Enterprise Application Integration in the Electric Power Industry

by Advisory Group D2.02 task force on EAI.

Members of the task force:
Erik Sandström Convenor
Mathieu Urcun RTE France
Maryse Lemmet RTE-France
Marc Berrier RTE-France
Monika Sturm Siemens Austria
Pontus Johnson KTH Sweden
Tore Månsson Vattenfall Sweden

Introduction to EAI

EAI stands for Enterprise Application Integration. The online dictionary Webopedia (http://webopedia.com) defines EAI as the unrestricted sharing of data and business processes throughout the networked applications or data sources in an organization.

The background is that information systems used by businesses are becoming more and more complex, covering increasingly broad aspects of companies' activities. Where they were once restricted to dealing with internal operations, information systems are now playing a key role in businesses' relations with suppliers and customers. In addition, more and more different types of solutions are now being used. Some older solutions are still efficient and remain in use, whilst newer systems are increasingly turning to market solutions. So as time goes on, companies have to master an increasingly diverse range of solutions. As information systems are gradually expanded and extended, there is an increasing need to ensure that each section of the company can communicate effectively with the others.

An example of the challenges is that data can have different values, for example current value, past values and future values. They may be used in different ways like localisation, financial value or technical description. One danger is that the company may duplicate data with their different values and uses which can result in damaging inconsistencies

EAI is the answer to these problems. It works in a number of ways. It is based on products that manage interfaces automatically. This means that applications can be streamlined, and a single specific product manages and processes all interfaces. The interfaces' different connectors only have to be adapted to fit the EAI product and not each other. Thus if one application evolves or is changed, the effects on other applications will be virtually nil. There are two clear advantages to this. First applications are independent from one another and second interfaces are operated automatically, guaranteeing greater security and efficiency.

EAI in the larger concept of integration - an academic view.

From an academic view the whole Enterprise architecture (EA) is an interesting area for research. The software systems, of typical mid-sized to large electric utilities in the industrialized world, belong to a category here referred to as *enterprise software systems*.

Software integration is in many respects similar to solving jigsaw puzzles. If the pieces were designed to fit, there is a fair chance of accomplishing the task with a reasonable effort. If – as unfortunately oftentimes is the case – there was little or no coordination between the developers of the individual pieces, then attempting to solve the puzzle becomes a difficult assignment, where either the pieces themselves have to be re-sawed or new interconnection pieces have to be fabricated and introduced into the puzzle. And when the pieces finally fit, the picture may very well have been altered. Previously of modest importance, enterprise software integration has recently and rapidly become a major concern for the software-dependent industry. With the increasing reliance on software systems and the proliferation of computer networks, the benefits of integration of related systems have become significant. Software integration thus constitutes a considerable business.

Three different perspectives on integration may be discerned, *monarchical* integration approaches, *oligarchic* integration approaches, and *anarchical* integration approaches.

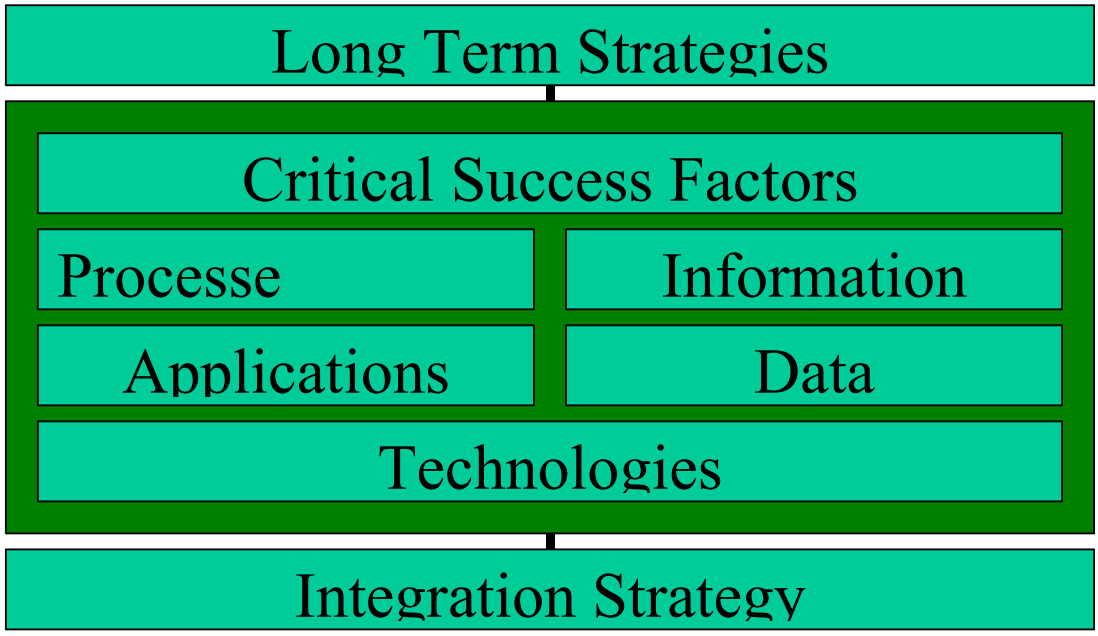
Monarchical integration approaches
Monarchical integration approaches assumes that the same agent has complete access to all components all the time, and is able to synchronize their development. They describe how software integration typically is achieved at a fairly fundamental technical level, considering concepts such as shared memory, inter-process communication, remote procedure calls etc. Important issues that are ignored are the results of organizational interaction, or lack thereof. In the monarchical scenario, the same actor is both component integrator and component developer; stereotypically thus, these issues concern the lonesome green-field programmer.

Oligarchic integration approaches
Oligarchic integration approaches presents the concepts of integration standards. Standards are often considered in the Open Systems Interconnection reference model (OSI) of the International Organization for Standardization (ISO). Integration standards are based on agreements among developers to employ a certain integration solution, not necessarily because it is the most efficient solution, but simply because it can be agreed upon. An unreasonable number of integration standards have been defined, and no single text can describe even a fraction of them. Stereotypically these issues are relevant for cooperating, large-scale, green-field development organizations.

Anarchical integration approaches
Anarchical integration approaches include methods for application integration. The standard literature on these methods is normally denoted Enterprise Application Integration (EAI), and concerns techniques and devices such as middleware, adapters, message brokers, etc. Application integration is typically performed using independent third-party software components. ETL (**e***xtract,* **t***ransform,* **l***oad)* is the more restricted mechanism used to migrate data from one database to another. Stereotypically, the anarchical view is relevant when components constructed by developers who never agreed on a common base, are to be integrated. Although the anarchical approach is most commonly considered in the context of enterprise software system integration, the two other approaches are of significant importance.

***Business Alignment Foundation** – an industrial view.*

Moving to the bustling world of the Electric Power Industry (EPI) we find that the Business Alignment becomes the key foundation for IT-architecture and integration. To develop a feasible integration strategy several aspects have to be taken into account. All these factors can be sculptured into a **Business Alignment Framework** (BAF).



According to the BAF business processes and information requirements are defined in parallel with the technology enablers and models, which are linked throughout the alignment process. Objectives and measures are defined and reviewed in the light of the intended overall strategy, which leads to adjustments and refinements of existing results. The approach used to develop the business alignment framework may include the following modules:

- Breakthrough objectives and process links
- Key processes
- Business models
- Information models.
- Technology enablers and models
- Solution mapping and selection
- Functional mapping
- Cost/Benefit analysis

Breakthrough objectives and processes
Based on a strategy review, potential breakthrough objectives are defined. Breakthrough objectives create a distinct competitive differentiation in the eyes of the customer when implemented (e.g.: performance increase, lower cost of ownership, consolidation,…).

Key processes
The next step is formulating key processes that have mayor effects on achieving the breakthrough objectives. These processes basically support the critical success factors. The processes are classified as *innovative, core* and *supportive*.

Business models
Business models are developed for describing *innovative* processes and their role within the overall organization. Business models are defined not only for facilitating communications and achieving consensus, but also as a basis for identifying enabling technologies.

Information models
Information models aim to identify and describe business data objects (e.g.: orders, locations, assets,…) together with their interrelationships. To support this goal, data objects must be driven by business needs and defined from existing information systems and applications.

Technology Enablers and Models
It is necessary to examine and define which technology elements, based on current technology and standards as well as future trends can be applied in the implementation of the business processes.

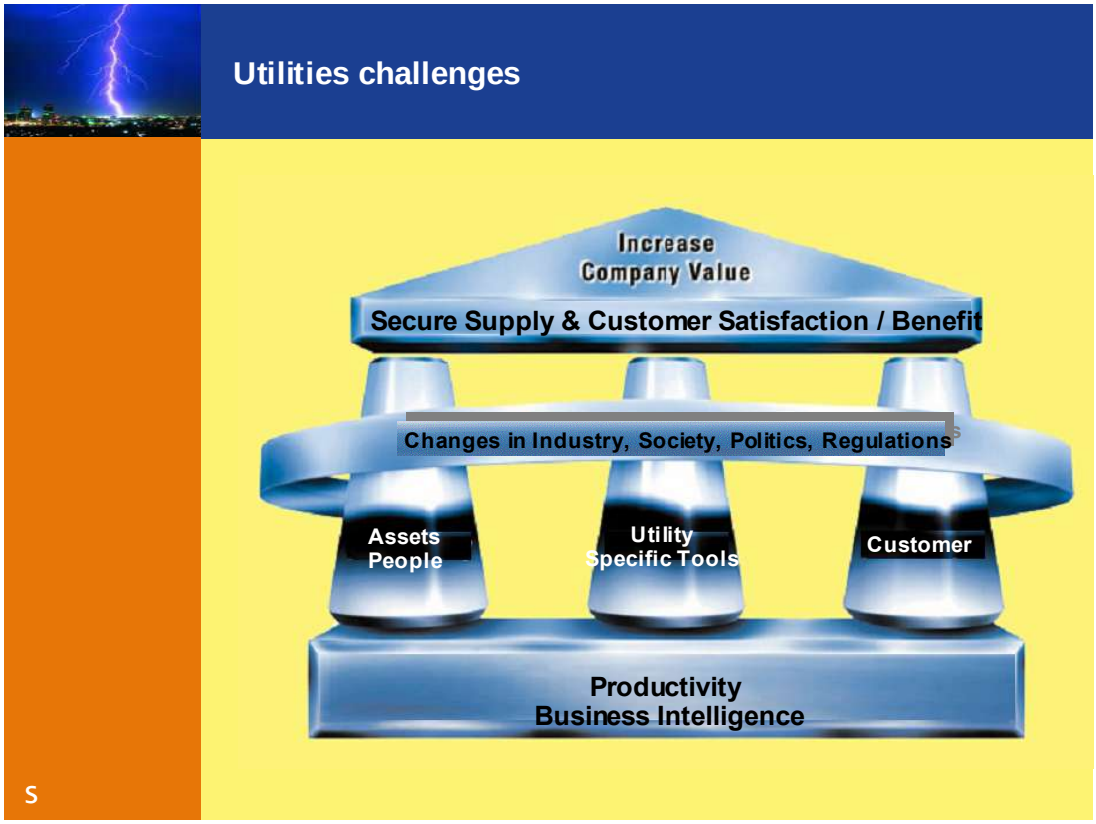
Solution Mapping and Selection
In this step the solutions that best support and enable the defined business processes are selected. To facilitate this selection a cluster of potential applications is developed. The clustering is performed at a very high level and does not yet include detailed functional requirements. Based on this solution cluster and the selected objectives, an analysis of existing integration solutions is performed.

Functional mapping
The defined business processes are checked with users in terms of the detailed fit with specific business or process events and compared to the functionality of the selected solutions. In cases where gaps exists, two alternatives are examined: Modify the business process or
Modify solution

Cost/Benefit Analysis
This step defines which parts and option of the whole scenario will be implemented. All costs related to the scenario are taken into account. This includes licenses, development costs, hardware, ownership costs etc. The final outcome of this analysis is provided to the management to facilitate informed decisions.

EAI enabling distribution efficiency *– a vendor's view.*

After deregulation hits electric utilities the environment changes dramatically. Vendors of SCADA/DMS systems work with many utilities and can spot trends and structures early. From this perspective the new environment of a utility for distribution of electricity could thus be characterized with the following picture.



While operating in a deregulated environment, it becomes very obvious, that the only two parameters that can be influenced by the utility are customers and assets.

In order to achieve best in class and cost effective business processes, most utilities followed in the past the path of :

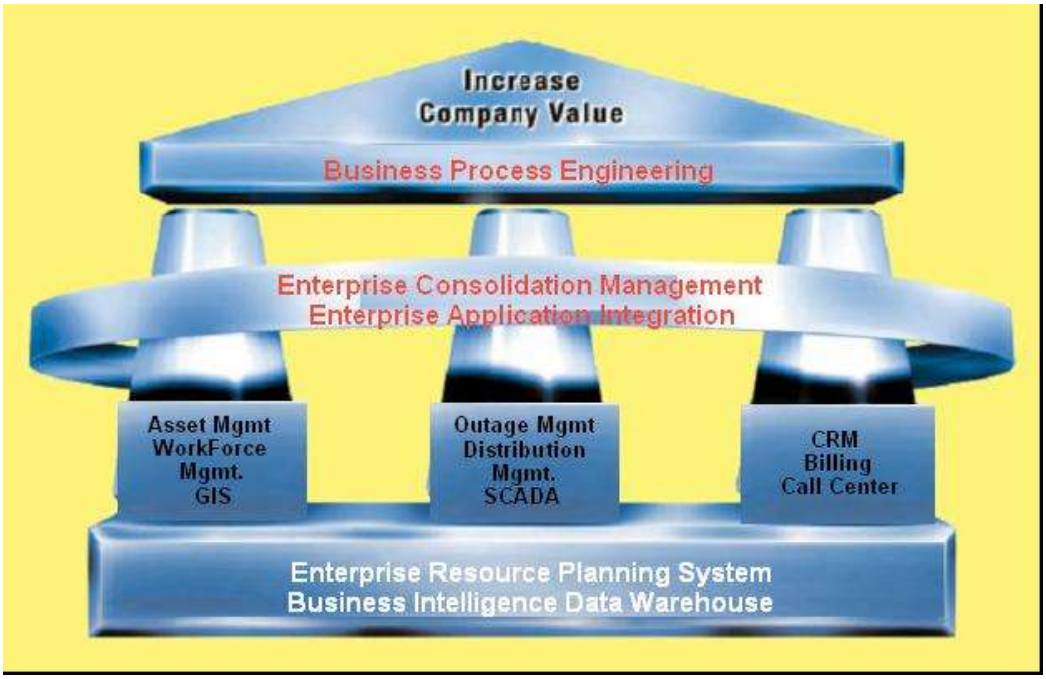
1) Purchasing and implementing a standard ERP System, Customer Information System (Customer One), supply chain management solutions and others.
2) Implementing point-to-point integration.
3) Launching new initiatives that are now business process oriented rather than product oriented.

In Enterprise Resource Planning (ERP) systems the business management components like financial management, cost controlling, balance calculation, asset management or human

resources do not differ much from solutions in other industries. But there are industry specific solutions necessary for an optimal support of the business processes within an utility and the asset management solution, derived from an out of the box product is one of these industry specific solutions.

All relevant figures regarding the business management situation of a utility must be accessible at every time. Flexibility, openness, Internet capability and process orientation are the most important requirements for modern ERP solutions. Essential for a utility is the integration of the ERP systems with the other applications of the utility IT landscape. This enables utilities i.e. to manage assets through their entire life cycle or to develop products and services that attract and retain customers in a highly competitive marketplace.

Only EAI-based solutions enable utilities to monitor, plan and develop their business on an entirely new level. Future IT solutions will have to provide up-to-the-minute facts and figures required to respond dynamically to the increasing management information demand. An ERP system, which is integrated with the other segments of the IT landscape, puts a utility firmly in control of the key business processes. The integration along the business processes of the applications in the area of Workforce, - Asset-, Outage Management and GIS, together with the customer information system, the ERP system and the SCADA, DMS system will be the future solution.



Important: Network Management

Now while no one will disagree to the comments above, we still find borders in many utilities between the transaction based financial world and the event driven / operational world.

Some integration examples, within the operational environment of a utility
Even the technical IT systems have to be adapted to the deregulated market environment. Only slightly affected but still important are Geographical Information Systems (GIS) used for the documentation of the network (geographical maps and facility data). Network control centre systems are faced with a number of additional requirements:

- Guarantee equal and non discriminating network access for all market participants;
- Interface to energy trading;
- Economical congestion management with billing according to origin;
- Calculation of wheeling costs
- Proof of the contracted supply quality
- Improvement of customer service
- Large number of different communication interfaces.

To make network operation more efficient, improvement of specific business processes is necessary. The network maintenance costs can be reduced by 30% or more with event driven or predictive maintenance of the equipment like circuit breakers or isolators. Therefore data from the control centre (switch counters, transformer overload hours) are needed in the asset management system. In addition to that, effective crew management for maintenance work and fault clearance can reduce repair and outage times.

The SCADA system however does have also asset information, geographical information and even customer information. The same is true for an Outage Management System, which will be derived from a SCADA system if the network is automated or will be an offline system, which gains the information from customer calls.

Implementation of EAI – a system operator's view.

Deregulation of the electric power industry has created new functions, operational roles and business practices. The system operator (SO) is now in charge of the power system and has a large impact on the development of the electricity market. The SO sees substantial changes to its internal information systems (IS), develops new systems for the operation of the market and has good insights in the developments in the utilities.

From this perspective we note that Utility companies that incorporate the activities of production, transmission and distribution have had to unbundle their information systems. This has led to applications being duplicated, adapted or even replaced by entirely new ones. In all cases, management of the interfaces between the unbundled sections has become crucial. In addition, the electricity market has evolved since deregulation and continues to evolve even now, although in precisely which direction nobody can say with certainty. As a result, the information systems used in the industry must be flexible and adaptable.

EAI and business
The unbundling of businesses is a specific integration-related problem that EAI can help to resolve. Amongst other things, EAI can be used to separate the production of data within the

company from the process of making it available to customers. Similarly, it can separate the twin procedures of collecting data from customers and processing it. Thus the IS can evolve without affecting customers, while the reverse is equally true, since the system that is visible to and used by customers can change without affecting the IS.

Relations with customers evolve over time, mainly to reflect changing market expectations.
Using EAI and rationalising communication are major advantages when it comes to modifying just those aspects of information systems that need updating, whilst leaving the rest unaffected. Finally, the sheer numbers of interfaces and sections present in information systems makes using them complex. Automating them provides a substantial and well-appreciated gain.

EAI-oriented organization

Setting up and making optimal use of EAI support products requires specific skills, but EAI cannot and must not remain only in the hands of IT personnel. In order for EAI to be implemented successfully, each one of the company's departments must be fully involved and they must share the same piloting system with the IS. The company must be organised in such a way as to allow this global data exchange to take place. It is up to each department to know just what data it can exchange with its counterparts. But of course if there is no place for dialogue, where that exchange can occur, departments do not necessarily think to share their information with others, or to re-use data that supposedly belongs to another department. Often this is because departments are not necessarily aware of what sort of information other parts of the business are producing or using or of what they could be providing themselves.

RTE methodology

RTE has set-up a methodology to move from business needs to realisation of an exchange through EAI mainly based on two focuses. The first focus deals with the functional modelling and cartography of the RTE IT, which will output functional specifications of the business process. The second focus is the description in each business area of a pragmatic policy for application exchange such as the use of a unique data referential
This methodology allows prioritisation in a specific *Governance Committee* the business processes before integration within the webMethods infrastructure.
Once selected, each project is lead with a standard set of functional and technical deliverables (Exchange Grid and Specification, Interface Contract) allowing managing in the same way specifications and testing of the multiple application interfaces.

Implementation of WebMethods

RTE has packaged the webMethods 4.6 products in order to make them fully operable and usable within RTE, that is, enabling technical supervision and management as well as functional supervision of exchange infrastructure. Since the first exchange released in May 2003, the infrastructure is growing as a backbone for RTE IT exchanges. Theses exchanges mainly involve Oracle based application, SAP R3 and an in-house B2C application with approximately 1 million/a month webMethods documents exchanged.

Evolving EAI solutions – *the view of a multinational utility.*

During the past decade, the Scandinavian electricity industry has undergone radical changes due to market deregulation. The legislative reforms have resulted in lower margins, a wave of mergers and acquisitions, and new requirements for business operations. These consequences of the deregulation have had a significant impact on the software environment of electric utilities. Investments in new systems have resulted from attempts to streamline the operations, from initiatives to offer new services, as well as from regulatory requirements. Software system integration projects have resulted from mergers and acquisitions as well as from efficiency programs in the enterprises.

From a Swedish to a European utility.
During this decade Vattenfall has changed from a dominant Swedish utility to a North-European utility competing in the electricity market. The EAI area has been of interest for Vattenfall since the mid 90'ties when the first trials of interconnecting IT applications where made. The interest was first manifested on the administrative part of the IT-support for Vattenfall and the drivers are still to be found on this side. The IT-support for power control systems has for long time felt the urge to protect the SCADA systems, process control systems and similar from the potential dangerous connections to other areas, i.e. administrative networks and Internet by physical separation.

EAI at the nuclear plant Ringhals
The most prominent area where EAI currently is used at Vattenfall is at the nuclear power plant at Ringhals placed on the Swedish west coast. Still the sensitivity of the process control systems has prohibited the connection to the integration platform of these systems. The new administrative platform that was taken into production in 1998 was based on an integration platform consisting of IBM MQSeries as the transport mechanism and the Mercator integration broker. This platform was later extended to take care of other integrations needed at the Networks business unit as the exchange of customer information between the billing and the grid calculation applications. Both these are so called legacy applications meaning that a lot of resources have been put down into the creation of the connectors/adapters to the respective applications.

EAI at Vattenfall in Germany
Vattenfall has also a large operation in Germany where EAI is used to integrate a number of applications with the SAP R/3 and IS-U applications. The platform set up for this is based on Microsoft BizTalk and was put into production in 2002. As most of these applications are "standard" applications often the adaptors can be bought from commercial vendors and the effort needed to connect these applications to the EAI platform is substantially reduced. The EAI platform in Vattenfall Germany handles around 100 000 messages per day through approximately 70 different interfaces while the Swedish counterpart handles 50 000 messages per day on the average, at peaks the rate can raise to as high as 500 000 messages per day.

Moving forward
The future evolution of the EAI platforms at Vattenfall will contain efforts to consolidate the platforms in use to one and to extend the usage to incorporate web services for integration of external partners, large customers and large suppliers. We will also study the possibility to base customer portals on the EAI platform.

The near future will also see the start up of integrations between the traditional administrative environments and the IT-applications and support of control rooms, SCADA systems, process control, meter value management, meter management etc. This will also mean that these applications will be connected to a common data communications network with connections to Internet and all threats and risks that will appear have to be managed in order to allow for the use of Enterprise Application Integration.

More areas to be investigated by Cigré.

Some initial investigations of EAI have been done under the broader scope of Information systems and Internet targeted by Cigre advisory group AGD2.02. Four articles were presented at the SCD2 Colloquium in RIO 2004 and a new working group is being formed. Several detailed areas are under discussion for future reports or articles including Meta Data Models and Documentation, Standardisation of Utility Data, EAI and B2B, SCADA/DMS/EMS integration, Implementation steps and Utility Case Studies

References:

Cigré Study Committee D2 Special report from Rio 2003 addressing papers A05, A08, A10 and A12

A05: "The Architectural Information View: A new Perspective for Enterprise Software Management".

A08: "Experiences from RTE's experimentation on EAI".

A10: "Enterprise Application Integration at Vattenfall".

A12: "Implementation of EAI solution as an exchange infrastructure within the RTE IT System".

Terminology at http://webopedia.com