A Data Model for Energy Decision Support Systems for Smart Cities
The Case of BESOS Common Information Model

G. Anadiotis, E. Hatzoplaki, K. Tsatsakis and T. Tsitsanis
Hypertech Energy labs, Perikleous 32, Chalandri, 15232, Athens, Greece

Keywords: Energy Management System, Common Information Model, IEC 61970, Design, Methodology, Data.

Abstract: Integrating Energy Management Systems is a necessary task in order to be able to offer a range of services for citizens and public authorities. This task requires integration at the data level in order to expose data coming from different systems in a unified way. In this paper we describe the creation of a Common Information Model to unify disparate Energy Management Systems in the context of the BESOS project. We identify related work, describe design decisions and methodology and give an outline of the data model itself, based on profiling and extending the IEC 61970 standard.

1 TOWARDS A CIM MODEL FOR EMS MANAGEMENT

1.1 Integrating Energy Management Systems

Energy Management Systems (EMS) deployed today in typical districts that are consuming or producing energy suffer from a major drawback: no matter how well-thought or sophisticated they may be, they lack integration. This drawback hampers their usability for all potential classes of users, as the development of end-user applications and decision support solutions cannot be based on a holistic view of underlying data.

BESOS (Building Energy Decision Support Systems for Smart Cities) is an E.U. Research and Development project (BESOS, 2014) that proposes the development of an advanced integrated management system which enables energy efficiency in smart cities from a holistic perspective. The goal for BESOS is to enable the integration of disparate EMSs to share data and services among themselves and with external third party applications through an open trustworthy platform.

The BESOS CIM consists of the necessary data models addressing different Smart Grid components and respective information elements of varying granularity that ensures the semantic and syntactic interoperability between the various components comprising the BESOS energy management framework. In this paper, we give an account of the work performed in order to deliver the BESOS CIM as a critical aspect towards the interoperability of diverse energy management sources.

The paper is structured as follows. In Section 1, we introduce the domain and establish the need for a common information model. In Section 2, we give an overview of related work and examine its impact on the design decisions made. In Section 3, we outline the data modeling methodology used for the development of BESOS Common Information Model. Furthermore in Section 4, we present the BESOS CIM itself while we finally conclude and present a future outlook of the work in Section 5.

1.2 The Need for a Common Information Model

The main goal of the BESOS project is to create a centralized infrastructure to deliver services and applications for Smart Cities. More specifically, the project involves a number of Gateways collecting and delivering Smart Grid data from EMSs, a Middleware layer aggregating and exposing that data via APIs and a services layer delivering end user applications on top of the data (Figure 1). The task of the Middleware layer is two-fold: on the one hand, to integrate data coming from different Gateway sources, and on the other to offer Services to the application layer. The Middleware Layer implementation uses a data meta-model for this, based on simple classes: Entity, Metric, Attribute,

Anadiotis G., Hatzoplaki E., Tsatsakis K. and Tsitsanis T..
A Data Model for Energy Decision Support Systems for Smart Cities - The Case of BESOS Common Information Model.
DOI: 10.5220/0005422800510059
In *Proceedings of the 4th International Conference on Smart Cities and Green ICT Systems* (SMARTGREENS-2015), pages 51-59
ISBN: 978-989-758-105-2

Message and Strategy which are further adapted on the different applications examined.

In mass scale applications though, we need to weight the benefits and drawbacks for this option: simplicity for Gateway systems integration vs. transferability over applications development. In the end, simplicity for application development prevailed, as after it would be hard for a healthy application ecosystem to be developed on top of this Middleware if it only supported a meta model.

So the meta model is still used internally to integrate Gateways, but on the upper layer the APIs exposed to application developers use a fully blown data model as defined in the BESOS CIM. Thus, the existing meta model is mapped to the BESOS CIM to provide a semantics-based model.

2 STATE OF THE ART ANALYSIS AND IMPACT ON BESOS CIM

2.1 Introduction

In order to proceed with the design of the BESOS CIM the approaches taken by other projects in the domain as well as related standards were examined and further summarized.

2.1.1 Relevant Data Modeling Work

As the main focus on the E.U. is the provision of an interoperable operation of EMSs, different approaches have been adopted. A set of indicative projects from EE semantics Group (eeSemantics, 2013) was reviewed in terms of data modeling.

A first approach to the definition of a common model among different components was defined as part of FIEMSER project. FIEMSER introduces a Data Model formalized in UML diagrams, describing the object/relational mappings between the data components, persisted using ORM frameworks (Laresgoiti, 2011). The FIEMSER approach informed BESOS methodologically and the respective data model was considered as it has been expressed in UML. In addition, concepts related to User & Groups Permissions were adopted from FIEMSER.

A framework conceptually similar to BESOS is the one from SmartKye Project. It specifically targets public authorities responsible for public services demanding energy. The SmartKye data model is defined as XSD models following a meta-modeling approach and its main concepts are Attribute, Entity, Message, Metric and Strategy (García, 2013). In addition, concepts related to the market operation were also defined in BESOS CIM.

A key project towards the incorporation of heterogeneous energy assets in district level is COOPERATE. For this purpose an open, scalable neighbourhood service and management platform was developed and a substantial part of it is the Neighbourhood Information Model (NIM), as it serves as a common information source for the developed services (Look, 2013). The design of the

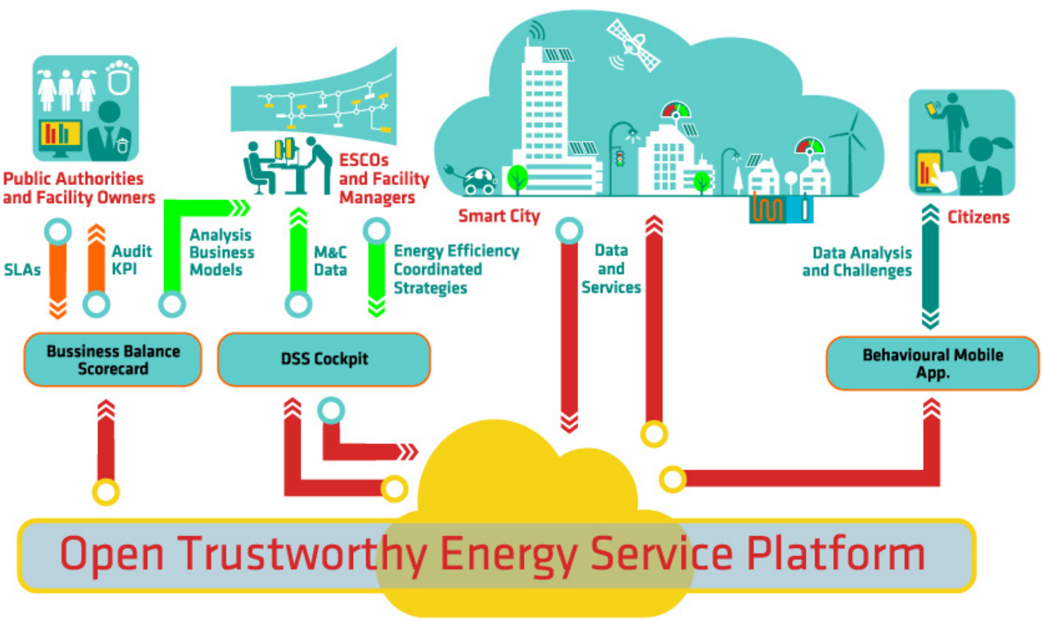

Figure 1: The BESOS project platform overview.

NIM followed some basic principles that informed the BESOS approach as well: reuse and extension of existing Information Models from related projects and design of a flexible and extensible NIM.

In addition to the common ground methodological approach addressed in previous references, the KnoholEM project focuses on knowledge-based energy management for public buildings and adopts an ontological modeling approach (Häfner, 2013) which divides its data model in 2 parts, namely the generic ontology (GO) and the building-specific ontology (BSO).

KnoholEM was taken into account towards the modeling of building from the links established mainly with IFC (ISO 16739, 2013), but also with gbXML. BuildingControl related concepts were adopted from IEC 61970 and further included in BESOS CIM.

2.1.2 Alignment with Standardization

A key objective for BESOS is the transferability of the whole solution. Therefore, it is critical to define common and reusable interfaces by adopting common standards in the Smart Grids domain. During the State of the Art analysis a list of standards was reviewed (VDI, CityGML, IFC) while IEC 61970 and IEC 61850 are presented as the most important and close to BESOS approach.

The IEC 61970 series of standards (Alan, 2007) deals with the application program interfaces for energy management systems (EMS) and defines a common vocabulary and basic ontology for aspects of power industry. Since there is UML formalization on IEC CIM it can set the basis for BESOS concepts. Though IEC CIM is a well documented and massively applied standard, is not adopted as-is in its entirety. Firstly, it is a very extensive model with many of its concepts not being relevant for Smart-cities applications. On the other hand, there are certain concepts (SLAs, Business roles, Contracts), to be modelled in BESOS, that are missing from IEC CIM, therefore the model needs to be extended.

On the other hand, IEC 61850 (Mackiewicz, 2006) standard for the design of electrical substation automation has raised special interest thought the modeling of primary process objects as different standard logical nodes which can be further grouped under different logical devices. The IEC 61850-7-420 (IEC 61850-7-420 ed1.0, 2011) has recently been formalized by means of UML, covering some types of DERs. Even though there are not standardized (XMI) artifacts that can be reused for modeling purposes, the details on assets modeling offer a surplus towards the integration on the proposed framework. On the other hand, it is well-known that IEC 61850 and IEC 61970 have inconsistencies (Ling, 2013), making the use of both problematic. There have been efforts for the harmonization of the two standards (EPRI, 2006) (Kim, 2013) however differences in Configuration and Run Time models mean that the result is not fully harmonized or easy to use. Thus, we have adopted IEC CIM as the anchor point for the BESOS CIM while specific attributes coming from IEC 61850 are further adapted on BESOS framework.

2.2 BESOS Design Methodology

Following the need for a fine-grained information model and taking into account the relevant work of a multitude of related research projects and existing standardization on the field of Smart Grids, a common ground methodology has been devised for the definition of BESOS CIM. The main points of the approach are further provided.

2.2.1 Modular Design

For a domain that is extensive, as is the case for BESOS and Smart Grid domain, a modular approach (Schutte, 2011) "*...**helps** organizing data model concepts in more manageable chunks...*" that are easier both for modellers to process as well as for users to comprehend.

While at times it may be convenient to have a single point / file of reference for the entire data model, for a model that is as extensive as the BESOS CIM this becomes impractical. Thus the modularization approach has also been adopted by the data modeling work in BESOS to the definition of the main concepts of interest.

2.2.2 Common Ground Modeling Approach

While the adoption of advanced domain modeling techniques and formalisms such as ontologies seems feasible for BESOS case, this approach is not preferable for our case due to the requirement for the transferability of BESOS solution. IEC CIM - a UML based modeling approach- set the basis for the proposed model while some performance concerns lead us to adopt a combination of XML and UML for the data modeling methodology.

2.2.3 Meta-modeling Approach

One of the main requirements on the modeling methodology is to proceed with models that are easily adapted to existing software applications towards the direct transferability of the framework. This has in fact been one of the key decisions shaping the data modeling work, as the contrast between a compact meta-model (Apolinarski, 2014) and an explicit data model was taken into account.

Towards this direction, BESOS CIM covers parts of the domain that are deemed stable and universal (e.g. instances of Power Generating Units) while the ones that are more dynamic in nature (e.g. instances of metrics) are dealt with by means of meta-modeling. Considering the plus and cons for each approach, the decision was reached to go for an explicit data model , while adopting the meta-model approach for parts of the model that are of a truly dynamic nature.

2.2.4 Integration of Standards

As BESOS framework is proposed for the management of assets on smart city level, it became evident that BESOS would not proceed to model Building structure in detail. Therefore, a great deal of standards under consideration (VDI 3813 (Technical rule, 2013), CityGML (CityGML 2.0) and IFC) became less relevant under this light, as they focus on Building structure. In addition, specific business aspects related to Demand Response (e.g. OpenADR 2.0b) were not deemed to be critical due to the need to proceed with generic interfaces on application level.

Thus, the choice came down to the - *supported by IEC committee (IEC 62357, 2011)* - IEC 61850 & 61970, as the standards that are more closely related to the domain that is the focus of BESOS. However, due to the fact that there is well-known semantic incompatibility between them, and in order to avoid getting entangled in the disproportionate effort required to address this issue, the choice was made to base our approach on IEC 61970 (IEC CIM) while to further enhance our model with attributes from IEC 61850-7. A number of important factors (Adoption and community support, Tooling support, Domain relevance) were also considered.

Therefore, the decision was reached to base the BESOS CIM on the existing standards following the tension for alignment of new applications with the existing ones. Prior to the detailed presentation of CIM, a beyond the State of the Art Section summarizes the innovation of BESOS framework.

2.3 BESOS CIM beyond the State of the Art

BESOS promotes the efficient integration of flexible demand with distributed generation through a fully fledged CIM that ensures the interoperability (syntactic and semantic) between the applications and the distributed EMS. This is the main innovation of the proposed framework, standing on top of the existing models towards the provision of a unified approach for the management of diverse EMS. In order to highlight the innovation impact of BESOS CIM, we consider the Smart grids map representation as proposed by IEC (IEC Smartgrids map, 2014) and CEN / CENELEC (M490, 2013).

The following tables visualize how the different models and standards adapt to the main domains proposed by IEC covering different attributes from EMS management to the prompt market & enterprise operation on Smart-cities era.

Table 1: Domain based Comparative Overview.

Data Model	Domains			
	DER/ Customers	Generation	Distribution	Transmission
FIEMSER	x	x		
SmartKye	x	x	x	
COOPERATE	x	x		
KnoholEM	x	x		
VDI 3813	x			
IEC CIM		x	x	x
IEC 61850	x	x		
CityGML	x			
BESOS	x	x	x	

Table 2: Zone based Comparative Overview.

Data Model	Zones			
	Market	Enterprise	Operation	Field/ Station
FIEMSER		x	x	x
SmartKye		x	x	
COOPERATE	x	x	x	
KnoholEM			x	x
VDI 3813				x
IEC CIM	x	x	x	
IEC 61850			x	x
CityGML		x		
BESOS	x	x	x	x

3 CIM MODELING APPROACH

Developing a data model for an integration project is a complex task, not only because of the complexity of the domain, but also due to the different views on data and business processes. The methodology used to develop the BESOS Data Model was devised taking into account best practices in the domain, both in terms of techniques as well as in terms of overall approach. The respective steps towards the delivery of BESOS CIM are further analyzed setting the overall modeling framework.

Consultation with Stakeholders: Following the initial selection of assets, partners responsible for managing EMSs were asked to define EMS functionality (interfaces) and managed objects.

Modeling based on IEC CIM: At this phase of the methodology CIMTool (CIMTool, 2012) was leveraged in order to browse the IEC CIM standard and try to identify concepts that could be adopted by the BESOS CIM.

Data Model Modularization and Sanitization: As CIMTool produces a monolithic form (single XSD file), we introduced a phase in the process in which the contents of the resulting XSD file were divided into a number of separate XSD files referencing each other.

Additional Modeling Concepts: At the end of the modularization and sanitization phase, a few concepts needed to express the BESOS CIM that were not part of the IEC CIM, had to be added manually in the XSDs (work that distinguishes the BESOS CIM from IEC CIM). The goal of this process is to address the whole list of concepts defined by users but still be in line with standardization.

Information Model Visualization: We adopted an approach in which we formalized the data model using XSD and visualized it using UML.

4 BESOS COMMON INFORMATION MODEL

BESOS CIM was developed using the methodology introduced in the previous section. The data model was broken down in 7 logical modules (Location, Users, Assets/ Structure, Metrics, Documents, Control) in order to facilitate cohesion and reusability. In the following, we give an overview for each module while also additional attributes that define the role of each module within BESOS framework are provided.

4.1 Location Module

This module includes concepts used to capture information related to location, as well as general concepts that are used throughout the data model and have been included here for convenience.

Identified_Object: This is the concept adopted from IEC CIM and is the high level generic object inherited in all IEC CIM classes.

Status: introduced in the IEC CIM to be used as a generic container to hold status-related information. Additional attributes related to geographical parameters (coordinates etc) are considered on BESOS **modeling** framework.

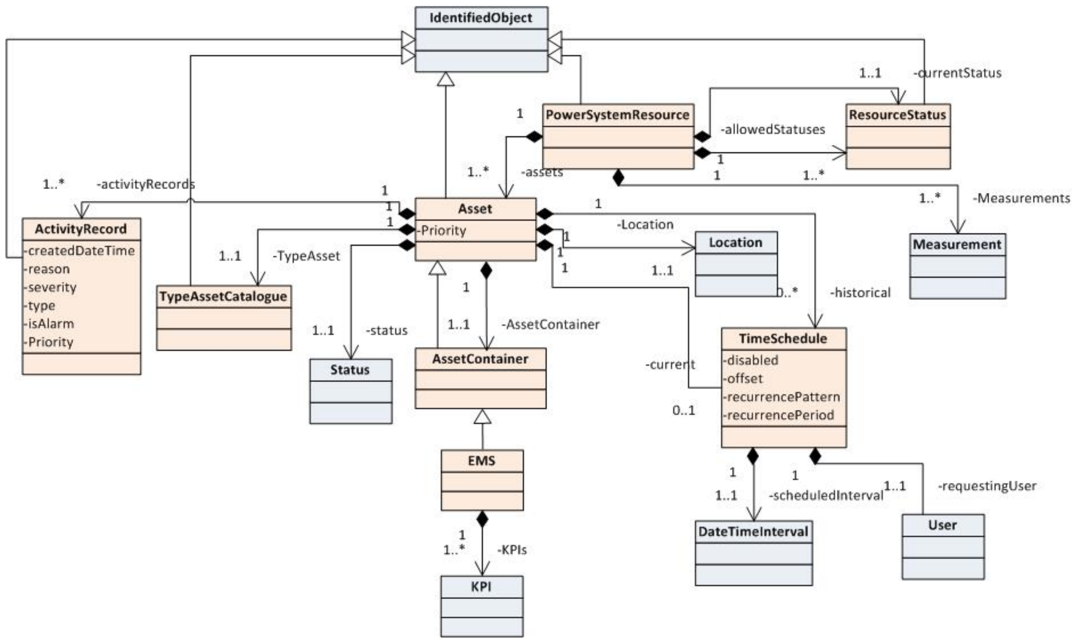

Figure 2: Asset Structure. Blue-shaded classes are external to the module.

4.2 Organization & Users Module

This module introduces concepts capturing information about organisations as well as users. The former have been adopted by the IEC CIM and are further enhanced with additional properties to accommodate BESOS needs. Within BESOS, assets owners, Aggregators, ESCOs and residential users are defined as the main stakeholders of the platform and therefore incorporated in the respective data model. The definition and further modeling of Business Actors is one of the main innovations of BESOS project towards the expansion of IEC CIM modeling framework.

4.3 Asset Structure Module

This module (Figure 2) includes concepts capturing information about Assets that are examined in BESOS project while also covering generic assets in a smart city level. Therefore this module is core for BESOS CIM, defining the parameters to be considered towards the specification of each asset examined. Due to the core role of this module, a detailed view of the main classes is further provided.

The **Asset** class has been adopted from IEC CIM and is used to represent the logical manifestation of a piece of equipment, as opposed to the physical one for which the **Power System Resource** is used. **ActivityRecord** class records activity for an entity at a point in time; activity may be for an event that has already occurred or for a planned activity. In addition to activity record, a **TimeSchedule** is used to describe anything that changes through time and has been adopted from IEC CIM.

The **PowerSystemResource** class is used to represent the physical manifestation of a piece of equipment, as opposed to the logical one for which the Asset is used. Power system resources can generate Measurements and they have a list of **AllowedStatuses** and a **CurrentStatus** associated with them. Each asset defined is characterised by a specific **type** and therefore a catalogue of generic types of assets that may be used for design purposes is also applied. Within BESOS project, a list of different assets has been selected and therefore a detailed analysis of each type is further presented as part of the data model of the project.

4.4 Assets Representation Module

This module includes concepts capturing information about specific types of Assets. The **equipment** class, adopted from IEC CIM and extending Power System Resource, represents the parts of a power system that are physical devices. It has properties to record its NominalPower and whether it is normally-In-Service and defines the high level abstraction of each type of asset examined in BESOS. Then, in order to provide an asset specific data model, an overview of the main assets represented in the scope of the project is given.

The **GeneratingUnit** class, adopted from IEC CIM and extending Equipment, represents a single machine or set of synchronous machines for converting mechanical power into alternating-current power. A **point of light** is defined as the asset which is responsible for the management of traffic and public lights. This asset is very important in city level management and therefore is further incorporated in the model. As the numbers of **electric vehicles** has increased recently, these set a typical asset to be examined in smart city level. In addition to the electric vehicle as a single entity, a **charging station** is defined as an aggregated type of EV assets.

In addition to the general types of generation and consumption, we need to address also building assets that set the main type examined in a city level. A **public building** is characterized as an asset that incorporates both consumption and generation characteristics while a **residential building** type is modelled as a piece of Equipment able to generate Measurements and addresses the citizens also as end users of BESOS platform.

4.5 Measurements & KPIs Module

This module incorporates concepts capturing information that help keep track of dynamically evolving attributes (metrics) as well as KPIs defined utilizing these metrics. Both Measurements and KPIs follow the same pattern: there is a definition, a list of values and a source for each value.

More specifically, a **measurement** type represents any measured, calculated or non-measured non-calculated quantity. Measurement is used as a metric definition while its evolving values through time are captured using its Measurement Value property. The **Measurement Value** class represents the current state for a measurement. A state value is an instance of a measurement from a specific source.

Additionally to measurements a reference to **Key Performance Indicator** class is defined, associated with an EMS. KPIs follow the same pattern as Measurements - i.e. they have definitions, values, and sources, in order to help keep track of historical values and multiple sources. In addition KPIs are linked to the Measurements used for their definition via the Measurements property as well as to their values via the KPI Values property.

The **KPIValue** class represents the current state for a KPI. KPIs can be associated with many state values, each representing a different instance for the KPI. In order to proceed with the holistic management framework, there is the need to examine different types of metrics and indicators either as snapshots or as time series. Thus, a **TimeSeries** is used to define intervals over which aggregated metrics are calculated.

Further to the time series definition, the **Step** class defines a step for use while also the **Datetime** defines the time granularity of the analysis. Therefore the calculation of aggregated metrics and indicators is dynamic towards the provision of a meta-modeling framework that fully addresses the end users diverse requirements.

4.6 Document Types Module

This module (Figure 3) includes concepts capturing information related to the business – strategic aspects of BESOS towards the identification of different business services and models to be provided by the business actors.

Adopted from IEC CIM, **Document** is a parent class for different groupings of information collected and managed as a part of a business process. Therefore, this class defines the abstract layer for the whole business layer. The SLA concept represents the **Agreements** between 2 organizations as examined in BESOS project, specifying related terms (monitored via KPIs) and assets. It has properties pointing to Assets for which the SLA has been created, KPIs involved in SLA, the organization and the priority. On the other hand, the **StrategyAction** represents one request from a municipality to end user – e.g. “Operate in eco-mode”. It is modelled as a subclass of Agreement to designate its semantics and inherit properties. It has properties pointing to Strategy Constraints and Strategy Goals applicable to this strategy action (both of type Strategy Element) as well as a Priority.

The **Strategy Element** concept is used to model specific strategic sub-objectives as part of the strategy actions. It has properties pointing to target value, Assets involved, a KPI or a Measurement the desired value of which is within the goals of this strategy and a Strategy Relation Type signifying the relation with the specified KPI (greater, equal, etc).

As the Strategies and SLAs are defined for a specific time period, an interval between two time points, adopted from IEC Model, is defined pointing to start/ end date of each business service.

4.7 Control Module

This module includes concepts capturing information related to control commands as delivered from the Application level to the EMS level in order implement the control strategies defined. As the type of message during a control command is not of a unique type, a hybrid approach

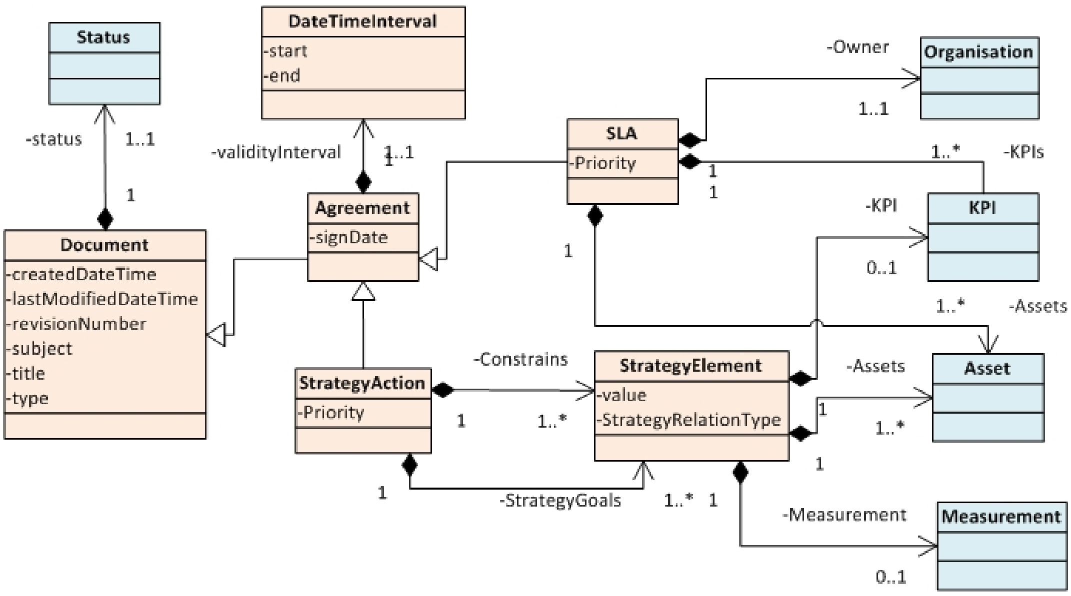

Figure 3: Document Types. Blue-shaded classes are external to the module.

has been followed within data model, addressing both generic message types (to be further interpreted in EMS level) while also asset specific control commands towards the definition of the set point of operation. The control types are aligned with assets and strategies in order to provide a detailed view on the definition of control commands.

The source (XSD) files for all modules can be accessed through a dedicated link (BESOS XSDs, 2015) (a temporary location until they are transferred to the BESOS project web site).

5 CONCLUSION AND OUTLOOK

We have introduced the rationale behind building a data model used to integrate disparate EMSs and examined the process through which it has been constructed and the design choices that have driven it. We have answered the most crucial dilemma in terms of modeling (the use of an explicit data model versus a minimal meta-model) by adopting a middle ground based on lessons learned from other projects and also addressing the main requirement needs. When compared to other data models we took into account in the state of the art, we can identify certain points of differentiation for the BESOS CIM.

To begin with, BESOS CIM focuses on the domain of energy management at the city level, as opposed to IEC 61970 that covers a broad array of domains. Furthermore, compared to IEC 61970 and IEC 61850 BESOS CIM covers both the network level and the EMS level connecting these distinct layers of the smart grid. BESOS CIM also extends the standards by adding new assets such as Electric Vehicles and Point of Light, as well as covering aspects of security and priority on assets (covered in standardization by IEC 62351). Last but not least, as opposed to IEC 61968 and other standardization efforts, BESOS CIM introduces the role of ESCOs and Aggregators as stakeholders in an open energy domain. By making the modeling process and the model itself publicly available we hope that they can be of use to anyone facing a similar task. The goal of BESOS platform is to provide a holistic solution for energy and mobility management that will be easily transferable and towards this direction, the BESOS CIM is provided in a way that could be easily adopted and further mapped in any part of integration process.

ACKNOWLEDGEMENTS

This work has been carried out in the context of the BESOS EU project (Grant Agreement 608723).

REFERENCES

BESOS - Building Energy Decision Support Systems for Smart Cities -E.U. Project, http://besos-project.eu/

eeSemantics Wiki Home Page, https://webgate.ec.europa.eu.

Laresgoiti, I., Perez, J., Tellado, B., Riano, S., Liu, X., Dragone, M., Haag, G., Marcel, J., Bourdeau, M., 2011. FIEMSER Data Model, available from http://www.fiemser.eu/?page_id=40#D5.

García, J., Karnouskos, S., Ilic, D., Cheng, W., Peris, R., Alacreu, 4. L., Sauter, R., Dimeas, A., Hatzoplaki, E., Saldaña, S., Pons, L., García-Casarrubios, D., 2013. Reference Architecture and Energy Services. Available from http://smartkye.eu/download/1025/

Look, M., Greifenberg, T., 2013. Report detailing Neighbourhood Information Model Semantics available from http://www.cooperate-fp7.eu/

Häfner, P., McGlinn, K., Gerdelan, A., Wicaksono, H., 2013. Method development: building behavioural model creation, building specific ontology creation. http://www.knoholem.eu/filelibrary/KnoHoIEM_D2_2.pdf.

ISO 16739:2013 Standard, Industry Foundation Classes, http://www.ifcwiki.org/index.php/Main_Page.

Alan W. McMorran, 2007. An Introduction to IEC 61970-301 & 61968-11: The Common Information Model. Institute for Energy and Environment, University of Strathclyde.

Mackiewicz, R. E., 2006. Overview of IEC 61850 and benefits. Power Engineering Society General Meeting.

IEC 61850-7-420 ed1.0 Communication networks and systems for power utility automation - Part 7-420: Basic communication structure - Distributed energy resources logical nodes.

Ling, L., Hongyong, Y., Xia, C., 2013. Model Differences between IEC 61970/61968 and IEC 61850. In Proceedings of the 2013 Third International Conference on Intelligent System Design and Engineering Applications (ISDEA '13). IEEE Computer Society, Washington, DC, USA, 938-941.

EPRI Technical Report: Integration of Advanced Automation and Enterprise Information. Infrastructures: Harmonization of IEC 61850 and IEC 61970/61968 Models, EPRI, Palo Alto, CA, 2006. Product ID 1013802.

Kim, Yang, Jang, Hong, Falk, Lee, 2013. A Meta modeling Approach to Unifying IEC 61850 and IEC 61970, SISCO.

Schutte, S., Scherfke, S., Troschel, M., 2011. A Framework for Modular Simulation of Active Components in Smart Grids, OFFIS.

Apolinarski,W., Iqbal, U., Parreira, J.X., 2014. The GAMBAS middleware and SDK for smart city applications. PerCom Workshops 2014: 117-122.
VDI 3813, Building automation and control systems (BACS), Technical rule, 2013.
CityGML 2.0 open data model, Schema available on http://www.citygml.org/index.php?id=1540.
OpenADR alliance, OpenADR 2.0a and the OpenADR 2.0b Profile Specification and schemas http:// openadr.org/
IEC 62357 Standard, 2011, to be developed by WG15 of IEC TC57working group.
Smartgrids Standardization map, available (2014) on http://smartgridstandardsmap.com/
M490 - Smart Grid Mandate Standardization Mandate, CEN/CENELEC, 2013, access on http://www.smartgrids.eu/CEN-CENELEC-ETSI.
CIMTool, an open source tool for IEC Common Information Model (CIM), access on http://wiki.cimtool.org/index.html.
BESOS Common Information Model, XSD Schemas, https://www.dropbox.com/sh/w5vigzxhn4mw2pn/AADac6yJ8ut5FojoOOKJK1J_a?dl=0.