WEB-BASED ERP SYSTEMS: THE NEW GENERATION

Case Study: mySAP ERP

Marie-Joseph GOMIS

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WEB-BASED ERP SYSTEMS: THE NEW GENERATION

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Marie-Joseph GOMIS

This final thesis is performed at University of Jönköping within the area of Computer Engineering. The thesis is the final part of the master education with specialization in Information Technology.

Supervisor at ING: Vladimir TARASOV

Examinator: Kurt SANDKUHL

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Summary

Abstract

With the proliferation of Internet, ERP systems like all the domains of Information Technology have known an important evolution. This final thesis project is a study about the evolution of ERP systems, more precisely about their migration to the Web giving birth to a new generation of systems: the Web-Based or Web-enabled ERP systems. This migration to the Web is justified by the difficulty of making possible the communication between partner’s legacy systems and the organizations’ ERP systems. A historical evolution of these systems is presented in order to understand the reasons that lead vendors to adopt the Web Service Technology. Based on different studies, the main technologies such as Web services, Service-Oriented Architecture and Web Application server are also presented. From an interpretative research approach mySAP ERP has been chosen as a case study. This Master’s thesis has been led into AIRBUS France Company within the framework of the SAP Customer Competence Center (SAPCCC) Web site project. The project is aimed at re-building the SAPCCC Web site. The new characteristic of the Web site is to make it accessible by all AIRBUS partners working with SAP applications. To make the Web site accessible by the partners from their own applications located on their own platforms the development has been done thanks to mySAP ERP which is an ERP using the Web service technology. Finally, this thesis presents a comparative study between traditional ERP systems and the new generation of Web-based ERP systems.

Keywords
ERP, Web-based ERP, Web services, SOA, Service-Oriented, mySAP ERP, SAP NetWeaver, Knowledge Management, Enterprise portal
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1 Introduction

1.1 Background and Purpose

Currently, the main objective of any organization is to be competitive in its market. However, staying in the race includes essentially two points: the customer satisfaction and the profit increase. For achieving these aims, it is fundamental for managers to be able to get the right information in short delay, which means an efficient management of the information flow through the business components of the company. Until the 90s, implementing ERP systems appeared as the miraculous solution but soon it appeared that these systems didn’t offer enough capabilities.

Indeed, from a general view, all this turns around an efficient communication in companies. But to be efficient, a company needs to improve the circulation of internal information but also of external one. This external information is not easily reachable by companies that possessed an ERP system because for a long time, ERP systems didn’t allow integration of the partners, customers, and suppliers applications within the system. So another solution has to be found. How applications from other platforms can communicate with ERP systems?

So far, there was only one platform on which different applications from different platforms communicate efficiently without any ownership cost: Internet. Internet is an environment that runs on standard protocols-without any owner-through which so different applications exchange data. These applications are essentially Web Services that belong to Web applications and can handle the communication between applications written in different languages and located in different platforms. Thereby, Web services organized into a Service-Oriented Architecture represent the solution that will enable a “tri-party business relationships” between the organization, suppliers, and the customers. The Service-Oriented architecture will help in improving interoperability between them. Combining the Web to ERP systems has given birth to a new generation of technology: the Web-based ERP systems.

The purpose of this thesis is to try to have a better understanding of these new ERP also called Web-enabled ERP systems and mainly to show that Web services improve considerably ERPs.

For this we will try to answer in this paper to these following questions:

- How Web Services are integrated into ERP?
- What additional values do Web Services bring to traditional ERP systems?

However, in order to have a concrete vision on how these systems work, we choose to study more deeply a specific ERP via mySAP ERP and its use in a project.

1.2 Disposition of the thesis

In order to give the best understanding of this study, you will find, in this paper, three main chapters. The section 2 presents all the theoretical background essentially from literature reviews, thus you will find the principal definitions and also the characteristics of the different components and technologies used for Web-Based ERPs. The section 3 concerns a case study: mySAP ERP, where a concrete description of how this kind of systems works and how Web services are integrated into it. This section is endorsed by the following section (section 4) in
which the practical part of the thesis is presented, showing how a Web site is built using technologies offered by a Web-based ERP system like mySAP ERP. And finally, in the section a comparative study where we compare the characteristics found in the literature reviews to the practical experience led throughout this final thesis project.
2 Theoretical background

2.1 ERP

2.1.1 Definition of ERP systems

An Enterprise Resource Planning system can be seen as software solution that helps to the management of all processes and data of an enterprise by integrating the business functions into a single system. ERP systems are composed by different modules related to different departments of a company and that share data through a single and unified database. These modules are in fact, software applications that concern the business activities as finance, logistics, CRM, human resources, supply chain, manufacturing, and warehouse management.

Seddon, Shanks and Willcocks gave a global vision of ERP systems by defining them as “a set of packaged enterprise application software modules, with an integrated architecture that can be used by organizations as their primary engine for integrating data, processes, and information technology, in real-time, across internal and external value chains.”[1]

Currently, ERP systems occupy an important place in companies; they represent an IT solution by permitting a logical data flow between various components of the Information System. They allow centralization and standardization of the information and transform it into useful data used by companies for decision-making. They are also used as strategic business solutions. Indeed these systems permit managers to access more easily to the important and right information and then to be able to take appropriate decisions faster and in the same time to improve their competitiveness.[1]

Figure 1: ERP systems concept [2]
2.1.2 Evolution of ERP systems

ERP systems as all the IT infrastructures have to follow new constraints met by companies. Thus, since their creation during the 1970s, enterprise systems have known a real evolution illustrated by the following figure (figure 2):

<table>
<thead>
<tr>
<th>2000s</th>
<th>Extended ERP</th>
</tr>
</thead>
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<tr>
<td>1990s</td>
<td>Enterprise Resource Planning (ERP)</td>
</tr>
<tr>
<td>1980s</td>
<td>Manufacturing Resources Planning (MRP II)</td>
</tr>
<tr>
<td>1970s</td>
<td>Material Requirements Planning (MRP)</td>
</tr>
<tr>
<td>1960s</td>
<td>Inventory Control Packages</td>
</tr>
</tbody>
</table>

Figure 2: ERP evolution [2]

Enterprise Resource Planning (ERP) is a name originally from Manufacturing Resource Planning (MRP II) that followed Material Requirements Planning (MRP). In order to automate their inventory control systems by using inventory control (IC) packages, most organizations adopted and implemented centralized computing systems during the 1960s. In the 1970s, material requirements planning (MRP) systems were mainly developed, for supporting the production planning or the planning of parts requirements according to the principal production schedule. A decade after, the aim of the companies was to optimize manufacturing processes; responding to this a new generation of software systems called manufacturing resources planning (MRP II) were introduced during the 1980s. MRP II permitted the synchronization of the materials with production requirements and included new areas such as distribution management, shop floor, project management, finance, human resources and engineering.[2]

ERP systems appeared in the beginning of the 1990s with the advantage of coordinating and integrating all the enterprise-wide business processes.[2] ERP systems are based on the technological foundations of MRP and MRP II. Presented in the beginning as the “new generation of MRP II”, it transcended soon the industry expectancies and from a technological view offered several benefits.[1]

Today, ERP systems are widely implemented into companies and allow them to better understand their businesses. They can standardize business processes and more easily aggregate best practices. They can also, concentrate their efforts on their customer’s satisfaction and on increasing their profit by creating more efficient processes.

ERP functions concern essentially finance (accounting), human resources management (personnel planning), sales and marketing (sales and order management), operations and logistics (manufacturing, service and maintenance, distribution, inventory management).

Progressively, “vendors added more modules and functions as “add-ons” to the core modules giving birth to the “Extended ERPs” These ERP extensions include advanced planning and scheduling (APS), e-business solutions such as customer relationship
management (CRM) and supply chain management (SCM). In fact ERP is becoming the e-business backbone for organizations doing online business transactions over the Internet. Then, Internet-based solutions have been developed for improving customer satisfaction and increase profit. The extension to SCM and CRM is destined to link in an efficient way the organization, suppliers and customers’ systems.[2]

2.1.3 Architecture of ERP Systems

One of the main characteristics of an ERP system is the centralization of all the data from the business functions of a company in a single unified database. However ERP systems are also characterized by their Client/server architecture (see figure 3). The client/server systems functions are performed following three logical organized layers:

- **Presentation Layer**: Graphical user interface (GUI) or browser for data entry or accessing system functions
- **Application Layer**: Business rules, functions, logic, and programs acting on data received/transferred from/to the database servers
- **Database Layer**: Management of the organization’s operational or transactional data including metadata; mostly employs industry standard RDBMS with structured query language (SQL) provisions

Thereby, with client/server technology, the processing of an application could be split between the server and the client workstations, and data management was separate from the servers.[3] Logical arrangement help the ERP user interface to run on the clients, the processing modules to run on the middle-tier application servers, and the database system to run on the database servers.

![Figure 3: Three-Tier ERP systems architecture][2]
2.1.4 ERP implementation

Traditionally, ERP are implemented as product based solution, the business define their requirements, come up with the product they want to use to meet their needs and then go by about customizing it.[4]

However things are not that easy, because of their wide scope of application within a business implementing ERP systems requires many competences so companies often seek the help of an ERP vendor or of the third-party consulting. These vendors offer three areas of professional services: Consulting, customization and support.[5]

The consulting team is responsible for the initial ERP implementation and for tailoring the system. Consulting for a large ERP project involves three levels: “systems architecture” for the design of the general dataflow for the enterprise; “business process consulting” during which the aim is to “configure” the ERP system to the organization’s needs and “technical consulting” that concerns essentially the programming.[5]

The customization is the most important part when implementing an ERP system. It is “the process of extending or changing how the system works by writing new user interfaces and underlying application code”. [5] When an ERP is installed the work practices change a lot so the customization is a way to try to give to the users a new work environment that permit them to work an easy way and to get more easily used to this new tool. Nevertheless, customizing an ERP can be very expensive and complex, because many ERP packages don’t support it.

The support also includes maintenance services that start once the ERP has been implemented. The consulting company must assist the staff in keeping the ERP software running in an optimal way.[5]

Implementing an ERP seems to be an enormous project, which cost a lot to companies, so it would be normal to ask ourselves why these systems are perceived as a revolutionary technology. The following section presents the positive and the negative points carried by these systems for the enterprises.

2.1.5 Benefits and Inconveniences of traditional ERP

As each new technology, ERP systems carried their bundle of advantages and disadvantages within companies.

2.1.5.1 ERP systems Benefits

Today ERP systems are present in many companies and give a considerable help in the management of the information flow and mainly in improving their competitiveness. Competitiveness is a result of many aspects that have to be fulfilled. Thus, with the birth of ERP systems, companies have found a tool for reaching this.

Indeed ERP systems offered several benefits such as a single and unified view of enterprise data, an easy way for software configuration and customization, a simplified client/server computing architecture, and reduced considerably the software costs.

Businesses accept ERP because it carries in its way solutions to unsolved chronic problems.[4] Often the Information Systems of large companies are composed by several different software applications. This plurality makes the communication between these applications quite difficult and sometimes inexistent, thus it is difficult for users to get the right information in the right moment. For example, the sales department obligatory works...
with the data from the production department, and because of the use of different software applications it can be difficult to access the information an efficient way. This is the first point where the ERP systems step in. Indeed by implementing an ERP system, the different business functions share a single database in which all the data is stored and can be accessed by the concerned users. One of the characteristics of these systems is the presence of a workflow system that permits the information spreading in all the modules that need it for their work. Storing all data in the same database avoids data and operations redundancy; improves the productivity by standardizing processes and methodologies; and reduces the delivery time because ERP minimizes the delay spending in retrieving and reporting the right information.

This concept of centralization gives a single point of customer information in the enterprise.[4] All the departments of a company can access all the necessary information related to a customer and by the way, be able to treat in an efficient way his/her order.

Furthermore, ERP carries a grateful help in standardizing Human Resources information. In large companies with multiple business units, ERP systems allow a unified, simple and general method for following up employee information, benefits and services.[4] All these advantages make ERP systems appear also as a strategic tool for companies because they help the manager to take the right decision for their businesses, thus to stay competitive.

Rachid, Hossain and Patrick, studied ERP advantages and regrouped them in the table represented by figure 4.

<table>
<thead>
<tr>
<th>What benefit</th>
<th>How</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliable information access</td>
<td>Common DBMS, consistent and accurate data, improved reports.</td>
</tr>
<tr>
<td>Avoid data and operations redundancy</td>
<td>Modules access same data from the central database, avoids multiple data input and update operations.</td>
</tr>
<tr>
<td>Delivery and cycle time reduction</td>
<td>Minimizes retrieving and reporting delays.</td>
</tr>
<tr>
<td>Cost reduction</td>
<td>Time savings, improved control by enterprise-wide analysis of organizational decisions.</td>
</tr>
<tr>
<td>Easy adaptability</td>
<td>Changes in business processes easy to adapt and restructure.</td>
</tr>
<tr>
<td>Improved scalability</td>
<td>Structured and modular design with “add-ons.”</td>
</tr>
<tr>
<td>Improved maintenance</td>
<td>Vendor-supported long-term contract as part of the system procurement.</td>
</tr>
</tbody>
</table>

*Figure 4: Advantages of ERP systems [2]*

These benefits were also regrouped into categories by Seddon that divided the practical benefits of ERP systems into five aspects: managerial, strategic, IT infrastructure and organizational. This categorization permits to see benefits of ERP systems from different points of view.
Inconveniences of ERP systems

Despite its multiple advantages, companies also need to handle many problems and disadvantages when they implement an ERP. Generally organizations meet problems with their ERP because they don’t a right view concerning the level of investment in ongoing training for all personnel concerned, including those implementing and testing changes that occur. These difficulties are also due to the lack of corporate policies needed for the protection of the integrity of the data treated in the ERP systems and how it is used [5].

The limitations of ERP systems include these main points [4] [5]:

- Often ERP system is implemented in companies where personnel with inappropriate education in ERP will use it. Installing an ERP leads to important changes in business practices so to an important re-education of the business staffs. The change management for ERP projects asks a lot of investment in order to help people to get used with the news processes.
- Customization of the ERP software is not always easy because this operation sometimes may involve changing of the ERP software structure, which is not usually allowed.
- Implementing an ERP system costs a lot to companies, so stay for a long time not suitable for small and medium companies. The high cost of this software is essentially due in part by the customization (the interfaces have to fit the user needs in order to
attenuate the changes) and also because of the integration necessary for communicating with the different partners applications.

✓ The system can be sometimes difficult to use (low usability)

✓ ERP are often seen as too inflexible and too difficult to adapt to the particular workflow and business processes of some companies, moreover the business process reengineering is defined as a critical factor in the success of ERP implementation.

✓ There are frequent compatibility problems with the various legacy systems of the partners, this lead in serious problem for the integration of these applications to the ERP software.

To summarize, ERP systems don’t carried only positive points into companies. They have lot of advantages but installing them also required to pre-study seriously different points and particularly if from a strategic point of view this is the solution for your company. The figure 6 gives a good overview of difficulties companies can meet when they choose to implement ERP software.

<table>
<thead>
<tr>
<th>Disadvantage</th>
<th>How to overcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-consuming</td>
<td>Minimize sensitive issues, internal politics and raise general consensus.</td>
</tr>
<tr>
<td>Expensive</td>
<td>Cost may vary from thousands of dollars to millions. Business process reengineering cost may be extremely high.</td>
</tr>
<tr>
<td>Conformity of the modules</td>
<td>The architecture and components of the selected system should conform to the business processes, culture and strategic goals of the organization.</td>
</tr>
<tr>
<td>Vendor dependence</td>
<td>Single vendor vs. multi-vendor consideration, options for “best of breeds,” long-term committed support.</td>
</tr>
<tr>
<td>Features and complexity</td>
<td>ERP system may have too many features and modules so the user needs to consider carefully and implement the needful only.</td>
</tr>
<tr>
<td>Scalability and global outreach</td>
<td>Look for vendor investment in R&amp;D, long-term commitment to product and services, consider Internet-enabled systems.</td>
</tr>
</tbody>
</table>

Figure 6: Disadvantages of ERP systems [2]

The evolution of the ERP systems is not concerned only by new functions but also by the use of new technologies. In the beginning the fundamental point of these systems was a single and unified database that allowed the storage of all data from all the business functions of an enterprise and a workflow system for sharing this data. Nowadays, the proliferation of Internet has consequences on every aspect of the IT sector including ERP systems that become more and more internet-enabled.[2] This impact influences, a lot, organizations’ requirements and lead to the birth of ERP based on the standards proposed by Internet. These ERP systems have been named “Web-based” ERPs and are essentially use web applications as Web Services.
2.2 Web-based ERP: The New generation of ERP Systems

As ERP systems have evolved and made businesses more and more efficient, a new set of demands sprang up. In the 1970s, the main objective was the automation of the basic business functions; today the companies want in addition automate processes that are unique to their operations. [3]

However, the main reason justifying the migration of ERP systems into the Web is that to improve their competitiveness, companies need to drive collaborative business. Implementing this collaborative business requires integrating their existing heterogeneous IT landscapes and extending this integration to their business partners, customers and suppliers.[6] Internet appears as the solution for integrating different applications belonging to different Information Systems. To answer to these new requirements, vendors have today developed a new generation of ERP systems based on the Web technology: the Web-based ERP.

The fundamental advantage of Internet is that it is a standards-based environment with no owner, so nobody can claim to have new and improved Internet.[7] Any company can access to a web-based ERP as long as it has an Internet connection and the right authorization. The Web allows the creation of an open platform that will permit different applications to communicate easily through the standards offered by Internet.

Web-based ERP systems lean on the Web Services but also on Service-Oriented Architectures (SOA) for building enterprise business blocks in order to aggregate the benefits of multiple Web Services and to simplify interoperability between them.

This chapter is one of the most important of this paper because we are going to look closely what a Web-based ERP is, how the migration to the Web is done and what new aspects Web Services carry to ERP systems. Before developing these points we need to have a brief overview about Web Services and Service-Oriented Architectures.

2.2.1 Web Services

But before we deeply enter in the world of web-based ERP it would be legitimate to make an overview of web services technology.

2.2.1.1 Definition of a Web Service

In essence, a web service is three specific things [8]:

✓ A way to find and register interest in a service (UDDI)
✓ A transport mechanism to access a service (SOAP)
✓ A way to define what the input and output parameters are for such a service (WSDL)

Web services represent an independent platform, not controlled by any one vendor that provides a way to allow applications to talk to one another. To communicate using web services, applications first have to find the service that is located in a library called UDDI (Universal Discovery, Description, and Integration). The UDDI sends the service to the client with the defined interface, then the application can communicate with the service through a standardized protocol called SOAP (Simple Object Access Protocol) built-up using an XML schema. The following schema (see Figure 7) shows these different actions:
Here is a triangle that represents the basic architecture of the Web service Framework (see figure 8):

2.2.1.2 Web Services Technology and its standards

Web Services are the new class of web applications. They are based on open conventional standards. They enable the combination of functions in a single process, even if they are implemented in widely different software components. To sum, Web services are independent entities that can be published, searched for and accessed across a network.
The Web Service architecture consists of four main components: Extended Markup Language (XML); SOAP, a protocol that enables the communication between services; Web Service Description Language (WSDL) that describes user interfaces, and Universal Description, Discovery and Integration (UDDI) where all the services are stored.

The concept of Web services appears in the beginning of 2000s. We find several papers where this technology is defined but we can retain the following one, which give us a large view of a web service role and the different components that characterized its architecture.

“A Web service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the Web service in a manner prescribed by its description using SOAP-messages, typically conveyed using HTTP with an XML serialization in conjunction with other web-related standards.”[9]

**XML**

XML is the foundation of the Web Services architecture. XML is a text-based Meta-markup language, which is used to define other languages. [11] As all the Markup languages it defines a formal syntax for structuring data but also semantics. XML can be seen, thanks to the existence of a syntax and semantics, as a simple and puissant mechanism for capturing and exchanging data between applications written in different languages and based in different platforms and operating systems. [10]

**SOAP**

SOAP is a mechanism used for the circulation of messages between clients and servers. More formally it “is a protocol for encapsulating a message as an XML payload using standard communications protocols such as HTTP” (DDA course) SOAP appears as a simple protocol, easy implement and well supported in the industry.

A SOAP message is XML-formatted and contains four parts: the envelope, the header, the body and the default. The envelope is obligatory because it is the element that identifies the XML document as a SOAP message. The header is an optional part containing extended information within the envelope tag. The request and the response are stored into the body tag, i.e. which method to call up at a remote server or the results when concerning an answer. The fault tag is placed within the body tag; it may exist in case any errors occurred when passing the message. [10]

Since SOAP messages are XML formatted, it will be easy to communicate through this protocol within a heterogeneous network, where web services can be reached from Internet web servers.

**WSDL**

WSDL is an XML document which describes a Web service. This document contains information about the location of the Web Service and specifications of the method that are implemented. (DDA course) Publishing a Web Service actually means to publish the WSDL documents.
UDDI

UDDI can be compared to a library where all the Web Services are stored. In reality, the UDDI provides three specific services: traditional White Pages for looking up a Web Service by name; traditional Yellow Pages for looking up a Web Service by topic and Green Pages for more detailed searches based on the characteristics of a Web Service.

Like ERP systems, Web Services constitute a revolutionary invention in the IT domain. Today, they are developed thanks to a variety of tools, for example, Java or Microsoft Visual Studio. However to be really efficient, Web services are structured into a Service-Oriented Architecture in order to improve their interoperability.

2.2.2 Service-Oriented Architecture (SOA)

SOA is a design for linking applications and data in order to achieve the expecting results for service consumers. SOA is also defined as a technical framework for designing software applications that use services available through the Web. Applications in SOA are built as Web Services which enclose well-defined business functions. These services are used by consumers/clients in different applications or business processes. [3]

More formally, OASIS (the Organization for the Advancement of Structured Information Standards) defines SOA as: “A paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with and use capabilities to produce desired effects consistent with measurable preconditions and expectations.”

The main aspect of a Service-oriented Architecture is the separation of the service implementation from its interface. [13] Therefore, it allows independent services with defined interfaces to be called to perform their tasks in a standard way, without taking in account the language in which they were developed or the platform on which they are located. [14]
As we mentioned above Web Services represents one of the tools for implementing SOA. Web Services standards are well accepted in the industry and provide greater interoperability between systems. [16]

After this study in which we have got an overview of the both technologies on which the migration of ERP systems into the Web is based, we can now, see in detail how this migration is done, how Web Services help connecting other enterprise applications to ERP system and which benefits this new technology carries to industry world.

2.2.3 Why ERP and Web Services?

Many years ago the main aim of companies was to find the best way for improving the realization of their basic business functions. Today, to in the competition, organizations have to focus essentially on Customer’s satisfaction. The key for achieving expectancies in the best way is an efficient communication.

Communication is the key of the success because if the right information is got, in the right moment, by the right person; then the resulted decisions can only have a positive impact. Since, customer becomes the center of companies’ preoccupations then the services offered by existing ERP systems become insufficient. To achieve this communication companies need to access quickly to the information from the customers, partners and suppliers applications and this is the point where ERP systems have difficulties. Indeed, before the adoption of web standards, one of the biggest ERP disadvantages was the enormous difficulty of integrating external applications (from partners’ systems, so located in other platforms) to the ERP system. Of course this was not the only reason that led on the extension of ERP software to the Web, but also because Internet is a standardized environment that presents many positive points.

To answer to this new demand, vendors choose to use the Web Service technology. Apshankar distinguished a two-fold advantage offered by Web Services in the context of ERP: ease of integration and reduction in costs through the hosted application model.

✓ Ease of Integration

Different studies have showed that integration is an important source of expenses across enterprises. For instance, “According to figures from the Meta Group, Global 2000 companies rely on an average of 49 enterprise applications, and they spend up to 33% of the IT budget just to get them to talk to one another.” [4]

ERP systems are complex and not designated for public use. However, currently, customers and partners want to access to the same information employees get via the ERP system, for example, information like order status, inventory levels and invoice reconciliation. The only problem is that nobody wants to change his all information system just for getting the wanted information. So the information has to be reached in simply way without all the ERP software. This is the point where Web Services come in play; in fact, via its URL an enterprise application can call an available service and furnish the appropriate data to the authenticated users in the right time.

The existence of Web Services makes the integration possible with a high quality of service for reliability, security, manageability, routing, discovery, testing, and effectiveness. Web Services use object-oriented technology as SOA for binding data and programming elements in methods in order to make them accessible by different applications.

✓ Reduction in Costs through the Hosted Application Model
Deploying a traditional ERP system sometimes involves considerable business process analysis, employee retraining, and new work procedures. Thus from a strategic view adopting Web Services for ERP implementation or improvement takes advantage of the investment made in the legacy ERP applications and provides them a new lease on life.

Another important point is that “ERP provides for integrated, multicomponent applications software, performing multiple business functions. It involves the use of packaged software instead of client-written custom software.”[4] This means less ownership costs for companies that want to use applications.

2.2.4 The concept of Web-based ERP systems

As we spotlighted above, the expansion of Internet in all the aspects of the IT sector had a real impact on companies’ requirements towards their information systems. The ERP systems naturally followed this progress and today several vendors try to use at best the advantages offered by Internet.

The main objective of “Web-based” solutions is to help improving customer satisfaction, increasing marketing and sales opportunities, enlarging distribution channels and having available more gainful billing and payment methods. To achieve this, Internet appeared as the perfect environment because it proposes standards that allow to access systems resources from anywhere at anytime, and this characteristic has helped ERP vendors integrate newer external business modules among them Supply Chain Management (SCM), Customer relationship Management (CRM), Advanced Planning and Scheduling(APS), Business Intelligence(BI), and e-business capabilities. [2]

We also saw earlier that one of the biggest difficulties for organizations was the integration of customers and suppliers’ applications into their ERP systems. So, by adding new modules such as SCM and CRM, ERP vendors offer the possibility to have an efficient “tri-party business relationships” between the organization, suppliers and the customers. [2]

The following figure (figure 10) illustrates the concept of “Internet-enabled” ERP systems.

![Figure 10: Web-based ERP system concept][2]

A supply chain management provides sub-modules for procurement of materials, transformation of the materials into products and distribution of products to clients. According to an IBM definition a “Successful supply chain management allows an enterprise
to anticipate demand and deliver the right product to the right place at the right time at the lowest possible cost to satisfy its customers. Dramatic savings can be achieved in inventory reduction, transportation costs and reduced spoilage by matching supply with actual demand” [2] With CRM systems, organizations are able to assemble knowledge about their customers, opening opportunities to assess customer needs, values and costs all over the business life cycle for better understanding and investment decisions. The sub-modules found in CRM usually support systems using Internet and other access facilities with the intention of increasing customer loyalty through improved customer satisfaction, in other words CRM is useful for e-commerce. “E-commerce is the conduct of business transactions among organizations with the support of networked information and communication technologies, especially utilizing Internet applications such as the Web and email, effectively reaching global customers.” [2] Therefore, adoption of e-commerce and e-business solutions is the justification of the extension of traditional ERP systems of most small, medium and large vendors.

From a technical view, extending the ERP signifies that the front-end Web-based Internet-business applications are integrated with the back-office ERP-based applications, enabling business transactions such as order placement, purchasing, inventory updates, employee benefits, etc. to take place between the customers, suppliers and the enterprise based on reliable, relevant data and applications instantly in a border-less domain. [2]

Web-based ERP systems also work with a Web Application Server that is involved to build run and deploy Web services. It works as a service provider and is in a certain manner the basement of these systems. The services are displayed on Web portals for instance and can be accessed by the internal employees through their Intranet Web site and by partners from their own applications. With the web application server these applications are made available through the Web then they can be accessed without any difficulty and communicate simply with the partners’ applications.

2.3 Current ERP Systems vs. Web-based ERP

At the end of this section we can say without any doubt that the ERP systems represent a revolution in the domain of Information Technologies. With ERP systems organizations found a powerful tool for solving a major problem: the circulation of the information between the different business components of the company?

ERP systems were immediately adopted by big organizations in which several different software applications have daily to communicate. Indeed the principal characteristic of these systems were a unified and central database in which all the data produced in a company are stored and can be accessed by all the business departments. This single point made things so easier because it gave a unified view of the enterprise’s data. Furthermore ERP systems offered others advantages such as: an easy way for software configuration and customization, a simplified client/server computing architecture, and lower software costs.

However as any software an ERP is implemented for end-users of who needs and expectancies often change. To keep their place in the market the vendors have to adapt their products to companies’ requirements. Once they get an efficient flow of the data within the different parts of their organizations, the focus was turned to customer satisfaction and the increase of competitiveness. It appeared that an incontrovertible way to stay competitive is to adopt a collaborative business. Thus, even if they, so far, fulfill companies’ needs, one of the weaknesses of ERP systems was the difficulty of integrating heterogeneous applications. So often, the solution when implementing an ERP is to abandon all the company’s former applications. ERP systems became then insufficient because to implement this collaborative business the organizations needed to integrate their existing heterogeneous IT landscapes but
also to extend this integration to their business partners, customers and suppliers. That’s the point where the Web appears as the key. Indeed Internet is by definition the standards-based environment with no owner through which different applications, written in such different languages and located on different platforms, communicate in an easy way. The base of this communication is the Web service Technology. Basing on this ERP vendors decided to integrate Web technology into their systems giving birth to the new generation of ERP systems: The WEB-BASED ERP.

Comparing to the traditional systems Web services largely helped make ERP systems more flexible and in the same way more accessible to small and medium enterprises. The table in the figure 25 shows us the differences between the traditional ERPs and the Web Service based ERP solutions.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Traditional Solution</th>
<th>Web Service Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scalability</td>
<td>Low</td>
<td>Very High</td>
</tr>
<tr>
<td>Time Frame for implementation</td>
<td>Very High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Maintainability</td>
<td>Low</td>
<td>Very High</td>
</tr>
<tr>
<td>Reliability</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Portability</td>
<td>Low</td>
<td>Very High</td>
</tr>
<tr>
<td>Cost to Enter</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Cost to Maintain</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Total Cost of Ownership</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>ROI</td>
<td>Moderate</td>
<td>Very High</td>
</tr>
</tbody>
</table>

*Comparison between traditional ERP and web-based ERP[4]*

After an overview of the reasons that led to the migration of ERP systems to the Web, the characteristics of the principal technologies used for this migration and the concept of Web-based ERP systems, we will present in the following chapter a concrete case study. mySAP ERP was chosen as a case study related to technological tools used for the SAPCCC project described in further sections.
3 Case Study: mySAP ERP

mySAP ERP is the last descendant of ERP systems family that have been edited by SAP one of the leader ERP vendors. It can be defined as a suite of ERP, CRM and other products that can be linked together using an Internet portal: SAP Enterprise Portal. It was introduced into the market in 2004 and can be seen as the logical suite of the SAP ERPs family. Today there is a new version of this ERP mySAP ERP 2005 defined as the first ERP system whose architecture is identical to a Service-Oriented Architecture framework. [18] The figure 11 is about the evolution of SAP’s ERP since the SAP R/3 4.6c launched in beginning of the 2000s.

Figure 11: Technical evolution to an ERP system respecting SOA Architecture

mySAP ERP is the successor of SAP R/3 and is characterized by the use of Services. For several reasons Services appeared as the future of ERP systems specially because they permit them to communicate with other applications from other platforms. They help improving the flexibility of these systems.

But to use Services it was important to make them communicate in an efficient way so the Service-Oriented Architecture (SOA) was the perfect framework technology to ensure that purpose. We have already seen in details the characteristics of SOA and its mechanism. Remember, Vogel and Kimbell have defined SOA as: “a technical framework for building software applications that uses available pieces in the form of Web Services”. Thus by “service” we mean “Web Service”. SAP, like many other ERP vendors adopted the Web Service technology.

Nevertheless instead of SOA, we talk about Enterprise Services Architecture (ESA) with mySAP ERP. ESA can be seen as the SAP’s interpretation of SOA that expands the concept of Web Services by enabling enterprise-wide, service-enabled business architecture. To compare, SOA can be seen as more of a technical concept and ESA as the draft that allow
services to achieve flexibility, openness and speed, three elements that are fundamental for your business success. [3]

Finally, thanks to ESA, SAP is able to furnish pre-packaged business processes with included connections for applications such as mySAP ERP. [3]

We can see in the figure 12, below that mySAP ERP is organized into two sets: components (CRM, SCM, self-services…) and an application builder platform: SAP NetWeaver.

![mySAP ERP framework](image)

Figure 12: mySAP ERP framework [18]

We will focus, our study, on the pedestal of mySAP ERP: SAP NetWeaver and its components particularly SAP Enterprise Portal and SAP Web Application Server.

3.1 SAP NetWeaver

SAP NetWeaver is an application builder platform edited by SAP for integrating business processes across various systems, databases and sources. [19] In this section we are going to see in details the role of SAP NetWeaver, its components, what is new in it for organizations.
mySAP ERP is today one of the most famous ERP in the market of Information Technologies, this is due in big part to its platform SAP NetWeaver that allows its different components to work in an efficient way. The figure 13 shows clearly that mySAP ERP is built on to of SAP NetWeaver. Vogel and Kimbell summarized the role of this platform for mySAP ERP, through a metaphor: “Just as a word processing application sits on top of an operating system as Microsoft Windows, mySAP ERP rests on top of a technology platform called SAP NetWeaver.” Thus to fully understand the potential of mySAP ERP, we need to know the rock on which it has been built. [3]

Here is the schema of the architecture of NetWeaver.

![SAP NetWeaver Platform](image)

Figure 13: SAP NetWeaver Platform [18]

The different components that composed SAP NetWeaver platform can be divided into two categories: The integration components and the development and management tools. [20]

Integration components are software products for achieving the work of enterprise applications by providing a puissant engine for a specific type of functionality. These components are, actually [20]:

- **SAP Enterprise Portal (SAP EP):** It provides a single and consistent user interface to organizations by allowing the creation of software that gathers all the necessary information and software tools.
- **SAP Business Intelligence:** As any Business Intelligence tools it provides tools for information integration so people can work with consistent and accurate data.
- **SAP Exchange Infrastructure:** It integrates processes and helps applications communicate between them.
- **SAP Mobile Infrastructure:** It helps writing interface for SAP applications such they can talk to any mobile devices (cell phone, pager, PDA) people need to work with.
- **SAP Master Data Management**: It is a system for harmonizing information that is distributed across a wide variety of applications. Concretely it is a toolkit for building real-time data warehouses for what SAP calls master data.

- **SAP Web Application Server (SAP WAS)**: It represents the platform application on which all the people, information and process-integration capabilities run. It is the tool for building and running applications such as web services.

Concerning the development and management tools they help create and execute/activate software. NetWeaver proposes four tools:

- **SAP NetWeaver Developer Studio**: It is one of the most important parts of SAP NetWeaver. It is an integrated development environment (it supports Java and ABAP programs), a modeling environment for user interfaces (Web Dynpro) and a tool to follow up all the information from the parts of a large program that is being developed by many people (Java Development Infrastructure). NetWeaver developer Studio helps developing applications such as Web Services and Web Dynpro Applications.

- **SAP Composite Application Framework**: It is a tool for creating new applications by combining organization’s existing services.

- **SAP Solution Manager**

So, SAP NetWeaver can be seen as a set of facilities constructed to work efficiently between them and that the main goals are to make applications work together, build new applications on top of existing ones, and lower the total costs of owning application.[20] Through SAP NetWeaver, SAP provided to organizations a well-done tool to make their work easier. But an important characteristic that makes MySAP ERP a revolutionary product is that SAP NetWeaver is a platform that supports the concept of SOA morphed into ESA (Enterprise Services architecture).

### 3.2 Web Service Technology for SAP NetWeaver

We have already enumerated the reasons for which Web Services represent the technology solution for the future of ERP systems. So now, we are going to see concretely, how an ERP system can work with Web Services. To illustrate this point mySAP ERP with its SAP NetWeaver technology has been chosen as a case study.

First, we have to get used with SAP’s nominations. Application services are Web Services that expose services from an engine or an enterprise application. These applications can perform actions like deleting an order from the CRM system, but they don’t need to be seen by the business user. To be displayed on a user interface they are grouped into enterprise services that are meaningful to the business user and reflect how a company thinks of its businesses. [20] “Enterprise services” is the name for services. They are technically based on Web service technology but they give a further vision by providing access to business content and functionality in business terms.[3] Finally SOA becomes Enterprise Services Architecture or ESA and represents the framework that organizes Web services into Enterprise services and application services, in order to make them useful for business activities. (See SOA architecture section 3.2.2) In other words ESA is SAP’s blueprint for helping developers design and implement their service-oriented business solutions. [21]

Still respecting the Web services paradigm, SAP ESA contains in its architecture a Web service Provider and a Web Service Consumer. To build and run these Web services SAP provided an application platform on top of which run all the components of SAP NetWeaver: the **SAP Web Application Server**. The Web service Consumer is represents by
the SAP Enterprise Portal on which the user interfaces are built. The figures 14 and 15 illustrate the structure of SAP ESA and the link between Web service Provider and Consumer.

**Figure 14: Providing Web Services on Open Standards [18]**

**Figure 15: Consuming Web services based on Open Standards [18]**

However, using Web Service technology is not enough, even if they carry out flexibility to MySAP ERP, the business users are not interested by how their system work in the back-end, how many engines are involved and so on, they care about the interface that permit them to interact with their system and if this interface allow them to get in an easier way and a acceptable delay the information they need for their work. That’s why the key to
making Enterprise services architecture work in practice is to have the best set of tools for taking advantage of Web services so that developers can create great user interfaces. [20]

To create these great user interfaces, SAP has provided among SAP NetWeaver components, the SAP Enterprise Portal.

### 3.3 SAP Enterprise Portal

![Figure 16: SAP Enterprise Portal architecture][18]

The portal is a control panel that brings in one point functionality from many different applications to help the user do his work. It can be a collaborative platform or a meeting room in which people share thoughts using instant messaging, discussion forums, Web presentation… It provides to customer updated product information and to suppliers a tool for planning their production according to customer demands. The portal is also a powerful development tool for developers; it allows engineers to create new composite applications by combining resources and applications. All the applications running on SAP Enterprise Portal are written in Java.

The portal can be seen as the visual interface between a user and all the fundamental applications and information an organization has put together to address business needs.

SAP EP represents the Presentation Layer of mySAP ERP. It permits to organize information in such way that they enable any user to make quick decision. This information is structured into role-based interfaces so each user can see only the information that is relevant for him or her. [20]

Actually, they are two ways to create user interfaces on SAP EP: either by developing new applications using SAP NetWeaver Developer Studio or by customizing user interfaces using predefined SAP Knowledge Management iViews templates.
3.3.1 SAP NetWeaver Developer Studio

SAP NetWeaver Developer Studio is a development environment for writing Java programs. Its purpose is to improve the productivity of developers and the quality of the code they write. For this, SAP has furnished three fundamental components:

- **Web Dynpro** is a modeling environment for creating user interfaces. In this environment developers design the interface of applications (creation of buttons, commands…) with the possibility to write less code, they can then spend less time fixing bugs and can change and customize user interfaces much more inexpensively.

- **The Java Dictionary** that keeps track of commonly used data types, for instance addresses, social security numbers, or phone numbers, and also database tables. This improves the reusability of codes and data used in different programs.

- **The Java development Infrastructure (JDI)** keeps track of the relationships between the different Web Dynpro applications composed by components. The source code and the relationships between these components are kept in a design-time repository and the SAP WAS which builds and runs them knows exactly what to build when a change is made. It is especially useful for the transport and the versioning of applications.

The process of integrating Web Services into the portal by using SAP NetWeaver Developer Studio is the following: first, the developers create Web Dynpro applications in which the user interfaces are designed, and then these applications will be transformed into Web services written in Java code. Finally, the SAP WAS will build, run and deploy these Web services and publish them in a UDDI that they can be accessed through the Web and on SAP portal. But to make Web services available on the portal, the developers must create Iviews in order to display them. The different steps of this process are drawn in the figure 17.

![Figure 17: process of integrating Web services with NetWeaver Developer Studio](image)

3.3.2 SAP Knowledge Management

SAP KM is a tool that offers to developers the possibility to customize user interfaces. For this SAP has provided pre-designed modules called iViews that avoid to create interfaces from scratch. This method is called the Flexible UI (User Interface) Technology and offers capabilities to adapt existing User Interfaces. Indeed iViews are small applications that compose a page in the SAP portal environment. They are tailored to the needs and the role of
the user and provide essential information and basic functionality. So for the customization
the developers just need to configure new iViews based on existing KM templates in order to
meet the user requirements. iViews interact with content management services, allowing users
to search, create, edit, view and deliver content through portal interfaces. All these services
are stored as Web services in the SAP WAS on which the SAP EP runs.

The WAS publishes all the existing Web services on an UDDI, then when a user wants
to achieve an action he called the corresponding page via its URL address. The UDDI then
displays on the page the corresponding WSDL that allows the user to interact directly with the
needed Web service. These Web services are called Content Management Services (CM
Services). So the advantage of SAP KM is that the developers skip the first parts of the
process drawn in figure 17. iViews can be seen as Web Dynpro applications that have been
developed by SAP developers and are made available on the portal through iViews templates.

Moreover for facilitating the access to these documents SAP Knowledge Management
offers capabilities to index, classify, navigate, search and publish all the documents produced
in the company and stored into KM repositories.

Classification is the system for organizing and identifying content so that users can
find it later. Classifying uses several systems calls taxonomies that help in structuring data in
ways that reflect how people think in a company so they can easily search and find particular
information.

Searching and Navigating is done thanks to a powerful indexing tool called TREX. The applications using TREX can access the TREX functions through the TREX clients that allow access to the TREX servers. TREX server also works as a service provider; it executes requests from the clients: it indexes and classifies documents and answers search queries. The following table (figure 18) enumerates the different functions available on SAP KM.
<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration of repositories</td>
<td>Information is typically stored in various types of repository such as file servers, groupware systems, or document management systems. Knowledge Management uses several preconfigured repository managers to integrate these repositories. The content is accessible through a central point: SAP EP. It is also possible to store documents in one of KM’s own repositories.</td>
</tr>
<tr>
<td>Navigation in folders</td>
<td>Portal users can navigate in folders and access the items in the folders of all integrated repositories in an iView in the same way as on a file server. Access to folders and documents is controlled using permissions. The user interface for navigating in folders can be configured flexibly and modified to suit various roles. Users can personalize the presentation of the user interface. Open interfaces allow developers to extend the user interface by integrating their own functions into the standard system, this operation is called customization.</td>
</tr>
<tr>
<td>Search</td>
<td>The search function helps find documents in all repositories integrated into Knowledge Management. The system displays only documents for which the current user has read permission in the results list. It is also possible to include the content of Web sites in the indexes using Web crawlers. This information is then also available via the search function in SAP Enterprise Portal.</td>
</tr>
<tr>
<td>Taxonomies and classification</td>
<td><strong>Taxonomy</strong> is a hierarchical structure of categories in which documents are classified according to content, organizational, or other criteria. Documents that are stored in different physical repositories can be included in the same category. Taxonomies portal users to navigate in a uniform structure throughout an organization even if information is stored in heterogeneous storage locations. After the initial configuration has taken place, the system automatically carries out classification of new and changed documents.</td>
</tr>
<tr>
<td>Content Management services</td>
<td><strong>Content Management services</strong> enable functions that can be used on the content of all connected repositories as long as technical conditions are met. These services include <em>subscriptions, ratings, public reviews, feedback, and personal notes</em>. Documents can also be imported into KM repositories from external sources by using the content exchange service.</td>
</tr>
<tr>
<td>Document creation and publishing</td>
<td>All portal users can create information in SAP Enterprise Portal as long as they have the appropriate permissions in the KM folder in question. A user can upload documents that he/her created using a PC application directly to a KM folder. He/her can also use forms to create information directly in the Web browser. The publishing process is supported by various functions such as the approval workflow.</td>
</tr>
</tbody>
</table>

*Figure 18: SAP KM functions*
4 Practical Part: SAP Customer Competence Center (SAP CCC) Project

4.1 Project Objectives

The objective of the project has been to rebuild the AIRBUS SAP Customer Competence Center web site (SAP CCC). The SAP CCC is an important Knowledge Base where are stored documents and information useful for SAP users (End-users and developers).

This rebuilt concerns several points:

- The improvement of existing functionalities, information circulation in order to make them clearer and easier to use.
- The use of new tools and new environment in order to improve the stability, the design and the maintenance of the web site.

The addition of new functionalities as a Search Tool also the creation of News and FAQ pages in order to get a more complete, dynamic and communicant web site.

Another important point is that today the wish of AIRBUS is to work in an easier way with its partners (customers and suppliers). Therefore the SAP CCC will be “opened” to the external partners who work for AIRBUS on projects concerning the integration of SAP solutions, particularly in order to make available rules and work processes advocated by AIRBUS.

A study about possible technological solutions has been made in order to achieve these objectives and to give to the end-users a product corresponding to their expectancies. The following sections concerned the different steps of the SAP CCC project, from the requirement specifications phase until the deployment phase. But before that let’s have a small look in the situation before the rebuild of the Web site.

4.2 Requirement Specifications phase

4.2.1 Description of the Former SAP CCC

AIRBUS SAP Customer Competence Center (SAP CCC) Website was actually reached through AIRBUS Portal (AIRBUS People) and was used for the consultation and the management of specific documents.

As we said before, SAP CCC is a Knowledge Base where the end-users and the developers can find helpful information for their development project and their activities related to SAP applications. It permits essentially to optimize the costs of the informatics projects by giving to the project teams the possibility to access to the right and necessary documents in a moderate delay.

There are two kinds of documents available on the web site:

- The General Information Documents: they contain diverse aspects related to SAP applications and the indicators for the performances and the statistics of different services.
The Sapnotes: they are a collection of best practices, processes, rules and standards applied for the different projects in accordance with the SAP environment constraints. These documents are, so far, created on SAP R/3 on PGI and follow a specific process that is not developed in this paper.

So far, SAP CCC was used for the publication and the consultation of these documents. The publication of these documents followed two different processes. The figure 19 shows us the former technical architecture of SAP CCC.

Based on the schema above we can see that in reality, the SAP CCC was a combination of two distinct web sites running on top of two web servers: a classical IIS (Internet Information Services) web server that permitted to display the principal site and the consultation of the general documents stored locally on the server; and an ITS server which allow the link with the Sapnotes present on SAP.

So, the Sapnotes are created on SAP and the ITS server “translates” the SAP interfaces in order to make them available on a web browser. Then when a user wanted to consult a Sapnote, the request was transmitted to the ITS server which linked the HTTP requests to SAP.

Concerning the Information documents they were edited by a manager locally on his machine and reachable by the users through an IIS server that made them available on the web site via a File Transfer Protocol (FTP). FTP is an open protocol for exchanging data.

The SAP CCC was developed using JSP technology. This technology uses HTML and Java languages and generates Java Server Pages, which were supported by the both web servers. The JSP Technology allowed the servers to link the user browsers to the different database in which the documents were stored. The IIS server provided by Windows possessed a JRUN module that helped in interpreting the Java pages. As for the ITS, it is provided by SAP. The IIS server was hosted on a non-maintained machine, which were non-referenced on AIRBUS Network and used an Operating System (Windows NT) that was not anymore used in the enterprise.
A general Use Case diagram was drawn in order to summarize the different functionalities offered to the end-users by the former SAP CCC.

![Former SAP CCC Use Cases diagram](image)

**Figure 20: Former SAPCCC Use Cases diagram**

### 4.2.2 New Requirements

For years the architecture presented above suited to the expectancies because it permitted to reach the needed information. Today reaching information is not sufficient; business people want also to work with welcoming interfaces what mainly includes a single user interface. They want to see a dashboard that helps them drive a process from beginning to end, without having to know how many different engines have to be implied.

To answer to these new exigencies it has been decided to rebuild the SAP CCC Web site such as users can all information via an only and unique interface. However the Customer Competence Center has to keep its original role of diffusing information to developers (project teams) and business users.

Furthermore end-users are waiting for new functionalities such as the management of the published data directly from the web site, a more powerful search tool with more options in order to get the wanted information in a shorter delay, News and FAQ pages for users.

These new expectancies lead on the review of the physical/technical and logical architecture of the web site and on the study about the most suitable technological solution in respect of AIRBUS volition to use standards offered by MySAP ERP.

#### 4.2.2.1 New SAP CCC physical and logical Architecture

To ensure transparency for the users, it seemed necessary to centralize the storage of documents then they can be reached through a unique server consequently via a unique interface. So it has been decided to replace the IIS and ITS servers by a unique Web Application Server (SAP WAS), which permits to create directly, web content on SAP’s portal (SAP Enterprise Portal) where the SAP CCC is hosted.
In another hand, the logical structure of the web site has been modified in order to propose new functionalities and a more efficient presentation and organization of the data. A search tool will be also available thanks to the KM module.

The SAP Enterprise Portal (SAP EP) runs exclusively on the SAP WAS and is written in a specific language: JAVA.

![Physical architecture of SAPCCC](image)

**Figure 21: Physical architecture of SAPCCC**

### 4.2.2.2 New SAP CCC Functionalities

The new SAP CCC will offer new functionalities in addition of the existing ones. So an administration interface will be available and also news and FAQ pages.

- **An administration interface**

  In order to be able to manage efficiently the Web site content (add, delete, create, modify… documents), it is necessary to have administration interface that will permit to an authenticated user (means that have access to the portal and who is associated to an administrator role) to manage the data used in the website.

  Contrary to the former SAP CCC, the new Web site enables the administration of the site directly through the portal.

- **A search tool**

  Thanks to TREX available on SAP KM the indexation of the repositories will be done in such a way that it will be now possible for the users to launch a multi-criteria search operation. So far, this action was available only for the Sapnotes but it will be extended to all the SAPCCC content (General Documents, FAQ, News…) Furthermore TREX allows a “full-
text” search like Google and so on. It will be also possible to launch specific searches for instance only for Sapnotes or General Documents.

- **News**

  In order to improve the diffusion of the information and to make the Web site more “communicative”, a page for News will be added to the SAPCCC. All the users that have access to the Web site can then see what new information is available, for example when a new Sapnote is published or modified or just for informing about any problem or new document of course all these information will be related to the Customer Competence Center activity. All the news will be archived and only the last ones will be directly displayed on the home page.

- **FAQ and How To**

  Still in the worry of allowing users to get the right information as fast as possible, the SAPCCC will propose an FAQ and an How To pages. The objective related to this is to give a better support to the users. Supporting users, actually, costs a lot to the Support Service because it implies SAP experts and a lost of time for retrieving the right answer to the questions, more it is often the same questions. The objective of creating these pages is to minimize the calls towards the Help Desk or in general the solicitation of the supports, key-users included.

  The FAQ will provide an answer to frequently questions about particular problems. It is useful particularly for development teams and business teams.

  The following schema shows the former support process:
4.3 Technological Solution

The company purchased mySAP ERP and the SAPCCC will be hosted on the SAP Enterprise Portal (SAP EP).

There are actually two ways to put content on the SAP Portal either by Customizing thanks to SAP Knowledge Management (SAP KM) or by specific development thanks to different tools such as: Web Dynpro for Java, Web Dynpro for ABAP, BSP, J2EE, and Mobile developments.

After studying both solutions, we decided to realize the new web site by using only the Knowledge Management (KM) module proposed by SAP Enterprise Portal (SAP EP). First, KM will permit to avoid specific development and to use only SAP standards. Indeed, the volition of the company to use the standards offered by SAP lead us to study more deeply the possibilities offered by the SAP EP and in another hand specific developments are done outside Airbus by consulting companies. Secondly, KM will provide an efficient Search Tool thanks to TREX that is a powerful tool allowing the indexation of all the KM repositories and enabling the user to launch “Full-Text” searching.

So, SAP KM has been chosen to achieve the project because it respects all the SAP standards and also because it offers a very efficient Search tool. This search tool is very important in the way that it will permit to users to reach the right information in a really good delay. In another hand, using SAP standards will make easier the maintenance of the website then any future person that will be in charge of this function will not have to deal with any particular code and as all.

However, one of the constraints was to keep identical the creation and validation processes of the Sapnotes. This is due to the fact that these processes require a specific transaction of which the change will be too important for the users. So the Sapnotes will be still created and validated on PGI but thanks to KM the documents will be transferred, using a RCP UNIX command, on a KM repository created for storing all the data used in SAP CCC.

To summarize, SAP CCC is hosted on SAP EP, and has been built by doing a customization thanks to SAP KM module. To create content with SAP KM, we used standard iViews templates provided by SAP this technique is called Flexible UI (User Interface) technology. The management and the consultation of documents are done thanks to KM features and the Sapnotes Search process is now performed thanks to an indexation with TREX. According to this solution we drew the new SAPCCC architecture presented on the figure 22:
The user requirements analysis and the chosen technological solution lead us to the design of the new SAPCCC user interface. So the following sections will presents the different modeling diagrams on which will be based the customization of the web site.

4.4 Design phase

This phase is concerned by the modeling of the requirements listen the section before. Models were drawn thanks to UML. These models are presented in the appendices. You will see three kinds of diagrams: the Use case diagram of the system, several Sequence diagrams in which the interactions between the different elements are showed and finally the Class diagram.

4.5 Development Phase

The development phase is composed by two parts: the customization of the user interface and the transfer of Sapnotes and information documents from the documentary database in PGI to the KM repository (Z_XGA_F320), as shown on the figure 22.
4.5.1 Customization with SAP KM

Customizing signifies build user interfaces that meet user requirements. It concerns the creation and the organization of content on the SAP EP. In fact, SAPCCC is a web application hosted on the portal and composed by several pages built thanks to standard iViews furnished by SAP KM. The aim is to configure these iViews in order to create an interface that reaches the requirements and thanks to the capabilities offered by the Flexible UI technology.

The flexible UI framework enables the navigation through KM repositories to be represented in many different ways on the user interface. To access items in a repository, users use a browse iView that can be displayed in different ways depending on three criteria:

- The role of the user
- The resource and the folders that are displayed
- The commands that are available for displayed items

To present iViews in different ways we use renderer and layout service packages that help create screen areas that suit different individuals. Customizing interfaces that reach the users requirements pass by different steps illustrated by the figure 23:

1. First the developer creates a new iView in the portal content. This iView is chosen among the different KM iViews templates available. The iView is just the browse that will display the interface; so when the template is chosen and added with a unique ID then the configuration of the interface strictly speaking can start.

2. The second step is the display of a specific resource; to do this the developer creates a Resource Renderer. The Resource Renderer may contain commands necessary for a user; an example will be show later. A command is a Java class that encapsulates an action for one or more items. It contains the data on how to present this action to the user including the whole screen flow needed for it. These commands can also be
grouped into sets called Commands Groups that belong to the Collection Renderer parameters.

3. The resource Renderer is followed by the creation of the Collection Renderer that renders a list of resources in different layouts. It contains a Resource Renderer.

4. And finally the developer builds the Layout Controller also called “Layout Set” defines the visible areas displayed in the navigation iView (see figure 24). These areas are all hard coded in each Java implementation class. The Resource and Collection Renderers created in the preceding steps are used to render the content of each area displayed within the Layout controller. For each area a flavor is defined. A flavor is used to assign a Renderer to a specific area in the layout.

5. The Layout set is then added to the iView parameters. Another important point is the folder where the resources are stored. Indeed, an iView point on a specific folder to display the resources that must be displayed.

6. To finish iViews can be organized into Pages that can also, in their turn, be grouped in Worksets. In the page the developer draw the repartition of the data on the user screen. Once the iViews created and organized the developer needs to define the Roles corresponding to the different categories of users. The definition of a role permits to characterize which resources are accessible by which group of users, in other words it specifies the users’ access rights. Thus only the webmasters can modify the content of the Web site.

![Figure 24: the basic components of a user interface.](image)

In the SAPCCC project the customization concerns the four principal modules of the Web site: the Information Documents, the Sapnotes, the Search tool, the News and the FAQ.
You will find in the appendixes section, several screen views of these modules and a complete example of the configuration of a particular User Interface.

4.5.1.1 Information Documents Consultation UI

This module enables end-users to consult the information documents available on the Web site. For an efficient consultation the documents will be organized into categories by the Webmasters. Also for each document a descriptive text is created and displayed to help the users during their navigation. The users can open a document in a different browser just by clicking on it and each document is opened in a different tab.

We configured a KM Navigation iView for creating this module. The user interacts with the iView through a page that display it. However, in order to help the users get the documents they need more quickly we created a Search iView only for the Information Documents. The Search Iview appears as a link on the Document Information Consultation page.

4.5.1.2 Sapnotes Consultation UI

This module has the same role than the one for the Information Documents. But the documents are not grouped in categories because of the way the files have been organized on the original UNIX server held on PGI. It is also built from a KM Navigation iView and contains a link for the users to search for Sapnotes only.

4.5.1.3 News and FAQ UI

An important point is that so far only News UI has been developed during the thesis work. The News module is important because it improves the circulation of the information. They inform the users about any modification that occurs, for instance if a new Sapnote or Information is uploaded or a new version of a document is available, also if a functional problem occurs.

The News UI is not built by the same manner than the other modules of the Web site. Indeed to create the News and FAQ UIs we used forms built thanks to XML Forms Builder. The forms contain data stored into XML elements belonging to a XML data schema.

XML Forms Builder allows developers to create forms for form-based publishing according to the user requirements. [22]

“The Form-based publishing is a Content Management application that furnishes a simple way to create and publish similarly structured XML documents with HTML forms”. [23] The News files are stored in the KM repository (Z_xGA_F320) as XML documents, but are edited and viewed in the browser using HTML forms. The transformations between XML and HTML are based on XSL stylesheets that define which transformations to perform and how to render the document content in HTML. The advantages of this solution are:

- The separation between the layout and the content
- The possibility of presenting in different ways a same content using different XSL stylesheets
- The option of making browser/client specific modifications.

To summarize before the creation of the UI we create first different XML forms with the XML forms Builder.
• **News Consultation UI**

The forms needed for the consultation of the News are:

- The **RenderList form**: this form is used to define the layout of a list entry in the flexible UI. It displays some of the elements of a document, namely in our case, the title, the date and the summary or description of a News item. To display an item the user just clicks on the title; this action call up the **Show form**.

- The **Show form**: it is called up when a user wants to display an entire News item. So this form presents the title, the news text, the author, the date, and the links for more readings.

Once the forms created, we need to display them on a UI then they can be accessed by the end-users. For this we used a KM Navigation iView and “NewsBrowser” as a Layout set. “NewsBrowser” is a standard SAP layout it has been developed by SAP developers and made available in the Content Management repository. It displays the **RenderList form** without any commands then the end-users can’t modify the items. The appendix 16 shows us the different forms and the Navigation iView.

• **News Management UI**

This UI is accessible only by the Administrators. It allows them to create, delete, and edit items. The forms needed for the management of the news are:

- The RenderList form: it displays the same elements than for the Consultation UI the only difference is that some commands are displayed on the Navigation iView. For this we used the “NewsExplorer” layout set in which we add commands as edit, delete, create a new News item

- The Edit form: it is called by the command “new News” or “edit” (see appendix 16)

Concerning the FAQ only the processes have been modeled, a report concerning the UML models and the administration processes.

4.5.1.4 **Information Management UI**

This part of the site is also available only for the administrators. It is the UI through which they organize the structure of the Web site and to add content.

All the files used in the SAPCCC are stored into a specific repository that has been created just for the project: Z_xGA_F320 (the “x” depends on the environment on which we are working: development, integration and production). The files are grouped in folders and each folder is normally related to an iView. The layout set “AdminExplorer” allows the administrator to copy/paste, move, and create…a folder

For adding content we configured an “Upload” iView which permits to load documents in the KM repository. The process is described by the sequence diagram “Upload a document” (See appendix 1).

4.5.1.5 **Sapnotes Management UI**

As we said some sections above, the process of creating Sapnote will not be changed because of different constraints. According to this, the solution that has been found is to relate the new SAPCCC with the former one. For that we configured a KM Transaction iView which will permit to the administrator to connect directly to SAP R/3 through the portal. Then he can manage the creation of the documents via its SAPCCC administration interface. (See appendix 3)
4.5.1.6 Search UI

The Search tool is one of the most important parts of the Web site. It is used by both the end-users and the administrators. We configured a Search iView to create it. Several options are presented to the users then they can launch a search with more details. The search is a text full search. A TREX index has been created, in another hand we configured two more search iViews: the “Sapnotes Searching” and the “information documents Searching”, the characteristic of these iViews is that they pointed only towards the folders that contains the Sapnotes and the information Documents.

4.5.2 Documents Transfer Process

The documents transfer represents the second part of the development phase. Indeed as we explained earlier the Sapnotes and the Documents Information are stored in PGI. Therefore, in order to make them available on the portal, we have to load them in the KM repository created for the project. (See figure 22)

Concerning the Documents Information they have been loaded one by one thanks to the Upload iView. But this method could not be applied to the Sapnotes because only the last validated version of each Sapnote file has to be published on SAPCCC and the large number of files didn’t allow loading them one by one. So to load them we have, at the least for the first time, to transfer all the files present on PGI.

The solution that has been found is to develop a specific ABAP program that executes UNIX Commands in order to collect all the Sapnotes Files in a table in SAP. Indeed the files are actually stored in a UNIX repository, so we first transfer them to SAP where they are stored in a table. The last versions of each Sapnote are then selected and copy into a text file. This file is stored in a temporary repository in SAP. Then a UNIX Script using the RCP command permits to download the selected files from the temporary SAP repository to the KM repository. Once the files loaded in the targeted KM repository, the portal automatically index them (indexers have been already created).

4.6 Tests and deployment Phases

After we created all the necessary User Interfaces and loaded the documents from PGI. We did different tests to be sure that everything is working well. The tests have been done mainly by the current Webmaster.

The deployment of the Web site has been done but for a beginning we deployed it only for internal users. This can be seen also as a test phase because it will permit to correct some elements before making the Web site available for the external users.
5 Discussion and Evaluation

In this section we are going to discuss the differences between traditional ERP systems and Web-based ERP systems through concrete examples taken from our practical experience during the realization of the SAPCCC project. For this we will based our evaluation on the different characteristics presented in the table of the section 2.3 and reminded below:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Traditional Solution</th>
<th>Web Service Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scalability</td>
<td>Low</td>
<td>Very High</td>
</tr>
<tr>
<td>Time Frame for implementation</td>
<td>Very High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Maintainability</td>
<td>Low</td>
<td>Very High</td>
</tr>
<tr>
<td>Reliability</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Portability</td>
<td>Low</td>
<td>Very High</td>
</tr>
<tr>
<td>Cost to Enter</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Cost to Maintain</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Total Cost of Ownership</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>ROI</td>
<td>Moderate</td>
<td>Very High</td>
</tr>
</tbody>
</table>

We will give some examples concerning the most representing characteristics:

**Reliability:** The reliability of the SAPCCC has raised a lot. ESA permits to separate the server side from the user interface that leads on improving the access to the information. The users interact only with the Web service Consumer that, talks to the Web service Provider giving then a better use of the resources and a faster access to the information. Furthermore, TREX gives a better search tool improved by the direct indexation of KM repositories.

**Maintainability:** by implementing the SAPCCC on SAP EP we have facilitated its maintainability. Indeed the content of the web site can be modified more easily because by using services it is no more necessary to modify the code to add new functionalities. If, for instance, the needs require the addition of new commands, the Webmaster can add these commands directly on the corresponding services accessible on the CM repository and these modifications will not have any impact on the system.

**Scalability:** Like for maintainability, the system became more scalable; the addition of new commands or new iViews change nothing to the architecture of SAPCCC or on the performance of the Web site and this doesn’t imply to touch the Web services provider’s code.

**Portability:** By separating the interface to the implementation, we have made the site completely independent of the material environment. Any change can be made in the material architecture, for example we had once got a new version of the TREX indexes, by recreating the indexes, and we just had to modify the name of the index in the search iView configuration to make it work normally.
**Cost of ownership:** The cost of ownership is really low compared to traditional ERP systems. The SAP WAS provides comprehensive management for all aspects of the Web site life cycle. Capabilities for change management, monitoring, and administration support help controlling the deployment and the modification of the different functionalities.

**Openness:** This characteristic is something particular to mySAP ERP compared to the other Web-based ERP systems currently in the market; the SAP WAS is fully J2EE compliant so in addition of ABAP the Web services can be developed in Java language. In another hand, SAP WAS fully embraces all leading open Internet Technology standards and Web services.

### 6 Conclusion

The conclusion will permit us to check if our research questions asked in the Introduction (section 1.1) have found an answer:

- **How Web Services are integrated into ERP?**

  The integration of Web services into ERP systems are mainly done by using a Service-Oriented Architecture that helps improve the interoperability of different services in order to make them communicate in an easier way. SOA use a Web Application Server in order to build, run, and deploy these Web services through the Web making them available to every authenticated user from his/her original application.

- **What additional values do Web Services bring to traditional ERP systems?**

  The different values bring by Web service Technology is presented in the comparison table between traditional ERPs and Web-based ERPs (section 2.3). In the section above (section 5) we confronted the characteristics presented in that table with the observations from our practical experience and it appeared clearer that Web services have several positive points for ERPs. We talked in the beginning of this paper that one of the current objectives of organizations is to make economies; by adopting Web-based ERPs the cost of ownership is lower and the ROI of these systems is much higher because of the less code and development needed for integrating the different systems. Also with Web ERPs, companies spend less money in training their employees and less time in implementing the system. Furthermore as described above, reliability, scalability, and portability are improved and the maintainability of all the applications of the system becomes much easier.

  Beyond all the theoretical study, this final thesis project has been above all, an opportunity to work concretely on a Web-based ERP. The SAPCCC project permitted me to understand in a better way how web services are integrated into ERP systems and how they can help in integrating different applications. I had the possibility to talk with some developers that explained me in which way Web services make the job easier for them. Indeed, with Web services technology they spend less time in customizing interfaces for users, because now any user can, from the application he/her works on, interact with any application held on the ERP system. From the managers point of view these systems help do economies and give a better customer satisfaction. And from the end-users’ point of view they don’t have to change their methods of work because they still keep the applications they are used with.

  As a developer I built an application that will be used by internal and external AIRBUS users from their own applications. So I could say that Web service technology help in realizing this aim. The approach used in implementing the new SAPCCC is innovating in the way that all the modules can now be reached by external users through the Web. Indeed, the iViews are Web services with a unique URL for each of them and any authenticated user...
can from any application located in any platform reach the SAPCCC. For instance, some internal users working with another application have had the access to the Sapnotes Consultation UI of the SAPCCC. For that we furnished to developers of that application, called PM Toolkit, the URL of the Sapnotes Consultation UI with which they create a direct link on their application.

To finish this project help me in working on all the part of a project, from the requirements specification to the deployment phase.
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8 Appendices

Appendix 1: SAPCCC Use Case diagram

The use cases are grouped into three groups:

- The group concerning the Sapnotes and The information Documents because the users interact with the Web site in the same way when they are working with them.
- The Sapnotes because with the new Web site the administrators can create and validate directly the documents. SAP R/3 is accessible through the portal thanks to an iView that permits to link the both applications.
- The group concerning the News and the FAQ.
Appendix 2: Sequence diagram: Upload a document

Upload a document

Adminstrator

: browse()

Find(filename, location)
Appendix 3: Sequence diagram: Create a Sapnote

Create a Sapnote

Appendix 4: Sequence diagram: Search for a document existing in the KM repository

: Administrator

: Sapnote Admin
From the search iView the user can launch a full text search and it is also possible to choose options search.
Appendix 5: Sequence diagram: Add a new folder in the Repository.
This operation is necessary to organize the files and is necessary when configuring an iView, especially Navigation iViews.
Appendix 6: Sequence diagram: Consult News or FAQ items.
Appendix 7: Sequence diagram: Create a News item
Create a News Item

Create new NewsItem()

Capture data(title, date, author, newstext, links)

Preview item ()

Open News EditForm display

News EditForm display
Appendix 8: Sequence diagram: Delete a News or FAQ item
Delete an item (FAQ or News)

Administrator

Open itemsList()

Delete item (item)

Confirm deletion (item)

: Admin FAQ/News View

Display list

Ok
Appendix 9: Sequence diagram: Create a New FAQ item

This sequence is different with the one for the News items because creating an FAQ item means give an answer to a question that has been proposed often. For this a special form: the ListEdit Form is available for them in which they can filled their questions. This list will be consulted by the administrators and they will choose the consistent ones and then give an answer by using the Edit form.
Create new FAQ entry

Administrator

Admin FAQ Iview

Open queue

Display list of questions()

List displayed

[If new question] Select (question)

Edit item()
Appendix 10: Sequence diagram: Propose a question to the Webmaster through the FAQ UI
As we explained in the appendix 9, the users can propose questions in they don’t find an answer in the FAQ UI.
Propose a Question

User

User FAQ Iview

Open itemsList()

Display list of items()

[If item not found! Add new question()]

Edit question ()

Open ListQuestion

ListEditForm displayed

RenderListForm
Appendix 11: SAPCCC Class diagram
Appendix 12: SAPCCC Welcome Page. It is composed by two iViews: the News and the Remarks.
Appendix 13: Sapnotes UI
Appendix 14: Search UI.

In this page are displayed the results of a search. You have a summary of each document done automatically, the tool also proposes to the user related expressions for a more targeted search.
Appendix 15: Sapnote Management UI
Appendix 16: Components of the News UI

- The Edit Form
• XML Forms Builder: the design of the different forms (Edit, RenderList, Show)
Appendix 17: Information Management UI and the components of the UI (layout controller, resource and collection renderer, commands)
Layout Set - AdminExplorer

Menu path: System Admin -> System Configuration -> Knowledge Management -> Configuration -> Content Management -> User Interface -> Settings

View "AdminExplorer"

<table>
<thead>
<tr>
<th>Collection Renderer</th>
<th>name</th>
</tr>
</thead>
<tbody>
<tr>
<td>AdminDirectory</td>
<td>AdminCollectionListRenderer</td>
</tr>
<tr>
<td>AdminDirectory</td>
<td>AdminCollectionTreeRenderer</td>
</tr>
<tr>
<td>AdminDirectory</td>
<td>AdminMenu</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resource Renderer</th>
<th>name</th>
</tr>
</thead>
<tbody>
<tr>
<td>AdminDirectory</td>
<td>AdminResourceRenderer</td>
</tr>
</tbody>
</table>

| Commands for Details Menu | | |
|---------------------------|--|
| DetailsGroup              | |

<table>
<thead>
<tr>
<th>Layout Controller</th>
<th>AdminNavigationLayoutController</th>
</tr>
</thead>
</table>

Edit Close
Layout Controller: AdministrationNavigationLayoutControllerCollection

Collection Renderers: AdminMenu, AdminBreadcrumb, AdminCollectionTreeRenderer, and AdminCollectionListRenderer.
Resource Renderer - AdminResourceRenderer

Displays single resources
Customer specific CommandGroup where Delete, Feedback (show and give) and Online Edit should be shown

Assign this CommandGroup to your ResourceRenderer