Common interface for electricity distribution service management

Elforsk Rapport 13:93

Lars Simonsson, Johan von Reedtz

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Förord

Rapporten 13:93 är ett resultat från projekt 31066 "Branschrekommendation för informationsflöde och innehåll inom ärendehantering och förebyggande underhåll" i det samlade utvecklingsprogrammet för Underhåll, Diagnostik och Reinvesteringsstrategi som startades under 2010.

Målsättning med ramprogrammet är att:

- *identifiera utvecklingsinsatser för det strategiska reinvesterings- och underhållsarbetet som kan leda till förbättrad nätekonomi, samt att medverka till att dessa genomförs*
- *öka kunskapen om nya möjligheter med diagnostiska metoder för underhåll av elnät*
- *skapa möjligheter till att förbättra underhållets styrning och planering*
- *sprida kunskap med syfte att höja kompetensnivån inom området*
- *vara en brygga mellan högskoleforskningens resultat och branschens möjliga applikationer*

Prioriteringar inom programmet har gjort att måluppfyllelsen är mycket god vad beträffar kortsiktiga och handgripliga projekt, men svagare vad beträffar långsiktiga frågor och managementfrågor. Reinvesteringsstrategier liksom reservdelshållning saknas i projektportföljen.

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Jämtkraft Elnät AB
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Sammanfattning

Målet med detta projekt har varit att undersöka förutsättningarna för att ta fram ett gemensamt informationsgränssnitt för underhåll och service hos elnätsföretagen, och att också rekommendera förslag till gränssnitt. Projektet har varit framgångsrikt och kan presentera huvudleveransen som är ett gemensamt gränssnitt för ärendehantering. Detta gränssnitt täcker identifierade behov inom processer såsom drift, kundservice, mätarhantering och underhåll av enstaka anläggningar. Gränssnittet är beskrivet i detalj både på engelska och svenska och innehåller informationsblock med tillhörande attribut. Ett gränssnitt för projektstyrt underhåll inom lokalnätsverksamheten har också levererats för att stödja inspektionsronder enligt EBR.

Det finns sedan tidigare några gränssnitt för ärendehantering inom de större elnätsbolagen i Sverige, men problemet är att de är olika definierade. Genom att det nu finns ett av branschen gemensamt framtaget gränssnitt som är redo att användas i tester och pilotverksamhet, öppnas många möjligheter. De viktigaste nyttorna som ett gemensamt gränssnitt skapar är att underlätta för befintliga processer men också att öppna upp nya marknadsmöjligheter.

En konkret nytta är först och främst att ett gemensamt gränssnitt underlättar utvecklingen av effektivare fältservice. Vår analys visar att för de flesta elnätsföretag är det en stor utmaning att implementera systemarkitektur som också stödjer behovet att planera och utföra fältservice. Normalt förekommande system för nätinformation, kundfakturering och mätar-hantering är inte välutvecklade för exempelvis resursplanering av service-tekniker. Dessutom fungerar de inte så bra i fält, där det krävs lättare och enklare utrustning av typ surfplattor eller smarta mobiler. Det måste bli mycket lättare att utföra och rapportera rätt om applikationerna utformades för att möta dessa behov. Då krävs ett gränssnitt för att kommunicera med bakomliggande system, och helst ett gränssnitt som kan stödja majoriteten av processerna. Detta finns nu framtaget till en preliminär version som kan börja testas!

En annan viktig nytta är att företagssamarbeten underlättas genom gemensamma gränssnitt. De större elnätsföretagen köper sedan flera år tillbaka servicetjänster via entreprenörer. Medelstora och mindre elnäts-företag undersöker också möjligheten att samarbeta med andra, också via lokala samarbeten med andra nätägare. Här kan branschgemensamma sätt att hantera serviceinformation visa sig vara mycket effektiva, för att exempelvis kunna dela resurser utan att samtidigt behöva dela system. Detta är nämligen det vanliga idag, att många entreprenörer tvingas in i nät-företagens system. Detta innebär många nackdelar, till exempel att licens-kostnaderna ökar men också att entreprenörerna inte kan bli så effektiva som de önskar då de tvingas ha olika rutiner och processer för olika kunder. Med gemensamma gränssnitt blir det också lättare för mindre serviceföretag att konkurrera om elnätsservice, eftersom tröskeln för att kunna utbyta information med nätägaren blir avsevärt lägre.

Med gemensamma definitioner och krav på serviceinformation blir det mycket enklare att öka kvaliteten på data i elnätsföretagens processer. Detta är något som framkommer i vår analys, där stora kvalitetsbrister orsaker svårigheter

att skapa långsiktiga strategier för nätförnyelse och andra prioriterade investeringar. Om alla ärenden i sina flöden följer samma informationsstruktur skapas möjlighet till aktiv och kvalitetssäker analys. Eftersom det är sannolikt att kraven på transparens och mätbarhet inom elnätsföretagens verksamhet ökar alltmer, skapas förutsättningarna för detta genom gemensamma gränssnitt.

Det kan också bli enklare för kunden att beställa service och tjänster som påverkar mätning och leverans av el. Pågående förändringar för att skapa en nordisk slutkundsmarknad går också ut på att öka marknaden för leveranser av smarta utrustningar till kunden, inklusive lokal produktion. Om det finns ett gemensamt sätt att hantera servicebeställningar så kan också de bolag som har direktkontakten med kunden använda dessa för att föra vidare behov till aktuellt elnätsföretag och deras leverantörer.

Det finns en stor förändringspotential inom elföretagens verksamhet, dels genom bättre utnyttjande av sina personella resurser, men också genom att öka värdet av alla fältservicebesök som görs. Uppskattningsvis går ca 15-20% av nätbolagens årliga kostnader till utförande av olika tekniska tjänster, vilket skulle kunna innebära i runda tal 7 miljarder per år i Sverige (totalt ansökte elnätsbolagen om över 40 miljarder kronor i intäkter för innevarande reglerperiod). Förädlingsvärdet av förbättrade processer och ökat värde skulle då kunna vara en inte oansenlig delmängd av dessa kostnader, kanske upp till 1 miljard kronor årligen. Det finns med andra ord ett bra ”business case” för förändring.

I rapporten görs en detaljerad nulägesbeskrivning av serviceprocessen inom elnätssektorn. Olika strukturer presenteras och servicetyper exemplifieras för att beskriva hur ett gemensamt ärendeflöde kan etableras. Vi bedömer att det i detta projekt använts en mycket djup och bred kunskap som bör betraktas som branschens samlade kunskap. Detta inom elnätsverksamhet, elmätning, serviceverksamhet, systemstöd och IT-utveckling men också om strategiskt förändringsarbete.

Projektet levererar gränssnitt som är framtagna för att underlätta förståelse. De är strukturerade i informationsblock som var och en innehåller ett antal attribut. Det kommer vara lätt att bygga ut och förädla modellen också för unika behov som kan finnas. Det finns också en basprocess för respektive gränssnitt framtagen och förslag på viktiga principer och värden. För att gränssnitten skall fungera krävs dock ytterligare arbete, framför allt en gemensam katalog på alla förekommande typer av serviceärenden. Det är förhoppningen att branschen använder resultatet av detta projekt att bygga vidare på. I rapporten beskrivs ett önskat förändringsscenario där branschföreningarna gör sig redo för att stödja förvaltningen av gemensamma gränssnitt.

Det finns en tydlig trend i samhället att satsa allt mer på att utnyttja information baserad på öppna gränssnitt. För många konkurrensutsatta branscher, exempelvis fordonsindustrin, är det en självklarhet sedan länge.

Det bör givetvis vara en självklarhet för elnätbranschen att följa denna trend!

Summary

This project aims to analyze the Service Management process in Swedish electricity distribution companies, and provide common interfaces to meet business needs for information exchange.

The reasons for this are many. Some interfaces have been taken into use by some larger companies, but they are very differently designed. At the same time, there are several companies trying hard to implement effective service management processes, but with no common information standards, the obstacles are great. There is simply no “one system solution”, resulting in the obvious need to exchange information between several systems. The benefits of defining common interfaces are analyzed and documented in this report. There are four major areas where common interfaces will be useful: improving the field service process, simplifying b2b relations, increasing transparence, and making it easier for customers.

The project has been executed by two senior consultants, Lars Simonsson and Johan von Reedtz, with the support of ten reference companies of various sizes and types. The current processes in these companies have been thoroughly analyzed and detailed information and examples from systems have been provided.

Service management in electrical distribution companies is a broad field of events, cases, work orders, and even projects. This has been structured and exemplified, leading to the conclusion that two interfaces are needed. One general case oriented order interface covering almost all events that occur in customer relations, operations and maintenance of individual objects. For inspection rounds in the local networks, another interface is recommended.

The recommended case oriented order interface comprises 18 information blocks containing a total of more than 200 attributes. It constitutes the “common denominator” of all information uses in the various processes encountered at the distribution companies. All information blocks are described in the report, but also in a detailed data dictionary attached (Excel and XML formats). The technical frameworks have also been investigated in this project. The method of using XML is nowadays common practice, and has been used to establish many integration solutions. Using this knowledge, a set of technical principles has been defined as a part of the recommended interfaces.

How can common interfaces be made successful? This is perhaps the most important question to answer, to prevent this report becoming just a report on paper, as so many others, and lacking any concrete outcomes. There is a need for a business case, and the project has developed a financial argument to support and promote more effective service management processes. Delivering the interfaces, ready to be tested and piloted, is the first step. When knowledge about the interfaces is more widespread and verified, there is a need for common governance of the interfaces, securing the interfaces’ competence and necessary future adjustments.

We truly believe that this project’s findings can make a difference, and constitute the start of a process of change that will be very beneficial to the electricity distribution sector!

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1b Case based order (Message schema, XSD)
2a Project based maintenance (Information content, Excel)
2b Project based maintenance (Message schema, XSD)

1 Introduction

1.1 Background

The electrical distribution business is complex and undergoing rapid development. IT has been an important enabler and driver for many areas of change. For instance, in the development of Advanced Metering Management , the automated reading technology, metering databases, consumption analysis and reporting are examples of processes that have been greatly improved due to the possibilities created by modern IT.

In general, the urge for efficient and effective use of IT in most processes has been the aim. However, the journey has, in many areas, not been as fast and not as successful as expected. Mobility, i.e. the use of IT in field operations, is an example of where the short term expectations were set very high, but where actual efficiency using these tools has just recently become reachable.

In a business process context, service management performed in the distributor's operations, asset management and customer service have been really challenging. Why is that the case? Probably because of the complexity and variety of the services are extensive. In addition because there are so many IT applications used in the companies. To support all possible types of services, the tools must be much more capable than those, for instance, that only support meter reading or meter exchanges. And there is always the need for optimized field service process, using effective planning and dispatching methods. The great mix of systems and the variety of processes create a great challenge.

How do we get the service management process to flow effectively through our systems, and achieve successful implementations at a reasonable cost? How can we make business-to-business processes work in practice, without starting big and expensive IT-projects each time? How do we make the process of operations and maintenance transparent within our company, without heavy administration?

This is the context, the starting point for the project, whose aim was to find something innovative, something new that really could make a difference!

1.2 Aim of this project

One of the most successful ways of dealing with processes that include many stakeholders and systems is to use common interfaces for the data interchange. A common interface is a message specification that is created for the benefit of many stakeholders, to use freely and as a basis for innovation. This way information can be transferrable throughout the processes, optimizing each step for each stakeholder and at the same time making it possible to monitor the information flow. Specifically, in a service order flow, the originator would create a need in one system. When ordering this need, the order will be sent to another stakeholder using the common interface, which then receives and imports the message into another system. In this system the order is executed, and then reported back to the originator using the same interface.

With an understanding of the complexity of the electricity distribution service management processes, the aim of this project is to find a common denominator of information used in all types of service. Several questions will arise in this context, such as the actual possibilities of success, general demands, and technical issues, as well as how to structure all the important data.

This project aims to deliver a common interface for services, including information model and attributes (known as an XML-schema). Based on an analysis of the service management process in many utility companies, there will be a presentation of examples of services that can use this interface, basic working process and principles. Finally, recommendations for the next steps towards realization will be given.

1.3 Method

The project has been led and executed by the authors Lars Simonsson, Meliux Utveckling AB, and Johan von Reedtz, Reedtz Consulting AB. As senior consultants in business and IT within the utility sector they have had a good platform to start from, and with the support of a reference group, they have seen this project to completion during 2013. The working method has been divided into the following steps:

1. Analysis of present market situation and present interfaces used
2. Getting the reference group on-board
3. Analysis of all types of orders that the interface should support
4. Developing information blocks for the information models used
5. Filling these blocks with attributes used in all processes
6. Adding basic process and other principles
7. Finalizing the result by making several reviews of the documentation

- The reference group in this project has had representatives from the following companies:Fortum Distribution AB
- Göteborg Energi Elnät AB
- Hofors Elverk AB
- Härnösand Energi och miljö AB
- Jämtkraft AB
- Sundsvalls Energi AB
- Svenska Kraftnät
- Söderhamn Nära AB
- Vattenfall Eldistribution AB

2 The purpose of common interfaces

2.1 Generally

Throughout the IT-evolution, each value-adding step has had a component of standardization of some sort. Following the development of the internet, for example, Ethernet and TCP/IP have been used for communication, SMTP for E-mail and HTTP for web pages. Entertainment is another area of standardization, using MP3 for music, Blu-ray Disc for movies, etcetera. There is no doubt that standards are really valuable in IT-oriented product development.

Most industries have encountered the need to exchange data between companies. The automotive industry is a good example, having established ODETTE[1]. The Organization for Data Exchange by Tele-Transmission in Europe acts as an impartial body identifying, agreeing and documenting standards and recommendations for improving the efficiency of business to business communications between trading partners in the automotive industry. Odette aims to drive down costs and improve efficiency throughout the Supply Chain. Technologies covered include EDI, Automatic ID/Barcode Labeling and CAD/CAM, particularly in the area of logistics, engineering, purchasing, finance and e-business. Odette publications are free to SMMT members.

These processes are generally quite challenging, not only in bringing all stakeholders together in each case, and creating something that everyone can support. The possibility of succeeding is mostly determined by will and energy, actively managing the obstacles and at all times having the target in sight. Standards can always be established given the right focus, circumstances and resources.

IBM's former CEO, Sam Palmisano, who initiated and led the transformation of IBM from a hardware to a services focused company said regarding standards: "In all future services that IBM want to be a part of, standards are important for success. All mature business sectors have created standards. Standards are necessary and are in practice the only way to solve the big, critical and complex problems of today."

When established, standards are generally really valuable for the users, as a platform for the development of products and services, but also as a means to steer and control the deliveries from a customer point of view.

[1] For a full list of all Odette standards, see http://www.odette.org/publications.

2.2 Present standardized information interfaces in the electricity distribution industry

The electrical distribution industry in Sweden has set information standards for some parts of the business processes. Two of these areas are:

- Handbook to the Swedish Electrical market, containing all the messages and guidance needed for making a deregulated electrical market work in Sweden.

  The framework that the handbook describes is governed by "Elmarknads-utveckling"[2], and answers questions and errands from the market actors. It is supported by Svensk Energi[3], independent electricity companies and the Swedish national grid.

- Mandatory reporting from the distribution companies to the authorities and government statistics.

  Such mandatory reporting to the Swedish Energy Markets Inspectorate can be made by XML-defined interfaces. This includes information about outages (down-time) and information for Ex ante regulation of electricity network fees.

However, outside these areas, there is a great need for further standardization:

Within the field of operations and maintenance (service management), there are a handful of information interfaces presently in use, but no common information interface. It has become more and more obvious that a unified and common interface would have many benefits.

Some standards are also found internationally in the electricity distribution industry, and are briefly discussed later in this report.

2.3 Benefits of common interfaces for service management

Several benefits of introducing common electronic interchange interfaces in the area of service management in electricity distribution have been identified. They are of different kinds and are grouped as described below:

- Field Service

  Support the development of digitalized working processes and making management of information possible in field service processing.

- B2B interaction

  More cost effective implementations and easier to establish business to business relations of different kinds.

[2] http://www.svenskenergi.se/Elmarknadsutveckling/
[3] http://www.svenskenergi.se/

- Increased transparency

  Easier to overview business performance and KPI's regarding Asset Management, by the means of transparent information about the actions performed in the electricity distribution network as well as network status.

- Easier for customers

  The roadmap for the Nordic Regulators recommends that energy suppliers should be responsible for the customer contacts, rather than the electricity distribution operators (DSO's). Common interfaces are mandatory to succeed in this market change.

For each group of benefits, several practical and cost efficiency factors are found, and these are discussed below.

Field Service

New mobile digital equipment has evolved rapidly in recent years, and although the wait has been long, hope is increasing for the success of mobile equipment used in field service. However, the lack of standardization makes it difficult to easily find integrated software solutions, and the pilots made in the industry are still quite expensive.

When no real alternatives exist, the common practice for field service is to extend the network owner back-bone systems for use in the field as well. This solution has two major disadvantages. First, it creates the need for more licenses from the back-bone system provider, which increases the cost in general. But perhaps the most important drawback is that this solution prevents the service provider from developing optimal processes for service management, since different systems and routines will be used for different customers. New common interfaces would make it possible to open up the situation and enable the service provider to use systems optimal for the service management process.

At the same time, there is no "one-system-solution" for the distribution business. Normally, at least two back-bone systems are used, one for asset management operations, and one on the customer delivery information side. Even other systems for Advanced Metering Management (AMM[4]) could have service processes built in! This tends to divide the processes, but using a common interface that manages all types of information could make compatible field service systems possible.

There have also been arguments for better quality management in the service management process, and especially in the ability to control the details in the executing process in the field. A common interface could contain a set of guidelines and controls, developed by the market actors that improves information quality and controls all steps needed in the execution of the service in the field. To be able to train new personnel, more detailed instructions are commonly used and, generally, normally expected.

Business to business (B2B):

[4] Advanced Metering Management, see https://en.wikipedia.org/wiki/Smart_meter

When analyzing the B2B solutions in use in the reference companies, these are found in large utility companies that have outsourced the service management execution process to service providers. The purpose has been to establish an effective "order and report" process within a frame agreement. In each case, they have only been successful when backed up by a substantial development project involving both parties (network owner and service provider), together with IT-personnel from each back-bone system and the infrastructure communication personnel. Very cost consuming, and in many cases based on too limited definitions of the process in focus. A project like this could, in general, consume about 5 million SEK, and that could account for a large part of the profit target for the outsourcing project as a whole. A common interface would substantially reduce the cost of setting an outsourced service agreement in production.

Another perspective is that the market competitiveness of electrical service for distribution purposes could increase if common interfaces were to be established. So far, it has only been possible for the largest service companies to interconnect with the network owners using interfaces. With a common interface, the possibility for participation in request for proposal (RFP) and Quoting would be extended to medium and small size service companies. The competition would increase, and this would be especially noticed in the northern part of Sweden, where there are few large service operators in the market.

Another B2B relation that is becoming increasingly interesting is local cooperation between the electrical distribution companies themselves. This is mainly caused by the fact that many of these companies in Sweden are very small, and find it difficult to meet all the new business requirements. There are actually network companies that have less than 1000 customers! This means that, when cooperating, several processes could be set up between these companies, making effective use of their combined resources. Common interfaces would make this more feasible and economically attractive, perhaps combined with new IT-systems and portals systems where common interfaces could be used in different ways.

Increased transparency in electricity distribution

In many European energy markets all network owners are under the supervision of authorities (regulators), in the interest of the customers and in support of environment friendly energy consumption. Several regulations regarding AMM have been introduced in recent years, but investment budgets in relation to the size of the present network have also been examined.

All these work demands transparency of different kinds, and has often been rendered into information management guidelines, both driven from authorities as well as driven by competitiveness. In any case, information is always the foundation for business overview and understanding. Pre-decisions by the regulator on the accepted level of income for electricity distribution companies are a great driving force for improved efficiency, and the first step would always be to get more information about the business reality.

First steps towards asset management include asset information and event management. The usefulness of transparently reviewing different events and deviations in the network on a regular basis cannot be overstated. This would also need to have customer claims or reports in constant view.

Also, the state of the network is of great interest, and using standards for reporting controls and asset status will generate more information for the owners, enabling improved control of risk.

Overall, a common interface for service management will probably be one of the most important tools with which to overview Operations and Maintenance, as well as customer service. If used in all field service processes, it will be a means of measuring the processes in time, cost and quality.

Easier for customers:

Also, in the same context of transparency, there are currently ongoing studies regarding a “One Nordic Electricity consumer market” where “Only one invoice to the customer” is discussed. This would have a great effect on the relation between the end-customer and the distribution company, since there will be no business relation between these parties. Only when something (normally physical changes) has to be done in the customer premises, does contact with the network owner need to be taken.

But will the customer even know which network owner should be contacted? The first contact would definitely be with the electrical sales company! It is highly probable that, for the sake of simplicity for the customer, the electric sales company would like to cooperate with the network owner in the ordering of service, and a common interface would also be of great benefit here!

2.4 Business case

The analysis made in this project regarding the present service management processes at the electricity distribution companies shows the need for improvements. Only when the service processes are better defined and are built upon a common set of information definitions, can the benefit realization be made. The standardization will then also act an enabler toolset for improvement. It is not actually about systems, it is about information. From the basis of detailed information, the processes can be measured and, step by step, improved.

Is there a business case?

Our analysis shows that, in general, the service management share is about 15-20% of the total sector turnover. With a total of about 35 billion SEK yearly in Sweden, the cost of service management could be up to 7 billion SEK. When developing more efficient processes, or making them more transparent, the improvement factor could be at a level of perhaps 15%, which translates into about 1 billion SEK! This could be realized in lower cost or improved quality on network asset management related information.

This indicates that there is a (very) good business case for standardization of service management processes!

3 Electricity distribution service management – an overview

As a first step in this project, the service management processes in the Swedish distribution companies have been analyzed. The reference group companies have provided information about how they work and with what guidelines and IT systems. In this report there will be no details about individual companies presented, only the overall picture.

3.1 Services in electrical distribution networks

3.1.1 Overview and structure

Technical services in distribution business display great variety, both in terms of type and size. Structuring this can be done in many different ways from a technical or a business perspective – we have chosen the following structure:

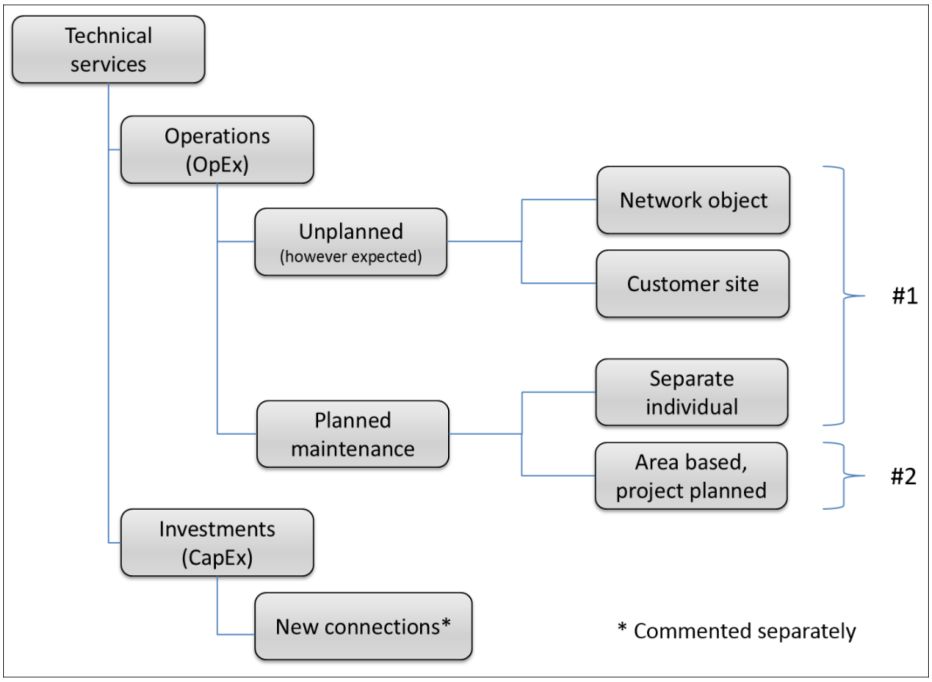

Figure 3-1 Structure of technical services in utility companies.

The division between Operations and Investments is a basic principle used in most companies. Technical services can also, at first level, be divided into operations or investments. Operational services are managed as costs, having direct effect on the business result for the period (OpEx). Investments are "the construction of assets" that will finally be an asset with its depreciations, in relation to the assets lifetime (CapEx).

This study focuses on the operational services, taking only the smallest types of investments into account. Normally, investments will be executed in projects which are outside the scope of this study.

The next level in the operational services structure is defined by the target asset location for the service, or the organization of the service execution. Operational services are divided into case oriented services, and planned maintenance.

Case oriented services are generally unplanned, however expected, due to the large number of network objects as well as customer delivery sites. The term "unplanned" could be interpreted differently, and is in most cases a matter of time frame. A normal categorization used in the processes is to separate "urgent" cases from "not-urgent". In this structure we do not organize the cases based on urgency since we regard the information used in the process to be the same. Examples are malfunction, outage, customer changes or services of different kinds.

Case oriented services can be divided into basically two different types, focusing on network objects (equipment) or focusing on the customer delivery site that contains the electricity meter used for measuring consumption. This structure is important since the information used in the process, describing the case, is very different. These differences will be defined later in this report.

But operational services also include planned services which we categorize as preventive maintenance, or equipment status checks made in the distribution network. The planning time-frame can be on a weekly, monthly or yearly basis and a significant part of this preventive maintenance is done under the guidelines of the electrical safety authorities. These maintenance services can, in principle, either be ordered individually per network equipment, or via area based project-ordered groups of checks. This is normally dependent on the amount and significance of the equipment. At transmission and regional network level (above 40 kV), individual orders per equipment object are commonly used. These orders will have great similarity to case oriented orders.

In local network (less than 70 kV), the large number of network objects requires processes that are more practical than ordering case oriented per object. Instead, it is a normal procedure to order planned maintenance based on areas and type of object/maintenance, and plan the execution in a similar way to a project. The information structure of this process is very different from case oriented service and a separate information interface has been developed to meet the demands of this process.

The technical services will now be separated into two main categories, #1 Case oriented and #2 Project based maintenance – these are further described below.

3.1.2 Case oriented services (#1)

As described earlier, the categorization of case oriented services applies to unplanned service and individual planned maintenance. It is a challenge to get a total overview of all these types of cases, but this can be done using data from different systems involved in the processes. The systems are usually supporting Operations, Asset Management, Metering management and Customer relations and billing systems. There is some general "Errand"-systems used, but there is very seldom only one system handling all cases in a distribution company!

The analysis reveals that case oriented services have a set of common properties:

- The execution of the service is quite limited, up to a day's work in most cases.
- The order is initiated by the network owner, even if some actions can, if needed, be made on-site by the service technician without approval.
- A great deal of cases are started from a customer need, and received by customer service.
- Changes of equipment and/or meters are common when executing the service.
- A service case has only one location, either it is a network object or a customer delivery site.
- When ordering these services from external service companies, it is within a frame agreement and invoiced only on a monthly basis.

Through the analysis of the operational services performed in the distribution companies, different lists of actions or service catalogues have been identified. The structure and content has varied a lot, depending on the size of the company as well as business relations with the contactor if these exist. Several reference companies have had no catalogue or service list at all!

To be able to present some kind of common or "neutral" basic service catalogue in this project, the first step has been to categorize service types based on the focus of the service. Either a network object is in focus, or a customer delivery site. Individual planned maintenance is normally network object focused and will therefore be included in the network object focused cases. For each focus type we have then chosen a two level hierarchy.

<u>Network object focused cases</u>

All urgent events due to malfunction in the network are included in this category, normally managed from an Operation Central. These are registered in Distribution Management Systems (DMS) or different kinds of Enterprise Asset Management Systems (EAM[5]). The carrier of the information is normally called a Work Order, and relates to Network Objects defined as Locations or Equipment. A controlled process in terms of order state is used. Several orders are created due to deviations or problems of a minor grade when doing inspections. It can be as simple as just checking the equipment before doing project planning. In addition

[5] See https://en.wikipedia.org/wiki/Enterprise_Asset_Management

to this, the process of generating preventive maintenance orders is normally also supported by these systems, based on a preventive maintenance plan for selected objects. This is normally used at higher voltage levels, i.e. regional and transmission networks. A structure of a network focused case is presented below:

- Service need
  - Fault report
  - Service request

- Repairs
  - Urgent repair
  - Repair
  - Status check

- Preventive maintenance
  - Checks, inspections on equipment
  - Equipment overhauls
  - Overview inspections of overhead lines
  - Tree clearance

Customer site focused cases

These cases are normally related to the customer delivery site and often initiated from a Customer Service Center. Either the customer addresses the issue by phone, or the services are part of a planned change of the network in general. When working with changes at the customer delivery site, the metering equipment can be replaced, or changed. Issues about AMM are normal, as, for example, checking the communication. For larger consumers where the fuse is above 63A, transformation equipment needs to be managed as well.

Sometimes the customer building is torn down or reconstructed which also leads to changes in the location of the meter. Temporary electricity is used by events or constructing companies and has a process of its own, which is quite complicated with regard to metering. We also include other errands, such as protecting overhead lines when taking down trees, or safeguarding cables when digging, in this category, Systems used in this category are Customer Billing Systems or Customer Relation Management systems (CRM[6]). When changing metering equipment there are normally change orders supported in the metering database as a part of an AMM concept.

- Meter and metering issues
  - Checks
  - Exchanges
  - Communication

- Physical changes in delivery site
  - Move, reconstruction
  - Changing of fuse size

[6] See https://en.wikipedia.org/wiki/Customer_relationship_management

  - Electricity theft

- Status changes in delivery site
  - Starting the delivery
  - Closing the delivery
  - Temporary connections

- Electricity distribution
  - Faults, outages
  - Electrical quality issues

- Network protection
  - Taking down trees close to overhead lines
  - Cable localizing when digging

As described above, the case oriented services are of many types and can be categorized in many ways. The analysis of the present situation at the electricity distribution companies shows many different ways of listing the services in a "Service catalogue". This is very common when the services are outsourced to service providing companies.

Another dimension to these services is that contracted costs depend on the extent of the service. If and how far the service technician has to travel to the service location is one example. Adding these cost aspects, could result in a service catalogue containing more than 100 services. This is perhaps the most important structure, or metadata, that needs to be frequently defined when using a common interface for service management.

3.1.3 Project planned maintenance (#2)

As described earlier, local distribution companies have a large number of objects in the network. Overhead line poles, and cable boxes in the city environment, number hundreds of thousands. It is therefore common practice to order preventive maintenance checks by grouping objects per area, and order the work as a project. This minimizes the administration, and gives a structured way of controlling the maintenance process. This means in practice that one order would include many objects and be performed over a longer timeframe.

To support this process, the Swedish electrical distributors have created recommendations for network preventive maintenance (EBR Underhållshandbok) based on this process.

Here are some examples of local network preventive maintenance included in these recommendations.

- Overhead lines distribution networks are checked on a yearly basis often by helicopter. The checks are performed with video-recording, checking trees at risk of threatening the air-lines. Poles at risk can also be identified. This particular maintenance can also be ordered as a case oriented service.

- The more thorough maintenance of overhead lines is carried out about every 8^{th} year (called a maintenance check), moving from pole to pole on the ground, checking the network objects on each pole in detail. Earthing equipment is also checked while doing the thorough maintenance check of each overhead line.

- Secondary substations and the equipment in these substations are checked at different levels of detail. Cable boxes are checked about every 4-8th year.

For all the different maintenance checks, including those mentioned above, the Swedish energy companies have defined a recommendation for maintenance documentation. This is structured by object types (a number per type) and control points (a number per control point) in a detailed way. For each control point, a checked result is reported as a number 1, 2 or 3, meaning:

1. OK, no action needed
2. Action needed before next control
3. Urgent action needed

This second category of services is defined to support this maintenance process, which is normally planned in Network Asset Management systems (geographically based). When planned, and ready to order, a list of all objects and the maintenance check type will be created and delivered to the service executor. The reporting will normally be done each month during the execution of the total maintenance order.

3.1.4 New connections

The new connection process is maybe the most important service process in electricity network companies. In Sweden, the rules and guidelines for connecting customers are based on the law “Ellagen”. Within the concession area the electricity network company has to connect new customers to the network.

This process includes business agreements, contacts with the real estate constructors or electricians, technical detail planning, execution in several steps to finally establishing the new customer site and invoicing the customer. Depending on the number of connections made annually, smaller sized companies regard a connection as a project, following project processes. Mid-sized and large network companies normally process this as service or work orders.

Regardless of this, the fact is that new connections are capital expenditures (CapEx) that need to be activated as network assets when taken into operation. As the network size is a basis for regulating fees, the importance of good reporting and asset documentation of new connections cannot be stressed enough.

This project has the ambition to deliver full service interface support for this process as well. However, the complexity of this process results in several ways of administrating the information flow. The conclusion made by this project, with support from the reference companies, is to support each step of the service execution, rather than including the full process. This way, the process can be broken down into several case oriented services, related to customer site (the meter location) as well as network object (the connecting cable).

3.2 Service process examples

Service processes appear at first sight to be quite easy and straight forward. Something needs to be done, and someone is asked to do it. When the task is done, this is reported back to the person requesting the service. When this process is analyzed in more detail, there are at least five steps needed to describe what must really happen. A professional way of working must secure quality in the delivery, as well as the resulting cost and timeframe.

Phases in a typical order process

1. Events leading up to a service being ordered
2. Confirmation and planning
3. Execution
4. Reporting, technical as well as administrative
5. Closing and invoicing

Figure-3-2. A typical order process.

Each part can be detailed further, depending on the nature of the service. Some examples are given below. Note that no IT-systems are mentioned in these examples; instead we focus on the process and the information. The examples will show the extent of all steps and the information used in the process, and illustrates the need for common interfaces and the benefits these will give to all service processes.

3.2.1 Example 1: A network object focused service process

<u>Events leading up to a service order</u>

A malfunction is found by a service technician on a network object and is reported to the maintenance planner. The planner analyzes this problem and makes a decision whether the object should be repaired or exchanged, which is not always easy to decide for electrical assets. It could be necessary to contact different stakeholders if the object is expensive or technically complex to exchange and the urgency of the case needs to be taken into consideration. Since there is tree clearance planned in the near future on this overhead line, the disconnectors have to work properly. The maintenance planner decides to repair the object, and orders the job to be done as soon as possible.

<u>Confirmation and planning</u>

To be able to repair the object, in this case a 10 kV overhead line disconnector, it is necessary to turn off the power on the line, which needs to be planned, and the affected customers need to be informed a couple of days before the work is planned. The service technical department asks for a planned turn off, and this is planned together with the operating central staff. The customers are informed, and the planning is concluded, and the maintenance planner is informed about the new execution plan.

Execution

The work starts with securing safety by shutting the power off in the secondary substation. The repair is executed and the power is turned on again. In this case no complications occurred - the work went smoothly.

Reporting

The service technician reports the time and cost of repair material needed including a short technical report about the work.

Closing and invoicing

The maintenance planner makes a final review and then archives the case documentation, including asset information history for follow up purposes. An invoice is created and sent to the customer if so agreed.

3.2.2 Example 2: A customer oriented service process

Events leading up to a service order

A customer living in a house has wanted to improve the heating system to try to minimize energy costs. He has had some contacts with his energy company and made a decision to install some new heating devices and remove the old one. He is advised to increase his fuse from 16A to 25A, and at the same time install a new hour-based meter to optimize the consumption when the electricity price is low. He decides to do this and orders the service.

Confirmation and planning

The order is confirmed by the electricity distribution company, which makes a change-order to the service company to be executed within 2 weeks. The service company confirms this and calls the customer to plan access to the house at a convenient time, and then take the power down for a moment to execute the change. The plan is reported back to the distribution company. Just a day before the work is supposed to be made, the customer calls and wants to reschedule. This is done and the plan is updated.

Execution

The work is done, the fuses and meter are changed, and the connection to the automatic reading system is tested and approved.

Reporting

The service technician reports the new information about the customer site, together with the time and cost of repair material needed to his employer, including a short technical report about the work. All technical reporting to the distributor is made as agreed, including the cost for the work.

Closing and invoicing

The distributor company approves the case and informs the service company, and archives all information about the case. The service company includes this case in the next monthly bill to the distribution company.

3.2.3 Example 3: A project planned maintenance work

Events leading up to a project order

The maintenance planner makes a plan for preventive maintenance next year, and structures the network assets checks to optimize cost and delivery. In this case a plan for 500 cable boxes on the eastern side of town is grouped and an order for maintenance checks on these objects is made in December, to be executed during the first half of the next year. The planner makes a mini-tender within the present frame agreements available and selects a service provider for the job and orders it.

Confirmation and planning

The project is confirmed by the service provider, who makes a plan to check 100 cable boxes a month from February to June, and report this on a monthly basis.

Execution

The job is delegated to a service technician who performs his task as planned. During the execution he finds a couple of cable boxes that need to be fully exchanged, and in one location he finds a cable box open and unclosable, which is reported and executed as an urgent case.

Reporting

The reports are made using the recommended guidelines that most Swedish electricity distribution companies use (EBR[7]), including some enclosed photos. Each month a progress report is sent to the owner, and an invoice is sent as well.

Closing and invoicing

The distributor company follows the project and archives all information properly. The invoice is checked towards reported checks made for each month the project is ongoing. When closing the project, a complete follow-up is made, and a reinvestment plan for cable boxes over the next few years is presented to the asset manager.

3.3 Business to business situation

In the examples made of service processes, there can be different business relations established, which in the end will have an effect on the demands on a service interface. During the analysis the following different situations have been found:

1. One single company:

    The service technician is employed in the electric distribution company; the complete process is within one single company.

[7] See http://www.svenskenergi.se/Vi-erbjuder/Webbshop/Fakta-pa-webben/EBR-e/

2. Two companies in the same company group:

    All field service in the company group is organized in a company, providing several companies in the group with personnel and equipment for field services. There is an internal agreement established that regulates hourly rates of the personnel etc.

3. Service provider, frame agreement:

    The electricity distribution company has made a Request for Purchase (RFP), and signed a commercial frame agreement with a service provider, based on the RFP and the offer. All business transactions between the companies are defined in the frame agreement.

4. Local cooperation between electricity distributors:

    Two or more electricity distributors have started to cooperate. They have started a common company to take on the new processes they what to share. They establish formal commercial agreements for each successful collaboration process.

5. Multi-utility companies:

    The electricity distribution is organized in the same company as other utilities, for example IP-networks, water and district heating. The company tries to optimize the processes based on common resources and local knowledge, and using the same IT-platforms.

All these different business relations need to be supported in a common interface for service management.

3.4 Company size does matter!

In the analysis, an overview of the Swedish electricity distributor market has been produced, and the findings show great differences between the implementation of service processes, depending on the size of the company.

3.4.1 Large companies

In Sweden, there are three large commercial electricity companies, each with more than 500 000 customer delivery sites. These companies all have product oriented organizations, thus electricity distribution is a separated commercial company. The majority of the services are outsourced to service providers, outside the company group. Frame agreements are established after formal RFP-procurement to maximize competition. More than 100 000 cases are executed annually per company.

All three companies have defined and implemented information interfaces for case oriented service management, but not in a similar way. To a large extent the interfaces are driven by the internal structure of the ERP[8] system, but are also

[8] See https://en.wikipedia.org/wiki/Enterprise_resource_planning

developed as an extended AMM process supporting most services. Service catalogues exist, but are not commonly agreed upon.

3.4.2 Medium companies

In many cities of around 100 000 citizens, there are regional energy company groups owned by the municipality. With organizations of around 200-500 employees, and at least a couple of formal companies, there are many different ways to organize the business. Many of these companies have quite a lot of service technicians, often organized in small specialized groups. As the business needs a variety of systems for all processes involved, it is a great challenge to make the service process efficient.

These companies seek more efficient processes and means to measure this, and acknowledge the need for standardized definitions used in the service processes. This would be a great first step towards developing better solutions, but will probably not change their IT strategy in the short term. As soon as their IT vendors can adapt to common information interfaces, the more options for the processes will evolve, step by step.

3.4.3 Small companies

About 140 out of a total of 165 electricity distribution companies in Sweden have less than 50 000 customer delivery sites, and they all have quite small organizations to take care of the network. The local knowledge of the networks is really good, and based on individual experience. But as the demands on the business rise due to new regulations and increased customer pressure, collaboration with other local electricity companies is starting to emerge.

The information management issues tend to be quite challenging, and are one of the most important factors in successful collaboration going forward. One way is to share IT systems and thus distribute the cost. To make other strategies possible, common information interfaces are a highly interesting means to increase collaboration.

3.5 New regulation customer centric model

Having a European common energy market as a target, several projects and change initiatives have started to support the process of finally making it possible for customers to actually buy electricity from vendors in other countries. A deregulated market is a basis of this process, and the Nordic countries have all implemented this model. The next step towards the common energy market, that is being discussed, is to create a customer centric model of invoicing the energy and distribution cost. This means that the customer would only be invoiced by one market actor, preferably the electric sales company, who would include the distribution cost in the invoice.

When analyzing these proposals, it is easy to come to the conclusion that customers will also contact the electricity sales company for technical distribution matters. To support the idea of a common market and to make things easier for the consumer (and increase customer satisfaction), the energy sales company should also take a part of the service process. Here, a common interface for service management would really come in handy, supporting the process from the customer, via the supplier, then on to the distribution company that finally could order the actual work from a service provider. Looking at the picture below, made by the Swedish regulator, the promotion of a common service interface would be almost mandatory to create a "fit-for-purpose" process.

We also include text from the NordREG, Nordic Regulatory Authorities, stating:

Efficient information exchange: system operators, market players and customers need to share information efficiently to ensure high-quality retail market processes such as switching. Interoperability will benefit customers and should therefore be widely implemented, by agreeing on a minimum set of data to be exchanged and through compatible formats and functional open standards. Moreover, information exchange between suppliers and DSOs is evolving towards ‘data hub’ models, where information is sent to, received from and possibly stored in a central data hub, making it easier to verify data and exchange information. Although data hubs are not a prerequisite for efficient retail market processes, the rationale for data hubs will be strengthened by the increased amount of information exchanged in ‘smart energy systems’; the advantages of different ownership/control regimes should therefore be further investigated in terms of quality, cost-efficiency and governance.

4 Technical frameworks

4.1 Managing information exchange

4.1.1 Theoretical background

Over the last 15 years an ever increasing need for enterprise IT integrations has emerged. Fortunately, theoretical work, by Thomas Erl[9] amongst others, has been conducted to describe how this complexity can be addressed and handled in practice.

The Service-Oriented Architecture (SOA[10]) has been one of the most successful enterprise patterns developed so far to enable handling of the ever increasing IT integration complexity. The basic idea with SOA is to break down software functionality into logical pieces that a system can expose as callable services from other IT systems in a unified way and independent of any underlying technology.

To implement SOA, the Enterprise Architecture Integration (EAI[11]) concept is normally used, which is realized as an integration framework in the form of a software middleware. The middleware enables information integration between various disparate systems within a company and can also include systems in other companies.

Popular examples of middleware software include Microsoft BizTalk, IBM Web-Sphere, TIBCO ActiveMatrix BusinessWorks, among others. The services provided by these EAI tools include routing and transformations services, service orchestration, data services, adapters to ERP systems, web services, REST based web services, custom development, just to name some capabilities. Today, more or less all enterprises of moderate to large size have such tools installed to handle their integration needs.

Of importance is that information is communicated in a data neutral way ensuring a more simplified and standardized handling in all participating IT systems. This is normally achieved by using standards as Web Services[12], or, more recently gaining ground through REST[13] based, implementations. The actual description of the information being sent between systems involved when using Web Services is normally described through XML[14] schemas. The work of the authors described in this document delivers such XML schemas describing the specific information needs in the electric utility business with an emphasis on the Swedish market.

We are not going to further describe the concepts and theoretical foundations used in SOA in this document as this is not the main subject for this document.

[9] http://www.servicetechbooks.com/
[10] http://en.wikipedia.org/wiki/Service-oriented_architecture
[11] http://en.wikipedia.org/wiki/Enterprise_application_integration
[12] http://en.wikipedia.org/wiki/Web_service
[13] http://en.wikipedia.org/wiki/Representational_state_transfer
[14] http://en.wikipedia.org/wiki/XML

For the interested reader there is a lot to explore and a good starting point might be the books written by Thomas Erl.

4.1.2 A practical use case

It might be useful to look at a simplified practically oriented overview that reflects a typical setup in the Swedish utility market, taking the theoretical background previously described into account.

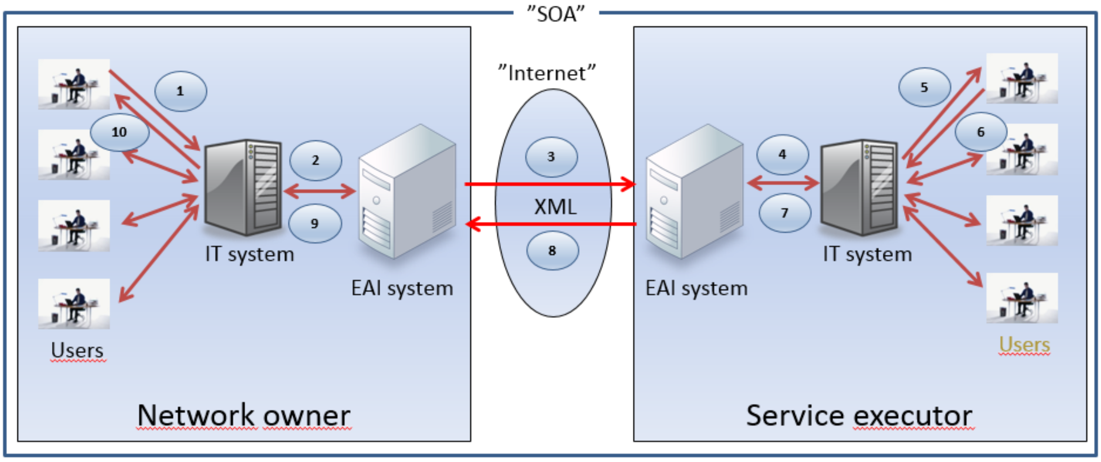

Figure 4-1. A typical integration setup based on SOA principles, an overview.

If we break down this figure into process steps according to the numbering, we end up with the following (slightly) simplified process:

1. A user in the electricity distribution company is working in a case management IT system (typically an ERP system or a GIS[15] system) and decides that the currently processed case is ready to be sent to the service provider company. The user is triggering the starting point for the integration through a specific functionality (like a button).
2. Necessary data is collected by the case management system software and sent to the EAI system. Already here, a neutral format like XML is often used.
3. The sending EAI system receives data, and typically maps, and transforms the internal data format to the XML format agreed between the electricity distribution company and the service provider company. The XML data is sent to the receiving EAI system, typically using technology like Web Services over a secured internet connection. The XML data should be validated by a standard electrical utility specific XML schema as defined in our project, hopefully.
4. The receiving EAI system receives the XML data and maps and transforms this data in a suitable format for the receiving IT system, to be further processed.

[15] Geographic information system, see https://en.wikipedia.org/wiki/GIS

5. An end user typically finds the sent case information through a report searching for any newly delivered cases sent from the electricity distribution company. When such a new case is found, the user starts processing the case and makes sure that the activities involved in the case are properly addressed.
6. The case is processed further by the user in the service provider company. A typical scenario is that the proposed date and time for the actual work needed can't be met by the service provider company. Then, a new proposed date and time is sent back to the electricity distribution company for review.
7. The case management software in the service provider company formats and sends the data in a suitable way to the EAI system for further processing.
8. Data is again mapped and transformed to the same XML format (as prescribed by the XML schema in step 3 above) and sent to the receiver EAI system at the electricity distribution company.
9. Data is received, mapped and transformed to a suitable internal format that the case management software can handle.
10. The case is updated with the new proposed date and time for the planned case activities. The user in the electricity distribution company is often notified by email or workflow that a response has been received from the service provider company. When this user analyses the new proposed date and time an action might be taken due to the new circumstances. The circle is closed and a new integration flow might be initiated again following steps 1-10 as described here.

Some points to note in the process flow:

- All communication is by nature asynchronous. In practice this means that there is no absolute guarantee that an answer will be received when a request is sent out, due to various technical failures that might occur. When all communication goes well and the response in step 6 is automatically sent by the service provider company, a response time around 10-30 seconds is regarded as normal, from the electricity distribution company's (as the sender) point of view.
- This document aims to standardize the information in the middle of the figure – the XML data information container. From a practical point of view there is nothing that prevents the communication between the IT system and the EAI system from using the same XML format. Due to diverse system landscapes this is probably quite difficult to realize, but if the same format is used this simplifies the application layer complexity considerably.
- In the figure there is an understanding that the electricity distribution company and the service provider company are independent companies and thus the relation is of type "outsourced utility service". Both companies then have a need to run their own controlled EAI system instance. When both parties are within the same legal entity, then there might only be one EAI system. There can, of course, be variation here but the general technical setup remains roughly the same.

- Ideally, every touch point between systems involved in the integration should adhere to the “loosely coupled principle”. This implies that there should be no deep technical dependencies between the systems so that it is relatively painless to change/upgrade a technical component (IT system, EAI system). It is the XML data representation (governed by a standard XML schema) that could/should be the enabler here!

  As such, this architectural design viewpoint is a small part of the larger SOA picture depicted by the outer rectangle in the figure above.

4.2 Recommend practical principles

During this project, with the aim of standardizing information, we have identified quite a few principles that are already used in practice or should, in our opinion, be adhered to.

4.2.1 Use only one XML schema for cost efficiency

When a system communicates via XML messages it can be tempting to use a new XML representation for each type of message. One message type could be the initial ordering of a complete case, another message type could be the updated planned date and time for a case work to start and so on. Each message is now exactly tailored to the specific message type design and no fields are defined that are not to be used when using this message type. This can be seen as positive.

Each and every XML schema behind the defined messages types then needs to be implemented (imported, mapped, developed, tested, documented) in the EAI system and also often in supporting documentation system. This is normally a rather time-consuming process that obviously costs money. So, the use of many XML schemas, which need to be maintained, is from a cost perspective rather negative.

Our experience and practice from quite a few integration projects clearly show that it is much cheaper to have a “maximum” XML schema defined that can be used for all message types within a defined overall process (like the case management process). Practice has shown that this approach inevitable lowers the TCO[16] (Total Cost of Ownership) for the integration process flow during its lifecycle.

Implementation is done only once in the EAI system. The IT systems connected to the EAI system naturally send only the specific information needed for a specific process step. The EAI system maps these attributes using the agreed XML schema fields for the process step and, when sending this XML instance, only the sections that actually contain data are included, thus de-cluttering the XML instance from unnecessary complexity.

In our view this is one of the most valuable lessons learnt and, from a cost reduction perspective, something very important to adhere to for any EAI XML

[16] http://en.wikipedia.org/wiki/Total_cost_of_ownership

schema implementation initiative. This is the reason why we only have two XML schemas defined in this project – one XML schema for case oriented services and one XML schema for project planned maintenance.

4.2.2 Extensibility within an XML schema

The XML schemas defined in this project build upon the idea of structuring related information in blocks. The general problem when defining a standard XML schema is that there will always be a need for an implementation project to add fields that the standard lacks. Fortunately, in the definition of XML as a language this has been thought of.

One small block used for return message handling is called InfoCode. Here a special element with the representation `<xs:anyAttribute/>` has been added.

```
<xs:element name="InfoCode">
        <xs:complexType>
                <xs:sequence>
                        <xs:element name="InfoCodeType" type="xs:string" minOccurs="0" maxOccurs="1"/>
                        <xs:element name="InfoCodeMessage" type="xs:string" minOccurs="0" maxOccurs="1"/>
                        <xs:element name="InfoCodeClass" type="xs:string" minOccurs="0" maxOccurs="1"/>
                        <xs:element name="InfoCodeNo" type="xs:int" minOccurs="0" maxOccurs="1"/>
                        <xs:element name="InfoCodeMessage1" type="xs:string" minOccurs="0" maxOccurs="1"/>
                        <xs:element name="InfoCodeMessage2" type="xs:string" minOccurs="0" maxOccurs="1"/>
                        <xs:element name="InfoCodeMessage3" type="xs:string" minOccurs="0" maxOccurs="1"/>
                        <xs:element name="InfoCodeMessage4" type="xs:string" minOccurs="0" maxOccurs="1"/>
                </xs:sequence>
                <xs:anyAttribute/>
        </xs:complexType>
</xs:element>
```

Figure 4-2. The anyAttribute in an XML schema.

The meaning of this attribute is that new elements can be added freely in an implementation XML schema, but a XML instance of this new modified XML schema can still be correctly validated against the original “master” XML schema. This gives built-in extensibility and solves the problem when fields are missing in the “master” XML schema during an implementation project.

All blocks for the two XML schemas defined in this standardization project have the anyAttribute included. In an ongoing maintenance phase new commonly agreed fields might be added to form a new version of the “master” XML schema. This ensures that only fields of general interest are added. A feasible idea is to centrally maintain and develop these “master” XML schemas within the electricity community.

4.2.3 Principles used in defined XML schemas

We have followed some common sense “rules” when defining the two XML schemas in this projects. As such, we have tried our best to balance more specific needs to more common ones and at the same time not trying to make any assumptions that could be seen as problematic in an actual project implementation.

In chapter 4.2.2, Extensibility within an XML schema, the common way to extend an XML schema is described in some detail. As this principle is so important it has its own chapter.

Without any specific order the remaining guiding principles followed have been:

- Any attribute which has a character type format has been defined as string.

  ```
  <xs:element name="TechAdmVersion" type="xs:string" </xs:element>
  ```

  There isn't always a need to have unlimited characters for each such defined attribute but it makes the XML schema more generic and thus more usable.

- The business logic handling the actual content for each attribute is not to be defined by the XML schema but in the IT systems communicating via the EAI platform using the XML schema. This is an important principle that we follow strictly. It has also the side effect that it makes the XML schema definition easier to define and agree upon, at least in the initial life of the XML schema definition.

- Date and time is quite often needed. In the cases where only a date is needed we still use a format like this:

  ```
  <xs:element name="MeterPODate" type="xs:dateTime" </xs:element>
  ```

  If the time is not needed then these fields are simply don't filled. The type="xs:dateTime" is XML schema standard and has the notation like 2013-11-01T08:00:00+01:00[17].

- For any utility business, location awareness is a key ingredient for all field service activities. For coordinates we have chosen to have a generic attribute that explicitly defines which coordinate standard an instance of XML schema follows. This attribute is called TechAdmCoordinateSystem and found in the TechnicalAdm block. A typical value here is WGS84[18]. All coordinate attributes in an XML schema instance should then follow the defined coordinate standard in the TechnicalAdm block.

- In an XML schema it is possible to define on an attribute level the cardinality like this:

  ```
  <xs:element name="MeterFuse" type="xs:string" minOccurs="0" maxOccurs="1"/>
  ```

  The MeterFuse attribute may have a value (not mandatory) as defined by minOccurs="0" and if the attribute has a value it can only exist once as defined by maxOccurs="1".

  When defining the XML schemas we have tried to be as liberate as possible and not making any specific assumptions of the usage in an actual implementation.

  In a maintenance phase this is a typical discussion point that may have the effect that the cardinality is adjusted for certain attributes because reality has proved the XML schema definition not to be accurate enough.

- In some block both a description and what we have defined as a "long text" coexist. The difference here is that the description attribute, although defined as string, should typically be around 40 characters but the long text attribute could be as much text as needed.

[17] A standard exists, https://en.wikipedia.org/wiki/ISO_8601
[18] A standard exists, https://en.wikipedia.org/wiki/World_Geodetic_System

In an ERP system this is a quite normal setup. It is by no means mandatory to follow this advice but we feel this to be as a decent way to distinguish different text types.

- In any IT system an identification for an attribute often has both an internal and an external representation. The programs normally work with the internal representation but when presented in for a user in a GUI[19] then the external representation is used. In such cases we have followed this notation for internal and external representation.

  Internal – with Id:

  ```
  <xs:element name="TechAdmSenderId" </xs:element>
  ```

  External – with Descr:

  ```
  <xs:element name="TechAdmSenderDescr" </xs:element>
  ```

- For some attributes we have set the mandatory flag (defined as minOccurs="1") when we have found out that this information block can't exist without these attributes having a value. We have tried to be very conservative as, again, not to make assumptions of any implementation project specific needs.

  ```
  <xs:element name="TechAdmVers" type="xs:string" minOccurs="1" maxOccurs="1"/>
  ```

- To be able to send supporting documents (MS Word, MS Excel, drawings etc.) have been have been more and more a necessity during recent years. Earlier this wasn't technically feasible, or at least very difficult and thus expensive, but today these hurdles have been solved. Increased bandwidth in 3G and 4G GSM cellular networks have helped tremendously here.

  In the Document block two ways are possible to handle attached document in an XML instance. The simplest one is to reference an URI (like https:\\www.myserver.se\document\drawing1.dwg) and send this. The receiver then must fetch the document separately from the server. This is beneficial from a bandwidth perspective but have consequences as that a document server must be available. From a strict delivery perspective it can't be guaranteed that referenced document are actually delivered.

  The other alternative is to embed documents as binary components within the actual XML instance. This, of course, will have an impact of the XML message payload when sent. The benefit here is that the XML message is delivered completely as is and this can be tracked by the EAI systems involved.

  Both alternatives are currently used in the Swedish utility market. Which one to choose is more of a design decision and maybe also influenced by technical possibilities.

[19] https://en.wikipedia.org/wiki/GUI

5 Interface #1, Case oriented order

In this chapter, the case oriented order interface is described in detail. The first section contains the overall information model and the information blocks, together with comments about attributes. The full interface is presented in Excel format and attached to this report.

5.1 Overview and process

The demands on the solution, set by the various types of services performed in an electrical distribution network, would be to support all types of service, which makes the information model substantial.

As long as everything in the interface can be individually defined, the number of blocks or attributes, as such, will not be a problem. The model will only mirror the complexity that exists, and not make it appear simpler than it actually is.

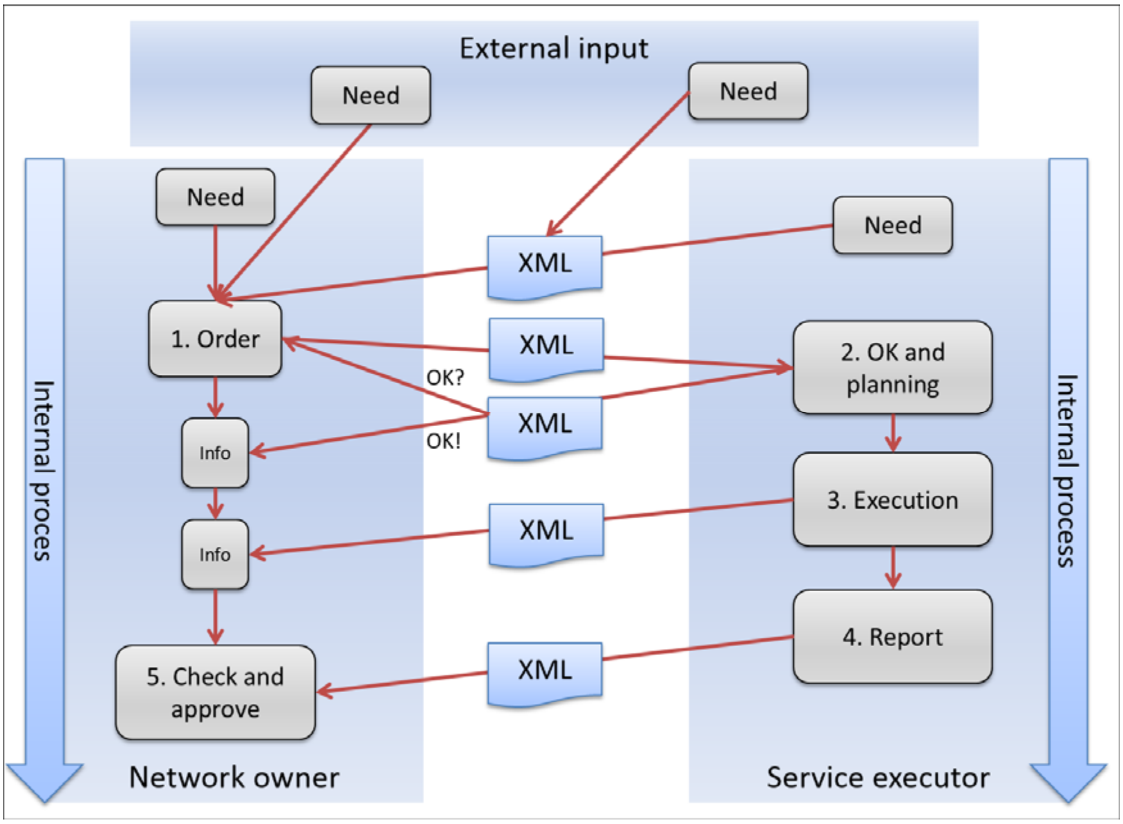

Figure 5-1. Case oriented process.

The process is started with a need to do something. This need can occur in several ways both internally within the electricity distribution company and as external input from the public or from a service provider company.

When it has been decided to do something about the need an order is created. This order is planned and sent to the service provider company for execution. Messages can now be sent back and forth detailing the on-going process flow. Finally, the order is technically finished and reporting is done. The electricity distribution company does some final approval checking and then an invoice can be created for work done by the service provider company.

This is quite an overview but do reflect how an order is normally carried out.

5.2 Information blocks and content

The figure below gives an overview of the information model used for case oriented services. To the left there are information blocks containing general headers, business information, partners (stakeholders and contact information), and the starting point for several cases, a service request block.

In the center is the location, either a consumer site or a network object. To the right, there are the practical actions ordered and reported, including time reporting, document attachments, material and components and finally message control.

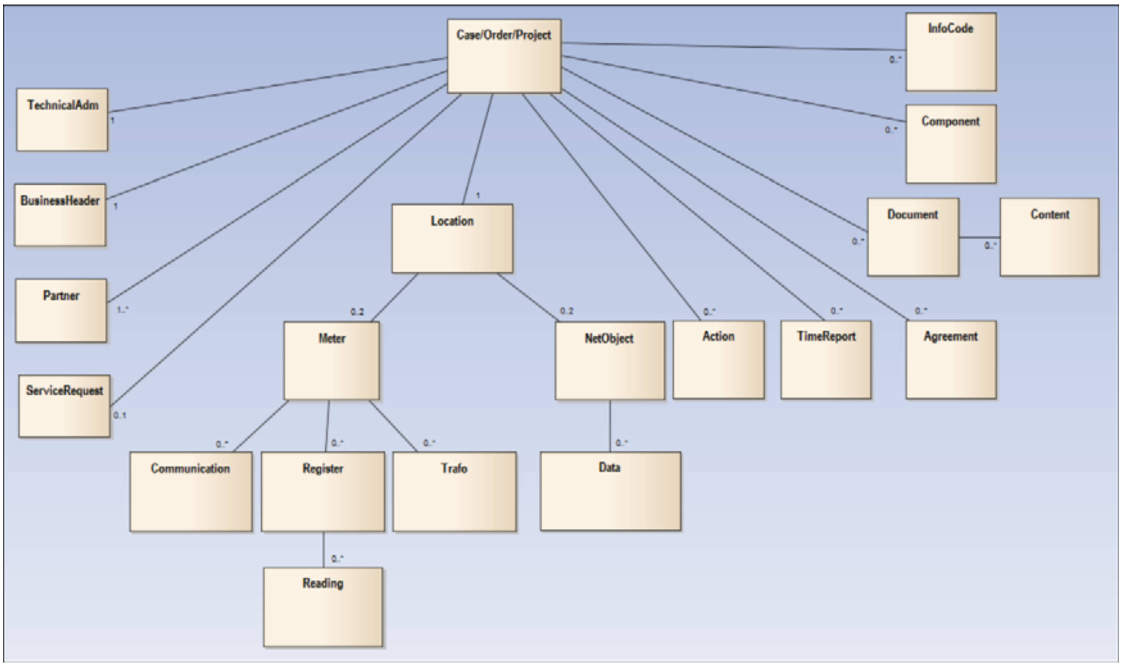

Figure 5-1. Information model of case oriented order interface.

1. TechnicalAdm

   The purpose of this block is to control the technical aspects of the interface. It is primarily used by the exchanging systems to have control over the process of exchanging data.

   Included in the block is information like sending and receiving system, version, a unique identity for the instance, type of message sent and so on. Mostly technical attributes that are needed when two IT systems are to communicate in a reliable and unison fashion.

2. BusinessHeader

   The business Header contains information about the “order object” like description, long text, planned start- and end date, status, agreement reference to name just a few attributes.

   In principal, three different objects are used as the "order object"[20] in the distribution companies – case, order or project. Trying to unite the companies on what to use is not recommended, rather to make it possible to use the preferred terminology. From a service action point of view, the "order object" can be different, as long as the execution object is perceived as the same for the service technician.

3. Partner

   One case can have many partners. To avoid redundant attributes for contact information of different stakeholders and roles in the process, the partner block is used. Partner data is normally used in ERP-systems where contact data like address, phone, e-mail etc. are common. The partner type attribute distinguishes between various partners like customer, payer, owner, case administrator.

4. ServiceRequest

   The service request is often the start of a service process. It can be registered by several different roles, such as the field service technician, maintenance planner or possibly the customer or the electrical sales company.

   The block contains attributes describing the need, categorizations and prioritization. Documents can be added to the message in a separate information block. Typically, information as in the term “Felanmälan” (~error report) is located in this information block.

5. Location

   One case, only one location is the rule. This is perhaps the most important principle in this common interface, and the location will constitute the place where the work is being executed. Common information about the location, whether it is a customer site or a network object, is geographical coordinates, real estate identification and various area attributes.

6. LocationMeter

   The LocationMeter is the customer delivery site, always including meter site identification as well as meter id. This is the most extensive block, containing nearly 30 attributes, and supporting processes of AMM but also manual reading. It also supports the process of changing meters when executing the services.

[20] To make reading easier we use the term Case for the ”order object”.

This information block will probably support most metering systems and technology in the utility business, even if several data attributes are strictly electrical.

7. LocationMeterRegister

   A meter can have several reading functions, such as energy, current or power. Also, maximal value metering can be used. This is why the interface contains a Register block that can be of any multiplicity for the LocationMeter block.

8. LocationMeterRegisterReading

   This the actual consumption data, as a reading value of a register in a meter. These all have a date+time identification, providing the support for historic meter values.

9. LocationMeterTrafo

   Data from the transformation equipment is located in this information block. When the fuse level is about 63 Ampere, there will be the need for transformation of the current to enable metering, otherwise the current will be too high for the metering electronics.

   On regional and transmission networks this is mandatory for all high voltage metering. This transformation equipment will be installed per phase, and can also include voltage transformation.

10. LocationMeterCommunication

    This is the final information block related to the LocationMeter node, and includes the communication data. Remote and automatic metering (AMM) demands communication equipment.

11. LocationNetObject

    Normal maintenance on the network assets is executed on an equipment object. This is the information block containing general object data such as object identification, place in asset hierarchy, type, manufacturer, date for production use, ownership etc. This general data set has been defined when comparing many asset management systems used in the utility sector.

    This block also support the change of the object from Current Object to New Object. Information about the location of the nearest place where the current can be broken when doing maintenance may also be included in the message.

12. LocationNetObjectData

    This is a generalization of network object data, using a data model that can accept any technical data for any object.

    Note that there is a need for guidance on the attribute identities to enable effective data transfer and updating to the backbone asset management system. Mandatory attributes must be included in the sending of equipment data.

13. Action

    Action is the block containing the actions that are ordered for execution, and enables reporting of whether the action has been executed or not. On the other hand, it is possible to include actions that are executed but not ordered. All actions can contain information about what to do, and what has been done and when.

    For advanced processes there is a need to include templates of work to be executed, and the related obligatory reporting to be made.

    All actions need an Action Id and description that will support any service catalogue agreed upon, even though sector common catalogues would be preferable.

14. TimeReport

    Supporting time reporting will have a positive effect on any process where cost control on each case is preferred. This is perhaps not common between a network owner and a commercial service provider. Here, invoices will be the cost object and details are in frame agreements.

    However, for the use of this interface within company groups or within one company, there are several benefits of making case oriented time and cost reporting. For example, time reporting may be used as the basis for paying salaries for the individual employee and at the same time be the foundation for billing a customer.

15. Agreement

    The agreement block has information about relating frame agreements and other business relevant information. Fields like agreement id, purchase order, service type, various cost levels, SLA can be found here.

16. Document and DocumentContent

    These blocks contain document attachments to each case, either as a document link or the actual documents are carried in the message. The document block contains metadata of the electronic document, and the DocumentContent block contains the document itself.

    Note that there is a standard procedure used to divide an electronic document into smaller parts for ease of transfer on the internet. This procedure has been well tested in actual productive utility integrations and works well.

17. Component

    For some processes, there will be a discussion between the network owner and the service provider about volumes of work expected. For instance when the owner plans the job an estimate may be made for the amount of work to be done (normally lengths and digging volumes), but the service technicians may find different values when investigating the actual place for the service order.

This block can then be used to contain volumes in a message to the other party, making it possible to agree upon this before the process moves further. Components can also be used for material specifications if needed.

18. InfoCode

This last block is only used for IT technical purposes. There are attributes to inform the other party that the message has successfully arrived, and about the result of the implemented data into the back bone system.

This is a very important value addition to an ordinary process, supporting all deviations that can happen in the service management process using this interface. Any information can be mapped here but the use should normally be various return codes like "Order 123456 successfully created with reference to notification 987654" (example inspired by an SAP ERP system).

5.3 Additional standardization concepts needed

To really have a complete standardization some further concepts would need to be agreed upon. If agreed and used these potential standard "catalogues" could help fostering a "common business language". More or less all information blocks could at some level be standardized. These concepts could include for instance:

- Case Type definition

  A common catalogue of case types ("Ärendetyper") would greatly improve the process flow in the Swedish market. Both from a technical perspective and maybe even more from a commercial perspective. The former is probably easier to achieve but the latter is also important and could potentially be commonly agreed upon.

  This is the most important additional standardization that the authors could think of! Difficult but not impossible is our take.

- Status definition

  A common catalogue of process status codes and their understanding in the overall case oriented order process flow would also be of great value.

- Partner Type definition

  A common catalogue of partner types and their coding would help as well.

- Action codes definition

  A common catalogue of action codes would be beneficial. At least for the more commonly used actions this could be very useful as they are the same regardless of company implementation. Today no such standards exists.

- Metering data definition

  A common catalogue of metering data has its place for certain attributes.

- Network object data definition

  A common catalogue of network object data could also be of value for certain attributes.

6 Interface #2, Project oriented preventive maintenance

In this chapter, the interface for project oriented maintenance is described in detail. The first part contains the overall information model and the information blocks, together with comments about attributes. The full interface is presented in excel format and attached to this report.

6.1 Overview and process

In chapter 3, the analysis of the present service processes at the electrical distribution companies was presented. The structuring of all the different types of services performed led to the conclusion that there was a general difference between case oriented orders and project oriented preventive maintenance. This concerns both informational content as well as the process itself.

The main differences in the information content are presented below:

Case based order	Project based preventive maintenance
Only one location per order	Many locations per order
Only one network object per order	Many objects per order
Full support for energy metering management at customer site	Only general support for reporting values on network objects

Figure 6-1. Principal differences in information content.

There is nothing that prevents the use of a case oriented order interface for project oriented preventive maintenance as well, but this will generate a large number of XML-files, one for each object. This has also been the case during the execution of large energy meter exchange projects.

But for general local network preventive maintenance one XML-file and messaging process would be too administratively cumbersome for the purpose. Instead, the planning and execution of an inspection round would need just one XML-file. This would be exported from the network owner's GIS-based system, and transferred to the service provider. The service provider would use mobile maintenance systems integrated with general GIS-functionality.

This interface also includes the possibility of including the previous results from preventive maintenance, as well as present network object technical data. This makes the interface ideal for asset inventory checks in the field.

The process itself will be highly different from case oriented orders. At first, the planning of the maintenance is made in detail by the network owner. The executor receives the list of the objects to check by the XML-file, and plans the execution. He then makes an order confirmation to the originator. Since the period of execution could be several months, maybe up to a year, there have to be several consecutive reports made from the executor. The invoicing of the work would also occur several times during the project's lifetime.

During the maintenance checks made in the field, urgent needs for action will be found. For example, a dangerous tree about to fall over an overhead line, or cable boxes that are unsafe for the public. In these cases, it is important that a report is made to the network owner. This could be done using the first interface, the case oriented order. Use of a mobile app, including GPS coordinates will enable a fast and effective start to the fault report process!

Finally, the whole project is executed and reported back to the network owner, including summary reports of the general state of the network.

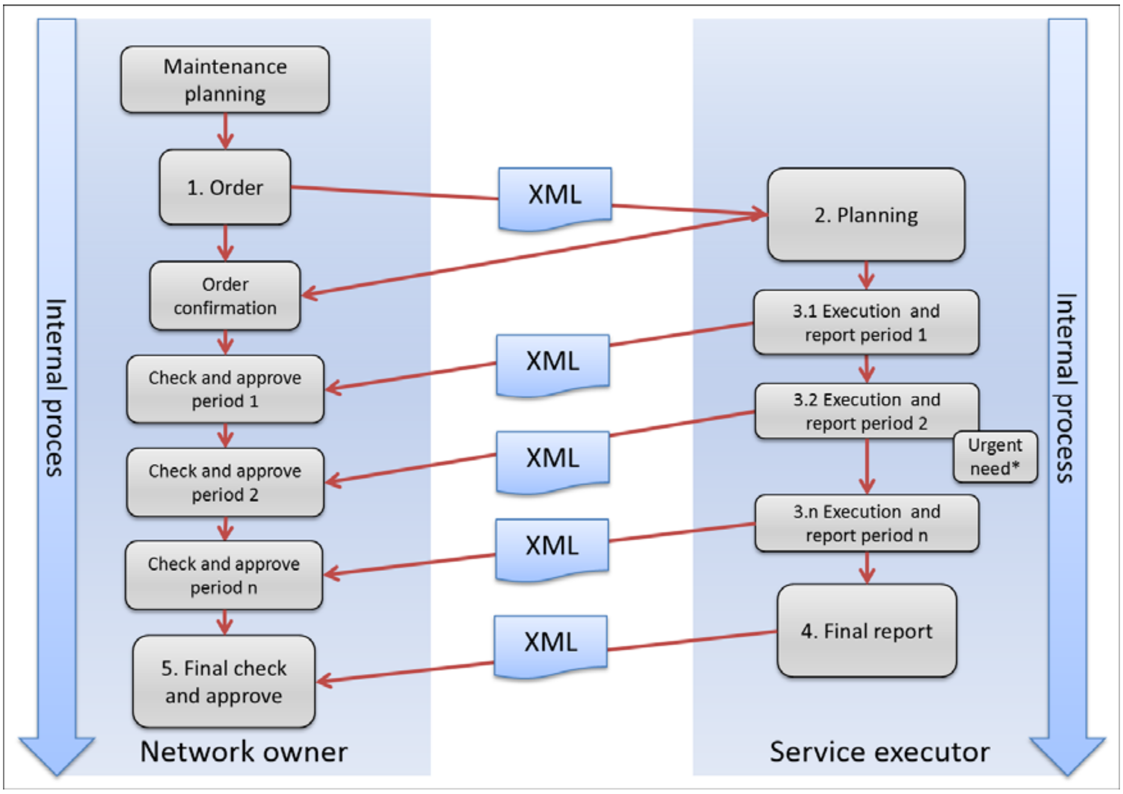

Figure 6-2. Project oriented preventive maintenance process.

6.2 Information blocks and content

The general information blocks of the case oriented order interface have been reused. This is a choice made to increase overview and understanding. Blocks containing information about the customer site and metering management have been deleted. Instead, new blocks for network objects and maintenance checks have been added. Note that the block NetObjectData has been reused to minimize the differences between the interfaces. The relations to the document blocks have been changed to the block NetObject, making it possible to attach photos and protocols to each object.

The following blocks used in the case oriented order have been removed from the project oriented preventive maintenance interface:

- ServiceRequest
- Location
- LocationMeter
- LocationMeterRegister
- LocationMeterRegisterReading
- LocationMeterCommunication

LocationMeterTrafoThe following blocks have been added to the project oriented preventive maintenance interface:

- NetObject
- NetObjectInfo
- NetObjectInfoData
- NetObjectChecks
- NetObjectMeterValues

This will give an information model like:

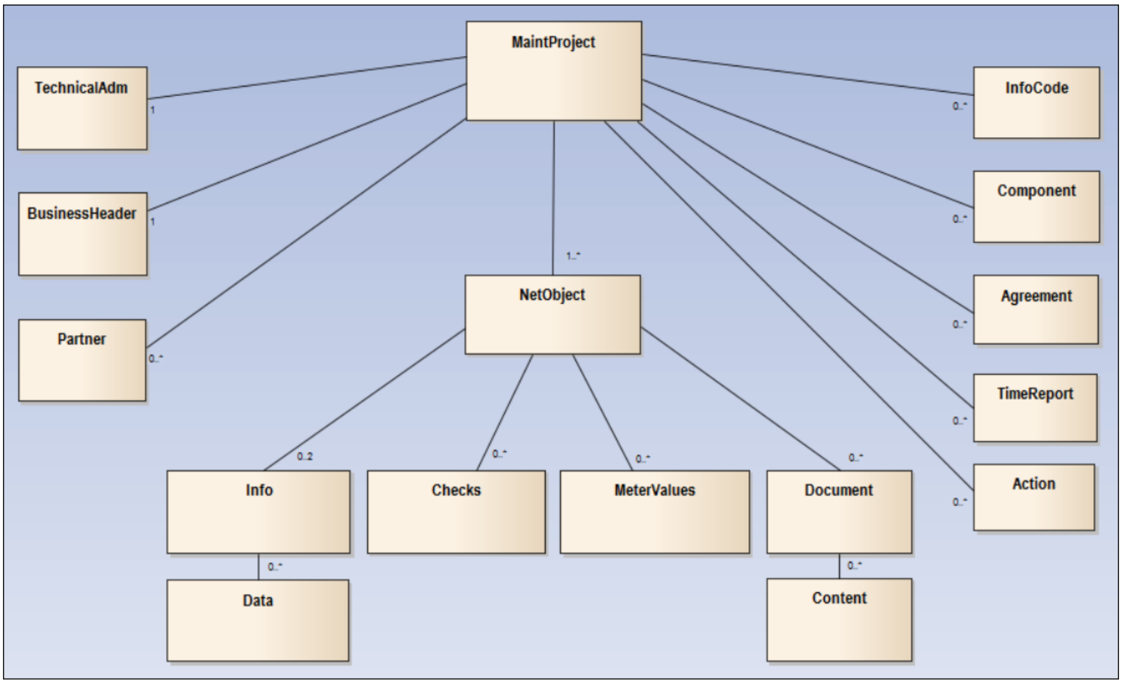

Figure 6-3. Information model of project oriented preventive maintenance interface.

The added blocks of the project oriented preventive maintenance interface compared to the case oriented order interface are described in more detail below.

1. NetObject

   This block is defined to support many objects and different types of preventive maintenance per order. This means that the object identification and location coordinates are the carriers of the detailed information. All network objects can be categorized using EBR object types. This block also contains information about areas of different kinds.

2. NetObjectInfo

   All general information about each object is included in this block. The separation of this block from the NetObject block enables the update of network object information- a normal procedure when doing preventive maintenance. Many attributes in this block are reused from the corresponding information block in case oriented order interface. Examples are Type, Manufacturer and Date taken into use.

3. NetObjectChecks

   This block is the most important part of this interface, carrying information about the checks that are ordered. Each check has been defined in the EBR maintenance guidelines, with a unique number and description.

   The severity of the deviations noted when inspection is made, and a comment is included. Also, when deviations have been corrected at the same time as the inspection, there is an information attribute carrying details about this.

4. NetObjectMeterValues

   Compared to meter value management at a customer site, this block is a simplified set of attributes enabling the reporting of network object measurements. Examples are maximum current metering and temperature. This makes the block better suited for its purpose as part of a preventive maintenance process.

It can also be noted that documents are now assigned to the NetObject information block and not as a separate block as in the case oriented information model. Each network object can have documents that support the processing.

7 How can common interfaces be made successful?

7.1 Change management theory

All change is challenging. The speed of change is rapidly increasing, that is a fact for all businesses nowadays. To meet this challenge, knowledge about change management in general and as a method, is really useful. This has become as important as the process of project management when implementing IT, where methodology has existed since the 1990s.

Making common interfaces successful is a challenge. There could be an initial proposal, but the real change will only happen if many stakeholders are attracted to the idea and believe that it can be successful. Putting this into a theoretical change management context, developing a common interface would have the following phases.

1. Awareness

   The awareness of the possibility of using a common interface for some business processes is created and the understanding of the benefits has begun.

2. Desire

   After a period of time, when more colleagues and business partners are also aware of the idea, a wish for change starts to develop. A desire to be part of an interesting change is experienced. Perhaps it even feels exciting!

3. Knowledge

   When information about the suggested concept is available, and the interface has been tested and piloted in practice in some company processes, knowledge about the development will spread. This will be the tipping point for the change; if it works there is no turning back.

4. Ability

   Now several companies are starting to use or implement the interface. Improvements are made to stabilize the concept even more, and the market has now accepted the change as a common tool.

5. Reinforcement

   After using the interface for some time, there is a need to reinforce its use, and focus on the benefits it has created. New knowledge about the benefits will then be created, and the change is now completed.

These five steps are often used as a model within Change Management theory, called ADKAR (by PROSCI[21]). To get started, there is a need for change, a

[21] Focus on Change Management theory, see https://www.prosci.com/

"burning platform", often generated by market competition, or as in this case regulatory authorities prohibiting the raise of the network fees.

7.2 Implementation within the distribution sector

Why is there an urgent need for change in distribution companies?

For many years, electrical distribution companies had full freedom to decide network fees to meet the business needs. During the last 20 years, this has changed a lot. Today, there are regulating authorities following and monitoring the network fees in many countries. In Sweden, several different regulating models have been tested, and companies currently have to apply for the level of income for the coming 4 years (ex-ante regulation). This means that increased financial results can only be generated by lowering the costs, not raising the fees.

The fact that many service technicians are retiring due to age is another fact driving change. And many of them have worked for their whole career in the same company, and so possess detailed local knowledge about the networks and the need for maintenance etc. New employees have a real challenge to quickly understand enough to deliver quality work. The need for detailed instructions and checklists increases, and is also driven by quality standards.

These two examples are just some of the catalysts for change in the electricity distribution companies. Instead of trying to solve the challenges individually, sector driven standardization could be extremely effective. To make common interfaces for the electrical distribution sector successful, the following steps are recommended.

7.2.1 Awareness of common interfaces

This project will constitute the basis for generating awareness in the sector. With support from 10 reference companies of different sizes and areas in Sweden, the project has received the support it needed to create a state-of-the-art result. Even though the information interface presented in this report is not fully completed, it is sufficiently developed to be the foundation for the future process of change. By presenting this report at conferences and meetings, awareness of its existence will spread widely.

7.2.2 Piloting creates desire

The next recommended step is that this concept is tested and piloted. This can also be called a proof of concept (POC). The idea is to have engaged parties that will learn about the interface and try it in reality as easily as possible.

To pilot this in the simplest way, three components are necessary: a web based tool, an integration service, and a simple mobile field service application. The web tool would simulate a back-bone application (like ERP, EAM or CRM applications) and create and send service orders using the interface. The integration service would receive and pass the information through to another application for field service. This could be implemented as a mobile "app" (application), where the technician could first receive and then report work executed. The outcome of the pilot will be very valuable for the standardization process, as it will clearly identify the rules and basic data that needs to be included.

7.2.3 Knowledge by governance

Without a governance organization, the standardization will not succeed. This fact needs to be addressed as early as possible. Earlier references to Odette, the organization behind the motor vehicle industry, prove this in an obvious manner.

By addressing the take over and further development to a common branch-specific organization, acceptance and deepened knowledge of the interface will be created. This is the dream result this project is hoping for! In this case, the governance organization should include electrical distribution companies of different sizes, as well as some of the major service providers. Contacts with the largest service providing companies in the electrical service sector have been very positive and even areas other than service management have been discussed as candidates for further standardization.

One of the most important things to work on in the governance process is a common Service Catalogue for the electrical distribution sector. On the basis of this service catalogue, common rules and data guidelines can be developed.

7.2.4 Getting application vendors on board to increase ability

There is one important group of stakeholders that has not been mentioned in this report so far, the IT application vendors. They are companies that compete in the sale and implementation of systems to the energy companies as well as electrical distribution companies. The market of sector oriented IT application vendors is so far common for the Nordic countries, but internationalization is a probable prediction. What will the reaction be to a new common interface creating change requests in their applications?

The guess is that standardization will be met very positively. Even if some vendors with mature applications in the last period of its lifecycle could perhaps see this as a challenge, the positive reactions will be most common we believe. As long as the common interface is really made common and open, it is quite easy to map data from back-bone systems to a message interface. There will most likely also be new players eager to move into this important business sector.

7.2.5 Reinforcement by benefit realization

One of the larger companies having integrated order systems with service providers could show greatly improved process efficiency due to the integration built. In this example the level of service orders executed in agreed time and cost had risen from about 50% to over 90%. This is one example of the importance of measuring the processes and improvements made. There are many areas where analyzing the service information content can prove to be beneficial - in all business related areas like asset management, in operations, in customer service. Measurement will be the tool to business assessment, to business improvements, regardless of the actual business to business relation that the common interface will be used for.

8 State of the art

The goal of this project is to provide a recommendation for common interface in electrical distribution service management. Even if the resulting interfaces cannot be regarded as a completed product for implementation, we believe that the result of the project must be considered to be “state of the art”. The arguments for this are as follows:

- The project has been executed by two senior consultants, both of whom have worked with the service management process in electrical distribution companies for about 20 years.
- The practical experience of the main applications, such as ERP, CRM or GIS based EAM systems, being used in this business area is extensive and covers both owner and service provider usage.
- There is extensive experience of the technical issues concerning mobile IT used in field service, meter management systems and integrations, as well as SOA concept and integration technology.
- The reference group has contributed with detailed information about all processes included in “Service Management”, including guidelines, process descriptions as well as screen shots from used applications.
- The reference group consisted of companies of various sizes. Large, medium and small companies in the business sector have been active in the project.
- All electrical distribution levels have been addressed, from transmission level, regional level and local level. The resulting interfaces support all service management at all these levels.
- All traditional business units in the distribution companies, from customer relations, operations as well as asset management have been analyzed. All the necessary information from these business areas have been addressed and included in the interfaces, thus creating a “common denominator” for all service management in the electrical distribution sector.
- The project has been executed during 9 months, making it possible for all stakeholders in the reference companies to come on board and take an active part in the development of these interfaces.
- Using an “outside in” and “top down” perspective, the project has ensured that the result is comprehensible for many different stakeholders, thus taking into account the need to spread information during the change management process initiated by this project.

We thank all participants that have supported this project, and truly believe that the recommended interfaces will make a difference - not only for the electricity distribution business but probably also in the utility sector as a whole!