A new cost model for comparison of Point to Point and Enterprise Service Bus integration styles

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Abstract: Almost no organization has information systems and applications without interaction and communication with other systems. Usually it is also necessary to integrate internal information systems and applications with the systems of other institutions (external 3rd party systems). Nowadays, the integration of existing and new implemented information systems is a key matter of interest for each organization. In this paper we present an example of a simple economic cost model for various integration architectures and approaches.

Key-Words: system integration, integration architecture, integration style, Point to Point, Message Bus, Enterprise Service Bus, cost model

1 Introduction

Almost no organization operates its information systems and applications completely separately and isolated, without cooperating and communicating with other systems. Usually, it is also necessary to integrate information systems and applications in the organization with systems of other external entities [1]. The integration of existing and newly implemented information systems is becoming a crucial issue for any organization [2].

In these modern times there is an exponential increase in the amount of required functionality of IS/ICT (Information Systems/Information and Communication Technologies) in the organization as a whole – not only the required functionality of one information system or application – it is important to distinguish [1]. This situation increases the requirements for coherence and cooperation between the various systems and applications in an organization. Therefore, a key aspect of any system is the possibility to integrate it into the existing IS/ICT environment in the organization [3]. The significance and importance of the system integration issues further emphasizes the fact that the chosen integration solution has a significant impact on the entire organization. It affects a large number of users, but its implementation is financially very costly.

In this paper we discuss the economic aspects of integration, i.e. how the integration architecture and the number of integrated systems affect implementation costs. Most organizations must sometimes decide which integration architecture, technology, suppliers, etc. will be chosen, and the decision is very important for future development.

2 Problem Formulation

From a technical point of view, there are many possible integration architectures and styles. In this paper, however, we will not address the technological aspects. We will only briefly describe two basic architectures and approaches. For more details please see literature [4], [5], [6] and [7]. In this paper we will address the issue of the integration of information systems and applications from the perspective of the organization and its decisions about the integration architecture. One of several factors is the cost of its implementation. An economic model has been created for this purpose, and it is able to compare the costs of different variants of integration architecture and input parameters.

2.1 Point to Point integration style

The easiest way to integrate multiple information systems or applications into a single functional unit is the Point to Point method. This method is simple and efficient for a small number of integrated systems, where no further expansion or changes of integrated solutions are expected. A significant disadvantage of this approach is that, for each system, interfaces must be created for all other

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integrated systems (syndrome n^2, where n is the number of integrated systems). Increasing the number of systems causes a fast quadratic increase in the number of interfaces and integration becomes more complex [4]. The Point to Point integration method is shown in fig. 1.

The Point to Point integration style can be implemented using a variety of standard technology. However, specific or non-standard technology, data formats and protocols are very often used for communication. Different styles (methods) of integration are also often combined. But then the system becomes very heterogeneous and difficult to maintain.

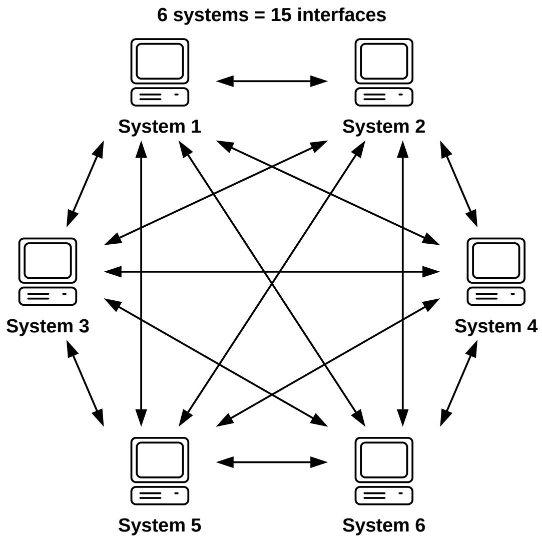

Fig. 1 – Point to Point integration style

2.2 Message Bus integration style

Message Bus is one of several possible approaches to system integration. Very simply, it is the use of a central communication point, which mediates the transfer of data between different systems or subsystems. A key feature is the mutual shielding of individual communication points and platform independence. Unlike other architectures based on similar principles of a central communication point, Message Bus provides greater functionality. One of the differences is that Message Bus is a decentralized solution. Message Bus has most of the business logic implemented in the so-called “adapters” that provide the interface between different systems; the bus itself ensures only the transmission of data messages. Message Bus usually provides a means of connecting and disconnecting the system without affecting other systems. Adding or removing a system does not necessarily affect existing systems, because data messages are not sent to specific recipients. In this method of integration, it is possible to achieve loose coupling between different systems. Star topology, as shown in fig. 2, allows a significant reduction in the number of interfaces, especially compared to the Point to Point method.

A typical representative of the Message Bus technology is an Enterprise Service Bus (ESB), which is currently one of the most popular ways of integration [8]. In the following sections of this paper, we describe only two typical architectural styles: Point to Point and Enterprise Service Bus. The aim is to compare the costs associated with the implementation of these two ways of system integration in various conditions.

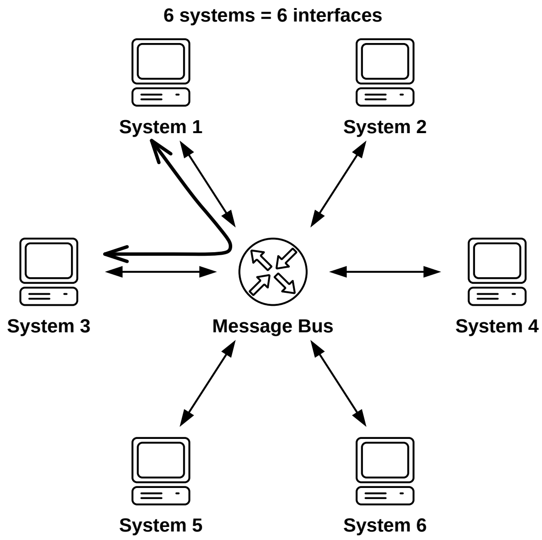

Fig. 2 – Message Bus integration style

3 Problem Solution

Usually it is not possible to encounter cases where applications and information systems are operated independently, without any integration with other systems within the organization or outside the organization. Thanks to the gradual implementation of newer and newer systems within the organization, the Point to Point integration style has typically been used. For a small number of integrated systems, this method is technically simple, straightforward, effective and less costly.

The gradual development of IS/ICT together with the Point to Point style used in organizations caused the integration of any new system and the maintenance of the whole information system to become more expensive and technically complicated [3]. For these reasons it is often necessary to consider changing the integration architecture to ensure sufficient efficiency and

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flexibility for future changes and implementation of new systems. Although there are many different integration architectures, there are usually two possible solutions. Consequently, only two different variants are usually taken into consideration:

• Maintain the status quo, i.e. continue integration using Point to Point style;

• Transition to a different integration architecture (such as ESB or similar), that allows you to create loose coupled dependencies between systems and reduce the number of interfaces.

Both alternatives are justified and are more or less appropriate for different situations. Factors influencing the choice of integration architecture and the financial costs of implementation include:

• Number of integrated systems and applications,

• Degree of integration (interdependence),

• Expected number of newly implemented (integrated) systems in the future,

• Costs of implementing and maintaining every single interface,

• Costs of implementing the new integration architecture.

In this paper we deal with the economic model describing the costs related to system integration. It helps decide which option is more suitable under the specific circumstances. But this is a simplified theoretical model, which does not take into account all of the aspects affecting the final solution to the problem.

3.1 Number of interfaces between systems

The total number of interfaces between systems in the Point to Point integration style is in extreme cases:

(1)

$$I_{PtPEx} = \frac{n(n-1)}{2}, n \geq 1$$

The variable n represents the number of integrated systems, I_{PtPEx} has an exponential character.

In reality it is a rare case. The degree of integration (interdependence) is usually lower – typically integrating all systems mutually is not needed. The real number of interfaces between systems in the Point to Point style of integration is then:

(2)

$$I_{PtP} = k.I_{PtPEx} = k\frac{n(n-1)}{2}, k \in \langle 0;1 \rangle$$

The parameter k represents the degree of integration of individual systems. A value of 1 means full interdependence of all systems (extreme case), a value of 0 means that all systems are operated separately (without any integration). The current value of the parameter can be revealed in the integration analysis. It is necessary to discover all the interfaces and data flows between different information systems and applications within the organization.

(3)

$$k = \frac{2.I_{PtP}}{n(n-1)}$$

I_{PtP} variable stands for the current number of identified interfaces between n systems. Empirically determined parameter values can be mostly ranging between:

$$k \in \langle 0{,}1; 0{,}2 \rangle$$

These values are based on practical experience during several projects and analysis at several large companies in the Czech Republic. The concrete value of this parameter depends on the specific organization and can vary considerably.

The total number of interfaces for integration using ESB is:

(4)

$$I_{ESB} = n, n \geq 1$$

The I_{ESB} value has a linear character and is directly proportional to n (number of integrated systems). In this case each system has created only one interface with the integration platform instead of many interfaces to other systems. A comparison of the number of interfaces for different integration styles is shown in fig. 3.

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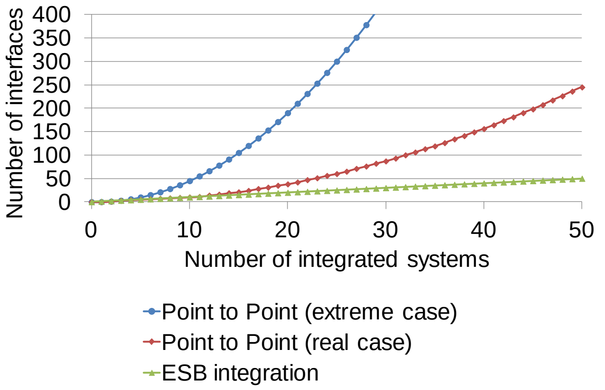

Fig. 3 – Number of interfaces between systems

3.2 Premise for integration using ESB

The basic premise for integration using ESB is that the number of interfaces between the integration platform and individual systems is not greater than the number of interfaces for the Point to Point style:

$$I_{PtP} \geq I_{ESB} \tag{5}$$

Integration using ESB makes sense only if there is valid following inequality (if we do not consider other technological aspects):

$$k\frac{n(n-1)}{2} > n, n \geq 1 \tag{6}$$

$$k > \frac{2}{(n-1)} \tag{7}$$

The minimum value of the parameter *k*, for which it makes sense to consider the implementation of an integration platform and integration using ESB is:

$$k_{min} = \frac{2}{(n-1)} \tag{8}$$

Fig. 4 graphically shows the dependency of k_{min} value on the number of integrated systems *n*.

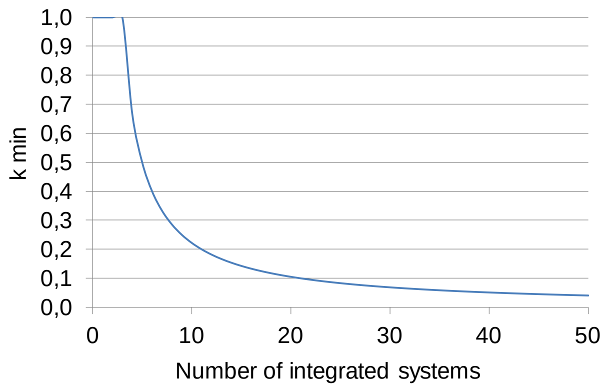

Fig. 4 – k_{min} value for integration using ESB

The graph shows that integration using ESB (or another similar technology) is more suitable for larger numbers of integrated systems; furthermore, it is not valuable for very small numbers of applications (assuming no other aspects).

3.3 Costs of system integration

Costs of system integration are influenced by several parameters, however, a major impact is primarily made by the number of integrated systems, which together with the degree of integration (interdependence) determines the number of implemented interfaces and thus, the overall cost of implementation.

3.3.1 The total costs

The total cost of Point to Point integration, while considering a real case (not an extreme case) are defined as follows:

$$TC_{PtP} = k\frac{n(n-1)}{2}C_I = \frac{k.C_I}{2}n^2 - \frac{k.C_I}{2}n \tag{9}$$

The total cost of integration using ESB are:

$$TC_{ESB} = FC_{IP} + VC_{IP} = FC_{IP} + n.C_I \tag{10}$$

In both cases the parameter C_I represents the cost of one interface implementation. In this case the formula is defined as a theoretical model; concrete (real) costs may vary depending on different interfaces. Therefore, this parameter should be perceived rather as an average value. From the perspective of the model, we deal with character and dependencies of individual variables, not their individual values.

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The parameter FC_{IP} represents the cost of the implementation of the integration platform into the environment of the organization (i.e. purchase and implementation of the necessary technology etc.). It is usually a one-time initial investment, which has a fixed character, i.e. it does not depend on the number of subsequently integrated systems. Conversely VC_{IP} variable costs are directly proportional to the number of integrated systems.

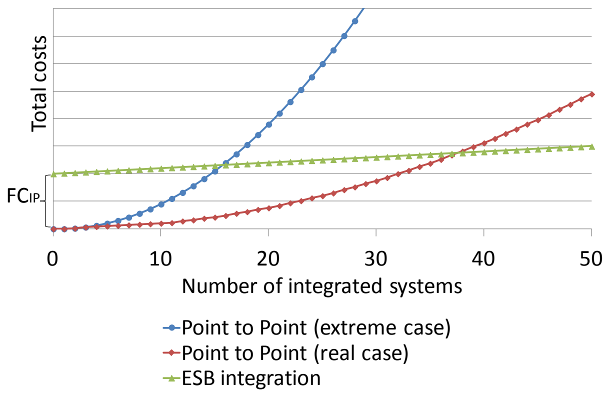

Fig. 5 – Total cost of integration

3.3.2 The marginal costs

Marginal costs show how to change the total costs if you increase the number of integrated systems by one.

The marginal costs of integration by the Point to Point style:

$$MC_{PtP} = TC'_{PtP} = k.C_I.n - \frac{k.C_I}{2} = k.C_I\left(n - \frac{1}{2}\right) \tag{11}$$

The marginal costs for ESB integration:

$$MC_{ESB} = TC'_{ESB} = C_I \tag{12}$$

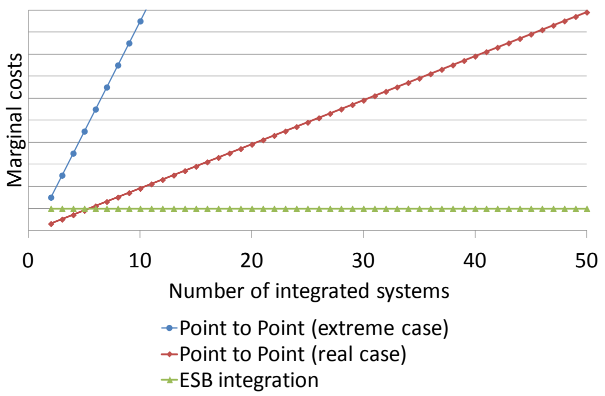

Fig. 6 – Marginal costs of integration

3.3.3 Total costs for the ESB implementation

In deciding whether to maintain the status quo and continue integrating using the Point to Point style or to switch to a different integration architecture, mostly ESB or a similar one which allows the reduction of the number of interfaces between different systems, it is necessary to consider several factors. With the increasing number of newly integrated systems, the costs of integration using the Point to Point integration style are rapidly growing. Conversely, integration using ESB requires a certain fixed cost for implementing an integration platform and certain variable costs for the modification of all or some of the existing interfaces. By using the ESB platform, it is possible to more easily and efficiently integrate new information systems and applications at a significantly lower marginal cost compared to the Point to Point integration style.

In this regard, the cost analysis of both alternatives is crucial. Before the implementation of an integration platform and ESB, it is necessary to consider not only the overall costs of integrating new planned systems, but also of modifying the existing interfaces for the needs of ESB. However, at the same time it is necessary to consider the savings generated by the integration of new systems using ESB, which is less expensive than using the Point to Point style. These savings reduce the overall costs of integration. Total costs for the implementation of ESB, while taking into account the savings resulting from the change of the integration architecture, can generally be expressed as follows:

$$TC_{IP} = FC_{IP} + \int_{1}^{n+n_{New}} MC_{ESB}\,dn - \int_{n}^{n+n_{New}} MC_{PtP}\,dn \tag{13}$$

$$TC_{IP} = TC_{ESB}(n + n_{New}) - [TC_{PtP}(n + n_{New}) - TC_{PtP}(n)] \tag{14}$$

$$TC_{IP} = FC_{IP} + (n + n_{New})C_I - \frac{k.C_I}{2}(n_{New}{}^2 + 2.n.n_{New} - n_{New}) \tag{15}$$

The total costs TC_{IP} in the model above include the savings as a result of the change in the integration architecture. This is a function of two variables and other parameters, where n is the number of existing, already integrated systems (for now using Point to Point style), and n_{New} is the number of new planned systems, which will be integrated (now already using integration platform and ESB). The total cost for the implementation of the integration platform consists of:

- Fixed costs for integration platform (FC_{IP}),
- Variable costs for the integration of both old and new planned systems using ESB ($n + n_{New}$ systems),
- Savings (with a minus sign) as a result of lower marginal costs for integration of new systems using ESB (n_{New} systems).

When deciding on the method of architecture and systems integration, particularly when deciding whether to switch from the Point to Point style to the integration platform, we are looking for a point (resp. points) in which the costs for implementation of ESB equals the savings resulting from the new architecture.

Decision criteria:

Balanced costs and savings: (16)

$$TC_{IP}(n, n_{New}, k, FC_{IP}, C_I) = 0$$

Higher costs than savings: (17)

$$TC_{IP}(n, n_{New}, k, FC_{IP}, C_I) > 0$$

Higher savings than costs (desired state): (18)

$$TC_{IP}(n, n_{New}, k, FC_{IP}, C_I) < 0$$

Fig. 7 shows the implementation costs for the transition from the Point To Point style to the ESB architecture depending on the number of existing systems and the constant number of planned integrated systems (in this case 10, 20 and 30). Values less than 0 represent the required state where the savings resulting from the architecture change outweigh the costs of integration platform and ESB. From this graph it is evident that higher savings can be achieved with higher numbers of new planned systems (curve shift downwards) and at the same time with higher numbers of existing systems (shift along the curve to the right bottom).

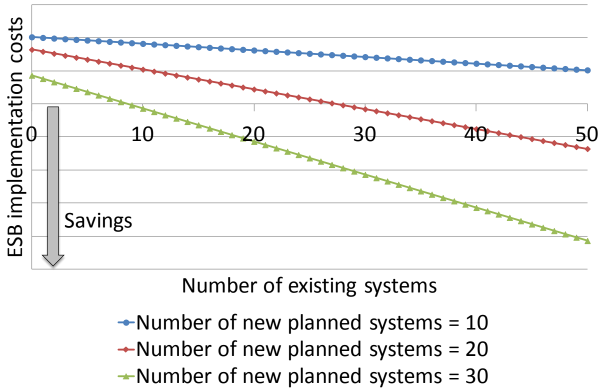

Fig. 7 – Implementation costs depending on the number of existing systems

Fig. 8 shows implementation costs depending on the number of new planned integrated systems and the constant number of existing systems (in this case 10, 30 and 50) – this model or this point of view is the closest to a real situation where we have to decide on the architecture and method of integration. From this graph it is evident that higher savings can be achieved with higher numbers of existing systems (curve shift downwards) and at the same time with higher numbers of new planned systems (shift along the curve to the right bottom). In this case the curve has an exponential character, i.e. an increasing number of new planned systems results in significantly higher savings than with an increasing number of existing systems.

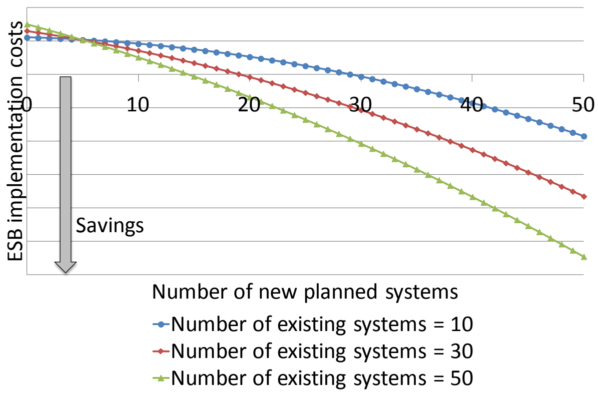

Fig. 8 – Implementation costs depending on the number of new planned systems

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4 Conclusion

In the selection and implementation of a specific integration solution, it is necessary to consider many aspects; however, an important factor will almost always be minimizing the costs of the integration of new systems, as well as the costs of the operation of existing and new interfaces between systems. In general, the aim should always be directed toward creating loosely coupled interfaces between existing systems instead of often used tightly coupled interfaces, which usually cause a number of problems. Overall, the system integration and the resulting solution have a significant impact on the entire organization and its scope affects a large number of users.

The proposed model represents a simple description of system integration issues when considering two alternatives – the Point to Point integration style and implementation of an integration platform, typically by using the ESB architecture.

The total cost for both integration styles are defined by equations 9 and 10. In the implementation of an integration platform and ESB, it is necessary to consider the total cost of the new planned systems integration, the cost of modifying existing interfaces, and the savings resulting from the lower costs of integrating new systems. The total cost of the ESB implementation, including savings resulting from the integration architecture changes, are expressed by the equations 13, 14 and 15. If these costs are less than 0, the implementation of the ESB integration platform achieves a savings compared to the currently used Point to Point integration style. On the contrary, if these costs are greater than 0, then the implementation of the ESB integration platform does not bring the desired savings for the organization. Total costs (savings) for the implementation of the ESB integration platform are a function of several variables. In particular:

- The number of existing already integrated systems, and
- The planned number of new integrated systems.

The amount of costs (savings) depending on these two variables is shown in fig. 7 and fig. 8. Greater savings can be achieved especially with a high number of new integrated systems. However, the implementation of ESB or other similar architecture does not represent benefits for a small number of systems, both existing as well as newly integrated.

The model does not address many other aspects. The biggest drawback is that the model addresses only the cost side of the system integration, not the revenue side. The change or implementation of integration architecture such as ESB can also have – apart from savings resulting from lower costs of integrating new systems – a positive impact on the functioning of the IS/ICT and thus on the whole organization in terms of greater efficiency of business processes, better availability of services, etc. These facts can have a positive impact on overall lower costs or higher revenues of the company.

Another drawback is a simplified definition of the costs associated with the implementation of a single interface – this parameter can vary significantly according to the technology in use. Additionally, the cost of new interface implementation for new systems may be different than the cost of existing interface modification.

A lower number of interfaces in ESB architecture represents lower costs of the whole information system maintenance for the organization. It might have an impact in future in terms of lower costs of IS/ICT operation. However, these savings are not included in the proposed model.

The above facts are an area for further development of the system integration cost model.

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