Enterprise Architecture Framework Oriented to Cloud Computing Services

Wilson Nieto Bernal
Department of System
Universidad del Norte, Uninorte
Barranquilla, Colombia
wnieto@uninorte.edu.co

José Oviedo Sánchez
Department of System
Universidad del Norte, Uninorte
Barranquilla, Colombia
jloviedo@uninorte.edu.co

Garyn Carrillo Caballero
Department of System
Universidad del Norte, Uninorte
Barranquilla, Colombia
garync@uninorte.edu.co

Heyder Paéz-Logreira
Department of System
Universidad de la Costa, Cuc
Barranquilla, Colombiana
hpaez@cuc.edu.co

Abstract—**Cloud Computing (CC) is a computing infrastructure paradigm that provides elasticity to software or hardware solutions on organizations, and is more powerful than traditional architectures for storage, processing, and distribution of data. Meanwhile, Enterprise Architecture (EA) describes organization's structure and allows assurance its objectives. Recent studies face to integration of EA with CC convergence analysis between EA and CC is required to facilitate true integration in organization. This paper aims contribute to reduce the EA and CC gap. Analysis of importance and benefits of EA-CC integrated approach is presented, beside a proposed EA-CC framework that can be extended to corporate governance models. Phases, activities, artifacts and deliverables from framework are described.**

Index Terms-**Enterprise architecture, Cloud Computing, Framework, Zachman, Togaf**

I. INTRODUCTION

Cloud Computing (CC) is a new paradigm to decentralize data centers, virtualizing the infrastructure and platform, and access to services through internet without the hermeticism of traditional corporate LAN [1]. This paradigm includes servers, laptops, tablets, apps, smartphones, emails and stored information [2]. Historically, these systems have been managed and supported locally. CC allows access to platforms, services and tools from browsers deployed in million terminals

CC reduces technical and physical management and maintenance resource troubles. In addition, CC provide dynamism, independence, portability, usability and scalability of platform tools. Google Apps, Microsoft Azure, Heroku and Amazon Web Services are CC examples [3].

Usually, TI department is responsible for determining the architecture of computing resources and network of the

organization. However, IT services, or part of them, can be assigned to a third party or external responsible, it named outsourcing [4]. Some companies such as Google or Apple have implemented CC solutions for email [5] and data storage [6].

An enterprise architecture is a high-level description intended to capture the vision of an enterprise integrating all its dimensions: organization structure, business processes, and infrastructure. Every single part of an enterprise is subject to change, and each change may have significant consequences within all domains of the enterprise. A lot of effort is therefore devoted to maintaining the integrity of an architectural description [7].

Integrated EA-CC models generate great benefits such as reduced costs of technology and response times, improved scalability, extensive storage, high availability, security parsing (HTTP) and continuity. [8]. Two additional cloud benefits are most overlooked: 1) resources migration frees up time to focus on business lines, and 2) this migration is easier and faster.

The aim of this paper is to provide a working framework for enterprise service-oriented architecture of cloud computing. The paper is organized as follows: first, literature review of the main frameworks of EA in the industry; next, the metodology of this research and the proposal framework description; finally, a case study is presented for the implementation of the framework and conclusions.

II. STATE OF THE ART

IEEE standard 1471 (ISO/IEC 42010:2007) for Architectural Description of Software Intensive Systems defines the term architecture as "the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution" [9].

According A. Zimmermann, M. Perez, G. Zimmermann, D. G. Firesmith, and I. Petrov, applications with Service-oriented Enterprise Architectures in the Cloud are emerging and will shape future trends in technology and communication. The development of such applications implies enterprise architecture (EA) with management of architectures for services & cloud computing (CC), also, web services, semantics and knowledge-based systems, big data management, among other architecture frameworks and software engineering methods [10]. Enterprise architecture service-oriented cloud computing are a current trend of information systems large-scale.

Below, a brief review of the main methodological frameworks for development of EA:

A. TOGAF

TOGAF is a Architecture Development Method (ADM) that provides a tested and iterative process for developing EA. Some TOGAF's activities are establish an architectural framework, transitions, develop architecture contents, and govern the architectures comprehension. The activities are fulfilled by employing continuous descriptions of architecture on iterative cycles, that permits enterprises manages to themselves in accordance with business targets. TOGAF ADM is a methodology and iterative method for EA development. Some EA features must be determined through TOGAF methodology such as: level of details, breadth of coverage, and horizon extent due to ADM [11].

B. DODAF (The Department of Defense Architecture framework)

DODAF is the holistic framework and conceptual model for EA development particularly in DOD agencies (Department of Defenses). DODAF was developed for specific domain enterprises, and was not designed to be used beyond those bounds. DODAF was designed to solve a wide array of specific issues within a singular organizational context, the DOD.

The DODAF method is Model-driven, that is specific templates of data that are used to aggregate and communicate data on a specific architectural issue. When these models are complete they become a "View" of a facet of the current DOD architecture. In DODAF 2.0, there are eight prescribed perspectives [12]:

- Performers;
- Resource Flows;
- Information and Data;
- Rules;
- Capabilities;
- Services;
- Projects
- Organizational Structures

C. GARTNER

Gartner methodology believes that EA is about bringing together three constituents: business owners, information specialists, and the technology implementers. Bringing given groups together and merge them into the one vision based on values of business, cause project has succeeded; otherwise project has failed. In Gartner point of view success could be measured by pragmatic term [13].

According to Gartner point of view EA project must be started with understanding enterprise direction on business, not with finding its current position. This activity needs to listen to the enterprise strategic plan and understanding how it response to this plan. In order to obtain pure and concise information about enterprise, Gartner tries to achieve them in simple words, without concerning about recommended standard documents, or technical babbling. The result of this method is providing common understanding about enterprise situation and strategic plan [13].

D. FEAF (Federal Enterprise Architecture Framework)

Federal Enterprise Architecture Framework describes a set of tools to help government planners implement the Common Approach. At its core is the model of consolidated reference (RM), which equips the Office of Management and Budget (OMB) and Federal agencies with a language and a common framework for describing and analyzing investments. It consists of a set of interrelated "reference models" that describe the six subdomains of architecture under [14]:

- Performed reference model (PRM);
- Business reference model (BRM);
- Data reference model (DRM);
- Application reference model (ARM);
- Infrastructure reference model (IRM);
- Security reference model (SRM);

These reference models provide standardized categorization for strategic, business, and technology models and information. Using a common language to describe investments supports analysis and reporting across agency Enterprise Architectures and facilitates identification of opportunities for sharing and reuse of services and applications across agencies. Each reference model has its own taxonomy, methods, touch points, and use cases that provide examples of how the reference model can be applied.

E. PEA (Enterprise Architecture Planning)

Was introduced by Spewak in 1992. EAP contains activities and processes in order to achieve To-Be architecture by considering four EA architectures including: Business, Data, Application, and Infrastructure. It is also known as the Wedding Cake. It covers two fist perspective of ZF [15].

EAP provides the process of using architectures for the utilizing ISs in order to support business and the plan in order to implement architectures. It comprises the following [15] (ZF):

- Initiation Planning;
- Preliminary business model;
- Enterprise survey;
- Current systems and technology architecture;
- Data architecture;
- Application architecture;
- Technology architecture;

- Implementation plan;
- Planning conclusion;
- Transition to implementation;

F. Zachman

Is a framework enterprise architectures created by John A. Zachman in 1984 and first published Framework for Information Systems Architecture, appearing in the 1987 IBM Systems Journal. Since the Zachman Framework™ classification was observed empirically in the structure of the descriptive representations (the architecture) of buildings, airplanes and other complex industrial products, there is substantial evidence to establish that the Zachman Framework™ is the fundamental structure for Enterprise Architecture and thereby yields the total set of descriptive representations relevant for describing an Enterprise [16].

III. METHODOLOGY

The study of this paper is exploratory, where it aims to provide evidence with base empirical through an analysis of relevance and importance of integrate the two technology, based on the literature review on frameworks leaders of in the industry, until propose an Enterprise architecture framework oriented to cloud computing services.

IV. PROPOSED FRAMEWORK FOR ENTERPRISE ARCHITECTURE ORIENTED TO CLOUD COMPUTING

EA provides a focus based on the strategy, business policy, planning, decision making and development resource, to be useful for the managers and support staff from the organization. To be effective, an EA program must be part of a group of management practices that form an integrated governance structure (Fig. 1).

Fig 1. Integrated Framework for Corporate Governance.

In order to integrate the architectural resources it proposes a Enterprise Architecture Framework Oriented Cloud Computing Services, obtained attributes of quality based on the integration of methodologies, standards, artifacts and good practices (Fig. 2), which provide proper governance of the EA and which enables achievement of strategic business objectives through project portfolios that provide solutions to the requirements. The following describes each step of the goal proposed model (Fig. 3);
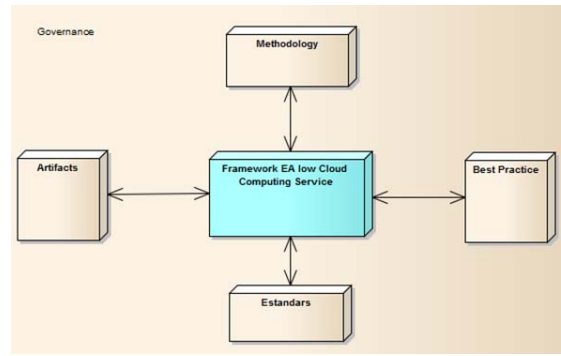

Fig 2 Integrated component to Enterprise architecture framework oriented to cloud computing services

A. Requirements, trends and opportunities:

You must analyze the needs, requirements and trends in each of the business units, validating weaknesses, opportunities, strengths and threats (SWOT) that may arise during implementation and from information products or services desired, apply reverse engineering technique and market research (benchmarking) to facilitate and reduce the gaps the current state to desired state through project portfolios to be established at this early stage.

B. Enterprise Architecture objective:

it shows precisely the desired state of architecture in each models described below;

- *Business model (Owner):* Displays all entities and business processes and how they interact. This is related to the owner, this is interested in operating the business, which requires modeling of the company by BPM, WorkFlow, business logistics, semantic models and business plans that allow you to control the operation of the organization; This perspective focuses on the business process, which is largely the process level.

- *Information model*: it refers to the list of important components for business as customers, suppliers, products, services, contracts, invoices, among others; this will have different descriptions related to the particular vision of each of these perspectives (the components and entities they are represented in a conceptual business model), but the designer is interested in a logic model that could lead to a database register which should determine the data elements and software functions that represent the business model. It deals with the specification of the conceptual plans of the information systems required to support the operation of processes.

- *High-level model:* Should identify list of core business processes, analyzing: input, output, and interrelationship between the process modeling to specification of programs (scheduler) based in the functionality associated with business process.

- *Geographical location model:* This should reflect the list of locations the business (perspective glider), its logistics modeling (owner) to the configuration of the network addresses (programmer) and the location where is located.

- *Requirements absorption model:* Based on business requirements, including validation. The requirements are identified, stored and managed at the entry and exit in each of its phases, these are prioritized and given solution.
- *Strategic model:* The Service strategy is modeled by defining the business case and services inventory, taking into account the requirements and their prioritization in order to obtain approval of the proposed architecture (portfolio of projects). You must set a clear methodology for communication, resource allocation, where they must eventually reflect the specific needs and requirements raised in the portfolios of projects or programs to be develop in the EA desired.

C. Enterprise Architecture vision

Create the vision of the architecture based on: the vision and corporative strategic plan of TI, by analysis of the value chain, the functional and non-functional requirements for the obtain general knowledge of the organization.

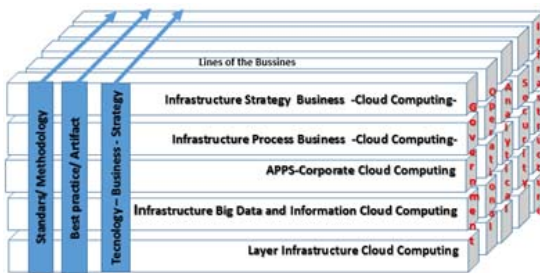### D. Architecture technological

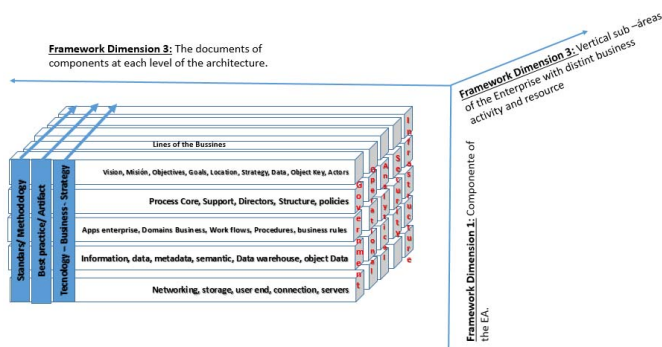

Figure 4 Proposed model

Figure 5 Detailed model.

- *Architecture of business services-oriented cloud computing:* Define the business strategy, organizational structure and core processes of the organization will be modeled and implemented with the EA guidance to CC service.
- *Architecture of information services-oriented cloud computing:* Describes the structure of the physical and logical data in the organization and your management model
- *Architecture of application services-oriented cloud computing:* Provides the definition functional each of the required information systems, the interrelation

between the systems and your relation with core processes of the organization.

- *Architecture technological services-oriented cloud computing*: Describes the structure of hardware, software and communication infrastructure, required for supporting the implementation of the information systems or project portfolio.

E. Roadmap: Develop a detailed implementation plan and of migration that addresses how to move Architecture of the baseline to the target architecture, it must ensure that the implementation plan and migration are aligned at management approach and implementation of changes, besides understanding business value and cost of the program and architecture transition are understood by the stakeholders.

F. Solution alternative: At this stage you must define whether the implementation of the projects will be done by recruiting, outsourcing, self-development, prototype, demos, services or XaaS

G. Project Management: Is the architecture that defines implementation projects, supervision during, later and at the end of its construction. In each project is should define scope and priorities implementation in development direction of the company, and should identify key resources and skills required to implement strategies that guide the development process during the implementation.

H. Government and management: define actions of regulation de TI with coordination of top direction to use resources efficiently through identifying gaps in business and TI strategies; elements alignment of organization strategy with TI objective, risk management, contingency planning, governance mechanism for TI service management and security are established.

I. Continuous improvement of enterprise architecture: through metrics, indicators and policies is established a maturity model that looking improvement actions in each of the components of the EA.

- *Level 0 immaturity:* the organization not implement Enterprise architecture process.
- *Level 1 basic:* the organization implement and satisfy process objectives of EA.
- *Level 2 Managed:* organization manages the EA processes and continuously controls the resulting products.
- *Level 3 Established:* EA processes in the organization is Standards-Based.
- *Level 4 Predicable:* Organizational uses qualitative methods in the EA processes.
- *Level 5 Optimizing:* Organization is continuously improving EA processes to meet the objectives.

Figure. 3. Enterprise architecture framework oriented to cloud computing services

V. CASE STUDY

In the case of proposed study is illustrated a successful integration of EA with CC services within IT strategies. Initially were developed market tools assessment whose aim to analyze the current state of the company against income and its direct competitors, later you must select the possible exist solutions on the market through the analysis of suppliers, assess risks (evaluate assets, obtain legal advice, analyze functional requirements and nonfunctional) and finally manage the risks in the proposed framework.

Applied a model of "top-down" in where is analyzed each of components of cube belonging the proposed framework, doing a sweeping under the vision of cloud computing from business strategies (mission, values, vision and strategic positions), business processes, process applications, storage levels and infrastructure levels of the organization.

Since Cloud Computing is a relatively new field to provide IT services, strategic decision that resulted from this case study, was started using EA-CC in a private cloud environment for the advantage that this presents to traditional architecture.

VI. CONCLUSIONS AND FUTURE WORK

CC is a modern and ample approach that integrates easily and quickly with the enterprise platform, providing greater ease of adaptation, recovery, reducing downtime and maintenance costs. CC has emerged as a paradigm for management and delivery of services dynamically form, independent and portable.

In this paper, we have proposed a framework EA-CC based on a theoretical analysis which describes concise form the conceptual elements that make architectures and current trends. As future work it is proposed:

1. Implement the Enterprise Architecture service-oriented cloud computing that is described in this paper.

2. Formulate an improvement for the model that allow include the framework future eventualities.

3. Validate the result of the implement of framework with other work of Enterprise Architecture.

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