Achieving enterprise interoperability through integration Conway's law and Functional Silos in mutual support mode: Case study of traffic management systems

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Abstract — In this paper will be presented the solution of achieving interoperability between enterprises that together design the software, or one enterprise wants to integrate their software module with software of other enterprise. The idea for this research has appeared after analyzing Conway's law and Functional Silos. Organizations should put more efforts on communication between people/teams in organizational structure. It is not enough for organization to share knowledge only on vertical axis, the communication on horizontal axis gives more opportunity for achieving common goals of enterprise. While analyzing the Conway's law and Functional Silos, have think about the solution for achieving interoperability between heterogeneous traffic management software's which are product of two different companies. The problem of interoperability of this research is when two enterprises want to integrate them software's. But on one side we have enterprise which have "old fashion" traffic management software based on old software architecture, and on the other side is enterprise which have the traffic management software with new generation of software architecture. The goal is that traffic management system from enterprise 2 communicate and processed data from traffic controllers (devices) from the system of enterprise 1.

I. INTRODUCTION

Enterprise interoperability is the ability of enterprises to provide services (data, information and processes) to other enterprises, and to accept services from those other enterprises, that the inter-connected enterprises operate effectively together. Enterprises are interoperable when their services are provided in real-time including between different organizations and different locations (Fig. 1).
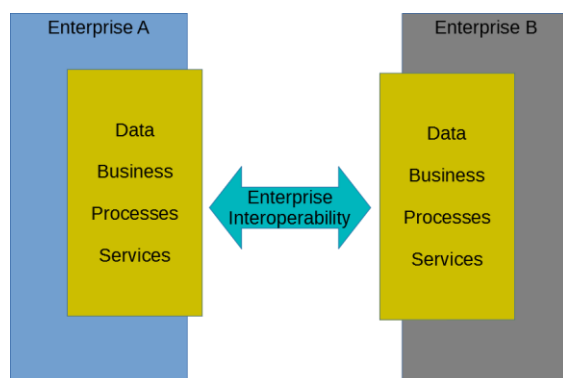
Figure 1. Interoperability concerns: data, service, process and business

"Any organization that designs a system will produce a design whose structure is a copy of the organization's communication structure" [1]. This hypothesis gives us opportunity that with changing the system concept we change the system and redirect communications. As an example, a team focused on quality control will communicate with a team which is focused on marketing stuffs.

The efforts in designing the enterprise should be focused/organized according to the need of communication. Communication is defined as a process where people in organization share the meaning and knowledge. There are internal communication between individuals/teams in organization and external communication with the individuals/teams from another organization.

Internal communication on horizontal axis between people is the key for achieving sharing of information's and common goals. The functional silo syndrome is based on theory that the problem in organizations is that they share the knowledge between people mostly on vertical axis, and little is shared on horizontal axis because each function develops its own special language and set of buzzwords (Phil S. Ensor). Design managers should keep their enterprise lean and flexible [1]. Functional silo is the group of individuals/teams in one department of organization which is the carrier of knowledge and information's. These knowledge is usefully for another team or department whose can integrate it in their business to achieve the common goals of enterprise. So, different types of teams need a different leadership styles (Kevin Seal)

"All management systems are based on the hierarchy of duty relations - competencies - responsibilities that link jobs and positions in an organization at all levels" (Fayol's bridge, Henri Fayol).

The second chapter of this paper is about methodology which is used in this research. The approach is based on quality research.

The third chapter describes the problem of the research and system context.

In the fourth chapter is presented the findings of this research throw interviews with some enterprises.

II. PROBLEM AND RESEARCH QUESTIONS

This paper is focused on solving problem of interoperability between enterprises that design software. The motivation and idea for researching this solution became from Conway's law and Functional silos (M. Conway and Phil S. Ensor). Main research question and problem is how enterprises can integrate their software's modules and achieve interoperability between

themselves. Today, the most enterprises are using state-of-art technologies in developing software. The problem happens when we need to make interoperable the existing software which is made in older programming technologies by enterprise A, and the software which is developed in newer technologies by enterprise B (Fig. 2). The main research question is how these to enterprises can achieve interoperability between their software solutions.

Figure 2. System context

The key of interoperability is standardization. Using appropriate standards in achieving enterprise interoperability is the best solution, but the next research question is, what is the price of interoperability ?. Standards are not cheap solutions in achieving interoperability and the enterprises should analyze is that acceptable and goal solution. Another way in achieving enterprise interoperability is throw interoperability agreements. Enterprises should make formal arrangements for cooperation through interoperability agreements [3]. Agreements should have enough details and focus on aim of enterprise interoperability. Also, these agreements usually include standards and specifications which enterprises sees that in necessary for their interoperability. The main benefit of using interoperability agreements is that enterprises can made an "company standard" in their way of achieving interoperability, which can be used in business with other enterprises and including them into the interoperable system.
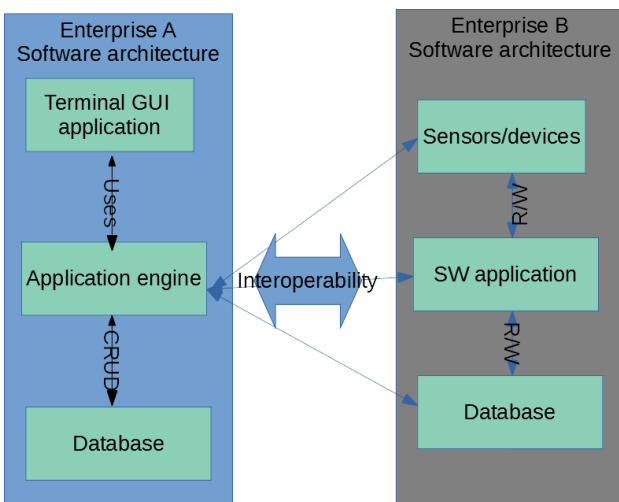

Figure 3. Problem of enterprise interoperability that design softwares

Organizations that design system will create a design whose structure is a copy of the organization's

communication structure. The first phase is to create the software structure which is the product of each enterprise, and this structure describes the organization's structure. The assumption and the initial phase is in this solution, that the design of company's product/software form creates its organizational and communication structure.

This solution is addressed on issue, on which way organizations can share information's and knowledge between themselves and achieve enterprise interoperability (Fig. 3), if organization and communication structure is based on functional silos [4]. The Functional Silo Syndrome (E., S., Phil.) defines that is not enough to share information's only on vertical axis, it is important to include and sharing data on horizontal axis in enterprise structure [5]. Any enterprise that designs a system will create a design whose structure is a copy of its communication structure [12].

III. METHODOLOGY

In this paper is proposed an approach based on Conway's law and Functional silos. Primarily, the assumption in this solution is, that design of enterprise's product/system is a copy of the communication structure of this enterprise (Fig. 4). The problem in this structure is to achieve interoperability if the communication link is only on top level and on vertical axis. So, the goal is to have communication and on horizontal axis between all teams, which will be presented on next chapter of this paper.
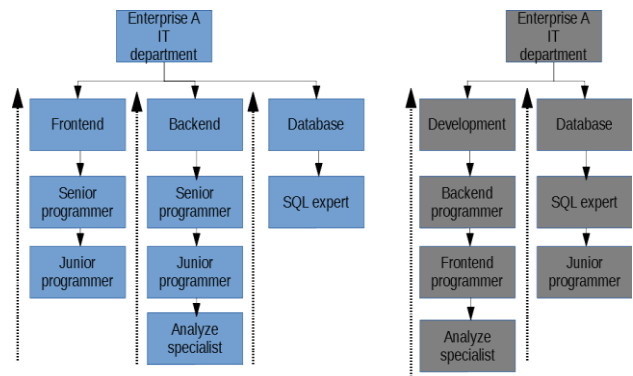

Figure 4. Enterprise organization structure is a copy structure of designed system (the assumption)

Structure, presented on Figure 4., has two barriers for enterprise interoperability: Inter-organizational and Intra-organizational. Employees has a limit formal and informal communication inside of one department. "Communication outside department is exceptional, and often not accompanied by open minded and open hearted approach" [4].

Criterion for the structuring of design enterprise: a design effort should be organized per need for communication and teams need different leadership styles as is shown on Figure 4. Managers of teams should keep their team lean and flexible for integrating with other teams and available for sharing data.

IV. FINDINGS

The presented solution (see Fig. 5) involved integration and achieving interoperability on both the vertical and horizontal axis. The goal is that people in the organization should start cooperating as allies, not as opponents, that enterprise interoperability can achieve on flexible way.

In different colors are defined teams, like a functional silo. This silo is one entirety of enterprise, which is capable to communicate with other silos on horizontal axis of organizational structure. The Functional Silo syndrome which was presented in preview chapter, with an assumption, has been solved with presented organizational structure (Fig. 4). There is no only sharing information and data on vertical axis between teams, it is included and sharing data on horizontal axis in enterprise structure

All teams have different leaders. Their aim is to keep organization flexible and stable. This solution puts the communication between employees on higher level, so employees will more flexible and productive. Employees are better educated and more sophisticated consumers of information and knowledge [12].
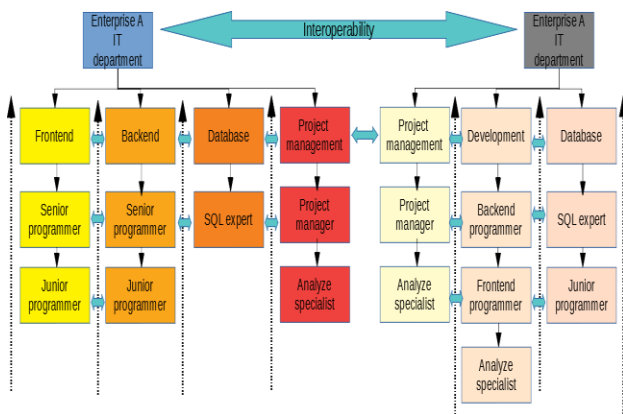

Figure 4. Enterprise's structure functions that are in mutual support mode

Quality research of this paper is realized by interview approach [13]. In this interview is included 7 enterprises, which are developing and deploying software solutions in field of traffic management systems. The aim of this approach is to analyze which is the percent of link between SW architecture and organizational architecture.

Type of Company	Type of Informant	Department	Number of employees	Type of org. structure	Type of SW architecture	Link
Headquater	IT manager	IT	3	Teritorial	*	10%
Corporate I	Lead SW manager	IT	8	Functional	SOA	80%
Corporate II	Senior engineer	IT	5	Functional	Client-server	70%
Corporate III	HW engineer	IT	2	Project	One tier	65%
Corporate IV	Development manager	IT	2	Functional	Two tier	80%
Corporate V	SW engineer	IT	4	Matrix	Three tier	75%
Corporate VI	Junior engineer	IT	2	Division	MVC	50%

Table 1. Interview (Quality research)

In Table 1., is presented the interview results which is based on next key parameters: Type of company, type of informant, department, Number of employees in this department, type of organizational structure, type of software architecture and level of link between organizational and software architecture.

The results what we can see in Table 1., is there are not complete level of link between these two architectures. Enterprises have an type of organizational structure which is not according to software architecture, they develop. Achieving interoperability between these enterprises is hard to do, because they have different types of organizational structure which are not in fully link with software architecture. The assumption is, that design of software has an impact to the structure of organization in aim of identifying the roles of employees and communication between them.

V. CONCLUSION

The aim of this research is to present one of the ways of achieving interoperability between organizations using Conway's law and Functional silos. Organizations involved in software production and its integration with existing software systems is the challenge of achieving interoperability. Namely, existing software systems currently do not have the same organizational structure as at the time they were developed. Therefore, this solution is based on the assumption that the design of the software system defines the structure of the organization, in order to effectively identify the roles and relationships between the teams. Effective realization of communication on the vertical and horizontal axis in the organizational structure, ie, by creating functional silos, achievement of interoperability between organizations.

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