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Informational Support For Information Systems Governance: The Applicative Cartography Repository

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INFORMATIONAL SUPPORT FOR INFORMATION SYSTEMS GOVERNANCE: THE APPLICATIVE CARTOGRAPHY REPOSITORY

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Abstract –

Information systems play a critical role in supporting complex processes in modern organizations Nevertheless, organizations are constantly evolving due to external and internal pressures like regulatory developments, business evolution help organizations, and cost containment. It follows that organizational information systems must be agile in order to be aligned with organizations strategies and help organizations manage continuous change and overcoming problems induced by the pressures of their continuously changing environment. Therefore, agile information systems are a critical resource that modern organizations must govern in order to use it effectively. Many authors have noted in recent years that information systems urbanization is one of the most promising approaches to building agile information systems. The governance of urbanized information systems is a complex activity that requires important resources and a deep understanding of the nature of information systems. In particular, to be effective, urbanized information systems governance requires three types of resources: informational resources, software tools managing informational resources, and human resources using these resources to carry out the urbanized information systems governance activities. The applications cartography repository is among the most important informational resources of urbanized information systems governance. In this paper, we propose framework of applications cartography repository which takes into account both the structural and dynamic of information systems urbanization.

Keywords: Urbanized information system; Information City Plan; Information system governance; Cartography repository, Architecture rule; Cartography dimension.

1 INTRODUCTION

Information systems play a critical role in supporting complex processes in modern organizations (Gurbaxani and Whang, 1991; Toffolon, 1996; Fisher and Kenny, 2000; Dewett and Jones, 2001; Toffolon and Dakhli, 2002; Laudon and Laudon, 2012). Nevertheless, organizations are constantly evolving due to external and internal pressures like regulatory developments, business evolution help organizations, and cost containment. Such pressures result in organizational changes including internal developments (restructuring of existing units, creation of subsidiaries,…) and external developments (acquisition of new companies,…). It follows that organizational information systems are not stable and must evolve constantly in order to be aligned with organizations strategies. Agile information systems are among the main instruments proposed in the literature to help organizations manage continuous change and overcoming problems induced by the pressures of their continuously changing, demand-oriented and highly dynamic business environment (Leavitt, 1963; Stohr and Konsynski, 1992; Toffolon, 1996). Therefore, agile information systems are a critical resource that modern organizations must govern in order to use it effectively (De Souza, 2006; Hovorka and Larsen, 2006). According to Keasey and his co-authors (Keasey et al., 2007), governance refers to "the structures, processes, cultures and systems that engender the successful operations of the organizations". It follows that governance is broader than management since it encloses both a managerial and a cultural dimension. Information system governance permits verify the contribution of information system to the added value of the organization, the alignment of information system's objectives with those of the organization, and the intrinsic coherence of the different parts of the information system. It includes coordination and monitoring of the information's system objectives and means in time and space so that it contributes to the achievement of the organization's strategy. Many authors have noted in recent years that information systems urbanization is one of the most promising approaches to building agile information systems (Sassoon, 1998; Jean, 2000; Chelli, 2003; Leroux, 2004; Longépé, 2006; Guetat and Dakhli, 2009; Imache et al., 2015). Information system urbanization is an architecture-oriented approach which consists in organizing applications so that they meet the strong coherence and weak coupling principles. This approach - is not a revolution which consists in building an agile information system from scratch, but an evolution from an existing non-urbanized information system to a target urbanized information system in accordance with a roadmap. Nevertheless, However, despite the advantages of urbanization, it poses at least two problems. On the one hand, it is an approach allowing the long-term evolution of an information system. Therefore, it may be in contradiction with organization's short-term needs related in particular to time-to-market. On the other hand, an urbanized information system must be in conformity with a set of architectural rules whose respect could make its evolution more difficult. Therefore, the governance of urbanized information systems is a complex activity that requires important resources and a deep understanding of the nature of information systems. In particular, to be effective, urbanized information systems governance requires three types of resources: informational resources, software tools managing informational resources, and human resources using these resources to carry out the urbanized information systems governance activities. The applications cartography repository is among the most important informational resources of urbanized information systems governance. In this paper, we propose framework of an applicative cartography repository which takes into account both the structural and dynamic of information systems urbanization. Our paper is organized as follows. Section 2 presents the information systems urbanization concept. In section 3, we describe the global model of information systems architecture. This model, based on the systems theory (von Bertalanffy, 1968), points out that information system architecture is composed of five interacting layers: the organizational processes architecture layer, the functional architecture layer, the applicative architecture layer, the software architecture layer, and the infrastructure layer. Each layer is associated with a cartography dimension. Section 4 is dedicated to the presentation of the applicative cartography repository. In section 5, we describe how this repository contributes to urbanized information systems governance. Section 6 concludes this

paper by describing the validation of the proposed framework and listing the future research directions.

2 THE INFORMATION SYSTEM URBANIZATION APPROACH

Information systems urbanization is based on the "Information city" framework which compares information systems to cities populated by applications that cohabit by exchanging informational flows and services according to a set of architecture principles and rules reflecting the organizational context characteristics and constraints (Guetat and Dakhli, 2009). Moreover, this framework assumes that specific applications of an information system may exchange informational flows and services with external information systems. The "Information City" framework helps organizations build an Information City Plan which to urbanize information systems by federating applications in a global structure composed of areas, districts, and blocks governed by organizations architecture principles and rules. Each area is composed of districts and each district is composed of blocks. The organization's Information City Plan construction is compliant with three rules:

1) Identify applications that support organization's front-office vs. organization's back-office;
2) Associate at least an area of the Information City Plan to each type of organizational processes;
3) Identify the applications that manage shared information and those that manage exchanges between information system applications.

There are five types of organizational processes: business processes, support processes, decision-making processes, customers and partners relationships management processes, and communication with the external environment processes. The first three types describe the organization's back office activities while the last two types describe the organization's front-office activities. It follows the organization's Information City Plan is composed of at least seven areas listed in Table 1. Each area is dedicated to a homogeneous subset of information system's applications.

Information City Plan area	**Organization component**	**Applications**
Inbound and Outbound flows management area	Front-Office	Applications that computerize the Communication with the external environment processes
Party Relationships area	Front-office	Applications that computerize the customers and partners relationships management processes
Business Intelligence area	Back-Office	Applications that computerize the decision-making processes
Support area	Back-Office	Applications that computerize the support processes
Business area (at least one area)	Back-Office	Applications that computerize the business processes
Integration area	Middle-Office	Applications that manage exchanges between information system applications
Shared Information area	Middle-Office	Applications that manage information shared by information system applications

Table 1. Information City Plan areas.

Therefore, an urbanized information system is composed of applications which belong to three organizational components: Front-Office, Back-Office, and Middle-Office. Information

system's Front-Office is made up of two areas: the Inbound and Outbound flows management area, and the Party relationships area. The Inbound and Outbound flows management area is dedicated to communication with the external environment using various channel (SMS, websites, EDI,…) while the Party Relationships area supports the management of relationships with organization's customers and partners. Information system's Middle-Office is made up of two areas: Integration area, and Shared Information area. The Integration area encompasses applications that support exchanges within information system. In other words, applications that belong to this area play the role of intermediary between information applications during informational flows and services exchanges. Enterprise Software Bus (ESB) and Enterprise Application Integration (EAI) are examples of applications that belong to the Integration area. The Shared Information area is dedicated to the applications that manage repositories containing critical information shared by all the information system applications: customers repository, products repositories, human resources repository,… Information system's Back-Office is made up of at least three areas: the Business Intelligence area, the Support area, and at least one Business area. The Business Intelligence area contains applications which support the organization decision-making processes: datawarehouses management systems, dashboards systems,… The Support area encompasses applications which computerize the organization's support processes. The organization's accounting and payroll systems are examples of applications belonging to the Support area. The Business area contains applications that support organization's business processes. An organization may have many business areas. This is the case of banks that can decide to manage applications supporting the savings processes and the domestic insurance processes in two Business areas. Figure 1 illustrates the Information City Plan. The behavior of the applications and their distribution in the areas of the Information City Plan is compatible with a set of architecture rules and principles among which we quote the following three architecture rules:

- **R1:** An information system application belongs to one and only one block of the Information City Plan,
- **R2:** Exchanges of informational flows and services between applications that belong to different areas of the Information City Plan must be intermediated by Integration area,
- **R3:** Exchanges of informational flows and services with external information systems must be intermediated by applications belonging to the Inbound and Outbound flows management area.

Information systems urbanization focuses on two main interrelated aspects of governance: structural and dynamic. The first aspect refers to the architecture of applications making up an information system while the second aspect emphasizes information systems integration related to information and services exchanges either within an information system or between many information systems. These two aspects reflect both the structural and systemic complexity of information systems resulting from the complexity of the organizational processes they support. Moreover, this approach provides instruments to facilitate information systems governance. The Information City Plan and the Global Model of Information Systems Architecture are examples of such instruments which help organizations build informational resources repositories necessary to carry out the activities of urbanized information systems governance. In the next section, we present succinctly the Global Model of Information Systems Architecture.

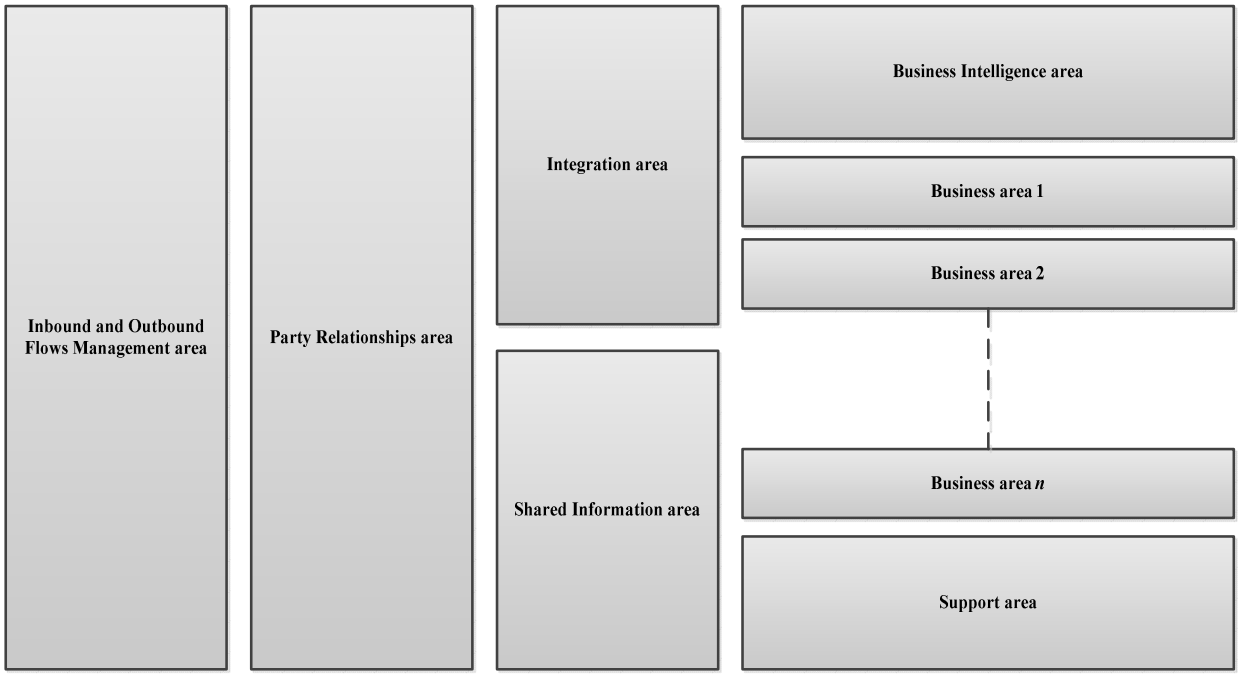

Figure 1. The Information City Plan (Source (Guetat and Dakhli, 2009)).

3 THE GLOBAL MODEL OF INFORMATION SYSTEMS ARCHITECTURE

The Global Model of Information Systems Architecture (Dakhli, 2008) is an instrument that helps understanding structural complexity and the systemic complexity of urbanized information systems and helps organizations build informational resources for effective governance such systems. It is a multi-layered model of information systems architecture which relies on six interacting layers: the strategy layer, the organizational processes architecture layer, the functional architecture layer, the applicative architecture layer, and the software architecture layer. The strategic layer describes the organizational problems to be solved and their organizational solutions. Such problems result from the organization's external and internal constraints. External constraints may be economic, political, social, legal or related to the evolution of the technology. Internal constraints reflect the impacts of external constraints on the organization's components: structure, people, production technology, tasks and information technology (Leavitt 1963; Toffolon, 1996). The organizational processes layer describes the organizational processes architecture at two levels: conceptual, and operational. The organizational processes architecture is updated according to the organizational solutions defined by the strategic layer. The functional architecture layer describes the information system architecture as a nexus of informational entities and functions. Because of the invariant and stable nature of informational entities and functions, they are independent of the organizational structure, the roles played by actors within an organization, and the production and computerization technologies used within organizations. The applicative layer provides a map which describes the information system's applications as well as the informational flows and services they exchange. The software layer describes each computerization solution as a set of software components and connectors distributed according to a software architecture model (e.g. MVC,…). A computerization solution is either the architecture of a new application which supports at least partly a new organizational process or the architecture of an existing application which is enhanced in

order to take into account the modifications of an existing organizational process. The Infrastructure layer describes the human resources, and the hardware and network resources used to implement information system's applications.
Each layer of the Global Model of Information Systems Architecture is characterized by a set of key concepts and their relationships. Table 2 lists the concepts associated with each layer.

Information system architecture layer	**Key concepts**
Organizational processes	Process, activity, task, automatic task, semi-automatic task, operation, procedure, use case, actor
Functional architecture	Function, elementary function, informational entity
Applicative architecture	Application, applicative platform, user service, applicative service, platform service, informational flow
Software architecture	Software layer, component, component service, software layer service
Infrastructure	Computer, technical platform, system software

Table 2. Key concepts characterizing the Global Model of Information Systems Architecture.

Moreover, this model is compliant with the Software Global Model which points out that the computerization process takes place in four spaces: the problem space, the solution space, the construction space, and the operation space (Toffolon and Dakhli, 2002). Indeed, the organizational layer corresponds to the problem space while the construction space encompasses the functional architecture layer, the applicative architecture layer, the software architecture layer, and the infrastructure layer. Figure 2 illustrates the Global Model of Information System.

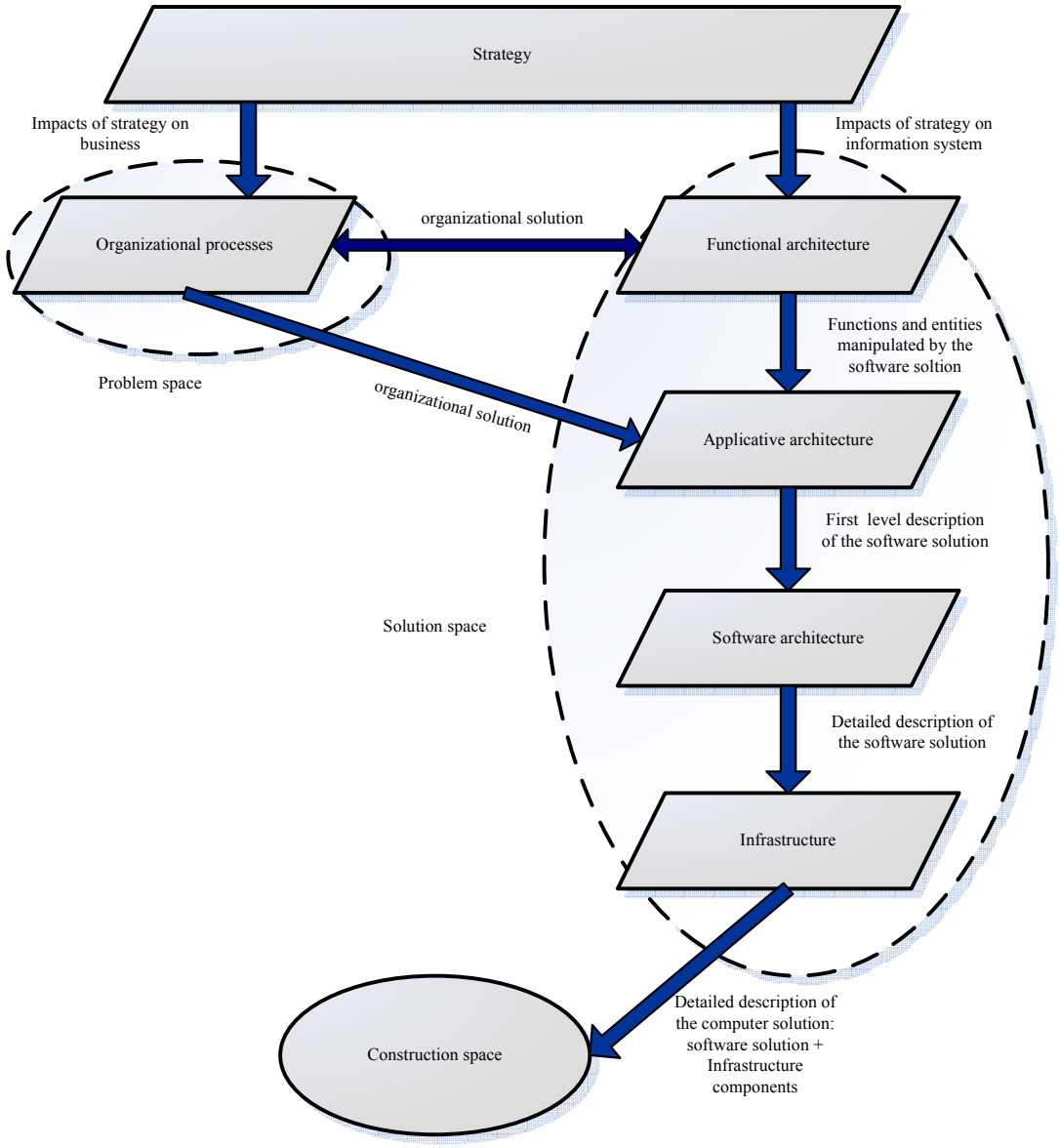

Figure 2. The Global Model of Information Systems Architecture.

4 THE APPLICATIVE CARTOGRAPHY REPOSITORY

The goal of an information system's cartography consists in providing a map of this information system with a variable level of details about applications, organizational processes supported, data processed, functions implemented, and infrastructure resources used. It focuses on organizational information system's applications, their dependencies, their functional scope, the organizational processes they support, and the infrastructure resources they use. According to the Global Model of Information Systems Architecture, the information system's cartography has five dimensions: the functional dimension, the applicative dimension, the software dimension, and the organizational processes dimension, and the infrastructure dimension. Each dimension is associated with a view of the information's system cartography. In other words, a dimension of the information system's cartography represents a particular concern of organizational actors involved either in the problem space or in the solution space (Toffolon and Dakhli, 2002). In this paper we focus on the applicative cartography repository which represents the information system's cartography views associated with the functional, the applicative and the software dimensions. Prior to

presentation of the metamodel of this repository, we define in Table 3 the main concepts characterizing this view: function, elementary function, informational entity, application, applicative platform, platform service, user service, applicative service, informational flow, component, component service, software layer, and software layer service.
There are four levels of applicative cartography: inventory level, structure level, dependencies level, and documentation level. The applicative cartography inventory level provides a comprehensive list of functions, elementary functions, informational entities, and applicative objects characterizing the applicative dimension (application, applicative platforms, services, components) including their most important attributes like a short textual description, an ID, the name of the organizational unit responsible, the date of release, the location in Information City Plan (area, district, block). The applicative cartography structure level describes on the one hand, the internal architecture of functions and informational entities (functional domains, elementary functions,...) and on the other hand, the internal architecture of applications and applicative platforms in terms of components, connectors, services, and dependencies. For each application (vs. function), this level is associated with two diagrams: applicative (vs. functional) tree, and intra-application diagram. An applicative (vs. functional) tree is a hierarchical decomposition of an application (vs. functional domain, function) into applicative objects (vs. functions, elementary functions) while an intra-application diagram identifies applicative objects necessary for the proper functioning of an application. In particular, such a diagram describes how an application implements exchanges with its environment. The applicative cartography dependencies level describes the dependencies between an application and other applications belonging either to the organization's information system or to external information systems. These dependencies are described at a macroscopic level. For example, if an application *A* calls services S_1, and S_2 exposed by an application *B*, the dependency between these two applications is noted "*A* uses *B*". Such a macroscopic description of dependencies between applications belonging to the organization's information system has three advantages. On the one hand, it is comprehensive and can be easily updated and on the other hand, it makes it possible to carry out a rapid impact analysis in case of an application failure. The applicative cartography dependencies level is associated with the inter-applications diagram which consists in an external view of an application that identifies its environment and the main informational flows and services exchanged by this application with organizational actors and with other applications belonging either to the organization's information system or to external information systems. The applicative cartography documentation level provides a detailed description of applicative objects that make up the organization's information system. In particular, detailed information is given at this cartography level about exchanges between applications in terms of information flows and services. Such detailed description may be materialized either by structured forms or by links to applications documentation. Information provided by this applicative cartography level is often not comprehensive and not up to date.

Applicative cartography concept	Definition
Informational entity	An informational entity is a set of information chunks which define a concept that has a lifecycle and is commonly used by the organizational actors while carrying their activities
Function	A function is an action which uses or transforms at least one informational entity
Elementary function	An elementary function is an action on only one informational entity
Application	An application is a macroscopic software covering a significant part of an organizational information system, and managing its own data. From the outside, an application is seen as a black box which has interfaces with other applications and end user. An interface of an application consists of a set of applicative services, and user services providing functionality. A software is an application if it satisfies four criteria: • **C1:** it has a lifecycle, • **C2:** it manages its own data for which it is responsible, • **C3:** it implements a coherent set of elementary functions, • **C4:** it is accessible without other application being so. However, an application may need application services from other applications to be fully operational, and depend on an applicative platform to operate
Applicative platform	An applicative platform is a basic software shared by several applications of the same construction. It has a life cycle and offers applicative platform services. An applicative platform doesn't have any precise business purpose. A Database Management System (DBMS) and a software package are examples of applicative platforms.
Platform service	A platform service is a technical service offered by an applicative platform
User service	A user service is an entry point of an application dedicated to human end users, which automates partially an elementary function or a sequence of several elementary functions
Applicative service	An applicative service is an entry point of an application dedicated to other applications, which implements an elementary function (action on one informational entity), or a sequence of several elementary functions
Informational flow	An informational flow is a message exchanged between two applicative objects (application, layer, component)
Component	A component is a base brick which implements a manageable and modular part of the functionalities of the application. It is a modular part of an application which can be activated separately via applicative services. The components of the same application generally depend strongly on each other. Application features and applicative services are distributed between application's components. An application component only belongs to a single layer.
Component service	A component service is a service offered by a component and dedicated to other components of the same layer
Software layer	A software layer is an aggregation of application components of an application with exclusive roles and responsibilities
Software layer service	A software layer service is a service offered by a software layer and dedicated to others layers of the same application

Table 3. Applicative cartography concepts.

Figure 3 illustrates the metamodel associated to the functional, applicative, and software dimensions of urbanized information system cartography repository.

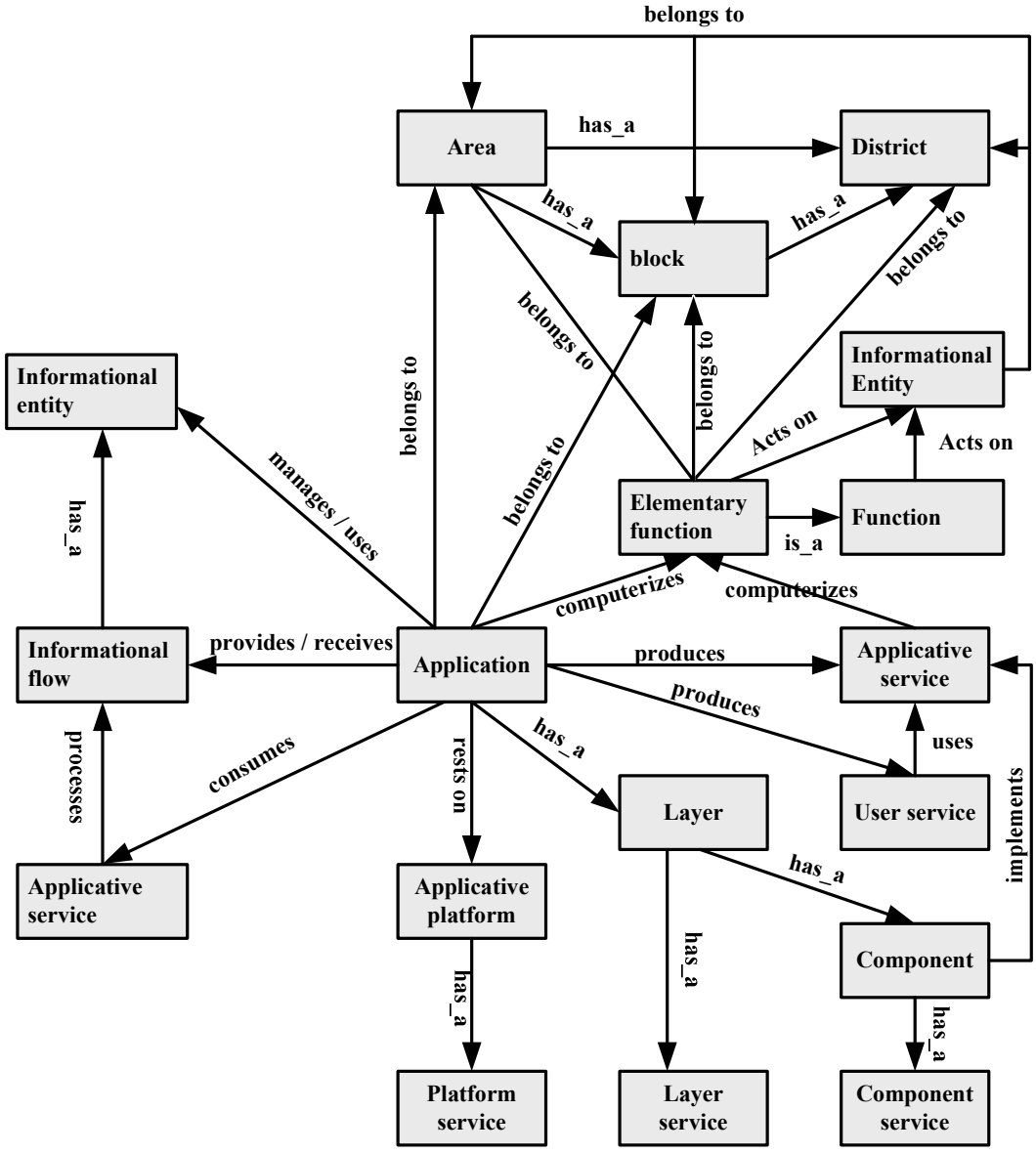

Figure 3. The metamodel associated to the functional, applicative, and software dimensions of urbanized information system cartography repository.

5 CONTRIBUTION OF THE APPLICATIVE CARTOGRAPHY REPOSITORY TO URBANIZED INFORMATION SYSTEMS GOVERNANCE

The applicative cartography repository provides knowledge that helps manage the organization's information assets. In particular, such knowledge can be used in several ways to support the governance of urbanized information systems. On the one hand, this repository permits identifying non-urbanized applications which belongs to many areas, districts, or blocks of the Information City Plan. Such applications violate the important architecture rule **R1** listed previously (**R1:** *An information system application belongs to one and only one block of the Information City Plan*) and the third criteria **C3** to be satisfied by applications (**C3:** *it implements a coherent set of functions*). Non-urbanized applications constitute an

information system governance problem whose resolution requires the decomposition of such applications into several applications that respect the urbanization principles and rules, and the applications definition criteria. For example, if *A* is an application which supports both Customers Relationships Management (CRM), insurance contracts management, and provides a dashboard for managers, A is non-urbanized since it belongs to three areas of the Information City Plan: the Party relationships area, the Business Intelligence area, and a Business area. Moreover, this application violates the criteria **C3** applications definition since it doesn't implement a homogeneous set of elementary functions. This example demonstrates how the Information City Plan, provided by the information systems urbanization approach, helps governing information systems. Another example of the contribution of the applicative cartography repository to information systems governance is the use of this repository to analyze the impact of an application. On the one hand, the application tree and the intra-application diagram make it possible to identify the layers, components, and services responsible for the failure. On the other hand, the inter-applications diagram makes it possible to identify the applications of the information system impacted by this failure. Furthermore, the inter-applications diagram, provided by the applicative cartography repository, permits identifying the point-to-point exchanges between applications. Such exchanges violate both the information systems approach weak coupling principle and the architecture rule **R2** listed previously (**R2:** *Exchanges of informational flows and services between applications that belong to different areas of the Information City Plan must be intermediated by Integration area*). Tools such as Enterprise Software Bus (ESB) and Enterprise Applications Integration (EAI) permit reduce coupling between information system's applications. Finally, the architecture rules related to the information systems urbanization approach facilitate the governance of exchanges between information systems. For instance, to respect the architecture rule **R3** (**R3:** *Exchanges of informational flows and services with external information systems must be intermediated by applications belonging to the Inbound and Outbound flows management area*), specific applications must be dedicated to exchanges of informational flows and services between an information system and external information systems. The application of this rule is related to security and confidentiality constraints required for the protection of the organization's information assets.

6 CONCLUSION AND FUTURE RESEARCH DIRECTIONS

In this paper, we have presented a framework of an applicative cartography repository which takes into account both the structural and dynamic of information systems urbanization, and demonstrated how it can be used to govern urbanized information systems. This framework has been implemented for two years experimentation in an international insurance company whose information system is urbanized and composed of 1231 applications deployed in many countries in Europe, Africa, and Asia. These applications are running in different environments ranging from mainframe to open environments using web technologies. The information system management staff is composed of about 700 employees organized in many teams, each team is dedicated to a subsidiary. These teams include managers, developers, project managers, technical engineers, enterprise architects, software architects, infrastructure architects, and cartographers. The role of cartographers consists in describing the information systems applications in the applicative cartography repository at the four cartography levels by taking into account the functional, the applicative, and the software dimensions. Many lessons have been learned after the first year of experimentation of our framework. Firstly, it is difficult to keep the information contained in the repository up-to-date. This is due on the one hand, to the difficult communication between the cartographers and the project teams who don't provide the cartographers with sufficient information on the

development, maintenance, and evolution of the applications they manage. For example, if an application calls a service provided by another application, this exchange is not systematically described in the applicative cartography repository. On the other hand, many cartographers point out that the effort devoted to cartography is not sufficient. Therefore, improvement of the communication between project teams and cartographers through a standardization of the communication channels and the documentation of applications is a first research direction. Secondly, information contained in the applicative cartography repository are heterogeneous since it detailed for somme applications and synthetic for others. It follows that a standardization of the applicative cartography repository is necessary to improve the homogeneity of its content. This another research direction. Finally, we have noted that two separate tools are used in this company for the cartography of organizational processes and infrastructure. These tools don't communicate neither with each other, nor with the applicative cartography repository. To avoid inconsistencies related to this dispersion of information, an extension of the applicative cartography repository seems necessary to take into account the organizational processes and infrastructure dimension of information system cartography. This is a third research direction.

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