THE ESSENTIAL TRINITY IN HIGH-TECH INDUSTRIES: ECOSYSTEM + PLATFORM + ARCHITECTURE

JOSÉ CARLOS CAVALCANTI
Department of Economics
Universidade Federal de Pernambuco- UFPE/Brazil
E-mail: cavalcanti.jc@gmail.com

Abstract

For a high-tech industry be successful globally it is not only necessary to have an ecosystem of enterprises and related organizations; it is essential that this ecosystem is geared to develop platforms of global products, processes and services, and that these platforms are based on solid industrial architectures. This is what we call the "**Essential Trinity**" concept, which is the main characteristic of high-tech industries in the United States of America, particularly in Silicon Valley. And what do these three combined concepts mean? Observation of complex high-tech industries nowadays has brought to the fore the idea that in many cases, industries can be better analyzed as networks of interconnected enterprises or industry ecosystems to try to capture the multidimensionality and the complexity of enterprises' relationships (Tee and Gower, 2009). Industrial platforms are technological building blocks that act as a foundation in which a series of enterprises, organized in a set of independent enterprises develop an interrelated set of products, technologies and services (Gower, 2009). An industry architecture focuses in the ways in which its activities across the value chain are divided between industry participants, paying attention to particular roles of the enterprise, interdependencies, e modes in which such organizations try to organize the labor division within the industry (Jacobides et al., 2006). In other words, the concept defines the modes of how rules and roles are distributed between the interacting enterprises. The main objective of this paper is twofold: first, to argue that the Brazilian Information Technology (IT) industry can be understood through the "**Essential Trinity**" concept; and second, to argue also that the main characteristic of this industry is that it has been historically organized only in terms of ecosystems of enterprises and related organizations, without developing neither platforms of global products, processes and services, nor solid industrial architectures. In order to develop these arguments, the paper will present the case of the IT industry in the state of Pernambuco (Northeast of Brazil), particularly through the development of its Porto Digital IT park.

Key words: *High-tech industries, ecosystems, platforms, architectures*

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1. Introduction

The term high-tech refers to technology that is at the cutting edge: the most advanced technology available. It is often used in reference to micro-electronics, rather than other technologies (http://en.wikipedia.org). And perhaps no other high-tech industry is more famous than that of the Silicon Valley. Silicon Valley is the southern region of the San Francisco Bay Area in Northern California, in the United States of America (USA). The term originally referred to the region's large number of silicon chip innovators and manufacturers, but eventually came to refer to all the high-tech businesses in the area, and is now generally used as a metonym for the American high-tech sector.

Despite the development of other high-tech economic centers throughout the USA and the world, Silicon Valley continues to be the leading hub for high-tech innovation and development, accounting for almost 40% of all of the venture capital investment in the USA, according to PricewaterhouseCoopers and the National Venture Capital Association (https://www.pwcmoneytree.com/MTPublic/ns/nav.jsp?page=region).

Although no one disputes such an international fame, it is still poorly understood why Silicon Valley has originated so many breakthrough innovations and large companies (Ferrary and Granovetter, 2009). According to these authors, the durability of Silicon Valley´s innovative competence over the last seventy years also needs more explanation. For this reason, and by using complex network theory – CNT (Barabási, Newman & Watts 2006; Jen, 2006; Thompson, 2004a), they try to analyze the complex innovative capability of Silicon Valley and to understand the heterogeneity of agents and the multiplexity of ties that support creation and development of high-tech startups. In their view, the presence of venture capital (VC) firms in an innovative cluster opens potential specific interactions with other agents in the network (universities, large companies, laboratories) that determine a particular dynamic of innovation. In this perspective, what is distinctive about Silicon Valley is its complete and robust complex system of innovation supported by social networks of interdependent economic agents in which the VC firms have a specific function (which is characterized by five different contributions: financing, selection, collective learning, embedding and signaling).

This seems to be a fairly reasonable explanation for describing the complex innovative capability of Silicon Valley, as well as its heterogeneity of agents and their ties. However, if one wishes to understand why and how those agents in Silicon Valley (and in other high-tech clusters) are organized, and the reasons for their specific forms of organizations, such an explanation can be considered necessary but not sufficient for taking into account a set of economic issues inherent of high-tech clusters, such as: Why and how do some startup firms scale globally faster than others? Why and how do some firms cooperate and compete simultaneously in the global market? Why and how do some firms outperform others in the high-tech industries?

This paper is an attempt, yet in a premature fashion, to advance a new explanation for why a high-tech cluster like the Silicon Valley is such an international economic success. For

a high-tech industry be successful globally it is not only necessary to have an ecosystem of enterprises and related organizations; it is essential that this ecosystem is geared to develop platforms of global products, processes and services, and that these platforms are based on solid industrial architectures. This is what we call the "**Essential Trinity**" concept, which is the main characteristic of high-tech industries in the USA, particularly in Silicon Valley. And what do these three combined concepts mean?

Observation of complex high-tech industries nowadays has brought to the fore the idea that in many cases, industries can be better analyzed as networks of interconnected enterprises or industry ecosystems to try to capture the multidimensionality and the complexity of enterprises' relationships (Tee and Gawer, 2009). Industrial platforms are technological building blocks that act as a foundation in which a series of enterprises, organized in a set of independent enterprises develop an interrelated set of products, technologies and services (Gower, 2009). An industry architecture focuses in the ways in which its activities across the value chain are divided between industry participants, paying attention to particular roles of the enterprise, interdependencies, e modes in which such organizations try to organize the labor division within the industry (Jacobides et al., 2006). In other words, the concept defines the modes of how rules and roles are distributed between the interacting enterprises.

In this way, the main objective of this paper is twofold: first, to argue that the Brazilian Information Technology (IT) industry can be better understood through the "**Essential Trinity**" concept; and second, to argue also that the main characteristic of this Brazilian industry is that it has been historically organized only in terms of ecosystems of enterprises and related organizations, without developing neither platforms of global products, processes and services, nor solid industrial architectures. In order to develop these arguments, the paper will present the case of the IT industry in the state of Pernambuco (Northeast of Brazil), particularly through the development of its Porto Digital IT park.

The remaining sections of this paper are organized as follows. In section 2 are presented in some brief details the concepts of ecosystems of enterprises and related organizations, platforms of global products and services, and industries architectures, concepts that constitute the concept of **Essential Trinity** advanced here. Section 3 presents the case of the IT industry in the state of Pernambuco (Northeast of Brazil), particularly through the development of its Porto Digital IT park. Finally, section 4 presents the main argument of this paper and the concluding remarks.

2- The concepts of Ecosystem, Platform, Architecture

2.1- Ecosystem

In Biology, the concept of **ecosystem** is interpreted as a community of living organisms (plants, animals and microbes) in conjunction with the nonliving components of their environment (things like air, water and mineral soil), interacting as a system. These biotic and abiotic components are regarded as linked together through nutrient cycles and energy flows. As ecosystems are defined by the network of interactions among organisms, and between organisms and their environment, they can come in any size but usually encompass specific, limited spaces (although some scientists say that the entire planet is an ecosystem)(http://en.wikipedia.org/wiki/Ecosystem).

This concept has been borrowed from Biology by other fields of knowledge, such as Economics, Management and Business. James F. Moore originated the strategic planning concept of a **business ecosystem**, now widely adopted in the high-tech community. The basic definition comes from Moore's book, *The Death of Competition: Leadership and Strategy in the Age of Business Ecosystems* (1996). The concept first appeared in Moore's May/June 1993 *Harvard Business Review* article, titled "*Predators and Prey: A New Ecology of Competition*". Moore defined "business ecosystem" as:

> "*An economic community supported by a foundation of interacting organizations and individuals—the organisms of the business world. The economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other stakeholders. Over time, they coevolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments, and to find mutually supportive roles." (http://en.wikipedia.org/wiki/Business_ecosystem)."*

The concept of business ecosystem has also been applied interchangeably with other concepts like clusters, social networks, and so on. Ferrary and Granovetter (2009), in contrast to the mainstream in research on innovation (that focuses on the innovation process inside the firm), analyze innovation as the result of inter-firm interactions supported by social networks. They use the complex network theory- CNT (Newman, 2003; Barabási, Newman & Watts, 2006; Jen, 2006; Thompson, 2004a) to analyze the innovative capability of Silicon Valley.

These authors view the economy as a complex network, whose nodes are companies and whose links represent the various economic and financial ties connecting them. Innovation and entrepreneurship are understood as resulting from the interactions of

numerous economic agents. First, they argue that the complexity is due to the numerous decentralized interactions between a large diversity of economic agents. Further, these economic agents foster multiplex ties by holding different social roles (student, citizen, parent, neighbor, member associations, etc.) and the economic interactions that generate innovations are embedded in the non-economic interactions. Second, CNT emphasizes the robustness (or resilience) of systems more than their stability to explain how a system can or cannot cope with external radical changes and competitive shocks. Therefore, Silicon Valley is viewed as made up of networks of heterogeneous, complementary and interdependent agents.

The term ecosystem has also been associated to the notion of *software ecosystem* (software goods and services are at the core of the information and technology- IT industry)(Bosch, 2009; Jansen, Finkelstein, and Brinkkemper, 2009). Software ecosystems is becoming an important field of research fueled by new business models in the software engineering domain, representing a redefinition of traditional roles and patterns for collaboration and innovation. This creates complex networked communities of organizations or actors (Hanssen and Dyba, 2012).

While in the early days of software engineering a software product was the result of effort of an independent software vendor to create a monolithic product, modern software technology strongly relies on components and infrastructure from third party vendors or open source suppliers. The relationships between software development firms and service companies shaped the product software landscape into software ecosystems, where suppliers and buyers of software products, components and technologies collaboratively create competitive value (Jansen and Cusumano, 2012). In short, software ecosystems are subsets of business ecosystems.

2.2- Platform

Following Baldwin and Woodard (2009), in the Oxford English Dictionary, the word ´platform` has been used since the sixteenth century to denote a ´raised level surface on which people or things can stand, usually a discrete structure intended for a particular activity or operation`. More recently, the concept of a platform has been developed by management scholars in three overlapping waves of research, respectively focused on products, technological systems and transactions.

According to Gawer (2009), the emergence of platforms, whether used inside firms, across supply chains, or as building blocks that act as engines of innovation and redefine industrial architectures, is a novel phenomenon affecting most industries today, from products to services.

Platforms are found in many industries, and certainly in all high-tech industries. As pointed out by Gawer (2009), Google, the Internet search engine, social networking sites such as Facebook, operating systems in cellular telephony, videogame consoles, but also payment cards, full-cell automotive technologies and some genomic technologies are all industry

platforms. But perhaps the most media-covered platform (and archetypal example) is Microsoft Windows. Windows is also a great example of just how much we still don`t understand about platforms (Gawer, 2009).

Baldwin and Woodard (2009) reviewed the use of the term `platform" in three distinct but related fields: product development, technology strategy and industrial economics. Although the term is used in diverse ways that seem difficult to reconcile, these authors find a number of common threads – most importantly, the conservation or reuse of a core component to achieve economies of scale while reducing costs of creating a wide variety of complementary components.

They argue that the fundamental architecture behind all platforms is essentially the same: the system is partitioned into a set of ´core` components with low variety and a complementary set of `peripheral` components with high variety. The low-variety components constitute the platform. They are the long-lived elements of the system and thus implicitly or explicitly establish the system`s interfaces, the rules governing interactions among the different parts.

Gawer (2009a) put forward two interesting research questions: (1) under which conditions can we expect industrial platforms dynamics to emerge and unfold? And (2) in the context of platform industry dynamics, what kind of platform strategies should firms devise, depending on whether they are incumbents or new entrants?

In order to answer to the first question, she set out to present a new typology of platforms (Table 1), which identifies the distinct contexts in which different types of platforms appear and summarizes their principal characteristics depending on the context in which they occur. She found that platforms are designed and used in three main settings: inside firms; across supply chains; or as industry platforms. Then, she suggests an evolutionary perspective on platform emergence, and identifies circumstances under which internal platforms evolve into supply chain platforms, which then can evolve further into industry platforms.

To answer the second question on platform strategies, she builds on Gawer and Cusumano´s (2008) concepts of ´coring` and ´tipping`, and specifies the combinations of coring and tipping that should be best suited to new entrants and to incumbents, depending on characteristics of the industry they operate in or wish to enter. She also suggests that firms´ design capabilities (i.e. whether a firm`s design capability is to be an integrator/system assembler or rather a specific/component maker) should have a decisive impact on which strategy to pursue.

Table 1- Typology of platforms

Type of platform	Internal platforms	Supply chain platforms	Industry platforms	Multi-sided markets or platforms
Context	Within the firm	Within a supply chain	Industry ecosystems	Industries
Number of participants	One firm	Several firms within a supply chain	Several firms who don't necessarily buy or sell from each other, but whose products/services must function together as part of a technological system	Several firms (or groups of firms) who transact with each other, through the intermediary of a double-sided (or multi-sided) market
Platform objectives	• To increase the productive efficiency of the firm • To produce variety at lower costs • To achieve mass customization • To enhance flexibility in the design of new products	• To increase productive efficiency along the supply chain • To produce variety at lower costs • To achieve mass customization • To enhance flexibility in the design of new products	For the platform owner: • To stimulate and capture value from external, complementary innovation For complementors: • To benefit from the installed based of the platform, and from direct and indirect network effects complementary innovation	• To facilitate the transactions between different sides of the platform or market
Design rules	• Re-use of modular components • Stability of system architecture	• Reuse of modular components • Stability of system architecture	• Interfaces around the platform allow plugging-in of, and innovation on, complements	• Not usually addressed in the economics literature*
End-use of the final product, service or technology	• Is known in advance and defined by the firm	• End-use is defined by the assembler/integrator of the supply chain • End-use is known in advance	• Variety of end-uses • End-uses may not be known in advance	• Not usually a variable of interest in the economics literature
Key questions asked in the literature	• How to reconcile low cost and variety within a firm?	• How to reconcile low cost and variety within a supply chain?	• How can a platform owner stimulate complementary innovation while taking advantage of it? • How can incentives to create complementary innovation be embedded in the design of the platform?	• How to price the access to the double-sided (or multi-sided) market to the distinct groups of users, to ensure their adoption of the market as an intermediary?

Note: * With the exception of Parker and Van Alstyne (2005) and Hagiu (2007a), who address questions that are central to the literature on industry platforms.

Source: Gawer (2009a)

2.3- Architecture

Architecture is both the process and product of planning, designing, and construction, usually of buildings and other physical structures. Architectural works, in the material form of buildings, are often perceived as cultural symbols and as works of arts. Historical civilizations are often identified with their surviving architectural achievements (http://en.wikipedia.org/wiki/Architecture).

The concept of architecture has been borrowed from the above domain to represent a large set of issues related to the organizational boundaries of firms and industries and their related products and services. For example, in the software development context the International Standard Organization- ISO/IEC 42010:2007 (System and Software Engineering- Recommended Practice for Architecture Description of Software-Intensive Systems) defines architecture as "*the fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution".*

Jacobides, Knudsen and Augier (2006) paper is considered one of the first attempts to develop the concept of *industry architecture*. For these authors, industries architectures are templates that emerge in a sector and circumscribe the division of labor among a set of co-specialized firms. They explain why these architectures emerge, usually early on in an industry´s life, as a result of balancing advantages from division of labor with transaction costs relating to the certification of quality of the final good or service. They further explain why these architectures sometimes become stable, thus creating the contours of an industry. Then they argue that firms may be able to affect the architecture of their sectors, especially when it is not sharply defined, and as such create an "architectural advantage".

In their view an industry architecture is a sector-wide construct that defines the terms of the division of labor. Drawing on recent work on design, they argue that architecture is an abstract description of the economic agents within an economic system (in terms of economic behavior and capabilities that support the feasible range of behaviors) and the relationships among those agents in terms of a minimal set of rules governing their arrangement, interconnections, and interdependence (the rules governing exchange among economic agents).

Architectures provide the contours and framework within which actors interact; they are usually partly designed (e.g. by regulation or de facto, by standards), and partly emergent (by the creation of socially understood templates and means to coordinate economic activities). Architectures affect industry participants in ways that may be either anticipated and designed in, or unanticipated (Jacobides, Knudsen and Augier, 2006).

In sum, it is possible to point out that the concept of architecture is suitable to define the ways in which rules and role are distributed between interacting agents in an industry or economic sector.

2.4- Ecosystem + Platform + Architecture = The Essential Trinity

Having defined briefly what each of the concepts of ecosystem, platform and architecture are individually, now it is possible to describe how to combine these three concepts in order to advance (yet in a premature fashion) an explanation for the international economic success of high-tech clusters like the Silicon Valley.

If one asks what do geographical areas in the USA like Silicon Valley, New England, Seattle Metro, Salt Lake City, New York Metro have in common, perhaps the first answer would be that all of them are high-tech zones, where companies like, Apple, Facebook, Google, HP, Oracle, Yahoo (in Silicon Valley), Microsoft, Amazon, Boeing (in Seattle), Adobe, Electronic Arts and Twitter (in Salt Lake City), to cite just a few, had started up, grew up and achieved international prominence.

But if one also wonders what had been the important factors for the emergence of such high-tech zones, perhaps the story would be the same: around a university, or a science and technology center, and encouraged by academic or science & technology leaders (as well as government agencies and other private businesses, according the historical context), faculty and graduates started up their own companies. As the demand for their products and services began to grow, the new companies helped to establish the creation of what is called here the first high-tech ecosystems of firms and organizations necessary to foster their own development.

As science & technology progressed, the newly founded companies also began to develop new methods of development and new business models to reach wider markets. Taking the IT industry as an example, up to the late 80s, vertically integrated companies delivered complete system stacks. These stacks contained everything needed to serve a customer; hardware and software; operating system and applications. In the late 80s and beginning of the 90s the horizontal layer structure of solution stacks changed into more modular clusters (Jansen and Cusumano, 2012). Now the ´software stack` is split up in activity layers that are complimentary to each other through interfaces and middleware. Because of this market structure, it is not uncommon that two software producing organizations may collaborate on one activity level and be in competition on another (Jansen and Cusumano, 2012).

It was this kind of development (particularly in the IT industry) that paved the way to the emergence of platforms of goods and services that achieved global markets. New concepts began to gain world acceptance, like IT platforms such as Windows, .Net, Linux, Android, Facebook, etc., that aside new technological standards (like XML, J2EE, Corba, etc.) and new hardware (like Playstation 3, HTC Diamond, PDA, etc.), promoted the global reach of products like Microsoft Word, Excel, Powerpoint, SAP BusinessOne, Oracle databases, just to illustrate a few.

Such a phenomenon led also to the appearance of platform leaders, which are organizations that manage to successfully establish their product, service or technology as an industry platform. Platform leaders tend to drive industry-wide innovation in a trajectory that

allows them to exert architectural control over the overall system, as well as derive large profits and erect barriers to entry in their own market (Tee and Gawer, 2009).

Platform leaders are highly dependent on innovations developed by other firms, but, at the same time, aim to ensure the overall long-term technical integrity of the evolving technology platform. They aim to create innovation in complementary products and services, which in turn increase the value of their own product and service. At the same time, they wish to preserve or increase competition among complementor firms, thereby maintaining their bargaining power over complementors. Platform leadership is therefore always accompanied by architectural control (Tee and Gawer, 2009).

In such a way, the concept of industry architecture emerged to define the ways in which roles are distributed among interacting firms. Industry architecture developed as a definition of both the division of labor between firms and the division of surplus in industries, and provided the template for both ´who does what´ and ´who gets what` (Tee and Gawer, 2009).

Consequently, by combining these three interconnected concepts as the concept of **Essential Trinity**, it is fairly reasonable to point out that for a high-tech industry be successful globally it is not only necessary to have an ecosystem of enterprises and related organizations; it is essential that this ecosystem is geared to develop platforms of global products, processes and services, and that these platforms are based on solid industrial architectures.

3- The case of the IT industry in the state of Pernambuco/Brazil

In order to bring evidence that could give support for the explanation for the international economic success of high-tech clusters (briefly dealt with in previous sections), the case of the IT industry in the state of Pernambuco, at the Northeast Region of Brazil, is presented here.

This industry is, to some extent, represented by its Porto Digital Technological Park (www.portodigital.org), which is located at the city of Recife (capital of Pernambuco), and most precisely, at the island (known as Recife Antigo – Old Recife) where the capital was founded in the 16th century.

The historical development of this industry can be reported as having two phases. The first phase dates back to the first decades of the 20th century, with the activities of the Recife City Hall. To process the data related to urban taxes and other operations, the City Hall hired some devices and services of the, then newly embarked in Recife, International Business Machine Corporation – IBM.

In the 1960s there was a progressive movement towards the utilization of data processing activities in the Pernambuco´s commercial banks. At the same time, federal and municipal agencies (such as SERPRO- Serviço Federal de Processamento de Dados and

EMPREL -Empresa Municipal de Processamento Eletrônico da Prefeitura do Recife) began also to use and provide data processing services for government activities.

But it was from the transition of the 1970s to the 1980s that the transition to the second phase of the Pernambuco´s IT industry began to take place. Although the creation of the Department of Informatics - DI of the Universidade Federal de Pernambuco – UFPE (university that was founded in 1946: www.ufpe.br) dates back the end of the 1970s, the most important factor contributing to the later progress of this industry was the creation of post-graduate courses at this department (Master degree in Computing Science in 1975 and PhD degree in Computing Science in 1992). The creation of these post-graduate courses was fundamental to a better provision of high skilled human resources for the Pernambuco´s IT industry and for other non-IT economics sectors of Pernambuco and other states in Brazil.

In 1996 a very important initiative took place as a spin-off of the Department of Informatics of the UFPE: the creation of the *Centro de Estudos e Sistemas Avançados do Recife - C.E.S.A.R.* The C.E.S.A.R., a private IT and innovation research center, emerged as the first substantive intervention of that department of the university, from faculty members and graduates, to start up their own companies, and to take advantage of the incentives for the Brazilian the IT industry. From that moment onwards the Department of Informatics evolved from providing just one course of Computing Science to offer two other under-graduate (as well as post-graduate) courses, Computing Engineering and Information Systems, and to become to be the Center for Informatics of the UFPE (www.cin.ufpe.br).

In the year 2000 another important initiative for the Pernambuco´s IT industry took place: the foundation of the Porto Digital technological park. As a result of a state government science & technology policy towards the generation of an IT cluster of world class, the Porto Digital mission is:

> "*To structure and manage a sustainable business environment able to create and consolidate world class information and communication technologies - ICT undertakings through the interaction and cooperation between universities, enterprises, government and non-government organizations in the state of Pernambuco*".

Today Porto Digital is an established technological park with more than 200 enterprises (producing ICT and creative economy products and services), which generates more than 6.000 high-tech jobs and revenues of more than US$ 400 million (at a 2.39 exchange rate real/dollar in 19/08/2013). The companies offer a wide range of products and services, since digital television devices, mobile technologies, embedded systems, security systems, high-performance computing, e-learning, design, web applications, enterprise management systems, and so on.

Along its 13 years of existence, the Porto Digital matured throughout specific phases that can be characterized as follows:

I- Conceptual modeling and structuring;

II- Institutional promotion and marketing;

III- Fostering interrelationships with local entrepreneurs and incorporation of new building assets;

IV- Integration of Porto Digital within the economic productive chains of the state of Pernambuco and extension of direct incentives to embarked companies;

V- Widening scope to incorporate activities of the Creative Economy (to add activities like media, design, cinema, animation films, etc.).

Each one of these phases corresponded to a different kind of management philosophy that had been conducted by the organization that was created from establishment of the Porto Digital in the year 2000, named *Organização Social Núcleo de Gestão do Porto Digital – NGPD*, a not-for-profit social organization that provides public services via contract with the state government of Pernambuco.

In this way, along these years the Porto Digital has been accumulating significant acknowledgments for its achievements, such as:

● Largest technological park of Brazil (AT Kearney-2005);

● Best technological park of Brazil (National Association for Promotion of Innovative Undertakings- ANPROTEC- 2007);

● One of the four world initiatives referred by the International Association of Science Parks- IASP (2008);

● First international services geographical denomination (Instituto Nacional de Propriedade Industrial- INPI- 2012).

Besides these acknowledgments of the Porto Digital park, some of its institutions and organizations have been awarded national and international honors and prizes that represent a testimony of the quality of the high skilled human resources, products and services, such as (to cite a few):

- **C.E.S.A.R.**:

  2010 FINEP (Financiadora de Estudos e Projetos-Ministério da Ciência, Tecnologia e Inovação-MCTI) Prize of the Most Innovative Science & Technology Institution of Brazil;
  2009 Most Innovative Business Model of Brazil- Revista Época Negócios;

2006 Excellence R&D Prize (Telecommunications Category) by the Anuário Informática Hoje;
2006 Quality Pattern Prize – Enterprise Revelation Category by the B2B Magazine;
2005 Info200 Prize for the Best Software Services Enterprise;
2004 FINEP Prize for the Most Innovative Institution of Research of Brazil;
2002 FINEP Prize of the Most Innovative Institution of Research of the Northeast of Brazil;
2003 Top 5/Top 20 no Asia Java Mobile Challenge;
2001 Case of creation of business in the World Economic Forum;
2000 Honor Mention in the Stockholm Challenge.

- **Center of Informatics- CIn/UFPE**:

2011 FINEP (Financiadora de Estudos e Projetos-Ministério da Ciência, Tecnologia e Inovação-MCTI) Prize of the Most Innovative Science & Technology Institution of Brazil;
(for more information of acknowledgments of this center, see: http://www2.cin.ufpe.br/site/secao.php?s=1&c=12)

Although the IT industry in Pernambuco can present such revealing figures, unfortunately it can only be considered as an ecosystem of enterprises and related organizations. Therefore, it did not evolve yet to offer platforms of global products and services that could also be based on solid industrial architectures. In other words, it developed just one of the foundations of the concept of the Essential Trinity.

4- The Brazilian IT Industry: just a multitude of ecosystems of enterprises and related organizations

One way to get a comprehensive and comparative view of what the Brazilian IT industry represents globally is to look at the "***The Global Information Technology Report - GITR***" and its ***Networked Readiness Index – NRI***, which are developed by the World Economic Forum - WEF (www.wef.org) in partnership with INSEAD. The WEF is a not-for-profit foundation, based in Cologny, Geneve, Switzerland, committed to improving the state of the world engaging leaders, politicians, academics and other leaders of the society to set global, regional and industrial agendas. INSEAD (previously named as **Ins**titut **E**uropéen d'**Ad**ministration des Affaires) is one of the largest and most prestigious post-graduate business schools of the world, with campuses in Europe, Asia and the Middle East, as well as Israel.

According to the 2013 *GITR*, Brazil occupies the 60th position amongst 142 nations of the world in terms of its *NRI*, which measures the state of the art of the information technology industry of each country; in other words, the *NRI* constitutes a true thermometer of the readiness of a country in relation to the adequacy and use of IT inside the economy.

If one tries to understand the reasons for why Brazil is in such a low position, it is only necessary to look at one of the four sub-indexes that comprise the *NRI:* Environment, Readiness, Usage and Impact. Specifically in the Environment sub-index (where the IT industry in Brazil had the worst score), and which is subdivided into two categories (Political and Regulatory; and Business and Innovation), Brazil occupies (for these two categories) the 107th and 78th positions, respectively.

This picture of the Brazilian IT industry is not compatible with the economic strength of Brazil, which occupies the 7th position in the world in terms of its Gross Domestic Product-GDP, according to recent data from the International Monetary Fund- IMF (http://en.wikipedia.org/wiki/List_of_countries_by_GDP_(nominal).

What can be inferred from these results of the *NRI* and of the *GITR* is that the Brazilian IT industry is facing several constraints, and that there must be some reasons (besides those of a political and regulatory nature pointed out by the *GITR*) for such a poor performance.

There must be several explanations for such a condition. But perhaps one answer that could be advanced here is of organizational nature, as the following. If the Brazilian IT industry would be understood through the concept of the **Essential Trinity**, as it should, one could easily perceive that in Brazil this industry is only constituted of a multitude of ecosystems of enterprises and related organizations across its territory, without developing any platform of products and services of global reach, that could be supported by solid architectures.

An evident demonstration that the IT industry in Brazil is formed by a multitude of ecosystems is the case of the Pernambuco IT industry presented here. In Brazil there are several ecosystems similar the Porto Digital but, unfortunately these ecosystems do not develop platforms of global nature, such as those developed in Silicon Valley and in other high-tech regions of the world. It is emphasized here the global nature of the platforms, since it is possible to exist internal platforms and supply chain platforms across the Brazilian territory. However, these platforms have less economic impact than those of a global nature.

Finally, after presenting the case for the use of the concept of **Essential Trinity** as an organizational concept for understanding the economic success of high-tech industries, for a better understanding of how these industries are organized further research is needed to assess the reasons why some industries, like the IT industry in Brazil, constitute ecosystems but do not evolve into building platforms of global products and services based on solid industrial architectures.

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