# PROPOSING AN ENTERPRISE ARCHITECTURE APPROACH FOR GIS PROJECTS

Wajih Krimi[1], Yemna Sayeb[2] Henda Ben Ghezala[3]

[1,2,3]*RIADI Research Laboratory University of Manouba, Tunisia*

**Abstract.**

Geographic Information Systems (GIS) create, sort, query, and provide a visual representation of these big data against the earth's surface as a map. The use of GIS has flooded almost every field in the engineering, natural and social sciences, offering accurate, efficient, reproducible methods for collecting, viewing and analyzing spatial data.
A GIS has the necessary tools to organize, store, retrieve and analyze data, but maps are the primary output of any GIS These maps show the relationship between data and earth's surface. This relationship defines a piece of data, provides a meaningful context, and converts it to a piece of information
The potential of GIS is limitless in many cases above, particularly for those concerned with resource planning, complex formulas are calculated to ensure the most efficient delivery. Whether you know it or not, your daily life relies heavily on GIS.
A GIS that develops from this unplanned, unmanaged, ad-hoc growth pattern will suffer from many problems. Servers and computer hard drives contain large numbers of duplicate, misnamed, or improperly formatted datasets. We tried to look for a solution to solve the problems mentioned above, we came to the conclusion that Enterprise Architecture can vastly improve GIS systems. In this article, we will explore how Enterprise Architecture can provide order and strategy for chaotic enterprise GIS systems.

**Keywords:**GIS, Geographic Information Systems, Enterprise Architecture, EA, Enterprise GIS, EGIS.

## 1 Problematic

Geographical Information System [GIS] is a computer system capable of capturing, storing, checking, integrating, manipulating, analyzing and displaying data in digital form related to the position of the earth surface [1.2]. GIS development has grown in line with the rapid development of technology during the past decades have expressed specific challenges in storage and spatial data analysts. It also functions as an important tool in the process of problem solving and decision making [3].

Servers and computer hard drives contain large numbers of duplicate, misnamed, or improperly formatted datasets. The result of these problems will be system users experiencing slow response times when performing data processing, querying, mapping, and losing valuable time searching for lost data. A lack of system planning will also lead to redundant projects, efforts, data format, and employee efforts, which will create staff confusion, wasted time and effort. These and many other flaws inherent to ad-hoc systems begin to reveal themselves as the use load on the system increases.

Many people would consider this ad-hoc system a successful implementation of an enterprise GIS. An enterprise GIS is a GIS that provides support and GIS capabilities throughout every level of the organization. The misconception that people have is that a true enterprise GIS will result from an ad-hoc development process [1]. An ad-hoc GIS is simply a system of chaos and disorder where each GIS user follows his/her own path [2].

When a GIS system matures to the point where GIS capabilities are available to anyone within an organization it is often considered an enterprise GIS system. Is this really an enterprise GIS system? The discipline of GIS is relatively new, and it is a virtual newcomer to concepts of enterprise databases and systems. Therefore, there are many different definitions of what constitutes or what defines an enterprise GIS System. The Environmental Systems Research Institute (ESRI) is the company that produces the ArcGIS suite, which has become the software standard for GIS. ESRI states that an enterprise GIS system is "A geographic information system that is integrated through an entire organization so that a large number of users can manage, share, and use spatial data and related information to address a variety of needs, including data creation, modification, visualization, analysis, and dissemination.This definition of enterprise GIS does not provide any form of organization strategy, principles, standards, or even goals. However, a future section of this thesis will demonstrate how enterprise architecture can provide these missing elements.

## 2 Solution

The generic mission of every organization is to exist tomorrow and be relevant to their customer base. The only means of making sure that they survive difficult times is by focusing on creating long term value and being ready to change to take advantage of opportunities should any arise [6]. According to [7], as part of the competences required by organizations to create value now and in the future, they must align the operations of the enterprise including the information systems, processes, and business functions with its strategic direction and business goals. This method of aligning information technology and business within the organization is referred to as Enterprise Architecture.

Langenberg & Wegmann [8] defines Enterprise Architecture as "blueprint that documents all the information systems within the enterprise, their relationships, and how they interact to fulfil the enterprises mission". EA is aligning information technology with business hierarchically [9]. Enterprise Architecture entails the use of frameworks that support enterprise analysis from the level of business to the level of Information technology. Zachman in 1987 introduced the "*Framework for Information Systems Architecture*" which is mostly regarded as the initial step towards the EA discipline [10].

The name "Enterprise Architecture" was however not coined until later in 1996 when the government of America via the Clinger-Cohen Act directed federal agencies to implement a holistic methodology to align business goals to information technology. The term enterprise architecture has aroused a lot of thoughts and interests and is now commonly understood as a hierarchical approach to aligning business and infor-

mation technology. Some very popular frameworks are The Open Group Architecture Framework (TOGAF), The Federal Enterprise Architecture Framework (FEAF), Zachman Framework for Enterprise Architecture, and The Gartner Methodology. According to [11] All of these different frameworks were initiated with the intention of solving two problems:

- **The Complexity of Systems** – Huge sums of money were being spent by organizations to build IT systems; and
- **Poor alignment of Business** – Organizations found it continuously difficult to align the rather high cost of IT systems with business need.

# 3 Research methodology

## 3.1 Description

The most effective way to create unified, organized, and efficient GIS is through enterprise architecture. Bringing enterprise architecture into GIS can be and should be done by everyone designing or developing plans for a GIS system. Merging the two types of enterprise systems might seem like a daunting task; it requires more thought and effort, but this extra level of planning will simplify system implementation, maintenance, and upgrading. The return on the investment of extra effort, thought, and planning is a well-organized, efficient, responsive GIS system that converts data into valuable information.

Our goal is to successfully implement a project of urbanization of a GIS by the proposal of a strategic approach to enhance the development of the information system and the management of interoperability between different subsystems by providing goal oriented guidance between the various stages of the definition of the target architecture. Our combined approach takes into account the different levels of concern and provides traceability between strategic objectives and different levels of the information.

The strategic alignment is the basic process of redesigning the organizational structures, information system processes and the production system so that they are in perfect accord with the strategy developed.We opt for MAPgiven its consideration of the context and the evolution of the strategic needs it offers and which constitute one of its specificities.

A MAP is a process model in which a non-deterministic ordering of intentions and strategies has been included. It is a labelled directed graph with intentions as nodes and strategies as edges between intentions. The directed nature of the graph shows which intentions can follow which one. A map consists of a number of sections each of which is a triplet. There are two distinct intentions called Start and Stop respectively that represent the intentions to start navigating in the map and to stop doing so. Thus, it can be seen that there are a number of paths in the graph from Start to Stop [4].

MAP offers a big degree of freedom in the sequencing of realization of the intentions and in the choice of techniques to apply [4] [5]. It joins in a contextual approach the process of analysis of which is seen as a succession of decisions which leads in its transformation of the product. The role of the map is to supply one support in the selection of alternatives by proposing methodological helps under forms of directives to guide decision-making. MAP allows us to create a guiding model. The model is composed of several intentions and according to the desired intention, different strategies are defined. Intentions and strategies are chosen based on the needs. This model will be able to guarantee a multi-level guiding support between the IS components in order to align with the strategy of organization. This strategic alignment aims to reinforce the use value of the Information system and make it an asset for the piloting and the development of the enterprise.

Following a consideration of the changes it remains possible either:

- To analyze the architecture of the existing IS to be able to identify the impact of the changes as well as the feasibility of the urbanization project so we can design and implement the target architecture.
- To design and implement the target architecture without analyzing the existing architecture, in this case it's about running a new project or doing changes on the existing one.

Fig. 1. shows our chosen approach and the result of applying it on GIS systems:

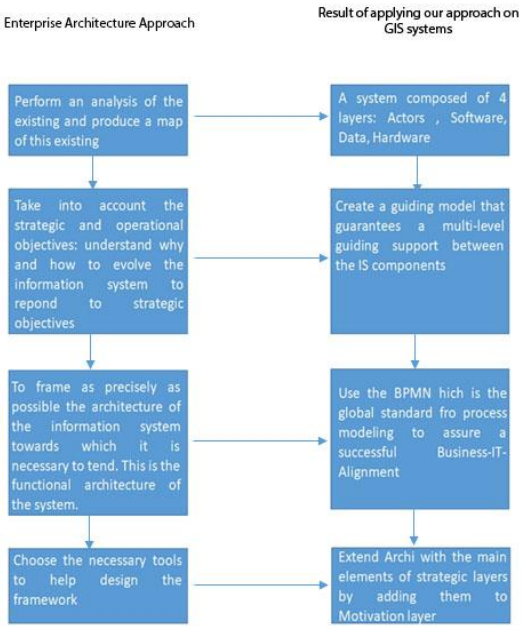


**Fig. 1**. result of applying our proposed approach on GIS systems

### 3.2 Architecture

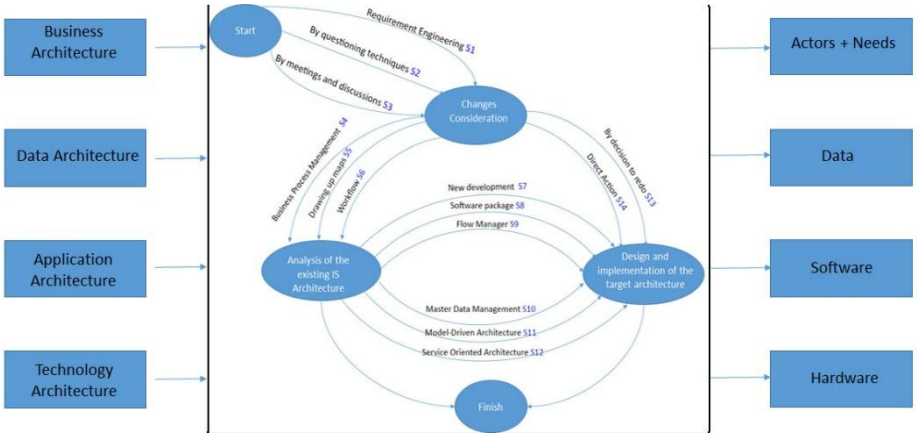


**Fig. 2.** Applying EA to GIS using MAP

The business architecture is defined as "a blueprint of the enterprise that provides a common understanding of the organization and is used to align strategic objectives and tactical demands, this will determine the goals when implementing a GIS system. A goal is a statement of what the organization will accomplished. Each goal is written in an easy to understand sentence structure. The goal statement could be simply"establish a GIS System". A simple goal statement avoids misinterpretations. When a vision of the organization is established, it is time to determine who is responsible for each part of the vision. Establishing and defining roles and responsibilities is important for creating the architecture's structure and chain of command. People need to know and understand how the flow of authority and ideas will move throughout the organization.

The Data architecture is key to the success of an Enterprise Architecture Program as information is created consumed and destroyed by the components that make up the other architectures. It identifies where important blocks of information such as customer record are kept and how typically accesses them. The heart of a GIS is data, and its pulse can be measured by the number of projects which successfully convert data into valuable information: the need to establish data standards. The primary function of GIS is to query and map information in relation to the earth's surface. It is critical that the data heart of a GIS be clean from errors or inaccuracies. Preventing mistakes is the first line of defense when protecting GIS data from errors. GIS system designers, developers, programmers, etc. should rummage through the toolbox of the data architect. Data architects are required to ensure that data sets are organized, clean, secured, and easily available. Their toolbox is filled with ideas and methodologies that will improve the flow of data in an enterprise GIS. The first tool that should

be “borrowed” from the data architect is the concept of developing data standards. GIS provides many different paths for someone to arrive at an answer to a question. Unfortunately, this means that there is no standardization of how to format, store, or use data within the system. Each person follows his or her own path, which creates a set of data that is filled with errors, duplicates, and is disorganized. A set of data standards for the enterprise GIS system will provide an efficient and streamlined flow of data into and out of the enterprise system. These standards will establish definitions and formatting practices for each piece of data. Standardizing data procedures will prevent the loss or misplacement of data and the resulting project delays or confusion that occur when information is missing. Then he created a geo-database: A foundation stone for both enterprise architecture and GIS is the creating of a central warehouse of data and information. This concept really boils down to creating a folder or database that is accessible for everyone on the system. The GIS system will use a geo-database for the data warehouse. A geo-database will locate all the available data into one container while providing the capabilities of distribution and versioning. The geo-database will add more flexibility and adaptability to the enterprise GIS system.

Application architecture is a map of the relationships of software applications to one another which is represented un an applications catalog that is a listing of all the applications that are used by or interact with the enterprise GIS system. This inventory assigns each software application a unique identification number, determines how it impacts the GIS, how many licenses are available, who uses it, what other applications need it, reliability, and when it should be replaced (end of lifecycle). When completed this catalog will display all of the software applications used within the enterprise system and double as a budgetary planning aid by revealing when applications need upgraded or replaced.
The technology architecture provides a blueprint for the range of hardware, storage systems, and networks which is represented in a technology catalog that is set up in a similar fashion as the applications catalog. However, this catalog tracks all of the hardware, (computers, monitors, printers, etc.) that is used or interacts with the enterprise GIS system. The catalog breaks the hardware down into categories and shows where each piece of hardware fits into the overall system. This catalog is a valuable tool for determining if, when, and how to budget for hardware upgrades or replacements.

## 4. Innovative Contribution

In this article we tried to explain how an Enterprise Architecture can address Enterprise GIS systems lacking, as in strategy, principles, standards, or even goals. By using Enterprise Architecture methodologies, we were capable of creating a strategy that leads us through the whole process of implementing an EGIS, by creating principles, standards and goals to determine our desired system. These elements men-

tioned above allowed us to avoid the problems that comes up from implementing an EGIS without having a strategy or goal likeduplicate, misnamed, or improperly formatted datasets, redundant projects, efforts, data format, and employee efforts, which will create staff confusion, wasted time and effort.

## References

[1]Crampton J. The history of distributed mapping. Cartographic Perspectives 2001; 35:48-65
[2] Cooke D.L. Topology and TIGER: The Census Bureau's contribution. History of Geographic Information Systems: Perspectives from the Pioneers 1998 (ed. T. Foresman).
[3] Chang, K.-T,Geographic Information System, The International Encyclopedia of Geography, 1–9, 2017
[4] Colette Roland, Naveen Prakash, "Bridging the gap betwen organisationnal needs and ERP functionality"journal of requirement engineering, 2000
[5] C. Rolland, N. Prakash, A. Benjamen,, A Multi-Model View of Process Modelling, journal of requirement engineering, 1999
[6] Collins, F. C. and De Meo, P. 2011. Realizing the business value of enterprise architecture through architecture building blocks. Coherency Management: Architecting the Enterprise for Alignment, Agility and Assurance, p. 333.
[7] Zachman, J. A. 1997. Enterprise architecture: The issue of the century. Database Programming and Design, 10 (3), pp. 44--53.
[8] Langenberg, K. and Wegmann, A. 2004. Enterprise architecture: What aspects is current research targeting. Laboratory of Systemic Modeling, Lausanne.
[9] Wegmann & Balabko et al. 2005. A Method and Tool for BusinessIT Alignment in Enterprise Architecture. 2005.
[10] Bhagwat, R. and Sharma, M. 2007. Information system architecture: a framework for a cluster of small-and medium-sized enterprises (SMEs). Production Planning \& Control, 18 (4), pp. 283--296.
[11] O'rourke, C., Fishman, N. and Selkow, W. 2003. Enterprise architecture. Boston, Mass: Course Technology.