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Candidate: Rajashekar Reddy, Billam

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Telemark University College
Faculty of Technology
Kjølnes
3914 Porsgrunn
Norway
Lower Degree Programmes – M.Sc. Programmes – Ph.D. Programmes TFver. 0.9

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Supervisor:	**Hans Petter Halvorsen**	sign.:. . . . .
2nd Supervisor:	**John Basserud, Magnus Beitdokken**	sign.:. . . . .
Censor:		sign. . .. .
External partner:	**Baze Technology**	sign.:……… ….. . . . .
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Abstract:

This project work has been written based on the use of semantic models in integrated operations for oil and gas and new energy. This includes study of integrated operations, study of semantic web and reference semantic models and standards such as IEC 61400-25, IEC 61850, ISO 15926, ISA 95, ISA 88, PRODML, WITSML, OPCUA and also developing and configuring a wind domain model. All the theoretical modules will be studied and all the practical implementation of different models such as RDS-PP or IEC 61400-25 is implemented.

The IEC standard series 61400-25 provides a solution for access to wind power information with standardized data names and semantic. It gives possibilities to procure monitoring and control solutions as separate parts, and to use a single system to store, analyze and present wind power information.

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Preface

This thesis work was prepared at Telemark University College, Norway in partial fulfillment of the requirements for acquiring the M.Sc degree in engineering.

The thesis work was written based on the use of semantic models in integrated operations for oil and gas and new energy. The main objective is to run several methods and sort out the best one among all.

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Readers of this report will be benefited to have fair idea of international standards IEC61400-25, RDS PP, IEC 61850, ISO 15926, ISA 95, ISA 88, PRODML, WITSML, and OPCUA

On behalf of this work at first I would like to thank our main supervisor Hans-Petter Halvorsen and external supervisor John Båserud and Magnus Beitdokken for many insightful conversations during the development of the ideas in this thesis. . I had a good time working around the company along with all these people sharing my views and ideas and working on my thesis work.

Skien, June 2010

Rajashekar Reddy, Billam

Nomenclature

CIM	Common Information Model
DER	Distributed Energy Resources
RDS-PP	Reference Designation System for Power Plant
CRM	Conceptual Reference Model
WITSML	Well site Information Transfer Standard Mark-up Language
PRODML	Production Markup Language
RESQML	Reservoir Characterization Markup Language
RDS-PP	Reference Designation System for Power Plants
IEC	International Electrotechnical Commission
OPC	OLE for process control
PI	Plant Information
WPP	Wind Power Plant
WPPS	Wind Power Plant Server
WT	Wind Turbine
WTC	Wind Turbine Controller

Overview of tables and figures

Part I
Theory

1 INTRODUCTION

1.1 Introduction

In this report an introduction to power plants and the arguments behind the need for a common communications standard will be presented. The IEC 61400-25 [IEC] standard that is used for communication with a power plant will be described. The visions for the project is presented together with a project description, this includes defining the overall scope for the project.

The forthcoming international communication standard IEC 61400-25(Communications for monitoring and control of wind power plants) of the IEC TC 88 is developed in order to provide uniform information exchange for monitoring and control of wind power plants. It will eliminate the issue of proprietary communication systems utilizing a wide variety of protocols, labels, semantics, etc., thus enabling one to exchange information with different wind power plants independently of a vendor. It enables components from different vendors to easily communicate with other components, at any location and at any time. Object-oriented data structures make the engineering and handling of huge amounts of information provided by wind power plants less time-consuming and more efficient. Scalability, connectivity, and interoperability can be maximized to reduce cost and needed manpower
The IEC 61400-25 standard is a basis for simplifying the roles that the wind turbine and SCADA systems have to play. The crucial part of the wind power plant information, information exchange methods, and communication stacks are standardized. They build a basis to which procurement specifications and contracts could easily refer.

This thesis work is about use of semantic models in integrated operations for oil and gas and new energy. Modern oil and gas operations do include the remote and distributed control of assets-leading to heavy demands on the communication links and information flow. These concepts include the use of semantics in order to make different systems able to link information and communicate. The main objective also include

- Study of integrated operations in both oil and gas domain and wind power domain with the mail focus on the wind domain
- Study of semantic web and reference semantic models and different standards like IEC61400-25,RDS-PP,IEC 61850,ISO 15926,ISA 95,ISA 88, PRODML,WITSML, OPCUA
- Baze fields data model and how different wind domain models fit into it followed by two subtasks
- Development and configuring a wind domain model based in standard within the Baze field database
- Automatically regenerate and put content into the Baze field wind model by configuring the number of wind turbines.

1.2 Objective

The main objective of this task is to study the theoretical concepts of semantic models in the oil and gas domain and wind power domain and practical implementation of different models for example RDS-PP or IEC 61400-25.

1.3 Background

Baze technology AS delivers Baze field, world class operation management software for production integrated operations for both oil and gas and new energy Baze field is a complete fact based operations management software for running offshore and more operations.

Integrated operations is mainly about tracking decisions, know who's taking actions on decisions defining who should be involved in the decision making having the right information available when decisions are made to handle risk issues. For Baze field system Baze technology AS received the Rosing award for user friendliness 2008.

Users need all available information in order to do integrated operations. For data integration and communication between different systems, semantic models are starting to become a standard way of sharing data. These tasks require good analytic skills like .NET/Silverlight development.

The introduction of the IEC 61400-25 standard affects both the communication solutions used for information exchange between wind power plant systems and external systems as well as the structure and naming of information.

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2 Problem Description

Oil and gas operations in the modern day include remote and distributed control of assets-leading to heavy demands on the communication links and information flow. Connecting and integrating business processes and information sources across organizational boundaries add to the complexity. Operations require a lot of attention to be paid to environmental aspects, as the tolerance for environmental hazards in such vulnerable areas must be as close to zero as possible. In order to meet all the requirements and at the same time maintain profitable operations, the industry has to create new field development and operation concepts. All these concepts come under the common term integrated operations.

This is one of the main focus areas in the oil and gas industry with the potentials of saving several billions NOK in the near future. These concepts include use of semantics in order to make different systems able to link information and communicate.

3 Theory

3.1 Integrated operations (IO)

An integrated operation mainly refers to the new work processes and ways of doing oil and gas exploration and production, which has been facilitated by new information and communication technology. It has also taken the form of a movement for renewal of the oil and gas industry.

The most interesting part of integrated operations has been the use of always-on videoconference rooms between offshore platforms and land-based offices which includes broadband connection for sharing of data and video-surveillance of the platform. With the help of this it made possible to move some personnel onshore and use the existing human resources more efficiently. It's even possible for a team at an office in a different time zone to be consulting the night-shift of the platform.

Tools like videoconferencing and 3D-visualization also creates an opportunity for new, more cross-discipline co operations. A shared 3D-visualization may be made to fit neatly to each member of the group, so that the geologist gets a visualization of the geological structures while the drilling engineer focuses on visualizing the well. The most important thing is the real-time measurements from the well, but the down whole bandwidth has previously been very restricted. Improvements in bandwidth, better measurement devices, better aggregation and visualization of this information and improved models that simulate the rock formations and wellbore currently all feed on each other. An important task where all these improvements play together is real-time production optimization.

With the deployment of integrated operations the petroleum industry draws on lessons from the process industry which can be viewed in the whole production chain and management ideas imported from the production and process industry. There are few companies which emphasize the integration and coordination of outside suppliers and collaborators in offshore-operations. In terms of operational intelligence it is stated that the oil and gas industry is lagging behind other industries.

Integrated operations management and work processes build on will be familiar from operations research, knowledge management and continual improvements well as information systems and business transformation.

3.1.1 Integrated operations and the oil& gas ontology

The Norwegian Oil Industry Association (OLF) has defined the term Integrated Operations (IO) as "real time data onshore from offshore fields and new integrated work processes". OLF has estimated the economic potential of IO to be in the magnitude of 250 billion NOK. Figure 1 illustrates OLF's plan for IO adoption. [1]

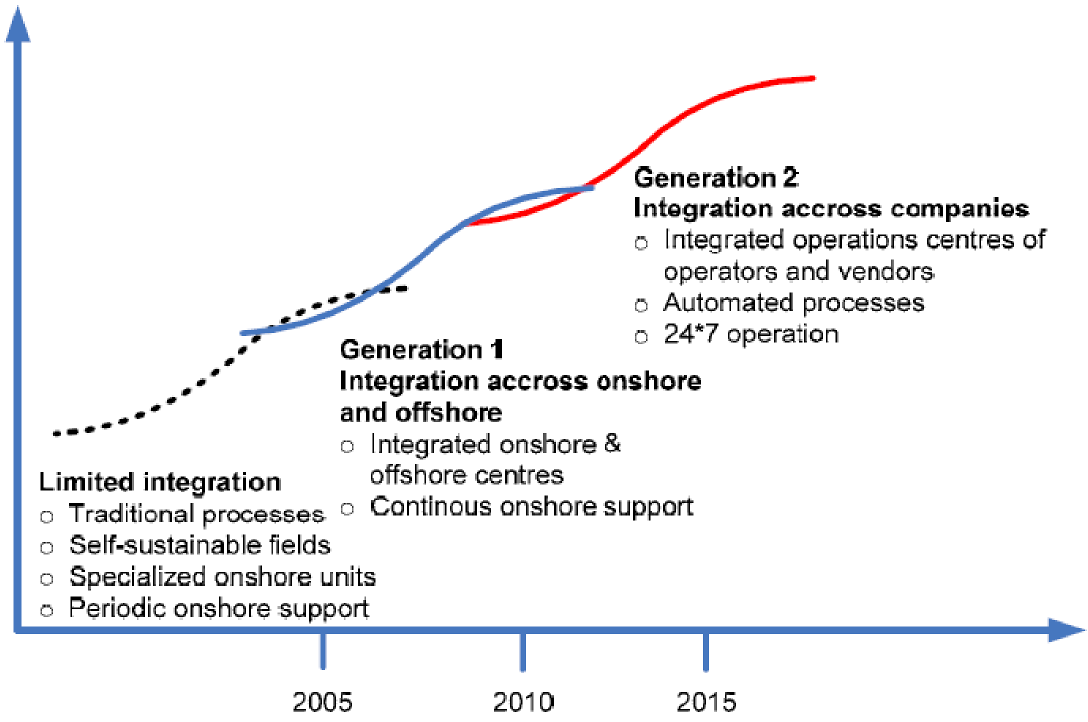

Figure 3-1: OLF plan for IO [1]

Generation 1 activities include:

- Establish the required physical infrastructure such as the required computer networks and fiber optics.
- Move experts from the platforms and drilling rigs to onshore centers. I.e. enable experts on duty in Houston to assist a drilling operation in the Barents Sea, having the same situation awareness as the driller.
- Development and implementation of new business processes to take advantage of the Field technologies.

Generation 2 activities include:

- Development of the Oil & Gas Ontology based on ISO 15926.
- Development of a new generation IT systems designed to transform huge amount of data into decisions and advice.
- Tailor organizations to utilize the potential offered by fielding of new technology

For major actors at the Norwegian Continental Shelf (NCS) such as Statoil Hydro the focus now is implementation of generation 1 solutions. The experience so far is that this, for many reasons, is not a trivial task. One is organizational. Changing safety critical processes is a daunting task that requires a careful approach. Another is technical. The architecture found in the existing IT solutions does not support the new concepts of operation. Despite the challenges, implementation of IO has proved successful with respect to return on investment.

Historically the instrumentation and automation efforts of production assets have been rather Rudimentary, where the industry has automated when they needed to, not when they could. With the development of cheap and reliable sensor technology, the idea of increased instrumentation has emerged. The rationale is simple; with more data available, we are able to make better decisions, and thereby improve the recovery rates and reduce the operational cost. The challenge is not that humans are not able to process and use the available high volume data streams, nor are the legacy IT supporting today's manual business processes.

The practical impact of this is that OLF's vision for IO generation two requires fielding of a new generation IT systems. These systems must be architected to interoperate across assets, operations centers and corporate boundaries in a timely and secure manner. They must also compensate for the inherent weaknesses found in existing legacy systems.

3.1.2 The purpose and scope of the reference architecture

Simplify acquisition, deployment and operation of the IT systems required to support the vision of OLF IO G2.

The scope of the patterns will be within the most common or the most anticipated types of Solutions, assumed to be 5 - 10 types.

- The portfolio will cover the areas of IT applications and IT infrastructure, but at a logical level (avoid specific product names when possible).
- The areas of security (risk management), IT operations (quality management) and use of standards will be included
- The focus will be on, quick wins
- The solution patterns should enable coordination with business-level architectures to
    - is able to reflect new technology enabled opportunities for work processes in Business level architectures and

    - o collect requirements to IT solutions from new ways of working as reflected in Business level architectures.

In addition, the Reference architecture shall provide a language that enables the actors involved in IO G2 to:

- Better articulate needs in terms of required IT capabilities
- Increase their understanding of the potential and limitations of a specific IT solution (Shared repository of reports, real time integration of asset and corporate back office systems, etc).
- Simplify dialog on IT matters across geographical and organizational boundaries; among actors inside organizations involved in IO G2 as well as between such organizations.
- Bridge the gap between detailed solution designs and general stakeholder concerns.

In this draft, the set of patterns is scoped to solutions for large oil and gas companies within the

Upstream domains:

- Drilling and completion
- Reservoir and production management
- Operations and maintenance.

Motivation

An integrated operation leads to cost savings as fewer people are stationed offshore and an increased competence. A well organized reservoir management, lower costs and fewer mistakes during well drilling will in turn raise profits and make more oilfields viable. Integrated operations comes at a time when the oil industry is faced with more brown fields where the cost of extracting the oil will be higher than its market value, unless major improvements in technology and work processes are made. Working onshore control and monitoring of the oil production may be come necessity as new fields at deeper waters are based purely on unmanned sub-sea facilities. Moving jobs onshore has also been touted as a way to keep and make better use do an aging workforce, which is regarded as a challenge by western oil and gas companies. Since the average age of industry workforce is increasing with many nearing restring age, integrated operations is being leveraged for knowledge sharing and training of younger workforce.

4 THE SEMANTIC DATA MODEL

4.1 Introduction

A semantic date model is a date modeling technique to define the meaning of data within the context of its interrelationships with other data. In brief semantic data model is an abstraction which defines how the stored symbols relate to the real world. In other words a semantic date model is also known as conceptual data model can be in the figure 4-1.

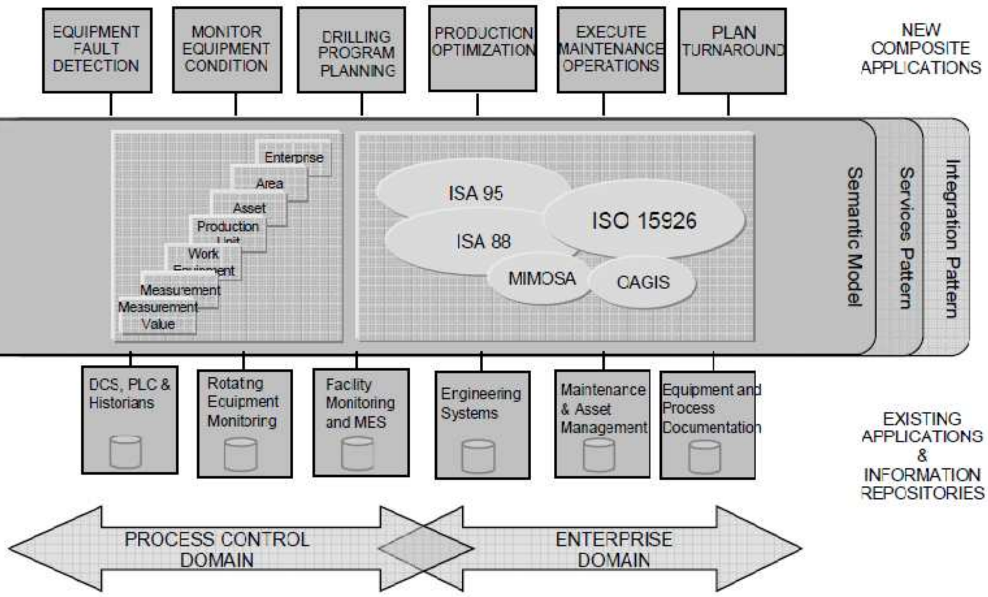

Figure 4-1: Semantic data model [2]

the above figure 4-1 shows a basic semantic model which consists of new composite applications such as equipment fault detection, monitor equipment condition, drilling program planning, production optimization, execute maintenance operations, plan turnaround each one capable of handling different functions . When it comes to the inner view of semantic model it consists of ISA 95, ISA 88, MIMOSA, ISO 15296, and CAGIS each one different from one another.

4.1.1 USES OF SEMANTIC MODEL

A semantic model can be used in many ways some of them are as follows:

Planning of data resource

A preliminary date model can be used to provide an overall view of the date

Required to run an enterprise. The model can then be analyzed to identify and scope projects to build shared date resources.

Building of shareable databases

A fully developed model can be used to define an application independent view of date which can be validated by users and then transformed into a physical database design for any of the various DBMS technologies. In addition to generating databases which are consistent and shareable, development costs can be drastically reduced through data modeling.

Evaluation of vendor software:

Since a data model actually represents the infrastructure of an organization, vendor software can be evaluated against a company's data model in order to identify possible inconsistencies between the infrastructure implied by the software and the way the company actually dies business.

Integration of existing databases- By defining the contents of existing databases with semantic data models, an integrated data definition can be derived. With the proper technology, the resulting conceptual schema can be used to control Transaction processing in a distributed database environment. The U.S air force Integrated information support system is an experimental development and Demonstration of this type of technology applied to a heterogeneous DBMS Environment.

Summary

The structure of DBMS(data base management system) whether hierarchical, network or relational cannot totally satisfy the requirements for a conceptual definition of date because it is limited in scope and biased toward the implementation strategy employed by the DBMS. Thus the development of semantic date modeling techniques has been defined since there is a need to define data from a conceptual model which means that the techniques to define the meaning of data witling the context of its interrelationships with other data. In real world, in terms of resources, ideas, events, etc are symbolically defined witling physical date stores. In this real world how the stored symbols are related to it is being defined by a semantic data model. Thus in real world a semantic model acts as a true representation. According to kolas and shelf the mail aim of the semantic date models is to seize more meaning of data by integration relational concepts with more powerful abstraction concepts knows from the artificial intelligence field. The basic view is to provide high level modeling primitives as integral part of a data model in order to facilitate the representation of real world situations.

The use of semantic models was first recognized by the U.S. air force in the mid1970s as a result of the integrated computer-aided manufacturing (ICAM) program. The objective of this program was to increase manufacturing productivity through the systematic application of computer technology. This ICAM program recognized a need for better analysis and communication techniques for people involved in improving manufacturing productivity. The ICAM developed a series of techniques knows as the IDEF methods.

IDEF0 used to produce a function model which is a structured representation of the activities or processes witling the environment or system.

IDEF1 used to produce an information model which represents the structure and Semantics of information witling the environment or system.

IDEF2 used to produce a dynamics model which represents the time varying Behavioral characteristics of the environment or system.

4.2 Semantic web

Semantic web is a web that is able to explain things in a way that computers can understand. There are some sentences which can be understood by humans but not by the computer. This is the reason what semantic web is all about. A semantic web describes things in a way that computer applications can understand it. The semantic web is not about links between WebPages, it describes the relationships between things and properties of the things.

The semantic web uses RDF (resource description framework) to describe web Resources. A RDF is a language for describing information and resources on the Web. Setting information into RDF files makes it easier for computer programs to search, discover and process the information from the web.

If the information about certain things such as vehicles, train schedules, tickets are all stored in RDF format then intelligent web applications could collect Information from many different sources, mix the information and present the Output in an easy and meaningful or understandable way.

The semantic web is not very fast growing technology since RDF was developed by the people with academic background in logic and artificial intelligence and Hence it’s not that easy to understand for traditional developers.

The semantic web is an evolving development of the World Wide Web in which The meaning of information and services on the web is defined, making it possible for the web to understand and satisfy the requests of people and machines to use the web content. As its core, the semantic web comprises a set of design principles, collaborative working groups, and a variety of enabling technologies. Some elements of the semantic web are expressed as prospective future possibilities that are yet it be implemented or realized. Other elements of the semantic web are expressed in formal specifications. Some of these include resource description framework(RDF), a variety of data interchange formats like RDF/XML,N3,Turtle, N-triples and notations such as RDF schema(RDFS) and the web ontology language(OWL) all of which are intended to provide a formal description of concepts, terms and relationships within a given knowledge domain.[3]

4.3 Reference semantic model

4.3.1 Mediation through Semantic Reference Models

Such mediation tools are based on “ontology’s” or, more modestly speaking, semantic reference models. A semantic reference model provides a synthetic view of all interrelated “classes” or” entities” the existence of which is recognized in a given domain, and defines the precise meaning of the relationships that exist between and among them.

The CIDOC Conceptual Reference Model (CIDOC CRM) is one such semantic reference model. It was developed specifically for museum information by the ICOM CIDOC (International Council of Museums, International Committee for Documentation3). It has been in development since 1996 and it is about to be published as an ISO standard, ISO 21127. The CIDOC CRM can be used as the basis for data exchange between systems, as a reference guide for the design of new cultural heritage information systems, and as the basis for integrated query tools and mediation systems’ data schemas. [4]

Although the CIDOC CRM focuses on museum information, it proved possible to use it in the context of bibliographic and museum information integration. Much of the semantics defined in the CIDOC CRM for museum objects is also valid for the description of bibliographic resources. The main difficulty comes from the fact that museum descriptions relate to physical, individual, “unique” objects, whereas bibliographic descriptions focus on the abstract notion of “publications”, which are exemplified by the individual items actually held by libraries. An international working group is currently striving to harmonies those two views by expressing the FRBR model, the conceptual model developed by IFLA (International Federation of Library Associations and Institutions) for bibliographic information, and “plugging” it into the CIDOC CRM. However, this objective is far from being achieved, and there is no publicly available documentation about this process for the time being. Since bibliographic and museum information integration was one of the objectives of the European-funded SCULPTEUR project, and this project had a rather tight deadline, it was decided not to wait until FRBR and CIDOC CRM models were harmonized, and to start working using solely the CIDOC CRM model.[4]

4.3.2 Purpose & scope

Develop an implementable reference semantic model that can be used by processing & manufacturing companies to connect

- Real-time measurements
- Planning & scheduling information
- Life cycle information

5 IECV61400-25

5.1 Introduction

The chapter an overview about the application of advanced standards like XML and web services in the international standards IEC 61850 (Communication networks and systems in substations), IEC 61400-25 (Communications for monitoring and control of wind power plants), and IEC 61970 (CIM, Energy management application program interface - common information model). It introduces the comprehensive set of semantic definitions (process and Meta information) for substations, wind power plants, and the whole electric power system. The information exchange - based on a set of very common services, MMS, SOAP, and TCP/IP - and the use of XML for easier configuration of devices and systems are introduced. The integration of sub- station configuration information into the control-center configuration (CIM, Common information Model) and vice versa will be discussed.[5]

Process automation solutions are widely accepted for power systems. They are mostly based on a huge number of proprietary specifications or (de facto) standards. Globally, utility deregulation is expanding. It requires integrating, consolidating, disseminating, and interpreting real- time information quickly and accurately within a utility - from power plants to the power con- Sumer in the shop floor or domestic user. Future electric power systems face a growing demand of configuration information (Meta information) that describes the process data, the automation device, and - possibly - the primary equipment. To meet the future requirements, three new standards have been defined: IEC 61850, IEC 61400-25, and IEC 61970. [5]

The IEC 61400-25 series defines communications for monitoring and control of wind power plants. The architecture of the IEC 61400-25 series has been selected to provide an abstract definition of classes and services such that the specifications are independent of specific protocol stacks, implementations, and operating systems. This part of the IEC 61400-25 series specifies the mapping of these abstract classes and services to protocol stacks.

NOTE: Performance of the IEC 61400-25 series implementations is application-specific. The IEC 61400-25 series does not guarantee a certain level of performance. This is beyond the scope of the IEC 61400-25 series. However there is no underlying limitation in the communications technology to prevent high-speed application (millisecond level responses).

5.1.1 Definition of information models

An information model is a representation of some aspects of real functions (respectively primary equipment) and the associated automation and communication systems. The purpose of creating an information model is to help understand and describe how information looks like and how to exchange this information between devices in the real world.

The model is restricted to information and information exchange. The automation functions - That is the programmed behavior of the automation devices that processes the information - are outside the standards discussed in this article. The behavior may be programmed using common programming languages like C, C++, IEC 61131-3 etc.

The information model comprises hierarchically structured information to provide the semantic of the data to be exchanged.

Three information models are presented and briefly discussed in this paper:

- Information model for substation and feeder equipment (IEC 61850-7x)
- Information model for monitoring and control of wind power plants (IEC 61400-25)
- Information model of a power system as seen from a control center viewpoint (IEC 61970 CIM - common information model)
- Another three models of some aspects of electric power systems (extensions for IEC 61850) are under preparation:
- Information model for power quality monitoring (IEC 61850 extension)
- Information model for Distributed Energy Resources (DER)
- Information model hydroelectric power plants - communication for monitoring and
- Control

5.1.2 IEC 61400-25: Communications for monitoring and control of wind power plants

Scope

The focus of the IEC 61400-25 series is on the communications between wind power plant components such as wind turbines and actors such as SCADA systems. Internal communication within wind power plant components is outside the scope of the IEC 61400-25 series.

The IEC 61400-25 series is designed for a communication environment supported by a client-server model. Three areas are defined, that are modeled separately to ensure the scalability of implementations:

- Wind power plant information model,
- Information exchange model, and
- Mapping of these two models to a standard communication profile.

The wind power plant information model and the information exchange model, viewed together, constitute an interface between client and server. In this conjunction, the wind power plant information model serves as an interpretation frame for available wind power plant information. The wind power plant information model is used by the server to offer the client a uniform, component-oriented view of the wind power plant data. The information exchange model reflects the whole active functionality of the server. The IEC 61400-25 series enables connectivity between a heterogeneous combination of client and servers from different manufacturers and suppliers.

As depicted in Figure 5-1, the IEC 61400-25 series defines a server with the following aspects:

- Information provided by a wind power plant component, for example, 'wind turbine rotor Speed' or 'total power production of a certain time interval' is modeled and made available for access. The information modeled in the IEC 61400-25 series is defined in IEC 61400-25-2.
- Services to exchange values of the modeled information, defined in IEC 61400-25-3.
- Mapping to a communication profile, providing a protocol stack to carry the messages, i.e. the service requests and responses and the values from the modeled information (IEC 61400-25-4).

IEC 61400-25-5 defines test cases associated with information, services and protocol stacks for conformance testing of both servers and clients.

The IEC 61400-25 series only defines how to model the information, information exchange and mapping to specific communication protocols. The IEC 61400-25 series excludes a definition of how and where to implement the communication interface, the application program interface and implementation recommendations. However, the objective of the IEC 61400-25 series is that the information associated with a single wind power plant component (such as a wind turbine) is accessible through a corresponding logical device.

This part of the IEC 61400-25 series specifies the specific mappings to protocol stacks encoding the messages required for the information exchange between a client and a remote server for:

- data access and retrieval,
- device control,
- event reporting and logging,
- publisher/subscriber,
- self-description of devices (device data dictionary),
- Data typing and discovery of data types.

The mappings specified in this part of IEC 61400-25 comprise:

- a mapping to SOAP-based web services,
- a mapping to OPC/XML-DA,
- a mapping to IEC 61850-8-1 MMS,
- a mapping to IEC 60870-5-104,
- a mapping to DNP3.

All mappings are optional, but at least one optional mapping shall be selected in order to compliant with this part of 61400-25.

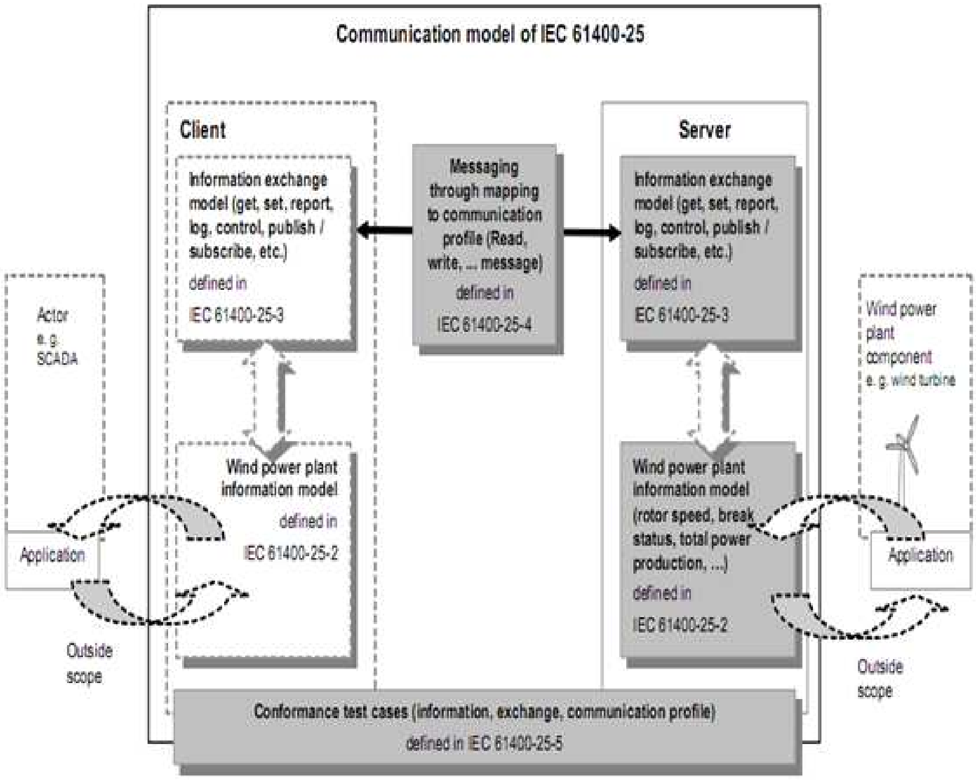

Figure 5-1: Conceptual communication model of IEC 61400-25[5]

The above figure 5-1 shows a conceptual communication model of IEC 61400-25. it consists of five parts

Part 1: Overall description of principles and models: The first part offers an introductory orientation, an overview of crucial requirements and basic principles, and a modeling guide.

Part 2: Information models: The wind power plant specific name tagged information describes the crucial and common process data, meta-data (data about data, e. g. scale factor or engineering unit), and configuration data of a wind power plant. Process information is hierarchically structured and covers, for example, common process information found in the rotor, generator, converter, grid connection and the like. The data may be simple (value, timestamp, and quality) or more comprehensive (adding more meta-data, for example engineering unit, scale, description, short hand reference, statistical and historical information of the process value)

Part 3: Information exchange models: All process and meta-data can be exchanged by corresponding services. Access to the meta-data (including configuration information with regard to the wind power plant information model and services and communication stacks) provides the so-called self-description of a device.

Part 4: Mapping to communication profiles: Mandatory mapping to web services using XML and SOAP; the services carry the exchanged values from the modeled information. Annexes include examples on mappings to other protocols, such as IEC 60870-5-101/104 and DNP3. [5]

Part 5- Conformance testing: This part of IEC 61400-25 specifies standard techniques for testing of implementation conformance, as well as specific measurement techniques to be applied when declaring performance parameters.[5]

5.2 IEC 61400-25-1

5.2.2 Introduction

IEC 61400-25 is a standard based on IEC 61850 and is therefore an expansion of the standard to couple with wind power generation resources. The approach is to decompose the functions into the smallest entities, which are used to exchange information. The granularity is given by a reasonable distributed allocation of these entities to dedicated devices (IED). These entities are called logical nodes (e.g., a virtual representation of a rotor class, with the standardized class name WROT). The logical nodes are modeled and defined from the conceptual application point of view. Logical nodes are collected in a logical device representing.

IEC 61400-25 is basically built upon the same principle with LNs as transitions objects, but differs slightly in the way how the abbreviations are defined. The first letter in the abbreviations which defines the LN in IEC 61850 specifies the class of physical equipment the LN belongs to. But the first letter in the logical node in IEC 61400-25 starts with ‘W’ (Wind), this in order to apply the basic rules for the use of Logical Nodes and Data classes and their extensions. These rules are defined in annex A of IEC 61850-7-4 and in the clause 14 of 61850-7-1. For example, according to IEC 61850 the logical node which interfaces the power transformer starts with the letter “Y”. The same kind of functionality is associated with the logical node WPTR. IEC 61850, combined with IEC 61400-25 represents complete solution for communication between control centre and all the components that are part of a wind farm. This is illustrated in Figure 5-3. [6]

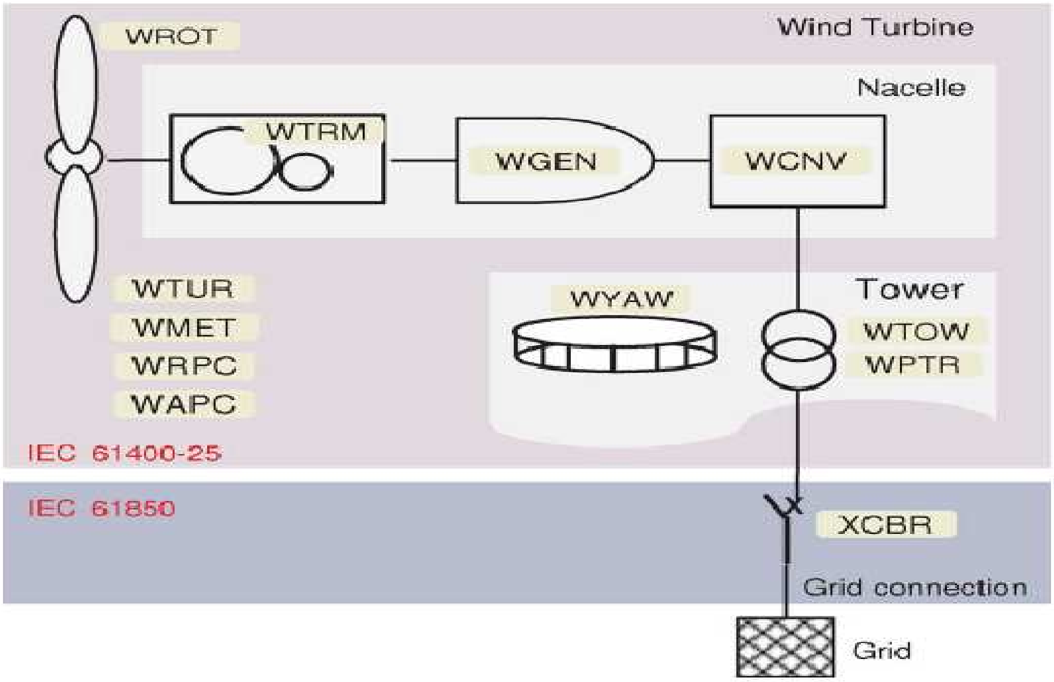

Figure 5-2: *Mapping to WT functionality using The IEC 61400-25 and 61850 standards* [6]

The above figure 5-2 illustrates the mapping of WT functionality using the IEC 61400-25 and61850 standards. The IEC 61400-25 series addresses vendors (manufacturers, suppliers), operators, owners, planners, and designers of wind power plants as well as system integrators and utility companies operating in the wind energy market. The IEC 61400-25 series is intended to be accepted and to be used world-wide as the international standard for communications in the domain of wind power plants.

The IEC 61400-25 series has been developed in order to provide a uniform communications basis for the monitoring and control of wind power plants. It defines wind power plant specific information, the mechanisms for information exchange and the mapping to communication protocols. In this regard, the IEC 61400-25 series defines details required to exchange the available information with wind power plant components in a manufacturer-independent environment. This is done by definitions made in this part of the IEC 61400-25 series or by reference to other standards.

The wind power plant specific information describes the crucial and common process and configuration information. The information is hierarchically structured and covers for example common information found in the rotor, generator, converter, grid connection and the like. The information may be simple data (including timestamp and quality) and configuration values or more comprehensive attributes and descriptive information, for example engineering unit, scale, description, reference, statistical or historical information. All information of a wind power plant defined in the IEC 61400-25 series is name tagged. A concise meaning of each data is given. The standardized wind power plant information can be extended by means of a name space extension rule. All data, attributes and descriptive information can be exchanged by corresponding services.[7]

The implementation of the IEC 61400-25 series allows SCADA systems (supervisory control and data acquisition) to communicate with wind turbines from multiple vendors. The standardized self-description (contained either in a XML file or retrieved online from a device) can be used to configure SCADA applications. Standardization of SCADA applications are excluded in the IEC 61400-25 series but standardized common wind turbine information provides means for re-use of applications and operator screens for wind turbines from different vendors. From a utility perspective unified definitions of common data minimize conversion and re-calculation of data values for evaluation and comparison of all their wind power plants. [7]

The IEC 61400-25 series can be applied to any wind power plant operation concept, i.e. both individual wind turbines, clusters and more integrated groups of wind turbines. The application area of the IEC 61400-25 series covers components required for the operation of wind power plants, i.e. not only the wind turbine generator, but also the meteorological system, the electrical system, and the wind power plant management system. The wind power plant specific information in the IEC 61400-25 series excludes information associated with feeders and substations. Substation communication is covered within the IEC 61850 series of standards. [8]

The intention of the IEC 61400-25 series is to enable components from different vendors to communicate with other components, at any location. Object-oriented data structures can make the engineering and handling of large amounts of information provided by wind power plants less time-consuming and more efficient. The IEC 61400-25 series supports scalability, connectivity, and interoperability.

The IEC 61400-25 series is a basis for simplifying the contracting of the roles the wind turbine and SCADA systems have to play. The crucial part of the wind power plant information, the information exchange methods, and the communication stacks are standardized. They build a basis to which procurement specifications and contracts could easily refer.

The IEC 61400-25 series is organized in several parts. IEC 61400-25-1 offers an introductory orientation, crucial requirements, and a modeling guide.

NOTE1 Performance of the IEC 61400-25 series implementations are application specific. The IEC 61400-25 series does not guarantee a certain level of performance. This is beyond the scope of the IEC 61400-25 series. However, there is no underlying limitation in the communications technology to prevent high speed application (millisecond level responses).

NOTE 2 IEC 61400-25-4 is, at the time of the publication of IEC 61400-25-1 (this part), still to be published. With IEC 61400-25-4 the mapping of the information and information exchange models to a specific communication profile will be described/defined in detail. IEC 61400-25-4 may consist of more than one normative mapping but at least one of the optional mappings has to be selected in order to be in conformance with the IEC 61400-25 series. IEC 61400-25-4 is expected to include the following mappings. [8]

- Web services
- IEC 61850-8-1 MMS

- OPC XML DA
- IEC 60870-5-104
- DNP3

Each of the different mappings specifies individually which and how information models (IEC 61400-25-2) and information exchange models (IEC 61400-25-3) will be supported. The mapping will only reflect the information model and the information exchange services given in IEC 61400-25-2 and IEC 61400-25-3. The individual selected mapping will as a minimum support the mandatory data and data attributes, and the associated services. A specific mapping may, for implementation reasons or due to underlying properties of the communication protocol used, need to extend and clarify individual information or individual services in IEC 61400-25-2 and IEC 61400-25-3. IEC 61400-25-4 will in this sense have the highest priority of the ranking order in regards of implementation. [9]

The capability to exchange data in real time between different parts of the system is an essential precondition for distributed control and monitoring. Each unit's data must be accessible for other units, supervisory controllers, and the monitoring system as well as through one or more human-machine interfaces (HMIs), which do not need to be physically located in the same part of the system. Show on figure 5-3 below.

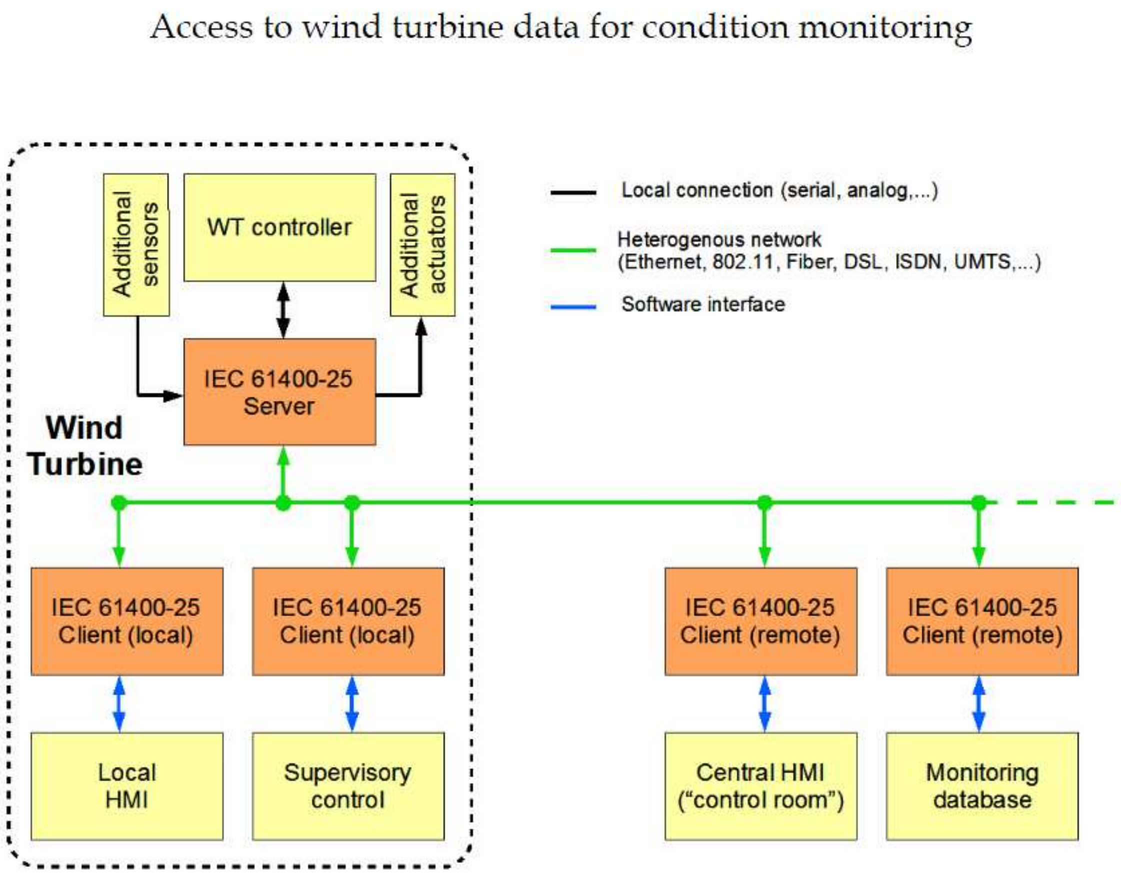

Figure 5-3: wind turbine communication [10]

The above figure 5-3 shows how a wind turbine communication works. it consists of a server IEC 61400-25 which are internally connected to additional sensors ,actuators and WT controller we have client IEC 61400-25 connected to local HMI , IEC61400-25 connected to supervisory control, IEC 61400 on the other base connected central HMI and IEC 61400-25 connected to monitoring database. These connections to the client's acts as software interface

5.3 IEC 61850

5.3.1 Introduction

IEC 61850 is a standard for the design of electrical substation automation. IEC 61850 is a part of the International (IEC) Technical Committee 57 (TC57) reference architecture for electric power systems. The abstract data models defined in IEC 61850 can be mapped to a number of protocols. Current mappings in the standard are to MMS (Manufacturing Message Specification), GOOSE, SMV, and soon to Web Services. These protocols can run over TCP/IP networks and/or substation LANs using high speed switched Ethernet to obtain Fast Transfer of events the necessary response times of < 4 ms for protective relaying.[11]

5.3.2 IEC 61850 features include

- **Data Modeling** -- Primary process objects as well as protection and control functionality in the substation is modeled into different standard logical nodes which can be grouped under different logical devices. There are logical nodes for data/functions related to the logical device (*LLN0*) and physical device (*LPHD*).
- **Reporting Schemes** -- There are various reporting schemes (*BRCB & URCB*) for reporting data from server through a server-client relationship which can be triggered based on pre-defined trigger conditions.[11]
- **Generic Substation Event (GSE)** are defined for fast transfer of event data for a peer-to-peer communication mode. This is again subdivided into *GOOSE* & *GSSE*.
- **Setting Groups** -- The setting group control Blocks (*SGCB*) are defined to handle the setting groups so that user can switch to any active group according to the requirement.
- **Sampled Data Transfer** -- Schemes are also defined to handle transfer of sampled values using Sampled Value Control blocks (*SVCB*)
- **Commands** -- Various command types are also supported by IEC 61850 which include direct & select before operate (SBO) commands with normal and enhanced securities.[11]
- **Data Storage**-- SCL (Substation Configuration Language) is defined for complete storage of configured data of the substation in a specific format.[11]

5.3.3 Benefits

- Supports a comprehensive of substation functions
- Easy for design,specification,configuration,setup and maintenance
- High level services enable self-describing devices &automatic Objective discovery Standardized naming conventions with system content
- Configuration file formats eliminate device & dependencies and tag mapping enables exchange of device configuration
- Strong functional support for substation communication
- Higher performance multi-cast message for inter-relay communications
- Extensible enough to support system evolution

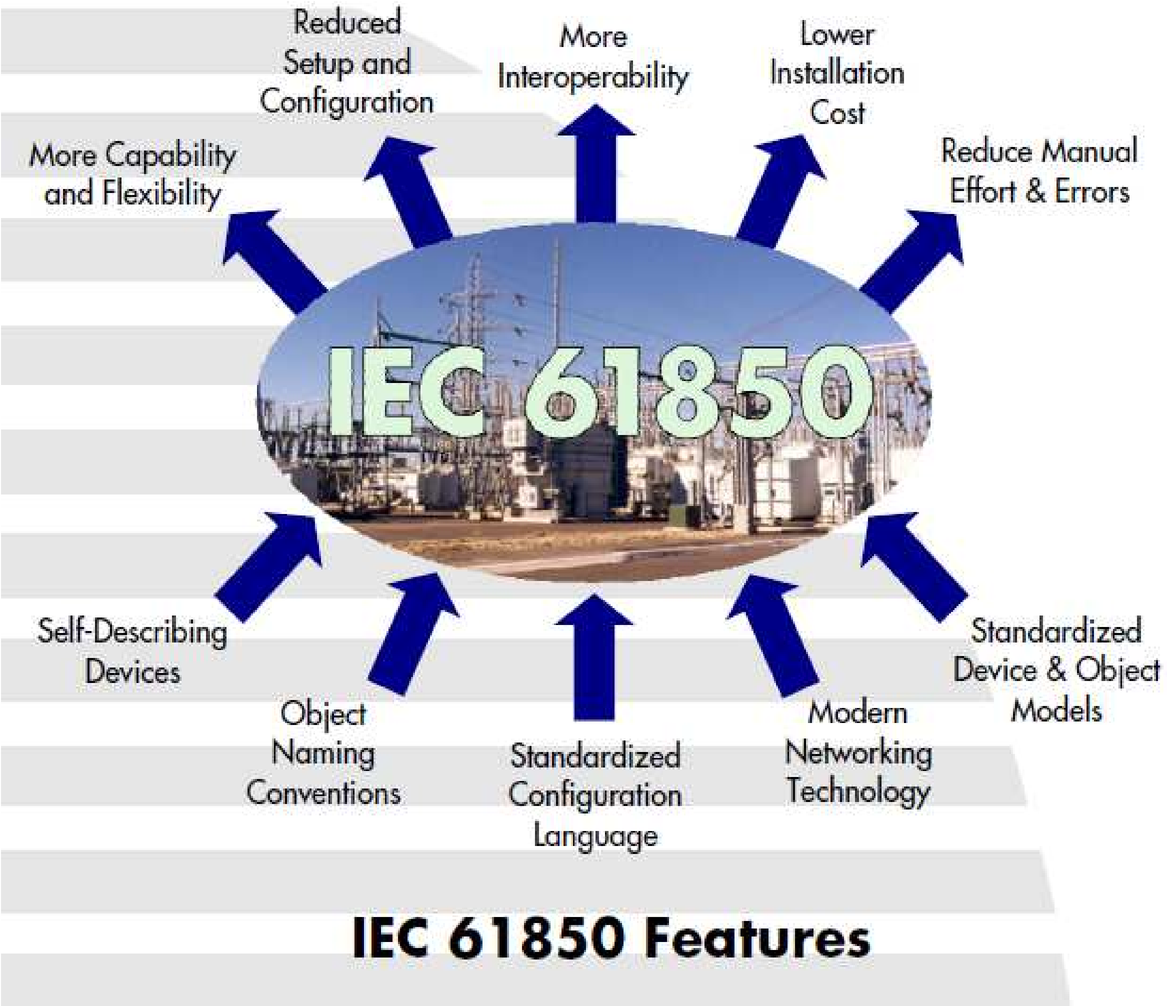

Figure 5-4: IEC 61850 Features [11]

The above figure 5-4 shows a brief view about the features of IEC 61840.The main features of IEC 61850 are it has more capability and flexibility, uses reduced setup and configuration, it have more interoperability, makes installation cost very low, manual efforts are reduced with self describing devices, object naming conventions, consists of standardized configuration language, built with modern networking technology and finally with standardized device and object models

5.4 RDS-PP

5.4.1 Introduction

RDS-PP is the further development for the proven identification system for power plants KKS. Compared to this, it provides a number of innovations and extensions, coming up for today's requirements for designation of power plants components. [12]

The new designation system is based on international standards, especially to DIN ISO 16952-1, DIN EN 61346-1 and IEC/PAS 62400, related to the structuring principles and the designation systematic. [12]

The international harmonization of the RDS-PP and its constant structuring help to avoid errors and misunderstandings during the designation whereby the plant reliability is increased.

Reference Designation System for Power Plant (RDS-PP) is a technical standard which uses basic principles of international standards as a base. The standard is intended to designate system parts within a power plant and construct a "system key" for power Plant systems. [12]

5.4.2 Characteristic features

The RDS-PP is based on structuring principles, designation rules and letter codes specified in international standards published by IEC and ISO and fulfill the prerequisites for

- Finding worldwide acceptance, and application of the same, standardized code letters.

The RDS fulfils the requirements of European Directives in terms of

- Operational safety,
- Ergonomics,
- Procurement, and
- Declaration of conformity.

The RDS-PP is in full agreement with the national/international sector-specific standards for Power plants DIN 6779-10:2007-04 and ISO/TS 16952-10 and thus complies with the mentioned international standard for reference designation systems.

The RDS-PP can thus be considered to be a standard-conforming designation system.

5.4.3 Why is RDS-PP introduced?

RDS-PP provides reliability

International harmonization and the consistent structure of RDS-PP help to avoid designation errors and misunderstandings, thus increasing plant reliability.

Through the integration into international agreed upon standards, RDS-PP substantially contributes to the fulfillment of legal safety requirements, given in the European Directives e.g. in the Machinery Directive, as well as in numerous national legislative acts.

RDS-PP is a cost-saving

Like already the RDS-PP is a common standard for operators and manufacturers of power plants. The now world-wide acceptance is opening up additional opportunities for long-term cost savings at the planning, building and operation of power plants. [13]

In addition, the reference structure laid down in RDS-PP has the potential of raising considerable synergy effects with respect to consistent IT based document management solutions.

RDS-PP is IT compatible

Due to its consistent structure, RDS-PP can be used as a powerful navigation tool to obtain complex information for planning, operation and maintenance. RDS-PP is a suitable basis for the development of software applications, which can be integrated into existing IT-landscapes. These are applicable for operational tasks as well as for training purposes [13]

5.4.4 Consequences

- The RDS-PP is (after official publication of the ISO/TS 16952-10) a designation which is supported by international standards.

- The RDS-PP integrates systematic structures and letter codes which are applicable to All industries, which in the medium term will result in an easier integration of "standard components" into the power plant process.[14]

- Suppliers of "standard components" cannot decline the request for designation According to RDS by just alluding to standards that are applicable in other industries or to their house standards. This makes it easier to make also such suppliers adhere to The RDS-PP; this will relieve planners and operators of time consuming and costly Reworking. [14]

- Successful implementation of the RDS-PP within a limited time frame will be possible if the operators require designation according to RDS-PP in their specifications; this will trigger the swift development/adjustment of tools at planners and suppliers

5.5 Technology ISA-88

5.5.1 Introduction

ISA-88 is an international standard. It helps industries to produce in a flexible way. The standard consists of models and terminology for structuring the production process and for developing the control of equipment. ISA-88 can be applied in fully automated, semi automated and even in completely manual production processes. [15]

- ISA-88
- ISA-88.01
- ISA-88.02
- ISA-88.03
- ISA-88.04
- ISA-88.05
- ISA-88 and XML

5.5.2 ISA-88:

General Information

ISA-88 is a standard for batch processing industries. It can also be applied in discrete and continuous processes that require a certain amount of flexibility. The ISA-88 models and terminology are developed for the control of production processes. So product and production are the focus of ISA-88.

The ISA-88 standard is intended for

- People who are involved in the design, construction or execution of batch processes;
- People who are responsible for the development of batch control and the associated software;
- People who are involved in the design and marketing of products in the area of batch control.

5.5.3 ISA-88.01

International industrial standard

The ISA-88.01 standard is titled ANSI/ISA-88.01- 1995, Batch Control Part 1: Models and Terminology. The standard has been accepted internationally. It was developed especially for the batch processing industry.

Bach processes

You will find batch processes in the chemical and pharmaceutical industries as well as food, beverages and paper industries. One characteristic of batch processing is that it is hard to preserve the batch identity if a batch is stored together with another batch. Another characteristic is that it is possible to make different end products with the same equipment. That is why a high amount of flexibility is required. The ISA-88 standard provides a way to bring flexibility into batch control.

Continuous and discrete processes

Although the standard was developed for batch processes, it can also be applied to continuous and discrete processes. Examples of continuous processes are water purifying and gas winning. An example of a discrete process is the production of cars. If in such processes a certain amount of flexibility is required, the ISA-88 standard can be applied.

Before ISA-88.01: 'Equipment' with hard coded procedures

In batch industries, equipment is used to process raw materials in a predefined sequence. Usually this sequence is programmed hard coded, for example in PLCs. The equipment is physically capable of executing other functions or executes existing functions in different sequences, but, because the sequence is hard coded, not all the possibilities are used. If you want to make a different end product with the same equipment, you will need the help of a control system engineer. This will cost time and money.

ISA-88.01: Models and terminology

ISA-88 consists of models and terminology for structuring the production process. The main idea of ISA-88 is to separate equipment control from the procedure that describes how to make the end product. This is how it becomes possible to execute different procedures for different end products, using the same equipment.

Physical model

ISA-88.01 provides a hierarchical model for structuring the physical equipment, which is called the Physical model. Based on this model the control system engineer programs all the possible functions of the equipment.

Recipes

The product knowledge is described in recipes. ISA-88.01 defines 4 different kinds of recipes: General, Site, Master and Control Recipes. Every recipe consists of different levels. The highest level defines the process described in the recipe. The lowest level shows what has to be done, step by step, to make the end product. Process engineers, without any detailed knowledge of equipment control, can develop ISA-88 recipes.

Recipes command equipment

When all equipment possibilities have been programmed, the process engineer can choose phases (basic equipment functions like mixing, heating, adding raw materials). The process engineer develops a recipe by putting these phases in the right sequence. The recipe instructs the equipment what function to execute, and in which sequence. That is how raw materials are processed into a certain end product. By applying ISA- 88 it becomes easier to put new products into the market, due to the elimination of programming new functions.

Control activity model

When producing a batch, equipment and recipes definitions are required. Batch process control is also equally important as well. For example scheduling, recipe management, process control need to be defined. ISA-88 provides a model for these activities: the Control Activity Model. By using this model you can develop a flexible control system, in order to realize a flexible production process.

Results of ISA-88.01

The standard was published in 1995. Since then it has been applied all over the world. It is known that the application of ISA-88 can lead to a lot of advantages.

For example:

- Improved flexibility
- Improved through put
- Improved use of capacity
- Higer prosess quality
- Improvement of production yields
- Less operator action needed
- Improved conformance to functional specifications
- Improved communication between suppliers, end users, consultants, system integrators
- It becomes easier to integrate solutions of different suppliers
- Reduction of time to market

5.5.4 ISA-88.02

Data structures and guidelines for languages

ISA-88.02 consists of data models, tables and a standard method for depicting recipes. The data exchange models treat four important aspects of information that are described in ISA-88.01: recipes, equipment capacities, and scheduling and batch journals. The relational tables can be used for the exchange of information between different systems.

Data model, data structures and internal relations

ISA-88.02 defines data models that specify a set of objects, attributes and their basic relationships that cover the concepts of Part 1 at a high level of abstraction. The intended use of these models is to provide a starting point for developing interface specifications for software components. The models address all of Part 1 as an integrated object model, but they do not presume or preclude any specific division of functionality between the systems.

Guidelines for languages

ISA-88.02 defines the symbols and rules for a graphical language that can be used to depict recipes. Recipes are the central feature of batch control, and they can address a wide range of complexity, but there is no one depiction that is ideal for all circumstances. The ISA-88.02 standard specifies a method for depiction of master and control recipe procedures that can be applied over a broader range of complexity, called Procedural Function Chart (PFC). [15]

5.5.5 ISA-88.03

Part 1 compared to part 3

Part 3 provides companies with a detailed definition of the contents of a General Recipe. Part 1 of ISA-88 gives only very little information about this kind of ISA-88 Recipe, because part 1 is focused on ‘Batch Control’. But end-users needed a standard focused on corporate management of product information. That is the reason why part 3 was developed.

General Recipes

General Recipes contain high-level information about the production of a product. The information in General Recipes is needed at different production sites. Every site has its own characteristics, for example capacity, processes, units of measurement, and language. Nevertheless, the enterprise wants to be able to produce the same product at different sites. Part 3 of the ISA-88 standard provides the solution to this problem

Contents of part 3

Part 3 focuses on General Recipes. It defines the information that a General Recipe should contain. It also defines some standard symbols for the depiction of General Recipes. This leads towards specific benefits including reduction of problems caused by differences in languages and absence of company standards. Part 3 also defines a standard methodology to convert General Recipes (General Product Information) to Master Recipes (Control of the equipment used to produce a product).

Advantages

General Recipes enable enterprises to work with a corporate product description, which can be used at different sites. They also make it possible to transform this information in a standardized way into Master Recipes, used for the control of specific equipment. This way it becomes easier for R&D and production to communicate, even if these departments are situated in different countries where people speak different languages.[15]

5.5.6 ISA-88.04

Part 4 of ISA-88 provides a detailed definition for batch production records, establishing a reference model for developing applications for the storage and/or exchange of batch production records. Implementations based upon the standard will allow retrieval, analysis, and reporting of selected batch production record data.

Although ISA-88 part 4 is intended primarily for batch processes, there may be considerable value for other types of processes. The standard is a good basis for compliance to the General Food Law, with its requirements for tracking and tracing.

5.5.7 ISA-88.05

Also in development is a Part 5 standard, Implementation Models & Terminology for Modular Equipment Control, in conjunction with the Make2Pack project.

WBF XML Schema's

In the year 2000 the World Batch Forum started an XML working group. The objective was to develop XML schemas based on the ISA-88 and ISA-95 standards. A lot of these XML schemas have already been published.

What is XML?

XML is a language for describing information. It is a new standard for the exchange of data, for publication of information and for integration of applications. In 1998 the World Wide Web Consortium decided that it would become a standard. XML makes structured elements available for automated processing. The main idea of XML is the separation of the contents of the document, the description of the structure and the presentation.[15]

Practical Use

You can use XML for the integration of automation systems, for describing functional specifications, and for publication on the Internet or Intranet. For example: you could put actual, real time information about your production capacity on the Intranet, making this important information available to anyone in your company.

ISA-88: BatchML

BatchML is short for Batch Markup Language. It consists of some schemas, which are based on ISA-88 part one and two. It defines XML elements for Master Recipes, Control Recipes, Recipe building blocks, Equipment elements, Batch lists and Enumeration sets.

Overview of advantages

"A model is a useful representation of a specific situation or thing. Models are useful because they describe or mimic reality without dealing with every detail of it. They typically help people analyze a situation by combining ideas with information about the specific situation being studied. Models help us to make sense of the world's complexity." (Steven Alter, Information systems, ISBN 0-13-043242-3) [15]

Just communicating about a system can be difficult because different people in the same conversation related to an information system often attach different meanings to common terms. S88 and S95 provide definitions of batch control terminology and enterprise-control system integration terminology. This terminology is presented within models, which explains the relationship between the words. For example, in the physical mode, the process cell is place on a higher level than the unit, which explains that a Process cell has one or more Units. [15]

5.5.8 ISA-95: the international standard for the integration of enterprise and control systems

ISA-95 is the international standard for the integration of enterprise and control systems. ISA-95 consists of models and terminology that can be used to determine which information has to be exchanged between systems for sales, finance and logistics and systems for production, maintenance and quality. This information is structured in UML models, which are the basis for the development of standard interfaces between ERP and MES systems. The ISA-95 standard can be used for several purposes, for example as a guide for the definition of user requirements, for the selection of MES suppliers and as a basis for the development of MES systems and databases.[15]

5.5.9 ISA-99: Manufacturing and Control Systems Security

ISA-99 provides a current assessment of security tools and technologies that apply to the Manufacturing and Control Systems environment. It describes several categories of security technologies; the types of products available in those categories; the pros and cons of using those products in the Manufacturing and Control Systems environment, relative to expected threats and known vulnerabilities; along with preliminary recommendations and guidance for using those security technologies.

- ISA-99 Enterprise Control Systems
- ISA-99.01 Security Technologies for Manufacturing and Control Systems
- ISA-99.02 Integrating Electronic Security into the Manufacturing and Control Systems Environment
- ISA-99.03 Operating a Manufacturing and Control Systems Security Program
- ISA-99.04 Specific Security Requirements for Manufacturing and Control Systems

5.6 OPC UA

5.6.1 Introduction

OPC consists today of a lot of standards and each of the standards are implemented as a server. An OPC system will therefore consists of a set of servers having the data and a set of clients using the data. These servers can be installed on one or several computers depending on the structure of the SCADA system. The important aspect here is that every software module that should be integrated into this SCADA system must support the OPC protocol. The implementation of the OPC protocol will depends on the functionality of the client or the server. Normally is the implementation of the OPC in the client less time consuming than the implementation on the servers. [15]

OPC Unified Architecture is a new architecture:

1. Using protocols based on XML and .NET technology from Microsoft and will influence all the OPC specifications. DCOM is often based on DLL (Dynamic Link Library) given a lot of problems with different versions (DLL hell) and DCOM communications have problems through firewalls. Very often most of the security has to be switch o¤ the let the OPC system work.[15]

2. With better integration between the different OPC specifications as the OPC-DA, the OPC-DX, the OPC-CD, the OPC-AE, and the OPCHDA specifications. Today will normally a server be installed for each of the specification, why not combing the specifications in fewer servers?

3. For focusing more on services, the OPC-UA will be more based on the Service Oriented Architecture (SOA) to focus more on services, not functions.

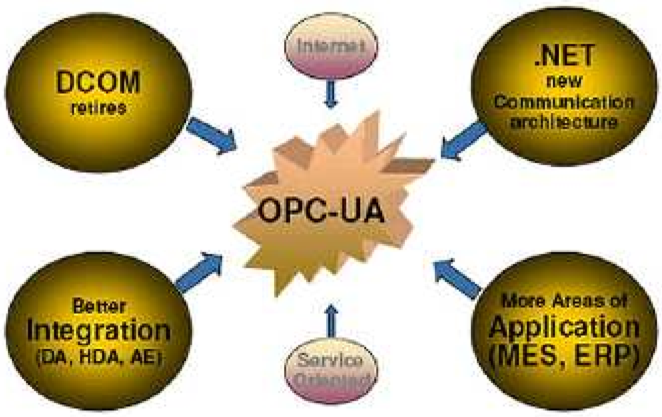

Figure 5-5: The contents of the OPC-UA specification. [16]

4. For better integration on non-Microsoft systems, allow an easier integration of system not having tight coupling. This includes systems like embedded systems, systems. Communicating over internet to mention some.

Figure 5-5 shows an overview of the OPC-UA specification. The specification contains a new communication standard and has a better integration of the OPC-DA, the OPC-HDA, theOPC-AE, the OPC-CD, and the OPC-DX specifications. Some more areas of application are MES, ERP.

There are three primary factors that influenced the decision for moving forward with the OPC UA architecture (Www.Matrikon.Com 2007):

1. The major OPC installation base, Microsoft is focusing their future efforts on Web Services and SOA applications. In addition, there is increasing pressure from end users looking for OPC support on Linux and other non-Windows platforms.

2. OPC is no longer a simple point-to-point solution, and is becoming the backbone of increasing complex OPC architectures, that involve multiple specifications. Vendors and users require a single interface that exposes the key functional areas of OPC.

3. The OPC Foundation would get more and more requests from clients and other institutions to leverage its standards to aid those who are defining other industry standards at a granularity below the interface level.

5.6.2 Why use OPC

1. Using standard network technology,

- Proven,
- Good performance,
- Using existing networks,
- Security and availability,
- Cost,
- Knowledge,
- Wire and wireless.

2. Open communication standard,

- Independent,
- Many suppliers,
- Good performance.

5.6.3 OPC development

Two main reasons for developing your own client or server:

- Control,
- Performance

Easy to develop a client, from a couple of days and up depending on the functionality of the client. A server is much more work, almost a year (from 3 to 12 months) depending on the knowledge of the specifications. The servers should also be approved by the OPC foundation.

The type of knowledge (Krogh 2005):[16]

- OPC specifications,
- Windows security,
- OOP (Object Oriented Programming),
- Developing tools,
- COM/DCOM
- OPC toolkits.

5.6.4 OPC test

The OPC system should be tested before installing into a real plant. The best way of testing such a system is to use any simulation modes of the server if the hardware is not available. Most OPC servers have a simulation mode and the next chapter will show the usage of a freeware OPC server from Matrikon1 in simulation mode. This server has a limited number of variables but can be used for smaller tests. [16]

5.7 PRODML

5.7.1 **Introduction**

In today's fast-paced oil and gas business, volatile pricing, tightened regulatory compliance, shrinking budgets, terabytes of data, and limited time for information analysis are among the myriad factors that continually pressure companies to increase the efficiency of their E&P operations. Digital oilfield technology is a tool that many companies have successfully used to realize such gains in efficiency. [17]

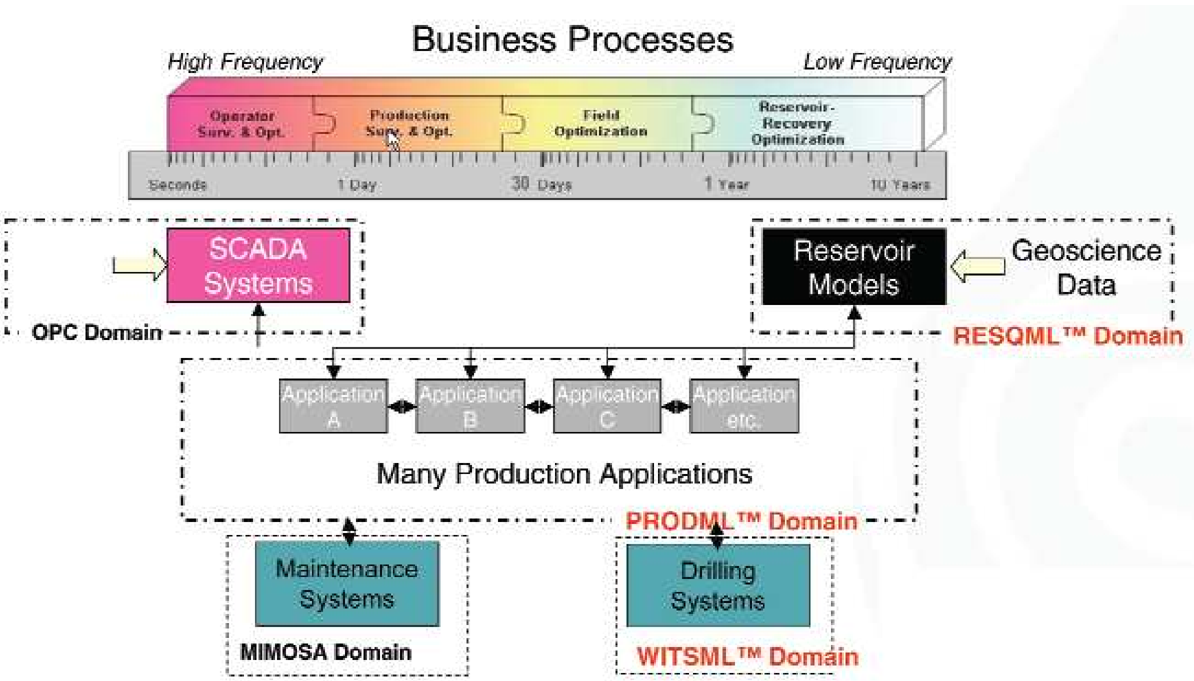

Figure 5-6: PRODML aids in all aspects of production optimization [17]

The above figure 5-6 shows PRODML aids in all aspects of production optimization. The indications are shown with high frequency on one side and low frequency on other side. The reservoir models are then connected to production applications which in turn connected to maintenance systems and drilling systems also known as MIMOSA domain and WITSML domain

PRODML provides a data transfer mechanism independent of the software and workflow currently in use and offers a means of sharing a single asset model across all applications.

The need for PRODML

Integration in E&P is a powerful tool in support of detailed workflows for faster, safer decisions in oil and gas operations. Unfortunately, integration efforts are often sub-par due to legacy systems that were not designed for that purpose. Data generated from these systems, which were deployed some time ago, are specific to a particular application and not designed for sharing across applications or other systems.

The challenges for integration in oil and gas exploration include:

• A lack of standardization in data;

• An excess of point-to-point links between systems;

• Poor management of reference data;

• Lack of support for the extended enterprise.

Scope

The scope of PRODML has grown to enable production operations, optimization, and reporting and data management for the E&P domain. The current inventory of PRODML standards not only includes production optimization, but adds production reporting, production fiber-optic distributed survey use, and the production lab results/fluid properties use. The PRODML community is working on a multiyear roadmap that includes use cases of increasing scope and complexity. Among the use cases under consideration are:

• Longer-term asset planning, including reservoir performance management;

• Support for electrical submersible pump (ESP) and mechanically pumped fields;

• Optimization

5.7.2 Benefits

PRODML builds on the earlier success of WITSML to improve data and work process efficiencies in production optimization. Previously, oil companies and service providers dedicated an inordinate amount of time, money, and effort to converting common data for in-house custom-built systems. PRODML allows the transfer of production data more easily, saving money across the industry, and allowing companies to concentrate on the real business of making wells and production facilities work more efficiently. The PRODML standards have the following potential benefits to software providers and E&P companies:

Improved operational efficiencies

Production optimization systems are more reliable and accurate with a lower total cost of ownership because information is used more efficiently and effectively.

Safer operations

Opportunities for remote monitoring, collaboration, and
Timely intervention to solve problems can result in reduced exposure for personnel and a safer working environment.

Improved data trustworthiness and compliance

Improved quality facilitates the management of information to monitor, Optimize, and report asset performance. Operators can more easily exchange Data and collaborate with partners, host governments, and service providers, Ensuring adherence to contractual, corporate, and regulatory obligations.

Accelerated adoption of recommended production Optimization practices

Standard processes, as well as innovative variations, can be applied more consistently and efficiently.

Broader awareness of opportunities for production Optimization

With access to more timely information, operators can better support field systems and contribute to integrated operations and production optimization. PRODML is an industry initiative to provide open non-proprietary standard interfaces between software tools that are used to monitor, manage, and optimize hydrocarbon production. Applications currently used to support production. Workflows are available from multiple vendors, but without PRODML they cannot be easily integrated due to a proprietary data structure and non-compatible architectures. The most recent version comprises a set of XML schemas and Web Services that support data exchange, integration, and queries for optimizing free-flowing wells based on real-time measurements and network models, production well tests, distributed temperature sensing, and production reporting. There have been PRODML success stories in data transfer and reporting in XML files, data integration using Web Services and XML, and workflow automation using the Generic Data Access and Shared Asset Model. Energetic has custody and manages this standard for the oil and gas industry. A roadmap has been developed for the PRODML standards to support production workflows from the reservoir-wellbore boundary to the custody transfer point. [17]

5.8 WITSML

5.8.1 Introduction

WITSML (**Wellsite Information Transfer Standard Mark-up Language)** is the standard developed to solve the problem of a shared data representation between companies. WITSML is an XML-based language that allows industrial data to be represented in a predefined form and exchanged between companies. It was originally aimed at a large group of organizations (including oil companies, service companies, drilling contractors, application vendors and regulatory agencies) to allow the flow of technical information between companies. WITSML-enabled applications are becoming popular for a large number of organizations, and are almost a necessity for reporting based applications.[17]

A WITSML document represents a set of data that can be encapsulated within a single XML document. The document is used to represent a subset of the well-site domain. Static and real-time data can be represented within these documents. Static data is represented in an object-oriented fashion that embeds related data inside the same document. In contrast to this, real-time data is structured to allow quick additions to the document. These documents are usually split up into a header and data section. When new real-time data is collected, it is published by the server by adding a new value to the data section and updating the header to inform clients that new data is available.

5.8.2 Why WITSML is required

The volume of information used in the oil industry has grown at a steady rate as technology has become cheaper and more available. Historically the interchange of well-site data was performed by the serial transfer of ASCII data. This data stream was known as WITS (**Wellsite Information Transfer Standard)** and was the most basic form of communication between companies. The documents produced for this stream were not user friendly and were difficult for humans to read. WITS did, however, allow basic data to be shared between the necessary parties.[17]

As the volume of data increased it was clear that the ASCII stream was not sufficient to support the demand. A company, called Energetic, took up the challenge to modernize the WITS language and develop an XML-based standard for well-site data exchange. WITSML was the result of their work. WITSML is based on existing Internet standards (W3C, SOAP, WSDL, and XML) and is similar to other XML standards. The language is defined using XML Schemas that specify everything from the data objects that can be represented, to the units for each measurement. Using schemas to structure this language allows quick and accurate validation on the documents produced, and ensures that documents exchanged are in the correct format.[17]

5.8.3 Benefits

- Improved ‘ plug and play ’ for moving data between systems
- Operators: reduce cost ,improve vendor competiveness
- Contractors; reduce need to support different systems for different operators.

5.9 RESQML

5.9.1 What is RESQML?

RESQML is the exchange format for transferring earth model data between applications in a vendor neutral open and simple format.

5.9.2 Benefits of RESQML include:

• **Integration with WITSML and PRODML**

RESQML will be able to harvest the WITSML and PRODML object descriptions providing integrated access to well data and production data from rig to well data analysis software: from units of measures, geodetics and trajectory to markers and core descriptions.[18]

• Fast and easy browsing

By making each RESQML object self-contained, it is possible to support flexible workflows to browse or exchange horizons or faults or grids without having to carry along the entire set.

• Easy update

By taking a modular approach, it is much easier to ensure data coherency and focus on any step of the construction of the model or model update.

• Traceability

The rich XML description will allow built-in documentation to much more accurately track the origin of the datasets manipulated and the software and workflows used to construct the data.

• Grids

RESQML will extend RESCUE to support giga-cell models and unstructured grid structures. Grids will be maintained in open binary formats for fast direct access.

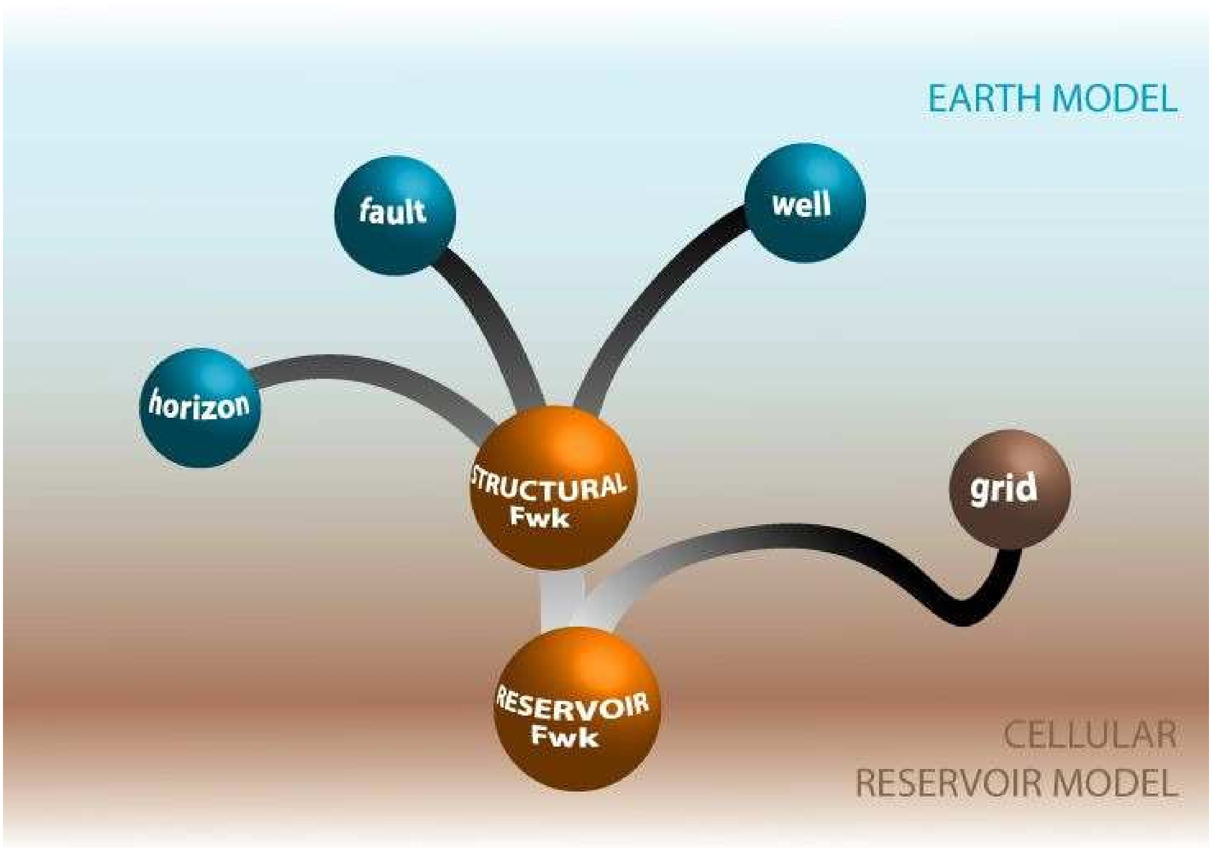

Figure 5-7: Cellular reservoir and earth model [19]

The above figure illustrated the cellular reservoir and earth model as we can see that structural framework and the reservoir framework acts as the main domain and the horizon, fault, well and grid acts as the sub domain.

• **Geo-Referencing**

As in WITSML, all objects will contain position with respect to a Reference Coordinate System.

5.10 ISO 15926

5.10.1 Introduction

ISO 15926 currently consists of 7 parts. The published parts, currently parts 1, 2 and 4, can be bought from ISO.

Information concerning engineering, construction and operation of production facilities is created, used and modified by many different organizations throughout a facility's lifetime. The purpose of ISO 15926 is to facilitate integration of data to support the life-cycle activities and processes of production facilities.

The data model and the initial reference data are suitable for shared databases or data warehouse computer systems in development project and in operation and maintenance. Furthermore, as well as, for defining the terms used in product catalogues in e-commerce. Another used of the standard is as a reference classification for shared databases and product catalogues not based on ISO 15926.

Part 1 Overview and fundamental principles

ISO 15926-1:2003 specifies a representation of information associated with engineering, construction and operation of process plants. This representation supports the information requirements of the process industries in all phases of a plant's life-cycle and the sharing and integration of information amongst all parties involved in the plant's life cycle. (ISO)

Part 2 Data Model

ISO 15926-2:2003 is a part of ISO 15926, an International Standard for the representation of process plant life-cycle information. This representation is specified by a generic, conceptual data model designed to be used in conjunction with reference data: standard instances that represent information common to a number of users, process plants, or both. The use and definition of reference data for process plants is the subject of Parts 4, 5 and 6 of ISO 15926. (ISO)

Part 3 Ontology for geometry and topology

ISO 15926–3 will make the concepts defined by ISO 10303-42 and ISO 10303-104, including concepts in Earth models and the GIS standards ISO 19107 and ISO 1911, available within the ISO 15926 environment. The ontology defined by ISO 15926-3 will be equally valid for CAD, GIS and Earth models. [20]

Part 4 Initial reference data

ISO/TS 15926-4:2007 defines the initial set of reference data for use with the ISO 15926 and ISO 10303-221 industrial data standards. (ISO)[20]

ISO Maintenance Agency (to replace Part 5)

ISO TC184/SC4 started an initiative to develop an ISO Maintenance Agency for reference data. Standards and procedures developed by this initiative shall replace Part 5. POSC Caesar (PCA) has participated in this activity. [20]

Part 7 Implementation methods for the integration of distributed systems

ISO 15926-7 is defining and testing implementation methodologies. Through the IDS project a short cut implementation strategy for using Part 4 reference data as a dictionary of standard terms has been developed.

5.10.2 Why we Need ISO 15926

We need ISO 15926 so we can exchange complex plant and project information easier and cheaper.

Primer: The Need for Context in Information Exchange

When we exchange plant information with traditional methods we rely on context to retain meaning. Information in ISO 15926 format is rich enough that we no longer need context to retain meaning.

Primer: Mapping Databases is Expensive

When we want to exchange information between two software applications, the traditional way is to map the respective databases together. We preserve context by manually examining the terms in each database to determine which are equivalent. Directly mapping two applications together is often the easiest short-term solution. But as more applications are mapped to form a network, the cost to maintain the individual maps grows exponentially.

Primer: A Peek at ISO 15926

To make the process of mapping applications together easier and more reliable, an organization can make a *common data dictionary* for all applications to use. This can take considerable effort just to create, but pays off when connecting another application to the Confederation of Applications. A major complication is revealed when two organizations, each with its own common dictionary, have to communicate.

ISO 15926 makes this situation easier in three ways[21]

- ISO 15926 is a *public* dictionary that all applications can map to.
- ISO 15926 is *extensible* so that the public dictionary can adapt to new developments.
- ISO 15926 is designed to be extensible *quickly* so new items can be used right away.

Primer: Focus on Business Processes

The barrier to interoperability between software applications is not technology. The barrier is business processes. We typically approach interoperability with more technology. Instead we should start With information modeling.

Primer: How ISO 15926 Will Make Your Life Easier [21]

There are a number of issues associated with the need for interoperability, or with current attempts at interoperability. This section shows how ISO 15926 will help. It concludes with four summaries:

Benefits [21]

- Primer: Benefits for Plant Owners and Operators
- Primer: Benefits for Project Managers and EPCs
- Primer: Benefits for OEM
- Primer: Benefits for Software Vendors and Service Providers

Part –II

Implementation

6 Results

6.1 Introduction

Wind turbines operate on a simple principle. The energy in the wind turns two or three propeller-like blades around a rotor. The rotor is connected to the main shaft, which spins a generator to create electricity. Wind turbines are mounted on a tower to capture the most energy. At 100 feet (30 meters) or more above ground, they can take advantage of faster and less turbulent wind. Wind turbines can be used to produce electricity for a single home or building, or they can be connected to an electricity grid for more widespread electricity distribution.[22]

Utility-scale turbines range in size from 100 kilowatts to as large as several megawatts. Larger turbines are grouped together into wind farms, which provide bulk power to the electrical grid.

Single small turbines, below 100 kilowatts, are used for homes, telecommunications dishes, or water pumping. Small turbines are sometimes used in connection with diesel generators, batteries, and photovoltaic systems. These systems are called hybrid wind systems and are typically used in remote, off-grid locations, where a connection to the utility grid is not available.[22]

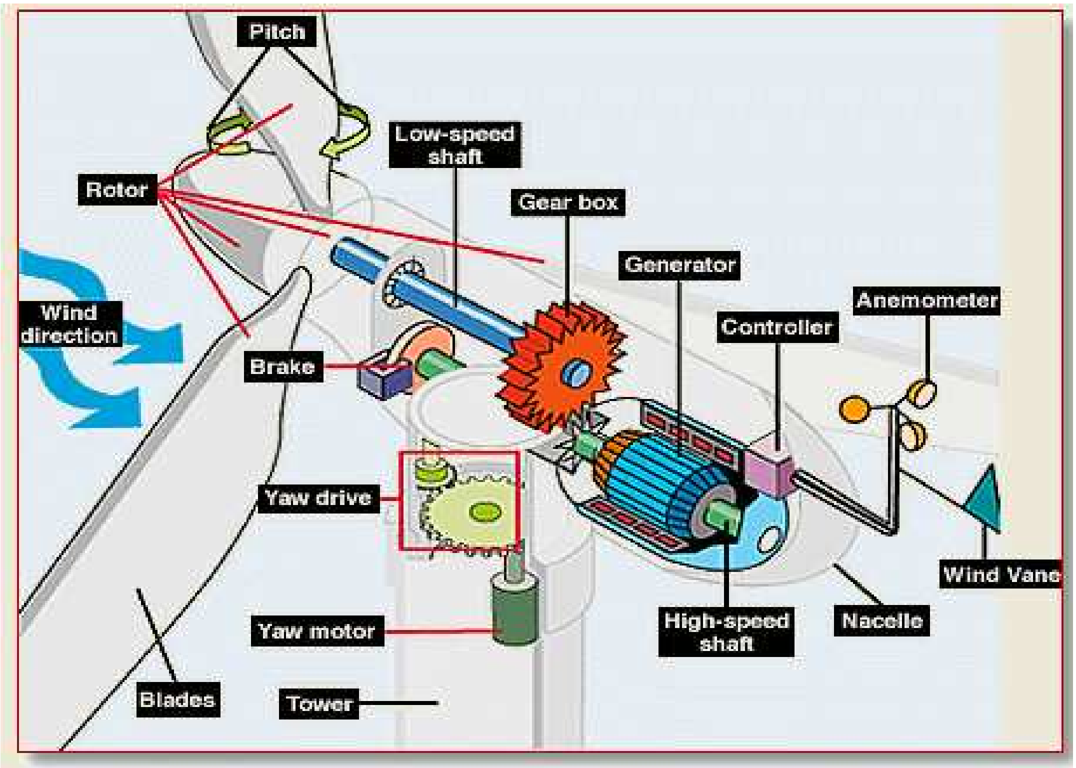

Figure 6-1: Inside the Wind Turbine [23]

Anemometer

Measures the wind speed and transmits wind speed data to the controller.

Blades

Most turbines have either two or three blades. Wind blowing over the blades causes the blades to "lift" and rotate.

Brake

A disc brake, which can be applied mechanically, electrically, or hydraulically to stop the rotor in emergencies.

Controller

The controller starts up the machine at wind speeds of about 8 to 16 miles per hour (mph) and shuts off the machine at about 55 mph. Turbines do not operate at wind speeds above about 55 mph because they might be damaged by the high winds.[23]

Gear box

Gears connect the low-speed shaft to the high-speed shaft and increase the rotational speeds from about 30 to 60 rotations per minute (rpm) to about 1000 to 1800 rpm, the rotational speed required by most generators to produce electricity. The gear box is a costly (and heavy) part of the wind turbine and engineers are exploring "direct-drive" generators that operate at lower rotational speeds and don't need gear boxes.[23]

Generator

Usually an off-the-shelf induction generator that produces 60-cycle AC electricity.

High-speed shaft

Drives the generator.

Low-speed shaft

The rotor turns the low-speed shaft at about 30 to 60 rotations per minute.

Nacelle

The nacelle sits atop the tower and contains the gear box, low- and high-speed shafts, generator, controller, and brake. Some nacelles are large enough for a helicopter to land on.

Pitch

Blades are turned, or pitched, out of the wind to control the rotor speed and keep the rotor from turning in winds that are too high or too low to produce electricity.

Rotor

The blades and the hub together are called the rotor.

Tower

Towers are made from tubular steel (shown here), concrete, or steel lattice. Because wind speed increases with height, taller towers enable turbines to capture more energy and generate more electricity. [23]

Wind direction:

This is an "upwind" turbine, so-called because it operates facing into the wind. Other turbines are designed to run "downwind," facing away from the wind.[23]

Wind vane

Measures wind direction and communicate with the yaw drive to orient the turbine properly with respect to the wind.

Yaw drive

Upwind turbines face into the wind; the yaw drive is used to keep the rotor facing into the wind as the wind direction changes. Downwind turbines don't require a yaw drive, the wind blows the rotor downwind.[23]

Yaw motor

Powers the yaw drive.

6.2 Implementation of IEC 61400-25 for wind power plants (extension of IEC 61850)

6.2.1 Information Categories

There are several different types of information which are necessary for activities within the wind power business. In the IEC 61400-25 standard a list of categories which is covered by the standard has been defined. The categories and their meanings are listed below and are represented in Figure 6-1.

Process information

- State information

  Discrete information concerning the current condition or behaviour of a component or System

  - Status

    Condition of a component or system (st1/st2/..Stn)

    - Alarm

      Statement of safety intervention by for example the turbine control system.

      - Event

        State transition (status, alarm, command)

- Analogue information

Continuous information concerning the current condition or behavior of a component Or system

  - Measured data
    (Sampled) value of a process quantity

    - Processed data
      Measured value, which has been processed (10m-average/…)

      - Three phase data
        Measured value of a three phase electric power quantity

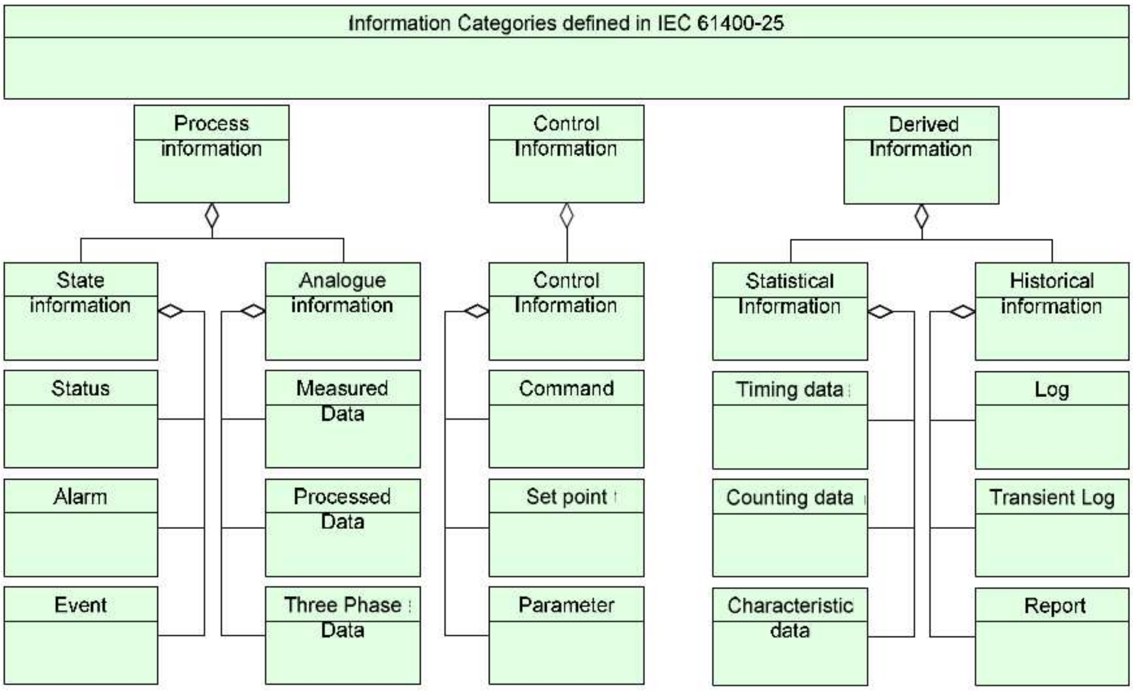

Figure 6-1: Information categories according to IEC 61400-25[24]

Control information

- Control information

Discrete information concerning the current condition or behavior of a component or System

  - Command

Controllable status for system behavior (enable/disable, activate/deactivate etc)

- Set point
  Reference value for a process quantity

- Parameter
  Controllable value for system behavior (adjustment)

Derived information

- Statistical information

  The result of applying a statistical algorithm to a set of data

  - Timing Data
    Total time duration of a specific state

  - Counting data
    Total number of occurrences of a specific event

  - Characteristic data
    Properties of information or data observed (min, max, average, std.)

- Historical information

  Information about the time passed

  - Log
    Chronological list of events for a specific period of time

  - Transient log
    Event triggered chronological list of high resolution source Information for a Short period of time

  - Report
    Periodical notification comprising the information that Represent the Data requested in the report control block

6.2.2 SCADA related domain with service management related domain

The standardized solution shown in Tables consists of two standards which use different approaches for structure and naming their objects. There is still no connection between the logical and the physical domains. This issue makes it impossible to generate a notification without having a human to interpret the alarm text to a functional location

.The purpose of the following analysis is to investigate the possibility to link the logical with the physical domain, in order to make it possible to generate the "Notification" directly without human involvements.

By studying the RDS-PP standard it can be seen that the objects in the physical domain correspond to a unique "system key". How this system key is constructed is described in the theory chapter. The standards IEC 61400-25 and IEC 61850, which has been described in the theory chapter, are based on the approach to group functions and objects into logical nodes. The degree of compliance between the logical nodes and the functional designation keys studied in the following analysis. [25]

In Table 6-1 it can be seen that one logical node corresponds to several of functional designation keys. This one-to-many relation is caused by the different approaches to decompose the functions. RDS-PP has a deeper structure for its functional decomposing than the IEC 61400-25 and IEC 61850 standards. The logical node is the lowest functional entity; further down in the hierarchy will only consist of data attributes which are difficult to associate to locations of a malfunction (e.g. pitch, blade angle, rotor rpm, etc.).

IEC 61400-25 LN	RDS-PP Functional Designation key	RDS-PP Description
WROT	MDA	Rotor system
WROT	MDA	Rotor blade A
WROT	MDA12	Rotor blade B
WROT	MDA13	Rotor blade C
WROT	MDA20	Hub
WROT	MDA20UL001	Cast body of hub
WROT	MDA20UL002	Spinner
WROT	MDA30	Rotor blocking

Table 6-1: One-to-many relation between LNs and Functional designation key

It can be seen in Table 6-1 that there are functions designated by the RDS-PP standard

IEC 61400-25 LN	RDS-PP Function Designation Key	RDS-PP Description
No match No match No match	SLGA01X SLGA01UMD10 SLGA01XA	Ancillary systems Foundation Ventilation and AC system

Table 6-2: No LNs to cover functional designation key

Table 6-3 shows that the RDS-PP standard does not support abstract functions. Abstract functions such as the logical node WRPC are not associated with a function related to a physical object. As a consequence of the fact that RDS-PP only reflects concrete functions and objects, there is no coverage to match the logical nodes in the standard [25]

IEC 61400-25 LN Description	IEC 61400-25 LN	RDS-PP Functional Designation Key
Alarm information Reactive Power Control Active Power Control	WALM WRPC WAPC	No match No match No match

Table 6-3: none physical related LNs have no matching Functional designation key

The analysis on the compliance between the logical nodes and the designation key has shown that there is no possibility to produce a mapping table which binary maps those standards. The proposed table is based on all logical nodes defined in IEC 61400-25 excluding three logical nodes listed in Table 6-3, is shown in Table 6-4. It can be seen that the logical node WROT associates both MDA and MDC which designate rotor and pitch system. A suitable expansion of the standard by grouping data attributes concerning the pitch functionality into a new logical node named WPCH may be considered, to obtain an a rigorous mapping between LNs and designation keys.[25]

IEC 61400-25 LN	RDS-PP Functional designation Key	RDS-PP Description
WTUR	MD	Wind turbine system
WROT	MDA	Rotor system
WROT	MDC	Pitch system
WTRM	MDK	Drive train
WYAW	MDL	Yaw system
WGEN	MKA	Generator system
WCNV	MKY10T	Converter
WTRF	MST	Generator transformer
WNAC	MUD	Cooling
WTOW	UMD20	Nacelle enclosure
WMET	MYA10	Tower
		Meteorology

Table 6-4: Component related LNs, mapped to functional designation key.

6.2.3 Modeling of wind power plant information

Information is the content of the communication that takes place within the framework of monitoring and control. The basic elements are raw data from the wind power plant component, which must be processed into specified information. Besides source data, wind turbine controllers usually derive a huge amount of additional information (10 minutes averages, alarms, logs, counters, timers, etc.). This valuable information is locally stored and available for future use or analysis.[26]

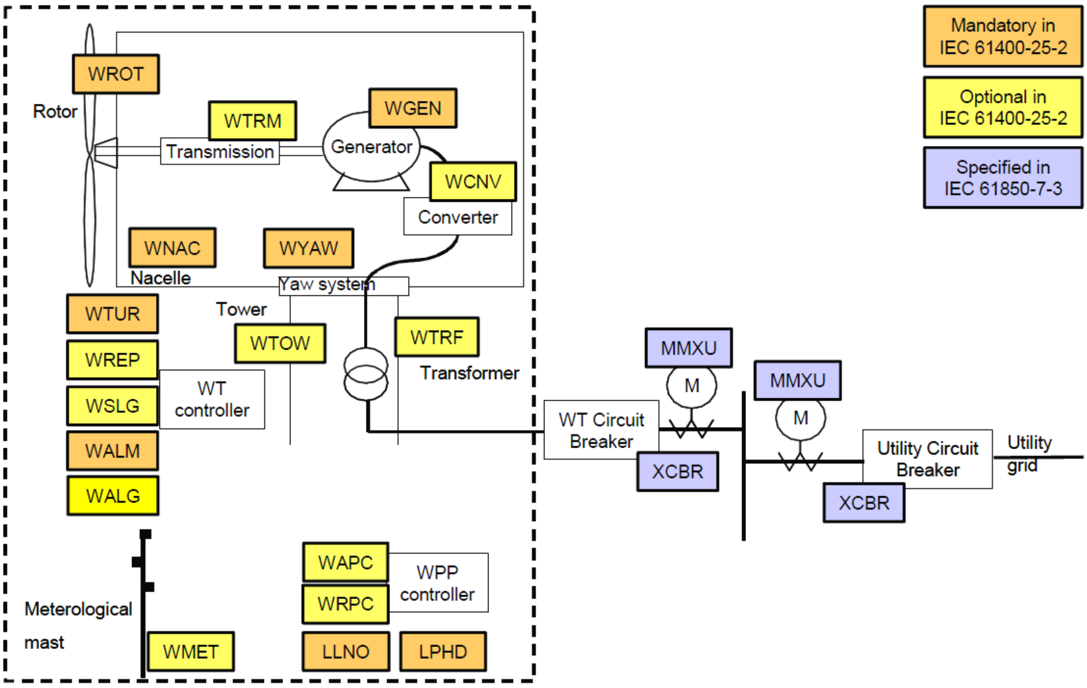

Figure 6-3: Modeling of wind power plant [26]

The modeling method of IEC 61400-25 can be used to describe wind turbine units from different manufacturers in the same information model. The standard also describes additional devices, components and functions in a wind power plant, such as meteorological information, alarm logs, event logs, and active and reactive power control. Figure 6-3 shows logical nodes of the information model. The logical nodes represent different components of a wind power plant. Mandatory logical nodes are expected to be available and optional logical nodes may be available depending on the type of wind turbine. When applicable the IEC 61400-25 standard re-uses information models of IEC 61850-7-3 and IEC 61850-7-4. [26]

7 Why a standard for wind power?

7.1 Objective for the IEC 61400-25

- Provide a uniform communication platform for monitoring and control of Wind power plants.
- Perform a way to minimize the communication barriers arising from the wide Variety of proprietary protocols, data labels, data semantics etc.
- Offering the possibility to manage different wind power plants independently of the vendor specific SCADA system.
- Enable components from various vendors to easily communicate with other subsystems, at any location, at any time
- Applying modern software object-oriented software technology, data Structures, enabling more efficient handling and presentation of information
- Maximize scalability, connectivity, and interoperability in order to reduce total cost of owner ship or cost of energy.

7.1.1 The scope of the IEC 61400-25

- Addressing all communication means between wind power plant components such as wind power plant.
- turbines and actors such as SCADA system and dispatch centres
- Applies to any wind power plant operational concept, i.e., both in individual and integrated operations
- The application area of IEC 61400-25 covers all components required for the operation of wind power plants including the meteorological subsystem, the electrical subsystem and the wind power plant management system
- The wind power plant specific information given in IEC 61400-25 is build on the common data classes specified in the IEC 61850 series of standards
- The standard excludes a definition of how and where to implement the communication interface and thereby enable any topology to be applied.
- IEC 61400-25 defines how to model the information
- perform information exchange map to specific communication protocols stacks
- perform conformance testing

7.1.2 IEC 61400-25-1 Objectives

Part 25-1: Overall description of principles and models

- An introductory orientation - standard document complex in brief
- Customer requirements - what to implement for the wind power domain
- A modeling guid how to make extensions

7.1.3IEC 61400-25-2 Objectives

Part 25-2: Information models

- The wind power plant specific information, describes the common process data, meta-data (data about data, e. g. scale factor or engineering unit), and configuration data of a wind power plant
- Hierarchically structured information covering e.g. process information found in the rotor subsystem, generator, converter, grid connection etc.
- The data may be simple (value, timestamp, and quality) or more comprehensive incl. scale, description, short hand reference, statistical and historical information of processed values.
- All information of a wind power plant defined in the standard is name tagged it defines a comprehensive name space. A concise meaning of each signal is given. The standardized wind power plant information can be easily extended by means of a name space extension rule

7.1.4 IEC 61400-25-3 Objectives

Part 25-3: Information Exchange Models

- All modeled and tagged data and meta-data can be exchanged by corresponding services

- Access to the meta-data (including configuration information with regard to the wind power plant information model and services and communication stacks) provides the so-called self-description of a device.

7.1.5 IEC 61400-25-3 Objectives

Part 25-4: Mapping to communication profiles

- Providing a protocol stack to carry the exchanged values from the modeled information in a server - client base

- **Mapping to five optional communication profiles**
  - SOAP-based Web Services (primary Western Europe + North America)
  - OPC/XML-DA (primary Western Europe)
  - IEC 61850-8-1 MMS (primary US, Sweden and Germany)
  - IEC 60870-5-104 (primary Norway)
  - DNP3 (primary North America, Australia and Asia)

7.1.6 IEC 61400-25-5 Objectives

Part 25-5: Conformance testing

- Specifies standard techniques for testing of conformance of implementations

- Specifies measurement techniques to be applied when declaring performance parameters.

- Application of standard test techniques will enhance the ability of customers to purchase systems that integrate easily, operate correctly, and support the applications as intended by the standard

8 Discussions

We come across two models i.e., RDS-PP and IEC 61400-25. we come across several outcomes from both these methods and after making several comparisons it looks like RDS-PP is much beneficiary model when compared to IEC 61400-25. among all the above compared models we come across many readings and it seems like according to my point of view IEC 61400 25 seems to be much better than compared to rest of those which is not sure since it is difficult to compare and conclude which one is better for wind turbine. So according to my point of view IEC 61400 25 is better as well as RDS PP has also got some good advantages.

The present solution to access wind power plant information by common client applications involves an OPC mapping between the vendor-specific naming and structuring to represent the same information. The resources consumed by this procedure will continuously increase, as more wind power systems(with their own way to represent information) are procured. This issue could be solved by implementing a common information model that all SCADA related systems apply to. This has successfully been carried out in the substation area by implementing the IEC 61850 standard. The IEC 61850 along with its extension, IEC 61400-25, is a complete solution to access wind power related information.

The proposed solution to harmonize the vendor-specific with the IEC 61400-25 andIEC 61850 standards does not concern issues regarding the intermediate phase where core and client application are based on OPC naming.

.

9 Conclusion and Future work

Use of semantic models in integrated operations for oil and gas and new energy includes several methods. We come across all those methods. The IEC 61400-25 series of standards provides the means to get open and easy access to key O&M data. This data is a necessity for making the evaluations and analysis needed to improve operation and maintenance of the wind power plants. The paper has shown how the standard can be implemented and what benefits are associated with its use.

The standard does not restrict nor mandate specific customer-supplier roles, but provides a solution that supports the whole range of business cases where the different actors can cooperate. Both the customer and the supplier can benefit from IEC 61400-25 through decreased costs for data access and system integration. Time and money can instead be put on the development of applications, functions and methods that increase the performance of the wind turbines.

Initially we start with the integrated operations and the relevant topics related to it. Then we come across semantics which make different systems to link and communicate. All theoretical concepts of semantics models were studied in detail and practical implementation of different models were shown.

In 1997, the European Wind Energy Association (EWEA) adopted the target set out in the European Commission's White Paper on renewable sources of energy for 40,000 MW of wind energy capacity to be installed by 2010. Three years later, EWEA revised its target upwards to 60,000 MW by 2010. This forecast has in turn proved to be conservative, with the expected rate of growth being outstripped by the reality. This is in line with the latest projections from the European Commission, which suggest that wind power in Europe could reach a total of 69,900 MW by 2010. Looking further ahead, EWEA has adopted a target for a total of 180,000 MW to be reached by 2020, of which 70,000 MW would be

The leading role that wind power could play in the power generating system of the EU over the coming two decades is evident when considering its share of new generating capacity expected to be installed in Europe over the first two decades of this century. In the period 1995-2000, wind power accounted for 23.4% of the net increase in generating capacity from all fuel sources across the EU. From 2001-2010 it is expected to account for 50% of the net increase, and between 2011 and 2020 for just over 70%. Between 2001-2010, the EWEA target provides 62GW of additional wind capacity. During the 20 year lifetime of the wind turbines, this would avoid external costs €188-480 billion.

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Part III

Appendices

Appendix A – Thesis Description

Telemark University College
Faculty of Technology

FMH606 Master's Thesis

Title: Use of semantic models in Integrated Operations for Oil&Gas and New Energy

TUC supervisor: Hans-Petter Halvorsen

External partner:
John Båserud, Baze Technology AS
Magnus Beitdokken, Baze Technology AS

Task description:

Modern Oil&Gas operations do include the remote and distributed control of assets – leading to heavy demands on the communication links and information flow. Connecting and integrating business processes and information sources across organisational boundaries add to the complexity. Operations require a lot of attention to be paid to environmental aspects, as the tolerance for environmental hazards in such vulnerable areas must be as close to zero as possible.
In order to meet all the requirements and at the same time maintain profitable operations, the industry has to create new field development and operation concepts.
These concepts all comes under the common term Integrated Operations. This is one of the main focus areas in the Oil&Gas industry, with the potentials of saving several billions NOK in the future.

These concepts include the use of semantics in order to make different systems able to link information and communicate. The main object for this task, is to study the theoretical concepts of semantic models in the Oil&Gas domain and wind power domain, and practical implementation of different models.

The main task will consist of the following subtasks:

- Study of Integrated operations in both Oil&Gas domain and wind power domain with the mail focus on the wind domain
- Study of semantic web and reference semantic models and different standards (like IEC 61400-25, IEC 61850, ISO15926, ISA 95, ISA 88, PRODML, WITSML, OPC UA, etc.)
- Proof of Concept implementation on how different wind domain models fit into BazeField's data model, with considerations and recommendations. This task will consist of two subtask's:

Adress: Kjølnes ring 56, NO-3918 Porsgrunn, Norway. **Phone:** 35 57 50 00. **Fax:** 35 55 75 47.

- Develop and configure a wind domain model based on standard within the BazeField database
- Automatically regenerate and put content into the BazeField wind model by configuring the number of wind turbines etc.

Task background:

Baze Technology AS delivers BazeField, a world class Operation Management Software for production integrated operations for both Oil&Gas and New Energy (mainly wind energy). BazeField is a complete fact based operations management software (OMS) for running offshore and remote operations.

Integrated operations is about tracking decisions, know who's taking actions on decisions, defining who should be involved in the decision making, having the right information available when decisions are made to handle risk issues, etc.

For the BazeField system, Baze Technology AS received the Rosing Award for User-friendliness 2008.

To do integrated operations, users need all available information. For data integration and communication between different systems, semantic models are starting to become a standard way of sharing data.

The tasks require good analytic skills, and some skills in .NET/Silverlight development. Many students have worked with Baze Technology AS as part of their thesis project and several students have stayed on as permanent employees at Baze Technology AS. We are always on the search for students who want to bring new ideas and technology or who seek experience with modern IT solutions.

Student category:

SCE students

Practical arrangements:

Training on BazeField will be given along with guidance on knowledge about semantic models and standards.

Signatures:

Student (date and signature): 01/02/10

Supervisor (date and signature): 29/1-10 Hans-Petter Halvorsen