

Deconstructing the ICT industry using the Info-communications Model

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Abstract

Motivated by the convergence of the previously distinct IT, Telecommunications and Content and Media industries, this research focuses on attempting to apply a layered policy model and more specific the Info-communications model, as a tool to map the emerging Greek ICT industry. Using the idea of the Layered policy model, this work provides a classification of the available service/activities of the ICT industry, and also a distribution of firms of Greek ICT sector in terms of the different functionality layer of the Info-communications model. The paper's results, derived by taking into account those firms that are members of the federation of Hellenic ICT enterprises (SEPE) according to their main / primary activity.

Introduction

For decades, the Information Technology (IT) and the Telecommunication industries had been characterized as relatively stable environments, which encouraged firms to sustain their market positions without any uncertainty [1]. However in the last decade, the technological advancements and innovation from the one side and the digitization, liberation, deregulation and globalization from the other side have played important roles in the transformation of the environmental conditions. The ability to provide services of voice, data, and multimedia over integrated wired and wireless IP networks has as a result the major restructuring of these industries. This continuous evolution is dramatically changing the structure of these industries by making the Information and Communication Technology (ICT) industry to emerge from the convergence of the previously distinct IT, Telecommunications and Content and Media industries.

The resulting ICT industry has blurred to a point that it is becoming difficult to distinguish between telecommunication, information and media services. The traditional vertically integrated industry structure with only three layers - equipment, network and application/ service layer - is currently deconstructed and being transformed into more horizontally interconnected function layers. The value chain of the industry is continuously disintegrating at a vertical level and integrating at horizontal level [2]. These rapid changes have created enormous complexity for all the involved firms in the resulting ICT industry, making them to re- assess their current situation and to re-evaluate their future strategic trends.

This research attempts to apply a layered policy model and more specific the Info-communications model, as a tool to map the Greek ICT sector. Relating the main activity of each involved firm with the functionality of the layers of the model, it presents the distribution of the Greek ICT firms based on the Info-communications model. By this approach firms have the capability to understand their industrial role and also to evaluate their decisions on how they join forces and integrate with other partners. Moreover, the study of the specialization of firms and also the study of the degree of vertical and horizontal

integration among them can contribute to useful findings that can be related with the dynamics of the emerging ICT industry

In the following sections, we discuss the research background on Info-communications layered model. Additionally, we present an approach to categorize and classify the ICT industry. We also attempt to map of ICT industry and finally we provide taxonomy of the firms of the Greek ICT sector based on the Info-communications model. The paper concludes with some preliminary results and suggestions for future research.

The layered policy model

The idea of the layered policy approach to regulate especially the telecommunications industry has been discussed by several authors [4],[5]. The layered policy model proposes a regulatory system that classifies technologies based on their common layered characteristics instead of regulating each communication technology with a disparate set of rules. Apart from regulation Fransman [6] suggested that a layer model may be particularly useful in illuminating the following issues concerning the understanding of the industry structure:

- Industry boundaries / subsectors
- Modularization and hierarchy
- Industrial organization (including issues of vertical and horizontal specialization and integration)
- The location of R&D
- Entry barriers
- The role of consumers/consuming

The first layered policy approach was Act 1996 (The “Act”). The “silo model” was constituted by three titles. Each title of the “silo model” imposes regulatory conditions based on the type of infrastructure on which a telecommunications service is offered. For example title I regulates fixed telephony networks, title II regulates wireless networks and title III regulates cable networks. Due to technological innovations and convergence in ICT industry is demanding a new layered policy model that will be able to provide a more analytical approach. So various layered policy models were generated which borrow their structure from the TCP/IP protocol stack and their main differences include the number and the functionality of their layers.

Kevin Werbach [7] proposed a model that constitutes of 5 layers: a) Physical, b) Logical, c) Application, d) Interface, e) Content. Another layer policy model was proposed by Sicker [8] who used the separate *Access* and *Transport layer* and also the other two layers of *Applications* and *Content*.

Finally, Fransman [9] with his Infocommunications model suggested 6 layers:

Equipment & Software Layer: describing for example switches transmission equipment, routers, servers, customer premises equipment, and billing software.

Network Layer: describing optical fiber networks, DSL, local networks, radio access networks, Ethernet and frame relay, and ISDN and ATM networks.

Connectivity Layer: describing internet access and web hosting, the IP interface, where operators such as Internet Application Providers and Internet Service Providers function.

Navigation & Middleware Layer: describing browsers, portals, search engines, directory assistance, security, electronic payment.

Applications Layer: including contents-packaging: describing web-design, on-line information services, broadcasting services.

Customer Layer: where finally the market for customers is defined.

The unified theme is that all layered policy models imitate the characteristics of internet protocol and OSI model that apply in IP-based transmission systems [10].

The ICT industry Segmentation

The rapid technological developments and the convergence of various technologies composing different business activities have made the delimitation of the ICT industry to be considered as a non trivial task. Various organizations have attempted to categorize the complex continuous evolving ICT industry. In this work, we investigate the categorization approaches applied by the Organization for Economic Co-operation and Development (OECD) and the European Information Technology Observatory (EITO).

According to the OECD, the ICT industry can be deconstructed by connecting from one side the firms and their main activity, and from the other side their products/ services. It has to be noted that there are assumptions where there are firms that provide products/services that are not classified in the ICT industry and also that there are overlaps with firms which provide content that it is dependent on the medium of its distribution. An international standard of industrial classification of all economic activities that is used by United Nations ISIC codes and a pan-European classification system which groups organizations according to their business activities and are used by E.U NACE codes are used. So by selecting the corresponding ISIC (rev.4) codes and NACE (rev1.1) codes respectively, the main activities of ICT industry according to OECD are the following [3]:

1. Programming / broadcasting activities
2. Telecommunications
3. Computer programming, consultancy and related activities
4. Information service activities
5. Wholesale of information and communication equipment
6. Wholesale of other machinery, equipment and supplies
7. Retail sale of information and communication equipment in specialized stores
8. Publishing activities
9. Motion picture, video and TV program production, sound recording, music publishing activities.

The European Information Technology Observatory (EITO) uses a completely different approach. It focuses on the side of ICT products/services adapting a market driven approach without using ISIC or NACE codes. So the main activities of the ICT industry according to EITO are [4]:

1. ICT equipment (computer hardware, end user communications equipment, office equipment, network equipment)
2. Software products (operating systems, application software, application tools, system infrastructure software, maintenance services)
3. IT services (ERP,CRM, e-commerce applications, implementation services, operation management, consulting, support services)
4. Carrier services (fixed/ mobile telephony, cable TV, leased lines etc)

Based on the previous attempts for categorization of the ICT activities, it is obvious that the emerging industry include the activities which fall into the union of the Information Technology and Telecommunications activities but also some of the content and media sector activities.

Following, we present an attempt to define the ICT industry by combining the findings of OECD and EITO approaches respectively. In other word it attempts to figure out the players and their roles that involved in the evolving ICT industry.

We distinguish the ICT industry into four segments: 1) Equipment, 2) Software, 3) Services and 4) Content. Table 1 provides the main activities/services of each segment.

Equipment	<ul style="list-style-type: none"> • End-user equipment • Network equipment
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Software	<ul style="list-style-type: none"> • System infrastructure software • Application Software
Services	<ul style="list-style-type: none"> • IT services • Internet Services • Carrier Services
Content	<ul style="list-style-type: none"> • Publishing • Broadcasting • Media production

Table 1: Activities/services of the ICT segments

By determining the main activities of the ICT segments the next step is to classify these activities/services in a more analytical mode considering the definition of the industry according to the OECD. A detailed view is provided below.

Equipment	
<u>End-user equipment</u>	<ul style="list-style-type: none"> • Manufacture of electronic components and boards • Manufacture of computers and peripheral equipment • Manufacture of consumer electronic • Manufacture of magnetic and optical media • Manufacture of mobile devices • Manufacture of telephony devices • Wholesale of computers, peripherals and other end-user equipment
<u>Network Equipment</u>	<ul style="list-style-type: none"> • Manufacture of routing and switching equipment • Manufacture of wired access infrastructure • Manufacture of mobile access infrastructure • Manufacture of transmission equipment • Wholesale of network equipment and parts
Software	
<u>System infrastructure software</u>	<ul style="list-style-type: none"> • Operating system and system-level software • Network, system, storage and security management software • Database engines, business intelligence infrastructure, integration platforms
<u>Application software</u>	<ul style="list-style-type: none"> • Graphical, technical software • Process-oriented applications (ERP, CRM, etc)
Services	
<u>IT services</u>	<ul style="list-style-type: none"> • Computer programming activities • Computer consultancy and computer facilities management activities • Other information technology and computer service activities
<u>Internet services</u>	<ul style="list-style-type: none"> • Data processing, hosting and related activities • Web portals
<u>Carrier services</u>	<ul style="list-style-type: none"> • Wired telecommunications activities • Wireless telecommunications activities • Satellite communications • Other telecommunications activities
Content	
<u>Publishing</u>	<ul style="list-style-type: none"> • Book publishing • Publishing of directories and mailing lists • Publishing of newspapers, journals and periodicals • Sound recording and music publishing activities
<u>Broadcasting</u>	<ul style="list-style-type: none"> • Radio broadcasting • Television programming and broadcasting activities
<u>Media production</u>	<ul style="list-style-type: none"> • Motion picture, video and television program production

	activities <ul style="list-style-type: none"> • Motion picture projection activities • Motion picture, video and television program distribution activities
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Table 2: Analytical description of main activities/services

From the above detailed view, we notice that the related services/activities of the ICT industry can be grouped into 10 different categories.

After the classification of the services/activities of the ICT industry, the next step includes mapping the evolving ICT industry using the Info-communications layered model. The reason for using this specific model is the more exact definition of its functional layers. The idea behind the use of the Info-communications model was to relate the different activities/services of the ICT industry as it is identified in the previous section with the layers of the Info-communications model in terms of their functionality. Considering the functionality of each layer and the analytical view of activities, we extracted the following diagram that indicates the equivalence of activities/services with the different layers of our model.

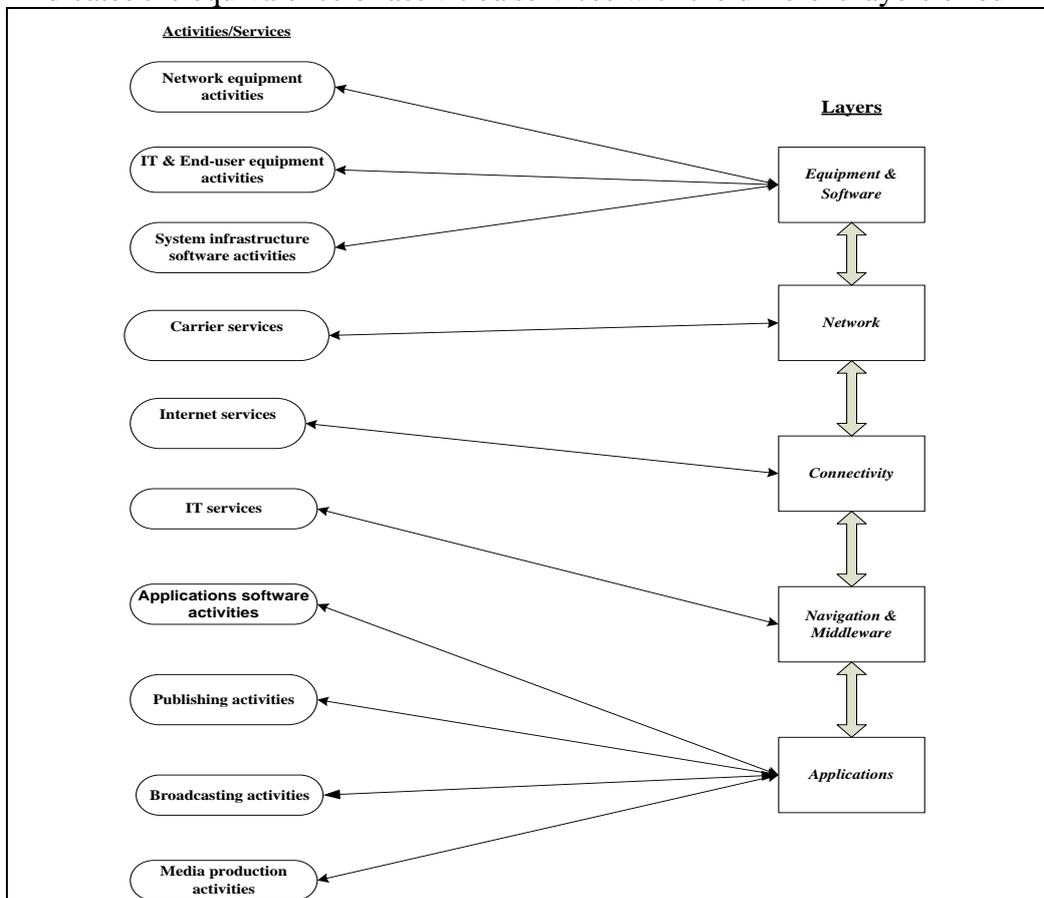


Figure 1: A map for the ICT industry

Starting from the Equipment & Software layer, it is clear that it is composed of firms that provide network and customer equipment, firms that produce the passive and active components that are involved in the production of equipment and also firms that develop software for that equipment. The Network layer groups all the telecommunications carriers which use various technologies such as optical fiber, DSL, satellite as a medium for their operations. The Connectivity layer includes the firms that provide connectivity access and services. The Navigation & Middleware Layer is composed of firms that provide the services that are complementary with the services of the firms in connectivity layer. Finally the Applications layer groups all those firms that provide content.

The case of Greek ICT sector

Finally we attempt to apply the Info-communications model as a tool to present the distribution of the firms in Greek ICT sector. More specifically, taking account those firms that are members of the federation of Hellenic ICT enterprises (SEPE), we categorize them in terms of its primary activity in each layer of the model.

Table 3 shows the number of firms for each layer and each activities/ services respectively.

Layer	Activities / Services	Number of firms
Equipment & Software	End-user equipment	38
	Network equipment	14
	System infrastructure software	43
Network	Carrier services	10
Connectivity	Internet services	16
Navigation & Middleware	IT services	52
Applications	Application software	47
	Publishing	15
	Broadcasting	5
	Media production	7

Table 3: Number of firms for each layer, activities/services

Table 3 depicts that the vast majority of the Greek ICT firms belongs to the Equipment & Software layer, the Navigation & Middleware Layer and the Applications layer. Computer consultancy and computer facilities management activities, process-oriented applications (ERP, CRM, etc) and network, system, storage and security management software are at the core of activities / services of the Greek ICT firms. Additionally, a significant number of firms are activated in the wholesale of computers, network, peripherals, and other end-user equipment. On the other hand, only few firms are in the Network and the Connectivity Layers. Wired, wireless, satellite and other telecommunications activities are difficult for the firms to be provided. This can be rational considering the large operational and functional costs and also the entry barriers from the regulatory regime of these activities. Now according to the Info-communications model, a layout of the Greek ICT sector can arise based on the total number of 247 members of SEPE as it can be shown in figure 2. The Federation of Hellenic Information Technology & Communications Enterprises (SEPE) is a non-profit organization. The main objectives of SEPE are to promote Information and Communications Technologies (ICT) in Greece and to enlarge ICT Industry's market. SEPE also represents the interests of the Greek ICT Enterprises vis-à-vis the Greek Government, the European Commission and other bodies of influence. SEPE is an advisor to many national and international bodies. Utilizing this role, SEPE is currently lobbying for:

- The modernization of Public Administration with the use of Information Technology.

- The development of a high - speed telecommunication network to address and assist the current Communication Infrastructure
- The design and implementation of programs aimed at addressing the needs of Small and Medium Enterprises (SMEs) and improving their competitiveness in the market
- The engagement of Information Technology into all levels of the educational system.
- The cooperation between the ICT market and the educational system.

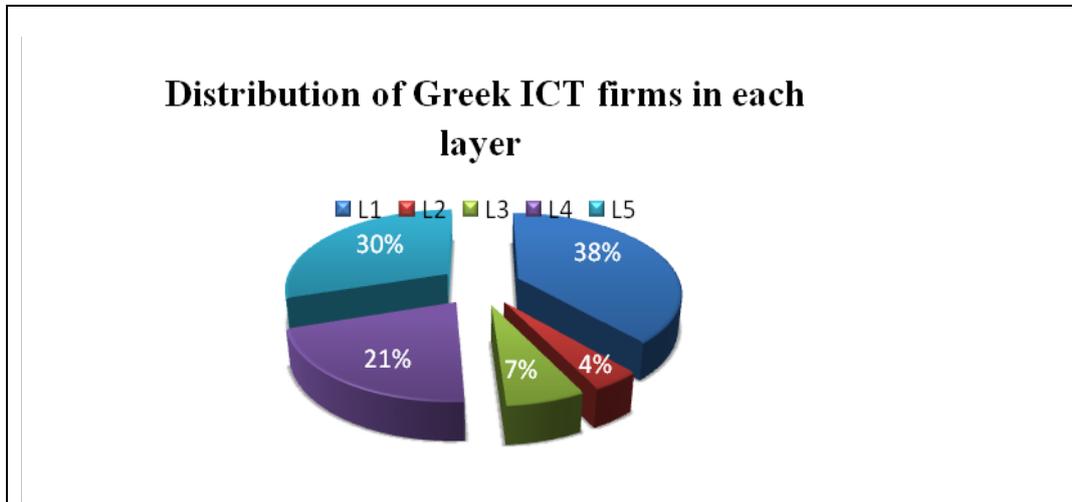


Figure 2: Distribution of Greek ICT sector

The 90% of the distribution of the firms of the Greek ICT sector belong to only three layers, while the rest 10% belongs to the two remaining ones. This disproportion allows us to note that services/activities related to informatics can be more attractive for the involved firms of the ICT industry.

Conclusions & Future Work

The ICT industry is passing through a re-integration phase. The traditional vertical industry structure of IT and Telecoms seems to be destructed into a horizontal one by reducing the entry barriers for new entrants [11]. It has become extremely important for the involved firms to review their growth strategies by extending their activities through mergers, acquisition and strategic alliances. Knowing that current strategies are inadequate, firms must create collaborative networks that allow them to access new technologies, realize economies of scale and scope and shorten development time. Thus, this work can be a useful tool for researchers to impress the structure of this collaborative network. Taking into account the classification of involved firms of ICT industry provided by the Info-communication model, the role of each node of the network can be extracted. Additionally this paper constitutes an attempt for the involved firms of the emerging ICT industry using of the Info-communications model to understand their industrial role and also to evaluate their decisions on how they join forces and integrate with other partners. This was done by providing an approach that uses a specific layered policy model as a tool to map the ICT industry. This detailed view that links the total available activities/services of the ICT industry according to the functionality of the layers of the model allows the involved firms to co-ordinate their services/activities in terms of their different growth strategies.

Considering that customer's needs are shifted to bundled services i.e. services that will be offered by one provider, firms have to extend their activities in all layers of the model. Assuming that the five layers of the model constitute the value chain of the emerging ICT

industry, a firm is vertically integrated if it extends their activities from one layer to another one. A firm is horizontally integrated if it extends their activities to the same layer. The definition of vertical and horizontal integration in terms of the layers of the model can be used as a tool for the involved firms to re-evaluate their strategies in order to cope with the challenges from the restructuring of the industry. We suppose that in the new emerging industry two types of firms exist, the specialized and the diversified. Then a firm should be characterized as a specialized if its services/activities cover the functionality of only one layer of the model. On the other hand, a firm is diversified when it provides services/activities of more than one layer.

Finally, the study of how activities /services within an industry are distributed among layers, the analysis of why and how some firms are occupied with a wide range of activities/services while others are more specialized and also the study of the degree of vertical and horizontal integration among firms can contribute to the study of the dynamics of the emerging ICT industry. In other words, it can contribute to the fact that the specialization drives the evolution of an industry with high technological barriers and intensive competition. Although the Info-communications model has been hereinafter applied as a useful tool for the deconstruction of the ICT industry, it will have to be complemented with other analytical techniques such as Agent-based Computational Economics (ACE) in order to explore the evolution of the industry.

In future, our research will be focused on the development of an agent-based model for the emerging ICT industry. The model will be constituted from agents that imitate the firm's behavior in this specific industry. These agents have a role, a value and rules of behavior. The role of each agent and also the way in which they interact will be defined in terms of the classification of services /activities of the ICT industry with the aid of the Info-communications model.

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