Cloud computing and Virtual Heritage: the social media-oriented paradigm experienced at Cineca

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***Abstract*—Cloud computing is today involving software development and usage in a new phase, entailing not only a pervasive relevance as a technology but also a cultural value as the novel paradigm for supporting knowledge construction. Cloud paradigms locate applications on the top of levels usually employed to manage the complexity of modern computer systems, delivering the metaphor of ubiquitous available resources (software as well as data), without having to care about where data are located nor how they will be delivered.**

The 'as a Service' formula is outlining a new epistemic scenario that addresses not only agile IT needs for dealing with a business which is made more globalised, but also humanities requirements for exploiting data in order to disseminate culture. We refer to this scenario as a social media-oriented Cloud computing, in order to distinguish it from the usual one, i.e IT agility.

This paper relates Virtual Heritage Cineca experiences aimed at developing Cloud solutions mixing humanities targets with Cloud technology results. The mixed approach investigated common principles grouping applications at the Cloud high abstraction level to implement a Web-centric one, as a Service meta interface that hybridizes standard Google Earth tools with application server patterns in order to improve the construction of knowledge about cultural data and resources, traditionally delivered on the Web (i.e. Web pages).

I. Introduction

Cloud computing is part of our daily life, affecting the way we think about data on the Internet. Its popularity is not only related to a technological dimension, but also connected to a metaphor - that of harvesting multiple server-based resources via a digital network (WAN, Web, etc.) without having to care about where the resource is located, nor how it will be delivered.

Across departments, Cineca is addressing both these aspects:

- as a technology: since 2011, Cineca strengthened the support to Universities (formalized with the product u-gov [1]), embracing the challenge of enabling business continuity and disaster recovery.
- as a metaphor, Cineca is involved in projects such as La Sapienza Digital Libraries [2] and the VMust.net network of excellence for Virtual Heritage (www.v-must.net), addressing the Cloud interleaving with Humanities requirements.

As a metaphor, Cloud computing is in fact outlining a new epistemic scenario that is widening the target of Cloud applications beyond the realm of business agility. The browser-centric approach implied by the 'as a Service' formula exploits the process rather than the tool, allowing users to pay more attention on the place that information occupies in its own 'map' of reticular meaning and interconnections, rather than on the physical device delivering data. This enhances effectiveness of heritage contents research and dissemination, enabling a knowledge construction [3] that is more natural for human beings ([4], [5], [6]). In order to highlight differences with IT agility solutions such as Amazon EC2 (aws.amazon.com/ec2/), we term social media-oriented the Cloud solutions applied to the new target.

The ViSIT Lab at Cineca started investigating a social media-oriented Cloud supporting Virtual Archaeology (VA), i.e. processes involving heterogeneous technologies in order to entail research and communication of heritage contents [8]. The VMust.net Europeand project gave us the chance of studying features and requirements in real production pipelines, pursuing different purposes:

- "Apa discovering Bologna" [9] aimed to allow heterogeneous team to produce assets (i.e. philologically accurate 3D historical and archaeological reconstructions) in the way consolidated in their own IT, while developing in the Cloud the mechanisms to share the pipeline management process;
- PARSJAD [10] envisioned the chance to enhance the dissemination of cultural data dynamically harvested in the Cloud with a Web-centric media based communication on browsing terrains;
- Marcus Caelius [11] dealt with the design of a production pipeline joining rigorous scientific accuracy with a notable graphic quality for its time and costs requirements, making it affordable for a small production such as Museums. The Cloud investigation involved the upload of assets in the 3DM opensim metaversity (www.3dmetaversity.org/) in order to plan an online collaborative virtual environment, suitable for teaching activities.

Especially for the Parsjad project, we were interested in investigating if techniques modeled on solutions for a different target (i.e. enterprise) at the same abstraction level can be

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suitable to support Virtual Archaeology (VA) purposes, too. A VA process entails activities of acquisition, 3D philologically accurate reconstruction, and geospatial system creation to transform digitalized data into information. The challenge was providing the process with the next knowledge construction step, helping people to transform information into knowledge.

The reminder of this paper is structured as follow: Section II relates the Parsjad prototype, explaining the basic approach. Section III will introduce the Luigi Bazzani exhibition as an evaluated case study. In Section IV we show further work entailed by the Bologna Porticoes Project. Finally, Section V will draw together the conclusions.

II. The Parsjad prototype

The Parsjad project focuses on the common archaeological heritage of the Northern Adriatic Coast. Among the other solutions, the Project planned the creation of a virtual archaeological park in order to increase the attractiveness of the area.

IBACN (EmiliaRomagna Regional Directorate for Cultural Heritage, Italy), in collaboration with the Department of History Cultures Civilizations, DiSCi - Bologna University, envisioned the implementation of a web-dynamic graphical interface as a supportive part of the european project.

In order to meet strict requirements by IBACN for a tool supporting knowledge construction while reducing the complexity of existing repo DB and exploiting data rather than offering a specific delivery technology, Cineca conceived a web-centric, flexible architecture entailing an 'as a Service' behaviour. The test repository was the IBACN Samira technology. However, the prototype was conceived as a separated tool, dynamically interfacing information coming from heterogeneous geographically distributed data sources.

As a result, the prototype outlines a mixed approach integrating a well-known, robust solution for 3D terrain browsing, such as Goole Earth plug-in, with virtualization and java enterprise edition (JEE) patterns. (A.C.)

A. The architecture

The Parsjad prototype embraces an application server architecture, implementing a three-tier paradigm, as shown in Fig. 1.

1) Presentation tier: The prototype collects information from heterogeneous, usually separately queried DB repositories. It maps the spatial organization, intrinsically characterizing heritage data, onto a browsable 3D terrain, to enhance an immediate and comprehensive view of data, while referring as linked-data (Tim Berners-Lee, www.w3.org/DesignIssues/LinkedData.html) the Web source that is responsible for delivering in-depth information (Fig. 2(a)).

Among technologies for customizing 3D Web-browsable terrains (i.e. X3D, www.web3d.org/x3d/; Unity 3D, unity3d.com; OS-G4Web [7], and Google Earth), the Google Earth plug-in offered a wide-spread distributed tool, combining ease of use with good guarantees of continuity and persistence. So standard Google Earth tools (KML and Google APIs) are integrated as services to implement a new information layer on the top of the Google Earth plug-in.

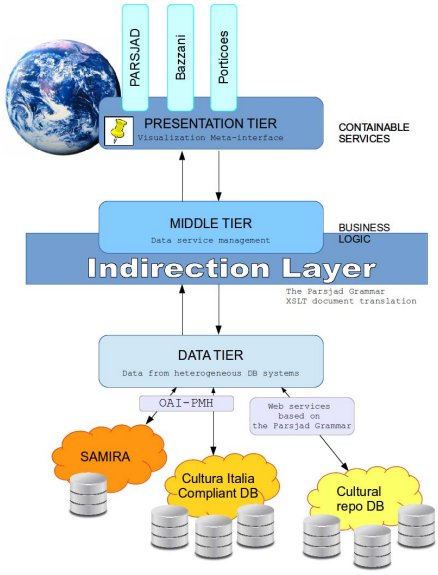


Fig. 1. The Parsjad Prototype Architecture

2) Middle tier: The intermediate tier implements the connection between data and their representation on Google Earth (KML). In order to allow the tool to automatically manage information, being independent from specific repo DB technologies, the middle tier implements an overlay layer, inferring the mechanism from virtualization technologies.

An XML schema grammar, that we term the "PARSJAD Grammar", has been specially written in order to translate data into an intermediate language (XML). An XSLT document still automatically enables the creation of the required KML format to customize the landscape.

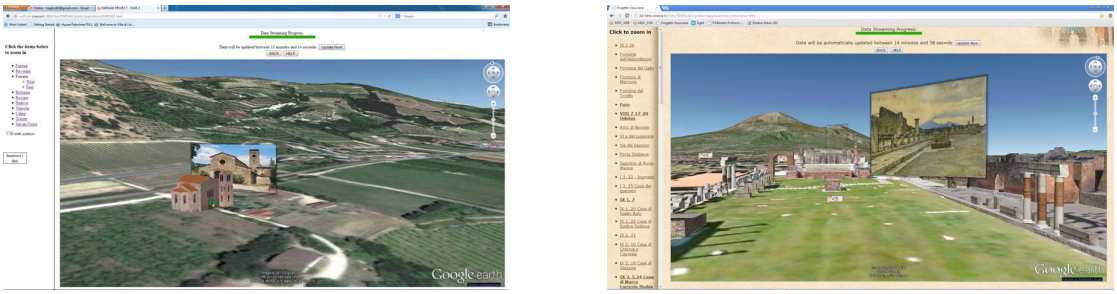
3) Data tier: The data level collects data in the native language. The harvesting uses the OAI-PMH protocol (Open Archives Initiative Protocol for Metadata Harvesting), a high level protocol collecting data without having to refer specific DBMS query technologies.

The OAI-PMH protocol allows the Prototype to bind any Repo DB compliant with Cultura Italia (www.culturaitalia.it/), which collects most of the cultural Italian heritage repositories. Furthermore, mirroring the Parsjad XML Schema, any cultural repo DB can implement a specific Web service to bind information to the Interface.

B. The meta-interface approach

As a VA process, the prototype embraces a meta-interface formula, providing information as 'containable' resources collected by a 3D terrain and made available with a browsing mechanism, abstracting the data harvesting with an as a Service formula.

The meta-interface formula matches an extended concept of the java container that is of crucial importance in order to extend application-servers toward social media-oriented Cloud computing ([12]). The special java structure can be seen as a resource "which has the capability to host other resources



(a) The Parsjad Interface

(b) The Bazzani Interface

Fig. 2. Google Earth plug-in based interfaces

or 'containables' and which offers some set of services to those resources" [13]. As an example, projects such as the Open Shinding by Apache are applying an extended idea of container (OpenSocial container) to social network behaviour in order to host OpenSocial apps quickly by providing the code to render gadgets, proxy requests, and handle REST and RPC requests. (Apache Shindig Open Social container, shindig.apache.org).

In a Cloud Computing paradigm the extended concept of containers lead to encapsulated environments that can collect information while hiding direct access to sources. So Smartphone, Tablets, eReaders and so on constituing the new generation of 'containers' for networked bits of information, which is fully aligned with the idea of the Web as a spreaded repository of data.

III. A CASE STUDY - THE BAZZANI EXHIBITION

The Parsjad prototype proved flexibility supporting the exhibition [14] of watercolors painted at Pompeii by Luigi Bazzani at the turn of the XIX century that was held in Bologna in May 2013. The work was acquired in the "Vesuviana" framework, directed by professor Antonella Coralini and Daniela Scagliarini, with the Archeaological Department (currently Department of History Cultures Civilizations, DiSCi) of Bologna University.

The case study was evaluated at the "Archeovirtual 2012" exhibition organized by CNR ITABC - Virtual Heritage Lab - and V-MusT Network of Excellence, within the Mediterranean Expo of Archaeological Tourism, held in Paestum, Italy (www.archeovirtual.it).

Selected projects were made available in dedicated rooms, connected through a welcoming corridor. The target audience experience of the interface was surveyed with four tools: observations, visitor questionnaires, user interviews and developers interviews. In general, visitors appreciated the metaphor of navigating data which was visually highlighted on the terrain by photo-overlay watercolors (Fig. 3(b)). Furthermore, they highlighted the chance of evaluating the Bazzani watercolors compared with old and modern photos. The realism characterizing the Bazzani work in fact makes watercolors a valuable source of information for archaeologists and scholars, since many interiors, that at the time of Bazzani were still in good condition, are now irretrievably lost. (A.C.)

IV. FURTHER WORK - THE BOLOGNA PORTICOES PROJECT

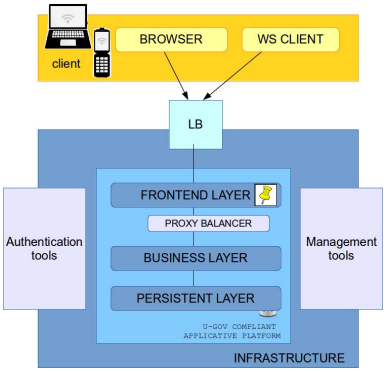
The Parsjad prototype is today being incorporated into the Porticoes Project [15], developed through the cooperation between the Municipality of Bologna, Cineca and the Architecture Department of Bologna University (DA). The aim is not only to support on-line access to resources related to the Bolognese porticoes system, but also to facilitate the improvement of data collection (especially 3D philologically accurate models) with user generated content in order to support Bologna's application for UNESCO world heritage status. In addition to this, further cultural and promotional cross-medial applications are to be developed, including apps, games, augmented reality and 3D architectural mapping events, which require the improvement of the prototype as a framework.

The Porticoes project is highlighting the chance to migrate the PHP technology of the Parsjad prototype toward a technology that is closer to application server patterns, by establishing collaboration between departments at Cineca, i.e. ViSIT Lab and DSET (Systems and Technologies Department).

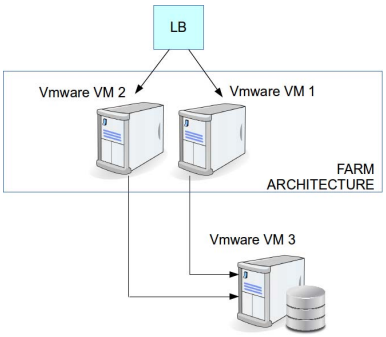
DSET has been involved to provision three VWare Virtual machines that will be configured as shown in Fig. 3(b). A farm architecture is implemented in order to support fault-tolerance. Furthermore, we will plan benchmark tests to evaluate the level of traffic that the system can manage. The third VM will be shared by the farm. It will be used to manage persistent data as well as to implement a first authentication DB-based mechanism that we are planning to migrate to Active Directory (LDAP).

In order to be compliant with the U-GOV main Cineca asset, the infrastructure will be as shown in Fig. 3(a). The service will be deployed as a Jboss web container in the farm, duplicated in each machine. A load balancer, implementing a L4 check (i.e. a check based on the TCP level), will route the applicative requests. The applicative check will by performed by Apache with a full mesh mechanism based on proxypass.

Differently from U-GOV (employing Oracle DB technologies) we are taking into account nosql DBs such as mongoDB (docs.mongodb.org/manual/tutorial/model-data-for-keyword-search): apart from the Opens



(a) U-GOV Jboss compliant infrastructure



(b) The VMWare planned farm

Fig. 3. The Porticoes architecture with ugov-compliant technologies

Source aspect pursued by the ViSIT Lab activities, they do not require a fixed pattern (schemaless), often avoid the operations of union (join), and aim to scale horizontally, which satisfies project requirements for dealing with cultural contexts and 3D assets.

V. Conclusion

This paper relates the experience at Cineca in developing social media-oriented Cloud solutions, i.e. solutions employing the 'as a Service' formula to address humanities requirements for exploiting data in order to disseminate culture. The related cases of study (The Parsjad prototype, the Bazzani Exhibition and the Porticoes Project) are based on a Web-centric, flexible architecture mixing 3D visualization tools with application server and virtualization patterns.

As a result, the interface implements a 'containable' framework, i.e. a high level extended container providing services to collect heterogeneous cultural data, while hiding specific complexities.

The employment of the service within the Porticoes Project is giving us the chance to extend the prototype as a framework, requiring the migration of the starting PHP solution to a Jboss deployable service.

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