UNIVERSITY OF LJUBLJANA
FACULTY OF ECONOMICS

# DIPLOMA THESIS

## Business evaluation of Enterprise Application Integration:

## The Case of Daimler AG

Ljubljana, April 2009 MATEJA KERAVICA

**DECLARATION**

I, Mateja Keravica, herebey declerate that I am the author of this undergraduated thesis written under the menthorship of mag. Petra Baloha. I permit the publication of this thesis on the faculty's web pages.

In Ljubljani, _10. April 2009_________ Signature: Mateja Keravica

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# INTRODUCTION

Rapidly changing environment and worldwide globalisation force companies to create flexible business processes and remain competitive. New applications and new technologies set challenges to leverage legacy systems and make even more data available to end users or customers. The pressure has increased; therefore organisations try to share real-time data within organisation, with customers, partners and suppliers to maintain competitiveness, to drive out inefficiencies, and to reduce costs. The technology has reached the point where the focus is not only on the developing part of information system but also on integration part of information system, to integrate multiple applications, data sources and human resources to provide the necessary information and transaction processing for effective decision making process. Information systems and applications that organisations have already implemented have contributed to better data and information management. Diversity of applications implemented in different time period by diverse vendors brought problems like heterogeneity of systems, islands of information and spaghetti structure of integrated applications. Big enterprise systems like ERP, SCM, CRM should be seamlessly integrated with other applications to work efficient. Integration of such enterprise systems with other applications and legacy systems are very complex that costs a lot of time and money. To stimulate communication between applications it creates a need for separate information system integration and exchange of information. Consequently appear need for *Enterprise Application Integration*, the technology that enables standardise communication between applications and information systems and helps to overcome mentioned problems.

The purpose of the thesis is to provide guide-lines for companies when trying to integrate applications across enterprise. Present the essence of Enterprise Application Integration and indicate benefits and risks that can occur. Moreover, the thesis present various levels of integration and architecture topologies that companies could adopt in order to resolve their dilemmas, it exposes the importance of information technology economics, represent evaluation methodologies and determines under which terms companies should apply enterprise application integration. Thus it answers “what”, “how” and “how much” questions that any company possess to itself when considering enterprise application integration.

The goal of the thesis is to propose appropriate EAI topology for a real world organisation. The proposition will result from thorough analysis of the company’s situation and from an assessment of chosen topology from the architectural and cost-benefit standpoints.

This thesis consists of two separate elements; the theoretical part and the case study. The former element will explain and clarify the “what”, “how” and “how much” questions. The importance of information technology in organisations and which the definition of the EAI rises with its pros and cons will respond to the questions of “what” companies are trying to achieve, “what” problems they are facing with and present a suitable solution. Answers on “how” to manage problems and “how” to implement EAI technology will provide an architectural standpoint, where EAI topologies will be presented. Financially feasibility of a project will be evaluated with the help of evaluation methodologies and estimate EAI project from a financial standpoint to answer question “how much”. The letter part of the thesis will be presented through a case study of a real EAI project of Daimler AG. Here the scenario follows the logical outline of the theoretical element and questions such as “what”, “how” and “how much” are answered from a particular organizational standpoint. The case of Daimler AG tries to solve the problems of the EAI, how the EAI technology should be realized from an architectural standpoint, and how high the economic value of the EAI would amount to. The final focus of the thesis will present a discussion of resolution which topology based on architectural and cost-benefit standpoints is convenient for the company and why.

# I ENTERPRISE APPLICATION INTEGRATION

## 1 IT IN ORGANISATION

Usage of information technology (hereinafter, IT) is present in every company; there is no area of business where personal computers would not play an important role. With the help of IT we can achieve greater flexibility, broaden the scope of research and narrow the time required for a particular task. Moreover, these elements will also ensure a better relationship with the customers and a reduction of stock and labour which enables a consistent flow of information on the organisational level which also contributes to the fact that we have to deal with a bigger flow of information and data (Gradišar, 2003, 3-10).

The Gartner Group survey revealed that the most important business issues of 2004 were as following: retaining loyal customers, improving productivity, cutting costs, increasing market share, providing timely organisational response and technology (Chang, 2005, 22). As presented in the survey the organisational, environmental and technological factors are changing quickly and unpredictably. These changes are creating a highly competitive business environment where organisations have to deal with and respond to pressures from the business environment. IT represents support that helps organisations to deal with these issues and organisations can respond and react quickly to these problems or opportunities (Turban et al., 2006, 12).

The Porter’s value chain model (see appendix 1) illustrates how IT supports organisational activities in enterprises as he divides organizations into two parts; primary activities and support activities. **Primary activities** are those through which produce the company’s products, such as; inbound logistics, operations, outbound logistics, marketing & sales, and services. The ultimate goal of primary activities is to make a profit for the company and the primary activities could be sustained and supported with single or plural support activities.

**Support activities** are; administrative/finance infrastructure, human resource management (hereinafter HRM), technology & development, and procurement where IT is placed under technology & development activity (Turban et al., 2006, 44-46).

## 1.1 IT support to individuals and processes in companies

IT represents support for organisations and their primary activities on the way to realising business strategies. IT, as a support activity is not only supportive to primary activities, but also to information, individuals or employees and business processes that collaborate with one another. For example, employees and business processes operate with information. There is a variety of applications and Information Systems (hereinafter IS) that are used for gathering, saving, processing, maintaining, employment, disposition and analysing the information that could be used in individual intention or in the management of business processes (Turban et al., 2006, 20-25). With other words IS help employees by easing and fulfilling their obligations at work and support managing of business processes. Because we differ between IS that support individuals at their work and IS that support business processes we will review them separately.

### 1.1.1 IT support to Individuals

IT as supporting tool for individuals supports employees and managers in decision making process and has impact on their work. Since IT is present the working habits have changed, the paper work has reduced. It helps individuals to raise their productivity of work, to work faster and to be able to deal with bigger amount of information. With the presence of internet communication has no border where even more information is on the reach beside more flexible form of work called telecommuting appeared**. Telecommuting** is outside the office arrangement that is flexible in working location and hours, from home or train, any time where employees can contribute their input. From psychological aspect telecommuting can lead to loss of social contact with other colleges and feeling of loneliness (Turban et al., 2006, 693-694)

IT as support activity brings some drawbacks as a consequence of increased productivity; it sets higher expectations that employees have to achieve. Greater pressure on the worker may cause frustration and an inability to keep up with the amount of data or so called information flood. It is because of this enormous amount of information, that it is hard to process and keep up-to-date and due to this a further frustration may arise, the frustration of the quality of data. Constant work behind a computer can bring a negative impact on health and safety of the individuals, job stress, risk of radiation exposure, strain injuries as backache or muscle tension in wrists and fingers are factors that can affect each individual. Managers should pay attention and organise different training programs for employees and try to assure that health and safety regulations are met when working on which simultaneously creates a good corporate climate. The frustrations of information flood and the quality of data mentioned above can overcome different IS that support employees and managers in selecting the right data making analysis that can contribute to better decision making (Turban et al., 2006, 696-702). There are some IS solutions on managerial levels that support managers by making important decisions for organisations; *Decision Support System* (DSS) supports decision making process through the enterprise managers. *Knowledge Management* (KM) supports knowledge creation, storage, transportation and maintenance through the organisation, *Business Intelligence* (BI) that is used for analysing, forecasting, evaluating risk and performance done by managers and personal (Turban et al., 2006, 296).

### 1.1.2 IT support to business processes in organisations

In an organisation a variety of complex business processes and different activities are running that need to cooperate. In big organisations there is an enormous amount of information that has to be kept up to date and shared for business intention. Usually, big organisations are separated into smaller units, which represent a inflexibility in the case of integration therefore, there is an inability to adopt changes in accordance to the quick changes of the market. It is very important that organisations do not just implement any IT solution but the right strategic IT solution regardless of the size of the company.

Organisations have implemented several IS in different departments of; logistics, operation/production, finance, accounting, marketing & sales, human resources, over the whole value chain, to support them and to organise, operate and manage information and data more efficiently, to make more efficient analysis and to help in a decision making process. Business activities do not run only within the organisation but also outside of the organisation. In order of the intention of companies, to work closely with their business partners as suppliers and the intention of meeting expectations of their customers, companies must adopted different forms of business like E-Business that enables the linking of internal and external data processing system. With E-business, companies realize orders electronically, handle customer services, cooperate with business partners, realise electronic purchasing and supply chain management much easier than without it (Turban et al., 2006, 139-141).

Business processes that are running in organisations can be supported with different information systems and applications. The major enterprise system solutions are ***Enterprise Resource Planning*** (ERP) that manages planning, organizing, coordinating and controlling information, in supply chain helps to manage internal and external relationship with the business partner. ***Supply Chain Management*** (SCM) manages manufacturing, inventory control, scheduling and transportation of information. It helps in decision making of the internal segments and to their relationship with the external segments. There are some other, supportive IS solutions ***Transaction Processing System*** (TPS) supports monitoring, collection, processing and dissemination which is used for internal operations of the organisation, ***Customer Relationship Management*** (CRM) which provides customer care, or ***Partner Relationship Management*** (PRM) that provides care for business partners. As enterprises are cooperating with business partners, they want to be closely connected with them therefore there is another supportive IS solution ***Enterprise Data Interchange*** (EDI) that supports cooperation and communication outside enterprise with other partner organisations (Turban et al., 2006, 296-318). During the last decade more and more business processes have been supported with standard IS solutions like ERP, SCM and other systems mentioned above. Scheer describes these standard solutions as best practice solutions that assure efficiency of business processes, but to assure competitive edge enterprises should implement a new practice that is flexible and cost acceptable (2004, 5-7). Therefore IT development is moving in direction of application integration.

In the following chapter we will examine what motivates managers to integrate applications. We will look at what problems managers are facing with, what EAI technology is, the pros and cons of it and what managers can achieve with different integration levels. Within this chapter we will complete and answer the "what" question that company asks when looking into the EAI area.

# 2 EAI AS A BUSINESS SOLUTION

## 2.1 Problem Discussion

Organisations are forced to be flexible and respond rapidly to the changing market environment, keeping competitive edge and deal with the real-time operations. Big organisations deal with large amounts of information and diverse IS therefore they need more time to adapt to changes on the market and follow technical trends. Executives expect faster return to investments and wish to create manageable long-lasting architecture. Many organisations have already implemented various applications that contribute to better data and information management, but constantly changing environment and new trends require constant adaptation to this environment. Stokes claims that, in order to achieve 21st century competitiveness, an organisation's core business applications such as ERP, SCM and the legacy systems must be seamlessly integrated with CRM and web-based portal applications that provide outward facing connectivity to suppliers, partners and customers (pg. 2).

In order to build seamless integrations between systems is rather complex, enterprises face diverse problems. Through generations of technology in large organisations applications have been developed separately at different time by different vendors. Therefore enterprises system landscape are typically comprised of thousands of applications that are custom build, acquired from third parties or are part of a legacy system operating in multiple tires of diverse operational systems (Hohpe & Woolf, 2007, 1-4). Each application uses different computer language, different database technologies which is supported through different operational systems, and operates on different hardware platforms. All of these elements represent the problem of **heterogeneity** which makes applications incompatible and unable to communicate, share business rules or information (Conrad, 2006, 22-23). A further negligence is the quickly changing technology and trends that are bringing on the market new applications. As Linthicum mention "management-by magazine" is often provided by organisations, when the coolest technology is implement or popular software is placed regardless of how well does it fits the process, rather than to take a business-driven decisions (Linthicum, 2000, 7).

Certainly these applications and software solutions work well individually but they create **Islands of Information** or **information silos**, which is an inability to exchange information with other related systems within the individual organisation. The constant pressure on IT departments to change the old systems and build seamless bridges to join applications seems grand. Users often find manual ways to communicate with different systems which consequently causes movement of information between the key systems. As a result when common data changes the updates that are done manually in different systems will lead to double data entry and eventually some of the data will became inconsistent and overlap (Kumar, 2007). Enterprises get into such a mess for two different reasons. Firstly it is hard to write applications especially creating large application that can cover all processes in enterprise it is next to impossible. And secondly, this problem of spreading business functions across multiple applications and their flexibility to select the best package solution for its needs (Hohpe & Woolf, 2007, 1-4).

The problems do not only appear when data needs to be exchanged within enterprises, but also between business processes. Enterprises are collaborating with their supplier, business partners and customers where communication and exchange of information is required. Integrating with business partners and suppliers over the internet is called E-business. **E-business** is mostly known in two forms as business-to-business (hereinafter B2B) including supply chain integration and business-to-customers (hereinafter B2C) including internet commerce which means sharing information externally through dissimilar business processes of one or more companies. In adopting standards from other companies the other company has to agree to this adopting of standards. Therefore a need to have an open business processes arise and integrated value chains such as supply chain and the ability to work as a single company with integrated processes of partner's companies ( Turban et al., 139-140). Another international problem is integrating new applications with existing applications to improve efficiency. Already existing applications as ERP work effectively if they are connected with other applications as well as CRM and SCM can assure greater customer focus if they are integrated rather than standing alone (Linthicum, 2000, pg. 10-15).

Problems also occur also within the integrated system landscape where the majority of enterprises have integrated their IS with traditional technology like point-to-point architecture that creates single links between applications. This technology is easily managed with integrating few applications, but additional applications demand to build additional connections which can grow so complex that they become unmanageable (Linthicum, 2000, 8). The presence of many applications with the above mentioned solution can create a spaghetti structure (see appendix 2) where the maintenance of the structure is extremely expensive. The point-to-point that is usually obtained in medium sized and large companies forms thousand of interfaces between applications that need to be developed and maintained. One of the main and current issues for information management is the complexity of linking all applications, as high development and maintenance costs. The most apparent approach to reduce the number of interfaces between applications is the implementation of the integration system (Schelp & Winter, 2006, 22). The integration system is a technology that enables to link all the described concerns with integration of several applications on different integration levels with different integration topologies called enterprise application integration.

Therefore the problems, that manager are dealing with and what do they want to achieve with, integration technology has been dealt with. As following the solution for the described difficulties will be presented and reviewed. In the next chapter we will look at what the enterprise application integration enables, what range can overcome mentioned problems, and what companies can achieve with EAI as regards to the levels of integration. This explains the "what" questions that companies poses when applying EAI.

## 2.2 Enterprise Application Integration

Enterprise application integration (hereinafter EAI) is an integration system that represents a solution to the above discussed problem, such as issues of integrating heterogeneous system landscape and information silos, connecting business processes within an enterprise, and reducing the complexity and costs of traditional integration approaches. Linthicum defines EAI as "unrestricted sharing of data and business processes among any connected application and data sources in the enterprise". It is a set of technologies that allow the movement and exchange of information between different application and business processes within and between organisations (2000, 3). The EAI is an integrating approach that connects applications, platforms and databases to enable secure enterprise collaboration. With the EAI solution organisation is able to integrate business processes internally and externally, with business partners and clients creating dynamic global organisation. In enterprises, multiple independently developed applications and data sources are integrated without making major changes to applications or data structure using incompatible technologies into a single system where information flow runs smoothly (Goldstone technologies, 3). The goal that the EAI helps to achieve is a reduction of unavoidable multitude of direct interfaces between applications through adapters that form connections between applications and platform (Schelp & Winter, 2006, 23).

Stokes says "the goal of EAI is to integrate and streamline business processes across different applications and business units while allowing employees, decision makers and business partners to rapidly access corporate and customer data no matter where it resides" (pg.1). The EAI systems support integration of business processes and information across different applications. It links applications as SCM, ERP, and CRM within a single organisation together to simplify and automate business processes. The challenge of EAI as Stokes describe: "is to ensure the automatic flow of information between disparate systems across the organisation without manual intervention" (pg.2). Therefore, the main idea behind the EAI is to integrate resources only once and pass them onto the target receiver. Between these there is a standardized communication server that enables interconnection within organisation which essentially means the EAI system is able to integrate resources without modifying them (Sdn.sap).

The main reasons why enterprises should implement the EAI systems are varied. With the EAI, technology companies can achieve integration of dissimilar applications and work as a single cooperation, especially package applications like the ERP which work efficient, if they are connected with the back end and legacy systems. Not only, can applications be integrated, they can also connects business partners, suppliers and customers across the world and enable fully integrating value and supply chain with the assured efficient of E-Business. A company can integrate new services and products with already existing applications and improve efficiency, operating costs and customer services across the organisation and therefore fulfil business process automation strategies. Besides integrating new applications, accelerate responses to changes and new business rules can be adopted in real time and act on new market opportunities which meet customer demands which assist the formation of company into "zero latency enterprise". The combination of shortening the applications lifecycle by integrating different applications and efficiently changing business rules are further reasons for why the EAI should be implemented (Goldstone technology, 3-4). The EAI enterprise can respond quickly on changing business conditions and significantly reduce costs of maintenance and development by leveraging existing frameworks (SeeBeyond, 2002, pg. 2).

Briefly, the EAI is used for data and process integration where information and business processes are linked together. The vendor independency can be assured where business rules can be extracted and implemented in applications so that even if one of these applications has to be replaced with a different vendor the application of the business rules do not have to be re-implemented. Where single consistent access interface is provided for applications, it prevents users from having to learn to interact with different applications (http://nlplab.kaist.ac.kr). The general advantages that enterprises gain with implementation of EAI system are the prevention of implementing point-to-point applications, high transparency with the help of central monitoring, more homogenised administration, more efficient customized interfaces, and technology independency (PSI, 2006, 1). With the EAI real time information access among systems can be provided, information integrity across multiple systems is maintained which also helps to streamline business processes and raise company efficiency (http://nlplab.kaist.ac.kr). The EAI ensure vendor independency as it enables a connection of dissimilar systems from different vendors (Linthicum, 2000, pg.4). Disadvantages that occur with EAI system are high costs for small and mid-sized companies where architectural costs are particularly high. Moreover, the EAI projects are time consuming where a lot of time needs to be devoted to up front design and a lot of resources are needed (http://nlplab.kaist.ac.kr).

As the company is familiar with the EAI technology and it pros and cons, in the following chapter we will discuss the levels of integration where "what" the companies want to achieve with integration levels has to be determined.

## 2.3 Levels of Integration

The enterprise application integration can be carried out in three different stages within the organisation depending on the organisational objectives and business processes. Integration levels are divided into three main stages; data integration, application integration and process integration and each of these integration stages has its benefits and drawbacks and suites particular organisational environment.

### 2.3.1 Data level

Data level integration is a process or technology of moving data between two or more data stores which share relevant business information between systems and applications where understanding and knowledge of application logic is not needed. Developers do not need to understand the data, or data flow and business rules. With the help of data transformation and data transportation services data is extracted from one or many data bases (hereinafter DB), if required, is transformed and placed in target DB. For example; sales data must move from one database to another. When a sale is recorded in the ERP system, it creates an event; this new information is copied over the inventory control for order fulfilment operations (Linthicum, 2000, pg. 18-28).

The main advantage of data level integration is the cost of using this approach. Because of the movement of data and unchanging application logic there is no need to change the code, therefore the cost of changing, testing and deploying of the application are excluded. Even more so, the technology used for data level integration is relatively inexpensive in comparison to other integration levels. Beside financial advantages, data level provides simplicity and speed-to-market as a result of not needing any modification of business logic. The EAI technology gives the ability to enterprise to move data from one place to another, which can be done rather rapidly. Data integration level is implemented when applications share data and do not need to understand each other, where business rules, data and application logic are left untouched. In essence, the application logic and business rules are unchanging. This method provides simplicity and is inexpensive to implement in comparison to other forms of the EAI. In many cases it is impossible to deal with the database exclusively without considering the application logic, as many cases data are closely related with the application logic and in this case is better to employ data levels along with method levels or exclusively method level integration (Linthicum, 2000, 8-27).

### 2.3.2 Application level

The application level provides application-to-application (A2A) integration over the organisation network. This can be achieved with **application program interfaces** (API) or other interfaces that exist within applications to bind them together letting them share application logic and data (Crouch, 2003, 6). Application level set the usage of application interfaces into focus. These application interfaces are exposed by developers to provide access to business processes and data is encapsulated within the applications or goes directly to the database thus is provided mechanism that allows encapsulated information to be shared. For example; if SAP data is required from Excel, SAP exposes the interfaces that allow user to invoke business process or gather common data. Actually, interfaces bundle many applications together and enable sharing of the business logic and information (Linthicum, 2000, 19- 38).

With interfaces we can access data and processes, place information in a format understandable for the target application and transmit the information. In this instance message broker seems to be the most appropriate solution (Linthicum, 2000, 19). With the usage of interfaces we avoid changing applications that would increase costs. Custom applications do not provide any type of interface that enables integration yet it still represents the risk of adopting the application and an increase of costs. Briefly, the application level approach is relevant as Stokes explain: “pre-built application adapters that allow core business such as ERP, SCM and legacy system to be seamlessly integrated with applications that provide outward-facing connectivity to suppliers, partners and customers” (Stokes, 5). The goal of the application integration is to rapidly integrate applications and data components to form a fully functional, powerful, data-rich infrastructure and a seamless corporate IT environment. Limitations that developers have to face are specific features and functions of application interfaces that vary from API to API (Crouch, 2003, 6).

The application level is appropriate to implement when in custom and packaged application access are required and both business processes and information, expose interfaces into their processes and data, when data is closely related to application logic which helps applications to complement and understand each other.

### 2.3.3 Method level integration

Method level integration is the most intensive form of EAI that allows enterprise to be integrated through the sharing of business logic, methods which exists within the enterprise. Methods can be shared by hosting on a shared physical server or by accessing existing methods inside applications using a distributed method sharing (Linthicum, 2000, 61). With a method levels we crate compose applications that provide infrastructures for accessing shared business processes (Crouch, 2003, 7). To achieve shared business processes a method level requires changes to the application source code (Crouch, 2003, 7). Therefore a large range of solutions must work together before the EAI on method level is implemented. Business managers should define model, change, and test a process flow. With this step managers could see what importance and impact changes have on the process flow (Stokes, 6). By integrating method level, many if not all applications have to be changed to take advantage of the method level integration. Changing the application logic represents the main disadvantage in comparison with other integration levels, where the application logic is unchanged. It represents a very expensive process since there is need to test, integrate and redeploy the application within the enterprise of the costs spiralling upwards (Linthicum, 2000, 62). Once the integration solutions are implemented, the managers could monitor the process flow across the enterprise and, rapidly respond to a problems and difficulties that occur within the process flow. With the help of alerts and alarms this solution enables to trace errors before they can impact the business operations and consequently focus on improving the quality of the service (Stokes, 6).

A method level should be used when managers want to share business logic and distribute methods among various applications. The goal of this integration level is an automation of business processes, so that the enterprise of business systems and the exchange of information are done between business processes within the workflow engine. This enables a rapid response to difficulties that arise in the process flow.

As we have reviewed the problems managers are faced with on a day to day basis and the issue of which integration levels can be applied to the EAI technology, the focus may be turned to analytical part of EAI. In the analytical part of the EAI the thesis will focus on the architectural and financial standpoints, in order to answer the questions of "how" and "how much" companies posses when integrating applications. The following chapter will be reviewing from an architectural standpoint of how the EAI project can be realized when dealing with different architecture topologies. The thesis will also display financial standpoint, where the information technology economics and financial methodologies will be examined in order to answer the question of how much investments in EAI topology are worth and whether it is reasonable to integrate EAI topology with the help of a cost-benefit analysis.

# 3 DESIGN OF EAI

When considering the design of the EAI, one of the main issues is the architecture. Organisations can apply EAI technologies and describe which architecture topology is appropriate. The EAI technology could be applied in three types of software architecture that differ by way of integrating applications. Each of these architecture topologies enable communication between applications and are appropriate for different forms of business operations. Not every architecture topology is suitable for every organisation therefore the architectural variety and their individual pros and cons need to be examined.

## 3.1 Point-to-point topology

The point-to-point (hereinafter p2p) topology is a traditional integration approach that enables direct communication between at least two applications. This topology creates a 1:1 connection, and forms direct, tightly bounded connections between applications (O'Brien). Here interfaces are exposed and direct messages are being sent through interfaces from one application to another (see appendix 5). With this art of connection the number of interfaces is increasing with the number of applications (Conrad et al., 2006, 84). The formula (1) calculates the number of interfaces (**I**) where **n** represents the number of applications in integration environment (Schroeck, 2000). Formula (1a) calculates the number of connections needed to integrate each application together.

$$I = (n * (n-1)) \qquad (1)$$

$$I_c = (n*(n-1)) / 2 \qquad (1a)$$

Another limitation of the p2p is that it cannot properly bind two or more applications as it has no facility of storing application logic or the ability to change messages on the flow (Linthicum, 2000, 133). This architecture is very inflexible and there is no possibility for any subsequent update of portals, business process management (BPM) and service oriented architecture (SOA) (Horn). If there are any changes in applications like up gradation, adding of new application or even replacement of old with new system the whole integration structure has to be changed. Therefore, a good documentation for further integration and changes is required. A Great advantage of p2p topology is its simplicity of linking applications together where developers avoid complexity of adapting differences between many sources (Linthicum, 2000, 124). This topology takes full advantage of original data as it is transformed in one or more target structures (Goldstone technologies, 9). However as it is the simplest, fastest and efficient way to integrate applications where particular requirements may fit to environment, the good software architecture will continue to support the occasional p2p connections (O'Brian).

Although start-up costs are very low (Horn), the maintenance and administration costs can rise very high with every additional application in environment and involve a risk of increasing errors (TechMetrix Research, 2002). Therefore implementations of point-to-point architecture is most suitable in smaller organisations or smaller units of company where small number of applications need to be integrated within enterprise where connections in smaller number are viable and application logic or business rules are not needed and there is no need for SOA, BPM or the presence of portals (Horn). To eliminate disadvantages of p2p topology and efficiently react on changes of applications and in system landscape companies can implement or exchange p2p with so called hub-and-spoke topology.

## 3.2 Hub-and-spoke topology

Hub-and-spoke represents many-to-many, m:n linking, where many applications are linked with other applications. It is the most commonly used topology and the best configuration for EAI (Linthicum, 2000, 134). A Central hub is placed between the start and target application where applications, the spokes, are connected to the central hub only once. It means there is no direct communication between integrated applications.

A Hub provides centralised services while connectors or adapters provide services for each spoke or integration point. A Source application sends a message to the hub that reforms the message, if necessary, and distributes it to the various spokes that are connected to the hub. Existing and new applications exchange data by the rules of business processes. Central hub routes the messages according to these rules, where data in the message is transformed into the format required by the target application while the application adapters provide integration with centralized hub. This topology creates central a point of control, where everything goes through the hub. Because this type of architecture is independent of an individual application business processes can change and grow without causing any changes to applications (Goldstone technologies, 8). Connections, interfaces and adapters between hubs and applications are shown in appendix 6.

EAI tools with a hub topology provided by various vendors have useful features like ready to use adapters that are connecting application to the central hub, advanced message routing between applications, mapping, management of complex intern applications and centralized administration of flows and processes (TechMatrix Research). The Advantages gained with hub topology are the reduction of re-entry of data as they are centralised, it enables re-use of data, monitoring and the auditing of data flow is eased as all data muss pass the central hub (Goldstone technologies, 8). The Hub-and-spoke topology reduces numbers of interfaces needed between applications. The number of needed interfaces shows us formula (2), where **n** is number of application in system landscape (Schroeck, 2000).

$$I = n \qquad (2)$$

The reduction of connections between applications significantly reduces system complexity and forms a less complex environment where with p2p architecture becomes impossibly complicated. Applications can be changed, replaced with any other system or new application can be added with much lower costs than the traditional topology. Besides, it causes higher performance of the company, the security rises and development cost reduces (ITC). When Hub topology start up costs are high but sequentially the follow-up costs like cost of maintenance, operational or costs of enhancement are much lower than with traditional topology. This topology is very flexible and is good basis for SOA and BPM (Horn). Hub-and-spoke provides flexibility and applicability to the integration problem area, jet it represents high complexity of linking so many applications together but with the new trends middleware is becoming better and handle many external resources (Linthicum, 2000, 135).

A big disadvantage of the hub is that it can become a bottleneck with high transfer volume and it can impact on performance (Schärtel & Peitzker, 2006, 47). Problems also occur when we want to integrate geographic distributed companies or company units that may have difficulties implementing hub architecture. Here the sender and receiver have to agree on which hub to use which is not a problem for internal integration, but it becomes an issue for the B2B and cross department integration (Parker & Suketu, 2001, 7) & (O'Brian). The multiple-hub configuration (see appendix 7) address problem of geographic distributed companies, B2B and cross department integration. In this configuration hub or message brokers enable to integrate several message brokers together, with the source and target application and also to any other message broker in configuration. Actually it can integrate virtually unlimited number of hubs and provide load sharing and backup in case of failure (Linthicum, 2000, 315) & (O'Brian).

Siemens Austria is one of the companies that have successful implemented the EAI technology. Because of the companies' large size and wide range of products the complex IT infrastructure had developed. Numerous applications within the company were integrated with p2p interfaces where each department used its own methods. As a result, hardware and staffing redundancies appeared as increase in development and maintenance costs. Siemens Austria decided to reduce costs and establish flexible architecture with EAI project. The number of diverse interfaces has been reduced and the interface management and IT monitoring have been centralized as well as alerting. The company has managed to significantly reduce the development and maintenance costs (TIBCO Software Inc., 2007).

## 3.3 Bus topology

The Bus topology provides many-to-one, 1:n, linking applications where the message broker can be on a bus network and provides message broker services to applications linked to the bus. Like with hub topology there is no direct communication, applications communicate via buses with one another (Linthicum, 2000, pg.315). The Source application and so called publisher puts a message to a local software bus and one or more applications that are interested in receiving events can subscribe to the message broadcasted on the bus (Goldstone technology, pg. 9). The receiving applications are called subscribers and the bus architecture is referred as publish/subscribe architecture. Data that the application publishes on the bus is transformed into a standard message format to be understandable for all applications connected to the bus. On every integrated system or application there is an adapter installed that performs message transformation and intelligent routing, which contains business rules and is responsible for linking integrated applications with the bus (Parker & Suketu, 2001, pg 6). Bus topology and connections are show in appendix 8.

With bus topology, shared architecture is provided which makes it cheaper; applications can be changed, replaced or added with lower costs than with traditional middleware. It is a flexible architecture and good milestone for SOA and BPM. Although the start costs are fairly high the follow up costs are much lower (Horn). Because bus architecture requires application adapters for transformation and routing that has to run on application makes development more complex and so the development and maintenance costs are higher than in hub topology (Parker & Suketu, 2001, pg 6).

The Enterprise service bus (hereinafter ESB) is an infrastructure that makes implementations of services oriented architectures (hereinafter SOA) much easier. With the help of the API services can be developed and provide reliable interaction to each other. Technically ESB is a messaging backbone that provides message transformation, routing, accept and deliver messages of various services and applications linked to the ESB. As we can notice there is no significant difference between proprietary bus and the ESB. The Only difference is in the costs that are much lower than with proprietary buses. The Proprietary buses usually have a lot of build in functionalities that need to be developed, where ESB is a standard based bus which makes the ESB suit cost less than p2p and hub topology. On the other hand the proprietary bus and hub can be implemented as service oriented where the ESB is service oriented (Goel, pg.5). A Bus topology is appropriate when we have to distribute messages to many applications and when we have to deal with problem of bottlenecks (Goldstone technology pg.9). It is also appropriate for 1:n linking's where high performance is required (Horn).

In comparison to the hub the ESB is more applicable in companies where system landscape of several systems needs to be integrated where a great deal of messages needs to be sent on applications, and new usually web facing applications needs to be integrated or existing applications with Web. The Hub on other side is more suitable for organisations with large projects where large number of systems need to be integrated, and when integrating a big back office systems and legacy systems (ZDNet, 2004).

The definition and essence of the EAI technology has been discussed as has its features and pros and cons along with it potential problems. From an architectural viewpoint the idea of how companies can respond to the problems within the enterprise system landscape and which topology can be applied to solve appointed hardships in first chapter. In the following chapter the EAI technology will be reviewed from a financial standpoint based on a cost-benefit analysis and the question of "how much" that company posses when investing in EAI technology will be addressed.

# 4 FINANCIAL FEASIBILITY OF EAI

The ongoing challenges for organisations are constant growth and long term survival on the market; therefore companies have to innovate continuously. It is not enough to just implement the best business practice and reduce the costs but to ensure consolidation of the business. Innovation is the key that brings progress and execution of next business practice that is reflected in new business processes. Therefore companies have to combine the best and next practice where the **best practice** assures efficiency which mean doing things correctly and the **next practice** that lead to competitive advantage and keeps company in leading position (Scheer et al.., 2004, 2). Constant development and adaptation to continual changing framework is very important for the long-lasting survival of company. Each change in the business process has adjustments of the IS as consequence and for these adjustments investments in IT are needed, therefore new IT projects are constantly emerging.

Elsener (2004, 71-72) defines 4 main reasons why IT project should be realised:

- **Realisation of business strategy**; constantly changing corporation environment, changes the business strategy, therefore different IT projects are following business and IT strategies
- **Improvement in efficiency**; is not just in realising new project but also in creating efficient workflows and processes, to see if the benefits exceed outrunning costs,
- **Reinvestment, of existing systems**; where systems, servers or terminals have to be replaced at end of their lifecycle with new systems and technologies,
- **Completion of obligations**; investing in projects and systems like tracing of production or securing confidential data which efforts cannot be expressed in monetary value but they have to be done for the existence of the company

### 4.1.1 Information technology economics

More and more attention is driven to IT investments and evaluation of IT investments, to achieve better business performance with help of costs reduction. The opportunities that new innovative technology brings and the changes that IT makes to productivity need to be exposed. The main question that has to be answered; is an investment economically justified, in other words is it worth the investment. An investment is economically justified when the benefits of investment exceed total costs of investment. To realize the evaluation we have to compare innovation with some other state or scenario; for example with competition investment or with a state of no action. Evaluation of IT investments is complex for two reasons; firstly, indirect impacts that are not seen in profit and secondly, due to the need of forecasting (Turk, 2005, 153-155).

The goal is not to realise the biggest possible number of projects with support of external experts, but to generate the optimum performance with the lower costs. This is possible with evaluation of investments that are invested in the projects. Therefore evaluation of IT investment helps in the decision making process, or more specifically to assure more efficient allocation of resources. IT investment can be measured in different ways. Different organisations use different methods, depending on what the purpose of evaluation is. Management chooses the evaluation method that can be changed over time as the finance personnel changes or when changes in IT investment regulations appear. Many organisations have automated programs that use company inputs to do evaluation calculations (Turban et al., 2006, 566). The traditional evaluation methods are divided into the non-financial part of the evaluation that is used to select product and evaluate intangible benefits, and the financial evaluation that gives an idea of the costs and benefits. Looking at evaluation methodologies, there are quite a few that can be applied in evaluating IT investments of EAI technology. With the help of the described financial methods the evaluation of IT investments in EAI technology will be presented in an assessment analysis on the case of Daimler AG in following chapter.

### 4.1.2 Non-financial evaluation

Many investments have intangible benefits which are hard to express in monetary terms. It is clear that customer and employee satisfaction ease distribution and improve control but how to measure this improvement? Ignorance of intangible benefits means that their value is zero and it can indicate that the investment is being rejected or that the investment does not bring expected improvement. Ways that overcomes this imperfection are rough estimations of intangible benefits in monetary value where a risk exists that estimations can be done too low or too high. Even more so, by comparing categories of product from diverse vendors that mostly fulfil needs and expectations. **Scoring methodology** uses weights and scores to assign evaluation criteria in different areas. Weights are allotted and the scores are assigned to each characteristic of the product, than the total calculation of weights are realised. Each component receives a score on scale from 0-10 or 0-100 and higher score is estimated as the best. (Turban et al., 2006, 561-563). Mostly non-financial evaluations are used in product evaluation process when we are choosing the product. This evaluation methodology is very flexible where any time new components can be added and it is helpful by solving assessment problem of intangible benefits by linking them to chosen components that are good for the company performance (Turban et al., 2006, 562-564).

### 4.1.3 Financial evaluation methodologies

Financial evaluations include diverse methodologies and financial analysis that focuses on reviewing costs and benefits caused by introducing new technologies. In praxis it is preferred to deal with evaluation criteria that can be expressed in monetary value and give more precise objective results. Most applicable methodology in praxis is Cost-Benefit Analysis which scoop diverse evaluation methodologies. To choose the right evaluation methodology we have to know exactly what we want to evaluate and what we want to achieve with the evaluation process. The Evaluation process is not just an analysis from the financial aspect but it can also indicate opportunities for the organisation operation and business processes that are in business case done as complete analysis including financial factors as allegation improvements on business area (Turban et al., 2006, 560-565). In the following part of the thesis the cost benefit analysis and its diverse evaluation methodologies that enable a realisation of evaluating IT investments will be evaluated. Some of the described methodologies will be used in evaluation case of EAI technology.

Cost benefit analysis is one of the tools used in decision making and can give the financial view of EAI topology. Analyses are used in planning and decision making when we want to compare cost and benefits. Cost benefit analysis (hereinafter CBA) is dealing with the monetary values; in case where intangible benefits dominate is this not the most appropriate methodology. CBA has no specific approach or methodology therefore is important what we want to evaluate and choose appropriate variety of business analysis. In evaluating IT Investments the CBA evaluates cost that IT investment cause and the benefits that it brings. The Evaluation process of IT investment in CBA is usually done in next sequence (Turk, 2005, 156):

- Problem definition
- Definition of criteria
- Gathering or assessing of costs and benefits
- Comparison of costs and benefits
- Decision making and react suitably

As a traditional tool in evaluating IT investments are used ROI (Return on Investment), TCO (Total cost of ownership), and breakeven point. With these methodologies it is possible to see what the ROI of EAI topology is, how the EAI topology effect and TCO effect are chosen and where the breakeven point of EAI topology is.

#### 4.1.3.1 ROI

**The Return on Investment** (hereinafter ROI), is a primary tool for prioritization of investment it also evaluates how efficiently money was invested with available assets. The ROI is used in almost every decision making and planning process. When several projects are compared, it is ROI that identifies projects that generate the most value as well screen out projects that may reduce value if they are deployed (Sward, 2006, 57-59). ROI can be calculated and reported in different ways. ROI calculations for IT investment in EAI we will use calculations as follows:

$$ROI = (gains - investment\ costs) / (Investment\ costs) \qquad (4)$$

In formula (4) gains or benefits of IT investments are divided with investment costs. The result is ratio of gained or lost money relevant to money invested and is usually expressed with percentage. The percentage express how much profit or cost saving can be realized with IT investment (Return on Investment ROI). The main objective of the ROI analysis is to provide financial guidance in the decision making process that will optimize the investment returns (Sward, 2006, 59). It is used in assessing purchase decisions like computer systems and go/no-go decisions. There will be attempts to find alternatives that improve ROI by reducing costs, increasing gains or accelerating gains (Solution matrix, 2004). On the other hand, the obtaining of the ROI also depends on the implementation success. Many systems are not implemented on time, within budge, or with features planed (Turban et al., 2006, 564-566).

#### 4.1.3.2 Total coat of ownership

**The total cost of ownership** (hereinafter TCO) is a method for calculating total costs of infrastructures with contemplating direct and indirect costs. It is a method for calculating costs of owning, operating and controlling an IT system. Elsener (2004, 208) defines costs of TCO on **Direct costs** that are for organisation easier to define and measure:

- **Hardware costs**, purchasing, maintenance and infrastructure of Hardware
- **Software costs**, purchasing, maintenance and infrastructure of Software
- **Operation costs**, cost of all processes and support, and
- **Administration costs**, costs of administration and coordination of training for workforce

In a contrary instance, indirect costs are difficult to measure and hard to define. Its impact on the IT infrastructure is often underestimated. Under **indirect costs** we count:

- **Application development costs**, the costs of developing own applications
- **Downtime costs**, the lack of availability of regarded system
- **Training costs**, the costs of formal learning seminars for regarded application
- **Self-learning costs**, the cost of self learning and opportunity seminars, and
- **IT supports costs**, the costs of the Help-desk etc.

There is a strong coherence between the direct and indirect costs, meaning mistakes done with managing direct cost are usually shown in indirect cost. This methodology helps understand and analyse how the integration of new technology impact the TCO and also shows how we can impact with cost coherence on direct and indirect costs, depending of corporation's objective (Elsener, 2004, 210). The TCO methodology is important and necessary for IT management but it does not demonstrate the impact IT has on profitability (Sward, 2006, 3). The Methodology that demonstrates impacts on profitability is the break even analysis.

#### 4.1.3.3 Break even point

**The break-even analysis** helps to calculate the point at which the revenue and expenses are equal; at this point the profitability area and losses area are divided. This analytical tool is in economics used in sales and provides view of relationship between sales, cost and profits. The **break even point** is calculated to determine if it would be profitable to sell certain product, to determine the price of the product and quantity of products that need to be sold to cover the expenses. Calculations are done with help of fixed costs and variable costs, with the price of the product and units of product.

$$TC = TR \quad (5)$$

$$TR = P * Q \quad (6)$$

$$TC = VC * Q + FC \quad (7)$$

$$P * Q = VC * Q + FC \quad (8)$$

$$Q_p = FC / (P - VC) \quad (9)$$

The break-even point is where the expenses equals sales, is in the formula (5) total costs (TC) equal total revenue (TR). Total revenue (formula 6) depends of price (P) and quantity (Q) of the product. Total costs (TC) (formula 7) are combined from fix costs (FC) and variable cost (VC) multiplied with quantity (Q). To evaluate the quantity a break-even point will arise and calculate (formula 9) where profitable quantity ($Q_p$) depends of fix costs (FC) that are divided with distinction of price and variable costs (Jankowiak, 2005).

A Break even analysis can be used in evaluation process of the EAI technology in terms when wanting to define at what point is worth to integrate the EAI technology. In this case the fix and variable costs of EAI technology are estimated. As revenue the benefits of the EAI technology are enclosed which is brought into integrated environment. In the EAI evaluation case interfaces or applications represent the quantity that defines the break-even point therefore the FC, VC and benefits depend on interfaces in system landscape. If looking at the case in more in detail the FC of EAI product are costs of hardware, software, licences and trainings and the VC of EAI product are costs of maintenance, external services, integration costs, operation costs and possible trainings. The benefits are difficult to evaluate as a savings assessment, maintenance assessment, and efficient error tracking system are vital to this process. The Break-even point occurs where costs and benefits are equal (see formula 5) (Kuhn, 2004, 8). With the assistance of evaluation methodologies it is possible to calculate how large an economic investment this is for the company, whether the ROI is high enough, how it reflect on the TCO and when the best time is to invest in the EAI or whether to remain with the as-is state. From a financial standpoint, the question of “how much” that company posses when integrating applications arises. However before assessing the case of Daimler AG the costs of the EAI need to be considered in order to be able to offer a proposal based on the cost-benefit analysis through the EAI topology.

### 4.1.4 Cost definition of EAI technology

To realize the financial evaluation of EAI system the estimate costs and benefits that are compared to some other states must be evaluated. These are mostly compared to the state of not acting, otherwise known as the, as-is state. The Evaluation process can be realized when cost factors are easily expressed in monetary value. This condition meet IT costs of implementation, architecture, and operational/maintenance costs of applications and interfaces. The Indirect cost savings and benefits of process optimization and automation are usually more used as arguments for EAI and sometimes hard to express in monetary value. Before assessing the costs however, it is required to have a view of the IT development plan that serves as a basis for the business case with a clear overview of the development of interfaces, to expose changes that happen with implementing an EAI system (Leer & Nelius, 2002, 1).

Lee & Bass set up a basic way of dividing the costs of implementing EAI system in three components; architecture, integration and operating/maintenance cost (2001, 2)

- **Architecture costs-** cover the integration development as execution and operating environment. Therefore this includes the cost of new hardware, cost of licences, and cost of implementing architectural software and hardware. These costs depend on complexity of EAI software and entities. Architectural costs of EAI can be much higher than costs of traditional architecture topology where costs of hardware and software usually do not occur.

- **Integration costs** are related to development of interfaces and collaboration between systems. These costs are variable and driven by the number of interfaces that need to be developed. Development costs of interface include services of analysing, building and testing. Complexity of interface that is expressed in Full-time equivalent is influencing on the height of integration costs.

- **Operating/maintenance costs** include on-going operations and maintenance costs for the architecture and integration. These costs are driven by the number of interfaces that need to be maintained and grow with the number of interfaces that need to be maintained. Operating costs are known as; data exchange volume, administration cost, monitoring, security costs, error handling and costs of enhancement.

As we have reviewed theoretical part of thesis and discussed how managers are faced with enterprise application integration we will continue with the case study. In the following part of the thesis will be presented through a case study of a real EAI project of Daimler AG. Here the scenario follows the logical outline of the theoretical part and questions such as "what", "how" and "how much" are answered from an organisational viewpoint. We will propose an appropriate topology for the company that will result from thorough analysis of the company's situation based on architectural and cost-benefit standpoints.

# II CASE STUDY: EAI DECISION IN DAIMLER AG

## 5 ABOUT DAIMLER AG

Daimler AG is a German corporation with a seat in Stuttgart. Beside automobiles Daimler AG manufactures trucks, vans, busses and provides financial services within its corporate groups Mercedes-Benz Cars (hereinafter MBC), Daimler Trucks, Daimler Financial Services, Mercedes-Benz Vans and Daimler Buses. Globally, Daimler AG is a leading producer of premium passenger cars and is the largest manufacturer of commercial vehicles. The history of the company goes back to 1886, when the company was grounded by its founders Gottlieb Daimler and Carl Benz and the corporation merged in 1998 with the US-based Chrysler Corporation. On the 14$^{th}$ May 2007 Daimler Chrysler announced the sale of Chrysler Group to private equity and on the 5$^{th}$ October 2007 the shareholders approved the remaining of the company titled as Daimler AG. In 2007 Daimler AG achieved total revenue of 99.4 billion Euro and market capitalisation of about 67.4 billion Euros with 272.382 employees, manufacturing in 17 countries (Daimler intranet portal, 2008). Daimler AG group Mercedes-Benz Cars has a brand portfolio (see appendix 9) of luxury passenger cars, light commercial and heavy commercial vehicles within Mercedes-Benz and Maybach and a variety of city cars, known as Smart (Daimler intranet portal, 2008).

### 5.1 Plant Sindelfingen

Plant Sindelfingen was founded in 1915 by Daimler-*Motorengesellschaft*, today's plant is Daimler's biggest production facility (see appendix 10). The plant has grown to an area of 2.897.709 m$^2$ and provides workplace for about 36.390 employees. In Sindelfingen there are produced upper and middle-range segments of the production line. Annually about 430.000 S-, E-, C-, CL-, CLS-Class and Maybach passenger cars (see appendix 11) roll of the assembly line. Every day about 1500 trucks and 52 railway wagons deliver raw materials and supply parts. Daily 2.100 vehicles leave the plant to fulfil customer expectations around the world. The organisation plan of plant Sindelfingen is shown in appendix 12.

### 5.1.1 Department ITP/FL

The ITP/F is the IT department for passenger cars that supports Mercedes-Benz Cars with the distribution of IT resources on core processes to create competitive advantage. One of the core processes is the logistic assembly plants managed by ITP/FL department. The competence logistic vehicle assembly plant helps design competitive business processes by providing customer oriented IT support for the processes material logistics, dispatching, supply of international plants and stamp shops. The structure of ITP/FL department is shown in appendix 13. Within the ITP/FL department the Project Automotive Supply (hereinafter AmSupply) is driven. It is long-lasting project with goal to design future logistic processes and model IT support for the processes in three production plants Bremen, Rastatt, and Sindelfingen. The Project AmSupply is divided into 11 smaller units, so called partial projects (hereinafter TP). A more detailed structure of the project is illustrated in appendix 14. AmSupply focuses on series of logistics that are dealing with the material flow (TP1), demand and disposition (TP2), goods entry and shipment (TP3) (see appendix 12). The technical chief design (TP8) represents the realisation of the software design and integration methodology. It sets standard guidelines within the operational and infrastructural projects and it is responsible for the IT architecture through all phases of the IT projects. Besides they look for the balance between the corporate specifications, references of SAP and requirements of the project which regards all parts of the IT architecture from implementation over software, hardware and network infrastructure to security architecture and system management (project documentation).

The tasks that concern my participation at this project and this thesis are to describe the chosen topology and chosen products by Daimler AG. It will be considered whether this topology is suitable from an architectural standpoint and financial standpoint based on the cost-benefit analysis. The Case study part follows the logical outline in the theoretical part. Therefore, firstly the issue of the companies problems arises and whether it is dealing with them efficiently and if not, how to deal with them efficiently and conclude with financial standpoint of EAI topology. Here the selected topology will be discussed and whether it is appropriate from a financial standpoint based on cost-benefit analysis. In the following chapter we will look at initial situation of the company.

## 5.2 Initial situation of the company

The EAI technology within the AmSupply project will be implemented in a series of logistics that are part of the logistic centre. Their main objective is to optimize and increase the efficiency of the main processes; product development, customer order oriented production, and material procurement. With these processes there is a minimal total cost (manufacturing and logistics cost), a higher quality (process reliability and transparency) and shorter process cycle is trying to be achieved (Intranet portal). Series logistic includes a material flow, demand and disposition, goods entry and shipment. These processes represent primary activities of AmSupply project that are supported by IT to follow the objectives of the logistic centre. In the production process a series logistics affects the material procurement process in operations, transportation control, receiving goods, the control of material flow, transport management and shipments. Innovation will be integrating operations as contract management, component demand, evaluation activity and disposition. All mentioned processes will be covered with the project AmSupply. As we are aware of the meaning of the objectives of the series logistics it is now possible to overview the problems these objectives raise (project documentation).

In the following chapter we will look what problems logistic department is facing with and what managers want to achieve with EAI technology.

# 6 PROBLEM DISCUSSION AND OBJECTIVES OF DAIMLER AG

In the MBC modernisations have been completed to a certain level, but there is always 'room for improvement' which welcomes original innovations and changes. In the series logistics in the German assembly plants the IS and processes have to become efficiency oriented and standardised. The high process- and IT- complexity expires as technology urgently demands a consistent process standards and modernisation of the IT-Systems. As seen from notable figures mentioned earlier, the Assembly plant Sindelfingen has to deal with enormous amount of data and information to be able to produce 2100 vehicles per day and manage raw material and supply parts delivery of 1500 trucks. To operate processes effectively and accurately in accordance to the IS they have to be correlated and provide an instant exchange of information. Currently processes with a variety of different applications and legacy systems that have been implemented over the years are very inflexible and modernisation of these IS and processes cost the company a lot of time and are cost ineffectual.
Other imperfections are processes that are heterogenic, and cross plant barley standardised. There is a detrimental process control throughout the functional IT-systems and a great redundancy of master data. According to the redundant data management systems there are about 500 interfaces that are not process oriented. Some logistics systems are about 20 years old and the "know how" bearer extinct, thus the further development of these systems is aggravated. The consequences that a state like this brings is that the implementation of continuously improvement processes cross plant will be impossible. Aggravated bordered ability to respond to future challenges, the implementation of the standards and technologies to process innovation is impossible or extremely costly and increased the error rate through the aged IT technology. The risks that the project wants to overcome are decreasing technology supported through vendors, the IT developers increased error rates through faulty interaction of different technologies, decreasing controllability by maintenance, further development and working process, where new applications can be barely implemented whit

this high complexity (project documentation). Purely describing the imperfections is a reason for which the AmSupply project is being carried out in the ITP/FL department. According to Daimler estimations logistics systems that are about 20 years old will not be able to operate from 2012. They are already inadequately low-speed and further developments are not cost-effective to increase efficiency and innovation of processes. Through the AmSupply project consistent process standardisation in the MBC assembly plants would be achieved. The objectives are to modernise logistic processes with competitive business processes and customer oriented IT applied in three assembly plants; Bremen, Rastatt, and Sindelfingen. The integrated cross plant process standardisation and modernisation of IS in series logistics should be achieved. Another objective is the displacement of the 21 legacy systems and applying the best-practice process standards cross plant in logistics supported with the SAP-systems. However the main long-term objective is to roll out the AmSupply in all assembly plants. Architecture topology that is currently used is point-to-point and has many drawbacks when implemented in big structure therefore this change is essential.

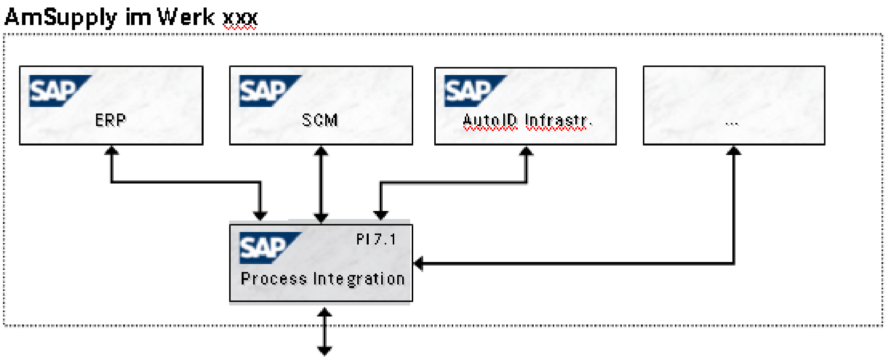
As we are aware of the problems that IT managers are faced with and how they tackle these we will focus on analytical part of the case. In the following chapter we will review the architectural standpoint of the EAI project and describe the chosen topology in the financial standpoint we will perform evaluations with the help of the discussed financial methodologies for the relevant topology. To conclude our case we will discuss whether the chosen topology is based on a architectural or financial standpoint and whether it is convenient for the company.

# 7 DESIGN OF EAI IN DAIMLER AG

## 7.1 Topology

The SAP tool PI 7.1 was created by ITP/FL to achieve a set of objectives integration solution, which integrates processes and systems. Any communication in a series of logistics between SAP and non SAP applications takes place over one PI per plant, which also applies for the communication between the SAP applications. Guidelines indicate that each interface has to use EAI technologies and exceptions can only be made in a case where the technological conditions are exceeded or if the exclusion of IT, TDC or FIM department is confirmed.

*Figure 1: AmSupply EAI statement detail view of process integration per Plant XX*




*Source: AmSupply Project Documentation*

Figure (1) illustrates how the Process Integration PI 7.1 is integrated with other SAP and non-SAP applications in Plant XX. Is also indicates the ability to integrate PI 7.1 with other applications outside the plant. Integrations with other applications outside the plant enable communication and exchange of information between the plants within the company. The plants are not connected directly to one another but through the central PI. In appendix 18 the EAI infrastructure is presented on global a level, where several plants with only one PI per each plant (WXX) are going to be connected with one another over a central PI that is placed in the central system. The MQS represent current situation where hosting is provided for information exchange. The central PI/SAP does not only connect the plants of MBC but also the other Daimler production corporate facilities i.e. the Daimler Trucks and Power Train (PT). The global data exchange with partners over integration tool PI will be applied on systems EDI and WEB-Services meaning that the central SAP/PI will be providing external and corporate internal communication and external and corporate internal mapping (Project Documentation).

It is apparent that the company has chosen the hub spoke topology to solve problems they are faced with. Business processes and applications are well structured and were recently modernised only leaving the integration part in series logistics with room for improvement. The hub & spoke topology is more appropriate than bus topology which would be too expensive, due to the intervention in applications and processes. Moreover, the ESB is appropriate for SOA where in this case the architecture is oriented functionally. The next chapter consists of a brief overview of the chosen PI 7.1 product.

## 7.2 The solution: SAP NetWeaver 7.1

### 7.2.1 About the solution

To achieve short and long term objectives and to overcome difficulties that are on sight ITP/FL departments dedicated to implement EAI solution strategies. The selected integration product is the SAP's NetWeaver Process Integration 7.1 (hereinafter PI 7.1). The SAP AG was launched in September 2008 as the SAP NetWeaver PI 7.1 and its latest version of SAP NetWeaver Exchange Infrastructure (XI). The SAP NetWeaver platform is a bundle of integration components and development tools that allow the IT department to link processes and information (see appendix 15). The NetWeaver tool has capabilities of user interface development. The information management enables the management of the company's information assets with the help of master data, business intelligence and content management to integrate business information in heterogeneous IT landscape. With business process management (BPM) companies can standardize and optimize operational processes, reduce costs, and improve quality. BPM provide tools to design, models, to run and monitor, operate and improve business process flexibility. Life-cycle management enables efficient implements and operates on critical business processes. It further allows the leverage of existing investments in technology infrastructure and applications and the security and identity management provides security standards (Sdn.sap).

The EAI software component PI represent process oriented collaborations of the SAP and non-SAP applications within and out of enterprise borders, and it is compatible with software products of other companies. It integrates applications with existing legacy systems and assures that integrated applications based on open standards like web service and industry standards. PI settles communication between different units regarding connectivity, format, and protocols. It is used for managing of cross functional business activities in BPM and because it includes a lot of SOA enabling standards is used as one of the building stones for SOA technology in future development (Sdn.sap). PI 7.1 forms main central component that provide monitoring and integration repository that are main features of the new version. Generally, an integration server or a message broker executes SOAP messaging, routing and mapping which takes care of additional connectivity and cross component BPM. It also provides centralised integration knowledge that manages central business processes, web services, interfaces, mappings, collaboration agreements, share classification and publications of businesses and services (discovery of documents). It represents an openness and compatibility to the existing integration solutions with open standards as it incorporates existing functionality into new processes (Sdn.sap).

### 7.2.2 Arguments for implementing NetWeaver

There are many reasons why implementation of SAP platform was chosen among other vendors. Firstly, the company guides the software distribution strategy and are trying to create homogenise system landscape what affects the TCO. The TCO argumentation will be explained in detail in the evaluation. The system landscape technology that is used in different operational processes is supported by the SAP packaged applications such as SAP ERP, SAP SCM and others. As mentioned earlier on in the chapter, the PI 7.1 enables linking between SAP systems as non-SAP applications what is a great advantage. One of many arguments for the PI is the experiences which are gained with the primary variety of integration solution XI in other departments and projects. The usage of NetWeaver PI 7.1 process integration solution brings several benefits, like the reduction of complexity with central integration platform for all systems and integration scenarios where system landscape complexity become transparent for IT administrators and IT developers which consequently saves operational costs. Provided functionality for the BPM and integrated standard software with preconfigured integration content leads to better performance and other benefits that the PI brings for enterprise are a central overview and a manageability of collaborative processes. This means that, if changes occur then they are done centrally and thus apply to all integrated systems which reduce data inconsistency. Essentially it represents an openness of integrating with other systems and simplified upgrade of SAP solutions (Sdn.sap).

As the problems, goals and ways of achieving these goals have been discussed in relation to the company, we may now assess the chosen EAI topology and overview it from a financial standpoint based on the cost-benefit analysis. With the help of the assessment methods we will review how rentable the IT investment in the EAI technology is and what cost effective and technologically justified such an investment would be.

# 8 FINANCIAL FEASIBILITY OF EAI IN DAIMLER AG

An evaluation of investments indicates when an investment is economically justified and when is worth investing. It also helps determine which projects should be invested in and when investments will be beneficial. In the case of Daimler AG we will determine when the IT investment in the EAI solution strategy is justified. We would like to indicate the opportunities and risks that the implementation of EAI solution strategy may arise within the company. For the realization of the evaluation process we will compare two types of application integration; these are p2p architecture which is a current software architecture used by the company and the hub and spoke architecture that represents EAI solution strategies for the company. With the assistance of the described evaluation methods in chapter 3 we will expose the differences between these two architectures, and compare their maintenance and development costs. We want to learn when the IT investment in EAI solution strategy is justified and worth investing in and when it is better to maintain the traditional integration approach. To realize our goal of the evaluation process we will compare cost factors of the EAI / hub and spoke architecture with p2p architecture. To be able to indicate cost differences between architectures we will contemplate them in 4 scenarios; with the cost benefit analysis we will be able to determine cost and benefits, calculate the break-even point, the ROI and the TCO. All calculations will be realised with the help of factors and parameters. Before we start with the calculations we have to know the as-is state and to-be state of the company.

## 8.1 State description

With the state description we want to show the current situation i.e. the as-is state of the company and the to-be state of the company the implementation of innovation that should be brought about will be described.

### 8.1.1 As-is state

The current architecture that is being used is the point-to-point topology, 1:1 linking. The connectivity between applications and systems in system landscape is relatively strong. It means that almost every system communicates and exchanges information with some other system or application. The series logistics are operating in majority with SAP system where major packaged applications as ERP and SCM need to communicate with other SAP and third party applications. In system landscape are several legacy systems that need to be modernized or replaced. Beside internal communication there comes to interchange of information with external systems of companies' business partners and suppliers over EDI application. Between applications there are several objects that with help of interfaces send message and exchange data. The latest number of defined interfaces was around 750 on 27.8.2008 (SAP consultant).

### 8.1.2 To-be state

The target state that should be achieved with implementation of EAI solution strategy is to integrate all systems of series logistic to the central hub to have a centralized administration and control over data. The EAI forms a strong connectivity, n:m linking through the central hub and enables all the applications that are connected to the hub can communicate with each other. Applications integrated in the system landscape stay the same as in its current state. These are major package applications and other SAPs as third party applications and legacy systems that must be connected to the central platform of SAP NetWeaver process integration PI 7.1.

For evaluation process interface complexity plays an important role, however more details we will be reviled in next chapter. We have normal complex interfaces that need up to 20 FTE (full time equivalent) of development, for middle complex interfaces 21 to 44 FTE needed and for development of very complex interfaces we need from 45 and more FTE. The majority of the interface complexities are middle with a few highly complex interfaces. Therefore, we will take middle complexity of interfaces with an average FTE development of 35 FTE (SAP consultant). As the development costs are expressed in factors of our calculations and the evaluation process will be done with the help of the factors expressed in FTE. The target state of the new architecture brings the ability to use the already existing interfaces that are reducing the numbers of interfaces where the complexity of interfaces stays the same. The administration of all the systems are driven through the hub which enables the central administration of monitoring activities which run from the sender to receiver through the hub, central administrated configuration or routing, mapping or design, and security.

## 8.2 Cost comparison

The cost comparison exposes cost differences that can be used as indicators of the argument for investment. The implementation of the EAI solution strategy decreases costs of maintenance and operating costs and essentially has a positive impact on the development costs. The reason for decreased costs is a different architecture of the p2p and the EAI; therefore we will display the behaviour of the two architectural costs. In this chapter we will compare the development costs of interface expressed with the full time equivalent (FTE) where calculations are done through a series of factors. The cost differences of development cost in software architecture of p2p and EAI are demonstrated with the help of four scenarios that can occur within company. These scenarios are:

- **Scenario 1**: Development costs in strong and weak connected landscape
- **Scenario 2**: Adding new interfaces in strong connected landscape
- **Scenario 3**: Bringing weak connected landscape into strong connected landscape
- **Scenario 4**: Replacement of existing system in strong connected landscape

### 8.2.1 Scenario 1: Development Costs in strong and weak connected landscape

In scenario 1 we will assess the development costs in strong and weak connected system landscape within p2p and EAI architecture topology. The applications in weak connected landscape systems are not connected to every application within the landscape system. We set that weak connected system landscape to have up to 35% of all application connections between the systems (in medium is up to 69% and in the strong category it is from 70% of all connections). We also set each application has one interface that need to be integrated. We know that in practice there is no fully, connected landscape system with the p2p architecture and that there can be more than one interface per system or application. We are setting this condition to be able to realize calculations and to demonstrate the differences between architecture topologies. Undoubtedly, several interfaces per systems increase the costs within the EAI unlike the p2p topology, where costs ratio stays the same.

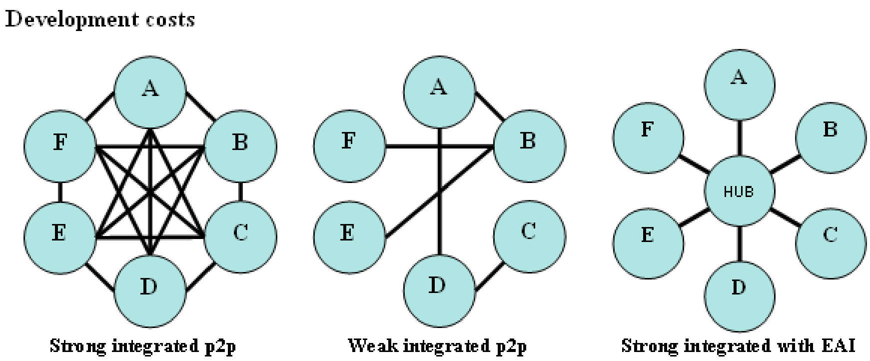
As the development cost of an interface we consider specifications, tests and deployments of interfaces. The development costs of an interface is driven by the number of interfaces (I), the full-time equivalent (FTE) factor, and daily rate of the developer which is demonstrated with its formula (10). The formula (10) applies in calculations of development costs in both architecture topologies.

*Development cost = I * (FTE * Daily rate)* (10)

Some factors of development costs are more or less the same as those in both architecture topologies. The Daily rates of the developer can be set for internal or external development experts by the company. In calculations, we consider the daily rate of internal expert. Since the daily rate of the development expert is in the p2p and the EAI architecture topology is the same it does not influence much of the behaviour of the development costs. Therefore we will appraise daily rate factor with 1.

**The full-time equivalent** factor (FTE) indicates how many days developer needs to integrate two applications together to develop interfaces that exist between systems. The FTE factor impact is a complexity of the interface. The higher the complexity is the more time is needed for the interface development. The analysis and design, implementation and test of interface are services that are counted in full-time equivalent factor. We set the complexity of the interface development in both architecture topologies is the same way, since we would like to expose the development costs when we have to develop the interface of the same complexity in different architecture topologies. Here, the FTE factor is set as 1. The main difference that appears in the development costs between the observed topologies is the number of interfaces that need to be developed. The difference in numbers of interfaces between strong and weak connections of the p2p architecture and the EAI is demonstrated in figure (2).

*Figure 2: Ratio of dev. costs in strong and weak connected landscape of p2p and EAI topology*




Now we will look at how the numbers of interfaces reflect the development costs. We suppose that one interface per system is the middle-to-normal complexity, and the daily rate as well as the FTE factor stay the same in both architecture topologies. The EAI software architecture decreases in the number of interfaces. If we have *n* systems we also need *n* interfaces within the EAI architecture topology which is shown by formula (2). With the p2p architecture we need to significantly develop more interfaces which shows us formula (1). So, if we look at the number of interfaces that need to be developed in the landscape system with 6 systems that represents strong connected landscapes with the EAI, we only need to develop 6 interfaces. With the p2p architecture we need to develop 15 interfaces to achieve the same number of systems in the system landscape, as is seen in figure (2). The development costs in the p2p architecture in the weak connected system landscapes are much lower. For the 6 systems the weak connected landscape are around 5 interfaces. If the development cost formula is multiplied with the factor 0.35 a weak connected landscape system is presented. The development costs expressed in the full-time equivalent (FTE) according to additional systems within the EAI and the p2p architecture in strong and weak connected system landscape is demonstrated in figure (3).

*Figure 3: Development costs of EAI in strong connected landscape and development costs of p2p in strong and weak connected system landscape*

**Error! Not a valid link.**

Figure (3) show us that if we have a strong connected landscape system up to three systems need to be integrated. Implementation of the EAI solution from the development cost aspect are no more cost efficient than the p2p architecture. But, if we have 4 or more systems in a strongly connected landscape system, then we should consider implementing the EAI solution. The more systems we convert into landscape systems the greater the saving will be in relation to the EAI in comparison to traditional p2p architecture.

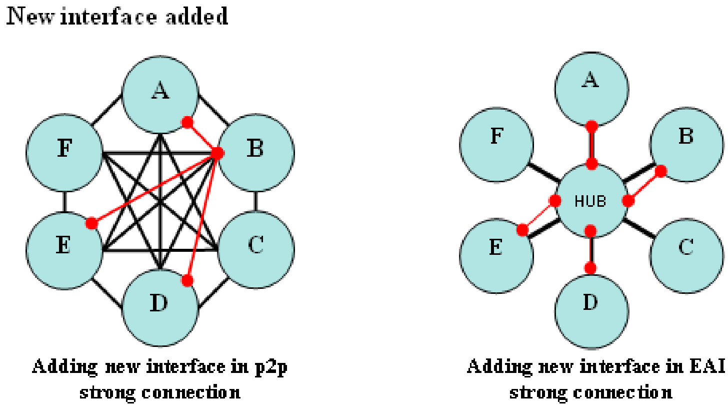
If we look at the p2p architecture in a weak connected system landscape, we notice that development costs within the p2p architecture are lower and do not increase as rapidly as the as the development costs of the p2p in strong connected system landscape. However the development costs in weak landscape systems compared to the EAI architecture are still higher. The EAI savings are 10 times greater than those of the p2p architecture in weak connected landscape. Therefore the weak connected system landscape is reasonably used within the p2p architecture if there are 10 systems or less. To choose the EAI architecture instead of continuing with the p2p architecture it depends on the strength of the connectivity and number of systems in the landscape system. If we are operating in weak connected system landscapes with up to 10 systems, it is reasonable to stay with the p2p architecture topology. In strong connected system landscape is reasonable to choose the EAI architecture that brings savings already with 4 applications in system landscape.

### 8.2.2 Scenario 2: Adding new interfaces in strong connected landscape

In scenario 2 we will observe what happen with the development costs when we want to integrate new interfaces in existing strong connected system landscape. This cost observation can be used for predicting enhancement costs that scoop changes and add new interfaces in the existing landscape.

We have already described the development costs that include the costs of specifications, tests and deployment activities. Formula (10) will be used for calculating the development costs. If we add a new interface into the existing system landscape the factors change. The daily rate factor stays the same regardless of the topology in 1. The number of interfaces stays the same in both observed topologies since we are adding additional interface into the existing system landscape. With the p2p architecture each new application needs to be connected to every application in the landscape in order to form a strong connection. Therefore, every application need to be configured and functionalities like mapping, monitoring, routing and security must be checked. When the EAI architecture applications are connected to the central hub every new interface also needs to be connected to the central hub. As we can see in figure (4) the red lines show the connections that needed to be built if we want the application in the B exchange and information to applications A, E and D. With the p2p architecture every point of application interface need to be developed and determine the data format, data flow etc. With the EAI this application interfaces determined the central hub with the help of pre-built adapters of applications, which represent less work for the developers.

*Figure 4: Ratio of connection when adding new interface in p2p and EAI strong connected landscape*




Because the central hub contains pre-build adapters, standards and enables functionalities like mapping, monitoring, routing and security, developers need less time to prepare specifications for interfaces, do the tests of interfaces and spend less time for the deployment of new interfaces in the system landscape. The factor that changes and plays a main role in these calculations is full-time equivalent. Here the EAI architecture can save us up to 40% work (sap consultant) by implementing new interfaces in comparison to the p2p architecture. The days that developers need for new interface implementations are conditional to the complexity of the interface. We set that we have middle complex interfaces for which developers need 35 FTE with EAI architecture (SAP info). Because the EAI architecture saves up to 40% of the implementing new interfaces the p2p architecture developers need 58 FTE to implement new interfaces. The cost difference between integrating new additional interfaces in the p2p landscape and the EAI landscape is shown in figure (5).

*Figure 5: Costs of adding new interfaces into strong connected landscape with p2p and EAI architecture*

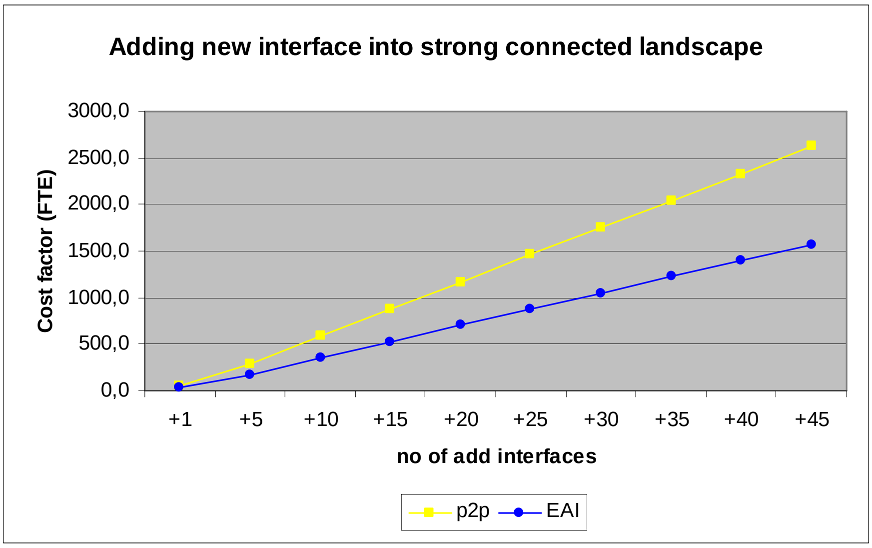



Figure (5) demonstrates how costs increase with additional new interfaces integrated in the strongly existing connected system landscape. We can see that with every additional interface in strong connected system landscape development costs are increasing in both observed topologies. The development costs of the p2p architecture are raising faster with every additional interface in comparison to the development costs of the EAI architecture. It is evident form figure 5 that if we integrated 15 new interfaces within the p2p architecture development costs are 933 FTE where the EAI topology is 525 FTE. It is clearly demonstrated that with the EAI architecture we can integrate interfaces much faster independent numbers of systems in landscape. On other hand, the costs can be considered as enchantment costs that are dealing with changes and adding's of new interfaces into already existing landscape, where these costs are much lower with the EAI architecture than with the p2p architecture.

### 8.2.3 Scenario 3: Bringing weak connected landscape into strong connected landscape

Scenario 3 is predicting development costs in situations where we want to change from weak connected system landscape into strong connected system landscape. The development costs in this scenario are driven by the number of systems in the system landscape. The FTE factor in this scenario fix is the same in both architecture topologies; the number of systems in system landscape differs from the architecture and the strength of the connection. Then our calculations can easily be realised when we set one interfaces per system. The development costs in scenario 3 are calculated with the formula as follows:

$$Development\ costs = FTE * no.\ of\ interfaces \qquad (11)$$

The EAI architecture topology represents a strong connected system landscape where every application is connected to the central hub and so communicates with every application connected to the hub. Here, the number of needed connections is equal to the number of systems, *n*, which is demonstrated by formula (2). With the p2p architecture we can have different levels of connectivity within the system landscape. In the first scenario weak connected system landscape represent up to 35% of all connections being developed in system landscape. Now if we want to change from weak connected system landscapes to strong connected system landscapes we need to develop and implement the missing percentage of connections that form strong connected system landscapes. The missing percentage of the connections in the system landscape is 65%. To calculate the number of interfaces in an already existing system, landscape is done with a p2p architecture topology, where *n* represents number of systems, we use calculations as follow:

$$\textit{Number of interfaces p2p} = (n-1) \qquad (12)$$

*Figure 6: Ration of connections of bringing weak to strong integration landscape in p2p compared to EAI*

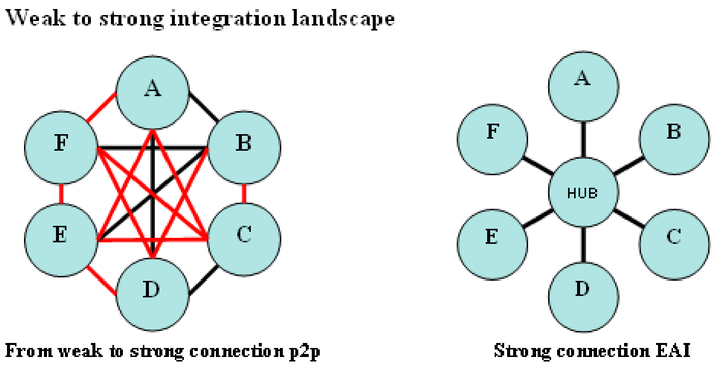
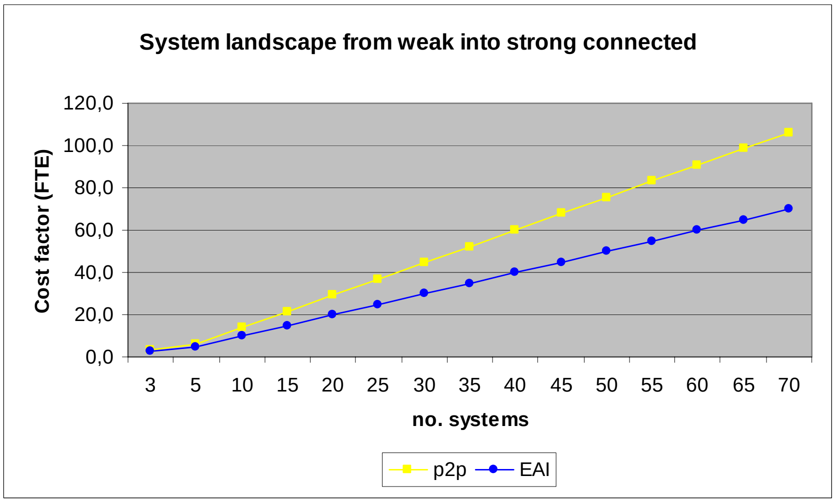



Figure (6) illustrates interfaces and connections that need to be developed and implemented to form strong connected system landscape, with the red lines. The red lines we are bringing to the p2p architecture convert the connection from weak to a strong system landscape. The EAI architecture already represents strong connected system landscapes and therefore there are no extra connections needed. Within the EAI architecture we will observe development costs for every interface and with the p2p architecture topology 35% of connections are already established therefore, we will observe the rest of the 65% interfaces that are needed to form a strong connected system landscape. Number of interfaces for the p2p architecture will divide by the factor 0.65 that represents the missing interfaces that need to be developed to form a strong connected system landscape. Figure (7) displays us with the development costs needed to form strong connected system landscape with two types of architecture topology. The yellow line represents the p2p architecture topology and demonstrates how high the development costs are to bring the weak connected system landscape into the strongly connected system landscape. The blue line represents the EAI architecture topology and demonstrates development costs that form strong connected system landscape. The development costs expressed with the FTE are conditional to the number of systems in system landscape.

*Figure 7: Development costs of forming strong connected system landscape with p2p and EAI architecture topology*




From figure (7) we can comprehend that the development costs expressed with the FTE in system landscape of 30 systems with the p2p architecture topology that forms strong connected system landscape such as the 45FTE. Development costs with the EAI architecture topology that forms strong connected system landscape are 30FTE. With the EAI architecture topology we have lowers the development costs of forming strong connected system landscapes. It clearly indicates that in case of forming strong connected system landscape we gain savings with EAI architecture.

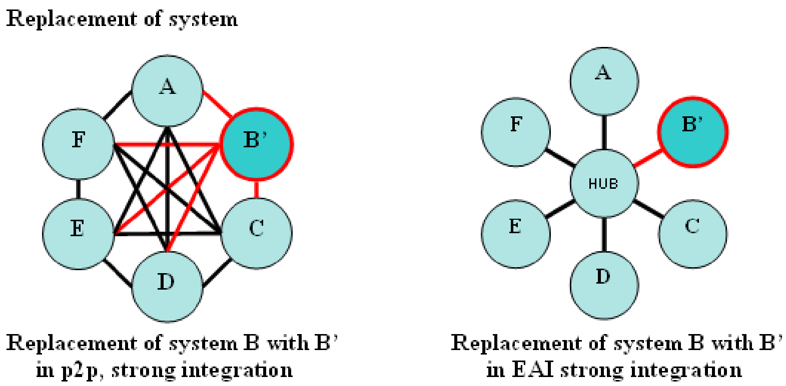
### 8.2.4 Scenario 4: Replacement of existing system in strong connected system landscape

Scenario 4 demonstrates the development costs of a system in an existing and strong connected system landscape has to be replaced. This scenario is quite frequent and it can happen when we have many legacy systems that cannot operate properly, are hard to maintain and administrate or when new technologies or approaches appear.

We will observe the development costs of the system replacement in strong connected system landscapes with 50 systems or applications in the system landscape. The FTE factor determines days needed for replacement of one system and is equal in both software topologies. Costs of replacement are driven by the number of systems that need to be replaced in fix determined landscape. Quantity of interfaces needed to be developed is driven by the number of systems in system landscape. The quantity of interfaces differentiates by architecture topology. With the EAI topology number of interfaces depends of connected systems, *n*, that is fix factor in this scenario. Because all of the systems and applications in the system landscape are connected to the central hub and we are dealing only with the development costs of the interfaces between central hub and system that need to be replaced. With the p2p topology the number of interfaces depends of number of systems in system landscape. Because within the p2p topology in strong, the connected system landscape each system or application is connected to other system in system landscape and the fact that we are calculating number of interfaces in existing system landscape we use formula (12).

The figure (8) demonstrates a replacement of system B with system B’. The red lines represent the connections that have to be newly developed when replacing systems in strong connected system landscapes. Within the p2p architecture topology application interfaces need to be newly developed at every application in system landscape to which is system B’ connected. Within the EAI architecture topology, new interface development is only done on the central hub and the system adapter of the new system, system B’.

*Figure 8: Ration of connections when system B needs to be exchanged with system B' in strong integrated p2p and EAI landscape*

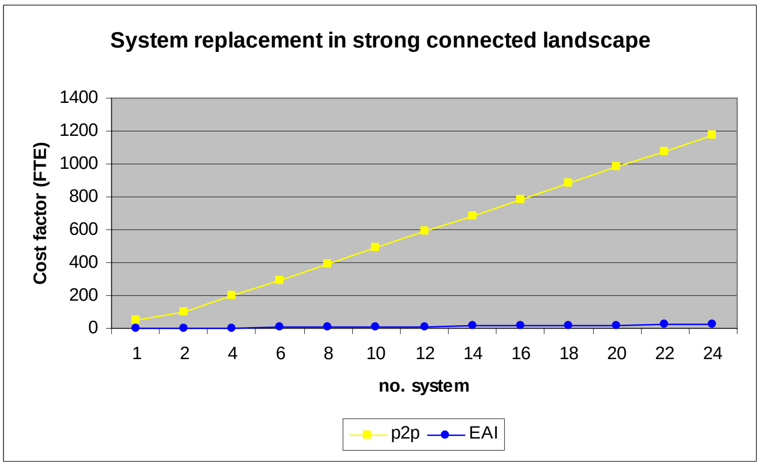



We described what influences the development costs of the system replacement and we can set a common formula. The Development costs of system replacement depend on the cost factor (FTE), system landscape (n), the number of systems (s), and the number of existing interfaces (i) that is set in figure 1 and are calculated with formula as follows:

$$\textit{Development costs of system replacement} = FTE * n * s * i \tag{13}$$

In figure (9) we can see the cost difference between the development costs of the system replacement in strongly connected system landscape. The yellow line of the p2p is rising significantly because of the architectural topology where the system replaces new interfaces which have to be developed on every existing application in the system landscape to achieve a strong connectivity. With the EAI these costs are much lower, as the replaced system only needs to be integrated to the central hub to which the other applications in system landscape are connected. The newly developed ones are only interfaces between the central hub and the replaced system.

*Figure 9: Costs of replacement of existing application in strong connected system landscape*




With figure (9) we can see the significant cost savings of the EAI architecture when replacing the system to a strong connected landscape. If we have a system landscape with 10 strong connected systems and we have to replace one system within the p2p architecture topology and the development costs of system replacement will be 980 FTE whereas the EAI architecture topology is only 20 FTE. It is certainly reasonable when we are dealing with the legacy systems that will have to replace some other systems to make this replacement in the EAI structure of the system landscape.

With the help of all four scenarios we were able to create a picture of how development costs are behaving in the p2p and the EAI architecture. We can clearly see that number of interfaces play the main role and influence the development costs. In all scenarios the development costs are significantly lower within the EAI architecture than with the traditional p2p architecture topology that is a consequence of the reduction in number of interfaces. With the help of pre-build adapters, developers need less time to develop and integrate the interfaces. In the following chapter we will review other cost components and the benefit factor and calculate the evaluation methods to assess the EAI topology from a financial point of view.

## 8.3 Evaluation

As a solution of the architecture topology is solved it is now possible to asses the financial indicators. With this evaluation process we can to calculate the point at which the implementation of the EAI software is profitable in comparison to the traditional p2p architecture topology. This calculation will be done with the help of a break-even analysis described in chapter 3 and it will represent a break-even point of the EAI architecture topology. The ROI analysis will be used to identify the return on investments and screen out if the IT investment in the EAI technology presents the risk that can reduce the business value. With the TCO method we will support the decision of choosing the NetWeaver as an integration product. Before we start with calculations we have to conduct a cost and benefit analysis. With the assistance of Daimler's colleges cost and saving factors of the EAI and the p2p architecture were expressed in FTE (full time equivalent) factor for operations of maintenance, error management, and business process management shown in table (1) on next page.

*Table 1: full time equivalent factor of operations*

| Operations | **FTE** |
|---|---|
| Maintenance | 440 |
| Error management | 110 |
| Business Process | 40 |

To realize the evaluation of the IT investment in the EAI technology we have to perform a cost and benefit analysis.

### 8.3.1 Cost analysis

In this chapter we will take under the scope of operating and maintenance costs and close the chapter with calculating the total costs of the EAI and the p2p architecture topology. The cost factors monitoring, error handling, adjustment configurations, data/software updates and data volume were observed in the p2p and the EAI architecture topology. With the help of Daimler's experts, suitable parameters were assigned to each factor so that the calculations could be realized. The Differences within the operating/maintenance costs factors are show in appendix 16. To assure relevant cost comparison within the EAI forms a strong connected system landscape we observe both topologies in the strong connected system landscape.

From appendix 16 is seen that all of the observed cost factors represent lower expenses within the EAI architecture in comparison to the p2p architecture. The monitoring costs within the EAI architecture are much lower than within the p2p architecture. The reason is the central hub that enables a centralized control and monitoring of applications connected to the hub. The p2p topology monitoring has to be done at every integration point of every application which makes the operational costs of the p2p in comparison to the EAI architecture double as high. The same occurs when reviewing the EAI topology, which enables centralized error handling whereas the p2p architecture we have to look at every integration point of each application in system landscape. The work doubles within the p2p architecture which makes the expenditures, in comparison to EAI architecture, twice as high.

The expenses of adjustments in configuration with the EAI topology are lower than within the p2p topology. The costs of the adjustments within the configuration are a lower characteristic of central hub that comes with pre-build adapters. This saves up to 40% of the time that developers devote to these adjustments. A further adjustment is the configuration cost driven by the number of interfaces. The EAI topology applications are directly connected to hub which reduces the number of interfaces, where the p2p topology applications are connected directly to other applications in the landscape and adjustments have to be done at every point that this application is connected to. Furthermore the Data/Software update expenditures are higher within the p2p than in the EAI architecture. Data update costs are driven by the number of interfaces where this number is much lower than within the EAI due to the central hub, to which all the applications are connected to. This makes data updates easy to maintain where the p2p topology on every integration point in landscape updates have to be sent and checked. The data exchange volume expenditures are lower with the EAI where much a higher data volume can be exchanged in shorter time between applications than with the p2p where the administration costs of data volume are more than double the amount.

With the help of parameters that have assigned the value of the cost factors we could show that not only are the development costs of operating and maintenance lower but the costs are also lower in comparison to the traditional p2p architecture. The architecture costs are different in comparison to those of operating/maintenance costs. The costs of hardware and software are included in the architecture costs which represent a significantly higher expenditure for the EAI architecture in comparison to the p2p architecture. To implement the EAI system special platforms, servers, adapters and software are needed to implement the EAI system. For accurate functioning of the p2p architecture no special hardware or software is required, therefore we have no architectural costs within the p2p architecture topology. In architecture costs we also count costs of licences that in p2p architecture do not occur.

To completed the cost analysis, besides the operating/maintenance costs and architectural costs the development costs also need to be considered which are further discussed in chapter 6.2. Table 2 shows the total costs sorted by their main cost categories for the EAI and the p2p architecture which are expressed in the cost parameter of the FTE.

*Table 2: table of total costs with EAI and p2p architecture expressed in FTE for 200 interfaces*

| Total costs in FTE for 200i | EAI | p2p |
|---|---|---|
| Architecture costs | 3450 | 0 |
| Operating / Maintenance costs | 1947 | 2950 |
| Development | 7000 | 11600 |
| **Total costs** | **12397** | **14550** |

It is possible to draw the total costs of implementing applications with the EAI architecture and p2p architecture from the table above. The total costs of the EAI are lower than the total costs of the p2p architecture although the latter have no architectural costs.

### 8.3.2 Benefit analysis

The evaluating benefits of IT investments are hard as they can be expressed through indirect forms which are not necessary seen as a profit to the company. Usually, benefits of IT investments are expressed through savings in business processes, in maintenance, in development and in efficient error management. Such savings can reflect as a reduction of personal or can contribute to higher customer satisfaction and improved relations with suppliers and business partners. The benefits of the EAI in comparison to the p2p architecture topology are show in appendix 17. The developers need less time to develop and integrated the interfaces with the EAI however there are fewer interfaces to integrate. This time could be used more efficiently if the developers worked on some other task, in other words, we could employ less personnel for the interface development activity. Time saving can further be achieved through maintenance activities when the data updates are only done centrally and only once which creates significant savings in comparison to the p2p where every point of interface application has to be assessed and updated. A further benefit of EAI is the efficient error management which is carried out through centralized monitoring that rapidly points out mistakes in business processes and only takes a few seconds to send alerts through emails or mobile messages to the responsible actors. Mistakes in business processes can be discovered much sooner; there is less downtime for employees while they are waiting for the hindrance in processes to be discovered and dispatched. Moreover the costs of the end reparation are lower as are the costs of the guarantee. The EAI architecture includes a component that helps form business processes. Technology provides IT departments with a framework of tools to design, model, implement business processes, run, monitor, operate and improve business process flexibility throughout their life cycle. These tools are used by companies to standardize and optimize operational processes, improve quality and increase agility. With the p2p architecture we have no feasibility to realize these operations. Here the EAI architecture is in an enormous advantage in comparison to the p2p architecture.

Applications, that are seamlessly integrated with one another and can share information increase data quality. There is no double data entry and the data become more accurate, therefore all these benefits reflect a better operating process in production, logistics and data management**.** For example, with accurate data we can predict an accurate amount of supply parts which are needed. Even more so, accurate data leads to accurate information of the inventory state. It can be assured that supply orders and shipments of supply parts are realised in real time with minimal investments. A better view of a material flow prevents the downtime of employees where there is no need to wait on continues supplies of materials that represent an increase in productivity. The absence of the central hub in the p2p architecture topology makes the maintenance of consistent data as well as administration more complicated than with the EAI architecture. If we do not assure efficient maintenance and administration of data within the p2p architecture we can face consequences such as data inconsistency. It increases the risk of storage with inconsistent information which can reflect as a too high or too low inventory. A bad overview of a material flow may supply parts which cannot be delivered on time to assemble the line of increased downtime of production.

To realize the evaluation part we have to multiply the set factors with the value expressed in the FTE. The total benefits of the EAI and the p2p architecture are shown in table 3. We can see that the EAI architecture brings the highest benefits. The highest savings that the companies gain with the EAI implementation are in the development of interfaces.

*Table 3: Table of total benefits for EAI and p2p architecture expressed in FTE for 200 interfaces*

| Total benefits in FTE for 200i | EAI | p2p |
|---|---|---|
| Savings in development | 21000 | 11600 |
| Savings in maintenance | 880 | 440 |
| Efficient error management | 275 | 110 |
| Savings in business processes | 160 | 40 |
| **Total benefits** | **22315** | **12190** |

In the following chapter we will discuss the evaluation results and the argument for the EAI topology from a financial viewpoint based on a cost-benefit analysis.

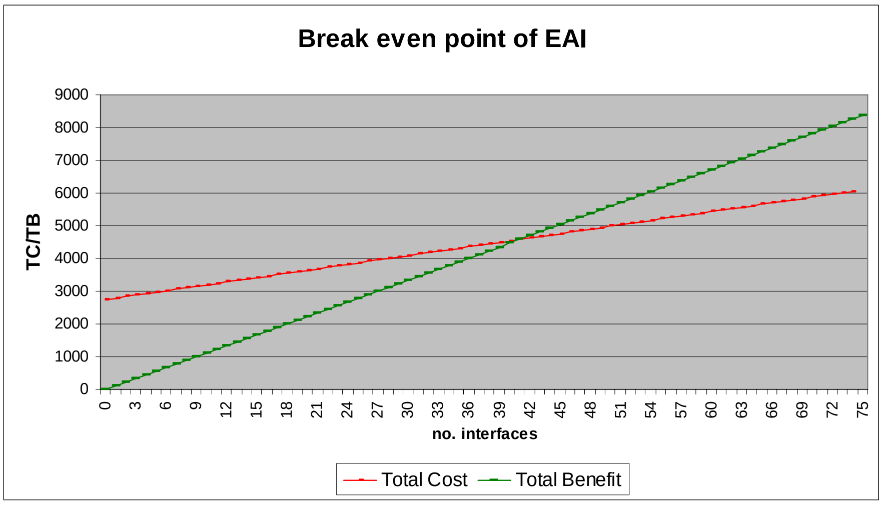
## 8.4 Financial feasibility discussion

With the conducted costs and benefits analysis calculations of the ROI and the TCO, the break-even point can be realized. With the break even analysis we can answer our main question and fulfil the purpose of thesis. To calculate this point it is reasonable to integrate the applications with the PI (EAI architecture topology), or in other words it is the IT investment in the EAI technology justified.

With the help of the TCO method we can argue for a selection of products. The TCO review costs of owning, operating and controlling the NetWeaver PI 7.1. The company guides software distribution strategies of homogenise system landscapes where the majority of the software products are distributed by the SAP vendor. The company has already applied for a SAP integration tool on several other projects; therefore the company is already aware of the SAPs products and their integration platform. These facts influence the TCO information system PI 7.1. There is already a built technological infrastructure what makes the hardware and software costs of the SAP integration tool lower. Administration activities will devote less time to organise trainings for workforces and the operating and support of familiar software will have a positive effect on the operation and administration costs. The funds for training of workforce are also lower, for formal learning and opportunity seminars since the employees have already met with technology of the known vendor. The presence of the help-desk that emerged with preliminary projects in the integration technology will be much lower. The ability to corporate knowledge can be exchanged within the corporation is significantly influences the TCO.

Break-even analysis is calculated where the total costs are equal to the total benefits and expose the break-even point of PI (EAI architecture). Figure 10 shows the break even points, where the TC and TR curves break at 41 interfaces. At this point the costs are equivalent to the benefits where implementations of PI bring neither losses nor profit. On the right side of the break-even point we have gained what the EAI architecture bring, where benefits are higher than the costs. From this point on the IT investment in the PI is justified. The break-even point losses the implementation of what the EAI architecture would bring as the costs here exceed benefits. This signifies that it is lucrative if we do not implement the EAI technology.

*Figure 10: Break even point of EAI architecture*




If we have a landscape of less than 41 interfaces it is recommended to stick to the traditional p2p architecture. The costs of PI are too high and benefits that the PI brings are too low. If we would implement the PI (EAI architecture) in a system landscape with less than 41 interfaces we would not achieve a cost effective operation but rather operate with a great loss. When we have to integrate 41 and more interfaces it is cost efficient and economical justified implementing PI (EAI architecture). Here the benefits are higher than the costs which are expressed in the profitability of the investment.

The financial methodology of the ROI, which is described in chapter 3 and defined by formula (4) we have calculated that the ROI ratio of IT investments in the PI (EAI architecture) is 0,761. It means that with the IT investment in the EAI we have gained 76.1% of the invested money. The ROI of the IT investment in the PI is positive and it represents greater return on investment what indicates that this IT investment is justified.

Financial evaluations have indicated positive results for the chosen PI 7.1 EAI topology. The TCO gets lower with the SAP integration product as the company is already using SAP products where some software knowledge already exists within the company. The ROI is positive and high enough which means that an investment in the EAI will bring greater returns and the break-even points indicate that system landscape with 41 interfaces and more of these should be using the EAI topology to integrate applications. We can propose the PI 7.1, EAI topology for real time companies (what kind of companies?) from both an architectural and financial point of view.

* * *

The case study of the EAI project at Daimler AG has shown how organisations deal with applications for integrations. The integration of the EAI project within the Daimler AG follows the outlined logic in theoretical part and answer questions such as “what”, “how” and “how much”. The logistic department at Daimler AG in Sindelfingen has been dealing with problems within series logistic. These problems are; the heterogenic processes that are cross plant barely standardised, bad process control and redundancy of master data. About 500 interfaces and about 20 year old systems which “know how” bearer extinct and further problems have build the state that is hard to maintain. The Implementation of the continuous improvement processes cross plant will not be possible in future. Within series logistic cross plant standardisation and enterprise applications integration with hub & spoke architecture topology of SAP NetWeaver PI 7.1 product will be realised. We have reviewed the chosen topology from an architectural and financial standpoint. The architectural viewpoint enable the EAI data transformations, mapping and routing technologies that integrate systems seamlessly where exchange of information is easily realized without writing additional codes. The business process engines enable a control increase and automation of business processes. Centralized monitoring and administration are simplifying management and operation of large integration infrastructures. It assures a guaranteed delivery and accurate data and enables real-time information operations. From a financial standpoint the EAI economically requires a lot of resources. Architecture and licences expenditures are especially high, however the costs of development and number of interfaces that need to be developed have reduced with the help of pre-build adapters and central hubs with centralized monitoring and administration costs of operating and maintenance sink. It is not necessary that integration solutions need to be at reasonable price, the benefits that integration solutions bring should be high enough in themselves. With the help of the ROI, the TCO and the break-even point it is possible to determine the investment in the EAI topology which is economically justified when companies want to integrate more than 41 interfaces within a system landscape. It is reasonable that companies invest into the EAI project and the implemented EAI architecture topology cross plant to enable modernised business processes, standardisation and centralized control.

## CONCLUSION

Constantly changing environment, innovations and worldwide globalisation force corporations have to have flexible business processes and follow environmental challenges. Organisations try to share real-time data within organisations, with customers, partners and suppliers in order to maintain competitiveness. To be able to share data and information with end users, customers, and suppliers companies have to integrate their systems and applications. As we have learned from this thesis and case study, companies must consider applying applications integrations upon which the three questions of “what”, “how”, and “how much” must be raised.

The case study of the EAI project at Daimler AG demonstrates how organisations deal with applying application integration. The integration of EAI project within Daimler AG follows the outlined logic of three questions. Firstly, companies have to define what problems they are faced with and what do they want to achieve with the application of integration. In the analytical part they have to look at the EAI technology from an architectural and financial viewpoint. Corporations that wish to solve integration problems can choose among different levels of integration; the data level integration, the application of the integration level, and method levels of integration. Companies use these levels to determine what they wish to achieve with the EAI technology. Integration enterprise applications can be carried out through three different architecture topologies; the traditional point-to-point topology, the hub-and-spoke topology, and the bus system topology. Here companies have to analyse the architecture of the topology from an architectural and financial viewpoint. From an architectural standpoint, companies compare architecture topologies and establish how to integrate enterprise applications. Contrastingly, the financial viewpoint companies examine the feasibility of the EAI topology and assess whether the investment would be an economically sound move. With the help of the cost-benefit analysis companies can support or reject investment within the EAI topology.

The main issue in the thesis is the idea that application integration is complex and that it involves diverse integration levels where the expertise of architecture topologies and economical knowledge is needed. The chosen EAI topology must be open and extensible to changes, cost effective and economically justified. The most suitable architecture topology is not always the most cost effective or economically justified, thus if the organisation decides to implement enterprise application integration into all interfaces and applications into the system, landscape should be connected to the EAI architecture topology. The Break-even point can occur even sooner which can justify the EAI project before it is even rejected. Halfway progressing in such complex and exacting projects brings no effort rather brings higher costs and inefficiency in performance realization. We can say that enterprise application integration is more and more present in companies worldwide and sooner or later application integration will not represent a practice of the future but rather the ultimate best practice.

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# APPENDIX

## Appendix 1: Povzetek diplomske naloge v slovenskem jeziku

### ANALIZA INTEGRACIJE POSLOVNIH APLIKACIJ KOT POSLOVNE REŠITVE: PRIMER DAIMLER AG

### UVOD

Svetovna globalizacija in hitro spreminjajoče se okolje silijo podjetja, da oblikujejo fleksibilne poslovne procese. Nove aplikacije in tehnologije zahtevajo, da podjetja delijo prave podatke znotraj organizacije, s strankami, s poslovnimi partnerji in dobavitelji ter tako ohranjajo konkurenčnost, odpravijo neučinkovitosti in zmanjšajo stroške. Informacijska tehnologija se je tako razvila, da v ospredje ni več postavljen samo razvoj informacijskih sistemov, temveč tudi integracijski del. Najrazličnejše aplikacije in informacijski sistemi, ki so jih podjetja vpeljala v poslovanje, so prispevali k boljšemu upravljanju s podatki in informacijami. Raznovrstne aplikacij in informacijski sistemi različnih ponudnikov, ki so bili vpeljani v podjetja, v različnih časovnih obdobjih, so privedli do problemov heterogenosti sistemske strukture, informacijskih otokov in špageti strukture integriranih aplikacij. Veliki organizacijski sistemi, kot so ERP, SCM, CRM, bi morali biti medsebojno povezani, da bi delovali učinkoviteje, vendar je integracija velikih operacijskih sistemov zelo kompleksna ter zahteva veliko časa in sredstev. Spodbujena komunikacija in izmenjava informacij med aplikacijami in informacijskimi sistemi, je sprožila potrebo po Integraciji Poslovnih Aplikacij (IPA ali EAI – *enterprise application integration*), tehnologiji, ki omogoča standardizirano komuniciranje med aplikacijami in informacijskimi sistemi ter pomaga pri odpravljanju omenjenih problemov.

Namen diplomske naloge je služiti kot priročnik za podjetja, ko poskušajo vpeljati integracijo poslovnih aplikacij v podjetje. Razložiti kaj integracija poslovnih aplikacij omogoča, kaj so prednosti in slabosti IPA. Predstaviti nivoje integracije ter opisati arhitekturno topologijo IPA, katero podjetje lahko vpelje kot strateško rešitev. Izpostaviti pomembnost ekonomike informatike, predstaviti finančne metode in razložiti, kdaj je primerno, da podjetja vpeljejo IPA. Tako odgovorimo na vprašanja »kaj«, »kako« in »koliko«, ki si jih zastavlja vsako podjetje, ko razmišlja o integraciji poslovnih aplikacij.

Cilj diplomske naloge je predlagati ustrezno arhitekturno topologijo IPA za podjetje, ki razmišljajo o vpeljavi IPA in analizirati odločitev o izbiri arhitekturne topologije v podjetju Daimler AG. Predlog bo podan na podlagi rezultatov iz analiz stanja podjetja in ocen topologije z arhitekturnega in finančnega vidika.

Diplomska naloga je sestavljena iz dveh delov; teoretičnega in praktičnega. V teoretičnem delu se bomo osredotočili na vprašanja, ki si jih zastavljajo podjetja, ko vpeljujejo IPA. Na kratko bomo opisali pomen informacijske tehnologije v podjetjih, pregledali s kakšnimi problemi se soočajo podjetja, kaj jih pripravi, da začnejo razmišljati o IPA, in kaj želijo doseči z IPA. Na kratko bomo opisali topologijo IAP in predstavili kako lahko podjetja vpeljejo IPA. Za konec teoretičnega dela pa se bomo še posvetili finančnemu delu. Predstavili bomo pomen ekonomike informatike ter opisali finančne metode, ki omogočajo izvedbo analize stroškov in koristi. Praktični del sledi konceptu iz teorije in se bo prepletal s teoretičnim delom. V praktičnem delu bomo pregledovali primer IPA projekta v podjetju Daimler AG ter si tako pomagali, z ilustrativnimi primeri, bolje približati teoretični del.

## 1 INFORMACIJSKA TEHNOLOGIJA V PODJETJIH

Uporaba informacijske tehnologije je vedno bolj prisotna v podjetjih, saj s pomočjo IT lahko dosežemo večjo fleksibilnost in razpršenost dela, skrajšamo čas dela, vzpostavimo boljše odnose s strankami ter zmanjšamo zalogo in delovno silo. IT omogoča pretok informacij na organizacijskem nivoju, vendar zaradi večje količine podatkov in informacij lahko povzroči poplavo in neobvladljivost informacij. IT predstavlja predvsem podporo primarnim aktivnostim podjetja, kot tudi sekundarnim aktivnostim, in tako omogoča podjetju pri dodatnem ustvarjanju dobička, kar je opisano s konceptom Porterjeve verige. IT kot podpora posameznikom v podjetju olajša delo, omogoča da delavci delajo hitreje, in upravljajo z več informacijami, obenem pa nudi večjo fleksibilnost dela, kjer delavci lahko prispevajo svoj delež, ko niso na delovnem mestu (*telecommuting*). Poleg pozitivnih dejavnikov IT, lahko le ta negativno vpliva na zaposlene. Zaradi velikih količin informacij so delavci preobremenjeni, ker je lahko veliko podatkov neažurnih, lahko delavci dvomijo o kvaliteti podatkov, hkrati lahko IT povzroča manjše zdravstvene težave. Informacijski sistemi, ki omogočajo zaposlenim, predvsem managerjem, pri poslovanju in odločanju so; sistemi za upravljanje znanja (KM), sistemi za podporo odločanju (DSS) in poslovna inteligenca (BI).

IT ne služi le kot podpora posameznikom temveč tudi poslovnim procesom v podjetjih. Da bi podjetja bolj učinkovito upravljala s podatki, izvedla učinkovitejše analize, in si pomagali pri odločanju, so vpeljale različne informacijske sisteme, v različnih oddelkih. Veliki poslovni sistemi so; sistem celovitih programskih rešitev (ERP), sistem za upravljanje oskrbovalne verige (SCM), sistem za upravljanje odnosov s strankami (CRM) in drugi. Sistem, ki omogoča poslovanje in komuniciranje izven organizacije s poslovnimi partnerji je sistem EDI. Vsi navedeni sistemi predstavljajo najboljšo prakso poslovanja, ker je konkurenčnost na trgu vedno večja, morajo podjetja posegati po novih alternativah. Tako se razvoj informacijske tehnologije razvija v smeri integracije aplikacij. V nadaljevanju bomo pogledali s kakšnimi problemi se managerji soočajo, in kaj je rešitev na obstoječe probleme znotraj podjetij.

## 2 INTEGRACIJA POSLOVNIH APLIKACIJ KOT POSLOVNA REŠITEV

Veliko organizacij je vpeljalo najrazličnejše organizacijske sisteme, da bi si olajšali poslovanje, vendar konstantno spreminjanje okolja sili podjetja, da se prilagodijo spremembam, ki prinašajo novosti. Ker so se informacijske sisteme vpeljevali v različnih časovnih obdobjih, različnih ponudnikov, podjetja vsebujejo najrazličnejše aplikacije, sisteme, katere so podjetja prilagodila sama, ali so le ti del starega sistema, ki obratuje na različnih poslovnih ravneh. Tako vsaka aplikacija uporablja različen programski jezik, različno tehnologijo baz podatkov, je podprta z različnimi operativnimi sistemi in deluje na različni strojni opremi. Vse omenjene raznolikosti vodijo v problem heterogenosti sistemov, saj so aplikacije med seboj nezdružljive, ne morejo komunicirati, si deliti poslovnih pravil in informacij, ne da bi vanje posegali. Obenem inovacije in nove tehnologije na trgu pogosto privedejo do »upravljanja po trendu«, ko je v poslovno okolje vpeljana najnovejša in modernejša aplikacija, in ne tista, ki bi najbolje sledila informacijski strategiji in poslovno podprti odločitvi. Zagotovo aplikacije in programske rešitve delujejo učinkovito, vendar lahko predstavljajo informacijske otoke, ali informacijske silose, in onemogočijo komuniciranje s sorodnimi sistemi znotraj podjetja. To povzroči pritisk na oddelke IT, da poiščejo alternativne rešitve, do nedostopnih podatkih v informacijskih silosih, ali kar sami zaposleni poskušajo razviti primerno rešitev, in tako premakniti podatke med ključnimi sistemi. Posledično, ko se podatki spremenijo, so spremembe narejene na posameznih mestih, kar privede do podvajanja vnosa podatkov in neažurnosti podatkov. Problemi se pojavijo tudi kadar podjetja želijo izmenjati podatke, izven podjetja, s poslovnimi partnerji. Z E-poslovanjem je podjetjem omogočena izmenjava podatkov različnih poslovnih procesov s številnimi drugimi podjetji. Tukaj se morajo podjetja dogovoriti katere standarde bodo podjetja uporabila. Pojavi se potreba po odprtih poslovnih procesih, po integrirani oskrbovalni in vrednostni verigi, da lahko podjetja poslujejo, kot celota, s poslovnimi partnerji. Nekatera podjetja so že integrirala poslovne aplikacije, da bi omogočila nemoteno izmenjevanje podatkov, vendar je večina pri tem uporabila tradicionalen, takrat edini obstoječi ali primeren način povezovanja aplikacij, ki v obsežnejšem obsegu aplikacij v sistemskem okolju povzroča »špageti« strukturo. »Špageti« struktura je skoraj nemogoča za vzdrževanje in povzroča gromozanske stročke administracije, vpeljave novih aplikacij, nadzora in vzdrževanja.

S podobnimi problemi so se soočali v podjetju Daimler AG. V podjetju Daimler AG, proizvajalcu osebnih avtomobilov s sedežem v Nemčiji, Stuttgart, so se odločili, da izpeljejo projekt IPA v logistiki, in sicer serijski logistiki. Probleme, ki jih je podjetje videlo v serijski logistiki so; procesna heterogenost, ki čez proizvodnjo ni standardizirana, slab nadzor nad funkcionalnimi informacijskimi sistemi (IS), logistični sistemi stari 20 let, katerih nosilci znanja izumirajo, nadaljnji razvoj IS je v prihodnosti otežen. Tako želijo s projektom I PA preprečiti tveganja za zmanjšano tehnološko podporo s strani ponudnikov IS in razvijalcev IT, povečanje napak zaradi napačnega delovanja različnih tehnologij, zmanjšan nadzor nad vzdrževanjem, nadaljnjim razvojem in delujočimi procesi, ter zmanjšano možnost dodajanja novih aplikacij z veliko kompleksnostjo. Cilje katere želijo doseči v podjetju so; modernizirati logistične procese s konkurenčnimi poslovnimi procesi, čez proizvodnjo vpeljati standardizacijo procesov in posodobiti IS ter zamenjati stare sisteme. V naslednjem poglavju si bomo pogledali IPA, kot poslovno rešitev.

### 2.1 Integracija poslovnih aplikacij

Integracija poslovnih aplikacij je neomejeno izmenjevanje podatkov in poslovnih procesov med vsemi povezanimi aplikacijami in podatkovnimi viri v podjetju. Je sklop tehnologij, ki omogoča premikanje in izmenjavo informacij, med različnimi aplikacijami in poslovnimi procesi, znotraj podjetja, kot med podjetji. Z IPA je podjetje sposobno povezati poslovne procese, znotraj kot zunaj podjetja, s svojimi poslovnimi partnerji in strankami, in tako ustvariti dinamično globalno organizacijo. Z IPA so vse večje, neodvisne aplikacije in IS medsebojno povezani, brez večjih posegov v aplikacije ali podatkovne strukture. Tako lahko, kljub nezdružljivi tehnologiji znotraj sistemov, podatkovni tok teče gladko. Cilj IPA je povezati in upravljati tok poslovnih procesov v različnih aplikacijah in poslovnih enotah ter hkrati omogočiti zaposlenim, managerjem in poslovnim partnerjem, hiter dostop do poslovnih podatkov. IPA omogoča učinkovito povezovanje s poslovnimi partnerji, dobavitelji in strankami, kar zagotavlja polno povezano oskrbovalno in vrednostno verigo ter učinkovitejše E-poslovanje. Podjetje lahko, s pomočjo IPA, brez večjih ovir vpelje nove storitev in produkte, v sistemsko okolje z obstoječimi aplikacijami. IPA zagotavlja neodvisnost od ponudnikov IS, saj lahko povezujemo najrazličnejše aplikacije in IS med seboj.

IPA je izvedljiva v treh integracijskih nivojih, podatkovnem nivoju integracije, aplikacijskem nivoju integracije, in integracijski nivo metod.

- **Podatkovni nivo integracije**, je proces, ali tehnologija, premika podatkov med dvema ali več baz podatkov, ki omogoča izmenjavo relativne poslovne informacije s sistemi in aplikacijami, kjer poznavanje in razumevanje aplikacijske logike ni potrebno. Transformacijske in prenosne storitve omogočajo, da so podatki izvlečeni iz ene ali več baz podatkov, spremenjene, če je potrebno, in postavljene v ciljno bazo podatkov (BP). Primer podatkovnega nivoja integracije je razviden na primeru, kadar moramo premakniti podatek o prodaji iz ene BP v drugo. Ko je podatek o prodaji zabeležen v ERP sistemu, je zabeležen nek dogodek, nova informacija je kopirana v sistem zalog, kjer čaka na izvršitev dejavnosti. Prednosti tega nivoja je cenovno ugodna tehnologija in enostavnost, saj gre za prenos podatkov, kjer ni potrebno razumevanje logike poslovanja, tako ni poseganja v kodo aplikacije. Podatkovni nivo je primeren kadar podjetja želijo izmenjati samo podatke, in poznavanje poslovnih pravil in logike ni potrebno.
- **Aplikacijski nivo integracije**, omogoča povezovanje aplikacij s pomočjo vmesnika aplikacijskega programa (API), da si le ti izmenjujeta poslovne procese in podatke. Razvijalec izpostavi vmesnik aplikacije in tako omogoči, da si povezani aplikaciji, izmenjujeta poslovne procese in podatke. Primer; kadar je SAP podatek zahtevan iz Excela, SAP izpostavi vmesnik, ki omogoči, da uporabnik pokliče željen poslovni

proces ali skupen podatek. Z uporabo vmesnikov se izognemo spreminjanju kod aplikacij, ki predstavlja veliko kompleksnost dela in ogromen strošek. Aplikacijski nivo se uporablja kadar aplikacije želijo izmenjati poslovne procese in podatke, kjer je poznavanje aplikacijske logike in poslovnih pravil potrebno.

- **Integracijski nivo metod**, omogoča, da je podjetje povezano z delitvijo poslovne logike in metod, ki obstajajo znotraj podjetja. Metode se lahko izmenjujejo z gostovanjem na skupnem fizičnem strežniku, ali z dostopom do metod znotraj aplikacij, z izmenjavo distribucije metod. S tem nivojem ustvarimo sestavljene aplikacije, ki vsebujejo infrastrukturo za izmenjavo poslovnih procesov. Da bi to lahko dosegli, moja biti zavedene spremembe v izvirno kodo aplikacije. Ta nivo je stroškovno zelo drag, in zahteva korenite spremembe, ne samo aplikacij, temveč tudi poslovnih procesov.

V podjetju Daimler AG so se odločili za aplikacijsko integracijski nivo, saj želijo med seboj povezati aplikacije, ki bi si lahko izmenjevale poslovne procese in podatke. Kot smo videli lahko podjetja uporabijo različne integracijske nivoje za reševanje svojih problemov, v naslednjem poglavju poglejmo, kako lahko podjetja integrirajo poslovne aplikacije.

# 3 ARHITEKTURA IPA

Topologija arhitekture IPA se deli na tri oblike; tradicionalni integracijski način p2p, hub and spoke ali zvezdasta arhitektura in bus arhitektura.

- **P2p-tradicionalen način**, omogoča direktno komuniciranje med aplikacijami in ustvarja 1:1 povezavo, kjer si aplikacije pošiljajo direktna sporočila s pomočjo vmesnikov. Ta arhitektura povečuje število vmesnikov z vsako dodatno aplikacijo v sistemskem okolju. Formula za izračun potrebnih vmesnikov je $I=(n*(n-1))$. Integracija večjega števila aplikacij, s tovrstno arhitekturo, ni priporočljiva, saj povzroča »špageti«strukturo. Kadar je potrebno vpeljati spremembe, v sistemsko okolje, kot so posodobitve, dodajanje novih aplikacij, ali zamenjave starega sistema z novim, celotna integracijska struktura mora biti spremenjena, kar predstavlja veliko dela za razvijalce, in posledično visoke stroške dela razvijalcev. P2p arhitektura ne omogoča shranjevanje aplikacijske logike, ali spreminjanje sporočila med pošiljanjem, je zelo nefleksibilna, in ne nudi možnosti upravljanja s poslovnimi procesi. Obenem je zelo preprosta, cenovno ugodna in hitro integrirana arhitektura, ki je primerna za manjša sistemska okolja, z nekaj aplikacijami.
- **Zvezdasta arhitektura (hub and spoke)**, omogoča povezanost večjega števila aplikacij med seboj in tvori m:n povezavo. Zvezdasta arhitektura vsebuje centralni del, ki je postavljen med začetno in ciljno aplikacijo, na katerega so povezane aplikacije v sistemskem okolju. Centralni del omogoča centralne funkcije, medtem ko adapterji na centralnem delu, nudijo storitve za vsako aplikacijo ali točko vmesnika aplikacije. Aplikacija pošlje sporočilo centralnemu delu, ta pretvori

format informacije, če je potrebno, in jo dostavi raznim aplikacijam povezanim na centralni del. Zvezdasta arhitektura bistveno zmanjša število vmesnikov aplikacij. Formula za izračun števila vmesnikov je I=n. Seveda zmanjšanje vmesnikov posledično zmanjša sistemsko kompleksnost, kjer so lahko aplikacije zamenjane, ali posodobljene, brez večjih posegov v aplikacijske kode. Zvezdasta struktura s pomočjo centralnega dela omogoča centralni nadzor, centralno administracijo in centralno vzdrževanje sistemov in aplikacij. Obenem omogoča centralno transformacijo podatkov, inteligentno usmerjanje podatkov, in upravljanje s poslovnimi procesi. Ta arhitektura je primerna v podjetjih, ki želijo povezati večje število aplikacij, kjer aplikacije izmenjujejo podatke in poslovne procese, in ki želijo imeti večji centralni nadzor na poslovnimi procesi ter vzdrževati nivo prilagodljivosti.

- **Bus arhitektura**, poveže aplikacije sistemskega okolja z bus-em, preko katerega si aplikacije izmenjujejo podatke in poslovne procese. Aplikacija objavi informacijo na bus-u, in vse zainteresirane aplikacije, lahko vpokličejo podatek objavljen na bus-u. Podatki, ki so objavljeni na bus-u, so pretvorjeni v standardni format razumljiv vsem aplikacijam povezanim na bus. Na vsaki aplikaciji, ki je povezani na bus, se nahaja adapter, ki skrbi za oblikovanje in transformacijo sporočil, inteligentno usmerjanje sporočil, skrbi za poslovna pravila podatkov in aplikacijsko logiko, in ima odgovornost povezati aplikacijo z bus-om. Bus arhitektura je cenovno zelo draga, zato je posluževanje po tej arhitekturi bolj primerno v podjetjih, ki želijo združevati spletne storitve v poslovni nivo podjetniških storitev, in za storitveno naravnane poslovne storitve (SOA).

V podjetju Daimler AG so se odločili za zvezdasto, hub and spoke arhitekturo, saj podjetju omogoča centralni nadzor nad poslovnimi procesi, enostavno posodabljanje, zamenjavo in dodajanje novih aplikacij, standardizacijo procesov in integracijo heterogenih sistemov. Tako so v serijski logistiki zasnovali koncept poslovne rešitve. Izbrali so produkt podjetja SAP AG NetWeaver PI 7.1, ki bi povezoval vse SAP in druge aplikacije in IS znotraj sistemskega okolja. PI 7.1. bi se uporabljal za komunikacijo in izmenjavo poslovnih procesov, med aplikacijami znotraj proizvodnje, kot tudi zunaj proizvodnje, z drugimi proizvodnimi enotami podjetja, poslovnimi partnerji, dobavitelji in strankami. V naslednjem poglavju bomo pogledali, ali je izbrana arhitektura s finančnega vidika izvedljiva in ali je smotrno investirati v tehnologijo IPA.

## 4 FINANČNA IZVEDLJIVOST IPA

Vsak projekt, ki se izvaja znotraj podjetja, se poleg tehnične izvedljivosti, natančno preuči tudi finančna izvedljivost. Vedno več pozornosti se posveča investicijam v IT, da bi podjetja lahko dosegla, čim boljši poslovni učinek z nižjimi stroški. Ekonomika informatike obravnava področje investicij v IT, in se ukvarja z vprašanjem, ali je investicija ekonomsko upravičena, z drugimi besedami, ali je vredno investirat. Investicija je ekonomsko upravičena, ko koristi presegajo stroške investicije. Da bi lahko izvedli vrednotenje investicij, moramo investicijo primerjati z neki drugim stanjem, ali neko drugo investicijo. Vrednotenje investicij v IT je zahtevno iz dveh razlogov, kot prvo IT prispeva veliko neoprijemljivih koristi, ki niso vidni v dobičku, kot drugo pa je potrebno napovedovanje stroškov in koristi, kar pomeni, da naše ocene niso natančne, vendar predstavljajo nek približek. Vrednotenje investicij v IT nam pomaga sprejeti prave odločitve ter omogoči učinkovitejše upravljanje z razpoložljivimi sredstvi. Investicije lahko vrednotimo na različne načine; poznamo finančni in nefinančni način.

### 4.1 Nefinančno vrednotenje

Nefinančnega vrednotenja se poslužujemo, kadar investicija prinese veliko koristi, ki jih ni mogoče izraziti v monetarni vernosti. Da bi koristi, ki ne morejo biti izražene z monetarno vrednostjo, enostavno prezrli, jih zanemarili, bi pomenilo, da je njihova vrednost enaka nič, in tako pomenilo, da se investicija zavrne, ali le ta ne prinese pričakovanega izboljšanja. Neoprijemljive koristi lahko vrednotimo z utežmi in dodeljenimi vrednostmi, vendar so takšna vrednotenja pogosto pristranska in ne podajo realne slike. Nefinančnih načinov vrednotenja se poslužujemo kadar se odločamo med produkti in ocenjujemo njihove lastnosti.

### 4.2 Finančno vrednotenje

Se osredotoča na analiziranje stroškov in koristi, ki lahko poda bolj natančne ocene vrednosti investicij. Finančni način vrednotenja nudi različne finančne metode, s katerimi lahko ugotavljamo finančno izvedljivost projektov. Najbolj uporabljena je analiza stroškov in koristi, ki vključuje naslednje metode:

- **ROI-rentabilnost**, je metoda, ki pomaga določiti prioritetno investicijo ter pove kako učinkovito smo investirali sredstva. ROI vrednost mora biti pozitivna, izbrana je tista investicija, ki ima večji ROI. Formula za izračun ROI investicije v IPA je; ROI= (zaslužek – investicijski stroški)/investicijski stroški. Rezultat vrednosti je izražena v procentih.
- **TCO**, je metoda za izračunavanje stroškov lastništva, upravljanja in nadzora IS, ki pove kako investicija vpliva na celotne stroške lastništva. Ta metoda računa celotne stroške infrastrukture opazovane z vidika direktnih in indirektnih stroškov. Direktni stroški so stroški programske opreme, stroški operacijskih sistemov in programov, operativnih in administrativnih stroškov. Indirektni stroški so stroški razvoja aplikacij, stroški šolanja, usposabljanja in izobraževanja, in stroški podpore IT. Vedno več podjetij se s pomočjo metode stroškov lastništva odloča o investicijah v IT.
- **Točka preloma**, je metoda, ki se pogosteje uporablja v prodaji, za določanje cene produkta. Lahko jo tudi uporabimo za izračun investicij v IPA, kadar želimo ugotoviti, kdaj je primerno vpeljati IPA. V točki preloma so celotni stroški izenačeni s celotnimi koristmi. V tej točki ne ustvarimo ne izgube ne dobička. Desno od točke preloma se

nahaja polje kjer poslujemo z dobičkom, in je vpeljava IPA smiselna. Levo od točke preloma poslujemo z izgubo, in vpeljava IPA nebi prdstavljala optimalne rešiteve.

Stroške, ki jih opazujemo pri vrednotenju investicij v IPA so arhitekturni stroški, stroški razvoja in operativni stroški. Navedene stroške smo opazovali na primeru podjetja Daimler AG, in sicer smo primerjali stroške tradicionalne p2p arhitekture z zvezdasto (hub and spoke- H&S) arhitekturo, slednja predstavlja investicijo v IPA.

- **Arhitekturni stroški**, so stroški strojne opreme, programske opreme in stroški licenc. Arhitekturni stroški H&S arhitekture so veliko večji, kot pri tradicionalni arhitekturi p2p. Predvsem zato ker p2p arhitektura ne potrebuje posebne strojen in programske opreme, da bi bila integracija aplikacij možna. Z vidika arhitekturnih stroškov je za podjetje ne ukrepanje oz. nadaljevanje s trenutno p2p arhitekturo stroškovno učinkovitejše.
- **Stroški razvoja,** predstavljajo stroške razvoja vmesnikov, ki tvorijo povezavo med aplikacijami. Stroški razvoja se obnašajo različno glede na arhitekturo, in so odvisni od števila vmesnikov, ali sistemov, v sistemskem okolju, katerega želimo integrirati. Na primeru podjetja Daimler AG smo opazovali stroške razvoja v štirih različnih scenarijih. Prvi scenarij je prikazoval obnašanje stroškov razvoja vmesnikov z H&S in p2p arhitekturo v šibkem in močno povezanem sistemskem okolju. Stroški razvoja vmesnikov so bili z H&S arhitekturo nižji kot s p2p arhitekturo. Glavni razlog je v številu vmesnikov, ki je z H&S arhitekturo občutno manjše, kot s p2p arhitekturo. Drugi scenarij je primerjal stroške razvoja z vidika dodajanja novih vmesnikov v močno povezanem sistemskem okolju. Ker so z H&S arhitekturo aplikacije povezane s centralnim delom, je potrebno spremembe in novosti izvesti na adapterjih ter novem vmesniku. S p2p arhitekturo je potrebno poseganje v vsako aplikacijo, na katero mora biti novi vmesnik povezan, kar predstavlja več dela za razvijalce. Zaradi centralnega dela, so stroški razvoja z H&S arhitekturo nižji od stroškov razvoja s p2p arhitekture. V tretjem scenariju smo opazovali stroške razvoja situacije, ko je potrebno šibko integrirano sistemsko okolje spremeniti v močno integrirano sistemsko okolje. Ker H&S arhitektura omogoča komunikacijo in izmenjavo podatkov z vsemi aplikacijami, ki so povezane na centralni del, je samo sistemsko okolje močno integrirano. S p2p arhitekturo pa imamo lahko različno močne stopnje integracije, saj so aplikacije povezane samo s tistimi aplikacijami, s katerimi morajo komunicirati in izmenjavati podatke. Tako pri izračunu števila vmesnikov zajamemo le tisto število, ki je predstavlja razliko med šibko in močno integriranim sistemskim okoljem. Stroški razvoja vmesnikov so z H&S arhitekturo nižji zaradi lastnosti in karakteristik centralnega dela. V četrtem scenariju smo opazovali stroške razvoja, kadar je potrebno zamenjati IS ali aplikacijo v sistemskem okolju. Zaradi značilnega centralnega dela H&S arhitekture, je pri zamenjavi sistema potrebno na novo razviti vmesnike med aplikacijo in centralnim delom. S p2p arhitekturo je potrebno na novo razviti vse vmesnike, s katerimi je bil IS ali aplikacija povezana, kar drastično poveča

stroške. Iz vidika stroškov razvoja, je za podjetje bolj primerno obravnavane scenarije izvajati v sistemskem okolju integriranim z H&S arhitekturo.

- **Operativni stroški,** so stroški vzdrževanja, posodabljanja podatkov in programske opreme, stroški prilagajanja konfiguracije, in stroški sistemskih napak. V podjetju Daimler AG smo operativne stroške ocenili s parametri in jih primerjali v p2p in H&S arhitekturi. Ugotovili smo, da zaradi centralnega dela H&S arhitekture, se vse dejavnosti odvijajo centralno in nudijo preglednost in izvedljivost vseh aktivnosti centralno. Stroški vzdrževanja, posodabljanja, prilagajanja in kontrole so manjši, kot s p2p arhitekturo, kjer je potrebno na vsaki točki povezave in na vsakem vmesniku aplikacije posodabljati, prilagajati konfiguracijo, in kontrolirati potek podatkov, kar požene stroške spiralno navzgor. Z vidika operativnih stroškov smo ugotovila, da so le ti nižji, če imamo sisteme integrirane z H&S arhitekturo, kot s p2p arhitekturo. Po izračunih so tudi celotni stroški H&S arhitekture nižji od celotnih stroškov p2p arhitekture.

Koristi, ki jih podjetje ima z IPA smo pregledovali v p2p in H&S arhitekturi. Koristi so prihranki poslovnega procesa, prihranki razvoja, prihranki vzdrževanja in prihranki sistemskih napakah. Zaradi lastnosti H&S arhitekture in centralnega dela, so prihranki višji, kot s p2p arhitekturo. Ker z H&S arhitekturo podjetja porabijo manj časa za razvijanje aplikacij bi lahko zaposlili manj osebja in tako prihranili. Prihranki v vzdrževanju in sistemskih napak pomenijo predvsem, da zaradi centralne kontrole, so napake v sistemu ali procesu zaznane mnogo hitreje, kar predstavlja skrajšan reakcijski čas. Čas, ki ga zaposleni porabijo za čakanje, zaradi sistemskih napak in okvar, ki onemogočajo njihovo delo, se zmanjša, kar poveča učinkovitost zaposlenih. Zaradi hitrejšega odkrivanja napak se zmanjša število garancij in končnih popravil. S p2p arhitekturo bi porabili bistveno več časa za odkrivanje napak, saj bi morali na vsaki točki integracije preverjat pomanjkljivosti, izvajati kontrolo in nadzor.

Rezultati vrednotenja investicij IPA s pomočjo projekta v podjetju Daimler AG so nam pokazali, da integracija IPA proizvajalca SAP pozitivno vpliva na stroške lastništva, saj je podobna integracijska tehnologija starejše verzije, bila uporabljena na drugih projektih v drugih oddelkih podjetja, vendar znanje potrebno za izvedbo takšnih projektov je še prisotno v podjetju. Podjetje upravlja poslovanje z najrazličnejšimi SAP aplikacijami, kar pomeni, da zaposlenim SAP tehnologija ni nepoznana, tako da ni potrebno organizirati dodatnih šolanj in izobraževanj za zaposlene. ROI investicije v IPA je pozitiven in presega 70% kar pomeni, da se kar velik delež investicije povrne. Analiza točke preloma pokaže, da je IPA smiselno vpeljati v sistemsko okolje z več kot 41 vmesniki, v sistemskem okolju z manj kot 41 vmesniki, bi bila ta investicija zavrnjena, saj bi škodila poslovni vrednosti podjetja. Podjetje je izbralo primerno rešitev za reševanje integracijskih težav s tehnološkega vidika, kakor tudi s finančne izvedljivosti.

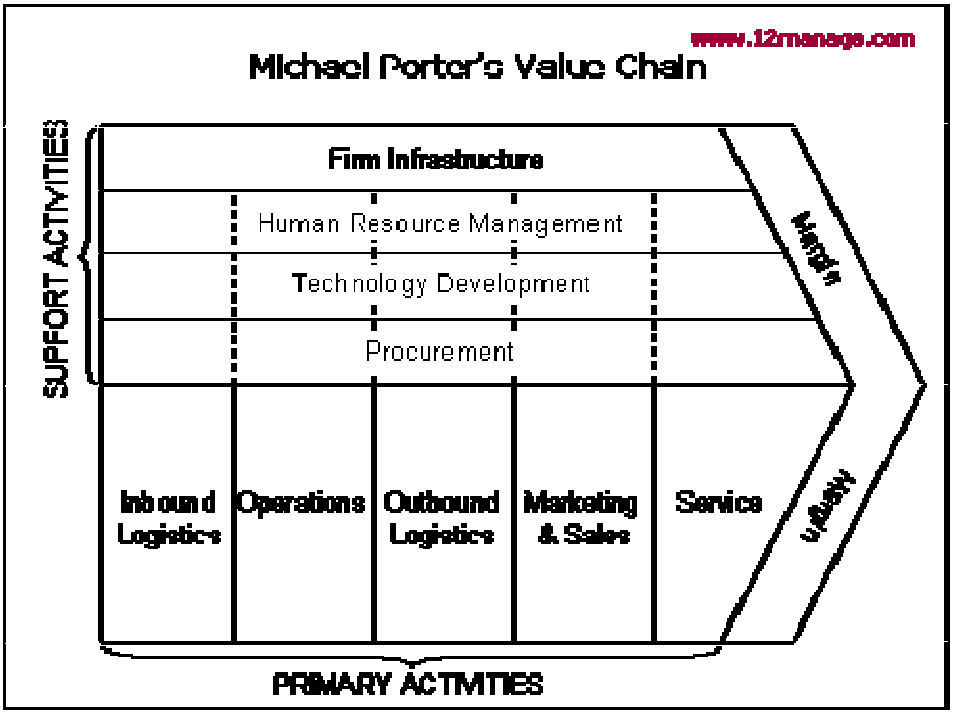
## SKLEP

Spreminjajoč se globalni svet sili podjetja, da se prilagajajo spremembam, ohranjajo konkurenčnost in tako preživijo na trgu. Podjetja poskušajo izmenjavati prave podatke znotraj organizacije, s poslovnimi partnerji, dobavitelji in strankami, da bi lahko izmenjevale podatke morajo integrirati aplikacije in IS. Kadar se podjetje odloči za IPA, kot smo videli iz primera, sledi trem vprašanje »kaj«, »kako« in »koliko« na katera poskuša odgovoriti. Podjetja najprej pogledajo kakšni so problemi, kaj želijo spremeniti in izboljšati, kaj želijo doseči z IPA in kaj je rešitev za nastalo situacijo. Ko se podjetje odloči za primerno rešitev, se je potrebno odločiti kako se bo ta rešitev izvedla, in ali je primerna s tehnološkega vidika. Pomembno je pogledati ali je izbrana arhitekturna rešitev finančno izvedljiva, čemur vedno več podjetij posveča veliko pozornosti. Iz diplome smo razbrali da je IPA zelo kompleksna tehnologija, ki zahteva tehnično in ekonomsko znanje. IPA nudi organizacijam možnost izmenjave podatkov znotraj, kot izven, podjetja, učinkovitejše poslovanje in ohranjanje konkurenčnosti. Podjetja, ki izvajajo projekte IPA in želijo povezati aplikacije, naj integrirajo celotno sistemsko okolje, saj več kot je integriranih sistemov, večja učinkovitost integracije aplikacij je dosežena.

## Appendix 2: List of abbreviations / Seznam kratic prevedene v slovenščino

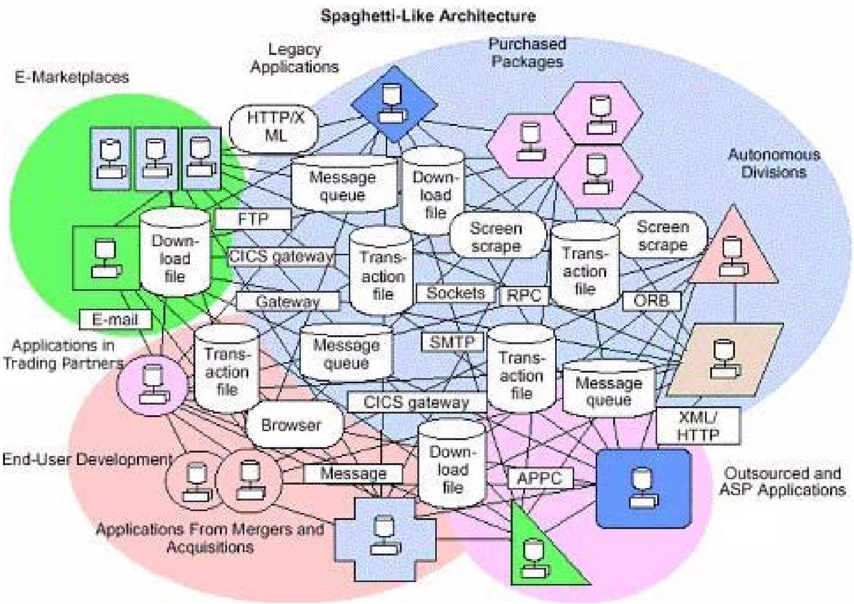
| | *Slovenski prevod:* |
|---|---|
| A2A – application to application integration | aplikacija – aplikaciji povezava |
| API – application program interface | vmesnik aplikacijskega programa |
| B2B – business to business | podjetja - podjetjem |
| B2C – business to customer | podjetja - potrošnikom |
| BI – business intelligence | poslovna inteligenca |
| BPM – business process management | upravljanje poslovnih procesov |
| CBA – cost benefit analysis | stroškovno profitna analiza |
| CRM – customer relationship management | upravljanje odnosov s strankami |
| DB – data base | baza podatkov |
| DSS – decision support system | sistem za podporo odločanju |
| EAI – enterprise application integration | integracija poslovnih aplikacij |
| EDI – enterprise data interchange | sistem za izmenjavo podatkov |
| ERP – enterprise resource planning | celovite programske rešitve |
| ESB – enterprise service bus | organizacijsko storitveni bus |
| FC – fix costs | fiksni stroški |
| FTE – full-time equivalent | zaposlitveni kazalnik |
| HRM – human resource management | upravljanje s človeškimi viri |
| IS – information system | informacijski sistem |
| IT – information technology | informacijska tehnologija |
| KM – knowledge management | upravljanje znanja |
| MBC – Mercedes-Benz Cars | Mercedes-Benz Cars |
| MOM – message oriented middleware | sporočilno orientiran |
| p2p – point-to-point integration topology | točka do točke arhitektura |
| PI, PI 7.1. – process integration (SAP product) | integracija procesov 7.1 SAP izdelek |
| PRM – partner relationship management | upravljanje odnosov s poslovnimi partnerji |
| PT – power train | proizvodnja agregatov |
| ROI – return on investment | povratčilo od investicije |
| RPC – remote procedure call | proceduralni klici |
| SAP – SAP AG Corporation | podjetje SAP AG |
| SCM – supply chain management | upravljanje oskrbovalne verige |
| SOA – service oriented architecture | storitveno naravnana arhitektura |
| SOAP – service oriented architecture protocol | storitveno naravnan arhitekturni protokol |
| TC – total costs | celotni stročki |
| TCO – total cost of ownership | celotni stroški lastništva |
| TPS – transaction process system | transakcijsko procesni sistem |
| TR – total revenue | celotni prihodki |
| VC – variable costs | variabilni stroški |
| XI – exchange infrastructure (SAP integration product) | infrastruktura izmenjave |

**Appendix 3: Porters value chain**



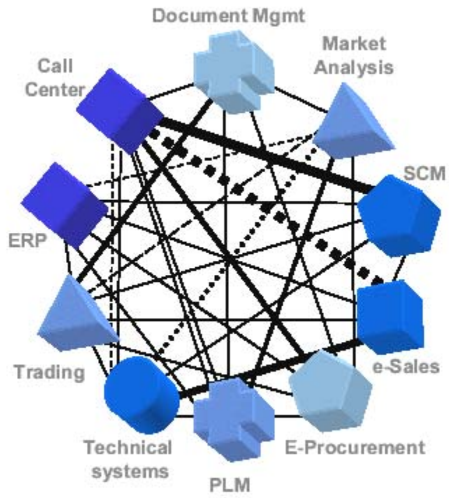

*Source:Value chain framework, 1985*

## Appendix 4: Spagethi structure of system landscape



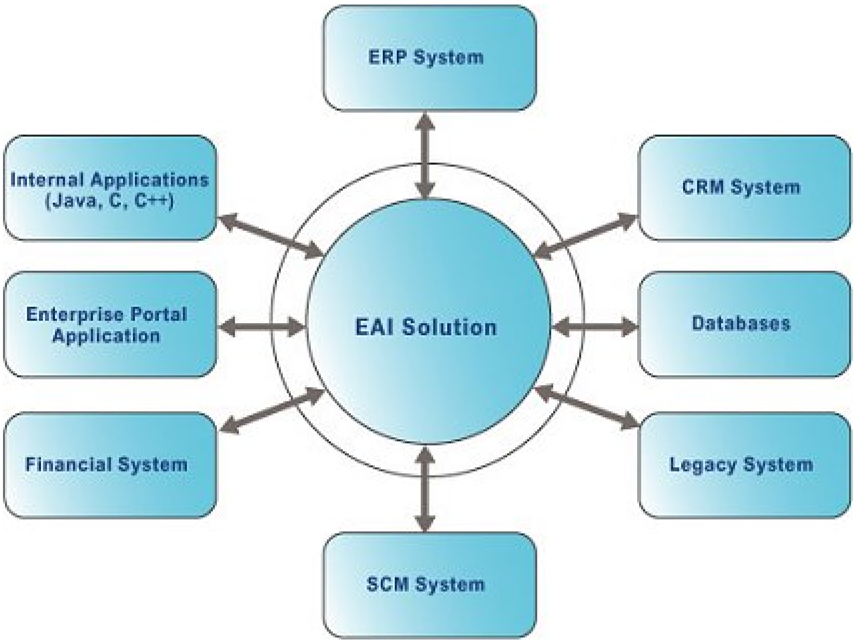

*Source: Basics of enterprise application integration, service oriented architecture, enterprise service bus, model-oriented architecture, 2007*

**Appendix 5: Spaghetti structure with p2p middleware with many applications**



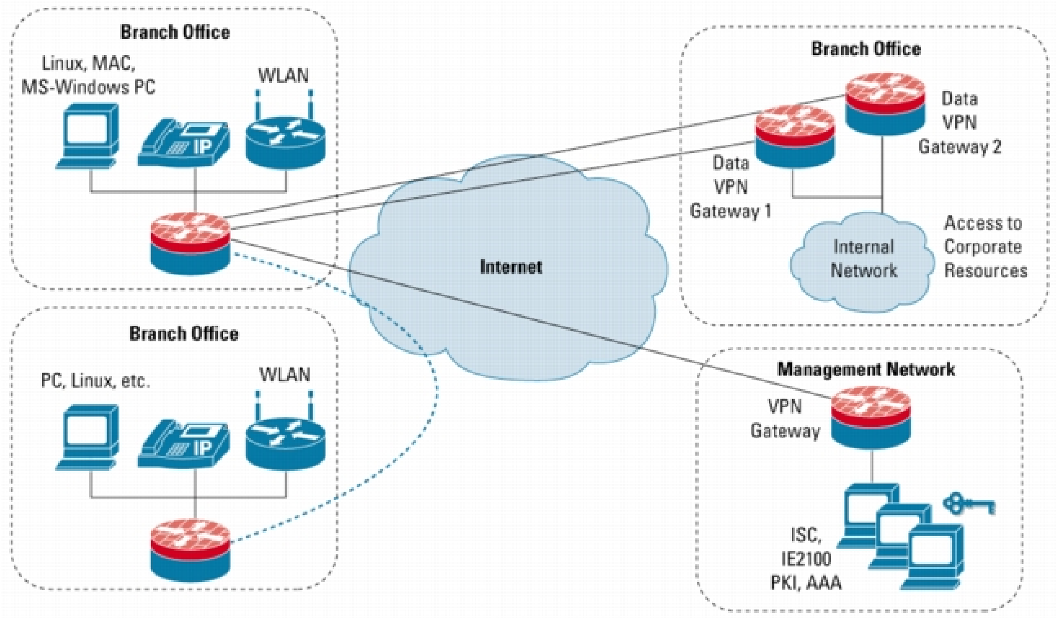

*Source: Value Assessment SAP Exchange Infrastructure, 2005*

**Appendix 6: Hub-and-spoke topology with message broker middleware**



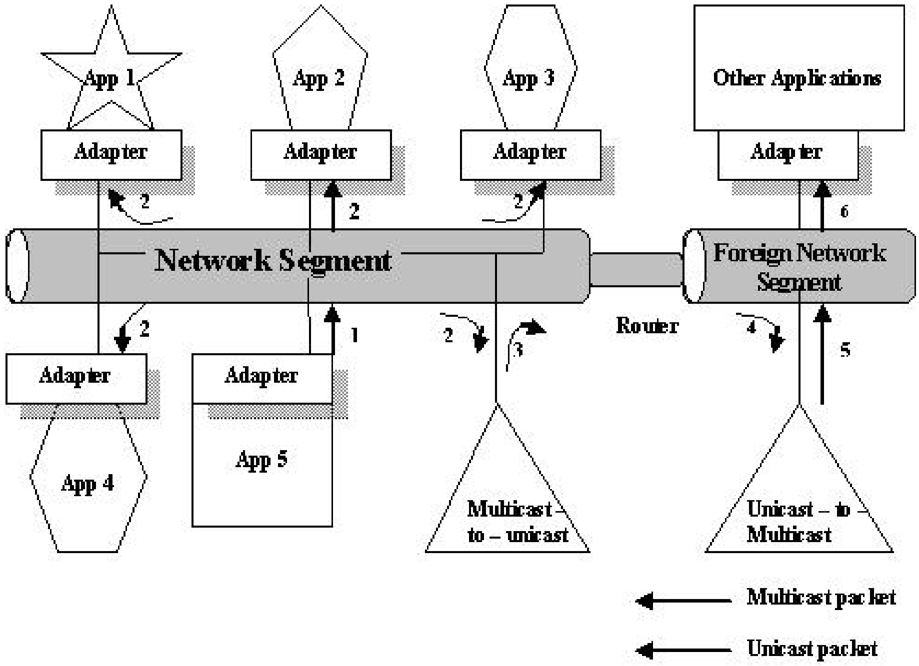

*Source:Stay in front architecture and tools,2009*

## Appendix 7: Multi Hub architecture




*Source: Cisco ISO Software Release 12.2(18)SXE New Features and Hardware Support, 2008*

## Appendix 8: Bus topology




*Source: EAI interview questions, 2009*

## Appendix 9: Brand portfolio of Mercedes-Benz Cars

*Source: Daimler intranet portal, 2008*

## Appendix 10: Production Plant Sindelfingen

*Source: Daimler Intranet portal, 2008*

**Appendix 11: Production line produced in plant Sindelfingen**

C-Class

CL-Class

CLS-Class

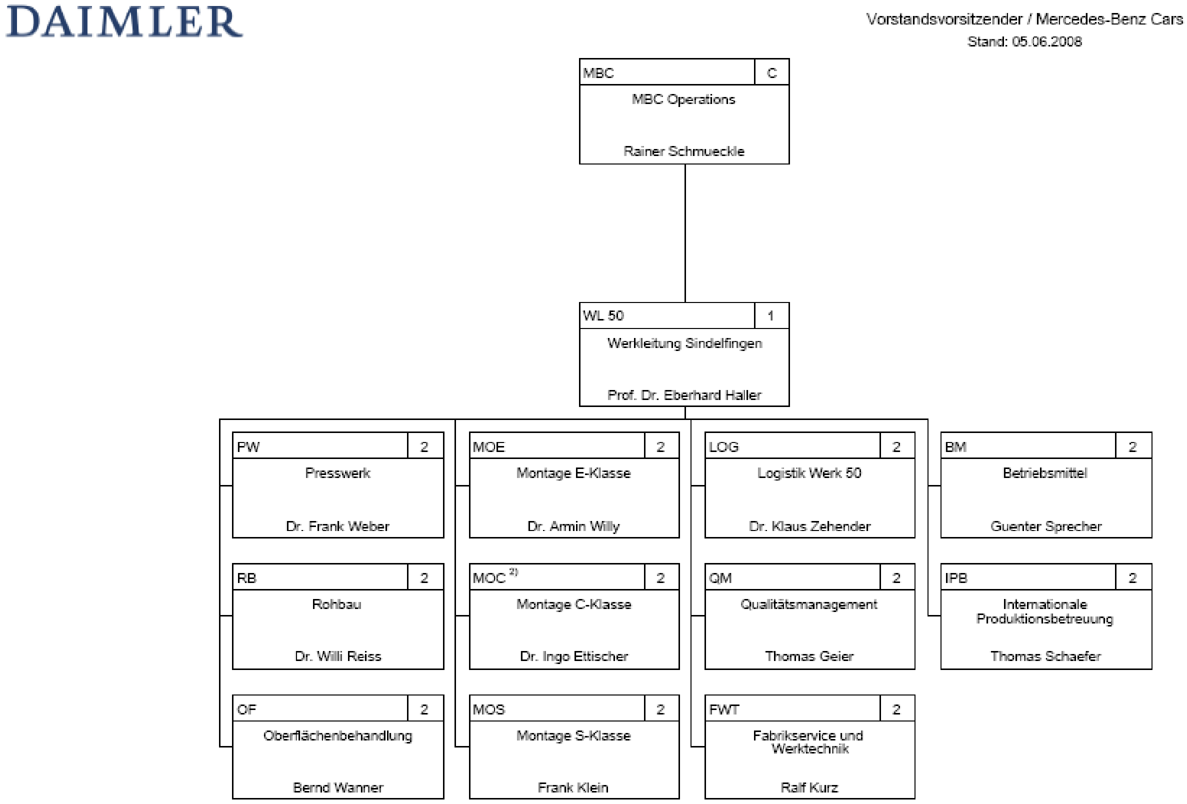
S-Class

E-Class

Maybach

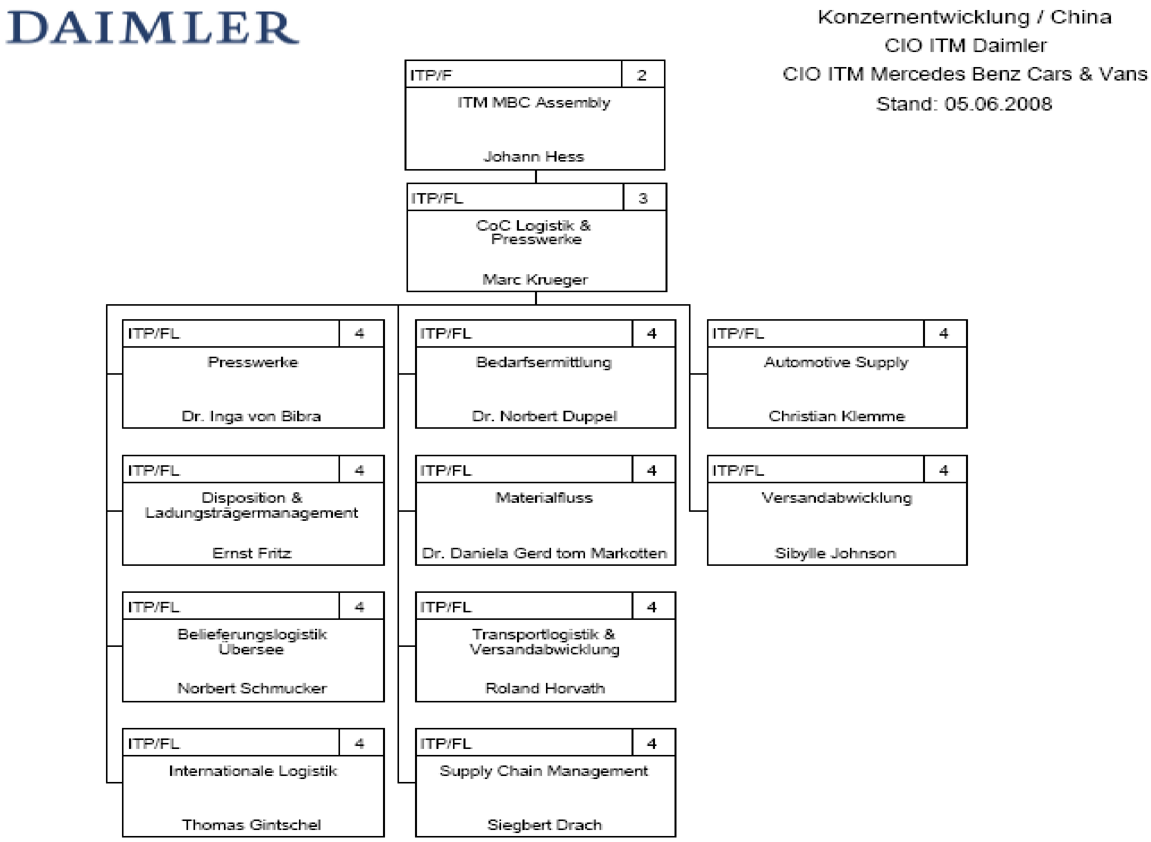
*Source: Daimler intranet portal, 2008*

## Appendix 12: Organisation plan of plant Sindelfingen



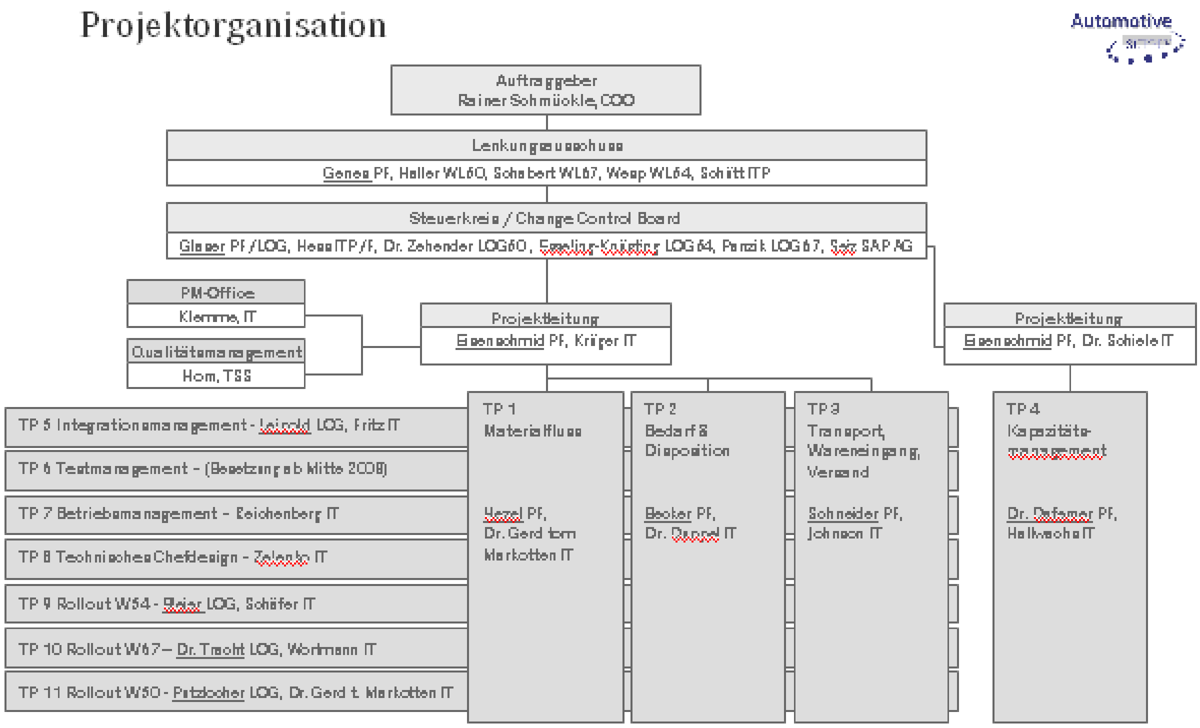

*Source: Project documentation, 2007-2008*

## Appendix 13: Organisation plan of ITP/FL department




*Source: Project documentation, 2007-2008*

## Appendix 14: Organisational plan of AmSupply project




*Source: Project documentation, 2007-2008*

**Appendix 15: SAP NetWeaver platform**


*Source: Value Assessment SAP Exchange Infrastructure, 2005*

## Appendix 16: Comparison of operating and maintenance costs in p2p and EAI architecture in cost factor

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## Appendix 17: Benefits of EAI in comparison with p2p expressed in cost saving factor

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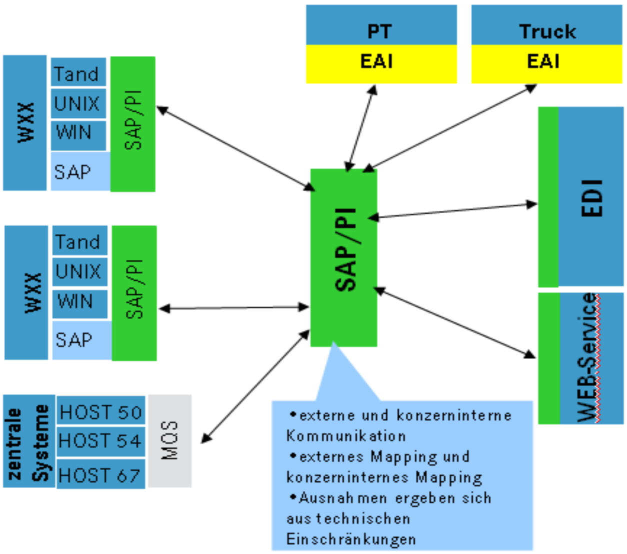
## Appendix 18: AmSupply EAI Infrastructure on Global level




*Source: Project Documentation, 2007&2008*