Co-Evolving Industry and Enterprise Architecture: Exploring the Platform Architectural Advantage of BT in the UK

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***Abstract*--Incumbent telecommunication service providers have a long history and strong capabilities in network services. With increasing competition with firms from various technological trajectories (Internet, Cable TV and Satellite) boosted by technological and service convergence, leading incumbent telecommunication service providers have strategically repositioned themselves to include IT-driven services, offering integrated solutions to large customers. The ICT industry architecture has evolved in such a way that it favours those firms with enterprise architecture which cultivate (i) a platform-based approach for their organisational processes, products and services; and (ii) openness. This paper uses the case study methodology to explore the lessons from the case of BT in the UK that can be used to increase the architectural (and competitive) advantage of incumbent telecommunications service providers, aligning industry and enterprise architecture. We argue that more than on the technology itself, incumbent telecommunication service providers may focus more on their enterprise architecture by deploying technology aimed at conferring architectural advantage dynamically engaged with the ICT industry architecture. A framework is offered to help incumbent telecommunication service providers to better understand and position themselves in the 'battle of architectures' by aligning enterprise and industry architecture and by establishing platform 'architectural advantage'.**

I. INTRODUCTION

This paper builds upon [45] 'Profiting from Technological Innovation' and the notion of 'architectural advantage' as proposed by [20] to explain the dynamics of innovation in the ICT industry, particularly the evolution and business transformation of incumbent telecommunications service providers such as BT, Deutsche Telecom, France Telecom and others.

Our initial motivation comes from the realisation that industry and enterprise architecture are usually developed separately in the literature, although they are very much intertwined. Thus, the aim of this paper is to integrate both industry and enterprise architecture in order to propose an initial framework that may inform firms and other stakeholders in the ICT/Telecommunications industry as well as in other industries in order to establish a better foundation for execution and for alignment of the enterprise architecture with the industry architecture. In particular, we will be exploring the platform architecture as the preferred one for the ICT/Telecommunications industry.

A. Research Methodology

This paper is part of a broader research that investigated the strategies for business renewal of incumbent telecommunications operators. The research was based on case study method and it was done in three stages. Stage 1 was the exploration phase where the context of the research problem and incumbent operators were investigated. One of the outcomes of this phase was to narrow the options down to BT as the main case study to be developed. Stage 2 was the phase of exploitation where more information about BT and the industry was gathered addressing the research questions. Stage 3 served to further exploit the insights and inferences reached in phase 2 and attempted to get feedback on those inferences. The evidence was obtained through documentary analysis and a large number of interviews. The research methodology is fully described in [40], and it is not going to be repeated in this paper.

B. Structure of the Paper

In section II, we review the concepts of industry and enterprise architecture, and introduce the concept of platform architecture as an integrative approach for both the industry and enterprise levels. In section III, we elaborate on the ICT/Telecommunications industry architecture, and on section IV, on BT (UK) as a case of enterprise architecture. Platform architecture is the one which aligns both industry and enterprise architecture which is discussed in section V, where we also offer a framework of analysis to inform firms and stakeholders not only in the ICT/Telecommunications industry, but in other sectors where the platform architecture might be relevant. In section VI, we conclude the paper with the argument that the proposed framework can inform firms to position them in the 'battle of architectures' by aligning enterprise and industry architecture and by establishing their 'architectural advantage'. As this is a work-in-progress, the next steps of this research are also proposed.

II. LITERATURE REVIEW: INDUSTRY, ENTERPRISE AND PLATFORM ARCHITECTURE

This literature review elaborates on the more general industry architecture, then the architecture from the viewpoint of a firm (the 'enterprise architecture'), and it finally elaborates on the 'platform architecture' as the integrative approach for the industry and enterprise architecture in the ICT/Telecommunications industry. The wider literature provides insights into product architecture and its relationship with industry (e.g. [14, 39, 49], however product architecture is out of the scope of this paper.

A. Industry Architecture

According to [35], understanding the role of industry architecture is very important in order to understand how to

capture value from innovation. And also industry architecture characterises 'the nature and degree of specialization of industry players (or "organizational boundaries") and the structure of the relationships between those players' (p. 283). Reference [20] defines industry architecture by 'templates that emerge in a sector and circumscribe the division of labor among a set of co-specialized firms' (p. 1201). In other words, there might be a type of map or framework that describes the players within the boundaries of the system (understood as a particular instance of the whole market system) and the way those players relate to each other.

Within the industry architecture, there might be vertical and horizontal relationships or architectures. Many industries started with vertical architectures, as closed boundaries, and subsequently evolved to more horizontal architectures due to market forces or due to regulation [35]. The PC (Personal Computer) industry and the ICT/Telecommunications industry are examples of the evolution from vertical to horizontal architectures. An important insight is that firms may create and shape 'architectural advantage', i.e. create high value products and services without resorting to vertical integration [20, 45].

Complementarity and mobility are two important factors that characterise industry architecture [20]. With more horizontal architectures, firms strive to position themselves alongside the most powerful firms in the industry to offer complementary assets which may ultimately capture more value than those from mainstream firms. Complementarity relates to superior returns through the combination of two or more assets. Product, services and processes can be complementary in this sense [20].

Mobility refers to the ability of switching the components of those combinations with negligible costs [20]. Complementarity and mobility are important aspects of horizontal architectures such as found in the ICT/Telecommunications industry.

B. Enterprise Architecture

Another instance of architecture is 'enterprise' architecture, seen as subordinated to industry architecture. Enterprise architecture is usually understood as the integration of an organisation's structure, processes, applications, systems and techniques [22]. Reference [38] argues that enterprise architecture is a strategy to create a proper foundation for business execution and a 'platform for innovation'. The emphasis is on the execution of the strategy and on the creation of a 'smart' company where employees feel that their work is effective, ethical, and the 'right' effort is being applied.

Although there is a 'jungle' of enterprise architecture frameworks (see, for example, [42]), a more generic framework is proposed by [38] to create and exploit the foundation for execution (figure 1). This framework is chosen for being general enough to be useful across many sectors/industries and for addressing specifically the issue of an enterprise having a good foundation for execution, which many companies are trying to achieve and that can be easily related to the platform architecture. This framework has the following elements: operating model, enterprise architecture and IT engagement model. And the authors argue that there are stages of enterprise architecture maturity: business silos architecture, standardized architecture, optimized core architecture, and business modularity architecture. These stages are very useful to explain the maturity process happening in the ICT/Telecommunications industry (as shown in sections III and IV of this paper).

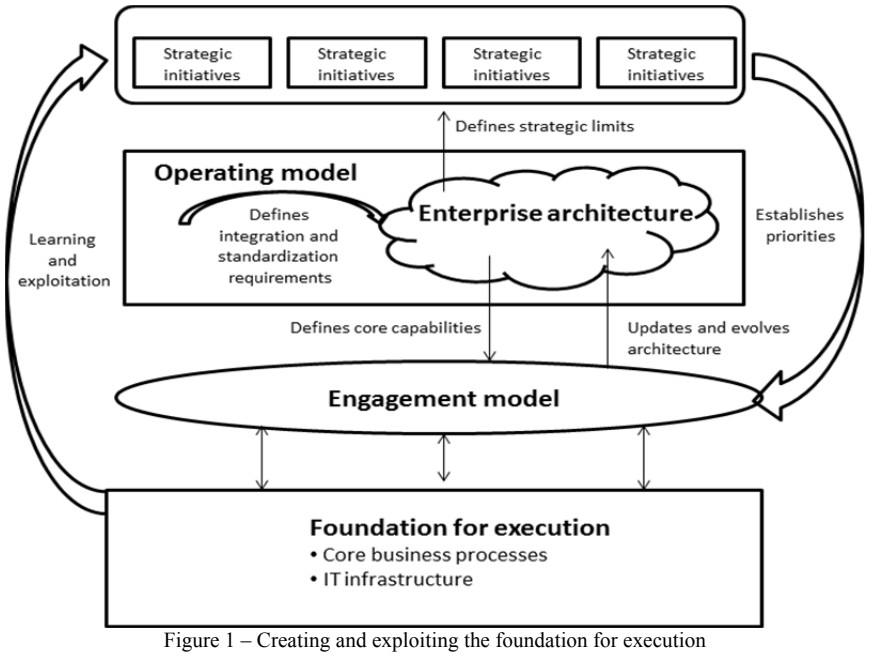

Figure 1 – Creating and exploiting the foundation for execution
Source: [38, p. 10]

One critique of the enterprise architecture approach is the strict focus on the enterprise without relating to the external environment (industry) (see, for example, [4]), and sometimes presented as a step-by-step methodology (e.g. [2]) usually targeting practitioners who want quick answers, which can of course be very elusive. By integrating the industry and enterprise architecture through the platform architecture, we expect to be contributing to address these issues.

A. Platform Architecture

Platform is defined in Oxford Dictionary as 'level surface raised above the surrounding ground or floor, esp one from which public speakers, performers, etc. can be seen by their audience' [34, p.946]. This definition highlights an important feature of platforms: visibility to the audience. The visibility corresponds to the degree of exposure to the audience, who can be customers or users in the telecommunications industry context. Thus, the concept of platform is preferred to system, as this last one does not highlight the visibility or exposure of the system to customers and users, such a way that these last ones can influence its design and the products and services derived from the platform. Interestingly, reference [17, p. 2-3] defines high-tech platform as 'an evolving system made of interdependent pieces that can each be innovated upon'. This definition seems to be still highly dependent on system and does not emphasize the visibility or exposure of the system to the 'audience'. It emphasizes though the interdependency of the various systems' parts and the evolution through innovation of each part. These are characteristics already emphasized in systems.

This section elaborates on the concept of platform as an architecture and strategy for firms to overcome the constraints of cost, speed-to-market and customer experience *at the same time*. There are two major approaches to the platform thinking and strategy, the internally and externally focused strategy approaches for innovation.

Internal Platform-based approach for innovation

The internal (to the firm) approach of platform recognises 'a subsystem or interface that is used in more than one product, system, or service' [27, p. 149]. This is the product platform, where the reusability of components to improve time-to-market and cost reduction in product and service development is emphasized (see, for example, [28], [32], [30], [44] and [29]). This stream of literature is inspired by the automotive industry, where, for example, [28] shows how Honda reuses its engines in different models of cars for different market segments. It is also applicable to IT (e.g.IBM) and services industries as shown in, for example, [32].

The concept of platform is a 'common sense way for a firm to leverage technologies into new markets and, at the same time, reduce per-unit costs through more efficient production and procurement' [32, p. 26]. Here the idea of platforms is applied to products and from the supplier perspective (like IBM and SUN). And the issue of product complexity is very generic and not well defined. Usually this literature of product platform is connected to manufacturing, and thus production. This is not the case for incumbent telecom operators that have outsourced their equipment development to specialised equipment providers. Also, the reduction in per-unit cost does not explore the potential of different forms of collaboration, as the Internet culture is making it possible and more popular.

External platform-based approach for innovation

The notion of platforms emphasizes the visibility or exposure of the internal system to the external system. It also lends the idea of flux or flow in the interfaces.

Reference [17] puts forward the idea of platform leadership, and the examples are firms like Intel, Cisco Systems and Microsoft. Their perspective, as well as of those from the product platform literature, are from the suppliers perspective and usually the literature does not focus on how large users build their platforms in order to deliver new services. Telecom operators now use Cisco Systems and Microsoft product and systems platforms to build their network platform. The leadership (from the suppliers' perspective) consists in establishing market standards and architectures that are eventually adopted by large users and that are continuously advanced, providing the initiator with a sustained competitive advantage against rivals.

The discussions about platform in the literature usually concentrate on the product as the unit of analysis (see, for example, [46] and [26] for a discussion on multimedia platforms, analysing DVD and CD-ROM; [16] about Intel's microprocessor; [17] about Intel, Cisco, Microsoft, Palm, NTT DoCoMo and Linux). The notion of platform does not usually scale up to the large network platforms being implemented by incumbent network operators, like BT, France Telecom and Deutsche Telekom. An exception is [17], who used the example of NTT DoCoMo to illustrate how NTT is using different business models to create an environment where third parties are encouraged to develop applications for their mobile phones. The platform being developed is for any device (mobile and fixed phone, PC, laptop, blackberry, IPod, Palm,…).

Some characteristics of platforms are important to take into account in order to understand the platform-centric organisation. And how platform innovation leads and facilitates service innovation in the telecom industry. Reference [9, p. 115] argued that

> *The platform [-centric organisation] is far from being a specific organizational structure, where one can recognize a new configuration of authority and communication lines. Rather it is a virtual organizing scheme, collectively shared and reproduced in action by a pool of human resources, where structure and potential for strategic action tend to coincide in highly circumstantial ways, depending upon the transitory contingencies of the market, the technology and the*

competitors' moves. Schematically, the platform can be regarded as a pool of schemes, arrangements and human resources.

Firms organise differently in order to develop and implement capabilities to adopt a platform-centric organisation. The platform approach has significant implications for the way firms organise innovation in services, including some pitfalls when transitioning from single-product approach to platform approach [30].

Exploiting the Concept of Platform Architecture

The concept of platform stems from the principle that stability and variability can go together [3]. And businesses yearn to have more stable aspects that may help predictability and control. Thus within the platform there is a 'stable component' which can make sense of the variability around it. Business can eventually reduce costs by not having to 'reinvent all the wheel', and by providing a more stable mental construct (e.g. an architecture) that can provide some rationale for actions and decision making.

As reference [3] pointed out, the platform architecture is conceived in such a way that there is a core or common part which does not change or change very little over time, and a variable part which gives the flexibility of producing a new or different product or service without having to 'reinvent the wheel', keeping costs lower due to the existence and reuse of the common part.

The concept of platform can be analyzed in various units of analysis. Platform-based approach can be embedded in products, projects, firms, networks, and markets. As much as the concept of fractal is concerned, the idea is that a closer look of certain complex objects can reveal the same type of structure, i.e. there are some elementary principles or rules upon which complexity is created. Platforms were first widely used in products, thus the so-called product platform. Another level of analysis is the network, as a set of interconnected nodes. The network itself is not sold to a customer, but it is the means to sell other products and services. These various units of analysis can be viewed in what [3] identify as three waves of research on platforms. The first and second waves are primarily based on product platforms. The first one focusing on the reusability concept of platforms to create derivative products [e.g. 31, 48]. The second wave emphasized the power of the product platform to create an ecosystem and drive innovation in the industry, with the typical examples of Intel's microprocessors, Microsoft's operating system, and Cisco's systems [e.g. 17]. The third wave emphasizes the platform at the level of markets, networks and governance structures [e.g. 37]. Intel, Microsoft and Cisco are examples of 'platform leaders' [17] due to their extensive use of the platform-based approach and their success as global players in the ICT market.

III. ICT INDUSTRY PLATFORM ARCHITECTURE

Incumbent fixed telecommunications operators have been building the so-called Next Generation Network (NGN). The concept was extensively discussed in many fora in the period of 2000-2003, like in the ITU-T (International Telecommunication Union – Telecommunication Standardization Sector) and ETSI (European Telecommunications Standards Institute) [1]. The NGN is seen as an all-IP, packet-based integrated network, where application and services are separated from the transport network, so that voice, video and data are transformed into packet data and delivered as integrated services to the customer [33]. NGN is expected to reduce the complexity of the network, avoiding the use of 'stove pipes', where for each service it is necessary to deploy a specific network from the backbone to the end customer. The transition to NGN represents 'the transition from yesterday's network-oriented to tomorrow's service-dedicated operations […]' [13, p. 60-61]. Ideally, services should be driving the network, which would be prepared and flexible enough to accommodate the needs of the particular services required by customers.

Network technology has been evolving to adapt to new technologies. Four distinct areas can be identified: (i) manual switching boards; (ii) analogue/mechanical switching; (iii) digital switching; and (iv) packet-switching including Asynchronous Transfer Mode (ATM) and Internet Protocol (IP).[1] The shift from analogue to digital switching and transmission occurred in the 1970s and 1980s [19]. Packet switching emerged in the 1990s, where ISDN, ATM and IP competed with each other [26]. And the 2000's showed that IP has prevailed in the market [15]. The network technology has now been evolving to have IP at the core of the network, besides the access. This has been allowing more flexibility to the network to cope with the changing demands of markets and customers.

Reference [15] lists three core technologies that came from the Internet and influenced the Telecoms Industry in its transformation into what is called Infocommunications Industry: packet switching, Internet Protocol (IP) and the World Wide Web. To this may be added the advent of broadband. When the average telephone call shifted from 3 minutes to about 20 minutes due to the use of dial-up access to the Internet, BT thought about doubling or tripling the number of switches, but the advent of broadband changed this thought.[2] The greater telecommunication channel capacity achieved with broadband was also favoured by developments in fibre optics.

Reference [15] argues that the 'engine of innovation' moved from the own R&D laboratories of network operators (in what he calls Old Telecoms Industry) to the specialist

[1] These four waves of innovation were addressed by Paul Reynolds, CEO of BT Wholesale in several key note speeches, including IEC 21st Century Communications World Forum on 21st February 2005, Supercomm on 6-9 June 2005, and FT Worlwide Communications Conference on 06 December 2005.

[2] Interview with BT Senior Manager, November 2005.

equipment suppliers. Network operators like BT tend to spend more on software-related R&D activities, as they concentrate increasingly in the creation and development of new services [6].

A. NGN Employing Platform Architecture and Strategy

NGN is more than network transformation, it is about business transformation.[3] In the beginning of the 2000's, the silo-based architecture was deemed to be a source of competitive disadvantage for the incumbent telecom operators to compete in the services market. A layered-based architecture has been proposed in order to overcome this drawback.

The premise behind the layered-based architecture is that the silo-based architecture does not allow the incumbent operator to change and create services quickly. Having the capability to deliver new services quickly is supposed to be a source of competitive advantage for the incumbent telecom operators. Although this would offer customers greater choice, each of these services will still have costs associated to design, promotion, and servicing. For this reason, an interviewee argued that more services may not be the adequate answer for the incumbent telecom operators' competitive advantage.[4]

Incumbent telecommunications operators are usually recognised by their robust and reliable services. However, the aim is to grow without significantly increasing operational costs. Because the network and management processes are built to create robustness and reliability, change is difficult and expensive. Growing through the provision of more and different services cannot be achieved with the conventional network and processes for delivering new services [36]. In order to change the cost structure, the telecom operators (supported by their suppliers) have been trying to find ways of discovering new sources of revenues (through new services) while keeping operational costs down. The operational costs include not only the usual costs of producing and delivering services, but also the cost of creating them. Hence, there is a concern to create an environment and processes where the cost of experimentation and the cost of failure are significantly reduced.

In order to create cost-effective variety of services, [41] suggests the concept of leveraged high-variety strategies, i.e. 'strategies that allow firms to achieve high variety and high growth, without a corresponding increase in costs or complexity' (p. 54). And it is proposed that platform thinking is the key to these leveraged high-variety strategies, defining platform thinking as the 'process of identifying and exploiting commonalities among a firm's offerings, target markets, and the processes for creating and delivering offerings' (p. 54). This platform approach is based on the internal view of reorganising for the reuse of components within the network in order to build new services. This is also the view taken by [27, 28] and [32], which they illustrate by examples from the automotive and IT industries. Another view of the platform approach is the assumption that the firm itself is not capable of creating, effectively promoting, delivering and supporting all the relevant services in the future, so that it needs to open up its platform, exposing the capabilities of the network in order for third-party firms to develop new services on top of it and invest in their promotion and support. This is the view explored by [17], based on developments in the IT industry (e.g. IBM, Microsoft and Intel).

The transition to NGN means migrating the technology of the core network to all-IP. This is a general consensus in the industry, although different telecom operators are considering different approaches of migration, depending on each circumstance. In Europe, BT decided for the most radical approach in terms of speed and scope.

B. Industry and Firm Layers

The impact of the Internet on the Telecommunications Industry is analysed by [15], mostly from the perspective of the infrastructure that underpins it. The concept of layers is generally used for describing the structure of the telecommunications industry, which is shown in Table 1.1 and Table 1.2 for the Old Telecoms Industry and the so-called Infocommunicatons Industry respectively.

TABLE 1.1 – LAYERS OF THE OLD TELECOMS INDUSTRY

Layer 3: Service layer (voice, fax, 0800 services)
Layer 2: Network layer (circuit-switched network)
Layer 1: Equipment layer (switches, transmission systems, customer premises equipment)

Source: [15, p. 37]

Comparing Table 1.1 and Table 1.2, three observations can be made. One is that the layer model became more complex from Table 1.1 to Table 1.2 mainly in the services level. Layers 1 and 2 of Table 1.1 (the Old Telecoms Industry) remain conceptually the same, as they have fundamentally the same functions (equipment and network layers). However, the difference is that the layer on top of the network layer is increasingly becoming IP-dominant, simplifying the complexity of having various different technologies (like frame relay, ISDN and ATM). The second observation is that the scope of service has broadened as the services layer (originally only citing voice, fax and 0800 services) is split up into some other layers as a consequence of the emergence of new players, allowed by the IP technology and World Wide Web. A final observation is that the customer has become an increasingly important variable to be considered in services. Table 1.1 does not even mention the customer, and Table 1.2 starts to do so.

[3] Interview with Deutsche Telekom Senior Manager, March 2006; interview with BT Senior Manager, March 2006; and interview with France Telekom Senior Manager, October 2006. And also interview with Alcatel Senior General Manager, March 2006; and interview with Siemens Senior Business Manager, March 2006.

[4] Interview with IBM Manager, March 2007.

TABLE 1.2 – THE INFOCOMMUNICATIONS INDUSTRY: A LAYER MODEL

Layer	Activity	Example companies
VI	*Customers*	----
V	*Applications Layer*, *including contents packaging* (e.g. web design, on-line information services, broadcasting services, etc.	Bloomberg, Reuters, AOL-Time Warner, MSN, Newscorp, etc.
IV	*Navigation & Middleware Layer* (e.g. browsers, portals, search engines, directory assistance, security, electronic payment, etc.)	Yahoo, Netscape, Microsoft, Google, etc.
III	*Connectivity Layer* (e.g. Internet access, Web hosting)	IAPs and ISPs
IP interface		
II	*Network Layer* (e.g. optical fibre network, DSL local network, radio access network, Ethernet, frame relay, ISDN, ATM, etc.)	AT&T, BT, NTT, WorldCom, Qwest, Colt, Energis, C&W etc.
I	*Equipment & Software Layer* (e.g. switches, transmission equipment, routers, servers, CPE, billing software, etc.)	Nortel, Alcatel-Lucent, Cisco, Nokia-Siemens, Huawei, Fujitsu

Source: Adapted from [15, p. 66]

The layer model has some impact on the way incumbent telecom operators are thinking about their infrastructure. They realised that the silo-based approach for services was not adequate to meet the speed-to-market, cost reduction and customer experience aims. This led the operators to rethink their network in terms of creating a layered infrastructure, which is based on reusing common network capabilities and opening interfaces for other firms to develop applications on top of the network [23]. This is one aspect of the platform approach as advocated, for example, by [29] and [27] for the level of products. Reference [23] is proposing the reuse of 'common capabilities' at the level of network functionalities, not for specific products or services. In this respect, 'the network will become the platform',[5] which shows the impetus to consider platform strategies.

Adding to the case of the increasing relevance of the customer in service innovation in the telecom industry is the role of content within the service. It is not only the voice, video or data service, but what are the specific applications being delivered. Reference [25] noted that telecommunications operators tend to concentrate on the technical issues of the service, not on its contents, citing the example of electronic trading and its legal implications. With the expansion of the scope of services and the advent of the World Wide Web, the issue of content has been taking increasing attention due to the services provided through the Internet. The applications running on top of the network require increasing attention of the incumbent telecom operator: their creation, development and delivery, and ultimately their business model. If the incumbent operators are to produce their own content, they can compete and be complementary to Internet players such as Google and Yahoo.

This situation seems to trigger the need of telecom operators to shape capabilities to cope with this context of converging infrastructure and services, ultimately converging into the customer experience. The infrastructure, represented by the NGN, leverages the capabilities to create and deploy new services. To facilitate this process, the infrastructure tends to be decoupled from the services layer [8].[6] Also the decoupling goes in line with the layer structure shown in Table 1.2. The layer structure at the industry level can be mapped into the structure of incumbent telecom operators (e.g. BT), as shown in Figure 2.

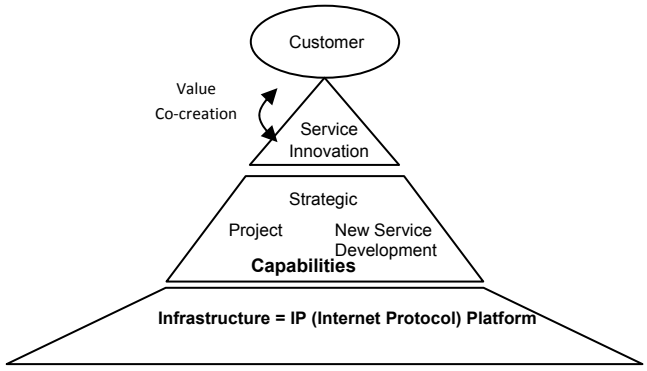

Figure 2 – Layered structure of the incumbent telecom operators
Source: Author's elaboration

With the decoupling and layer structure, changes in services do not necessarily translate into changes in the infrastructure. The decoupling facilitates the platform approach, if the network/infrastructure capabilities are organised and modularized in a way that they can be reused in different types of services. In this context, the business-to-business type of service allows incumbent telecom operators to tap into new sources of revenues exploiting their relationship with large customers, so that value is created with the customer. The inclusion of the customer and value co-creation emphasizes the shift from the strategic (supply-led) to the idealistic model (demand-led) [cf. 24] and evidenced by the shift in BT's strategic to a more customer-focused approach (as in [5, p. 7]).

[5] This quotation is from a speech given by John Chambers, CEO of Cisco Systems, at Interop Las Vegas on 2nd May, 2006. It can be found in [21].

[6] The decoupling of infrastructure from services layers was also emphasized in interviews with: Nortel Senior Manager, March 2005; Siemens Technical Director, March 2005; ECI Senior Technical Sales Engineer, March 2005; Veraz Networks Technical Director, May 2005; Alcatel Senior Manager, March 2006; Huawei Chief Engineer Manager, March 2006; ZTE Technical Director, March 2006.

IV. BT PLATFORM ARCHITECTURE

BT's decision to migrate to NGN was organised as a project, which was called the BT 21st Century Network (BT21CN). As a major undertaking, NGNs are designed to meet a customer's business and technical needs and they are also seen as a single and consistent network platform which will enable new services at a lower cost.[7] BT21CN represents BT's effort to manage the transition to NGN and it is seen as an integrated solution provided by eight preferred suppliers[8] with BT as customer, where systems integration and project management capabilities play a major role.

BT21CN is set to deploy a network seen as a platform, and its major business and technical characteristics are identified in this section. Platforms are seen not only as technical, but also as business constructs to achieve strategic goals. As explained in Section II, the concept of network platform integrates the notion of: (i) product platform [27, 29], where the main characteristic is the re-use of subsystems or interfaces; and (ii) of opening the interfaces to drive innovation in the industry [17]. Systems integration and project management are components of the platform capabilities which incumbent telecom operators need to develop in order to compete in the context of Next Generation Networks (NGNs).

A. The Evolving Platform Architecture of BT21CN

The BT21CN was announced in June 2004 although its history can be traced back to 2001 when a new chairman for BT was hired, Sir Christopher Bland, who came from BBC.[9] The main problem for BT at that time was a huge debt of around £ 28 billion. Sir Christopher Bland prepared the company to receive new people and in 2002 a new CEO was hired, Ben Verwaayen, coming from Lucent Technologies. He previously had worked for KPN (the incumbent telecom operator in the Netherlands) and ITT (a supplier of telecommunications systems). Also, a new CTO has hired, Matt Bross, who came from the US telecommunications operator Williams Communications. Ben Verwaayen seems to have brought a more aggressive leadership in terms of doing things faster and more decisively. And he seemed to be more open to radical approaches.[10] Another characteristic was that he worked to consolidate BT. In the past BT's business units (i.e. Ignite, BT Openworld, BT Wireless and Yell) were being considered as autonomous business to be sold separately to the market.[11] Verwaayen's unified view of the firm was opposed to the idea that BT was effectively a conglomerate with detachable parts. [12] The break-up of BT was suggested by market analysts during the debt crisis and OFCOM (Office of Communications)[13] seemed to be in favour of splitting BT into parts in order to enhance competition in the British telecommunication service market.[14]

Ben Verwaayen worked to consolidate what remained of BT and present 'One BT' to the market, starting even within his office, where he shared a single room with the directors, having physically removed the walls.[15] There was a time where the 'divisions' competed with each other, offering separate proposals to customers. Each 'division' had its own profit/loss account without worrying too much about the whole or other divisions.[16] In contrast, Verwaayen seemed to be more worried about articulating a clear vision for the overall BT corporate entity and strategy and communicating it to customers and shareholders.[17] With Matt Bross the CTO Office seems to be better coordinated in terms of unifying the architecture and the approach to innovation.[18] It seems apparent that one concern of the new top management was to consolidate BT into one single organisation. As Matt Bross put it:

> *To paraphrase Ben Verwaayen, the vision is for a transformation of BT from the 'schizophrenic, many-headed, behemoth' of today to a company perceived as a trusted ally in daily life. With a company the size of BT there is massive inertia holding back such a metamorphosis, therefore the biggest problem lies in actually implementing it.*[19]

The fragmented condition of BT was a major concern, and the major challenge of 21CN was not technological, as the technology was already available to realize the architecture. It was overcoming the inertia to implement it[20] which required changing the mindset of people from PSTN to NGN.[21] BT has set the aims of better customer experience, shorter time to market for service provision, and lower capital and operational expenditure. They soon realized that these aims could not be achieved with the current methodologies and processes [36]. As network operators can buy their systems and equipment from the same suppliers, such network

[7] Interview with BT Senior Manager, September 2005.

[8] The eight preferred suppliers are: Alcatel, Lucent, Siemens, Cisco, Ciena, Ericsson, Huawei and Fujitsu. Later in 2006 Alcatel acquired Lucent, forming Alcatel-Lucent. And Siemens (the carrier business, which was dedicated to telecom operators, distinct from the enterprise business) made a joint venture with Nokia in 2007, establishing Nokia Siemens Networks.

[9] Interview with BT Consultant, November 2005.

[10] Interview with BT Senior Manager, November 2005.

[11] Interview with BT Senior Manager, March 2006.

[12] Notable examples of conglomerates are GE and EasyGroup. Further discussion on conglomerates and unified view of the firm can be found in [12].

[13] OFCOM (Office of Communications) is the communications regulator in the UK.

[14] Interview with OFCOM Manager, July 2005.

[15] Interview with BT Consultant, November 2005.

[16] Ibid.

[17] Ibid.

[18] Ibid.

[19] From the interview with Matt Bross published on 04th August 2003 at http://www.opticalkeyhole.com/interviews/bt.asp (accessed on 18 August 2007)

[20] Interview with BT Manager, September 2005.

[21] Interview with BT Senior Manager, March 2006.

operators have the same access to technology as their rivals [15]. The technology being deployed in BT21CN has been deployed elsewhere or is available to other operators.[22] So the differentiation and competitive edge of telecom operators like BT lies not in the technology itself, but in how they use the technology to achieve their strategic aims.

The decision to proceed with BT21CN involved some major influences that may not be easily captured if the analysis is made only after the official start of this major project in 2004. The huge debt of BT in the beginning of 2000's created some malleability for change. BT people were aware that some change (maybe radical) was needed and they were more open and willing to accept it and cooperate.[23] The new CEO was keen to consider or adopt some radical change.[24] Coming from Lucent, he was supportive of initiatives that favoured standardization, avoiding proprietary solutions.[25] Everyone at that time was talking about IP anyway. It was already recognised that IP (in conjunction with MPLS) had the capability to be the common protocol for converged voice, data and video services.[26] Another factor was that the new CTO, Matt Bross, was 'excellent at putting complex things simply and selling up' to the board.[27] One interviewee said that probably 'Matt's skills, drive and charisma were a deciding factor, even though he had great support from Ben'.[28] At least for BT, it is apparent that the two newcomers in the top management exerted a decisive influence for a radical change. Also, the debate between consolidating and splitting up BT may have been a decisive factor for Christopher Bland to choose Ben Vervaayen instead of promoting someone from BT to continue the break-up of the company.

At this point in history, the central issue for all incumbent telecom operators in Western Europe was the PSTN replacement. BT's switches were becoming obsolete rapidly while other operators believed that they had more time to manage the transition to NGN. In fact, no one followed BT at first, but some years later, it is possible to see France Telecom and Deutsche Telekom talking about it.[29]

The fact that BT decided to do the migration at a faster pace than other incumbents in the world makes them a first mover considering the scale and scope of their NGN implementation, which represents a unique opportunity to explore the NGN commercial and technological environment from which lessons for future and ongoing deployments of the same nature may be learned. It is useful to note, however, that BT is a leader among large operations rather than all of telecommunications. Other smaller operators, like THUS in the UK, have claimed that they have already migrated to the all-IP NGN.[30] The commitment to the BT21CN project is evident as BT claims that it is necessary for them to switch off the PSTN network as soon as possible because the cost running two parallel networks would be disruptive for the BT operations and capabilities. BT claims that they are going to save about £ 1 billion per year from 2008/2009 as a result of the rationalisation of the network.[31]

B. The Role of Architectures

Whenever a telecom operator needs to build a new network or upgrade it, the architecture, the way these systems are combined, becomes of fundamental importance. In many instances, it can be noted the concern of building a coherent platform through an architecture. The architecture is the 'stable intermediate form' (cf. [43]) that is used by the operators and vendors in order to deal with complexity (complex choices and decisions). Large suppliers like Ericsson, Siemens and Cisco have their reference architectures which they try to sell to telecom operators. Smaller telecom operators usually do not have enough resources to ask the suppliers to change the supplier's architecture. However, large operators like BT usually do have such resources.[32] BT has developed its own architecture for the BT21CN and, while designing it, vendors were consulted and it became apparent that the technology required to implement the architecture was already available [10]. With this architecture in mind, BT selected the current preferred suppliers. Potential suppliers needed to already produce systems that were compliant with the architecture or to have a clear migration path to reach such compliance. Of course, BT also required that the technological choice should be defended with a strong commercial proposal showing the whole-life cycle of the solution offered over ten years.[33]

Using the chosen architecture as a reference, BT communicated with and selected their suppliers. BT's chosen architecture divided the network into five major parts, and the suppliers were invited to submit proposals for each part.[34] During the tender process to select the eight vendors, BT disclosed the part of the architecture in which the potential supplier expressed interest, and reserved the role of integrating all the parts to itself. In large projects, the total systems integration is usually the responsibility of a prime integrator from the supplier side. However, due to the scale

[22] Interview with BT Senior Manager, October 2005.
[23] Interview with BT Senior Manager, March 2006.
[24] Interview with BT Senior Manager, October 2006.
[25] Interview with BT Consultant, November 2005.
[26] Interview with BT Manager, October 2005.
[27] Interview with BT Senior Manager, March 2007.
[28] Ibid.
[29] Interview with BT Senior Manager, November 2005.
[30] Interview with THUS Senior Business Manager, October 2006.
[31] This claim is made in the BT press release on 09 June 2004, announcing officially the plans for BT21CN. And the claim was repeatedly propagated in trade conferences, such as the Supercomm 2005 in Chicago, on 06th June 2005 by Matt Bross, BT CTO.
[32] Interview with Alcatel Manager, May 2005.
[33] Interview with BT Senior Manager, March 2006.
[34] The five parts are: access, metro, core, transmission networks and i-node. The i-node is where the 'intelligence of the network reside (e.g. call control, network management, operation and support systems). At least two suppliers were selected for each part, except for the i-node, according to the press release issued by BT on 28th April 2005.

and scope of the project, and the opportunities to gain knowledge that could be transferred to other areas, BT decided to take the role of prime integrator. The architecture, in this sense, represents the tool through which BT intended to develop technological and system integration capabilities, and to understand whether the various offers from the suppliers would comply with their architecture. Hence, BT activities for BT21CN are largely concentrated on systems integration [10]. Acquiring a competence in architectural design, BT learns how to integrate systems and equipment from various vendors. Interestingly, BT has taken the view that it will be able to sell this capability to other firms (telecom operators), and this is what they intended through internal initiatives targeting telecommunications operators in developing countries.[35]

The architecture of the BT21CN is based on the principle of being 'a single converged network carrying all services' and on the idea of reusable service components, so that a product designer can rapidly create and change the services BT provides' [36, p. 13]. This situation is characterized by an 'aggregation' of networks where 'each network [is] associated with a single service and support systems (customer care and billing, for example) that have been developed for each network and service by its own internal software developers' [36, p. 11]. Thus, this 'stove-pipe' or 'silo' based approach became unsustainable for the requirement of faster service provision, and a platform-based approach was proposed.

C. From Silos to Platforms

The silo structure means that the service is associated with the network (infrastructure). So establishing a new service means having a strategy of constructing a new infrastructure or for modifying the existing infrastructure in significant ways. Either of these two strategies is very inadequate for meeting the aim of decreasing the time-to-market for new services and the flexibility and choice required by customers. Pressed by competition and declining revenues from its traditional fixed-line voice services, BT established a shorter time-to-market for new services as a strategic objective. Thus, the IP technology provides the possibility of building an infrastructure based on a single networking technology for voice, data and video services. And on top of it, it can be offered communications services that are decoupled from the infrastructure, so that changes in services do not necessarily imply changes in the infrastructure.

This adoption of the platform approach[36] has had a huge impact on the operational and support systems (OSSs) for the services offered by the telecom operators, and on the architecture of BT21CN.[37] OSSs are also based on silos, as each service tended to be implemented independently from the others. This creates major problems with interoperability as most of the systems use proprietary protocols.[38] Customer's requirements have evolved to different ways of requesting resources and services from different parts of the organisation and this blurs the boundaries of the organisation's internal divisions. For example, in the past customers bought a voice service separate from a data service, and a back office system for each one, separately. Nowadays, it is possible to click for a voice application in a PC or laptop, which makes the distinction irrelevant [23].

D. Impact of the Platform Approach on the Operational and Support System (OSS)

From the middle of the first decade of the 2000s, it has been the plan of incumbent telecommunications operators to move from silos to platform in order to improve time-to-market of products and services.[39] This would simplify the architecture of the network leading to cost reduction in its upgrade, maintenance, and making changes less difficult. Also the Operational and Support System (OSS) is being redesigned to have an increasing number of commercial-off-the-shelf (COTS) components, an approach clearly favouring modularity (technological modularity). The OSS can be defined as the set of all components that are necessary to transform an application into a complete service (such as billing, authentication, etc.) [36].

Each OSS system is still very proprietary in nature, having been devised to attend to specific needs at the time it was deployed. OSS systems do not follow a reference architecture because there never was such a reference architecture.[40] The BT21CN architecture, dividing the network into five parts, did not include the OSS. This part of the system was treated separately, as it offered other significant challenges at the service and applications level. Such challenges range from the system upgrade (both software and hardware) to the communication with other parts of the system supplied by other firms. For example, when implementing new services, a corresponding OSS may need to be installed and integrated with the existing system. Due to the proprietary nature of the protocols and hardware

[35] Interview with BT Senior Manager, March 2007.

[36] The platform approach was further emphasized in interviews with: IBM Technical Director, October 2005; Siemens Senior Business Development Manager, October 2005; Huawei Technical Director, March 2006. And it was also advocated by incumbent telecom operators, such as BT (from interview with BT Senior General Manager, July 2005), Belgacom (from interview with Belgacom Senior Commercial Director, September 2005), Swisscom (from interview with Swisscom Senior Programme Manager, October 2005), Deutsche Telekom (from interview with DT Technical Director, March 2006); France Telecom (from interview with FT Senior General Manager, October 2006), Telefónica (from interview with Telefónica Managing Director, October 2006), Portugal Telecom (from interview with Portugal Telecom Senior Director, October 2006).

[37] Although BT made separate tender processes for the OSS and for BT21CN, they are interconnected. Some parts of the OSS (e.g. network management system) are directly related to the suppliers of BT21CN, but other parts (e.g. billing system) are indirectly related. However, both OSS and BT21CN face the silo/platform issue.

[38] Interview with BT Senior Manager, March 2007.

[39] Interview with BT Manager, September 2005.

[40] Interview with Ovum Senior Analyst, March 2007.

being used any change involving upgrade or integration becomes very expensive and time consuming.[41]

Another problem with the existing OSS systems is that they are not usually part of the service. Whenever a customer wants to activate a new service, the OSS processes are run in background, sometimes with manual intervention, and the service can take days to be activated.[42] This is in conflict with the 'total customer experience' approach that BT envisions. One of the requirements that BT has imposed on suppliers is the need to open the source code for OSS systems. This is a dramatic change from the viewpoint of suppliers, as their business model assumes a service contract where they charge for and carry out the adaptations made in their OSS system. With this initiative, BT has asserted more control of the changes to be made in the OSS system and to the extent that BT can make the changes itself, supplier revenue may be lowered. However, this strategy may backfire as changes in the OSS system made by BT may have unintended consequences in other parts of the system which may prove more costly than leaving the changes to the supplier.

There is a tendency to resolve such technical efficiency issues through the adoption of a modular approach in OSS systems. It is fair to say that the entire NGN is premised on the concepts of platform and modularity. For example, the IMS (IP Multimedia Subsystem) is a subsystem that is supposed to offer the platform to develop new services. It would correspond to the operating system (like Windows, UNIX, etc.) where new services would be developed on top of it, and the underlying hardware (infrastructure layer) would be assumed to carry out functions without specific additional instructions.

E. Impact of the Platform Approach on the Architecture

Reference [18] argues that some firms have made innovation in the architecture of their products (the way the components are interconnected), but with the same components. Their unit of analysis is the product. In the BT21CN, innovation occurs at the network level. And the new services produced by the network are uncertain to a certain extent. Taking the network as unit of analysis, not a single product or discrete system, innovation occurs both in architecture and in component levels. The NGN is not a 'like-for-like' replacement of functionality', i.e., it is not to simply replace the PSTN switch and put an IP NGN router in its place.[43] The architecture is modified in order to simplify it and achieve the reductions in operational expenditure that are expected after completing the transformation. According to this new architecture, BT expects to reduce the number of network elements from 100,000 to 30,000.[44] The main technological component is also being changed. The IP router has more functionality in it and allows more different types of network configurations. This gives the network designer more choices when designing the architecture and configuring the network with possible implications in the reduction of operational costs and more flexible services. Thus, both architecture and components[45] are changed.

The architecture and the platform approach are directly related to the characteristics of the physical infrastructure of the BT21CN. BT needs to develop capabilities to build this new infrastructure, new company-level capabilities are developed, and existing capabilities are leveraged.

V. DISCUSSION

The aim of this discussion is to interpret and integrate the industry and enterprise architecture through the platform architecture in the light of the theoretical lenses presented in the literature review (section II). Also, in this discussion, we are going to propose a framework of analysis that may help firms to position them in the 'battle of architectures' by establishing their 'architectural advantage'.

A. Platform Architecture Integrating Industry and Enterprise Architecture

At the industry level, the layered architecture as explained by [15] provides an instance of the platform architecture, where common aspects of the network are joined together from the more hardware/network oriented layers at the lower levels to the more software/application oriented layers at the higher levels.

At the firm level, the BT case study shows that BT21CN was implemented having the platform architecture in mind, with a single converged network based on IP (Internet Protocol) as the basis for the network services and applications. Through the establishment of common capabilities, it was expected that BT could reduce the development time of new services from 18 to 6 months. This is much based on the concept of reusability, which is now very much diffused as a good practice for software development based on object-oriented approaches.

B. Co-Evolving Industry and Enterprise Architecture

Reference [38] proposes stages of Enterprise Architecture Maturity, composed by: (i) Business Silos architecture, (ii) Standardized Technology architecture, (iii) Optimized Core architecture, and (iv) Business Modularity architecture. These stages (or phases) fit neatly into the evolution of the ICT/Telecommunications industry and BT. An important insight here is that the stages of the maturity process

[41] Interview with BT Senior Manager, March 2007.
[42] Interview with BT Technical Manager, September 2005.
[43] Interview with Juniper Technical Manager, March 2006; interview with Telefónica Senior Technical Manager, October 2006; interview with France Telecom Senior Technical Manager, October 2006; interview with Cisco General Sales Manager, March 2007.
[44] Interview with BT Senior Technical Manager, March 2006.
[45] Components can be huge equipment or systems, many of them can be classified as Complex Products and Systems (CoPS) as in [11].

proposed by [38] are not decoupled from the happenings (or evolution) at the industry level. In the ICT/Telecommunications industry, with the emergence of IP (Internet Protocol) as the 'the facto' standard in the industry for the convergence of voice, video and data services, business silos had become inefficient.

In this case, the standard technology (IP) drove the dismantlement of previous business silos (based on separate voice, video and data services), and the stages proposed by [38] do not seem to be possible to be followed in the proposed sequence. With IP as the standard technology, it was created a layered structure (less about business silos) with an optimized core (stage iii) based on IP, and with intensive use of modularity and reusability of functions (stage iv). Thus, in this case, stage ii drove stage i, changing the previous architecture of business silos. At this point, it is important to mention that there is an element of co-evolution between the industry and enterprise architecture that is missing in the model proposed by [38], and that it is important to consider when shaping the enterprise architecture.

One important aspect of the co-evolution between industry and enterprise architecture is the pace of standardization in industry. Particularly in this case study, the pace of change was fast, and frequently the pace of change of standardization bodies (e.g. ITU-T) was not fast enough for BT. Thus, decisions had to be made favouring one specific line of standardization, which meant some risk taken by BT. In general, many decisions had to be taken without the technology (and its standardization) being mature enough.

C. Framework

Based on the framework proposed by [38], shown in Figure 1, and on the data from section IV (BT Platform Architecture) it is possible to propose an enterprise framework for BT, which can be possibly generalised for other incumbent telecommunications service providers. The framework is presented below in Figure 3.

One major consideration here is that the strategic initiatives at the application level are not restricted to consumer, but are also applicable to large customers, in business-to-business transaction. Thus, one way of extending this framework is to compound them towards the industry level, considering aspects of complementarity and mobility when developing the strategic initiatives (Figure 4). The platform architecture hides the complexities of the lower layers closer to the network. The long term survivability and growth may depend on the 'architectural advantage' that the incumbent telecommunications service providers may have in terms of their agility and effectiveness in developing their strategic initiatives to take advantage of complementarity and mobility at the industry level.

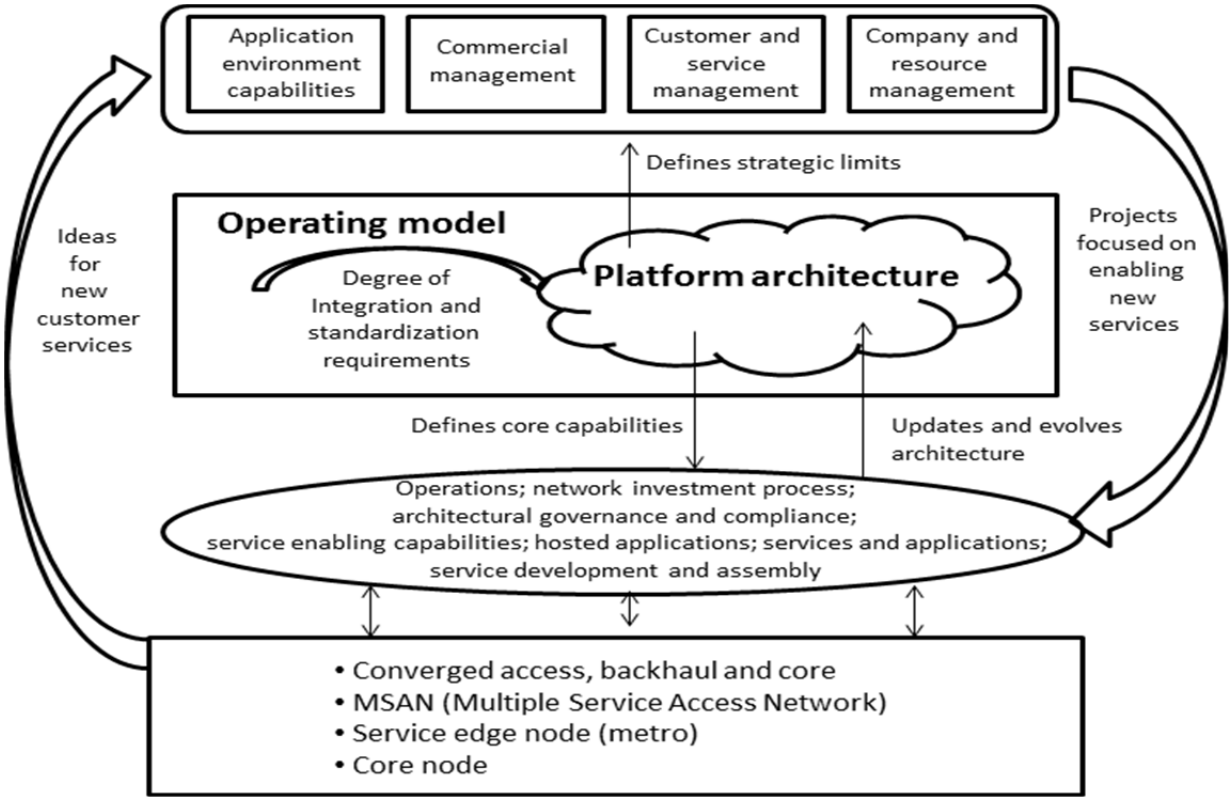

Figure 3 – BT Enterprise Architecture Framework
Source: Researcher interpretation based on [38, p. 10] and [47, p. 29]

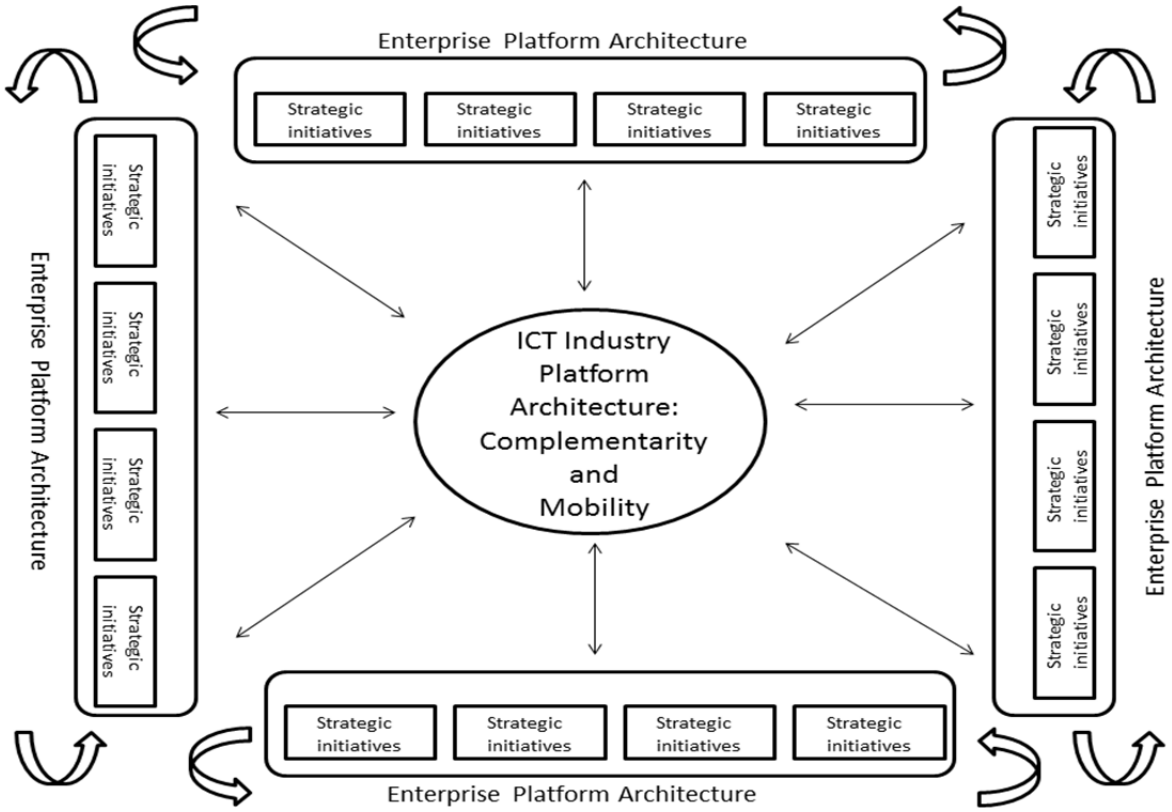

Figure 4 – The Enterprise-Industry Framework Considering Complementarity and Mobility at the Industry Level

D. Architectural Advantage

The direction that the ICT/Telecommunications industry is taking is similar to the PC industry some years ago, where firms like Microsoft and Intel focused on '*achieving architectural advantage* by nurturing complementarity in an emerging open eco-system' [20, p. 1029-10]. However, as opposed to achieving architectural advantage through products, incumbent telecommunications service providers have the challenge of achieving it through their enterprise architecture. Here, bottlenecks, where mobility is limited in terms of switching costs and potential entry, and hence competition is also limited [20], may be more difficult to identify and may be even meaningless when referring to complex systems and networks which are not mass manufactured.

VI. CONCLUSION/FUTURE RESEARCH.

This is a work-in-progress, where we are proposing a framework of analysis to inform firms in their pursuit of improving their enterprise architecture (Figure 3 and Figure 4). It is based on the ICT/Telecommunications industry, where the platform architecture has been evolving in a fast pace at both industry and enterprise levels.

Although the move towards the platform approach is a clear tendency in BT and other incumbent telecommunications providers, at this stage it is not yet clear if this approach will be ultimately successful. Incumbent telecommunications providers are trying to avoid being relegated to the role of pipe providers by creating an infrastructure that allows them to participate in the innovation of services and applications, competing and collaborating with Internet-based firms such as Google and Yahoo. Also, requirements such as opening the source code of the OSS system indicate BT's intention to increase the scope of its innovative activities. The open source demands have led to power struggles between suppliers and BT that have (so far) been resolved amicably. They may continue to be resolved if mutual benefits can be negotiated along the way. Even though it produces new tensions and conflicts, the platform approach influences and is influenced by the architecture conceptualised for BT21CN. Recent developments indicate that the platform architecture has been paying off, with BT's business model of balancing 'customer service delivery – cost transformation – investing for the future' showing a healthy performance with decreasing operational costs as reported in [7].

One main point of this paper is to emphasize the co-evolving aspects of industry and enterprise architecture that

are usually missing in the wider literature which usually tends to focus on either one or the other. The framework of Figure 3 represents BT Enterprise Architecture, which may be applicable to other incumbent telecommunications service providers. The framework of Figure 4 attempts to integrate the industry architecture and the enterprise architecture emphasizing complementarity and mobility at the level of strategic initiatives of enterprises. As these frameworks were developed for the ICT/Telecommunications industry and firms (specifically BT), a plausible question is to what extent they are applicable to other sectors and industries (being ICT, in many aspects, a more dynamic and advanced industry when compared to other industries).

We believe that this discussion about industry and enterprise architecture in the ICT/Telecommunications industry is important because at the moment there is a hot debate about new concepts such as SDN (Software-Defined Network) and NFV (Network Functions Virtualisation) which are compatible with the concept of platform architecture. In particular, SDN focuses on software development on top of a common network (decoupling software and hardware layers), and NFV emphasises the capabilities of the network to be virtualised such that quick and effective reconfigurations are possible and the service providers can play with different and higher number of options of business models.

We recognize that a major limitation of this research is that it considers only one case study (BT in the UK). Thus, the next step is to refine the frameworks of Figure 3 and Figure 4, conducting other case studies in incumbent telecommunications service providers such as Deutsche Telekom, France Telecom and NTT. Also the new trends in SDN and NFV need to be considered.

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