

# **CYCLES OF CONVERGENCE AND DYNAMICS OF GROWTH IN THE SMARTPHONE INDUSTRY**

*Paolo Calvosa, PhD graduate*

Researcher in Business Management, University of Naples Federico II, Italy

---

## **Abstract**

Over the last few years, with the definitive manifestation of the effects of the ‘digital revolution’, a convergence process has taken place and through which the boundaries of the Information and Communication Technologies industries have become increasingly ‘blurred’ and unstable. Amongst the ICT industries in which the convergence process has brought about the most relevant changes, there appears that of the mobile phones. This industry has been characterized by a series of cycles of convergence which have favoured the emergence of hybrid mobile devices, the smartphones. Worldwide sales of smartphones to end users totalled 1.2 billion units in 2014, a 29 per cent increase from 2013. Sales of smartphones in 2013 exceeded annual sales of feature phones for the first time. The work analyzes the effects of the process of digital convergence on the dynamics of growth of the smartphone industry. In particular, the paper: identifies the various cycles of convergence which have contributed towards the growth of the smartphone industry; analyzes, in relation to the various cycles of convergence, the main drivers of convergence, the overlapping industries and the types of convergence taken place; analyzes the impact of the various cycles of convergence on the development phases of the main industries affected by the convergence process.

---

**Keywords:** Cycles of convergence, drivers and types of convergence, mobile phone industry, smartphone, mobile operating systems

## **Introduction**

In recent years, with the definitive manifestation of the effects of the ‘digital revolution’, a convergence process has taken place through which the boundaries of the Information and Communication Technologies (ICT) industries have become increasingly ‘blurred’ and unstable. This process has led to the confirmation of a “hybrid competition” (Ancarani, Costabile, 2009) taking place between companies from different spheres of activity,

causing a profound reconfiguration of the competitive structure in various markets.

The process of digital convergence has been brought about not only by the technological innovations, but also by certain tendencies from the demand side. Consumers, in fact, have asked to integrate and combine the functional characters supplied by various types of technological equipment, favouring the creation of multifunctional hybrid devices.

The convergence industry has moreover been accelerated by the 'breakthrough strategies' adopted by several firms which have exploited the potentialities offered by technological discoveries in order to initiate certain 'strategic innovations' (Markides, 1997), based on the supply of products and services 'of value' for the customers which are radically new for the market (Kim, Mabourgne, 2005).

Amongst the ICT industries in which the convergence process has brought about the most relevant changes, there appears that of the mobile phones. This industry has been characterized by a series of cycles of convergence which have favoured the birth of a new segment of activities, that of the smartphones, born from the overlapping of various industrial and service sectors. In fact, smartphones combine into a single device the basic functions of the mobile phone with those of the handheld computers, of the video devices, of the music players, of the video game devices and permit access to a series of advanced services via the Internet (Kim, Lee, Koh, 2005).

The convergence process at the basis of the development of the smartphones industry is still in progress. In 2013 the world sales of smartphones surpassed those of feature phones (traditional mobile phones with basic functions) for the first time. By 2014, with a level of sales in terms of units reached 1.2 billion, through an annual 29 per cent growth rate, the smartphones represent two thirds of the total sales of mobile phone devices and the forecasts for the future show a further acceleration of the process of substitution between smartphones and feature phones (Gartner Group, 2015; 2014a; 2014b).

The general objective of the work is to analyze the effects of the process of digital convergence on the dynamics of growth of the smartphone industry. More especially, the specific cognitive contribution of this research is that of :

- identifying the various cycles of convergence which have contributed towards the growth of the smartphone industry;
- analyzing, in relation to the various cycles of convergence, the main drivers of convergence, the overlapping industries and the types of convergence having taken place;

- analyzing the impact of the various cycles of convergence on the development phases of the main industries – personal digital assistants, feature phones, mobile operating systems and smartphones – affected by the convergence process.

Coherently with the research questions, from the methodological viewpoint a qualitative-type analysis has been carried out through the adoption of the case-study approach (Yin, 1994; Eisenhardt, 1989).

The efficacy of the method is connected more especially with the adoption of a longitudinal-type of approach aimed at studying in depth the time succession of the most significant phenomena which have brought about the digital convergence process at the basis of the development of the smartphone industry. As observed (Mari, 1994, p. 36; 46), “the description of a phenomenon obtained through the qualitative methods, also refers to the time dimension of the events”. The researcher must study the time succession of the most significant facts for understanding the problem. This historical approach of analysis allows going deeply into the study of the links existing between the environment and the firms and therefore proves especially efficacious for understanding the processes of change in sectors such as those which are the object of analysis in which the evolution of such links has been so rapid and profound.

Thus one has proceeded along a span of time of some 30 years to the examination of environmental events and of market dynamics which have characterized the different industries which, by converging, have brought into being and developed the smartphone industry.

The analysis has been carried out by re-elaborating in an original way the information deriving from a series of secondary data. We have availed ourselves more specifically of official publications and archival documents, which include academic journals and books, annual reports, corporate brochures, press releases, business publications, analysis reports and market research. Moreover, use has been made of the information present in the official websites of the main firms operating in the sectors that are the object of analysis.

### **Industry convergence: definition, types and process drivers**

As evidenced, the convergence process is a phenomenon which has brought about relevant and continuous changes in the structure of various industries. Starting out from the 1980s, independent industries from the demand and supply viewpoint have swiftly been transformed, giving place to converging industries characterised in some cases by well-defined boundaries, in others by mobile confines, in continuous change and difficult to be defined (Weaver, 2007).

During the course of the 80s and 90s, convergence was used to denote almost all aspects of the impact of the ICT revolution, “with little attention to a clear-cut and coherent definition of the term” (Lindt, 2004, p. 2).

The first contributions in the sphere of management literature which have explicitly analyzed the term of convergence in the sense of converging markets and which have carried out a systematic reflection about its definition began to be produced starting from the second half of the 1990s (Katz 1996; Yoffie 1997; Greenstein, Khanna, 1997; Pennings, Puranam, 2001; Stieglitz, 2002).

In wishing to specify at the outset the meaning of convergence which will be used in the course of this work, reference can be made to the analysis of Lindt (2004, p. 2) who defines convergence as “a confluence and merging of hitherto separated markets, removing entry barriers across the market and industry boundaries”. This definition in fact emphasizes, in keeping with the cognitive objectives of the work, the impact of convergence on the redefinition of industry boundaries.

In the management literature the studies on the process of digital convergence have gone deeply into the analysis of the drivers that have brought about this process and the types of industry convergence.

The research on the drivers of the industry convergence have through time identified specific typologies of factors which, in a combined way and with various intensities, have led to the reconfiguration of the competitive structure of different industries.

Most studies on the theme have singled out in the technological one the driver which has most influenced the convergence processes in the last few years. There are three main technological innovations which have contributed towards the set up of these processes, namely the ‘digitization of signals’, understood as the possibilities of transformation of the data, sounds and images in a binary format (bit) and as such of easy diffusion and also easily vehiculable; the increase in the processing power of microprocessors, summed up in ‘Moore’s law’, which has permitted the production at ever more contained costs of devices with high elaboration potential; the integration and improvement of telecommunication transmission networks and the empowering of the band for data transmission (Ancarani, 2001a).

These innovations have driven towards a reconfiguration of boundaries in the sectors of telecommunications, information technology, consumer electronics and multimedia contents, giving shape to a sort of ‘metamarket’ of digital technologies (Chakravarthy, 1993). In this regard Collins, Bane and Bradley (1997) point to the creation of a new digital environment, characterized by a transversal value chain, in the sphere of which the activities of the converging industries tend to be distributed.

Therefore the competition logics change, since on one side in each of the phases of this value chain some companies come into competition originally operating in different industries; on the other because we are present at the diminution of competitive confrontation between companies in the same industry which, in the reconfiguration of the digital activities, tend to specialize on different productive phases.

The industry boundaries have been redefined also through legislative provisions which have initiated and supported the deregulation and privatization processes, especially in telecommunications and television and radio industries (Katz, 1996). These processes have eliminated the constraints which in many countries regulated the monopoly conditions, bringing about important changes in the structural and competitive balances of sectors that were previously separate (Ancarani, Costabile, 2009).

Other studies have shown the centrality of a further driver of the digital convergence, identified in the customer demand. This demand, having become ever more self-referential and demanding in time, has caused to emerge “clusters of needs integrated and convergent amongst themselves” (Ancarani, 2001a, p. 126). That is to say the consumers have expressed a greater need for integration, both to reduce the information and choice overload as consequence of the exponential increase in the range of products offered, and to improve and simplify the user experience in the cases in which it is necessary to utilise more devices for access to various digital functions (Gill, 2008; Pennings, Puranam, 2001). This has solicited the response of firms which, crossing the traditional boundaries, have given life to hybrid products through the combination of a series of multi-sectoral competencies.

The drivers described have imposed on the firms operating in the converging sectors modifications in their business strategy. Yet it is wrong to think that they have acted only from a perspective of adjusting to the changed environmental dynamics. In several cases it is precisely the firms which, in anticipating these changes, have contributed with their own strategies towards the development of the convergence process. Yoffie (1997, p. 9) in this regard observes that several firms through a “creative combination” of different competencies, have given life to a strategic innovation which has reshaped the competitive dynamics of different industries. The student, therefore, identifies in the “managerial creativity” a further driver of the convergence.

In this regard, as early as the beginning of the 1990s, Hamel and Prahalad (1990, p. 83) observed that “with market boundaries changing ever more quickly, targets are elusive and capture is at best temporary”. Some companies in converging sectors have been able to invent new markets, enter

emerging markets, and dramatically shift patterns of customer choice in established markets.

In conclusion, the process of digital convergence appears to be favoured by the acting of several forces both of a macro type, such as the changes imposed by the policies of deregulation and privatisation and by technological innovations; as well as of a micro type such as the convergent needs expressed by the demand and the strategic innovations adopted by business firms (Ancarani, 2001a; Ancarani Costabile, 2009).

The research which has examined the various drivers at the basis of convergence processes are also connected with the studies which have studied in depth the analysis of different types of convergence which may influence the changing of the industry boundaries. A first important contribution in this direction is that provided by Greenstein and Khanna (1997, pp. 203-204) which suggest that there are two primary kinds of convergence. The first is convergence in substitutes, when one technology can replace another and firms develop products with features that become similar to the features of certain other products; the second is convergence in complements, when two product technologies work better together than separately or work better together now than they worked together formerly.

Pennings and Puranam (2001) and Stieglitz (2002) develop this typology for convergence by adding a second dimension.

Pennings and Puranam introduce the categories ‘supply side’ and ‘demand side’ convergence, while Stieglitz likewise introduces a ‘supply-demand’ dimension by making a distinction between technology vs. product-based convergence.

By using more especially Stieglitz’s taxonomy it is possible to distinguish four generic types of market convergence: 1) technological substitutes: when the invention of a technology  $X_Z$  can be applied both in the production of product A and B, by replacing the older technologies  $X_A$  and  $X_B$  on the basis of the two products; 2) technological complements: when the creation of new technology  $X_Z$  opens up the possibility to combine the existing technologies  $X_A$  and  $X_B$  of two separate products A and B; 3) product convergence in substitutes: when new technological capability  $X_Z$  enables the changes of a product B which includes new feature, making it a (partial) substitute of product A; 4) product convergence in complements: when a new technology  $X_Z$  opens up the potential to jointly use two existing products A and B, delivering a higher value if consumed together.

The four generic types of convergence help in understanding how convergence can be viewed as a discontinuity in product architecture and technological subsystems, that redefines market and industry structure in different ways.

All this leads to the subject theme of how the convergence process impacts on the evolution of the different industries affected by this process. This aspect connects the theme of the convergence with the literature on the Industry Life Cycle (ILC) (Abernathy, Utterback, 1978; Keppler, 1997). The process of digital convergence contributes in fact towards determining relevant changes in the development of the industries interested by this phenomenon and, therefore, on the relative ILC curves. It has been observed in this regard (Lind, 2005, p. 16) that in consequence of processes of industry convergence if at the same time several simultaneous ILC-curves are in progress, “they will form an entangled n-dimensional space of mutual convergences into each other”.

This aspect does not yet seem adequately well analysed in depth in the sphere of management literature. For this reason “additional exploratory and explanatory research is needed in order to understand convergence developments as a form of innovation” (Hacklin et al. 2009, p. 724) and their impact on the development dynamics of the convergent sectors.

In the following case study, it is shown how the evolution of the smartphone market was affected over time by different cycles of digital convergence, and, in relationship to each cycle, the analysis of the main drivers of convergence has been gone into, of the types of convergence taking place, as well as of the industries now overlapping as a result of these cycles of changing.

## **The first cycle of digital convergence and the birth of the smartphone industry**

### ***The industry convergence among mobile phone devices and personal data assistants and the embryonic development of the smartphones***

It is not easy to provide a precise definition of the smartphone, in that the functional qualities and characteristics of this device are still today in continuous evolution.

A basic definition of smartphone means the handheld device which combines both the Personal Digital Assistant (PDA) and cellular phone technology (Liu et al., 2011). The first smartphones were in fact a combination of the functionalities of PDAs and mobile phones (Nosratti et al., 2012).

In order to understand how the integration has taken place between the functional qualities of these two devices, it is necessary however to analyse the convergence process that has taken place among these industries.

The mobile phone industry was created at the beginning of the 1980s when Motorola, a U.S. telecommunications firm, marketed the first mobile phone, invented by one of its employees in 1973 (, 2009).

Until the close of the 1980s the industry was characterized by a somewhat limited growth in sales and the mobile phone was generally considered an expensive piece of equipment mainly mounted in cars (Giachetti, Marchi, 2010). A series of technological and production factors, in fact, made the cellular phone still a product limited functional qualities, aimed at a niche in the market: the utilisation of analog communication systems, characterized by a reduced ability to remote data transmission; the reduced development of the telecommunication network coverage; the very high prices of the devices, connected to a still limited scale of production and high initial costs of research and development.

One must wait until the 1990s to witness the passage from an embryonic and introductory phase of the sector to one of growth, thanks to the numerous technological innovations and to the reductions in cost which increased its diffusion. It is more especially in the second half of the 90s that the mobile phone market begins to grow rapidly. In 1998 world sales in terms of units reach 162 million, with an annual growth greater than 50 per cent. The first five players in terms of sales – Nokia, Motorola, Ericsson, Panasonic and Alcatel –, which together represented 70 per cent of the market, came from the telecommunications industry (Gartner Group, 1999). In the same year the mobile phone penetration rate at world level, equal to 5.3 per cent, was however still rather limited, even though in sharp increase with respect to the 1 per cent of 1994<sup>1</sup>.

In parallel with the development of the mobile phone industry, one was present at the birth of a new industry in the sphere of the ICT. In 1984, a year in fact following the launch on the market of Motorola of the first mobile phone, a British firm of software for personal computers, namely Psion, put up for sale the first prototype of palmtop computer, the Organizer, giving life to a new industry, that of the Personal Digital Assistants (PDAs), definable, in first approximation, as mobile devices that function as a personal information manager (Norsati et al., 2012). The Organizer was not a large commercial success, also for the rather basic functions it possessed (clock, calendar, calculator and simplified database with research function), but gave place to a series of imitative strategies by firms of converging sectors. Sharp, Casio and Seiko, hailing from the consumer electronics industry, exploited the competencies it possessed in the production of handheld calculators and LCD displays in order to place on the market certain ‘electronic organizers’; Helwett-Packard and Poqet Computer, with various experiences in the field of computers, introduced devices which, although useful for the utilisation of rather simple functions, had at their disposal microprocessors and purpose-built software.

---

<sup>1</sup> Source: International Telecommunication Union (ITU).

In the first half of the 1990s progress in the field of the digitalization of the contents, of the miniaturization of the hardware components and of the telecommunications favoured the entrance into the sector of other firms coming from converging industries: Apple, software and hardware production firm for computers, which with the 'Newton device' coined the term Personal Data Assistant which was to identify the industry; Amstrad, a consumer electronics company; AT&T, a telecommunications company; IBM, a company producing hardware for computers (Stieglitz, 2002). In particular it was Palm Computing, a company of software for computers, which with the introduction in 1996 of the Pilot device gave a decisive boost to the development of the industry. This device, which had 128k of memory and a monochrome touchscreen display and four basic functions – calendar, addresses, to-do lists, and memos –, sold more than one million units in the first 18 months after introduction (Campbell-Kelly et al., 2014).

In the mid 1990s, the mobile phone and PDA industries were still separate but the technological innovations which were driving their growth ahead also started the process of industry convergence, by favouring the creation of several prototypes of smartphones.

There was a multiplicity of technological innovations at the basis of this process: the evolution of the telecommunication network technologies, with the affirmation of the digital standards – GSM, GRPS e UMTS in Europe and i-mode in Japan – that have improved the transmission capacity of the data, favouring the emergence of new mobile communication services such as the Short Message Service (SMS) and enabling a first use of mobile phones and PDAs for the connection to the Internet; the process of miniaturization of hardware components (screen, microprocessor, speaker, memorization device, battery, antenna) which made these mobile devices more compact and, at the same time, more powerful and functional; the development of wireless technologies which permitted connecting electronic devices to a local communication network (Wi-Fi technology) or to a personal communication network (Bluetooth technology).

The first functions typical of the PDAs added to the mobile phones were those of the clock, the calculator and the calendar, even if the lack of a full alphabetic keyboard tended to limit their use.

One of the first companies of the mobile phone industry to create a hybrid device was the market leader, the Finnish Nokia, which in 1996 launched the Communicator model, the first mobile phone to have a display in landscape orientation and a keyboard similar to that of PDAs (Fling, 2009). This phone permitted sending and receiving fax and SMS and could connect to the Internet, in addition to possessing the clock, calculator and diary/calendar functions. The Communicator model was not a commercial success, but gave way to a series of initiatives on the part of other mobile

phone firms that introduced innovative forms of hybrid devices, while the companies of the convergent sector, those of the PDAs, albeit trying to reach new functionalities which could exploit the technological innovations, tended to focus their product strategies on their own markets (Stieglitz, 2002).

As observed (Campbell-Kelly et al., 2014), it is in 1997 therefore that the term ‘smartphone’ came into use and represented a new way of thinking about mobile phones. Smartphones were no longer single-purpose or multi-purpose devices, but rather universal handheld computers that incorporated a telephone.

A further decisive passage which has brought about the convergence between the two industries and favoured the definitive development of the smartphones took place in 1998, when the market leaders in the mobile phone industry – Nokia, Motorola and Ericsson –, foreseeing the opportunities deriving from the convergence process, created a joint venture – called Symbian – with Psion, a leading company in the PDA industry. This joint venture aimed at creating a network of specialized competencies for the creation of an innovative operating system for advanced mobile phones based on the Epos operating system of the Psion (Ancarani, 2001b).

The Symbian project was the forerunner of a large change in the mobile phone industry, in that the idea was established that, with the development of information and communication technologies, next to the hardware component, the software component of the cellular phone assumed a key value. As is later investigated, starting from the experience of the Symbian operating system all the sector companies have given greater attention to the role of the software platform, giving place to a market of the operating systems for cellular phones which has acquired a specificity of its own, contributing conclusively to the success of the smartphones segment.

A further contribution to the convergence process and to the development of the smartphones and of the mobile operating systems was finally provided by the entrance into the PDA industry, in 1996, of the Research in Motion (RIM), an electronics and computer-science consulting business operating in Canada. In particular in 1999 the company launched on the market the BlackBerry, a device that allowed business executives to access their corporate e-mail wirelessly from anywhere. With such a device the company was established as one of the leader operators in the PDA industry. This device was furthermore the forerunner of the first smartphone of the RIM, the BlackBerry 5810, reached the market in 2002. This mobile phone, that included enterprise e-mail support, text messaging and a browser, was one of the first successful smartphones from the market sales viewpoint (Campbell-Kelly et al., 2014).

### **The convergence process among mobile phones and digital audio and video devices and the initial growth phase of the smartphone industry**

While, on the basis of the convergence process between mobile phone and PDA industries, the development began to be outlined of a first embryonic form of smartphone, the progress in the development of information and communication technologies gave a further impulse to this process. In particular, the evolution of digital technology had permitted in the 1990s the introduction of digital cameras and the launching on the market of digital music players, based on MP3 audio format.

This was the premise for permitting in 2000 two mobile phone companies, Sharp and Samsung, to offer their customers cellular phones with an integrated digital camera, and in 2001, to Siemens to include in the phone an MP3 music player (Hill, 2013). Within a short time, most of the mobile phone manufacturers introduced on to the market devices which included cameras and camcorders, as well as digital music players for the new audio format. Therefore the functional capacities of the mobile phones increased. In addition to the basic services such as voice communication and the SMS, further functionalities were added such as the possibility of taking photographs, recording videos, listening to music, playing with videogames, utilizing software for writing and processing data. The network operators exploited the technological potentialities in order to supply new services such as videocalling and the MMS (Multimedia Messaging Service).

Convergence was, moreover, favoured by the requests of the consumers, who expressed a need for simplification, wishing to utilize a single device in order to perform the functions carried out by a multiplicity of digital devices (mobile phone, digital cameras, digital music player, camcorders, electronic diary, etc.).

This second phase of the first cycle of the convergence process thus brought about the overlapping between the smartphone segment, which was being created out of the convergence between mobile phone and PDA industries, and the digital audio and video industries.

### **The second cycle of convergence and the accelerated growth of the smartphone industry**

A second cycle of convergence, initiated in 2007, brought about effects even more relevant than the preceding one on the competitive structure of the converging markets.

The nascent smartphone industry has in fact entered in convergence with the personal computer industry (hardware and software/operating system) and with the 'internet industry' (service operators and content distributors) bringing about radical changes in the use potentialities of the smartphones and bringing about profound transformations in the sphere of

the competitive logics of the mobile phone industry. This second cycle of the convergence process was determined, as later investigated, by the development of a series of technological innovations such as: the strengthening of the band for data transmission, through the adoption of new digital standards for mobile communications 3G and 4G; the progress in the digitalization of the contents; the further increase in the processing powers of microprocessors; the improvement in the hardware components of the mobile devices; the development of the mobile operating systems; the creation of purposely-built software applications. The technological evolution has permitted improving the use of the functions which characterized the smartphones at the end of the first cycle of convergence and of adding new ones, by transforming even more clearly such devices into mini portable computers. By means of a smartphone, in fact, it is now possible, both rapidly and intuitively, to surf the Internet and to access search engines, to utilize the email service, to connect oneself to the social networks, to download video and music online and to download and use a multitude of purpose-built software applications.

In actual fact, even before 2007 connection to the Internet was technically accessible through mobile devices, but the mobile connective technologies available had up to then only permitted limited exploitation the potentialities of utilization of the web-based services and, furthermore, the first forms of smartphones were characterized by a complexity of uses that is still quite high according to the corporate clients to whom they were mainly addressed.

In order to understand this aspect more clearly it is necessary to analyse also another driver of convergence connected to the innovative strategies of some firms outside the mobile phone industry who, exploiting the high competencies in the field of information technologies and high 'visioning capabilities', have speeded up the industry convergence process. In order to make a decisive contribution to the start of this further transformation phase of the industry have been in the specific instance a company coming from the converging sector of the personal computers, Apple, with the launching of the iPhone in 2007, and a firm coming from the converging sector of software and of internet-based services, Google, with the launching in 2008 of the Android operating system.

### **The impact on the convergence process of the entrance of Apple in the smartphone industry**

Apple Inc., one of the first companies to have produced personal computers for the consumer market in the 1980s, made its entrance in 2007 into the smartphone industry, with the launching on the market of the iPhone.

The choice of entering in the smartphone industry is prior to 2007. In 2005, in order to access non-governed complementary technological resources, Apple entered into an agreement of collaboration with Motorola and Cingular Wireless aimed at developing a version of its iTunes audio software, already present in a mobile phone of Motorola, for the creation of a smartphone called ROKR (Generator Research, 2009). This device, launched on the market at the beginning of September 2005, was a commercial failure, but for the company represented an important experience for understanding what were the technological competencies necessary for the production of mobile phones and in order to realise that the companies of the mobile phone industry did not appear to possess the knowledge of hardware and software typical of the sector of personal computers necessary for a better management of the potentialities offered by the convergence process.

With the launching of the iPhone the company brought about a profound change in the ‘rules of the competitive game’ in the smartphones segment and, in general, in the mobile phone industry, thanks to series of innovative features which characterized this device.

A first innovation introduced by Apple for the entrance into the sector was of a strategic type (Markides, 1997). The company realised before the others that there existed a latent consumer-type demand which would have been able to appreciate the advanced functionalities of the smartphones, especially if they had been characterised by a simpler and more intuitive use. The smartphones sold by other companies were, in fact, still rather complex to use and required a fairly high level of informatics knowledge, in coherence with the corporate clients to whom they were mainly addressed (Calvosa, 2011).

Having identified the target and the need to be met, Apple gave life to a device different from those of competitors, highly innovative and of a user-friendly type.

The company introduced important innovations, both of a software and a hardware type (West, Mace, 2010).

From the point of view of the software, in order to create a smartphone direct for a consumer market, Apple adapted for the iPhone the advanced ‘Mac OS’ operating system of the proprietary type, used for their personal computers. The adaptation came about by trying to simplify to the maximum the utilisation of the various functionalities of the device, especially those connected to the use of the Net. In particular, an important innovation which differentiated the Apple operating system that of its competitors was the adoption of a Graphical User Interface (GUI) with graphical icons of easy selection (then imitated by most of the competitors and establishing itself as standard).

Also from the hardware point of view Apple introduced several innovations which in a short time were established as sector standard. In particular, those that represented a moment of breakthrough regarding the production choices of the competitors are relative to the creation of a multi-touch screen with high sensitivity and graphic resolution, which permitted interacting with the device rapidly and intuitively by means of the ‘icons system’, and the ‘accelerometer’ which, by reconfiguring the visual output automatically in relation to the horizontal or vertical position of the device, facilitated an experience of use of the mobile phone similar to that of a computer (Laugesen, Yuan, 2010).

The innovations introduced by Apple have given life to a device different from that of the other producers of smartphones<sup>2</sup>. They still utilized QWERTY and numeric keyboards and, for the most part, did not foresee the utilization of the touchscreen, and hence of the ‘icon system’<sup>3</sup>.

The technological and experiential differences of the iPhone are reflected in a difference of behaviour of use of the Apple user compared to that of other smartphones, especially in relation to a new and improved Internet access capability. The results of an investigation carried out in the United States about a year from the launching of the product (Ling, Sundsøy, 2009) have shown that the users of the iPhone not only used Internet much more than other users of smartphones, but that they had considerably increased the use of the Net after the adoption of this device<sup>4</sup>. Furthermore, it has transpired that the use of the iPhone has, on one side, potentiated the possibilities of mobile connection, via Internet, with family members and friends, through the participation in social networks, and, on the other side, brought about a considerable increase in the use in mobility of the Internet for reasons of information and application.

The iPhone moreover combined the capabilities of a mobile phone and of an ‘Internet communicator’ with that of the ‘iPod’ music player with which the company dominated the personal digital audio device market. In particular, the iPhone was able to download by wireless music and movies

---

<sup>2</sup> The leaders of the smartphone market in 2007 were Nokia, a company of the mobile phone industry, which controlled almost 50 per cent of the market sales, and RIM/Blackberry and Palm, companies of the PDA industry (Gartner Group, 2009).

<sup>3</sup> Only some of the mobile devices which adopted the ‘Microsoft Windows Mobile system’ and the ‘Palm operating system’ foresaw the use of a ‘touch interface’, but were not equipped with a screen thought for use with with the fingers, preferring the use of the stylus for digitizing. In confirmation of the different perception by the consumer between Apple iPhone and the other devices, the results of a customer satisfaction survey carried out in 2009 have shown that only the iPhone supported sufficiently well the consumer oriented functionality that the new users required from a smartphone (CFI Group, 2009).

<sup>4</sup> Also an investigation by Google in 2008 showed that the iPhone users connected themselves to the Google search engine 50 times more than those of the other smartphones.

from the iTunes Store to be listened to through the iPod software inserted into the phone (Campbell-Kelly et al., 2014).

A year from the launching of the iPhone, Apple introduced a further innovation which permitted extending the range of utilities of a smartphone, reconfiguring anew the competitive dynamics in the industry. The company, coherently with the identifying of a consumer-type target to which to supply a smartphone simple to use but rich in contents, in fact launched in 2008 a section of iTunes on line store, called App Store, within which were released a series of software applications designed to allow the iPhone users to perform a group of coordinated functions, tasks, or activities<sup>5</sup>. This has made the iPhone a multifunctional instrument which the individual user may personalize on the basis of his needs. The company has therefore followed an approach similar to the one it had adopted in order to endow, through the iTunes Music Store, the ‘iPod’ MP3 music player with audio and video contents (West, Mace, 2010; Kenney, Pon, 2011).

As declared by the then CEO Steve Jobs, with the launching of the App Store the company has “reinvented what can be done with a smartphone”. In time also the other competitors created several ‘Mobile Application Stores’, obliged by the danger of losing ground with respect to Apple. Nokia, with the ‘Ovi Store’, and RIM, with the ‘AppWorld’ destined for the Blackberry phones, endowed their own smartphones with numerous software applications. In the same way, other business firms specialized in the production of mobile operating systems, such as Microsoft and Google, have given life to the virtual stores ‘Microsoft Store’ and ‘Android Market’, respectively.

### **The entrance of Google into the mobile operating system market**

The introduction of the software applications for smartphones sold via Internet is also connected to the further development of the smartphone operating system market.

As observed earlier, starting from the development of the Symbian operating system, the companies producing smartphones have paid greater attention to the role of the software platform in technological development of the mobile devices, giving place to a specific market of the operating systems for cellular phones.

---

<sup>5</sup> The business model is based on the creation of a network of external programmers, but connected to Apple via the Internet. The developers who intend to create software applications must download from Apple’s site a specific program and have to pay an highly contained annual subscription. For each transaction the developer collects 70 per cent of the price of the application and Apple the remaining 30 per cent. In this way Apple has added further contents which distinguish the iPhone, without bearing additional costs, but rather obtaining huge incomes therefrom.

The increase in the relevance of the software platform is confirmed by the results of numerous studies in the sphere of the literature of management which, in the last few years, have started to contribute knowledge of what the platform is and how it works in the smartphone industry (amongst others: Campbell-Kelly et al., 2014; Fautrero, Gueguen, 2013; Kenney, Pon, 2011; West, Mace, 2010). These studies, which are connected with the research on ‘the industry platform’ carried out in the previous years relating to the platform of Intel and Microsoft in the personal computers industry (Cusumano, 2010), have claimed that a technological platform influences business behaviours and relationships between actors in an ecosystem. Such an ecosystem for modern high-technology platforms “is characterized as having high levels of interdependence between actors, as well as high potential for innovation by each actor”. Hence, hardware firms and software firms depend on each other to push technology forward (Kenney, Pon, 2011, p. 241).

As a result, the companies producing smartphones, and also those with clear market dominance, have become dependent on the innovation of complementary firms of mobile operating systems in order to obtain a sustainable competitive advantage.

This is witnessed by the evolution of the smartphone operating system market. In this market in 2007, at the end of the first cycle of convergence, the leader was the Symbian operating system, created, as already shown, at the end of the 1990s by a joint venture which involved the leader firms of the mobile phone industry – Nokia, Motorola, Ericsson – and Psion, producer of PDAs. This operating system – just as the one produced by Microsoft – was a ‘proprietary licensed’ type and was utilized under licence by the main producers of smartphones, as confirmed by the data which show in 2007 a Symbian market quota in the smartphone operating system market of 63.5 per cent (Gartner Group, 2008). Beside this operating system typology, there coexisted the ‘proprietary systems’ of Apple and of RIM, provided exclusively to their own devices iPhone and Blackberry, and the Linux operative system, of an ‘open-source’ type (Campbell-Kelly et al., 2014; Kenney, Pon, 2011).

In 2008 Google, a company operating in the sector of the Internet based services, launches on the market the Android operating system. The company, not possessing the competencies for this kind of system on its own premises, had acquired in 2007 the software company Android, creating a consortium for the development of the software platform. The business model adopted differed from the one of the main market competitors. In fact Google decided to make this operating system ‘open source’, that is to say free to license and selectively open. The Android operating system has therefore become attractive for various firms producing smartphones,

especially of Eastern Asia, which not disposing of competencies to endow their own mobile phones with advanced software, had referred up to that time to the proprietary licensed operating systems of Symbian or Microsoft (Fautrero, Gueguen, 2013; Kenney, Pon, 2011).

In the same year of the introduction of the Android operating system, Nokia bought out the shares of the other companies which made up the joint venture Symbian, becoming the sole proprietor of the software, and then made it open source in 2009 with the creation of the Symbian Fondation (Kenney, Pon, 2011).

The market has rewarded Google's 'open source' operating system, which in a short time has progressively seen its sales quota increase until making it in 2014 reach a net market leadership, with a market quota of 80 per cent (Gartner Group, 2015). On the contrary, the period 2007-2013 recorded a continuous fall in sales of the Symbian operating system, also in relationship with the lost of position of Nokia in the smartphone industry. The negative trend of sales forced the company in 2013 to terminate the production of the Symbian operating system, bringing about the disappearance of the market.

The spread of Google's platform software has represented a decisive driving factor for the utilization of the cellular phone for access to the services supplied through the Internet. As observed (Kenney, Pon, 2011, p. 249), together with the iPhone, the "Android has fuelled the adoption of mobile data services and mobile usage of existing Internet services, including Google", thus accelerating the convergence process between smartphone and Internet industries.

### **Cycles of convergence in the smartphone industry: types and drivers of convergence and converging industries**

On the basis of the analysis hitherto carried out, and in keeping with one of the cognitive objectives of the work, it is possible to carry out some initial considerations on cycles of convergence which have brought about the development of the smartphone industry, describing for each cycle the main drivers of convergence, the overlapping industries and – utilizing the convergence categories proposed by Stieglitz (2002) previously illustrated – the types of convergence having taken place.

As schematized in Figure 1, the analysis has in the first place shown that in the last twenty years there has taken place a convergence process that is subdivisible into two macro-cycles.

A first cycle of convergence was verified between the mid-1990s and 2007. The main drivers on the basis of this cycle of convergence were mainly of a technological type and connected with the evolution of the demand. The technological innovations which have supported this process

were multiple: the evolution of the telecommunication network technologies, with the affirmation of the digital standards – GSM, GPRS, UMTS and i-mode – that have improved the transmission capacity; the process of miniaturization of hardware components, that made the mobile devices more compact and functional; the increased processing power of microprocessors; the process of digitalization of the contents; the development of wireless technologies which have permitted connecting the electronic devices to a local communication network (Wi-Fi technology) or to a personal communication network (Bluetooth technology).

From the point of view of the demand, however, a further factor which has guided the convergence process is the consumers’ request for simplification. They have expressed the need of being able to access in mobility through a single device to a multiplicity of functions (to telephone, to send e-mails, to take photographs, to listen to music, to record videos, to record information in agendas, etc.) which up till that time had been supplied by separate technological devices. Certain companies had replied to this request which, by exploiting the potentialities offered by the technological innovations, have accelerated the convergence process through the creation of the first forms of smartphones.

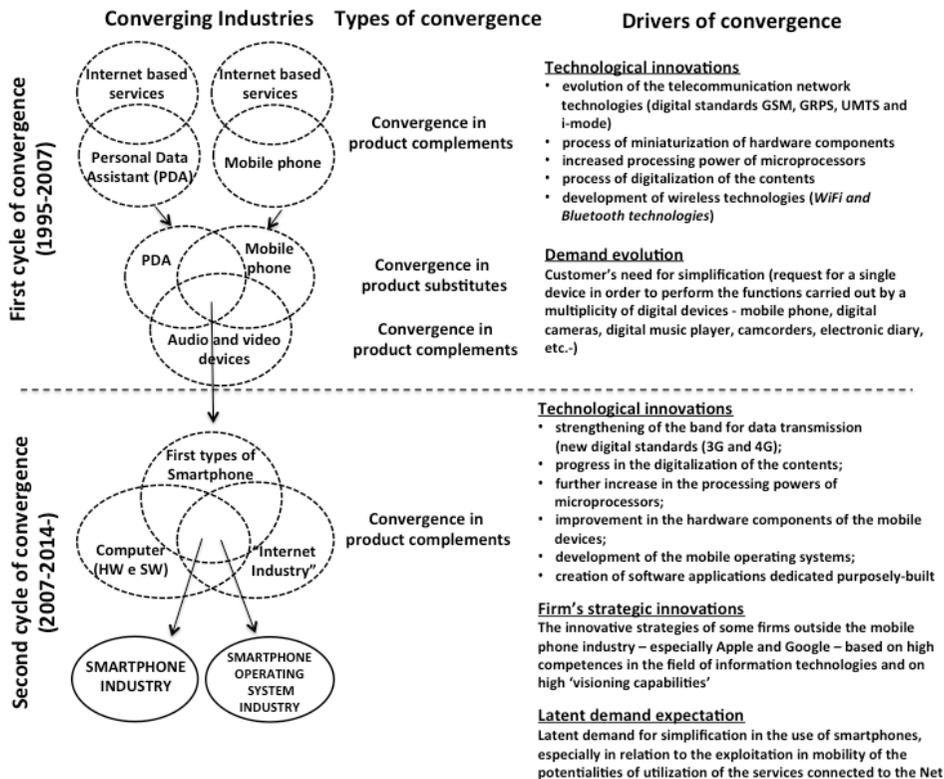


Figure 1. The process of digital convergence in the smartphone industry: cycles, types and drivers of convergence and converging industries. Source: our processing.

During this cycle of convergence, in a first phase the mobile phone and PDA industries have both overlapped with the internet based services industry through a product convergence in complementarities, especially in relation to the evolution of the telecommunication network technologies which have enabled for a first use of these two devices for the mobile connection to the Internet and therefore to the utilization of the e-mail service. Subsequently, two types of convergence were verified in parallel: on one side, two mainly through advances in miniaturization, a convergence in product substitutes of PDAs and mobile phones was created. The companies of each of these devices have in fact included in time the features typical of the other, bringing about, as confirmed by the sales data described in the next paragraph, a merge into one larger market, that of the smartphones, with similar technologies and product characteristics; on the other, especially by means of the digitalization process of the contents, there has come about a convergence in product complements between mobile phones and digital audio and video devices.

A second cycle of convergence instead took place beginning from 2007 and is still in progress. The drivers of this process were mainly of a technological type – the integration and strengthening of the band for data transmission (new digital standard 3G and 4G); the progress in the digitization of the contents; the further increase in the processing power of microprocessors; the innovation in the field of the hardware and software components; the development of the smartphone operating systems; the creation of purpose-built software applications – and connected to the propulsion drive provided by the strategies realized by companies coming from external sectors to those of the mobile phone – in particular Apple and Google –. These firms, with their innovative approaches, have accelerated the transformation process and the growth in the smartphone industry, responding in part to a latent demand for simplification in the use of smartphones, anticipating in part, through their high visioning capacities (Drejer, Riis, 2001), the expectancies of the clients regarding the possibility of exploiting the new potentialities offered by the convergence process.

All these factors have “provide the ‘glue’ for the existing products” (Stieglitz, 2002, p. 11) bringing about a process of convergence in product complements between the nascent sector of smartphones, those of software and hardware for the personal computer and the so-called ‘internet industry’, causing at the same time, as shown later, the decline in the sales of feature phones through a substitution effect of such devices with those of the new generation.

## Cycles of convergence in the smartphone industry and the relationship with the progress of the converging markets

A further cognitive objective of this research work is that of analyzing the relationship between the cycles of digital convergence in the smartphone industry and the development phase of the main industries involved by the convergence process. To do that it is possible to bring together the two cycles of convergence identified with the data relating to world sales in the converging markets.

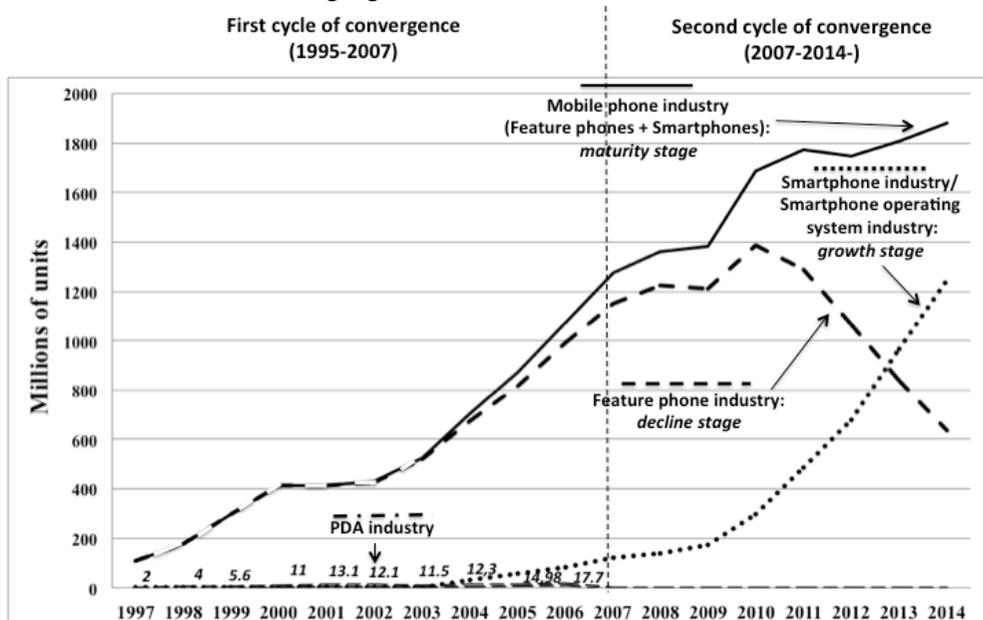


Figure 2. World sales and Industry Life Cycle of PDAs, Smartphones, Smartphone operating systems, Feature phones and Mobile phones (millions of units). Years 1997-2014.

Source: our processing on Gartner Group data.

In Figure 2 are graphically described the progress in world sales, during the period 1997-2014, of the PDAs, of the smartphones, of the smartphone operating systems and of the feature phones (traditional mobile phones with basic functions), as well as the total progress of the sales of the mobile phone industry considered in its entirety (summation of the sales of the smartphone and feature phone markets).

From the Figure there emerge some interesting considerations.

In relationship to the sector of the smartphones and that of the PDAs, the first cycle of convergence identified (1997-2007) was characterised, as emerged from the analysis carried out, by two different sub-phases.

A first phase, in the period 1997-2001, was marked by a phase of embryonic development of the smartphone. This segment had not yet therefore any specificity of its own with respect to that of the feature phones.

The sales inventories carried out by the main specialised companies (such as the Gartner Group and International Data Corporation-IDC) still included, in fact, the first forms of the hybrid mobile devices in the sphere of the sales of the two industries – mobile phones and PDAs – which were beginning to converge. In this period the segment of the PDAs develops at a constant growth rate, reaching in 2001 total sales in terms of units equal to 13 million. This segment, however, was characterised – as emerging from the graph – by much reduced dimensions if compared with the sales of the mobile phones (which in 2001 had reached a total of 413 million units), coherently with the mainly corporate use which was made of the handheld computers.

A second subphase of the first cycle of convergence, in the period 2002-2007, was in contrast characterised by the definitive affirmation of the new form of mobile device, the smartphone, which has pressed towards the surveying of the specific sales of this market. From the graph it emerges that in this phase of introducing a constant increase in sales of smartphone takes place, which in 2007 reached in only about five years some 122 million units. In the same period one also witnesses a much less sustained growth in PDA sales which in 2006 reach a total of 17 million units. During the period in question, findings of the Gartner Group's survey made a distinction between PDAs and smartphones, on the basis of the definition of the smartphone as a device which offers all the attributes of a PDA, "except that smartphones are voice-centric with data access as a secondary capability, and are designed for primarily one-handed operation" (Gartner Group, 2007). The Gartner Group observed however, that "60 per cent of all PDAs shipped in 2006 offered cellular connectivity, up from 47 per cent in 2005" confirming that the convergence process which was now leading to an ever smaller net distinction between the two device typologies.

At the end of this phase, and therefore of the first cycle of convergence, with the further percentage increase in the PDAs which had the cellular connectivity at their disposal, and with the increasingly inclusion of the typical features of the PDAs in the new mobile phones, the convergence between smartphones and PDAs had now led to an almost complete overlapping between these two markets, driving towards taking over the sales of the PDA in the sphere of the smartphone market<sup>6</sup>.

The second cycle of convergence, which can be made to start from 2007, year in which the Apple, with the iPhone, introduced radical

---

<sup>6</sup> It is useful to point out the data reported in Fig. 2 show that, despite the substained growth of the sales of smartphones, at the end of the first cycle of convergence they were still residual if considered with respect to the mobile phone industry taken in its entirety (these sales represented little more than a tenth of the total of those of the total market of mobile phones).

innovations in the characteristics and in the use modalities of the smartphones, was characterised by an accelerated change dynamic which has brought about the definitive passage of the smartphone industry from an introductory phase to a sustained growth, also thanks to the launching on the market of the new Android operating system of Google. As emerges from Figure 2, in fact, during the period 2007-2014 the sales of smartphones have registered a very high average annual growth rate, almost equal to 20 per cent. In particular it is in 2010 that there took place, as shown by the turning point in the graph, the passage towards an extremely well sustained growth phase of the Industry Life Cycle.

The trend of the sales of smartphones is closely connected to those of operating systems for cellular phones. As already shown in the course of the work, in fact, the convergence process which has brought about the birth of the smartphones has given life to the ‘smartphone operating system industry’ which, as indicated by Figure 2, in sales levels is equivalent to that of the smartphones, in that for every sale of smartphone there corresponds the sale of a mobile operating system. The level of connection between such sectors is therefore particularly high, also in relation to the close interdependence between actors of the two industries as high potential for innovation by each actor. In other words, the evolution of these industries is closely interrelated, in that the development potentiality and the strategies of the production companies of smartphones are dependent on the complementary innovations realized in the field of the software platform, and vice versa. As emerged in the course of the work, in fact, complementarily to what happened in the smartphone industry, the smartphone operating systems market was been affected by radical technological and competitive changes, changes which have brought the Android operating system of Google to dominate the market with a sales quota in 2014 being greater than 80 per cent (Gartner Group, 2015).

Passing on to the analysis of the feature phones market, it emerges from Figure 2 that during the first cycle of convergence – 1997-2007 – one witnesses three development phases in the level of sales. A first phase – 1997-2000 – was countersigned by a sustained growth characterised by two figure annual rates. The market felt positively the reduction in size and weight of handsets, as well as the reduction in prices of the expansion in the network coverage. A second phase – 2000-2002 – was instead marked by a slump in sales. In this period, as observed (Giachetti, Marchi, 2010, p. 1136) “mobile phone sales were somewhat depressed by the US economic recession starting in 2000 and exacerbated after 11 September 2001”. A third phase – 2003-2007 – was in contrast characterized by an extremely well sustained growth in sales, connected to the definitive affirmation of the cellular phone as mass produced, thanks on one hand to the introduction on

the market of low-price handsets and, on the other, to the numerous technological innovations which have also sparked off the development of the smartphone industry.

During the second cycle of convergence begun in 2007, in a first phase – 2007-2010 – the sales of feature phones have still grown, with a peak reached in 2010, when they reached almost 1.4 billion units. This phase of growth was followed by a rapid phase of decline which starting from 2011, brought about in only four years a reduction in the sales greater than 50 per cent. Such a rapid drop in this market appears the effect of a substitution process of the feature phones with the smartphones. The opposite trends of the two markets have in fact brought about, as can be evinced from Figure 2, the overtaking in 2013 of the sales of the smartphones compared with those of traditional mobile phones. In 2014, the smartphones, with more than 1.2 billion units sold, now represent two thirds of the total sales of the mobile phone devices. The forecasts for the future confirm this trend, which in a few years will lead the segment of the feature phones to assume a position completely residual in the market. The estimates show that the quota of smartphones on the total of mobile phones market should exceed 88 per cent in 2018 (Gartner Group, 2014b).

In Figure 2 are finally reported the sales of the mobile phones industry considered in its entirety – smartphones and feature phones –. The progress naturally reflects the development phases of the sales of the two markets which make it up. From the figure it emerges that during the first cycle of convergence, in a first phase – 1997-2002 – the progress of the sales of the sector corresponded to that of the feature phones, and was therefore characterised by a sustained growth in 1997-2000, and a period of stagnation, in 2000-2002. This was followed by a phase of continuous growth in sales, in keeping with a highly increased growth in the market of the feature phones and with the rapid development of the nascent smartphone industry.

During the second cycle of convergence, in a first phase – 2007-2010 – the sales of both markets making up the market of the mobile phone devices have continued to grow, contributing to a well sustained development of the same, while in a second phase – 2011-2014 –, in correspondence with the substitution process between smartphones and feature phones, a slowing down was recorded in the development rate of the total sales, index of a transition moment between one phase of growth to a maturity phase of the sector. More specifically in 2014 the sales reached almost 1.9 billion units, with the annual growth of 3.5 per cent. The actual moment of saturation of the sector considered is witnessed by the progress of the rate of penetration at world level of mobile phones, passing from 3.7 per cent in 1997, to 50.5 per cent in 2007 and to 95.5 per cent in 2014. It has

been observed in this regard that in 2014 relatively to the penetration rate at world level “mobile-cellular growth rates have reached their lowest-ever level (2.6 per cent globally), indicating that the market is approaching saturation levels” (ITU, 2014).

### **Conclusion and future research directions**

On the basis of the analysis carried out in the course of the work it is possible to carry out, in keeping with the cognitive objectives of the work, some conclusive considerations regarding the effects of the process of digital convergence on the dynamics of growth of the smartphone industry.

Firstly the analysis has permitted us to show that this process is subdivisible into two different cycles. During the first cycle of convergence, which may be set in the period ranging from the mid-1990s to 2007, in a first period the mobile phone and PDA industries both overlapped the sector of the Internet based services through a product convergence in complementarities. Subsequently, there came about in parallel two types of convergence: on the one side, a convergence in product substitutes of PDAs and mobile phones; on the other, a convergence in product complements between mobile phones and digital audio and video devices. The second cycle of convergence, which started from 2007, the year in which Apple, with the introduction of the iPhone, played the role of ‘forerunner’ towards a new use modality of the smartphone, a process of convergence came about in product complements between the nascent sector of smartphones, those of the software and of the hardware for the personal computer and the ‘internet industry’.

The study has been able to show that during each of the two cycles analyzed, various drivers, both of the macro-type – the technological innovations – and the micro-type – the drives from the demand side and the innovative strategies of the companies – have acted jointly in bringing about the process of digital convergence at the basis of the birth and development of the smartphone industry. In this regard it is important to show that these drivers seem to have carried out different functions in the development of the convergence process. In both cycles, in fact, the technological driver has represented the basic factor on which the other drivers seem to activate. In particular, the demand driver appears to have assumed the role of ‘guide factor’ of the development trajectory of the convergence process, while that represented by the innovative strategies of the companies seems to have mainly performed the role of ‘accelerator’ of the dynamics of convergence. This consideration appears in keeping with the indications of the scholars who have shown that in the markets characterized by the process of digital convergence only if the potentialities offered by the technological driver are addressed and sustained by the listening capacity of the client and the

capacity of ‘visioning’ on the part of the companies (Drejers, Riis, 2001), does one avoid “the risk that an over driven focusing on the technological driver leads towards confusing causes and effects of the convergence” (Ancarani, Costabile, 2005, p. 41).

The analysis carried out has also permitted describing, in keeping with the cognitive objectives of the work, the progress of the main sectors – PDA, feature phone, smartphone and smartphone operating system – affected by the convergence process in relationship with the different phases of this process. In great synthesis, it has emerged from the analysis that the convergence process has through time brought about the decline of the sales of PDAs and of feature phones through the substitution effect of these devices with the smartphones. The study has shown, moreover, that the continuous growth of the sales of smartphones, still on going, is closely interrelated with that which has characterised the sector of the smartphone operating systems, in that the development potential and the strategies of the production companies of the hybrid mobile devices are ever more dependent on the complementary innovations created by the producers of the software platforms.

The market changes described have brought about a profound change in the competitive dynamics in the sectors involved by the convergence process. As observed, in the industries characterized by this process, especially in the cases of convergence in product complements, “the incumbent firms are often slow to respond to the new technological opportunities. This opens up the possibility of entry for new entrants”. Therefore, the rate of entry by new firms in this converging sector is high, because newcomers pursue a focus strategy, concentrating on the development of the new technology and new complementary services (Stieglitz, 2002, p. 19). In fact the convergence has had a radical impact on the competitive positioning of the incumbent firms, operating in the mobile phone and in the PDA industries, with respect to that of the newcomer firms, coming from the converging industries. This open up to a further development of the research, already in progress, in the direction of studying how the convergence process in the smartphone industry has modified the logics of competition and the competitive positioning of the companies operating in the convergent sectors.

### **References:**

- Ancarani F., Costabile, M. *Concorrenza ibrida. Convergenza, tecnologie, esperienze di consumo*, Pearson, Milano, 2009.
- Ancarani F., Costabile, M. *Convergenza e Strategie di Marketing. Definizione del costrutto, esperienze aziendali, domande di ricerca, Mercati e Competitività*, n. 2, 2005, pp. 19-53.

- Ancarani, F. Dai settori ai metamercati, in *Convergenza. Nuove traiettorie per la competizione*, (a cura di) Valdani, E., Ankara, F., Castaldo, S., Egea, 2001a.
- Ancarani, F. Il metamercato digitale e la telefonia cellulare di terza generazione: il caso Symbian, in *Convergenza. Nuove traiettorie per la competizione*, (a cura di) Valdani, E., Ankara, F., Castaldo, S., Egea, 2001b.
- Calvosa, P. La capacità di innovazione strategica nei settori della convergenza digitale: il caso Apple Inc., *Mercati e Competitività*, vol. 2, p. 125-148, 2011.
- Campbell-Kelly, M., Garcia-Swartz, D., Lam, R., Yang, R. Economic and business perspectives on smartphones as multi-sided platforms, *Telecommunications Policy*, <http://dx.doi.org/10.1016/j.telpol.2014.11.001i>, 2014.
- CFI Group. CFI Group Smartphone Satisfaction Study 2009, 2009, [cfigroup.com](http://cfigroup.com).
- Chakravarthy, B. The Global Information and Communications (INFOCOM) Industry: Emerging Scope, INSEAD Note 08/93-349, Fontainebleau, 1993.
- Collins, D. J., Bane, P. W., Bradley, S. P. Winners and losers – Industry structure in the converging world of telecommunications, computing and entertainment, in Yoffie, D. B. (eds.), *Competing in the Age of Digital Convergence*, Harvard Business School Press, Boston, MA, pp. 159-201, 1997.
- Cusumano, M. Technology strategy and management: the evolution of platform thinking, *Commun ACM*, 53(1), pp. 32–34, 2010.
- Drejer A., Riis, J.O. New Dimensions of Competence Development in Industrial Enterprises, *The International Journal of Manufacturing Technology and Management*, vol. 2, nos. 1-7, pp. 660-682, 2001.
- Eisenhardt, K. Building Theories from Case Study Research, *Academy of Management Review*, 14, 4, pp. 532-550, 1989.
- Fautrero, V., Gueguen, G. The dual dominance of the android business ecosystem, in Letaifa, S.B., Gratacap, A., Isckia, T. (eds), *Understanding Business Ecosystems*, De Boeck, 2013.
- Fling, B. *Mobile Design and Development: Practical concepts and techniques for creating mobile sites and web apps*, O'Reilly, 2009.
- Gartner Group. GartnerGroup's Dataquest Says Nokia Became No. 1 Mobile Phone Vendor in 1998, Press release, Egham, UK, February 8, 1999.
- Gartner Group. Gartner Says Worldwide PDA Shipments Top 17.7 Million in 2006, Press release, Egham, UK, February 6, 2007.
- Gartner Group. Gartner Says Worldwide Mobile Phone Sales Increased 16 Per Cent in 2007, Press release, Egham, UK, February 27, 2008.

Gartner Group. Gartner Says Worldwide Smartphone Sales Reached Its Lowest Growth Rate With 3.7 Per Cent Increase in Fourth Quarter of 2008, Press release, Egham, UK, March 11, 2009.

Gartner Group. Gartner Says Annual Smartphone Sales Surpassed Sales of Feature Phones for the First Time in 2013, Press release, Egham, UK, February 13, 2014a.

Gartner Group. Gartner Says Worldwide Traditional PC, Tablet, Ultramobile and Mobile Phone Shipments to Grow 4.2 Percent in 2014, Press release, Egham, UK, July 7, 2014b.

Gartner Group. Gartner Says Smartphone Sales Surpassed One Billion Units in 2014, Press release, Egham, UK, March 3, 2015.

Generator Research. Apple: iPhone and App Store. Forward roadmap and impact on the mobile industry's gameplan, Digital Media Insight, 12 January, 2009.

Gill, T. Convergent Products: What Functionalities Add More Value to the Base?, *Journal of Marketing*, 72(2), pp. 46-62, 2008.

Hacklin, F., Marxt, C., Fahrni, F. Coevolutionary Cycles of Convergence: An Extrapolation from the ICT Industry, *Technological Forecasting and Social Change*, vol. 76, no. 6, pp. 723-736, 2009.

Hamel G., Prahalad, C.K. The core competence of the corporation, *Harvard Business Review*, v. 68, no. 3, pp. 79–91, 1990.

Hill, S. From J-Phone to Lumia 1020: A complete history of the camera phone, *Digital trends*, August 11, 2013.

ITU - International Telecommunication Union. Mobile-broadband penetration approaching 32 per cent. Three billion Internet users by end of this year, Newsroom, Press Release, 5 May, 2014.

Katz, M.L. Remarks on the Economic Implications of Convergence, *Industrial and Corporate Change*, 5, pp. 1079-95, 1996.

Kenney M., Pon, B. Structuring the smartphone industry: is the mobile internet OS platform the key?, *Journal of Industry Competition and Trade*, 11, pp. 239–261, 2011.

Kim, B., Lee, J.D., Koh, D.Y. Effects of consumer preferences on the convergence of mobile telecommunications devices, *Applied Economics*, 37 (7), pp. 817–826, 2005.

Kim, W. C., Mabourgne, R. *Strategia oceano blu. Vincere senza competere*, Etas. 2005.

Laugesen, J., Yuan, Y. What Factors Contributed to the Success of Apple's iPhone?, in *Proceedings of the 2010 Ninth International Conference on Mobile Business/2010 Ninth Global Mobility Roundtable*, USA, pp. 91-99, 2010.

Ling, R., Sundsøy, L. R. The iPhone and mobile access to the internet, Pre-conference workshop at the International Communication Association (ICA) Conference, Chicago, Illinois, 20 – 21 May, 2009.

Liu, F.-H., Chen, L.-J., Chen, H.-H. Sustaining Client Relationships in the Contract Manufacturer Own-Brand Building Process: The Case of a Smartphone Firm, *International Journal of Business and Management*, 6.7, pp. 59-68, 2011.

Mari, C. *Metodi qualitativi di ricerca. I casi aziendali*. Torino, Giappichelli Editore, 1994.

Markides, C. Strategic Innovation, *Sloan Management Review*, Vol. 8, N° 3, pp. 9-23, 1997.

Pennings, J.M., Puranam, P. Market Convergence & Firm Strategy: New Directions for Theory and Research, Paper presented at the ECIS conference, The future of innovation studies, Eindhoven, the Netherlands, September 20–23, 2001.

Stieglitz, N. Industry dynamics and types of market convergence: The evolution of the handheld computers market in the 1990s and beyond. Paper presented at the DRUID summer conference on “Industrial dynamics of the new and old economy – who is embracing whom?” Copenhagen/Elsinore, 2002.

Weawer, B. Research proposal: industry convergence: driving forces, factors and consequences, *Nordic Academy of Management Conference*, pp.1–20, Bergen, Norway, 2007.

West J., Mace, M. Browsing as the killer app explaining the rapid success of Apple’s iPhone, *Telecommunication Policy*, 34(5–6), pp. 270–286, 2010.

Yin, R. *Case study research: Design and methods* (1st ed.). Beverly Hills, CA, Sage Publishing, 1984.

Yoffie, D. B. (ed). *Competing in the Age of Digital Convergence*, Harvard Business School Press, Boston, MA, 1997.