An Open Enterprise Architecture Framework Design for the Cultural Heritage Domain

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Abstract

The purpose of this paper is to describe an open enterprise architecture framework, called "GeoHistory", for GIS-based cultural heritage management. The focus will be mainly on technological rather than business, data or information aspects. "GeoHistory" faces the challenge of designing, building, and maintaining a "small and medium-scale" distributed enterprise system that is able to adapt to changing business needs by improving e-business through semantic, interoperable, and enterprise integration. UML 2.0 was selected as the primary enterprise modeling tool for advanced modeling using a top-to-bottom approach for "GeoHistory". Under this model, component-based "GeoHistory" provides service-oriented applications through a Web portal. "GeoHistory" is spatially enabled because it integrates geospatial technologies, in particular GIS with historical research and documentation. Finally, the growth stages of "GeoHistory" will be examined in this paper, followed by how "GeoHistory" promotes effective management of the project by maximizing the use of geospatial data.

1. INTRODUCTION

Information and Communication Technology (ICT) plays an increasingly critical role in almost everything these days as well as in the work of the heritage sector which acts to understand, promote, present, preserve, and improve access to humanity's cultural and natural heritage. Many of today's cultural heritage (CH) organizations rely on digital information and communication technology to gather, organize, interpret, and disseminate data relating to their various projects. In many cases, this involves applications and services that were created at different times and designed for different computing platforms. The challenge now faced by these organizations is to provide efficient and effective methods by which these disparate technologies can work together to achieve academic and/or commercial objectives that are constantly evolving. "GeoHistory" a small-scale open enterprise architecture framework which has been developing in response to this challenge.

Enterprise Architecture (EA) is a concept from the business world which involves identifying the main components of an organization or project and clearly articulating how these components function together to achieve defined objectives. To achieve that, enterprise architecture requires a framework for focused business-IT alignment, change management, technology selection and excellence in execution. "GeoHistory", as an enterprise architecture framework, applies this approach to the cultural heritage domain through the use of particularly spatial informatics and cultural informatics.

"GeoHistory" faces the challenge of designing, building, deploying, implementing, validating, monitoring, evaluating, and maintaining an enterprise architecture for the cultural heritage domain. In the context of this study, the focus will be mainly on the design process which describes its design rationale in attempting to achieve maximum flexibility, interoperability, interactivity, maintainability and scalability for cultural heritage projects.

The whole approach is exemplified using a real-world case: the documentation project of

"Seddulbahir" and "Kumkale" two 17th century Ottoman Fortresses and its goal is to realize the project's motto: sharing "the life history of two Ottoman fortresses on the Dardanelles" with a broad range of enterprise constituents and public users.

Finally, this study examines not only how modern-day open enterprise architecture can be configured to embrace cultural heritage projects, but also assessed that Enterprise Architecture must be considered as essential in the present day CH organizations.

2. DEFINING ENTERPRISE and ENTERPRISE ARCHITECTURE

This section provides a conceptual overview of the field of Enterprise Architecture. Enterprise Architecture is still relatively immature from both a research and practice perspective and there is not a widespread consensus on the terminology. The terms "Enterprise Architecture" and "Enterprise" are interpreted and defined in many different ways and there is no single universally accepted definition yet.

In the course of developing this study, the definition of the term Enterprise is derived from the book "*How to survive in the jungle of Enterprise Architecture Frameworks*". An Enterprise is any collection of organizations that has a common set of goals/principles and/or single bottom line. In that sense, an enterprise can be a whole corporation, a division of a corporation, a government organization, a single department, or a network of geographically distant organizations linked together by common objectives. [1]

In this context, "KaleTakimi" -a small scale enterprise- is comprised of systems that interact with each other and which also has external constituencies. The internal and external business processes often share common characteristics when managing the enterprise's functional areas. Those systems developed by different groups in different times are operating as one system with a wide vision: This is what is defined as enterprise. Figure1 shows a schematic view of "KaleTakimi" as an enterprise. It includes the full breadth of the organization, as well as the full depth of domains. Different teams in different domains bring their own special set of demands to the business. More demands require secure and fast interactions which are electronic, common standards for information and communication technology. This innovative but at the same time can be disciplined entity-driven architecture and role-based process of "KaleTakimi" ensures consistent, reliable and adaptive business operations. An enterprise generally takes a set of drivers and produces a well thought-out and co-ordinated set of outcomes.

From the viewpoint of this study, definition of the enterprise is an open networked organization for which **knowledge** is the primary resource, **information** is the main asset, **data and data sharing** is the main business concern, and ICT is underlying tool.

It is worthwhile noting that Enterprise Architecture is an evolving discipline and, in its relatively short life, has already changed considerably in its scope. In the beginning, enterprise architecture was purely a function of IT. Its work was focused on issues such as enterprise application integration and formulating and implementing technology standards across the enterprise. Over the last decade or so, enterprises around the world have become more focused on improving their processes and flexibility on all levels through activities such as Business Process Reengineering. Against this background, enterprise architecture has broadened to become a critical connection between high level business vision and its effective expression through strategy, human process and

automation. As a discipline, it sits, almost as an umbrella, over business, technology, application and information architecture. [2]

Enterprise Architecture refers to the architecture of an Enterprise, identifies the main components of an organization and how components in the organization's nervous system function together to achieve defined business objectives. Components in this context are all the components that enclose the areas of People, Processes, Business and Technology, for instance, goals, strategies, financial information, governance, domains, stakeholders, services, information, communications, applications, technological infrastructure, databases, networks etc. [1, 3, 4]

An EA is, in some sense, a statement of philosophy. Like all philosophies, it must begin with assumptions about the present state and the desired future state. [5] After documenting the present state architecture and designing the future state architecture, a transformation strategy is developed by identifying the gaps between the as-is state and the to-be state, which enables an enterprise to evolve from the legacy systems of disparate stovepipe applications towards the to-be set of modernized, agile, and integrated business processes.

When creating an architecture it is useful to have a framework to identify and categorize the parts of the architecture [3]. Since there is no single universally correct or widely agreed-upon standard framework, organizations can either create their own framework or use an existing one of which there are several well-known frameworks available like Zachman Enterprise Architecture [3, 5]. Many organizations borrow/select one or more of existing proven EA frameworks and adapt/customize them to their needs rather than starting from scratch. On the other hand, with such a broad array of goals, it can be very difficult to determine which framework is right for an organization.

After several different schemes for defining enterprise architecture structure has been reviewed, "GeoHistory", multi-tiered conceptual framework, was begun to develop from scratch with its own interpretation of CH domain with a detailed meta-model in the form of an entity-relationship model rather than adhering one of the high-level industry-accepted frameworks.

Object Management Group (OMG)'s Model Driven Architecture (MDA) and Unified Modeling Language (UML) modeling techniques are being used for designing "GeoHistory" and making it executable model for CH domain.

Semantic Web technologies (in particular, Resource Description Framework (RDF) and Web Ontology Language (OWL)) are being used to represent conceptual reference model of "GeoHistory" by benefiting from some reference models, like CIDOC-CRM by the International Committee for Documentation of the International Council of Museums, OAIS by International Organization for Standardization, ORM by Open Geospatial Consortium, etc.

As intended in its design, semantic interoperability capability of "GeoHistory" allows it to be extended as different uses for another CH projects or organizations within CH domain.

3. WHAT IS "GeoHistory"?

3.1. Exploring the Challenges

In cultural heritage research, having an idea, acquiring data, and processing it isn't enough. With regard to ICT, there are many scientific and technological challenges facing those working in the CH domain.

The initial challenge for CH organizations is to better understand the past, achieve sustainable and successful management of cultural heritage resources and facilitate effective decision-making on CH by reducing project costs and time.

Recent developments in computing –the growth of Web applications, advances in data management and visualization technology, object-oriented programming, mobile computing, and wide GIS adaption- have led to an evolving vision and role for CH domain. CH organizations have demand on using best-of-breed ICTs in their projects in order to promote their research and teaching practice and enable some significant scientific researches of cultural heritages which not possible without them. On the other hand, most of those organizations claim that using these dizzying cutting-edge technologies is difficult due to high cost of software and/or data processing, and complexity, and the required training. In other words, researchers would prefer to focus on the science of CH instead of computer science. Furthermore, these state-of-the-art technologies make it possible to access of data in cultural heritage objects, like intact artifacts, while preserving them untouched for future research.

The CH community needs more versatile communication among all relevant disciplines, stakeholders and users of a cultural heritage project, primarily, between CH data/information/content/application providers, who are aware of that their expertise has strategical potential for CH projects, such as surveyors, photogrammetrists, mathematicians, statisticians, computer scientists, data management specialists, graphic designers, and CH specialists, who are sensitive to the importance of cultural heritage resources, such as archaeologists, historians, art historian, architects, conservation experts, museologists, curators.

CH field is now a very data and information abundant sector (as well as others) because of the exponential growth of data volume, complexity and quality driven by the exponential surveying (involving laser scanner, GPS, geophysics, satellite imagery data, chemical analysis) and computing technology. The challenge for many organizations is to unlock existing data held in research team's own silos and to make it available across the CH organization to perform strategic and operational decisions.

There is also a need within CH community to deliver more innovative, accurate and better content/data/information/applications/services. Better service delivery enables the exchange and sharing of spatial and non-spatial CH resources.

As it is indicated at the beginning of this section, in cultural heritage research, having an idea, acquiring data, and processing it isn't enough. CH research requires exploration of terabytes of data and the transformation of qualitative observations into quantitative results by placing management, process, computation, presentation and dissemination of vast volumes of data at the heart of modern cultural heritage research.

3.2. What is “GeoHistory”?

“GeoHistory” is a spatially-enabled open enterprise architecture framework for the cultural heritage

domain. The fundamental vision of "GeoHistory" is to engineer an enterprise architecture framework which proposes innovative, scalable, and flexible solutions for a cultural heritage environment to fulfill that cultural heritage community's specific challenges that are indicated above.

"GeoHistory" highlights an enterprise architecture approach, such that all data and services associated with cultural heritage resources can be accessed and manipulated through the Internet in an open, seamless framework to ensure accurate and effective decision making on cultural heritage management by maximizing the use of (geo)data, (geo)semantics and (geo)visualization.

To achieve this, the key issue is 'technology choice and fusion' based on an open architecture. "GeoHistory" uses the integration of technology that brings together different open source state-of-the-art technologies and open standards, including UML, XML, SOAP and Java, and extends their functionality with Internet, object-oriented concepts, business logic and GIS features to create a highly scalable ICT infrastructure by initiating a dialog between technologies and CH professionals. This strategy makes it possible for "GeoHistory" to have a broad interoperability across heterogeneous data silos and application environments. It closely follows emerging standards and technologies and also validates new technological approaches to develop the best of breed cultural heritage applications and services.

4. BUSINESS ARCHITECTURE OF "GeoHistory"

4.1. Scope

As an robust EA framework, "GeoHistory" typically includes the high-level vision, the missions, the business goals, objectives, strategies, solutions, and the design/governance processes under its business architecture.

The high-level business vision of "GeoHistory" is to manage the enterprise, to develop and deliver business solutions for business requirements of CH domain in a holistic way.

Business Goals of "GeoHistory" are as follows:

- The goal of this study is to describe a specific way in which to model CH studies, projects, organizations as an enterprise, and explore spatial, temporal, social, cultural, and economic interactions.
- "GeoHistory" involves overall documentation and management of all aspects of the enterprise.
- Another goal of "GeoHistory" is to gather the knowledge and experience of how best to bring technology, process and people together and address the impact they can have on each other.
- Other goal is also to examine geospatial information technologies, like (Geo)Spatial Information System (GIS), within both enterprise architecture and cultural heritage domain.
- Another goal is integration of various information systems (CH Site Management System, Architectural or Archaeological Information System, Monument Information System, Tourist Information System, (Geo)Spatial Information System, etc.) in one coherent architecture in order to facilitate integration of enterprise data and/or etc. and promote information sharing, increase usability and reduce IT maintenance costs.

- All the business processes conducted through the Internet are part of the e-business that is Web based e-heritage solutions for cultural heritage domain.

Main Business Objectives of "GeoHistory" are as follows:

- Promoting effective management

"GeoHistory" meets cross-organizational business requirements in achievable and traceable time-bound goals to perform sustainable and successful management of the enterprise.

- Increasing productivity within a collaborative working environment

"GeoHistory" is an inherently inter-disciplinary framework. It has a broad range of constituents and interfaces. It transcends the traditional boundaries among different domains. It provides better understanding, productivity, decision making and science by supplying interdisciplinary collaboration and exchange of knowledge and expertise.

- Setting up technology enabled platform

"GeoHistory" is fundamentally based on a rapidly developing technology. "GeoHistory" will provide CH professionals with an understanding of some of the complex technical and specific technical management issues that must be addressed when carrying out CH projects.

- Deploying high-level technologies

"GeoHistory" provides seamless integration of information, communication and geospatial technologies and their functionalities to improve the acquisition, distribution and use of data and information. "GeoHistory" facilitates interpretation, exploration and analysis of large volume of data by providing 'data exploration and discovery tools', 'state-of-the-art visualization', 'interaction and computing technology', 'analytical tool kit'.

- Making map-centric environment

"GeoHistory" is spatially enabled because its e-business is underpinned by (geo)spatial technologies, in particular Spatial Information System (SIS). It georectifies the historical maps to the base map by first digitizing and then transforming.

- Showing temporal changes of CH

Time-based animation of the fortresses shows the temporal changes in a virtual environment.

- Documenting the entire architecture

"GeoHistory" documents the entire architecture from requirements to implementation and defines the shortcomings in business and technological considerations need to be addressed.

- Sharing consistently deliverables internally and externally

"GeoHistory" is a sharing hub which joins up data, meta-data, information, knowledge, contents, (web) applications, services, resources, and systems in one united environment, which is web interface, to enable every member of a research team and/or other users to interact with the deliverables no matter where they are located. Building rich virtual research environment and a web based resource for edutainment and e-tourism.

- Having ability to rapidly response to changes

Adaptable design of "GeoHistory" will position the enterprise to respond rapidly to changing needs, emerging opportunities and threats of CH domain in terms of business strategies, governance, and technologies by aligning business and ICT strategies.

- Formulating affordable and interoperable solutions

"GeoHistory" is based on open architecture involving open computing standards, such as UML, XML, SOAP and Java to formulate and implement technology standards across the enterprise and to ensure interoperability with third-party tools.

- Reducing data silos with higher levels of integrity and accuracy

User works against one integrated system of systems that provides dynamic and changeable views of same information and eliminates duplication of data or data silos.

4.2. Business Strategy

"GeoHistory" life cycle was divided into six parts:

1. Design and Assess
2. Build
3. Deploy and Implement
4. Validate
5. Monitor and Evaluate
6. Maintain

4.2.1. Design Strategy

"GeoHistory" presents an innovative, adaptive and holistic unified framework design for EA that breaks the overall architecture into its major component areas. Afterwards for each component area, a sub-architecture framework is defined. Together, all architecture frameworks define a vision for successfully implementing EA in cultural heritage projects.

The design of "GeoHistory" was defined a three-phase development process consisting of overall EA framework and its sub-frameworks design, the components design within the frameworks and seamless integration of the components steps.

The overall framework will be multi-tiered to maximize flexibility, adaptability and stability. In a multi-tiered model, "GeoHistory" consists of several distinct but highly interrelated frameworks, each of which can be conceptualized as having its own distinct architecture.

"GeoHistory" is a integrating framework which incorporates the following architectures:

1. Business Architecture: The enterprise architecture describes the business but is also a part of the business. Therefore the architecture can be described within the architecture in terms of it's models, data, processes, etc.
2. Technical Architecture: The technical architecture within EA is the design required in order to "build a responsive IT infrastructure", "develop and manage distributed systems", "plan and manage communication networks", and "define how your business will operate in the next generation of enterprise technology".
3. Data Architecture: A major design objective of the data architecture within EA is to enable "effective use of the data resource".
4. Information Architecture: Information Architecture is defined in these studies as "a high-level map of the information requirements of an organization. It shows how major classes of information are related to major functions of the organization.
5. Application Architecture: The form and structure of the application architecture within EA is specifically designed to "improve the effectiveness of application development".

In this study, the focus will be mainly on technical rather than business, data, information, or application aspects.

Enterprise Architecture is about understanding all of the different components that go to make up the enterprise and how those components interrelate. Components in this context are all the components that enclose the areas of People, Processes, Business and Technology. In that sense,

examples of components are: strategies, business drivers, governance principles, stakeholders, units, locations, budgets, domains, functions, processes, services, information, communications, applications, systems, infrastructure, databases, networks etc.

The component-based design approach works very well in many ways, in particular, how all parts of an enterprise work together to provide the capability of an enterprise to achieve its vision. Seamless EA integration step shows how the components fit together through relationships among the components in the component network.

"Unified Modeling Language (UML)" was selected as the primary enterprise modeling and design tool for advanced modeling using a top-to-bottom approach of "GeoHistory".

Figure2 outlines this design philosophy.

4.2.2. Development Strategy

"GeoHistory" becomes the blueprint of the "KaleTakimi"s business goals and processes and underlying IT infrastructure. The concepts and principles presented in this study can be also applied in other cultural heritage projects.

A meaningful mission of this study is first to put "GeoHistory" to work via the documentation project of "Seddulbahir" and "Kumkale" Ottoman Fortresses and then, provide an EA pattern including semantic approaches. Open and ready-to-manipulate capabilities of the pattern allow the other CH organizations to tailor their solutions freely and easily.

5. TECHNICAL ARCHITECTURE OF "GeoHistory"

"GeoHistory" has a comprehensive and sophisticated ICT strategy to fulfill enterprise's technical challenges in order to create the most productive enterprise computing architecture for Cultural Heritage domain and Cultural Heritage Informatics by deploying high-level technologies. Major challenges are seamless integration of multiple disparate technologies to distribute the standards-based, interoperable and interactive services through an open, secure, scalable, distributed and loosely-coupled technical architecture and infrastructure that meets the demands of the enterprise's growth.

In the course of designing technical architecture, to suit CH Domain needs, a comprehensive overview of ICT and their integration problem was realized. There are not only a dizzying number of both open source and proprietary technologies available in the tremendous ICT market, but there are also rapidly evolving new technologies. To survive within that market, the enterprise needs strong technical architecture, which is possible only when the architecture is flexible enough to accommodate the integration of existing legacy applications, scalable enough to accommodate the new innovative technologies and adaptable enough to technology changes. In the market today, cultural heritage communities should be naturally cautious when they choose the right technology which supports their technical architecture of their studies or projects, especially in terms of cost, time and labor efficiency. In the ICT design strategy, there is a need to understand the technical aspects of the project in order to pick and chose right technology within the technology chaos.

Today 'being online' means 'being global' since the Internet is geographically independent virtual world. People browse, data moves between geographically separate databases through the Web which is new geographic space. In this design, the Web is being used as development platform and also user interface (Web browser-based GUI) to distribute data and application effectively.

Mapping technical architecture of "GeoHistory" covers nine main areas:

1. Open Architecture
2. Semantics Architecture
    1. Semantic Web
    2. Web Technology (the Web, Web 2.0, Web 3.0)
3. Service-Oriented Component Architecture
    1. Component-Based Development (CBD) Modeling and Design with Model Driven Architecture & UML/RDF/OWL
    2. Distributed Technologies (From Peer-to-Peer (P2P) (System) to Web Services and Grid Computing)
    3. Web-based Distributed Multi-Tier Client/Server Computing Architecture
    4. Service Oriented Architecture (SOA)
    5. Web Services Architecture
    6. Web Content Development/Management/Distribution Framework Architecture
4. Data Storage and Management Architecture
5. Visualization Architecture based on Computer Graphics Technology
6. Spatial Informatics Technology Architecture
7. Communication Architecture
    1. Network Architecture
    2. Mobile Computing Architecture
8. Infrastructure
    1. Computing Infrastructure (Enterprise Software)
    2. Physical Infrastructure (Enterprise Hardware)
9. Security Architecture

Technical Architecture Design Pressures are as follows:

- integrity → [semantics]
- standards-based interoperability → [open standards (XML, GML), data exchange standards (XML, GML), semantics]
- interactivity → [visualization]
- global distribution & connectivity → [SOA, Web Services]
- cost-efficiency
- easy accessibility & usability
- security
- flexibility

Architectural Design Principles of "GeoHistory"s Technical Architecture:

- To extend and integrate with new technologies later in the process, the architecture is based on open strategy which involves open standards like XML, HTML, GML, and technologies/softwares like JAVA, Linux.
- To manipulate easily, the architecture is component-based. A component is a module designed for a specific function and a component may also be replaced with a more appropriate component in the course of a enterprise's growth and as technology changes

without affecting the rest of the architecture. Changes can be confined to particular components or areas.

- During the initial stages, an organization requires minimal technical infrastructure to support its business. As the business grows and its demands increase, the architecture and infrastructure need to be scaled to meet the business growth. To provide good service, the technical architecture should grow at the same rate as its demand.
- To make scalable, flexible, distributed, the architecture is designed in multi-tiered manner. Multi-tier architecture provides the simplicity of developing the system in one development machine and the flexibility to move the components to several distributed machines in production.
- Since the process of bringing these existing systems into the new architecture involves a lot of money, time and effort, at the beginning, to ensure flexibility, the architecture design considers the integration of new technologies and existing legacy systems and applications.
- Provide performance availability, maintainability and simplicity

5.1. Spatial Informatics Technology Architecture

Everything happens somewhere, from the cradle to the grave and in all aspects of life. Positive events like births, schooling, work, marriage, as well as negative ones such as crime, disasters and death, all occur at a location. As a result, 80% of information has some geographic connection. Increasingly, because technology makes it possible, the linking of that location to people or incidents has become a powerful tool in understanding, analyzing and managing the world humanity live in. Not just to helps predict future events and manage them but also to helps evaluate a past situation and reconstruct it again as effectively as possible.

(Geo)Spatial Informatics Architecture of "GeoHistory" provides the ability to gather (geo)spatial data, information and associated attributes about the location and characteristics of man-made and natural features and events above, on and beneath the surface of the earth by encompassing a broad range of disciplines including geodesy, surveying, remote sensing, photogrammetry, etc. It then is capable of utilizing (geo)spatial data and information to model, analyze and interpret spatial relationships by encompassing cartography, mapping, generalization, SIS technology, etc. Subsequently, it provides the ability to present and distribute results to enable better decision-making by encompassing SIS technology, Internet, cartography etc. Eventually, it provides the ability to track man-made and natural features as they change over time and space by encompassing SIS technology, etc.

The SIS architecture of "GeoHistory" is currently emerging based on some new technologies that allow all SIS functions to run in a centralized server environment and be accessed from any device on a network, from browser-based user to mobile computing devices on the site.

The business objective is to apply SIS to the widest possible range of users in the enterprise by embedding spatial data and technologies, and SIS functionality in enterprise applications.

Another objective is to develop an open SIS architecture including open source SIS softwares and open standards in SIS. Both open source GIS databases PostGIS by PostgreSQL and MyGIS by MySQL are selected to store spatial data. MapServer 4.8.3 developed by University of Minnesota is being used as a SIS map server in the architecture. Since more than 65 spatial data formats are available in SIS market, to retain the interoperability, the architecture is based on open standards, in

particular, Open Geospatial Consortium (OGC) standards, such as GML, WMS, WCS, WFS, JPEG2000, GMLJP2.

6. CONCLUSION

The on-going study design of "GeoHistory" utilizes open interoperable technologies (specifications, guidelines, software, and tools) to bring the power of cutting edge IT technology to the study of cultural heritage resources and to create the most optimum cultural heritage research platform to support the entire life cycle of cultural heritage information.

As stated in the introduction, the purpose of this study is to explore the enormous potential inherent in an intimate relationship between the enterprise architecture concept and cultural heritage challenges. The theoretical concepts underlying the approaches to be advocated here concern the technology-driven cultural heritage studies through consideration of factors such as spatial informatics and cultural informatics.

In conclusion, the study was intended to be a new initiative for the cultural heritage domain, which assists the researchers to develop new approaches to the CH major, exploration and communication of the past.

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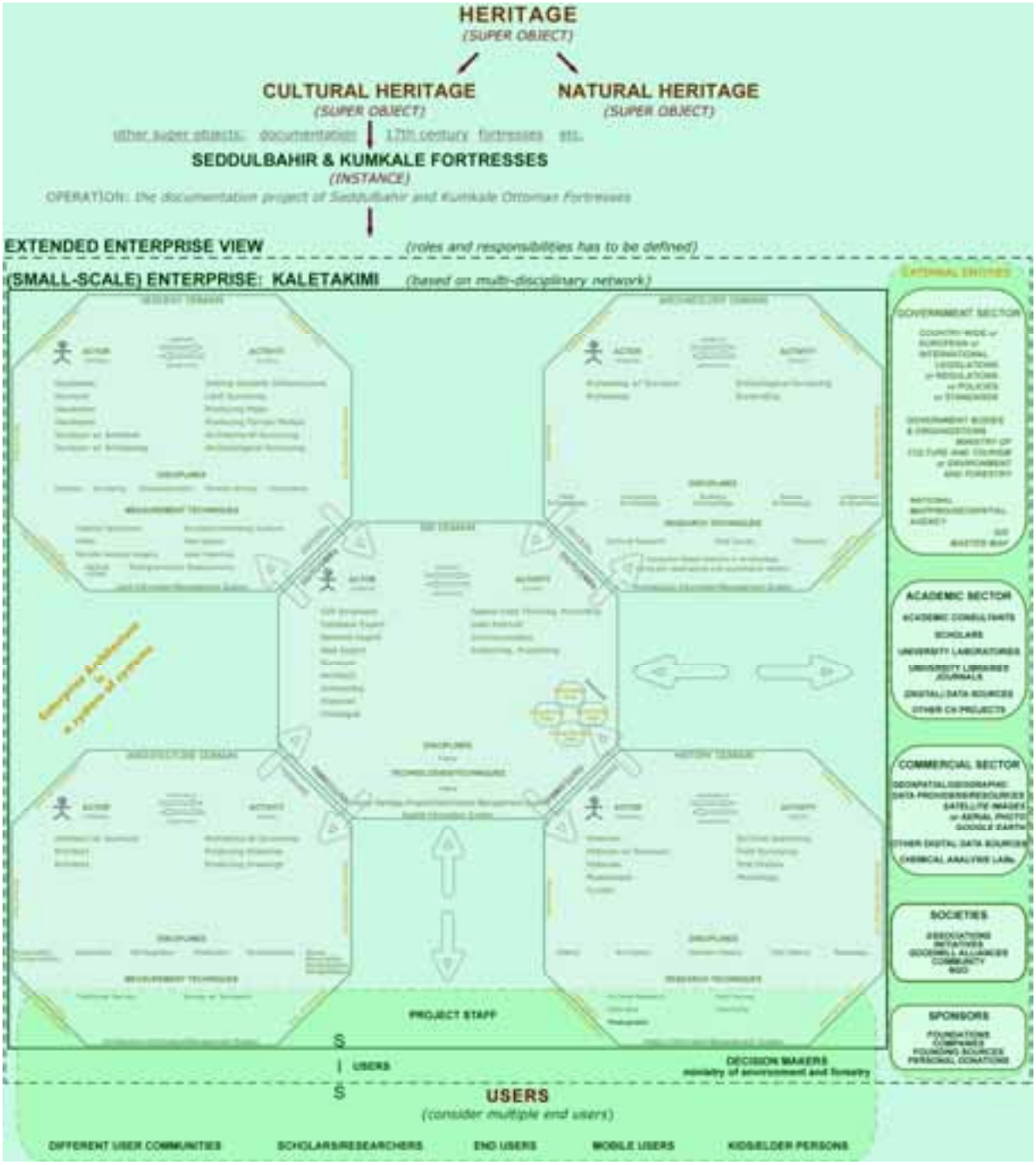
Figure1:


HERITAGE
(SUPER OBJECT)
CULTURAL HERITAGE
(SUPER OBJECT)
NATURAL HERITAGE
(SUPER OBJECT)
SEDDULBAHIR & KUMKALE FORTRESSES
(INSTANCE)
EXTENDED ENTERPRISE VIEW
(roles and responsibilities has to be defined)
(SMALL-SCALE) ENTERPRISE: KALETAKIMI
(based on multi-disciplinary network)
GOVERNMENT SECTOR
ACADEMIC SECTOR
COMMERCIAL SECTOR
SOCIETIES
SPONSORS
PROJECT STAFF
USERS
DECISION MAKERS
USERS
(consider multiple end users)
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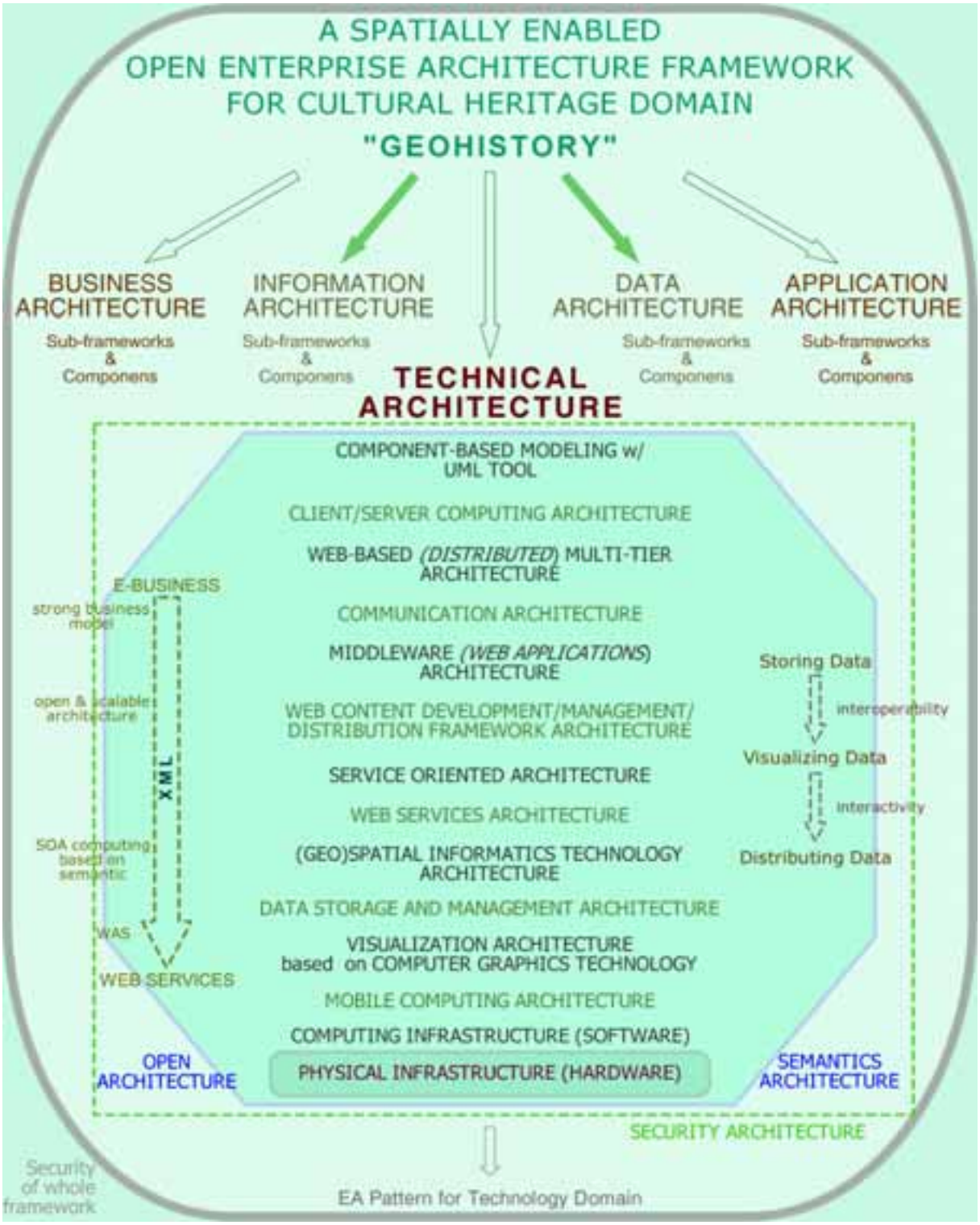
END USERS
MOBILE USERS
KIDS/ELDER PERSONS

Figure2:


A SPATIALLY ENABLED
OPEN ENTERPRISE ARCHITECTURE FRAMEWORK
FOR CULTURAL HERITAGE DOMAIN
"GEOHISTORY"
BUSINESS ARCHITECTURE
Sub-frameworks & Componens
INFORMATION ARCHITECTURE
Sub-frameworks & Componens
DATA ARCHITECTURE
Sub-frameworks & Componens
APPLICATION ARCHITECTURE
Sub-frameworks & Componens
TECHNICAL ARCHITECTURE
COMPONENT-BASED MODELING w/ UML TOOL
CLIENT/SERVER COMPUTING ARCHITECTURE
WEB-BASED (DISTRIBUTED) MULTI-TIER ARCHITECTURE
COMMUNICATION ARCHITECTURE
MIDDLEWARE (WEB APPLICATIONS) ARCHITECTURE
WEB CONTENT DEVELOPMENT/MANAGEMENT/ DISTRIBUTION FRAMEWORK ARCHITECTURE
SERVICE ORIENTED ARCHITECTURE
WEB SERVICES ARCHITECTURE
(GEO)SPATIAL INFORMATICS TECHNOLOGY ARCHITECTURE
DATA STORAGE AND MANAGEMENT ARCHITECTURE
VISUALIZATION ARCHITECTURE based on COMPUTER GRAPHICS TECHNOLOGY
MOBILE COMPUTING ARCHITECTURE
COMPUTING INFRASTRUCTURE (SOFTWARE)
PHYSICAL INFRASTRUCTURE (HARDWARE)
E-BUSINESS
strong business model
open & scalable architecture
XML
SOA computing based on semantic
WAS
WEB SERVICES
Storing Data
interoperability
Visualizing Data
interactivity
Distributing Data
OPEN ARCHITECTURE
SEMANTICS ARCHITECTURE
SECURITY ARCHITECTURE
Security of whole framework
EA Pattern for Technology Domain