

How Firms Interact and Perform in the ICT Ecosystem? (*)

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Abstract: This paper analyses the properties and the dynamics of the ICT sector as an ecosystem where firms interact, innovate, and compete through bundling and external growth strategies. By exploring the strategies of firms and their relative performances, we show that the allocation of revenue between the different Layers of the ecosystem does not reflect their respective contributions in terms of investment. The recent development of intermediaries such as search engines or electronic commerce firms is driving a migration of value from Europe and Asia to the United-States. Market players of the ecosystem perform different strategies to capture market value. Network Operators may choose to enter new Layers of activity that are currently yielding higher returns on investment to finance future Next Generation Network Access investments.

Key words: ICT ecosystem, competition, convergence, innovation, investment.

Economists have long been discussing the convergence of computer, telecommunications and media industries. This digital convergence is today at work and the magnitude of its effects is increasing. According to BAUER (2005), digital convergence enables the diffusion of different types of information (voice, data, audio and video) in a more unified way. Nowadays, telephony, Internet access and television services can be provided through different kinds of access networks such as xDSL, FFTx, cable, satellite and mobile. The convergence process is thus reshaping and extending the previous boundaries of the telecommunications' industry, further modifying its organisation and redefining the structure of market players' supply.

The purpose of this article is to analyse the economic rationales of information and communications technologies (ICT) industry, taking account of the economic relationships between the different market players. In order to provide a proper analysis of the way convergence dynamics are driving

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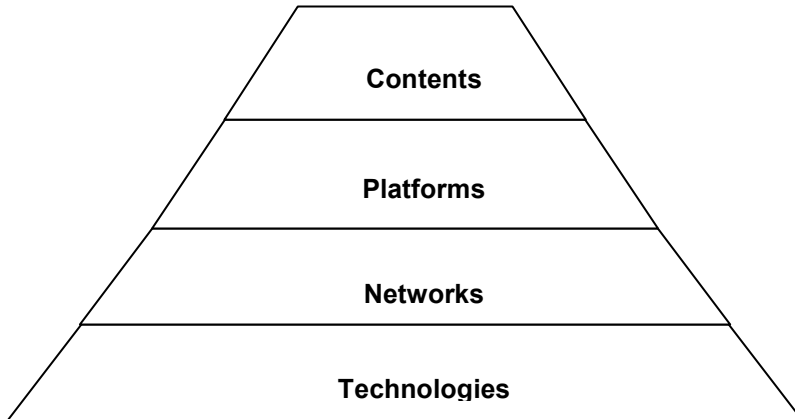
the strategies and interactions of ICT firms, we adopt a framework similar to LOMBARD (2008) and FRANSMAN (2007)¹, who use a Layer model to describe the economic relationships at work in the ICT ecosystem. While FRANSMAN (2007) focuses on the synergies between different breeds of players, we rather focus on industrial and market strategies of firms, the resulting market structures, and their economic and financial performances.

This paper provides an analysis of the current major industrial stakes and economic issues concerning the ICT sector, at the dawn of a major technological transition between copper and fiber local loops. By exploring the strategies of competing firms as well as describing the process of value creation and distribution across players, we show that the allocation of revenue between players does not reflect their respective contributions in overall ecosystem investment. The development of intermediaries like search engines or electronic commerce firms is a major driver of value migration from Europe and Asia to the United-States. Network operators may enter other Layers of activity in order to finance the deployment of Next Generation Access Network (NGAN).

■ Defining the ICT ecosystem

We consider the ICT sector as an ecosystem, where different market players interact within a common environment. We apply the Layer model developed by LOMBARD (2008) to analyse the dynamics of this ecosystem and the main evolutions at work. The Layer model is also used by FRANSMAN (2007) to describe the symbiotic relationships that occur within ICT industries. Firms are classified on the basis of their core business and main activity. Four groups of players are identified: technologies providers (Layer 1), network operators (Layer 2), platform operators or Internet intermediaries (Layer 3) and content providers (Layer 4). According to this classification, the Layer model can be drawn as follows:

¹ Whereas the Layer model was first published by Martin Fransman in 2007, this model was developed by Didier Lombard. Martin Fransman used Lombard's model in order to develop several analyses. In Japan, the Ministry of Internal Affairs and Communications (MIC) also uses a layer model.

Figure 1 - the ICT ecosystem

The networked elements are produced in the first Layer of activity. These include telecommunications switches and transmission systems manufactured by firms like Alcatel Lucent, Cisco, Ericsson, Huawei or ZTE; fixed and mobile phones produced by firms such as Apple, LG, Nokia, Motorola, Samsung or Sony-Ericsson and electronic devices connected to networks such as PCs produced by Acer, Apple, Dell or Toshiba, or MP3 players, digital cameras and TV produced by Panasonic, Sharp or Sony. Some of these elements are strung together in the second Layer by network operators.

Network operators include telecommunications operators (incumbents and entrants) such as AT&T, BT Group, Deutsche Telecom, France Telecom, Free, Telecom Italia, Telefonica, Verizon, mobile operators such as Vodafone, cable TV operators such as Cox Communications, Ono, Time Warner Cable or Virgin Media and satellite operators such as BSKyB or DirecTV.

The third Layer features Intermediation platforms, such as search engines like Google and Yahoo or electronic commerce firms like Amazon and eBay, as well as firms developing social networks such as Facebook and Twitter. These firms are based on two-sided business models and make use of access networks developed in the second Layer to provide their own (online) services. Search engines enable interactions between consumers and advertisers and derive their revenues exclusively from advertisers, while electronic commerce firms cater for both the sellers and the buyers.

Contents production industry is located in the fourth Layer. Content relates to the material downloaded or viewed by end users, such as textual information, music and movies. Content can be produced either by national broadcast channels like Antena 3, Canal+, CBS, TF1, or by media and entertainment conglomerates like Time Warner or Walt Disney.

The Layer model is well suited to an economic analysis of the ICT ecosystem. This model draws an explicit distinction between network operators, content providers and Internet intermediaries. It is therefore a useful tool to tackle the network neutrality issue². As it is shown in this paper, Internet intermediaries benefit from network operators' investments and perform a higher level of profitability. This model can also be applied to analyse the relationship between content providers and network operators. Content providers can benefit from network deployment because a rise in broadband penetration enables them to reach a more extended consumer base. Network operators also perform strategic moves toward content acquisition activities. Whereas content providers and network operators' business models differ in kind, there exist important economic interactions between those market players.

■ The convergence dynamics

Mergers and consolidations

The convergence dynamics relates to a process of industrial concentration which takes the form of mergers and consolidations. This process has two distinct forms: horizontal mergers that occur within a given Layer of activity, and vertical mergers that occur between distinct Layers. The latter are related to the adoption of external growing strategies or to the adoption of strategies aimed at adapting to the emergence of direct competition between once separated branches of industry. The previous often occurs within the Layer 2, where network operators tend to gather mobile and fixed networks under a same brand to build up bundled offers. For example, in the United-States, SBC bought AT&T, took its name and

² Net Neutrality refers to restriction for network operators to price discriminate amongst Internet intermediaries and content producers, to manage their traffic and to block access to networks.

then "swallowed" BellSouth in order to gain full control of Cingular, its wireless joint venture in 2006. In Japan, Softbank bought the Vodafone's wireless Japanese arm in 2006.

Network operators and networked elements providers may consider new revenues opportunities within the Layer 3, while applications and services providers may tend to conquer, retain and reinforce their technological autonomy by taking control of infrastructures. Such a move would allow internalizing the pace of innovation in products. Because of the diversification in activities and the growing intensity in competition, with markets featuring firms from different Layers competing for the same shares, there exist powerful incentives for firms to migrate from their core business to capitalize on new streams of revenues outside their original core activity. These factors' interplay results in the adoption of external growth strategies, in order to gather assets from different firms to increase productive efficiency instead of relying exclusively on extensive growth strategies that increase the amount of production factors.

Therefore, consolidation moves within the "new" ICT ecosystem are driven by the firms' need to gain a strategic control, to acquire complementary assets and inputs required to build up and further upgrade their ability to launch bundled commercial offers. Bundles thus allow the firms to further increase their production capacity. The dynamics at work can also be explained by replication behaviours from firms which tend to select the strategies and moves previously adopted by others. This leads to the emergence of a self-enforced consolidation process and such momentum results in new emerging competition patterns. Concentration moves that occur within a given Layer usually allow fixed and lately mobile operators to strengthen their position within their own sector of activity, as economies of scale related to infrastructure deployment and fixed costs are the driver of a growth in structure size. Economies of scales allow operators reducing production costs as their size grows. Thus, by acquiring external assets, firms are more likely to offer bundles to the final customer. We will discuss the business strategy of the firms in the next section.

For example, mergers and consolidations have led Apple and Google to compete in the Layer of numerical content distribution platforms, with iTunes and YouTube respectively. Both firms are now competing with two opposite business models. Apple's iTunes relies on exclusiveness to ensure its own returns on innovation while Google relies on indirect network effects of two-sided markets with a free platform supported by investments of advertisers. Google operates on access networks developed by network operators in

Layer 2 so that both sides of the market, final consumers Internet users and advertisers can interact to generate value added. Besides, horizontal and vertical mergers are not irreversible, depending on the market's response and on the external effects between the services that are bundled in a same offer.

There are also mergers between content providers and network operators. The merger between Time Warner and AOL was unsuccessful and the two units are now separated. Comcast and NBC are now merging. This is a clear illustration of convergence. Moreover, content producers and network operators' business models differ. Content acquisition helps network operator differentiating from their competitors whereas, content producers benefit from competition between network operators.

Bundling competition

Bundling refers to the selling of several products or services together. Network operators now apply bundling strategies in the form of triple and quadruple play. Such strategies consist in bundling fixed telephony, Internet access and television and also mobile telephony with quadruple play. Bundling has two different economic effects: it can increase firms' efficiency or increase competitive pressure. It increases firms' efficiency because it allows price discrimination and enables economies of scope. Several authors such as ADAMS & YELLEN (1976) and SHAPIRO & VARIAN (1998) show that bundling allows firms to price discriminate. When the willingness to pay differs a lot across consumers, bundling helps firms to extract consumer surplus and to increase their profits.

The following example illustrates how bundling allows to price discriminate. Let's assume that a monopolistic operator is selling two services, Internet access (i) and telephony (t), to two distinct consumers, 1 and 2. Each consumer buys at most one unit of each good and the costs of each good are set to zero. The willingness to pay of consumer 1 is 10€ for Internet access and 20€ for telephony. The willingness to pay of consumer 2 is 20€ for Internet access and 10€ for telephony. If the operator decides to sell the two services separately, the profit maximisation program will produce the following prices: $p_i = 10\text{€}$ and $p_t = 10\text{€}$. The operator's profit is then 40€. The operator abandons consumer surplus which is 20€. Suppose now that the monopolist decides to sell the services within a bundle. In order to maximise its profits, the bundle needs to be priced at $p_b = 30\text{€}$. The

operator's profit is now 60€. In this case, bundling allows the operator to capture the consumer surplus. Thus, bundling strategies help monopolists to reduce consumers' heterogeneity and thereby to price discriminate. The price discrimination still applies within oligopolistic market structures. The price discrimination effect is, however, weaker within oligopolistic than within monopolistic market structures (see REISINGER,2006).

Furthermore, bundling allows firms to achieve and to sustain economies of scope. Bundling together services such as telephony, Internet access, and television reduces managing advertising and marketing costs because all services can be advertised and distributed together at the same time. To that purpose, France Telecom has rebranded its MaLigneTV and Wanadoo divisions into the single brand Orange.

Bundling increases competitive pressure because it drives telecommunication incumbents and new entrants as well as cable and satellite operators into head-on competition. The factors that induce players to adopt bundling strategies differ according to the type of the player. Cable operators and Internet providers are moving toward bundling with aggressive intents. Because of technological properties of strategic assets and specific regulatory frameworks, cable operators offered triple play in Europe and US markets before telecom incumbents and internet providers actually did³; Internet providers use bundling as a device to gain access market and to gain market share from its competitors.

On the other hand, telecommunications incumbents, mobile operators and satellite operators can use bundling as a more defensive strategy to protect their core market and also in order to grasp shares of new markets. The undertakings of bundling strategies drive players in a head-on competition in several markets which results in a further increase of competitive pressure. Head-on competition results in a further rise in competition intensity within the core industries of players who adopt such strategies. This may in turn reduce bundle retail price and, possibly, the profits of firms.

Furthermore, competition arising from the adoption of bundled services strategies strengthens firms' incentives to differentiate themselves through the acquisition of exclusive contents. Such strategy is more consistent in a

³ In the USA, the Telecommunications Act of 1996 has allowed cable operators to launch telecommunications service before telecommunication operators could initiate TV business.

bundled service than in separated services competition framework. The income generated by the supply of exclusive content is sent back to the other components of the bundle. Thus, the gain from the acquisition of an exclusive bundle is higher in the case of bundled services competition. Several operators such as Belgacom, France Télécom or Telefonica have invested in contents and acquired exclusive rights for football games and/or movies distribution⁴. Exclusive content acquisition can help operators to gain market shares because of differentiation and price discrimination. Nevertheless, the purchase of an exclusive content may induce a significant investment with uncertain delayed returns. Furthermore, the distribution of an exclusive content along with an Internet access service can be deemed uncompetitive by regulatory agencies which may consider them as tying.

Furthermore, the "three players game" between content editors, network operators and final customer results in a mutual gain, where the first benefit from an increase in the size of their audience through networked diffusion, the second benefit from the resulting increase in traffic, and the last benefit from a wider content variety and the opportunity to choose its own access network operator. As a result, the whole ecosystem is likely to benefit from this new competition frame, and its global value is thus likely to rise significantly in the future.

Open innovation, innovation spreading and content diffusion

The convergence process creates new profit opportunities. There exists a consistency within the inner structure of the ecosystem: the growth of a given Layer of activity may have a significant impact on the evolution of the others, in terms of industrial strategy as well as economic and financial performance. When firms invest in R&D or when innovations occur within a given Layer of activity, the whole sector, as an ecosystem, can benefit from their diffusions driven by the network effects they may trigger throughout the patterns of adoption dynamics. The open innovation concept means that innovation applies in different Layers and impacts the whole ecosystem.

Consider the launch of the iPhone mobile handset by Apple. The diffusion of such major innovation allows the revenues of Apple, mobile

⁴ France Télécom – Orange acquired part of French football rights diffusion between 2008 and 2012 for 208 million Euros each year. Belgacom acquired exclusive Belgium football rights between 2008 and 2011 for 47.5 million Euros each year.

access network operators from Layer 2 and, to a lesser extent, content editors from Layer 4, to rise because of an increase in capacity demand and in the content stream. As a matter of fact, during the first quarter 2009, Orange's revenues increased by 7.4% while SFR's did not. Whereas Orange has commercialised the I-Phone, this was not the case of SFR. Intermediation platforms and Search Engines like Google will also benefit from the adoption of a third generation of mobile handset that is expected to foster Internet usage in mobility.

The dynamics of innovation enable Google to enter both Layers 1 and 2, by the means of its open and free Android operating system designed for mobile handsets, which business model relies exclusively on advertising. Furthermore, the revenues of Internet intermediaries' have recently strongly increased. Between 2007 and 2008, Google's revenues raised from 19.9 to 21.8 billion dollars.

The ICT ecosystem is thus characterized by three main economic effects. First, innovations from networked elements suppliers and network operators are spreading across the whole ecosystem and benefit the upper Layers.

Second, intermediation platforms succeed in capturing part of the value generated by the adoption of Internet services, while they rely on physical networks deployed by operators of Layer 2.

Third, and as a consequence, the intermediaries' demand in capacity is likely to increase drastically in the short and medium run. Therefore, the further rise of demand in capacity from players in Layer 3 and 4 and the related significant investment in the Next Generation Access Network (NGAN) by network operators of Layer 2 could lead to their development into upper Layers.

In order to fund the deployment of NGAN and the optical fiber local loop in particular, network operators need now to look for new available revenue prospects in order to be able to finance large investment related to such major technological transition. As all the Layers of the ICT ecosystem seem to rely on each other, from a technical and economical point of view, the development of a given Layer is therefore not neutral and has an effect on others and possibly on the whole ecosystem as well.

We now turn to a quantitative analysis of the dynamics at work between players.

■ Economic and financial analysis: the performances of ICT firms

Methodology and data

In order to examine the interaction between firms of the ICT ecosystem along with their economic and financial performances, we build a database providing information on 347 companies⁵. Our sample accounts for more than 80% of market capitalisation of ICT firms across the world. The firms are listed in the Appendix. While FRANSMAN (2007) provides similar analysis using a database containing 157 companies, we extend the sample to reach 347 companies which are grouped in four Layers according to their core business, and three different geographical areas (Asia, Europe and North America). Our database is therefore more extensive and allows a more comprehensive, reliable and recent economic analysis of the ecosystem.

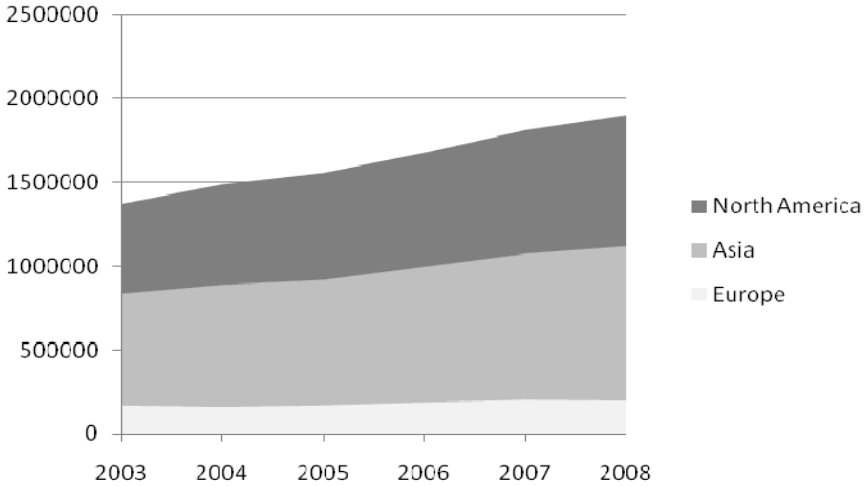
The financial and economic analysis is structured as follows: in a first section, we analyse the evolutions of the revenues in aggregated Layers. Three regions are considered separately (Asia, Europe and North America). OECD Consumer price indexes are used to convert Layers' revenues in real dollars in 2005. In a second section, we present the analyses of firms' financial ratios: profitability measured by operating income to sales, Return on Capital Invested given by the ratio of EBITDA on balance sheet assets and capital intensity which is given by the ratio of capital expenditures to sales. Firms' financial ratios and revenues are analysed according two levels of heterogeneity, the region and the Layer of activity.

Economic and financial analysis

The four graphs below represent Layers' revenues evolution between 2003 and 2008.

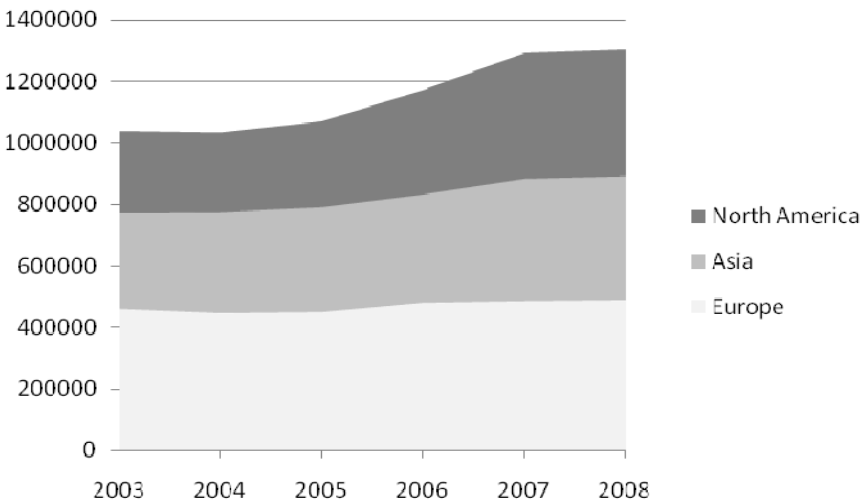
⁵ Raw data on firms is provided by Thomson Financial Database.

Graph 1 - Evolution of layer 1's revenues (millions of real dollars 2005)



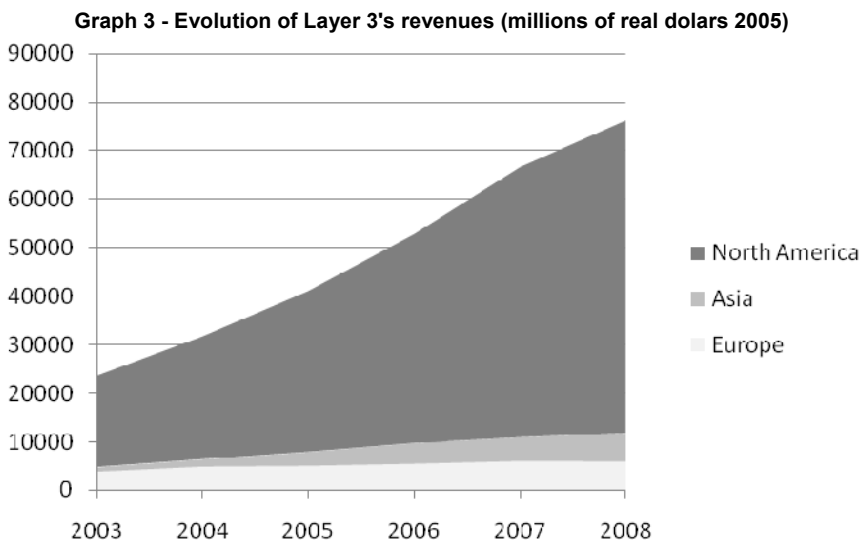
Between 2003 and 2008, the annual average growth rate of technologies producers' revenues is 6.73%. In 2008, the total revenues of the first Layer of activity reaches 1905049 (c'est le bon chiffre?) million dollars. American companies account for 41% of these revenues, while Asian companies account for 48.7% and European companies only account for 10.3%. The first Layer is dominated by Asian firms, while European industry is relatively weak in the field of networked elements industry.

Graph 2 - Evolution of Layer 2's revenues (millions of real dollars 2005)



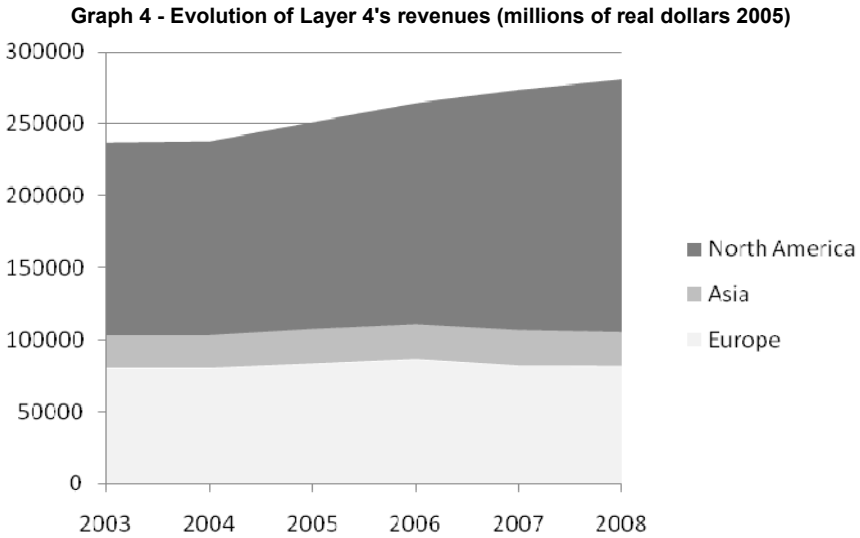
Between 2003 and 2008, the annual average growth rate of network operator's revenues is 4.63%, while in 2008, the total revenues of Layer 2 reaches 1302311 million dollars.

American firms account for 31.5% of these revenues, Asian firms account for 31% and European firms account for 37.5%, which shows that European network operators are world leaders.

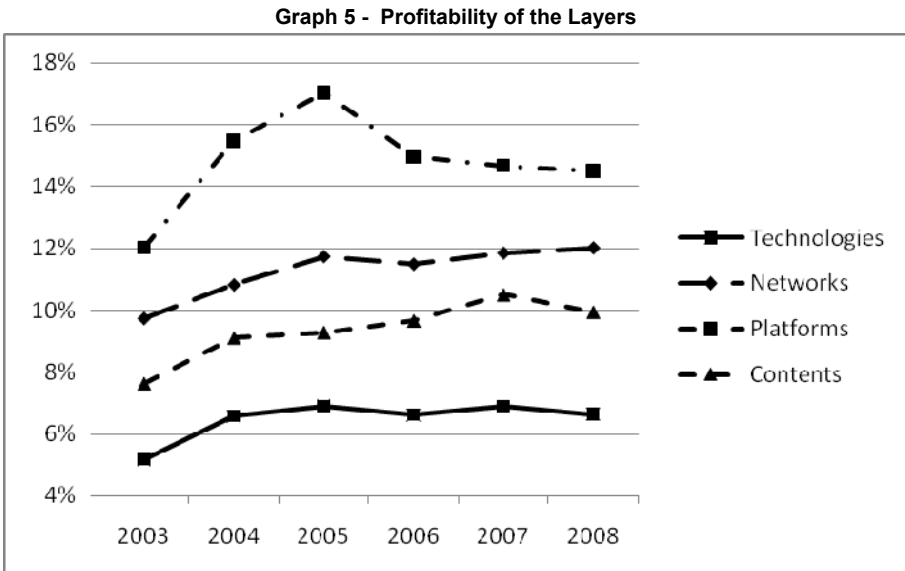


Between 2003 and 2008, the revenues of Internet intermediaries grow at the average annual rate of 26.5%. The total revenues of Layer 2 reach 76219 million dollars in 2008, while American firms account for 84.4% of the total amount of revenues and Asian and European companies exhibit a comparable weight (7.7% and 7.9%).

The Internet activity is clearly dominated by American companies. The annual average growth rate of Layer 3 is higher than growth average rates of the other Layers. However, the total revenues of Layer 3 are very low compared to the other Layers.



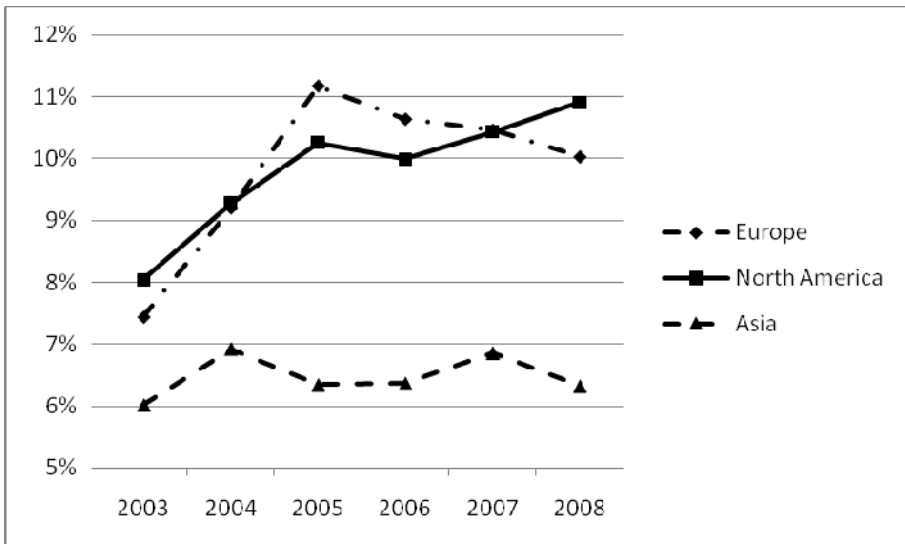
Between 2003 and 2008, the revenues of content producers grow at the average annual rate of 3.45% and the total Layer's revenue reaches 28521 million dollars in 2008. American firms account for 62.3% of total revenues, while European firms account for 29.1% and Asian firms only account for 8.1%. The content producers' Layer is largely dominated by American companies.



As Graph 5 clearly shows, the intermediation platforms and service providers of Layer 3 exhibits the highest profitability of the whole sample, followed by network operators of Layer 2, content producers and editors in Layer 4 and networked elements producers of the first Layer, which exhibit the lowest profitability. The platforms in Layer 3 benefit from high profitability levels as they manage to make an efficient use of the two-sided nature of their markets. Moreover, they benefit from Net Neutrality.

Such a regime prevents networks carriers from requiring fees from Internet intermediaries which benefit from unlimited network utilization. It also prevents them from controlling or blocking access of Internet intermediaries to networks.

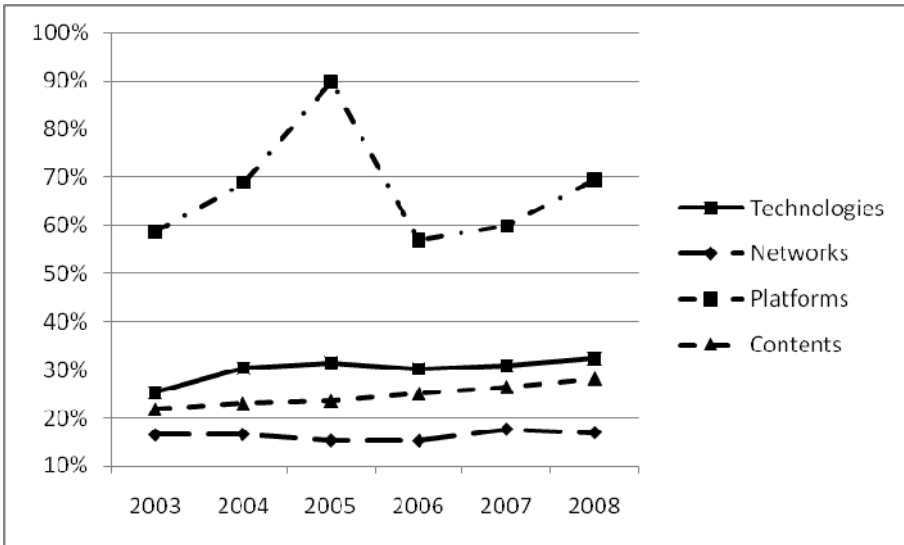
Graph 6 - Profitability of the geographic areas



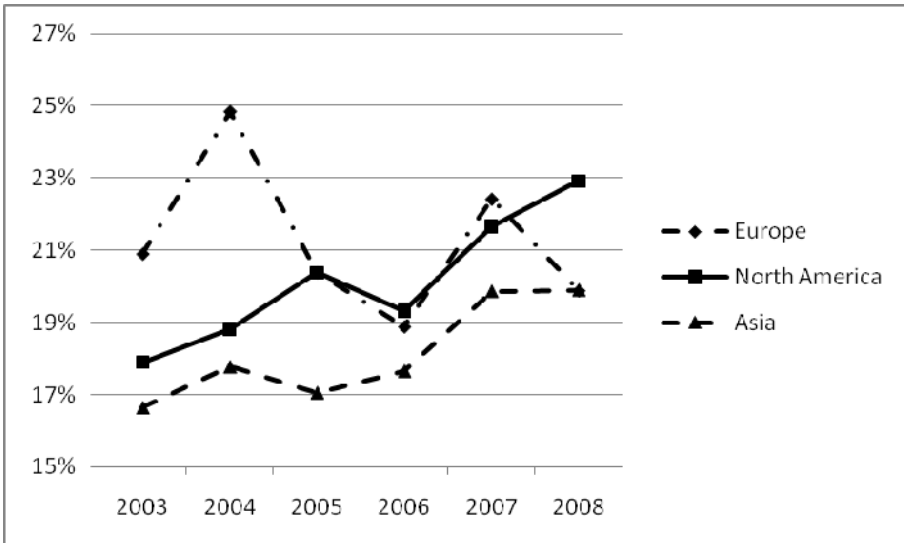
Graph 6 shows that European firms achieve the highest profitability between 2005 and 2006. Since 2007, American firms have shown the highest profitability level. Furthermore, their profitability has increased since 2006, while European firms' profitability has increased since 2005. As stated by LOMBARD (2008), most of the platforms in Layer 3 like Amazon, eBay, Google or Yahoo are American.

Therefore, the development of an advertising business model is currently driving a migration of value from Europe and Asia to the United States as shown in Figure 3.

Graph 7 - Return on Capital Invested of the Layers



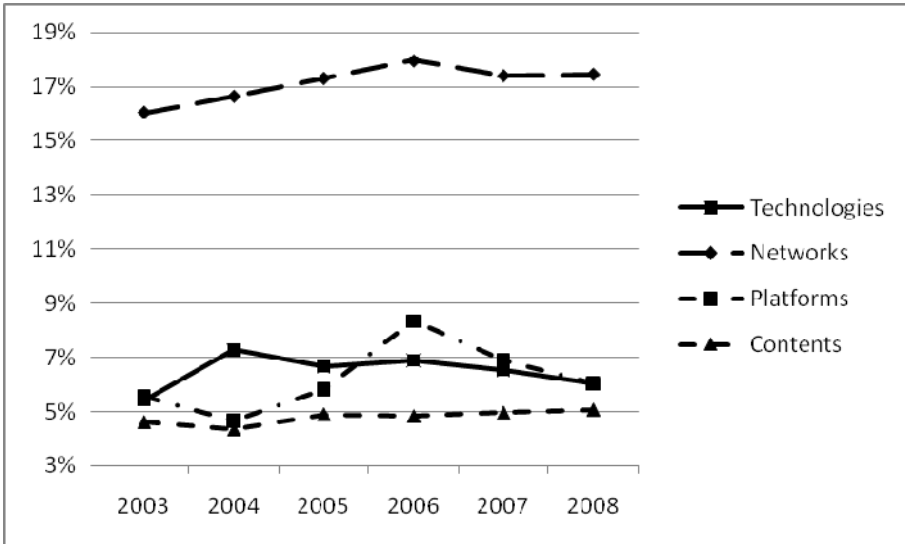
Graph 8 - Return on Capital Invested of the geographic areas



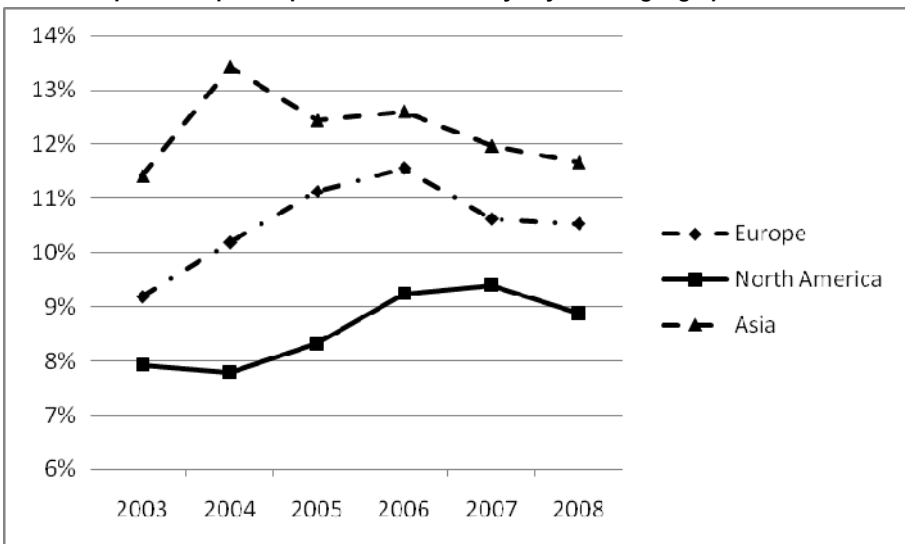
Graph 7 shows that the highest return on capital invested is obtained by platforms carriers in Layer 3, followed by networked elements providers, content producers in Layer 4 and network operators, which hold the weakest return on capital invested.

Network carriers have the lowest return on capital invested mainly because network maintenance and upgrade still require large investments. In 2008, the American firms show the highest return on capital invested, which has been increasing since 2006, while European firms' return on capital invested has decreased since 2007.

Graph 9 - Capital expenditures to sales by Layers and geographical areas



Graph 10 - Capital expenditures to sales by Layers and geographical areas



Network operators in Layer 2 are more capital intensive than their counterparts in the three other Layers. Network operators play a key role in the ICT ecosystem through their capital expenditures in network infrastructures, as they bear the investments that are necessary to deploy, maintain and upgrade the physical networks. Access networks are a crucial asset to the whole ecosystem. As shown by the financial ratios, content producers and Internet intermediaries do benefit from network operators' investments. Firms in Layers 1, 3 and 4 thus benefit from the investments of network operators in Layer 2. Asian firms have the highest capital intensity, followed by European and American firms.

American, Japanese and Korean network carriers have performed higher with Next Generation Access Network investments than European ones. NGAN deployment requires large investments for network carriers that need to be covered. Furthermore, such investments may have positive effects on economic growth (ROLLER & WAVERMAN, 2001)). To finance NGAN deployment, European network carriers may enter Layer 3 which has proved to be the most profitable so far. However, Layer 3's total revenues are low compared to other Layers' revenues. Network operators may also enter Layer 4 as some already have. Nevertheless, recent data show that Layer 4's profitability is lower than Layer 2's profitability.

Another strategy may consist in leveraging on the rising demand in network capacity and demanding financial compensations to platforms in Layer 3. However, the application of such strategy is not currently possible, due to the regime of Net Neutrality that prevents Internet access providers from gaining control on traffic.

Based on market trends and figures analysed, it can be supposed that the gap between Internet Intermediaries on the one hand, and networked elements companies and network operators on the other hand would continue to expand in the future. Demand in capacity is expected to rise while sources of revenues required to fund new generation access networks are uncertain at the moment. This uncertainty is related to the ability of network operators to succeed in the field of Internet services and contents diffusion, or to the possibility of raising funds by charging the use of capacity, which is a theoretical option, as the regime of Internet Neutrality still prevents such a pricing scheme. The decline in voice revenues and the rise in data revenues clearly show that network operators will have to upgrade their mobile network as well.

■ Conclusion

Our firm-based analysis of the ICT ecosystem has shed light on industrial and economical unbalances. The network operators of Layer 2 are the most capital intensive firms while their return on capital invested is the lowest of the whole sample. Network operators play a major role in the ecosystem through their investment effort, while Internet intermediaries benefit from these investments.

As network operators are about to enter in a new cycle of investment, the Internet intermediaries are the most profitable. Their operating income from sales appears to be the highest of the whole ecosystem. They also exhibit the highest return on capital invested, while they are among the less capital intensive firms of the ecosystem. Therefore, it would be useful to examine the opportunity of incentives aimed at leading Internet intermediaries which benefit from the use of physical networks to contribute to the financing of networks deployment in the future.

However, internet intermediaries' Layer total revenues appear to be relatively low compared to other Layers revenues. Network neutrality also prevents network owners from charging fees on internet intermediaries which in turn do not offer any contribution in the financing of networks investments. As most of Internet intermediaries are American firms it is likely that network neutrality benefits US economy.

Technologies providers in Layer 1 are the most R&D intensive players. Firms like Apple are now launching smartphones. The launch of smartphones allows technology providers to differentiate from competitors, to increase their revenues and their profitability through innovation. Furthermore the launch of smartphones increases the whole value of the ecosystem.

Content producers benefit from network deployment because of the rise in broadband penetration enabling them to reach a more extended consumer base. They are also facing new forms of competition. They should develop cooperation with network operators. Network carriers may enter upper Layers of activities in order to raise enough funds to support the future investments required to deploy the next generation networks. Several network operators have already entered content producers Layer of activity, as a strategic move. Meanwhile, the profitability of the fourth Layer still remains lower than network operators' and internet intermediaries' profitability.

Appendix: list of firms in our database

Layer 1

North America: Accenture, Activision Blizzard, Adobe Systems, Advanced Micro Devices, Affiliated Computer Services, Alliance Data Systems, Altera, Analog Devices, Apple, Applied Materials, Autodesk, BMC Software, Broadcom Corporation, Broadridge, CA Inc, Cerner, CGI Group, Cisco Systems, Citrix Systems, Cognizant Technology, Computer Sciences, Dell, DST Systems, Electronic Arts, EMC, First Solar, Fiserv, Harris, Hewlett-Packard, HIS, IMS Health, Intel, International Business Machines, International Game Technology, Intuit, Juniper Networks, KLA-Tencor, Lender Processing, Linear Technology, Maxim Integrated Products, McAfee, MEMC Electronic Materials, Metavante Technologies, Microchip Technology, Micron Technology, Microsoft, Motorola, National Semiconductor, NetApp, Nortel, Nuance Communications, NVIDIA, Oracle, QUALCOMM, Red Hat, Research In Motion Limited, SAIC, Salesforce.com, SanDisk, Sun Microsystems, Symantec, Texas Instruments, Total System Services, Verisign, Mware, Western Digital, Xerox, Xilinx.

Europe: Alcatel-Lucent, Amdocs Limited, ASML Holding, Autonomy, Cap Gemini, Dassault Systemes, Experian plc, Indra Sistemas, Koninklijke Philips Electronics, Nokia Oyj, Q-Cells SE, SAP AG, STMicroelectronics, Telefonaktiebolaget LM Ericsson, The Sage Group plc, Thomson.

Asia: Acer, Advanced Semiconductor, ASUSTEK Computer, Canon, Chi Mei Optoelectronics, Doosan Co., Elpida Memory, Flextronics International, Foxconn International, Foxconn Technology, FUJITSU LIMITED, Hon Hai Precision Industry, HOYA, HTC, Hynix Semiconductor, IBIDEN, Infosys Technologies Limited, Inotera Memories, KONICA MINOLTA, LG, LG Display, LG Electronics, MediaTek, Murata Manufacturing, NEC, NITTO DENKO, NTT DATA, Oki Electric Industry, ORACLE CORPORATION JAPAN, Panasonic, Panasonic Electric Works, Powerchip Semiconductor, Quanta Computer, RICOH COMPANY, Samsung Electro-Mechanics, Samsung Electronics, SANYO Electric, Seiko Epson, Sharp, Siliconware Precision Industries, SONY, SUMCO, Suntech Power Holdings, Taiwan Semiconductor, Tata Consultancy Services Limited, Tatung Company, Tokyo Electron Limited, TOSHIBA, Trend Micro Incorporated, United Microelectronics, Wipro Limited, ZTE.

Others: Check Point Software Technologies, Garmin, Marvell Technology Group, Seagate Technology.

Layer 2

North America: American Tower Corporation, AT&T, BCE, Cablevision, Centennial Communications, CenturyTel, Charter Communications, Cincinnati Bell, Clearwire Corporation, Comcast, Crown Castle International, DISH Network, Embarq Corporation, Equinix, Frontier Communications, Leap Wireless, Level 3 Communications, Liberty Global, Liberty Media, Mediacom Communications, MetroPCS Communications, NII Holdings, Pitney Bowes, Qwest, Rogers Communications, SBA Communications, Scripps Networks Interactive, Shaw Communications, Sirius XM Radio, Sprint Nextel, Telephone & Data Systems,

TELUS, The DIRECTV Group, Time Warner Cable, United States Cellular Corporation, Verizon, Windstream.

Europe: Belgacom, BSKyB, BT Group, Cable and Wireless, Deutsche Telekom, Elisa Oyj, Eutelsat Communications, Fastweb, France Telecom, Freenet AG, HELLENIC TELECOM, Iliad, Inmarsat Plc, Koninklijke KPN N.V., Magyar Telekom Nyrt., Mobistar, Portugal Telecom, SES, Swisscom AG, TDC A/S, Tele2 AB, Telecom Italia SpA, Telefonica O2 Czech Republic, Telefonica, elekom Austria AG, Telekomunikacja Polska, Telenet Group Holding NV, Telenor ASA, TeliaSonera AB, United Internet AG, Virgin Media, Vivendi, Vodafone Group, ZON

Asia: Advanced Info Service PCL, Bharti Airtel Limited, China Communications, China Mobile, China Telecom, China Unicom, China United Telecommunications, Chunghwa Telecom, CITIC Guoan, Digi.com Berhad, Far EasTone Telecommunications, Globe Telecom, Hutchison Telecommunications, Idea Cellular Limited, Jupiter Telecommunications, KDDI, KT Corporation, NIPPON TELEGRAPH AND TELEPHONE, NTT DoCoMo, PCCW, Philippine Long Distance Telephone, PT Indosat Tbk, PT Telekomunikasi Indonesia, Reliance Communications, Singapore Telecommunications Limited, SK Telecom, SOFTBANK, StarHub, Taiwan Mobile, Tata Communications Limited, elekom Malaysia Berhad, Tencent Holdings, TM International Bhd, Total Access Communication Public, True Corporation PCL.

Others: AFK Sistema, America Movil S.A.B, Bezeq, Brasil Telecom Participacoes, Brasil Telecom, Carso Global Telecom, Cellcom, Discount Investment, Egyptian Company for Mobile Services, Embratel Participacoes, Emirates Telecommunications, Empresa Nacional de Telecomunicaciones, Empresas Cablevision, Etihad Etisalat, IDB Holdings Corporation, Macquarie Communic. Infrastructure, Maroc Telecom, Mobile Telecommunications Company, Mobil'nye TeleSistemy OAO, MTN, National Mobile Telecom, Net Servicos de Comunicacao, Orascom Telecom, Partner Communications, Qatar Telecom, Rostelekom OAO, Saudi Mobile Telecommunications, Saudi Telecom, Tele Norte Leste Participacoes, Telecom Corp of New Zealand, Telecomunicacoes de Sao Paulo, Telefonica Moviles, Telefonos de Mexico, Telmar Norte Leste, Telkom SA Limited, Telmex Internacional, Telstra Corporation Limited, TIM Participacoes, Turk Telekomunikasyon, Turkcell Iletisim Hizmetleri, Vivo Participacoes.

Layer 3

North America: Akamai, Amazon, eBay, Expedia, Google, Idearc, priceline.com Incorporated, R.H. Donnelley, Yahoo!, Yell Group plc, Yellow Pages Income Fund.

Europe: PagesJaunes, Seat Pagine Gialle SpA.

Asia: Alibaba.com, Baidu, NetEase.com, NHN, Rakuten, Yahoo Japan.

Layer 4

North America: CanWest Global Communications, CBS, Clear Channel Outdoor, Discovery Communications, Dolby Laboratories, Gannett, Lamar Advertising, News Corporation, Omnicom Group, Quebecor, Regal Entertainment, The McGraw-Hill

Companies, The Walt Disney Company, The Washington Post Company, Time Warner, Viacom.

Europe: Axel Springer, Bertelsmann AG, Daily Mail and General Trust, Independent News & Media PLC, Informa, Lagardere, MEDIASET, Pearson PLC, Promotora de Informaciones, ProSiebenSat.1 Media AG, Publicis, Reed Elsevier NV, Reed Elsevier plc, RTL, Sanoma Oyj, TF1, Wolters Kluwer, WPP PLC.

Asia: DENTSU, Shanghai Oriental Pearl, TOHO, TOKYO BROADCASTING SYSTEM HOLDINGS.

Others: Fairfax Media Limited, Grupo Televisa, Naspers Limited.

References

ADAMS, W. & J. YELLEN (1976): "Commodity Bundling and the Burden of Monopoly", *Quarterly Journal of Economics*, XC, pp. 475-798.

ARLANDIS, A. (2008): "Bundling and Economies of Scope", *COMMUNICATIONS & STRATEGIES*, Special Issue November 2008, pp. 117-129.

BAUER, J.M.:

- (2005): "Bundling, Differentiation, Alliances and Mergers: Convergence Strategies in U.S. Markets", *COMMUNICATIONS & STRATEGIES*, No. 60, pp. 59-83.

- (2007): "Dynamic Effects of Network Neutrality", *International Journal of Communications* 1, 531-547.

ECONOMIDES, N. & J. TAG (2008), "Net Neutrality on the Internet: A Two-Sided Market Analysis", Net Institute Working Paper No. 07-45.

FRANSMAN M. (2007): *The New ICT Ecosystem: Implication for Europe*, Kokoro; subsequently published as *The New ICT Ecosystem: Implications for Policy and Regulation*, Cambridge University Press, 2010.

LOMBARD D. (2008): *Le Village Numérique Mondial*, Odile Jacob.

REISINGER, M. (2006): "The Effects of Product Bundling in Duopoly", Mimeo, University of Munich.

RÖLLER, L-H. & L. WAVERMAN (2001): "Telecommunications Infrastructure Development: A Simultaneous Approach", *The American Economic Review*, Vol. 91, no. 4, pp. 909-923.

SHAPIRO, C. & VARIAN H. R. (1998): *Information Rules: A Strategic Guide to Network Economy*, Harvard Business School Press.