral Transaction**

- AGC
- CDS
- CFE
- CIM
- CME
- HCM
- IMM
- IS&R
- SCADA
- OEP
- OMS
- OTS
- PDG
- TNA

**Flexible Data Maintenance for CIM based Control Systems**

- Automatic Generation Control
- Calculated Dispatch Schedule
- Communication Front End
- Common Information Model
- CIM Market Extension
- Historical Calculation Modes
- Information Model Manager
- Information Storage and Retrieval
- Load Forecast
- Load Frequency Control
- Operational Economic Planning
- Optimal Maintenance Scheduling
- Outage Scheduler (Generation/Transmission)
- Operator Training Simulator
- Preliminary Dispatch Generation
- Transaction Management
- Transmission Network Application
Flexible Data Maintenance for CIM based Control Systems

**IMM Interfaces**

Outage Scheduler
- Load Forecast
  - SGI
  - SOA-Adapter
  - IMM
  - HSB-Adapter

Short Term Generation Scheduling
- Support Functions
  - AGC/LFC
  - SCADA
  - IS&R
  - OTS
  - IS&R
  - NAD
  - FE
  - HSB-Adapter

Enterprise Service Bus (ESB) – SOAP Event and Messages

Ensemble of adapters for various applications:
- AGC Automatic Generation Control
- CDS Calculated Dispatch Schedule
- CIM Common Information Model
- CME CIM Market Extension
- FE Front End
- IMM Information Model Manager
- IS&R Information Storage and Retrieval
- LF Load Forecast
- LFC Load Frequency Control
- OS Outage Scheduler (Generation/Transmission)
- OTS Operator Training Simulator
- TNA Transmission Training Application
- TNA Transmission Network Application
Flexible Data Maintenance for CIM based Control Systems

Spectrum PowerCC Information Model Management

- The Spectrum PowerCC Information Model Management provides the functionality to enter and maintain all power system-related data.