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Electronic Health Records Information Security Dynamics for EHR Projects

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Abstract: *S ecuring information assets in National Electronic Health Record project is critical and complex. This research examined the effect of investing in this kind of project using S ervice Oriented Architecture and a system dynamics model that includes many concerns to analyze interdependencies between factors and explore feedback effects that emerge from its inherent dynamics.*
Keywords: *S ervice Oriented Architecture; S ecurity policies; System Dynamics modeling; Electronic Health Records S ecurity*

I. Introduction

Managing risk security for Electronic Health Records information assets requires big data tools and technologies in order to cope with the huge amount information that comes from hospitals, laboratories, clinics and the other agents involved on a national scale project.

To get interoperability of many systems on distinct sites and environments, service oriented architecture (SOA) solutions are essentially distributed computing solutions and the security aspects of these solutions become complex and require a structured approach to design so as to prevent that different distributed components adopt incomplete security mechanisms or even incompatible, causing degradation in the desired security level for the environment.

SOA is a specialized architecture and makes direct reference to the Enterprise Architecture of the health applications, in particular, issues related to high availability and resilience of the environment are main concerns of the architecture.

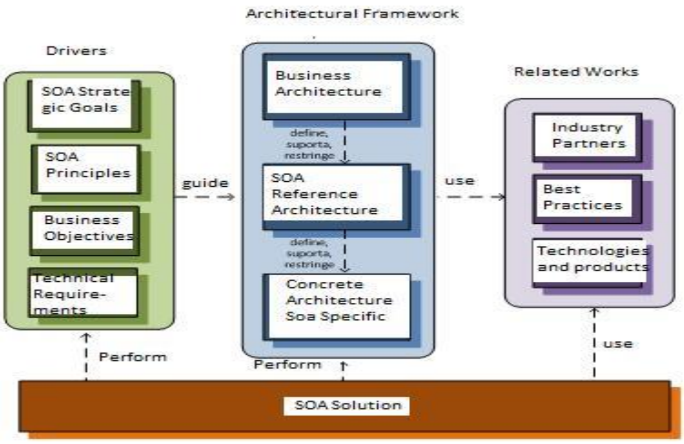

Fig 1: Architecture Framework Source: Adapted from OASIS Reference Model for Service Oriented Architecture Version 1.0 p. 5.

The IHE ATNA (Audit Trail and Node Authentication) profile describes a basic level of security through (a) functional access controls, (b) security audit log and (c) secure network communications. This is a standard member of the interoperability architecture CNS health and the National HER (Electronic Health Records), (to be) implemented in the service bus.

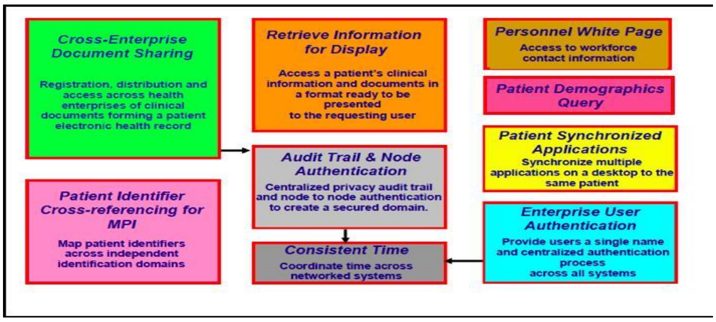

Fig 2: IHE Integration Profiles Infrastructure
Source: (IHE ITI_TF Volume 1)

The IHE Profile BPPC (Basic Patient Privacy Consent) establishes a method for creating patient privacy consent form to be used to enforce a privacy level suitable for use information. Although this profile is not directly related to technological issues of security, which are the focus of this assessment, it directly influences the business issues that drive the Security Architecture.

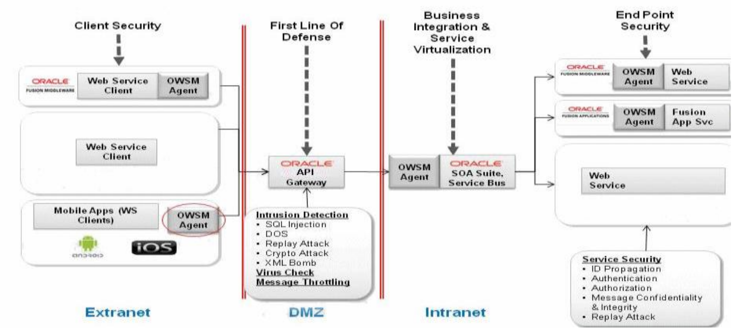

Fig 3: Overall strategy to EHR´s project using SOA and Oracle
Source: Oracle

This researchs aims to adapt Forrester´s market growth model in order to get insights of policies to guide decision making and to study a feedback loop structure that determines the growth and stability of EHR (Electronic Health Records) projects . Forrester states that "the complexity of these systems usually precludes intuitive determination of how a policy change will affect the total system". The idea is to get a simulation model of the feedback structure and policies to try policy changes to see how the system reacts on different conditions and premises.

To place the issues into perspective, this paper has three sections. First, it discusses and overview of the model. Next, discusses ways to model SOA security issues for EHR projects by the use of system dynamics method. Finally, in the conclusion, there are considerations regarding the use of a multi-paradigm approach to address SOA security typical problems.

II. Overview Of T He Model

Service Oriented Architecture and cloud computing provides the IT infrastructure, design patterns and other artifacts to an IT company get intrinsic interoperability between software programs and achieve other benefits like increase software federation, increase business and technology alignment, increase vendor diversification options, increase return over investment, increase organizational agility and reduce IT burden. Central in the model is the service bus that encompass agnostic and non-agnostic services that influence the revenues that come from their commercialization or even by its utilization or reuse. [6]

The preceding concepts will be exemplified in order to show their utility and how it can be used by a SOA security research once it may be considered an extension of IT governance or, in a broad sense, of corporate governance as a whole and some key activities that were revealed by the diagnosis did on an important Brazilian governmental IT organization as being part of it are:

- Managing the portfolio of services;
- Managing the service lifecycle;

- Using policies to restrict behavior;
- Monitoring performance of services;
- Managing how and by whom services are used;

The utilization of SD can add another way to see interactions within the company, within the market, and between the two. In this paper, a model with no influences of the outside
can be made in order to represent their behavior, the social-economic and political environment to provide deeper insights by simulation experiments and the flows of goods, services, money and information. Fig.1 shows the main relations on developing a secure information SOA based EHR Project implementation:

	Delivery delay +				
			B 3	Security Incidents	
	-				
SOA Security		+		+	
		+		Research and	
				Development	
+	R1	Credibility		+	
		+			
				Quality	
Organizational			-		
Maturity	+ Productivi			+	
+	ty			Security	
Controls				Infrastructure	
	B1			+	
	+	Costs			
			B 2		
	-			R2	
	Risks				

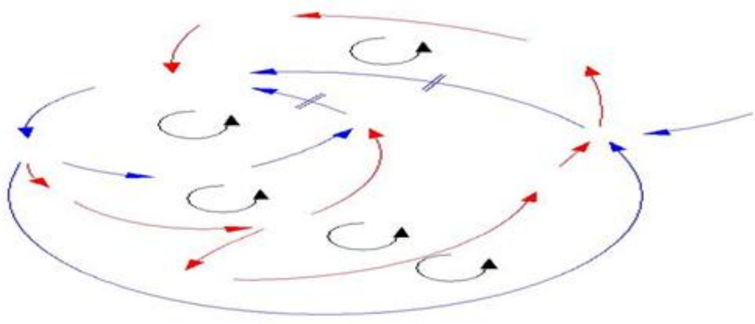

Fig 4: Cause and effects on factors for a SOA Security Site

The diagnosis revealed that the management of the demand, the quality, the credibility, the organizational maturity framework and investments in the IT infrastructure are central on a good SOA security program and that there is following reinforcing and balancing loops governing its dynamics:

R1: SOA security, organizational maturity, productivity, credibility. This loop focuses on productivity as a consequence of the adoption of an organizational security framework and the consequent enhance on productivity.

R2: SOA security, organizational maturity, quality. This loop is about the quality obtained as a consequence of the adoption of an organizational security framework;

B1: SOA security, organizational maturity, controls, costs, credibility. This loops considers the enhance on costs because the growth of controls on the adoption of the organizational security framework; B2: SOA security, organizational maturity, controls, costs, risks, Security infrastructure, quality. This loop considers that security infrastructure investments cause the growth on quality; B3: SOA security, organizational maturity, controls, costs, risks, Security infrastructure, quality, Security incidents, delivery delay. This loop considers that security infrastructure investments causes enhance on demand that may cause delivery delays if it exceeds the capacity available.

III. Modeling Soa Security Issues

Planning under uncertainty and considering operational risks inherent of IT enterprises requires reliable tools to do better analysis and to manage IT assets in order to set policies that assure good performance and credibility to such organization.

Thus, a decision making simulation model based on an adaption of Forrester's' Market Growth model[15][11][12] and on the system dynamics method were considered in order to represent interactions of intended rational policies in the study of dynamics that can arise of the complex combinations of SOA Architecture, Secure Infrastructure and resources available factors, principles and structures.

In Fig. 5, the model represents a governmental IT agency with functions and structures that share controls and together have an organizational security program that can produce an acceptable level of productivity and credibility that gives better governance if the costs are maintained on appropriate levels. Though revenues were previously budgeted, in the model they are used to express how many investments on IT infrastructure are permanently required in order to assure good levels of quality and thus, assure better security results. The focus is on those resources to be leveraged for SOA to deliver value to the business.

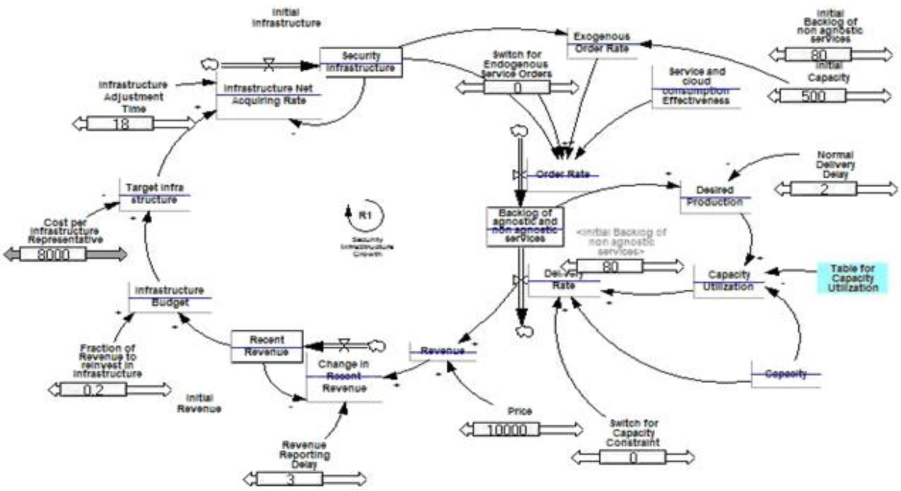

Fig 5: A System Dynamics Model of SOA security information adoption

Modeling is based on abstraction, simplification, quantification, and analysis [1]. The modeling process is an iterative learning process that encompass many steps like getting information about the real world or the problem articulation, structure a dynamic hypothesis, formulation or transformation of the dynamic hypothesis in many diagrams, testing and the policy formulation and evaluation [12] to assure that "the model's structure is sound and that it is capable of reproducing the dynamic symptoms of the original problem" [11]

For system dynamicists, once a decision is based on the observed state of the system, there are a structure of interacting feedback loops and it implies a circularity of cause and effect, where the system produces the decision which produces the action which produces change in the system [7]. Within the feedback loop there are level variables that mean accumulations within the system and mathematically are integrations. Rates variables that are system condition at any point of time represent the system activity and are the policy statements in the system which defines how the existing conditions of the system produce a decision stream controlling action.

To Forrester, "speak of systems implies a structure of interacting functions. Both the separate functions and the interrelationships as defined by the structure contribute to the system behavior"[15]. Rates are not instantaneously observable once they depend only on the values of the level. Rate equation defining a rate variable is a statement of system policy that describes how and why decisions are made. "A policy statement incorporates four components - the goal of the decision point, the observed conditions as a basis for decision, the discrepancy between goal and observed conditions, and the desired action based on the discrepancy" [7].

Fig 5 shows for addition of development capacity. The adition of capacity is contingent and can benefit from Services reusability once it can be commercialized and assure a way to supply the demand for services on an EHR context. Once it is a software component, it can be delivered immediately so the adequate expansion of development capacity is to assure timing on the development of new services and to reduce pressure for expanding capacity.The idea is to relate usability of services and the income that it can generate to assure investments on infrastructure. Once high availability and resilience of the environment are main concerns of the architecture.

IV. Conclusions And Future Research

A core objective of service-oriented computing is to achieve a state of intrinsic interoperability among software programs delivered as services[6]. On a SOA security management problem, SD aid to comprehend the complexity involved on EHR projects (different information, different decision rules, and different situations) with the macro behavior of the system [9], [4].

The agents have several interaction rules and, by simulation, it is possible to explore the emergent behavior along the time and the space [2], [3]. This modeling technique does not assume a unique component that takes decisions for the system as a whole. Agents are independent entities that establish their own goals and have rules for the decision making process and for the interactions with other agents.

As in Forrester's "market growth model, this model encompass bounded and intended rationality in its decision making. The SOA security decision making process is intended rational if **"**it would produce reasonable and sensible results if the actual environment were as simple as the decision maker presumes it to be, that is, if the premises accepted by the subject were true" [12] creating feedbacks or other complexities.

In order to reduce the complexity of decision making and to cope with bounded rationality because the incapability of processing much information and complexity, Sterman argues that "s ince optimal decision making with perfect models is impossible, people and organizations have developed a number of ways to simplify the task of decision making" [12] like:

(a) stablishing routines that "may be informal or highly codified protocols",
(b) using rules of thumb`(decision making heuristics) that "are based on simplified, incomplete models of the problem situation" and "tend to rely on relatively certain information readily available to the decision maker";
(c) managing attention by "directing the attention of its members toward some cues and away from others" and can include "formal reporting relationships, agenda setting, the geographical structure of the organization and physical layout of its facilities, and accounting and information systems";
(d) goal setting by setting "goals and adjust their behavior in an attempt to meet them" instead of "making decisions by explicitly solving optimization problems". Sterman also refers to the "behavior effort is reduced once a satisfactory solution to a problem is found or a satisfactory level of performance is attained"; and,
(e) problem decomposition when
"limited information processing capability forces people to divide the total task of making a decision into smaller units.

Sterman considered that "cognitive limitations and the other bounds on rationality mean decisions are often made as if there were no time delays, side effects, feedbacks, or nonlinearities" to conclude that "since real systems often involve considerable dynamic complexity, decisions made in this fashion often cause policy resistance, instability, and dysfunction"[14].

Setting specific goals provides decision makers with a concrete target against which they can compare the actual performance of the system and initiate corrective action when there is a discrepancy. The more concrete and specific the goal, the easier it is for people to determine which information cues are important and which can be ignored and to decide which actions to take to reach the goal.[12].

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