IMPLEMENTING CIM MODEL IN DISTRIBUTION SYSTEM OPERATOR

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ABSTRACT

This paper describes our CIM project, which includes integration of technical information systems using CIM standards, detected challenges during the project, our approach to them and outcomes. Detailed are described custom CIM model extensions, establishing secure and safe communication, role of CIM repository as database and performance, reliability issues. This project will significantly enhance the interoperability of different information systems and thus improve the data organization and its transparency.

INTRODUCTION

Elektro Ljubljana, as the biggest electricity distribution company in Slovenia, provides energy to more than 330 thousand users. The main part of our mission is to provide a safe, reliable, high-quality and sustainable system for distributing electricity.
As the matter of fact that digital age, energy revolution are the world we are living now, utilities should become much more than system operators for distribution of electrical energy. They operates with a huge amount of useful data that are not exploit enough.
Therefore Elektro Ljubljana started with a project that integrates the main information systems from operational view and enables data exchange. The aim of this project is to build vendor independent integration platform by integration of information systems (further IS) using CIM standards, (re)define business processes, define the source systems for each group of data, unify data models for exchanging information between systems and improve data quality using data validators.
The most important systems from the operation view (SCADA/DMS, GIS, CIS, HES, Lightning/Strike correlator and Asset Management System), have been integrated in this project. So far ISs have been integrated using point-to-point integration pattern which enhances data inconsistency, is usually not compliant with GDPR regulation and is under full control of IS vendor.
The new integration platform is based on CIM standard [1], [2] and follows the recommendations and good practices [3], [4]. Backbone of new integration platform is enterprise service bus. Adapters map data between custom and CIM format and enables communications between the ISs. Current network model is persisted in CIM repository for faster access and further data analyses. Important aspect presents the mechanism for security of integration platform, which is not subject of debate in this article.
In the next chapters some of the challenges as well as solutions and outcomes for them are presented.

1 DETECTED CHALLANGES

During the project lifetime some of the below mentioned problems/decisions were detected. Answers to many of them were found in CIM standard (IEC 61970, IEC 61968, IEC 62325) especially in [5].
Firstly the architecture of integration platform needed to be defined. Following the recommendations of the IEC 61968:100 standard enterprise service bus has been used to orchestrate SOAP messages between adapters and ISs.
As matter of fact that CIM integration platform integrates IT an OT systems the question about the security was examined.
Integration of asset management system and lightning/stroke correlator system could not be modelled using only CIM standard. Therefore necessary extensions to standard model were added.
Adapter, which translate custom data format to CIM standard were developed using java language.

1.1 Partial interoperability among different vendor product and CIM data model

CIM is an implementation agnostic model used by electric utilities to define classes describing the network model and content of business processes in utility. However due the variety of business processes in some cases CIM standard doesn't support to model all needed information for a given use case. In this case, standard should be extended.
Next challenge is related to "many to many" relationship (association) between classes. Class (for example object A) can have relationship to none, one, or more classes (for example object B). In case object A has a relationship to more objects (B1, B2, B3) reference need to be written in B1, B2, B3 objects. Problems occurs when many (A1, A2, A3) to many (B1, B2, B3) relationship need to be implemented.

1.2 General Data Protection Regulation

The EU General Data Protection Regulation (GDPR) is the most important change in data privacy regulation in

20 years [6]. The Regulation is binding and binding for all Slovenian organizations since the end of May 2018. All data transactions must be in compliance with GDPR. Another important aspect is security of integration platform. Before IS can send message the secure connection (https) between client and server must be established. Further the client must have appropriate credentials to access contents.

1.3 Single source of truth

Old point to point integrations have more master systems for the same type of data. I.e. same data are manually entered in SCADA/DMS system and GIS, which causes data inconsistency and duplication of work. Some of the integrated system i.e. SCADA/DMS need to have acces to full network model on demand. Building full network model from the GIS on request takes time and is not accaptable to make so much data traffic every time the request is send.

1.4 Performance, reliability issue

Due to importance of integration platform (i.e. it connects the critical ISs) it must be high reliable. Server failure can not cause integration platform breakdown. Expectation for integration of additional ISs is indicated so the platform must carry on more and more data traffic.

2 OUR SOLUTIONS

Regarding the aforementioned challenges this chapter depicts our solutions. More focus in on modeling extensions, because it is common problem. These solutions are not the only one possible, but it may contribute the best result.

2.1 CIM extensions

Extensions of CIM standard are in generally not desirable, but in case of gaps between the current state of CIM and integration requirements, they might be the only solution. It is not against the standard when the extensions are used properly.
CIM Primer Third Edition (Section 10) [7] recommends to model extensions by connecting new (custom) class to standard class using inheritance (generalization) and assigning additional attributes to new extended class. The similar way to model extensions uses Spanish railway infrastructure manager (ADIF) in Spain [8]. Most of the time only leaf classes are subjects of extensions using inheritance. Associations could be applied only between the extended objects.

CIM primer Third Edition also allows to add custom class as a parent class to standard class that already has its parent. Implementation of this kind extension is not supported using most popular program languages, because child class can extend only one parent class in java and .NET.
It is not recommended to add attributes directly into standard classes nor making new relationships between standard classes nor adding new relationship between extended and standard classes. Even though other vendors uses this kind of extensions too.

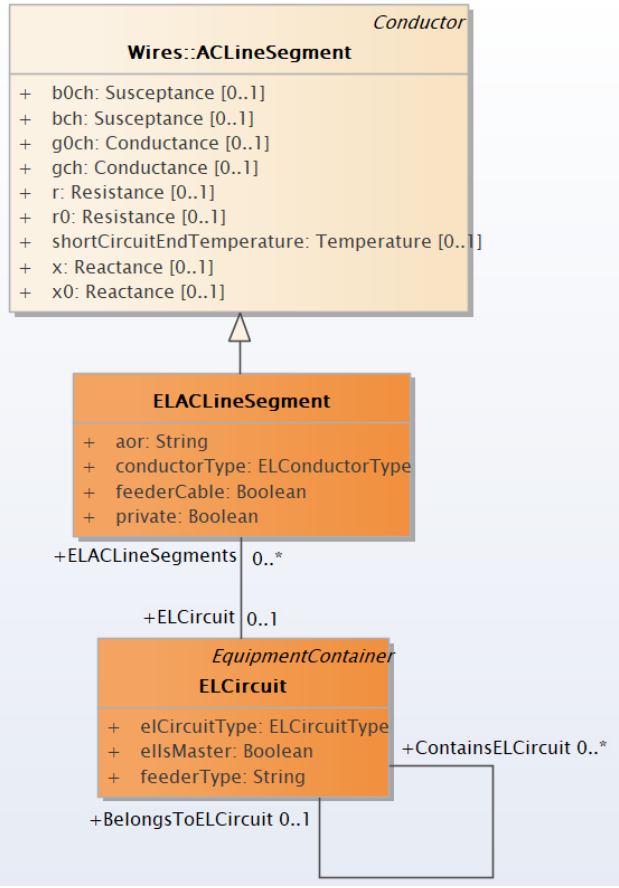

Image 1: Example of Elektro Ljubljana custom extension

Object's namespaces could be used as a mechanism to separate extensions from standard objects or as versioning mechanism as recommended in [9], chapter 2.2. Our solution uses namespaces for versioning the CIM profiles.

The whole process of modeling extensions starts with adding custom objects and attributes to them and associations regarding before mentioned rules.
It is preferred to have extended classes separated from the standard one (e.g. in Enterprise Architect it should be in separate folder under the same project).
After that, whole model (standard CIM model and extension folder) is exported as xmi file from Enterprise

Architect and imported into CIMTool. Namespace of each profile contains date time and IS name. Profiles are made using CIMTool and present subsets of before exported model. Completed CIM profile is exported as xsd, rdf file. Based on xsd file, the specifications for web services should be generated regarding the IEC 61968-100.

2.2 Users authentication and authorization

Security of personal data is guaranteed with responsible management of it: In practice this mean not writing personal data into the CIM repository database if it isn't necessary. Otherwise personal data could be written encrypted in it. Every user (in our project each IS represent one user) has its own credentials, which allows user to access the database via web-services on demand.
Access to personal data through web services is monitored via event logging feature within the Talend ESB.

To prevent unauthorized access to integration platform multi factor authentication. This is authentication with certificate and password. In first step, client and server authenticate each other's certificates. If successful, the secure connection between two of them are established. The second step is verification of client rights using username and pass. Client send its username and password as well as topic to access. Request for verification of user rights is send to AcitveDirectory, which creates token that allows user access to requested topic. Each token has limited time validity

2.3 Redefined master systems for each type of data

Before redefining the master system for each type of data all current bussines processes must be defined. GIS is ussualy master for network model, CIS for information about usage points and customers, MDM for meter readings, there is also asset manadgement system. In case there is more than one IS that acts as a master IS for the same type of data, bussiness process must be redefined. There could be only one IS that primarly owns particular type of data, all other IS could acces these data through integration platform.
Using common repository for storing limited data about the newtork model, assets, usage points turned out to be a good practise [3], [4].
It is ussualy connected to ESB just like one of the IS. CIM repository has mechanism to export full network model on request in rdf format. Every object, that is written in to CIM repository get its global ID (mRID), unique through whole integration platform.

2.4. Clustering with Load balancing

Addressed performance and reliability issue is solved using the cluster of servers managed by load balancer. Integration platform consist of a group of more (currently 3) ESB servers that orchestrate the messages between the adapters. Load balancer, located on separated server in high reliability mode, tells the adapter to which ESB server the message should be sent. In case if one of the ESB servers failed or is busy (not reachable) service locator i.e. load balancer detect it and allocate messages to the next available ESB server.

3 OUTCOME

3.1 Unified data models

Following the rules for exchange modelling bellow mentioned benefits are obtained:

- User has possibility to export extended object as standard object with standard attributes and relationships, without attributes in extended object. It is often done by casting child object into its parent object.
- Keeping extensions in separate folder makes easier to upgrade the version of the standard with a newer one. All that is need to be done is simply copy folder of extended object and its relationships into a project with a newer standard version.

Adding extensions into data model enhance complexity of modelling process.

3.2 Secure integration platform

CIM environment combines information systems from the business and process (SCADA-DMS) enviroments and so representing a potential target for a hecker attack. Using users authentication and authorization, we prevent third parties persons to access database or any of the IS through the Enterprise Servise Bus

3.3 Data consistency

Following the principle of "single source of truth" problems about data inconsistency and process duplication vanished.
Gathering all data about assets enable further quality analysis, like calculation of asset health care index for preventive maintains or network reconstruction planning.

Use of CIM repository as main dabtabase center redecuse number of queries to origin IS, improving perfomance of integration platform.

3.4. Redundancy, scalable platform

Used sollution enables load balancing and high redundancy. In case there is a need to have better performance or higher redundancy it is possible to simply add additional server to the group of ESB servers. It also enables uninterrupted server upgrades.

Acknowledgments

This paper expose the most common problems like how to model extensions, achieve high availability, load balancing, security and so on. During the CIM integration project many of the possible solutions have been tested. The best of them has been used and described above.
During the project new use cases for integration are noticed. Participating in all phases of integration project, from making specifications to developing adapters is highly recommended. Knowing how to integrate other systems is essentially because integration of information systems is not one time project.

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