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Models of Innovation in Global ICT Firms: The Emerging Global Innovation Ecosystems

Author: Martin Fransman, University of
Edinburgh

Editor: Marc Bogdanowicz, Institute for
Prospective Technological Studies

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Joint Research Centre

Institute for Prospective Technological Studies

Contact information

Address: Edificio Expo. c/ Inca Garcilaso, 3. E-41092 Seville (Spain)

E-mail: jrc-ipts-secretariat@ec.europa.eu

Tel.: +34 954488318

Fax: +34 954488300

<https://ec.europa.eu/jrc>

<https://ec.europa.eu/jrc/en/institutes/ipts>

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Abstract

This report focuses on the changing models of innovation adopted by some of the largest and most innovative global ICT companies in the world, including Apple, BT, Google, Microsoft, Skype, Telefonica and Vodafone. One of the main contributions of this report is to demonstrate that in order to understand these innovation models, it is necessary, at the same time to understand the dynamics of innovation at sector level. Beginning with an analysis of the innovation process in the ICT ecosystem, the author drills down into the company global innovation ecosystems that have been created by these global companies. In addition he explores some of the implications that proliferating company global innovation ecosystems have for government policy. He concludes that whilst innovation is changing the world, changing global circumstances are in turn transforming the innovation model in companies, both large and small, around the world.

Acknowledgments

This analysis was produced in the context of the *European Innovation Policies for the Digital Shift* (EURIPIDIS) project, which is jointly funded by DG CONNECT and JRC-IPTS.

The author would like to thank the many senior managers from all the companies who have given generously of their time and who have shared their thinking about the crucial process of innovation that takes place in their company. From them I have learned a great deal, even if in parts of this paper the interpretation is mine.

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Preface

This report was prepared in the context of the three-year research project on *European Innovation Policies for the Digital Shift* (EURIPIDIS) jointly launched in 2013 by JRC-IPTS and DG CONNECT of the European Commission in order to improve understanding of innovation in the ICT sector and of ICT-enabled innovation in the rest of the economy.¹

The purpose of the EURIPIDIS project is to provide evidence-based support to the policies, instruments and measurement needs of DG CONNECT for enhancing ICT Innovation in Europe, in the context of the Digital Agenda for Europe and of the ICT priority of Horizon 2020. It focuses on the improvement of the transfer of best research ideas to the market.

EURIPIDIS aims are:

1. to better understand how ICT innovation works, at the level of actors such as firms, and also of the ICT “innovation system” in the EU;
2. to assess the EU's current ICT innovation performance, by attempting to measure ICT innovation in Europe and measuring the impact of existing policies and instruments (such as FP7 and Horizon 2020); and
3. to explore and suggest how policy makers could make ICT innovation in the EU work better.

¹ For more information, see the project web site:
<http://is.jrc.ec.europa.eu/pages/ISG/EURIPIDIS/EURIPIDIS.index.html>

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EXECUTIVE SUMMARY

Everyone agrees that innovation is crucial for the performance over time of both companies and countries. However, there is far less agreement regarding two key questions:

- How does innovation happen?
- How can we make innovation happen?

The point of departure in this paper, and its main contribution, lies in the way in which these two key questions are tackled. The approach first starts with a conceptualisation of what is called an 'innovation ecosystem'. Secondly, this concept is applied simultaneously at both the sector level and the individual company level.

The ecosystem is defined as groups of symbiotically interacting 'players' which include: companies and other players such as the providers of knowledge, resources, and 'rules of the game'. It is the companies which constitute the economic 'engine' of the ecosystem since they create value for consumer-users, output, and employment. In doing so, however, the companies are also influenced by the other players in the ecosystem.

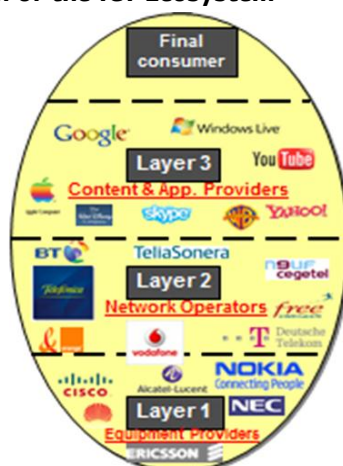
Second, two levels - the sector level and the company level - in the ecosystems are considered to interact with the result that it is not possible to fully understand the one without the other. One of the main contributions of the present paper is to demonstrate the necessity, if the process of innovation is to be properly understood, of a simultaneous analysis at both sector and company levels.

The analysis proceeds hence in two stages. The first stage involves the identification of the main players within the company who are collectively involved in the company's innovation process. Crucially, this analysis includes not only researchers and developers (accounting for the R&D on which most studies of innovation conventionally focus) but also other players such as those involved in company strategy, sales and marketing, design, software development, and distribution - players who are left out of most analyses.

The second stage of the analysis involves situating the intra-company players within the broader context of the key external players who are part of the company's Global Innovation Ecosystem. Increasingly (for both large and small companies) knowledge that is relevant for the company's innovation process will be found not only outside the company's legal boundaries but also outside its home country. This means that in order to benefit from this external knowledge, the company's Global Innovation Ecosystem needs to be designed so that it can effectively access and use knowledge globally.

The analysis shows that there are different kinds of company Global Innovation Ecosystems in the three layers of the ICT Ecosystem.

Exhibit 1: A simplified presentation of the ICT Ecosystem



In Layer 3 – the platform, content and applications layer – there is a unique hotbed of Internet-related entrepreneurship and innovation along with massive entry by new companies. In order to explain this hotbed of activity, the report develops the argument that the key determinant is the emergence of what is called the Internet Innovation Platform. Furthermore, six key characteristics of this platform are identified that together make it ideally suited to facilitating the entry of new, innovative companies: availability of network services; open low-cost access; relatively low fixed costs; very low marginal costs; high consumer surplus; high scalability.

Very different structural conditions exist in Layer 2 (the network operator layer). More specifically, this layer is driven by economic forces which include: very high fixed costs coupled with low marginal costs; economies of scale; and substantial entry barriers. The result of these forces is that Layer 2 is dominated by a small number of large operators. But this is not all. The inevitable focus of the operators on their networks has required a set of capabilities that are fundamentally different from the capabilities that the software-based Internet companies in Layer 3 need in order to become and remain competitive. This explains the inability of the dominant Layer 2 network operators to successfully diversify their activities into Layer 3 (despite their serious efforts to do so) in an attempt to avoid becoming the simple providers of ‘dumb pipes’ that carry data for others who make money from the use of that data. In addition, the innovation activities of the network operators in Layer 2 are also shaped by their reliance on innovation by ICT equipment providers in Layer 1. Having said this, the report also shows that telecoms operators such as Vodafone and Telefonica, have been making good use of their global networks as innovation platforms in their company Global Innovation Ecosystems.

Finally, Layer 1 players (the equipment manufacturing layer) may be divided into those that have managed to establish significant innovation platforms and those that have not. This has been one factor shaping their different company Global Innovation Ecosystems. A further force for change has been the entry of new, innovative competitors, notably Chinese companies such as Huawei and ZTE, but also new players from the US.

The increasing prevalence of company Global Innovation Ecosystems challenges conventional policy in several key areas including: technology transfer, intellectual property rights, financing, taxation, public procurement and even evidence-based policy-making. The essential point is that in company Global Innovation Ecosystems innovation is a joint product rather than being the result of the effort of a single firm. But this means that the designers of policies in these areas must now take account of the incentive effects on multiple rather than single players. Furthermore, they also have to understand the cooperative and competitive relationships between these players if they are to design effective incentives. All this can significantly increase the cost of formulating and implementing innovation policies in these areas.

1. Introduction

1.1 The innovation ecosystem

Innovation is crucial for both companies and countries. In companies it is innovation that is the main driver of longer-term competitiveness, profitability, and growth. In countries it is also innovation that is the main driver of both economic growth and social development.

This much is clear and widely agreed by analysts taking different approaches. However, there is far less agreement about what should be done in order to make innovation happen. This is true at the level of both company and country.

The aim of this paper is to identify changing patterns of innovation that are occurring at the level primarily of large, global companies. In doing this particular attention will be paid to the ICT Sector, one of the most dynamic and important parts of modern economies. Accompanying these changing patterns are, as we shall see, new ways of thinking about what should be done in order to bring about the kind of innovation that will enable the achievement of overall growth objectives.

At the conceptual heart of this paper is the idea of what is called an 'innovation ecosystem'. Essentially, such an ecosystem brings together groups of players who together make innovation happen. It is the symbiotic relationships between these players and their responses to one another that result in innovation. At times these relationships are harmonious, producing win-win outcomes; at other times they are conflicting, some winning whilst others lose. But it is the systemic total of these relationships that drive the innovation process.

Innovation, in turn, following Joseph Schumpeter, is defined as new products and services, new processes and technologies, new ways of organising people and things, and new markets, ways of marketing and business plans

In this paper the innovation ecosystem concept is applied at two different, but closely related, levels: at the level of the sector, and at the level of the individual company. Analysis is necessary at both these levels. The reason, this paper claims, is that what happens at the level of the individual company is significantly influenced by the relationships that the company has with other companies and other players, particularly in that company's sector but also in other parts of the (global) economy.

This paper focuses on the Global Innovation Ecosystems of some of the most important companies from all the layers of the ICT Ecosystem.

A Global Innovation Ecosystem is seen here as the set of interdependencies between the players of both the company and the sector-level, organised so that knowledge can be accessed and transformed into a marketable innovation.

More specifically, three sets of questions are examined, the answers to which have a key bearing on the performance of company innovation:

1. How should companies access external knowledge and resources and incorporate external players in their Global Innovation Ecosystem in a win-win way?
2. What role should research play in a Global Innovation Ecosystem and how should it be organised?
3. What do customers want now and what will they want?

Unsurprisingly, as the details of the design and organisation of company Global Innovation Ecosystems examined in this paper show, there is no 'one size that fits all', no 'right' answer to what are, after all, highly complex questions relating to highly complex systems. The idiosyncratic ways of organising the process of innovation in the leading global companies examined here highlight once again one of the key assumptions insisted upon in evolutionary economics: companies differ. And it is this difference, together with the selection processes that apply to

them, that drives the evolutionary processes and makes capitalist economies the restless, ever-changing systems they are.

The companies whose Global Innovation Ecosystems are described in some detail here include: Apple, BT, Google, Microsoft, Skype, Telefonica, and Vodafone.²

1.2 A bias in the thinking about innovation

Undoubtedly, this paper intends to strive against two main misconceptions about innovation: the exclusive role given to R&D in innovation, and the resulting R&D bias in innovation policies.

As a firm grows, particularly if it operates in an environment of rapid technical change, the firm may start doing some research, i.e. searching for alternatives or trying to prepare to face future emerging technical changes. In this way the firm develops an increasingly complex division of labour in its knowledge-creating activities by adding 'development' functionalities (improving on 'today's' products/services, technologies, and markets) and 'research' functionalities (searching for 'tomorrow's' products/services, technologies, and markets).

If the firm grows to a large size it is possible that research and development will become specialised functions. The two sets of activities – research and development – will usually be organised in different ways, located in different places (viz. in central research laboratories and business units respectively), and be quantitatively different (in a large modern company and in richer countries R may be only about 10% of total R&D).

With the evolution of R&D as a specialist set of functionalities at company level and to the extent that innovation produced increased competitiveness, performance and growth, R&D became identified as a key driver of success in the firm.

It was a short step from this perception to a related perception on the part of government policy-makers charged with increasing company and country performance that it was desirable to increase R&D, both at company and at country levels. In this way 'R&D' became a key policy objective.

Furthermore, in discussions of innovation R&D usually became the main focus of attention despite the fact that it constitutes expenditure aimed at producing beneficial innovation which, however, may or may not succeed in its aim.

In reality, the innovation process at company level also involves other players who may have little to do with the functionalities of research and development. Particularly important are, first, the firm's customers (who, after all, specialise in consuming/using the firm's products/services and in doing so acquire significant knowledge which may become a key input for future innovation) and, secondly, people involved in both sales and marketing who are typically those most closely in touch with the firm's customers. In addition, suppliers, partners, and competitors are often also key sources of innovation even though they are located outside the company in question.

² Note of the editor: These cases were selected for their obvious relevance in the current ICT industrial landscape and the availability of information obtained through interviews by the author. We acknowledge that they are not meant to show representativeness, or cover all layers of the model.

Two related debates

Closed versus Open Innovation:³ Current literature sometimes mistakenly conveys the impression that until recently the innovation process in firms has tended to be 'closed' in strong contrast to the 'open innovation' that has recently become fashionable ('closed' and 'open' referring respectively to innovation-related knowledge being sourced from within, and from outside, the firm). But 'closedness' has never been an option for innovating firms insofar as innovation-related knowledge from customers, suppliers, partners, competitors, and other players (such as universities and government research and standards institutes) has always been important for the vast majority of firms. It is likely that the unduly exclusive focus on R&D has been largely to blame for this misperception. This is not to deny the substitutability that in some cases exists between knowledge sourced from outside and knowledge sourced from inside the firm and the increasing awareness of the potential importance of outside knowledge (enhanced by the increasing globalisation of knowledge-creation and the advancement of ICT infrastructure that has increased accessibility to outside knowledge).

Intangibles? The exclusive focus on R&D when it comes to innovation has also led to a failure to acknowledge the importance of other activities that are only now coming to be recognised as also important in the innovation process. These include activities such as software development, marketing and branding, and organisational improvements that facilitate both the creation of innovation and the ability to absorb it from outside. Yet these activities are not included in the measurement framework.

³ This debate goes hand in hand with the "depiction" issue commented in Annex 3

2. The ICT Global Innovation Ecosystem

In this paper, we will explore the changing organisational patterns of innovation that are occurring in global companies by looking in more detail at the ICT sector. There are several reasons for focusing on this sector.

First, the ICT sector provides one of the most important engines of growth and social development at both company and country levels since it provides the information and communications equipment and infrastructure needed throughout the economy and society. Second, the ICT sector itself is an important sector in modern economies in terms of its contribution to GDP. Third, it is believed (though further research is needed) that the patterns and trends that are to be observed in the ICT sector in the area of innovation might offer lessons for many other sectors.

However, in order to understand the changing innovation process in some of the most important global ICT companies it is necessary to know more about the interdependencies between these companies that make up the ICT sector. The reason is that the nature of the interdependencies, as we shall see, has a bearing on the innovation process within individual companies. It is here that the conceptualisation of what we will call the ICT Ecosystem becomes important.

2.1 The sector-level innovation ecosystem

2.1.1 A layers model

The use of the biological notion of an ecosystem is helpful since it draws attention to the set of organisms (we shall use the word players) whose interactions with each other and with their environment make up the key characteristics of the ecosystem and facilitate an understanding of the evolution of this system over time.

In the case of the ICT Ecosystem, which are the main groups of players and how do they interact with one another? In tackling this question we will focus first on the company players in the ecosystem since it is these players that are primarily responsible for the output of the ecosystem and therefore constitute the 'engine' of the system.

At a high level of abstraction we will identify three groups of company players who interact through the inputs and outputs that they provide for each other. To put it slightly differently, they interact as the creators and users of knowledge embodied in the goods and services that they sell.⁴

The question, therefore, is how can we categorise the company players that make up the ICT Ecosystem (some of which are shown in Exhibit 2) in terms of creators and users of knowledge.

⁴ It is possible to disaggregate these three groups further. However, this complicates the analysis by creating a larger number of interacting groups and for present purposes such disaggregation is not necessary.

Exhibit 2: ICT Ecosystem - How do players fit together as creators and users of knowledge?



In answering this question we can identify the following three groups of companies that create and use each other's knowledge embodied in their products and services:

1. ICT equipment providers who create the elements that make up ICT networks.
2. Network operators who string these elements together in order to make networks (and who include telecoms operators, cable operators, satellite operators, and broadcasters); and
3. Platform, content and applications providers who create platforms, content and applications that run over the networks provided by the network operators.

But these are not the only users of knowledge (ICT products and services) in the ICT Ecosystem. Whilst the companies in the first three groups are intermediate consumers there are also final consumers who include individuals and households, companies from other sectors, and government bodies. We therefore must add a fourth group, namely

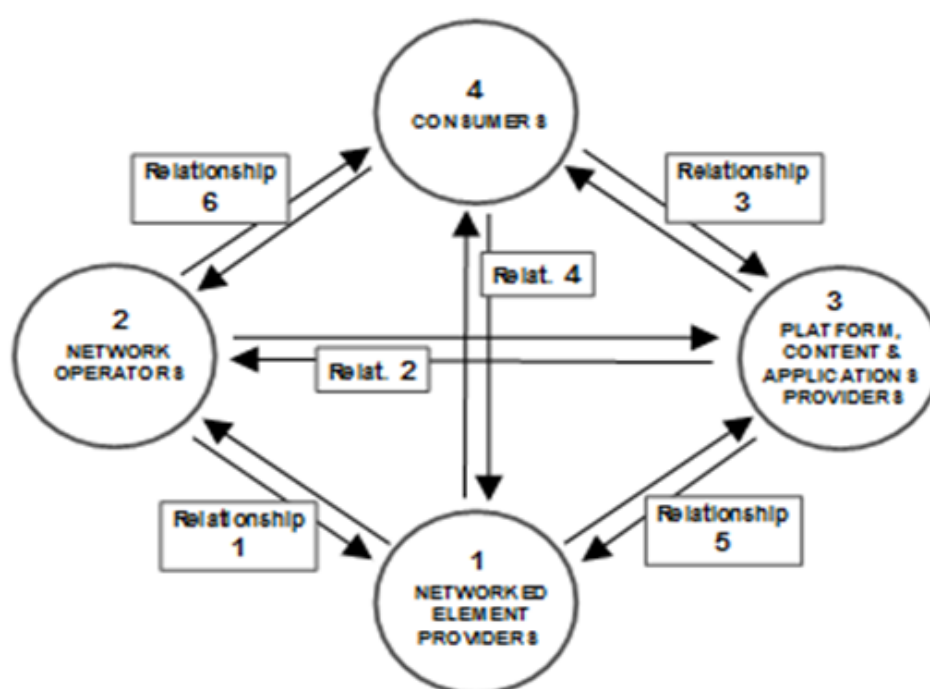
4. Final consumers.

We can think of these four groups of players as being organised in a hierarchically-structured architecture consisting of four layers. A simple model of this ICT Ecosystem, together with some of the major company players who populate each layer, is shown in Exhibit 1.

The following examples will illustrate how the ICT Ecosystem works. *ICT Equipment Providers* in Layer 1 (such as Ericsson, Huawei, Nokia-Siemens Networks, Cisco, Microsoft, Samsung, etc.) supply the network elements that the *Network Operators* in Layer 2 (such as BT, France Telecom, Vodafone, AT&T, etc.) need to construct their networks. These Network Operators provide the network services that are necessary for *Platform, Content and Applications Providers* in Layer 3 (such as Google, Facebook, Baidu, Amazon, etc.) to deliver their products and services. Finally, in Layer 4 we have the *Final Consumers* who also buy and use the output of the ecosystem.

The key point is that all of the four groups interact with all the others. Although Exhibit 3 correctly shows the functional hierarchical nature of the interactions – in much the same way that a foundation is needed before the ground floor of a building can be constructed, the ground floor is needed before the first floor can be built, etc. – it does not emphasise sufficiently the multi-directional nature of the relationships between the four groups. Exhibit 5, however, shows these interactions.

Exhibit 3: 6 symbiotic relationships between 4 players



As shown in Exhibit 3, each group interacts with all of the others. This makes a total of six relationships. It is helpful to see these relationships as symbiotic since the groups literally depend on each other for their survival. It is here that the process of innovation in the ICT Ecosystem enters our analytical story.

Company innovation takes the form of new products and services; new processes and technologies; new forms of organisation; and new markets, ways of marketing, and business concepts. There are many sources of this innovation ranging from those that are internal to the firm (including R&D and the contributions of others in the firm such as sales and marketing personnel, software developers, etc.), to external sources such as customer-users, suppliers, partners, and competitors.

The relationships depicted in Exhibit 3 illustrate in our view some of the most important of these sources (at least in a general way). It is within the context of these relationships that innovation happens.

Innovation occurs in part as value-creating conjectures are generated by people within the companies and within the wider innovation networks of which they are a part. These conjectures contain hypotheses about what may add value for particular consumer-users relative to what is already provided by competitors. However, uncertainty is attached to these essentially ex ante hypotheses since at the moment of conjecture it is not certain whether value will in due course be added.

The conjectures, accordingly, still have to be tested. And it is within the context of these relationships that testing takes place. The relationships, therefore, are a key dimension of the selection environment that together with the variety generated by the large number of creative conjectures creates the evolutionary processes that drive the ecosystem making it (in Schumpeter's words) the restless system that it is.⁵

⁵ Innovation, however, may also result from other processes that do not necessarily involve conjectures regarding what will add value for consumer-users. One example is basic research that may have no intended users in mind.

2.1.2 Additional Ecosystem Players closely involved in the innovation process

In addition to company players there are also others who play a very important role in the innovation process. These include players who provide:

- knowledge,
- resources, and
- the rules of the game.

Knowledge-providers who are not companies include universities and government bodies such as research institutes and standards setting organisations. They interact in various ways with the company players referred to earlier and through these interactions also help shape the innovation process.

Resource-providers include financial organisations such as banks, capital markets, sovereign wealth funds, private equity, venture capital, business angels, etc. Their decisions about whether or not to fund value-creating conjectures constitute one of the important *selection mechanisms* in the ecosystem.

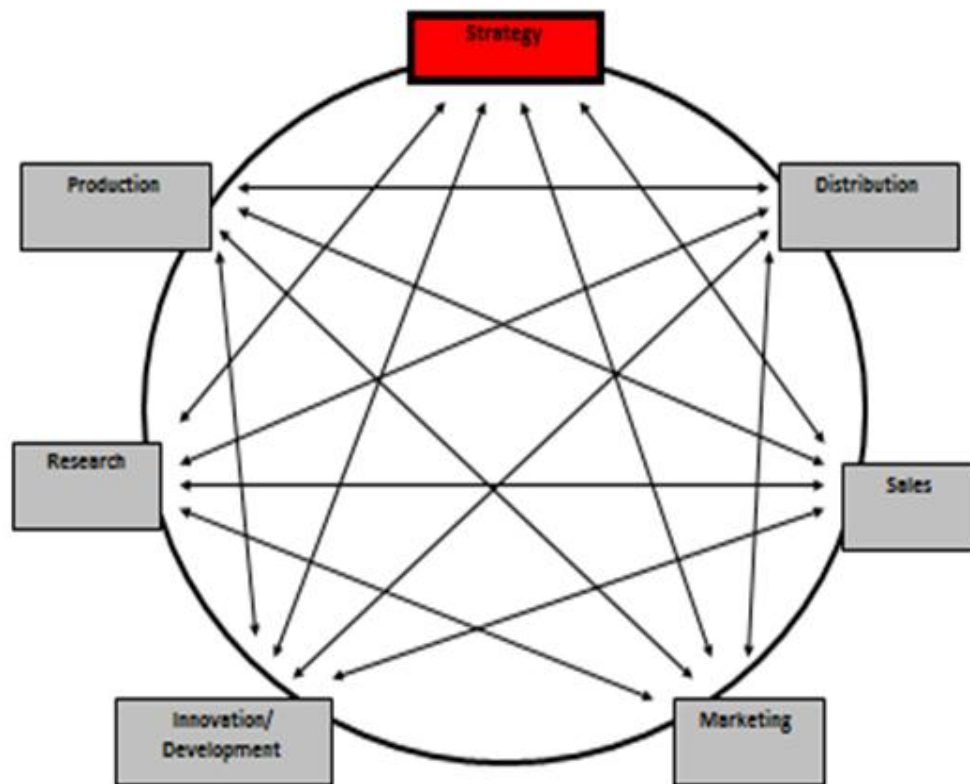
The rules of the game, more broadly the *institutions* (both formal and informal) that govern the interactions between the ecosystem's players also play an important role in shaping the innovation processes in the ecosystem. They include regulation and laws such as competition law, the law of contract, and intellectual property law as well as other influences like the incentives that are created by government intended to influence the innovation process such as tax incentives and government procurement practices. It is here that *political power* and *politics* enters the analysis since institutions are created and changed through political processes.

2.2 The company-level innovation ecosystem

The earlier section develops a generic sector-level model⁶ of what we call the ICT Ecosystem. However, if we are to understand innovation processes at individual company level, sector-level analysis is insufficient. The reason is that within the same sector-system context different companies will make different strategic decisions that will result over time in different company-level innovation ecosystems and processes. This influences the variation in R&D and profitability reported in Exhibit 17. In order to understand these company-level differences it is necessary to develop a generic company-level model of global innovation ecosystems. This model is shown in Exhibit 5.

⁶ What happens in each sector of the economy, of course, is also influenced by factors determined at national level. Examples are macroeconomic variables such as interest rates, exchange rates, growth rates, and inflation rates.

Exhibit 4: Innovation-related functions and relations within a firm



Seven functions within the company are identified that are related to the process of innovation. At the top is the overall company strategy formulation, depicted in red to indicate its supreme role as governor of the other functions. Production, distribution, marketing, and sales are the day-to-day bread-and-butter activities of the company. Innovation/development is taken here to include the activities of design and product/service development. They are distinguished in this exhibit from research. As shown in the exhibit, all these seven functions are interrelated although how they are to be effectively coordinated and how appropriate information is to flow between them so as to facilitate an effective innovation process is an organisational and management issue of some complexity.

These seven functions define seven intra-company groups of players that make up the intra-company innovation ecosystem. But these seven groups of players also interact in the innovation process with a number of external players in the company's total innovation ecosystem. This is shown in Exhibit 5.

Exhibit 5: A generic Global Innovation System

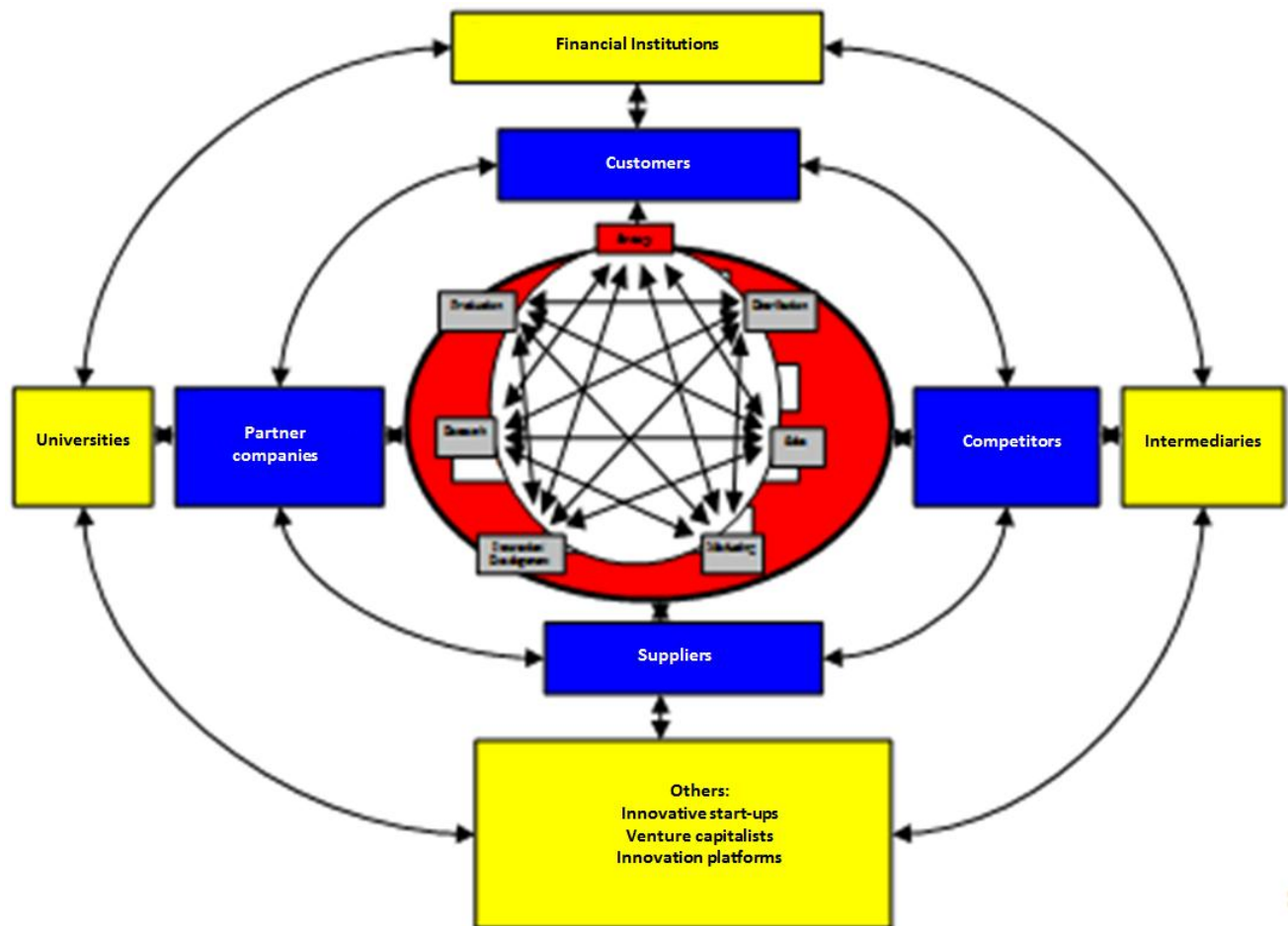


Exhibit 5 shows eight important external groups of players who may also play a significant role in a company's innovation process. In addition, as we shall shortly see, there are further players such as government, regulators, public research institutes, etc., not shown in these exhibits, who will also be crucial. The focal firm is depicted in the centre of the diagram shown in red. The focal firm has eight symbiotic and interactive relationships with the external players.

The first four groups of external players, shown in blue, constitute the focal firm's primary relationships. They are with customers, partners, suppliers, and competitors. The second four, which make up the focal firm's secondary relationships, are with universities, financial resource providers, intermediaries (such as consultants, lawyers, and accountants), and others who include innovative start-ups, venture capitalists (who provide capital but are just as likely to also provide connections), and innovation platforms. They are shown in yellow.

The above theoretical generic Global Innovation Ecosystem will serve as framework to observe and analyse how large multinationals of the ICT sector manage to access external knowledge and resources.

Taking in account the rapid increase of the globalisation of the innovation process since at least the 1970s, and its further acceleration in the last decade, it becomes increasingly important for companies, both large and small, to 'plug into' the knowledge generated globally, in BRICS countries but also Mexico, Korea, Turkey or Indonesia.

This raises some very complicated questions for companies, both large and small, wanting to access, absorb, and use this globally distributed innovation-knowledge.

3. Observing Global Innovation Ecosystems (GIE) – Case Studies

As already announced in the Introduction, we will examine in the following section three sets of questions which have a key bearing on the performance of company innovation:

1. How should companies access external knowledge and resources and incorporate external players in their Global Innovation Ecosystem in a win-win way?
2. What role should research play in a Global Innovation Ecosystem and how should it be organised?
3. What do customers want now and what will they want?

3.1 How should companies access external knowledge and resources and incorporate external players?

The starting assumption is that there is knowledge that is relevant for the focal company 'out there', beyond the company's boundaries (whether the company operates in one or many countries) and that the company may derive significant benefits (after taking the associated costs into account) from accessing this knowledge. In deciding how, in practice, the company answers the following questions:

1. Who in the company should be allocated the task of searching for this knowledge and establishing which external players possess this knowledge?
2. How should they go about searching?
3. How should their objectives be established in order to ensure that their external search activities make a positive contribution to the company?
4. How should their activities be coordinated with the other innovation-related players in the company (shown in Exhibit 5) so that their combined actions make a coherent whole?
5. Once the most important external players have been located and prioritised how should the relationship with these players be designed so that they are motivated to contribute in a win-win way?
6. Where in the world should they be primarily located?

The first difficulty that arises is that the function of 'external knowledge search and mobilisation' is different from any other innovation-related functions identified in Exhibit 4 and requires a different set of capabilities. Probably the closest function is that of research since research also requires a degree of external search (e.g. search for similar or related research that has been done by others). However, research by a company's researchers is usually aimed at the creation of new knowledge by the researchers rather than purely searching for and mobilising the knowledge of others. In short, although there may be some overlap, the mind-set required is different. And so are the capabilities.

This means that a new functionality is required for the task of 'external knowledge search and mobilisation' (even though trained researchers may be relatively well-placed to acquire the capabilities needed to provide this new functionality).

In turn this raises further questions: How should this new function be organised and managed? Where in the company should it be located? How should the people performing this task interact with others performing complementary innovation-related functions? Where in the world should the 'external searchers' be primarily located; etc.? It is one thing to locate external players who have relevant knowledge. But it is quite another thing to incorporate them into your company's Global Innovation Ecosystem and to motivate them so that they want to contribute to your innovation process. How should this be done?

It should come as no surprise that the above questions have been answered in different ways by different companies. Companies have different backgrounds and constitute very different collections of resources. Accordingly, there is no 'one size fits all'. This is a further driver of variation amongst companies, variation that is grist to the evolutionary process.

In this section we will examine the solutions that have been developed by several global ICT Companies beginning with BT, the UK incumbent telecoms operator.

3.1.1 The Case of BT

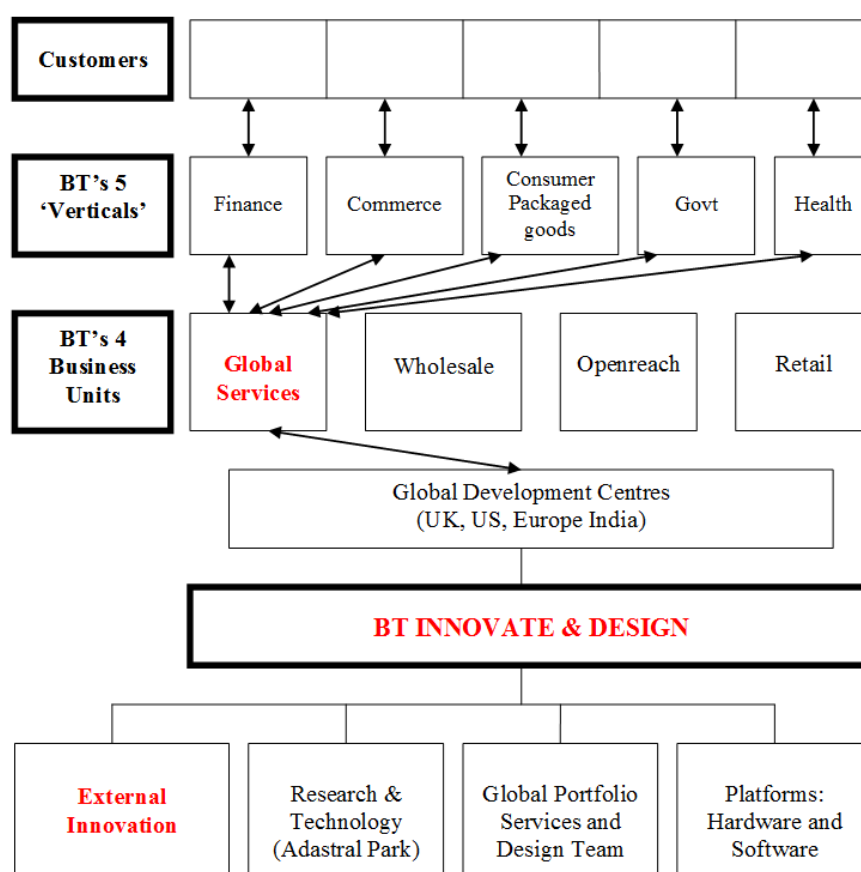
Incumbent telecoms operators (Layer 2) from industrialized countries - such as BT, Vodafone, and Telefonica - have recently begun to construct more elaborate and extensive Global Innovation Ecosystems. Traditionally, they have primarily been providers of connectivity services, both fixed and mobile voice and data services. They have provided these services over networks which they own. In terms of Exhibit 1 they are Layer 2 players.

Hitherto, their main source of revenue has come from these connectivity services. But these revenues have been falling largely due to the widespread diffusion of IP (Internet Protocol) networks which have brought down the cost (and profitability) of voice services. In response, telecoms operators have turned to faster fixed and mobile broadband services. In addition, they have diversified into non-connectivity services. These include the integration of IT and network services as well as the provision of platforms, content, and applications. Not only have they begun selling non-connectivity services globally, they have also started bringing in a far wider range of players who add value to the offerings they provide to their customers. Hitherto, enhancing their Global Innovation Ecosystems.

One company that has made creative organizational innovations in view of developing its Global Innovation Ecosystem is BT. In order to mobilize and accelerate innovation delivery, both internally and for its customers, BT has developed a Global Innovation Ecosystem that encompasses innovating with customers, external partners, and universities as well as using its own extensive research and development capabilities around the globe. In order to leverage innovation drawn from outside the business BT has established a new group called the *External Innovation* unit.

As shown in Exhibit 6, BT is divided organisationally into four Business Units: *Global Services* (that provides services not only to customers outside the UK but also to large UK companies); *Wholesale* (that services other telecoms operators); *Openreach* (a distinct business unit established by order of Ofcom, the British regulator, which offers services that involve the interconnection of BT's network to that of other service providers); and *Retail* (which provides services to retail customers).

Exhibit 6: The core of BT's Global Innovation Ecosystem



From the innovation perspective, the main concern of the present paper, the important point is that the activities of these entities are supported by BT's corporate innovation organisation called BT Innovate and Design. This organisation includes the Research and Technology unit based in Adastral Park (which formerly was the BT Martlesham central research laboratory).

Furthermore, the company has divided itself into what it calls five 'Verticals' in order to focus more effectively on five strategically prioritised groups of customers: finance, commerce, consumer packaged goods, government, and health.

Of particular interest in terms of the issues being addressed here is the External Innovation unit (highlighted in red in Exhibit 6) which is a key component of BT's Global Innovation Ecosystem.

Three characteristics of the External Innovation unit are noteworthy. The first is that its objective is to mobilize both external as well as internal knowledge and resources in the task of creating solutions immediately for customer problems. Secondly, the unit is formally under BT's group R&D organization, called BT Innovate and Design, rather than in the BT Global Services business unit which is where a normal development team would be located. Thirdly, the head of External Innovation is located, not in the UK, but in Silicon Valley.

The differing roles of 'External Innovation', 'Research and Technology' and 'Customer Innovation', all of which are part of BT Innovate and Design, merit further discussion. While External Innovation's role is to look outside BT for new innovation trends, technologies and services and how they might be quickly applied to help address new challenges and opportunities faced by BT and its customers, Research and Technology has more of a longer-term exploratory brief focusing on unique research and insight that cannot be drawn from the outside market and has the opportunity to develop unique IPR and differentiated services for BT. Research works intensively with BT's strategic suppliers, including major indirect channel partners. Research also addresses major business

challenges and trends identified by the senior executives and operational boards within BT - establishing capability in identified key innovation topics for BT. This brings important additional dimensions to customer projects and innovation events.

Clearly, the two sets of activities undertaken in Research and Technology and External Innovation are complementary and BT's own research programmes are continually tested and validated with what the External Innovation people are seeing outside BT to ensure that BT's own research is unique and differentiated and not duplicating what already exists elsewhere.

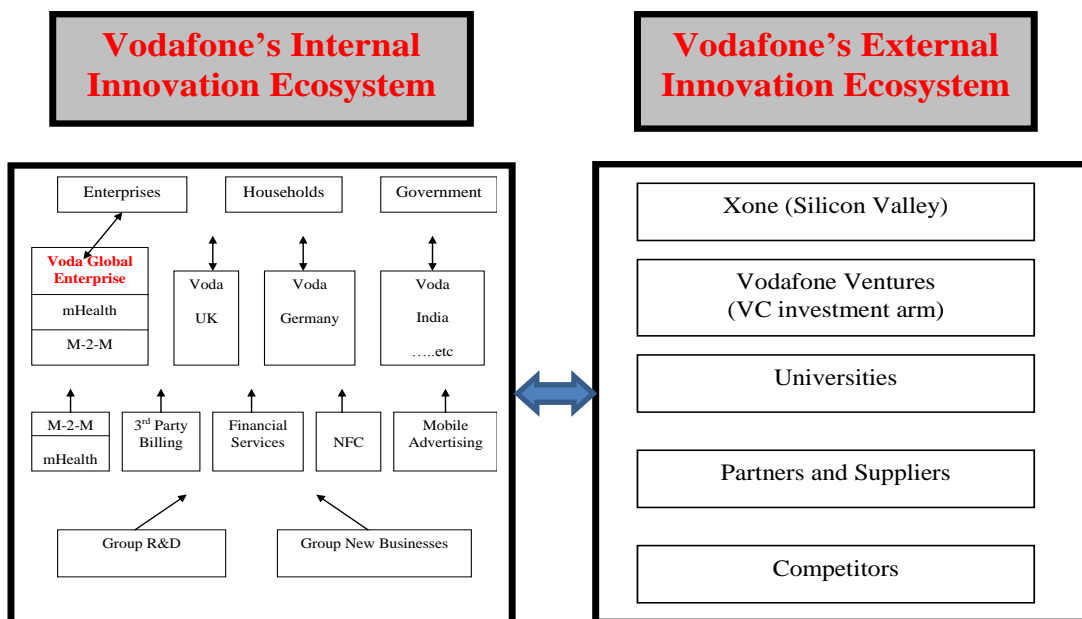
BT's organisationally innovative answers to the questions being addressed in this section:

- As Exhibit 6 shows, BT has boldly developed a tri-partite organisation of its innovation process in its Global Innovation Ecosystem: Research; External Innovation; and Development rather than the conventional dual organisation, Research & Development.
- Research and External Innovation are separated organisationally as a result of their different objectives, capabilities, mind-sets, and global location. However, they are both part of BT's overall corporate innovation organisation, BT Innovate & Design.
- Research deals with longer term exploration.
- External Innovation is shorter term, dealing with the current problems and needs of customers, by mobilising external players in its Global Innovation Ecosystem (more about this Unit in Section III.C). Although organisationally separated from Research it remains part of BT Innovate & Design.
- The head of External Innovation is based in Silicon Valley, rather than in the UK.
- Development is located in BT's business units and is similar to conventional development.

3.1.2 The Case of Vodafone

As one of the world's largest mobile telecoms companies in terms of subscribers Vodafone has also made strides recently in developing a structure to address the need for accessing a Global Innovation Ecosystem. Some of the main characteristics of this ecosystem are shown in Exhibit 7.

Exhibit 7: The core of Vodafone's Global Innovation Ecosystem



Vodafone started life as a UK electronics-defence company which in the mid-1980s became the main mobile competitor to the then incumbent, BT. Having acquired distinctive competencies in

mobile communications Vodafone soon embarked on a course of global acquisitions which rapidly gave the company a global footprint. This company history is reflected in the company's current organisational structure which, as shown in Exhibit 7, is based on relatively autonomous country subsidiaries (left-hand part, second line). Vodafone recognises three large groups of customers: enterprises, households, and government. Furthermore, the company has chosen a number of new business areas as strategic priorities. These are: machine-to-machine communications; mobile health (which are both located in Vodafone Global Enterprise); third-party billing; financial services; near field communications (NFC); and mobile advertising. These activities are supported, as shown in the exhibit, by Vodafone's Group R&D and Group New Businesses.

It soon became apparent to the company that large global enterprises were becoming an increasingly important customer segment. The problem was that their businesses extended beyond the company's country subsidiaries as a result of their global business activities. The organisational solution that the company devised to this problem was the creation of *Vodafone Global Enterprise* shown in red in the exhibit.

The following summarises some of the key characteristics of Vodafone Global Enterprise:

- Vodafone Global Enterprise (VGE) was created in 2005 to help large multinational corporations simplify their communications services.
- 2005 – 60 customers; 2006 – 120; 2007 – 300; 2009 – 600; 2012 – 600.
- Key role played by VGE's account managers who liaise closely with customers.
- Key role played by country innovation champions who champion the innovation needs of global enterprises based in their country.
- Scale and learning are leveraged over multiple customers.
- This has led to the development of a number of generic solutions relevant for most customers that are re-used across customers and countries.
- Challenges include:⁷ tensions between country operating companies and Vodafone Group over innovation; cross-operating-company innovation and re-use – how to make it work?; funding of innovation (who pays if many are benefitting?); and speed of innovation – often it is too slow.

In order to take advantage of relevant knowledge located outside its boundaries Vodafone has constructed what might be thought of as an *External Innovation Ecosystem* which, together with its Internal Innovation Ecosystem already described, makes up its total *Global Innovation Ecosystem* (similar to the generic Company Global Innovation Ecosystem that we have depicted in Exhibit 5). Vodafone's External Innovation Ecosystem is depicted in Exhibit 7. Here we will focus specifically on the role of *Xone* (pronounced 'Zone') and *Vodafone Ventures*.

Vodafone is attempting to use its key distinctive physical resource, namely its global telecoms network, as an *innovation platform* on the basis of which to attract committed external players who will provide their knowledge and make important contributions to the added value that the company hopes to add for its customers through its global innovation processes. The key points may be summarised in the following way:

- A key distinctive resource of telcos is their networks and subscribers attached to these networks. Vodafone has 390 million customers globally. (Facebook, by comparison, at the same time had 800 million users).
- Vodafone is using this resource as an 'innovation platform' which provides the foundation for complementary business activities in much the same way as Apple uses its iPhone and iPad to develop apps.

⁷ Author's view based on interviews and analysis

- Vodafone is using its global telecoms network to attract independent developers to create applications that will appeal to its customers. Venture capital funds and incubators provide additional incentives for these developers.
- However, a major challenge is competition from other innovation platforms, such as Apple's and Google/Android's.
- Vodafone has established a large operation in Silicon Valley⁸ aimed at facilitating collaboration with independent entrepreneurial firms.
- An example is Vodafone's Xone which began operating in Silicon Valley in September 2011. Since then, it has increased the number of it has in EU countries (Italy, Spain, etc.)

The main features reflecting the *design* of Vodafone's **Xone** within its Global Innovation Ecosystem are the following:

- Xone is intended to identify and qualify innovative technologies from startups, R&D labs, universities and venture capital portfolios with the potential to deliver new and innovative products and services to Vodafone's global customer base.
- Xone is based in Silicon Valley.
- It will also provide selected companies with commercial feedback. Companies are offered support from the Vodafone Xone team of professionals whose expertise spans business development, network and device architecture, consumer electronics, payment and billing mechanisms, data analytics and content delivery. Up to 24 companies are able to use on-site office and test space within Vodafone Xone.
- Companies will be able to test products and services in the Vodafone Xone test and development lab, which contains a fully functional replica of Vodafone's global networks and also includes a replica of Verizon's network.
- However, a major challenge is competition from other innovation platforms – such as Apple's and Google's – for complementor companies⁹ and experienced software engineers.

As the Cambridge University political-economist, Alfred Marshall, pointed out in the latter Nineteenth Century, knowledge is the main engine of growth; and, furthermore, organisation aids the creation and use of knowledge. In demonstrating this Marshall talked about what he called the 'external organisation' of the firm, that is its use of external players for its innovation process. Vodafone similarly has created an external organisation in order to incorporate outside players who possess relevant knowledge that may be harnessed in order to create additional value for the company's customers. The main features of this organisation are described in Exhibit 7. The symbiotic relationships shown in this exhibit are also referred to in the generic model of Company Global Innovation Ecosystems shown in Exhibit 5 which draws attention to the relationships established with outside players, many of which have been incorporated into Vodafone's Global Innovation Ecosystem.

This also implies that the allocation of company resources to external players who may be incorporated into its Global Innovation Ecosystem should be seen not only as complementing the company's own R&D – which it certainly does do – but should also, in some circumstances, be seen as an alternative to, and as a substitute for, internal R&D. Thus harnessing the knowledge of a

⁸ Note: this is not necessarily a new or winning move as other companies such as DT or Orange made similar moves already in the 90ies. This demonstrates further the internationalisation of the innovation activities.

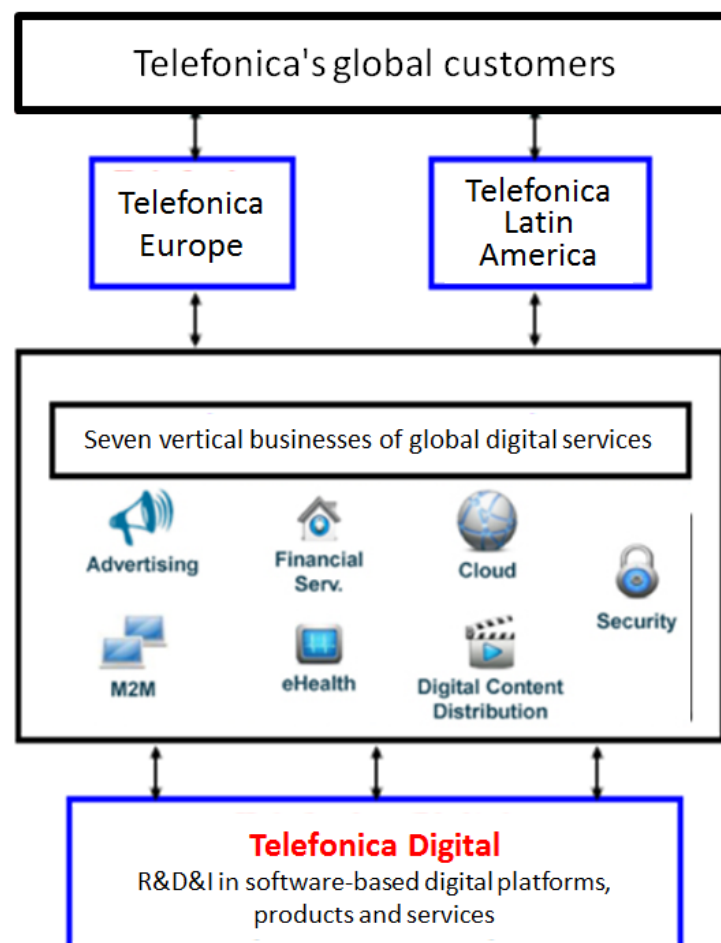
⁹ Complementors are businesses that directly sell a product (or products) or service (or services) that complement the product or service of another company by adding value to mutual customers; for example, [Intel](#) and [Microsoft \(Pentium processors and Windows\)](#), or Microsoft and [McAfee](#) (Microsoft Windows & McAfee anti-virus). (Source: Wikipedia).

complementary Silicon Valley company may not be too dissimilar in terms of results to commissioning an internal R&D unit to do the work even though in the former case the player lies outside the company's boundaries and chain-of-command and therefore a different kind of relationship is needed to mobilise the knowledge.

3.1.3 The Case of Telefonica

Telefonica, one of the world's largest telecoms operators which is heavily involved in Europe (Spain is its home country) and Latin America, has also created a Global Innovation Ecosystem to take advantage of external knowledge. A summary of its Global Innovation Ecosystem is shown in Exhibit 8.

Exhibit 8: The core of Telefonica's Global Innovation Ecosystem



Telefonica has aggregated its country businesses into two broader organisations, Telefonica Europe and Telefonica Latin America. The company has strategically prioritised seven 'vertical businesses' providing global digital services. They are: financial services; eHealth; machine-to-machine services; video services; applications; cloud services; and security.

Of particular interest for present purposes is Telefonica's organisation of its innovation processes in order to support these seven businesses. This organisation focuses on *Telefonica Digital*.

The following are some of the current features of Telefonica Digital:

- Telefonica Digital, set up at the end of 2011, is located in London (Regent's Street) and Madrid.
- Size; 2,500 people.

- Mission: to develop digital services in the seven vertical areas for Telefonica's operators in Telefonica Europe and Telefonica Latin America.
- Organisational structure: separate Profit & Loss unit. This is relevant as a separate P&L status affects accountability, transparency and incentivisation.
- Modelled more on Google and Facebook as software companies than on Telcos or IT companies.
- Telefonica Digital is also trying to include other players in its activities such as university researchers and innovative SMEs and start-ups.
- Telefonica's global networks are being used as an innovation platform with application developers and other partners being given the incentive of accessing the company's large number of customers.
- Challenges include: recruiting experienced software engineers against strong competition from start ups; overcoming the negative image of incumbent telcos in the digital space; competing with leading Layer 3 Internet-based players that are dominant in the area of platforms, content, and applications.

Like BT and Vodafone discussed earlier Telefonica has also attempted to globalise its innovation process by creating a Global Innovation Ecosystem. A particularly important objective of this ecosystem, as Telefonica emphasises, is to create the innovation processes that will allow the company to move beyond its connectivity services provided in Layer 2 of the ICT Ecosystem and to enable it to become increasingly competitive in Layer 3, the platform, content and applications layer (see Exhibit 1). In short, Telefonica is not content to simply be a transporter of the data used in communication networks but wants to participate in the profits that are to be earned in Layer 3.

The problem, however, as Telefonica itself is very aware,¹⁰ is that the capabilities needed in Layer 3 are in many respects different from those in Layer 2. For example, the traditional emphasis given in telecoms to communication reliability and quality of service dictates a very different software development process compared to that used by Internet companies which can afford to be far more experimental online, using practices such as beta-testing online which allows for more rapid software development. Telefonica is hoping that its Global Innovation Ecosystem and the global innovation processes that it facilitates will help it in its attempts to achieve its strategic objectives in Layer 3.

3.1.4 How to access external knowledge: The need for both internal and external organisation

As this section has emphasised, and as the Cambridge economist Alfred Marshal noted as long ago as the nineteenth century, in order to take full advantage of the knowledge that drives competitiveness, profitability and growth – crucially knowledge that resides both inside the company and outside it – it is necessary for a company to have both an internal and an external organisation. It is its external organisation that allows it to mobilise and acquire external knowledge. All the companies examined in this section, as we have shown, have created such organisation. However, we still need a far more sophisticated understanding about what needs to be done if we are to improve the design and effectiveness of such organisation. This should be an important priority for company innovation research in the future.

¹⁰ Experiences such as that of the acquisition of Endemol and its management between 2000 and 2007, have demonstrated such difficulties

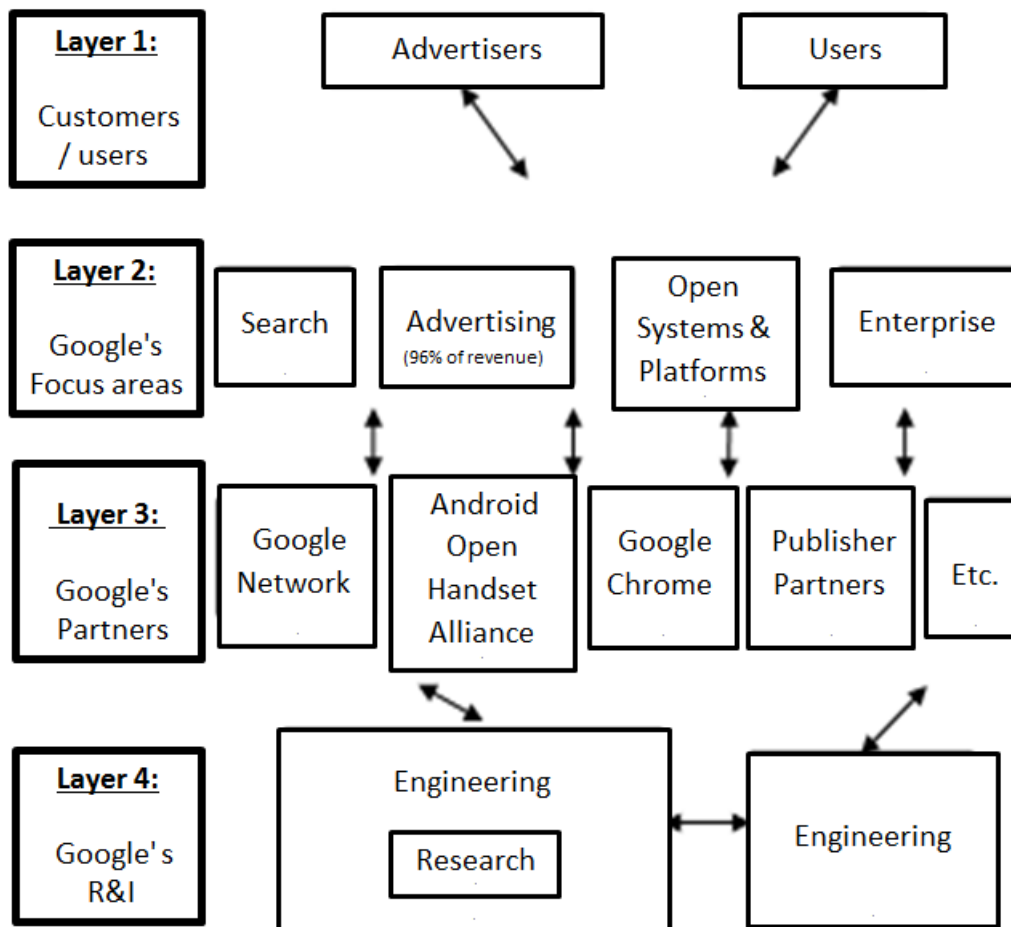
3.2 What role should research play in a global innovation ecosystem and how should it be organized?

Research is clearly a key component of any company Global Innovation Ecosystem. But complex issues arise regarding the precise role that research should play in the ecosystem and how it should be organised. In order to discuss some of these issues we will examine the contrasting solutions that have been generated by two of the ICT Ecosystem's leading innovators, Google and Microsoft.

3.2.1 The case of Google

Google's Global Innovation Ecosystem is depicted in Exhibit 9. It is organised in a number of layers.

Exhibit 9: The core of Google's Global Innovation Ecosystem



These are the highlights regarding Google's customer/users (Layer 1):

- Like many Internet companies whose business models have come to terms with the need to provide free services and applications on the Internet, Google has a sharp distinction between its customers (i.e. those who provide its revenue) and its users (i.e. the main users of its services and applications). Google's main customers are advertisers who provide 96% of its revenue.¹¹

¹¹ Essentially, by providing free a service that is in much demand – namely, search – Google has succeeded in capturing 'eyeballs' (i.e. the attention of significant numbers of consumers). These 'eyeballs', and information about the behaviour that governs them, are then sold to advertisers thus generating Google's revenue.

- Significantly, Google knows more about the behaviour of consumers (its users), at least in the advertising space, than advertisers. By enabling the latter to target specific market segments Google is able to charge a premium.
- In order to survive and thrive, Google must satisfy the needs of both its users and its customers. It is a typical two-sided market. Competitors are just a click away. And since the Internet is characterised by low entry barriers, potential competition is constantly emerging. To do this Google must innovate.

Google's Layer 2 deals with its main areas of activity:

- Google groups its own activities into four: search; advertising; operating systems and platforms; and enterprise.
- Through its activities in all four areas Google aims to meet the needs of its customers and users.
- But Google also draws significantly on the activities of numerous external players who also add value for Google's customers and users through Google's Global Innovation Ecosystem.
- Some of the major groups of external players are shown in Level 3.

Layer 3 contains Google's four main groups of partners:

- Google Network: is the network of advertisers that use Google's advertising programs to deliver relevant ads with their search results and content.
- Android Open Handset Alliance: With a business alliance of more than 75 technology and mobile companies, Google developed Android, a free, fully open source mobile software platform that any developer can use to create applications for mobile devices and any handset manufacturer can install on a device.
- Google Chrome: An open source operating system with the Google Chrome web browser as its foundation. Google works with several original equipment manufacturers to bring computers running Google Chrome OS to users and businesses.
- Publisher Partners: provide content and other material on Google Mobile.

Layer 4 deals with Google's supporting research and innovation subsystem. Its main features are as follows:

- Google has a total of 12 engineering centres in Europe (most of which include research). Zurich has the most important research centre in Europe with more than 360 engineers. London is the major centre for mobile, including Android. Other locations include Poland, but also Mountain View, Calif. or Israel.
- Functions in Layer 4 located in the centres that support the other layers include:
- Developer Advocates, members of the Developer Relations Organisation, who help to create an ecosystem of third-party developers of applications and businesses and who act as developers' advocates in Google.
- User Experience Teams who are a multi-disciplinary team of interaction designers, visual designers, user researchers, copywriters and Web developers who collaborate closely with each other and with engineering and product management to create innovative, usable products.

Google defines its product development philosophy in the following way:

"Our product development philosophy is to launch innovative products *early* and *often*, and *then* iterate rapidly to make those products even better. We often post early stage products at test locations online or directly on Google.com. We then use data and user feedback to decide if and how to invest further in those products."¹²

¹² Source: Google, *Annual Report*, 2012, emphasis added by the author

Similarly, Google presents its approach to research as below:

“Our culture is one that emphasizes rapid and significant innovation. In order to sustain this, we keep our research and engineering efforts integrated, with research activities located in almost every engineering group as well as in the research group.

This decentralized approach helps us to bring the best possible technology to our users by putting outstanding engineers and researchers in direct contact with the most relevant problems, and empowering them to deliver solutions to our end users directly.

At Google, *research ideas can immediately influence engineering products*, and product experience can directly motivate and shape our research agenda. This is not to say we focus only on shorter term projects; rather, we focus on [the] long term.”¹³

The decision was made at Google to not have researchers researching in an ‘ivory tower’. Instead they all are linked to particular Google on-line products/services, such as machine translation from one language into another (so that the user can search a data base in another language by putting in the query in his/her own language). This means that all Google researchers have direct contact with the products/services to which their research is applied and, very significantly, to the consumer-users of those services who provide them not only with the data to improve their models but also consumer-user feedback regarding context, needs, and problems (e.g. searching using voice within a noisy environment).

In this way, there is very tight-coupling between researcher, artefact (the Google product/service), and the consumer-user.¹⁴ This is in strong contrast to other companies that have chosen to have their researchers loosely-coupled to the company’s business units and consumer-users, precisely so that they can focus on future technologies, products/services, and markets.

As we will now show, there are strong contrasts between Google’s approach and that of Microsoft.

3.2.2 The case of Microsoft

Microsoft’s Global Innovation Ecosystem is described in Exhibit 10.

Microsoft has two closely-related customer concepts (Customers 1 & Customers 2). The first are those companies that pre-load Microsoft’s operating system and software in their computers. These customers are referred to as ‘direct OEM’s’. Also included in the first group are ‘system-building’ customers who use Microsoft’s software as part of the systems that they produce and sell. Microsoft’s second group of customers are final customers. They are divided into: individuals, SMEs, enterprises, government, education, Internet Service Providers (ISPs), and application developers.

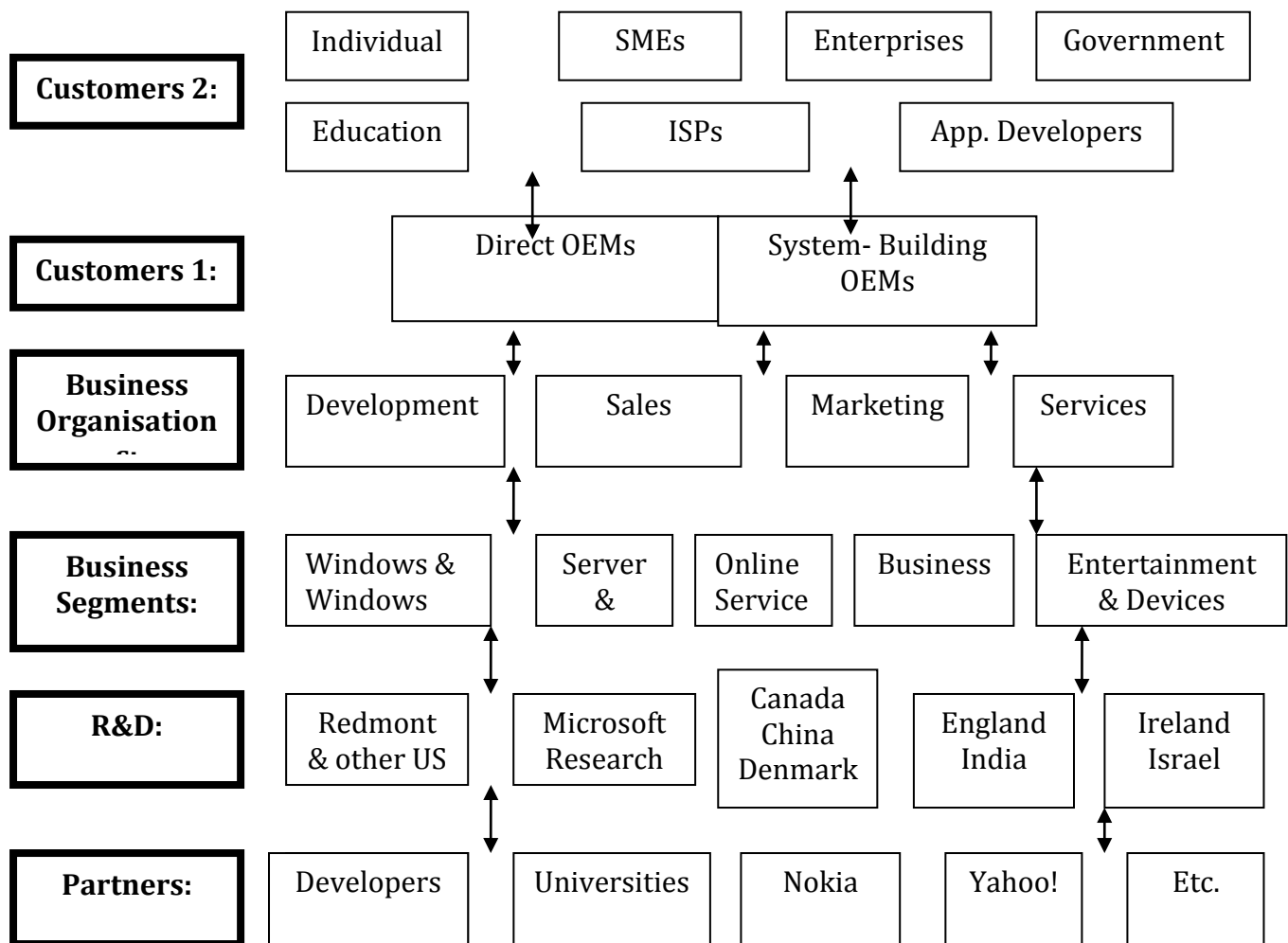
In order to serve these customers Microsoft has four ‘business organisations’: development, sales, marketing, and services.

Support for customers is further divided into ‘business segments’ which include: Windows and Windows Live; server and tools; online services; business; entertainment and devices.

¹³ Source: <http://research.google.com/about.html>, emphasis added by the author

¹⁴ In addition, Google has a large number of products and services, including apart from Search and Advertising, for example, Google Maps, Google earth, etc. These are (for the sake of clarity) not shown in the diagram.

Exhibit 10: The core of Microsoft's Global Innovation Ecosystem



'R&D' is the level that is responsible for generating the innovations that will sustain and refresh all the above activities as well as create the new opportunities for growth that will drive Microsoft's future competitiveness and performance. Most of Microsoft's R&D planning and work is centred in its home-base in Redmont, Washington State, although the company also has a global network of other R&D centres which include laboratories in Cambridge, UK (co-located with Cambridge University's computer science department), and Beijing, China.

3.2.3 The role of research in a GIE: Customer pull and innovation push

How should research be done, how should it be organized, and where in the company should it be located? The different answers given by Microsoft and Google to these important questions highlight how idiosyncratic are the designs of company Global Innovation Ecosystems.

Microsoft's answer is very similar to that of the old AT&T's Bell Laboratories, the most famous industrial research laboratory that produced more Nobel Prizes than any other. According to Microsoft, researchers - the best and brightest, recruited from universities - should be given a great deal of freedom to explore the areas in their fields of specialization that interest them and to come up with ways in which the fruits of their research may be used for the benefit of the company.

Their role is conceived as being similar to that of university researchers. Indeed, in many parts of the world Microsoft's research laboratories are located in key global hubs where excellent

university computer-related research is done. Examples include Stanford University in California, Cambridge University in the UK, and Tsinghua and Peking Universities in China.

Researchers are largely free to make their own decisions regarding the proportions in which they allocate their time and resources to academic research (resulting in academic publications) and Microsoft's development work. However, the company's research centers interact closely through a number of different channels with product development teams in Microsoft's various business units. And the research centers are proud of the important contributions that they have made to new Microsoft products and features, thus justifying the relative freedom that researchers enjoy. The quality of the output of each researcher in research (judged by published academic output) and product development (judged by commercial impact) is evaluated annually by Microsoft research managers and researchers are ranked accordingly. Researchers are rewarded on the basis of their performance.

Google conceives of the role of research in a very different way. It also recruits from amongst the best and brightest university graduates. But research is seen as an activity that is constantly and tightly aligned with the current needs of Google's users (mainly searchers and advertisers, the latter providing 96% of the company's revenue) rather than as a largely open-ended process of exploration. In order to reinforce this close coupling between research and user needs Google embeds its researchers in what it calls engineering centers whose overriding objective is to add value for users through close and direct interactions with them. In these centers user experience teams analyze the company's users in minute detail. Unlike Microsoft, Google sees no role for separated research centers that are relatively autonomous from final users.

Which of the two designs – of Google or of Microsoft – is preferable? The answer depends on how effectively researchers under each innovation ecosystem play the two very different roles that must be played by company research: customer-pull and innovation-push. Customer-pull involves research being 'pulled' by the current or conjectured future needs or wants of customer-users. In contrast, in innovation-push the direction of causation is from new innovations – for example, new science, technology, materials, forms of organization, business concepts – to new possibilities that are opened up which later add value for customer-users.

Companies need to do both kinds of research. While an excessive focus on customer-pull may result in satisfying *current* customer wants and needs, this may come at the expense of taking advantage of new science and technology etc. to generate *future* new opportunities for customers. Conversely, an excessive focus on innovation-push may have the effect of neglecting currently expressed wants and needs.

In short, there may be a trade-off between customer-pull and innovation-push. A dilemma facing managers of research is how to resolve this trade-off in a beneficial way for the company. It is possible that both Microsoft and Google could benefit from adopting aspects of each other's research design. Microsoft could design tighter direct couplings between researchers and final customer-users and Google could give its researchers, although embedded in engineering units, greater leeway to pursue open-ended research. But the fact that it is difficult to predict accurately *ex ante* whether these changes will result in improved competitiveness, growth, and profitability once again highlights the complexity of the innovation process and its consequences and the consequent difficulties that companies face in attempting to organise and manage them.

3.3 What do customers want and what will they want?

Business school textbooks and courses abound with material on 'understanding the needs of customers' and the 'voice of the customer'. This material is important. But in a world of rapid technical and market change more important over time is what customers *will* want. However, frequently customers do not know what they will want for the simple reason that they cannot conceptualise the alternatives that innovation will offer them in the future.

There are many examples. As Steve Jobs' biographer put it, Jobs believed that "customers don't know what they want until we've shown them." He invoked Henry Ford's line: "If I'd asked customers what they wanted, they would have told me, 'A faster horse!'"

Caring deeply about what customers want is much different from continually asking them what they want; it requires intuition and instinct about desires that have not yet formed. "Our task is to read things that are not yet on the page" [said Jobs].¹⁵

Similarly and earlier, Akio Morita, one of the founders of Sony, said: "I do not believe that any amount of market research could have told us that the Sony Walkman would be successful." Therefore Sony came to the conclusion that, "Our plan is to lead the public with new products rather than ask them what kind of products they want. The public does not know what is possible, but we do."¹⁶

The logic behind these beliefs is clearly evident. The problem, however, is that they raise very difficult issues when it comes to designing the symbiotic relationship between a company and its global customers, a key part of any Global Innovation Ecosystem. For example, what practices and processes should a company put in place in order to bring about the kind of innovations that will add value for customers? What alternative solutions are there to the customer understanding problem? Does the answer depend on the kinds of products and customers that the company has? Does the Internet provide new possible ways of dealing with this issue? What lessons are to be learned from the ways in which some of the companies in our sample have dealt with this problem?

In this section two examples will be examined. The first is the way in which the UK telecoms company, BT, has dealt with the issue. The second is Apple where we show that Apple has developed a unique approach to the customer understanding problem based on a Global Innovation Ecosystem that delivers what I will call 'emergent innovation'.

3.3.1 The case of British Telecom¹⁷

Earlier in this paper, in the section on BT, we examined the role of the company's 'External Innovation' unit. One key activity in the External Innovation unit is what BT calls its Customer Innovation Programme.

This programme is focused on leveraging BT's innovation experience and expertise to help accelerate their customers' business strategy and plans. By actively providing access to BT's Global Innovation Ecosystem and engaging customers on innovation BT's customers actually become part of that ecosystem, sharing ideas and helping shape and qualify BT's future innovation plan. This approach creates value for the customers concerned as they are able to draw on BT's expertise as well as creating value for BT by gaining new learning and insights from customers around the company's key research and innovation activities.

The overriding focus of External Innovation on *immediate* solutions to key business and customer challenges sets them apart from Research and Technology which is also part of BT's Innovate and Design (see Exhibit 6). A brief discussion of some of External Innovation's practices and processes will make this clearer.

The first practice that External Innovation has developed is referred to as 'showcasing'. This involves presenting large global customers with a concrete picture of what the future in their area, transformed by advanced technologies and applications, might look like. Fictitious examples might include the future supermarket, retail bank, and connected home. Nothing original thus far. But a key feature of these showcases, constructed in BT's Adastral Park where BT Innovate and Design is

¹⁵ *Harvard Business Review*, April 2012.

¹⁶ Akio Morita, *Made in Japan*.

¹⁷ Note the structure of BT GIE has been presented already earlier under III.a.1

located, is that they embody contributions made by independent partner companies, often venture companies from global hubs such as Silicon Valley or Israel.

The second practice is called 'hot-housing'. This involves identifying the problems of individual customer companies who are part of strategically prioritized market segments. The problems are identified drawing on the knowledge and interactions that sales staff, account managers, and members of External Innovation have with the customers. Customers from around the world are then invited to Adastral Park for several days of intense interactions with engineers, software specialists, usability experts, and researchers whose aim is to develop solution prototypes as soon as possible. Often competing solutions design teams are set up which compete to develop the most useful solutions as quickly as possible. Significantly, at times external players are also included in the teams thus leveraging through the Global Innovation Ecosystem the knowledge and resources of these players.

Both these practices offer answers to the problems posed by Steve Jobs of Apple and by Akio Morita of Sony quoted above who point to the conundrum of consumers being unable to articulate future wants without knowledge of the opportunities that will emerge in the future from improvements in current science and technology, forms of organization, and markets. By exposing customers to the kinds of opportunities that might emerge in the future (through showcasing) and exploring with them solutions to their problems (through hot-housing) BT is hoping to develop a dynamic way of understanding changing consumer wants through a co-evolutionary process involving players in BT, customers, and external partners. The BT case, therefore, illustrates the creative use to which an effective Global Innovation Ecosystem, that incorporates innovative contributions from external players as well as internal ones, can be put.

3.3.2 The case of Apple

The Apple Paradox refers to two paradoxical observations. First, as shown in Annex 1, Apple, has a low R&D-intensity but is a high-performer. Secondly, of the four companies in such category, Apple is the sole non-telecoms operator. We do explain in the Annex why the telecoms operators are high-performers even though they have low R&D-intensities. The reason is that they have in effect outsourced their R&D to their R&D-intensive ICT equipment providers. But how is the Apple Paradox to be explained? To answer this question it is necessary to understand more about Apple's evolution.

As a computer-maker Apple found itself having to survive in the face of a highly dominant player, namely Wintel PCs (based on an operating system provided by Microsoft and microprocessor from Intel) that had the vast bulk of market share. The most important strategy that Apple developed in order not only survive but also to thrive under these circumstances was to develop *design capabilities* that allowed the company to successfully differentiate its products while providing very similar functionalities compared to those of the dominant Wintel standard.

While Wintel provided high IP-protected profit margins for Microsoft and Intel, by making their operating system and microprocessor available to any PC-maker willing to pay the price, the two companies lowered entry barriers into the PC market. This led to significant entry (later also by Asian producers) and, as a result, falling profit-margins. These falling margins squeezed Apple's returns from its computers despite its design advantages.

In turn this prompted Apple's diversification in search of higher profit margins. Not surprisingly the company chose to draw on its distinctive competencies in design. The first successful diversification for Apple was the iPod which, significantly, was not invented in Apple but was sold to the company by a consultant who had previously unsuccessfully tried to sell the device to several other companies. Apple embellished the iPod using its design experience and competence and turned it into the highly successful product that it quickly became, even though the technology embodied in the iPod was already established and not newly developed by Apple.

In time, however, a similar process occurred with the iPod as had happened with Apple's computers: imitators jumped onto the wagon with their own MP3 players and profit margins were eroded. Once again Apple was driven to diversify. This time the diversified products, the iPhone and later the iPad, were created inside Apple, again drawing on its design capabilities. Although once more the technologies themselves were not new, Apple succeeded with the iPhone to challenge in a disruptive way the then-dominant design in the mobile phone market, coming up with a newly designed user-interface, namely a touch-screen. The iPhone, in no small measure due to its appealing design, with great success passed the market-selection test and diffused rapidly, together with the similar but larger iPad, turning Apple for a time into the world's most valuable company in terms of market capitalisation.

With a large and rapidly growing market base the iPhone and the iPad, assisted by the devices' operating system which facilitated the development of applications, soon became an *innovation platform* that supported the creation of complementary assets (applications) that enhanced the value of the platform itself.

Like the telecoms operators referred to in the Annex 1, Apple outsourced much of the R&D-intensive components of the iPhone and iPad. Perhaps most importantly, their R&D-intensive microprocessors were developed not by Apple but by one of the world's largest semiconductor companies, namely Samsung. Somewhat ironically, at the same time as becoming a key player in Apple's Global Innovation Ecosystem, Samsung also entered the smartphone market soon beating Apple in terms of market share in smartphones (if not in terms of profit margin).

Lacking Samsung's global distribution network built up to serve the company's wide range of electronic products Apple turned to an alliance with selected telecoms operators to distribute the iPhone thus incorporating them too into its ecosystem. Assembly was also outsourced, notably to Foxconn, the China-based subsidiary of the Taiwanese assembly company, Hon Hai. The final key group of players in Apple's ecosystem is the application developers already referred to earlier.

Some of the characteristics of the Apple Global Innovation Ecosystem are summarised in Exhibit 11.

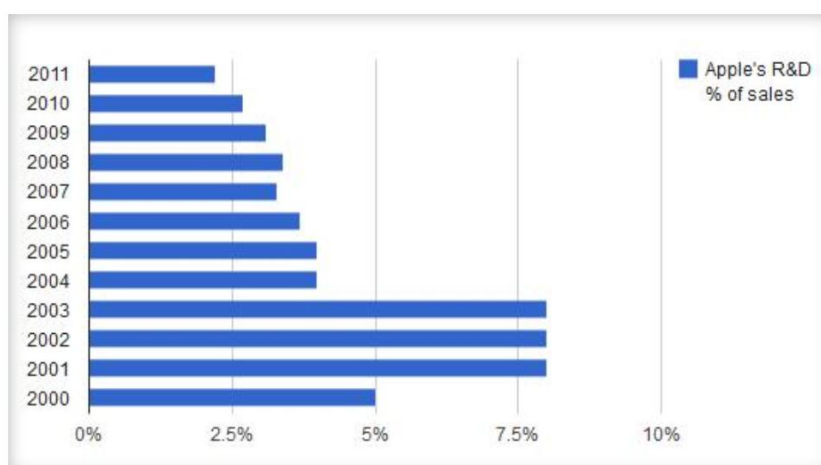
Exhibit 11: Characteristics of Apple's Global Innovation Ecosystem (source: Financial Times)

- March 6, 2008: Apple makes available a toolkit for third-party developers to develop apps for the iPhone
- The kit was downloaded more than 100,000 times in the first four days
- Mid-2012: 248,000 developers produce 550,000 apps for Apple devices
- Apple takes 30% of the revenue received by app developers from the app Store
- From 2008-2012 there were 446,000 app-related jobs created in the US alone
- Apple devices distributed primarily by local telecom operators
- Microprocessors for the iPhone come from Samsung; many of the other devices come from Asian semiconductor partners
- Assembly largely done in China by Foxconn/Hon Hai, a Taiwanese company, which employs about 1 million workers in China

According to conventional practice the 'high-tech; low-tech' distinction revolves around company R&D-intensity. According to this conceptualisation, however, not only is Apple a low-tech company, it is if anything becoming a highly innovative, lower-tech company over time! This is evident from Exhibit 12.

Indeed, as shown in Annex 1, Apple has by far the lowest R&D-intensity of all the companies listed in Layers 1 and 3 of the ICT Ecosystem. It is only in Layer 2 that major ICT companies are to be found with lower R&D-intensities than Apple and these are incumbent telecoms operators. However, as we have also established through a brief history of the evolution of Apple, the company is also highly innovative and this explains its extraordinary market capitalisation. Highly innovative but very low-tech: this is referred to in this paper as the Apple Paradox.

Exhibit 12: Apple's R&D Intensity



Credit: Larry Dignan / ZDNet

Source: <http://www.cnet.com/news/apple-r-d-as-percent-of-revenue-hits-a-low/>

Two determinants go a long way towards explaining the Apple Paradox. The first is the important role of design in determining Apple's competitiveness, as was discussed in detail in the history of the evolution of Apple. But design is not included in the conventional measurement of R&D.

The second determinant is Apple's decision to in effect outsource many R&D-intensive processes that are crucial for its main products. A notable example are microprocessors which are largely outsourced to Samsung which, although it is part of Apple's innovation ecosystem, is also a major competitor, indeed the leader in terms of market share, as we have seen, in the smartphone market.

In terms of the outsourcing of R&D-intensive processes Apple is more like the incumbent telecoms operators in Layer 2 of the ICT Ecosystem than it is like the other players in Layers 1 and 3. Other companies, however, that are far closer to Apple in terms of similarity of many of their products have made very different strategic choices regarding the division of R&D labour within their Global Innovation Ecosystems. Again, Samsung provides a good example. As Exhibit 17 shows, Samsung's R&D-intensity is some three times that of Apple's. Furthermore, Samsung is far less specialised – both horizontally and vertically – than Apple. Yet these differences have not prevented Samsung from outperforming Apple in the smartphone market in terms of market share and smartphones shipped, if not according to profit margins, as shown in Exhibit 13.

Exhibit 33: Who benefits from the Smartphone Ecosystem? – Apple versus Samsung

Performance indicator	SAMSUNG	APPLE
Smartphone market share	23.8%	14.6%
Smartphone profit margin	16.9%	30.8%
Smartphone shipped	27.8 m	17.1 m

Source: *Financial Times*, Oct. 2011

3.3.3 What consumers want: from hothouse solutions to emergent innovation

We referred earlier to what may be called the 'Consumer Demand Paradox', namely, the question regarding how consumers can express a demand for something that does not yet exist and which they cannot conceive of since they lack knowledge of the underlying new technologies and designs (pent-up demand). But if they cannot express a demand for these new things how can the firms making them calculate the returns they are likely to get?

We have seen BT's answer to this paradox which involves bringing customers together with BT's developers and external players in order to 'hothouse' solutions. Apple's Global Innovation Ecosystem, however, has another way of dealing with the paradox, a solution that involves what may be referred to as *emergent innovation*.

What is 'emergent innovation'? The best way to answer this question is to explain how it works in the context of the development of new applications (apps) in Apple's Global Innovation Ecosystem.

Whether intended or not, Apple's solution makes use of the principles of evolution. Ex ante, of course, it is uncertain whether any particular app will be selected by a significant number of Apple's subscribers. Given that there is an important degree of novelty in all new apps consumer-users first have to experience the app and learn what it can do before they can form a conclusion about how useful it is and, therefore, how much they are willing to pay. Business models that involve a combination of free apps plus paid-for additional features facilitate this experience-learning process by in effect subsidising the learning period. Naturally, each individual app provider starts by creating a *value-creating conjecture* in which he or she hypothesises about what will add value for consumer-users. The belief behind the individual app may turn out to be right, or, alternatively, it may prove to be wrong.

However, Apple's ecosystem, which provides significant incentives for app developers (who get 70% of the revenue generated from the sale of the app), facilitates the creation of a large *population* of apps. And there is considerable *variety* within this population. It is the consumer-users who *select* from this variety thus deciding which apps will be 'fit' enough to be reproduced and refined. Since, essentially, evolution equals variety plus selection, Apple's Global Innovation Ecosystem is in this way able to generate an evolutionary process out of which successful innovative apps, which meet customer-users' requirements, *emerge*. This process may, accordingly, be referred to as *emergent innovation*. In this process app innovations which also diffuse *emerge* as an *outcome* of the process. The generation of a large *population* of apps containing significant *variety*, together with a *selection* process that determines fitness, thus provides a solution to the Consumer Demand Paradox.

Before leaving this topic, however, it is worth noting that Apple was not the first company to create an emergent innovation solution to the Consumer Demand Paradox in the mobile phone space. In Japan, more than a decade earlier, the mobile subsidiary of the country's incumbent telecoms provider, NTT, created iMode which was based on essentially the same evolutionary process. DoCoMo's ecosystem, however, was, firstly, restricted to its subscribers and, secondly, was available only to users in Japan, thus constraining the overall growth of the ecosystem.¹⁸

¹⁸ For further details on DoCoMo's iMode see Fransman, M. (2003). *Telecoms in the Internet Age – from boom to bust to...?*. Oxford University Press.

4 Do the Layers of the ICT Ecosystem affect the Nature of Global Innovation Ecosystems?

Do company-level innovation ecosystems differ by layer in the ICT Ecosystem? Casual empiricism suggests that they do. This is evident, for example, from observation of Layer 3 – the platform, content and applications layer – where it is immediately apparent that Internet-related companies have created a hotbed of entrepreneurialism and innovativeness that is rapidly changing not only this layer and the ICT sector but also the entire global economy.¹⁹

What is it about the innovation process in Layer 3 that has facilitated this hothouse of entrepreneurial and innovative activity? This is the question that will be answered in the first part of this section. We will then go on, although much more briefly, to contrast the innovation processes in Layers 2 and 1.

4.1 The Internet Innovation Platform (Layer 3)

4.1.1 The Internet Innovation Platform characteristics

The argument that will be developed here is that the innovation process and the company-level innovation ecosystems that have emerged in Layer 3 have been crucially shaped by what we will refer to as the Internet Innovation Platform. It is the special characteristics of this platform that have provided some of the key conditions that, in turn, have facilitated the emergence of robust entrepreneurship and innovation. Significantly, however, these characteristics are the product, not only of Layer 3 itself, but also of Layers 1 and 2 – that is, are a function of the ICT Ecosystem as a whole.

These characteristics can be summarised as following:

- Availability of network services,
- Open low-cost access,
- Relatively low fixed costs,
- Very low marginal costs,
- High consumer surplus,
- High scalability.

We will now review briefly the characteristics.

Network services: In order to provide their offerings the Internet Content and Applications Providers (henceforth ICAPs) obviously required that Internet access and related equipment (including PCs, servers, routers, etc.) be in place. This required the prior evolution of these products and technologies.²⁰ The infrastructure on which the Internet runs and the related equipment and

¹⁹ One remarkable example is the Internet content and applications companies that have rapidly emerged in China's Layer 3, companies such as Alibaba, Tencent, and Sina Weibo. Not only have these companies emerged in an unprecedented short period of time, they have quickly become some of China's largest in terms of market capitalisation. Even more significantly, at the time of writing some of them are beginning to raise significant amounts of capital on global capital markets and are starting to challenge the US Internet companies that have dominated the Internet worldwide. The jury is still out regarding their likely success in making this challenge).

²⁰ It is worth noting here that technologies and the knowledge they embody, like Darwin's species, evolve. They evolve by shaping the products and services that firms sell. It is the market (and particularly its demand side) that plays the role of Darwin's nature, selecting some products and rejecting others. The technologies embodied in the successful products are reproduced by the firms that sell them and in this way become more prevalent over time.

services are provided by the firms in Layers 2 (including network operators and Internet service providers) and 1 (ICT equipment providers).

However, also important were the conditions under which the ICAPs and their would-be customer-users were able to access the Internet, the services and applications that run on it, and its equipment.

Open low-cost access: From the ICAPs' point of view low entry barriers are important pre-conditions. The first of these is that they obtain open access to the Internet in order to develop their websites and start their business. 'Open access' stands for a multiplicity of conditions that allows them without much constraint to pursue their entrepreneurial business concept on the Internet. For example, they do not need licenses or other permission and the availability of many Internet service and equipment providers, and strong competition between them, means that they can get the reliable facilities that they want.²¹

Relatively Low Fixed Costs: Secondly, these facilities are available at relatively low cost. While this means that variable costs are low, so too are fixed costs (including sunk costs). Accordingly, start-up cost is not a major obstacle for an entrepreneur wishing to implement an Internet-based content or application value-creating proposition.

The resulting relatively low start-up cost makes Internet entrepreneurship attractive to many younger entrepreneurs who are not necessarily well-placed to raise substantial amounts of capital. Skype, Google, eBay, Amazon, Facebook etc., all provide good examples.^{22 23}

These two conditions, - open and low-cost access - mean that entry barriers into the Internet content and applications part of Layer 3 are relatively low. In turn, this facilitates substantial entry, strong competition, and a flurry of entrepreneurial activity in this layer from the mid-1990s.

Very low marginal costs: This buzz of action was due, not only to low entry barriers, but also to several other co-determining stimuli. The ICAPs were able to reap substantial benefit from one of the most remarkable characteristics of the Internet, namely the very low producer marginal costs that it facilitates. Marginal costs in this context refer to the cost of providing content or an application to one extra customer.

The case of Skype illustrates this important point very well. For Skype this means the cost of providing its Internet communications software (that makes available features such as voice and video communications) to an additional customer. As a result of the low reproduction cost that the Internet facilitates (all the user has to do is go to Skype's website and download the free software), Skype's marginal cost is effectively zero. Once the software has been developed and put in place the extra cost to Skype of providing its voice over the Internet application to one additional customer is zero. This has further profound consequences for it makes possible a price of zero (provided that the supplying firm can find other ways of recovering its fixed costs and earning a sufficiently attractive profit to make the whole exercise worthwhile.²⁴). Skype does this through its charged products that complement its free Skype-Skype offering.)

High consumer surplus: Up to this point only the supply side, from the perspective of the content and applications providers, has been analysed. But this is only half the story of the Internet Innovation Platform. The other half lies on the demand side, from the point of view of the consumer-users of the content and applications.

²¹ For example, low switching costs often gave ICAPs flexibility as well as low cost.

²² For detailed studies of the origins of these ICAPs see Martin Fransman, *The New ICT Ecosystem: Implications for Policy and Regulation*, Cambridge University Press, 2010.

²³ In stark contrast, in other parts of the ICT Ecosystem start-up costs are extremely high. Examples are in Layer 2 where infrastructure-based new entrant network operators have very high fixed (including sunk) costs, as do semiconductor fabricators in Layer 1.

²⁴ See Shapiro and Varian, *Information Rules*, Chapter 2, for further details.

From the consumers' perspective the key point is the substantial benefit they derive from consuming the content and applications they select on the Internet. .

To begin with, the cost to consumers of accessing Internet-based content and applications is for most users relatively low.²⁵ This is due to a number of factors. Competition between Internet access providers (telecoms and cable operators and virtual operators who buy capacity and resell it to consumers) and regulation have lowered access prices. Furthermore, competition between equipment vendors (e.g. between PC and server suppliers) has reduced the price of equipment needed.

There is another important factor. This is the practice of flat-rate pricing for Internet access in fixed, and now increasingly also in mobile, broadband access. This practice itself has emerged from competition between Internet access providers and rapidly evolving technology that has increased capacity, e.g. xDSL and optical fibre. Flat-rate pricing (even with limits on the total quantity of data) means that from the consumer's point of view once the flat-rate has been paid the additional (marginal) cost of consuming content or an application is zero. The same is true for the consumer's extra equipment cost (since PCs typically have excess capacity). Once the consumer already has a PC, tablet or smartphone the additional equipment cost of accessing the Internet and its applications is zero. This implies that the consumer's marginal cost of adopting an extra unit of content/application is zero.²⁶

Against this low marginal cost of adoption the consumer must weigh the marginal benefit of adoption. This benefit is based on the consumer's calculation of the utility derived from the consumption. But the consumer will also take account of any additional benefit that may follow from this consumption.

Skype's voice and video applications provide a good example. In addition to deriving benefit directly from the call the consumer will also benefit from not having to pay his/her telephone or cable company (or paying less than what this company charges) for the call.²⁷ Adding these two benefits and weighing them against the zero marginal cost gives the consumer a substantial net benefit from the decision to consume Skype products.

This is a rather formal neoclassical economics-based account of the consumer's consumption decision. Less formally the consumer might say, "It is free for me to make a Skype call to another Skype user and, on top of that, I am saving a good deal by reducing my bill from my usual provider."²⁸

To conclude, the circumstances analysed here – themselves the result of the evolution of the Internet, its equipment, technologies and services – have combined to give consumers significant benefit from their consumption of Internet-based content and applications. This has brought eager consumers to the table, ready to select from the meals that competing innovative Internet-based entrepreneurs have cooked for them.²⁹

²⁵ Relative cost should be thought of relative to the consumer-user's income. For most users in industrialised countries and for upper and middle class users in developing countries, this cost is relatively low compared to many other items that make up their expenditure, usually around 2-3% of income.

²⁶ This ignores the opportunity cost of the consumer-user's time which under some circumstances may become a relevant consideration in making the consumption decision including the timing of consumption.

²⁷ The costs and benefits to the consumer of Skype's other applications will be calculated in a similar way.

²⁸ Some readers may question whether this formal account of the consumer-user's consumption decision provides a reasonable explanation of how they decide whether or not to consume the content/application. My answer is that even if the consumption process does not take place in precisely this way, and even if detailed calculations of the cost and benefit are not made, nevertheless these are the general considerations that will influence the consumer-user's decision.

²⁹ It is worth noting at this point that the analysis of the consumption decision in this subsection is static in the sense that the costs and benefits of consumption are assumed to be given. While this may throw light on part of the process, of greater relevance to the concerns of the present paper is how innovative

High Scalability: A further remarkable characteristic of the Internet Innovation Platform is its scalability (a characteristic that has surprised even the Internet's founders such as Vinton Cerf). This means that ICAPs are able to increase their output by orders of magnitude without significantly raising their marginal cost thus allowing them to maintain low prices. Equally importantly, high scalability means that with an increasing number of subscribers average cost falls making the business potentially more profitable.

Furthermore, with the widespread global adoption of the Internet, scalability crosses national boundaries allowing successful ICAPs to very quickly (and at low cost) reach global audiences. For example, Skype's more than 443 million subscribers are spread around the world as are the customers of other Internet companies that have grown globally at astounding rates, companies such as Facebook, Amazon, Twitter and eBay.

The resulting free Internet economy: The Internet, of course, is not the first or only place to offer free goods. But the Internet's characteristics (specifically very low reproduction and distribution costs) create for the first time the possibility of providing free goods on a substantial scale and over a global geographical area.

The free Internet economy which has evolved around the Internet and its characteristics has had profound consequences. Innovation motivates and incentivises consumption and investment. This is certainly true in Layer 3 where the innovative content and applications provided by the ICAPs have encouraged both consumption and investment. But the consequences of the free Internet economy go even further.

By catching the imagination of consumer-users (to a significant extent by the provision of innovative free content and applications) the free Internet economy has drawn a substantial proportion of the world's population from all groupings into what may justifiably be described as a new economic and cultural milieu. The recent concepts of Web 2.0 and social networking are indicative of this new culture. A related example is the new role that consumer-users, as discussed earlier in this paper, have come to play as proactive players in the innovation process itself.

As part of this culture the Internet has created in Layer 3 a new innovation platform. The possibilities provided by this platform are illustrated by Skype's innovative activities analysed in the following section. Skype offers a dramatic example of what is possible.

4.1.2 The case of Skype

At the end of the first quarter of 2009 Skype, as already noted, had over 443 million registered users around the world. At peak times, there were more than 17 million concurrent users and 300,000 simultaneous calls being made via Skype. Skype accounted for 8% of the world's international calling minutes in 2008 according to data released by TeleGeography Research.³⁰ In the fourth quarter of 2008 Skype-to-Skype minutes (i.e. the company's free service) reached nearly 20 billion, a 70% increase year-on-year, and SkypeOut minutes (the charged service) increased almost 70% over the previous year. Skype's 443 million registered users have made more than 100 billion minutes worth of free Skype-to-Skype calls. Skype is available in over 28 languages and is used around the world.

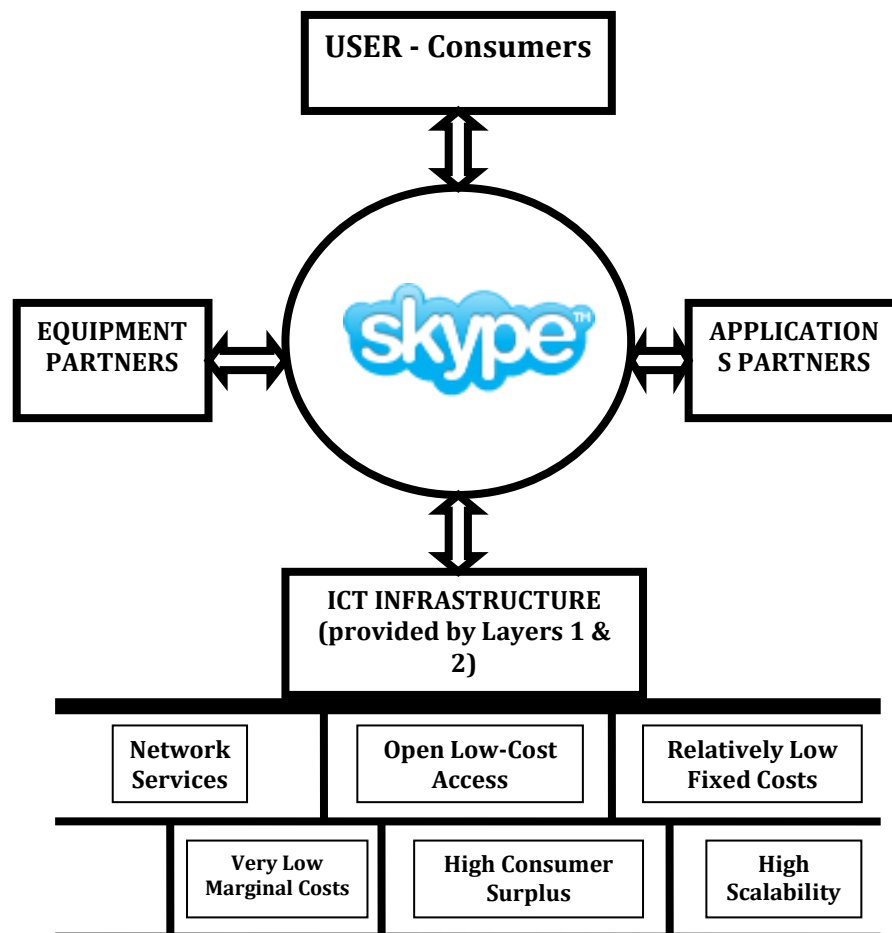
In Exhibit 14, the Skype Innovation System 'sits on top of' the Internet Innovation Platform as described earlier with its six 'building blocks' (hence the platform metaphor). Less graphically, as already mentioned, the building blocks provide the context within which Skype interacts with the co-creators and users of its innovation knowledge. This context, it should be noted, not only helps to define demand and supply conditions but also determines motivations and incentives. For instance, as was pointed out earlier, the high net benefit often provided to the consumers of

content, applications and equipment is produced and evolves over time. Later in this paper Skype will be used to illuminate this innovation process.

³⁰ *Telegeography*, 24 March 2009 (http://www.telegeography.com/cu/article.php?article_id=27800, last accessed 08/06/09).

Internet-based content and applications, together with low information and search costs and the other advantages discussed earlier, has brought consumers eagerly to the table ready to choose from the many offerings provided by the ICAPs.

Exhibit 14: The Skype Innovation Ecosystem



Skype has been able to provide substantial value (net benefit) for its customers (see above). Evidence for this conclusion comes from its large number of subscribers as well as the rapid growth both in numbers of users as well as minutes used.

Underlying Skype's relationship with its user-consumers is a tacit agreement giving them free Skype-Skype voice and video in return for them agreeing to make available a tiny amount of the excess capacity in their PCs, tablets and smartphones which are used for Skype's peer-to-peer software. Charged calls made to PSTN fixed and mobile subscribers allow Skype to recover its fixed cost and earn some profit. (Peer-to-peer keeps costs down and utilises bandwidth more efficiently by avoiding the use of servers, a significant cost that many other ICAPs have.)

But this is just the beginning of Skype's innovative interaction with its user-consumers. By getting to know more about its users' needs and the context of their use, Skype and its co-developers are able to create further innovations, thus improving user benefits. Many of the co-developers are also Skype's user-customers as are Skype employees themselves. This generates a further feedback loop, similar to the one from external user-consumers, which provides an input into the innovation process.

One example of adding to user benefit through innovation is SkypeFind³¹ that allows users to provide information about their favourite businesses and creates a communications link with these businesses.

Some of Skype's innovations emerge from its collaborations with partners. Application developers are one type of partner. Also, Skype collaborates with over 190 hardware manufacturers. Skype interacts with a community of around 14,000 software developers who independently create plug-ins that produce improved functionality for users (e.g. games, business applications, recording, web conferencing and application sharing, high-speed conferencing involving up to 500 people, call centre and customer management for SMEs, etc.).

Innovations in equipment enhance and extend the way in which users/customers experience Skype products. These improvements are made as Skype applies its knowledge of its users in collaboration with equipment providers. Examples include web-cams, Internet-enabled TV sets, mobile and WiFi phones, and cordless phones. Collaborators include Sony, Nokia, Intel and Panasonic. Skype has been developed as an application for use across various mobile platforms, including a version of the iPhone. More than 190 Skype-certified hardware products have been developed.

Skype also interacts with network operators and equipment vendors (who provide elements such as PCs, servers, routers, switches, transmissions systems, etc.) located in Layers 2 and 1. While these firms provide the infrastructure that Skype's customers require in order to access the company's services, it is the content and applications provided by Layer 3 firms such as Skype that generate the derived demand for this infrastructure. In this way, mutual benefit is generated. However, the symbiosis with network operators has raised questions about the funding of network investment.

The interaction between content and application providers in Layer 3 and network operators and equipment vendors in Layers 2 and 1 constitutes one of the core relationships in the ICT Ecosystem. For example, it is reasonable to assume that the availability of Skype's voice and video features has stimulated many of Skype's subscribers around the world to purchase PCs, laptops, tablets and smartphones or expand their network capacity (although the data does not exist to quantify this effect).

One example of cooperation with network operators is Skype's collaboration with mobile operator, Three,³² allowing users to make Skype-Skype calls and send instant messages from their mobile phone. Another example is Skype for Your Mobile allowing Skype-Skype communications without dependence on a PC, WiFi zone, or any special phone. However, it must be noted that other operators intended to block Skype rather than cooperate.

In this section, Skype has been used to illustrate the kind of company-level innovation ecosystem that has been facilitated in Layer 3 using the Internet Innovation Platform. It has been shown that it is both the characteristics and the economics of this platform that has fostered rapid entry by large numbers of entrepreneurial companies, under conditions of intense competition, that have generated a vast amount of new content and applications which, in some notable cases, have had revolutionary consequences for other parts of the global economy.

³¹ Source: Skype Support: "SkypeFind is a community-edited directory of business numbers. (...) SkypeFind relies on the Skype community to add and maintain business listings. All the businesses you find in the directory have been entered, reviewed, and edited by other people on Skype, making them more relevant for community members."

³² Three: Official name of this mobile operator in the UK.

4.2 Layers 1 and 2: driven by contradictory forces

But what about the other two layers of the ICT Ecosystem? Are their innovation ecosystems different from those in Layer 3 and, if they are, in what way are they different?

4.2.1: Layer 2

The industrial structure in L2 is fundamentally different from the other two layers. More specifically, due to a combination of very high fixed costs combined with very low marginal costs, significant economies of scale, and substantial entry barriers, L2 is dominated by a small number of network operators.

These structural determinants have triumphed contrary to the determined efforts of industrial-policy-makers and regulators from the mid-1980s to generate significantly increased competition in L2. The strong steps that they took to increase competition included: regulations forcing incumbent network operators to allow access to their networks to competitors at long run incremental cost-based prices; structurally separating the incumbent's local access services from the rest of its businesses (e.g. in the case of BT in the UK); and even breaking the incumbent up into a number of distinct companies (e.g. in the case of AT&T in the US where long distance services were separated from local services, new long distance competitors to AT&T introduced, and local services being provided by a number of distinct, competing companies, the so-called Baby Bells).

In the short run these policies resulted in substantial entry by determined would-be new entrant network operators, who included companies such as WorldCom and Global Crossing in the US, Colt and Energis in the UK, Softbank in Japan, and Iliad in France. With the passage of time, however, the structural forces referred to earlier exerted their effects and most of the new entrants vanished (largely through merger and acquisition) their disappearance hastened by the so-called Telecoms and Dot Com busts that occurred in 2000.³³ Only a few of the new entrants survived, including, notably, Softbank and Iliad. Currently L2 is dominated by a very small number of companies in all countries, even the large ones such as the US, China, Japan, and Germany. Judged by result, therefore, these attempts to restructure L2 turned out to be one of the more remarkable misadventures in the field of industrial policy in recent times although it is true that the degree of competition between the few players who dominate this layer far exceeds what existed before the mid-1980s during the monopoly era in L2.³⁴

One of the most interesting features of the network operators in L2, however, is their failure to diversify into L3 despite many attempts.³⁵

The explanation of this failure to diversify into the potentially lucrative L3 hinges on the very different innovation processes that dominate in L2 and L3. In turn, these innovation processes require fundamentally different company-level innovation ecosystems with distinctive relationships and dynamics between the players. This also implies that Capabilities required for producing Layer 3 Digital Services are fundamentally different from capabilities necessary for Layer 2 Network Services. Some of these differences are summarised in Exhibit 15.

³³ Fransman, M (2004), The Telecoms Boom and Bust 1996-2003 and the Role of Financial Markets, *Journal of Evolutionary Economics*, Vol 14, No 4, October 2004, 369-406.

³⁴ It is worth stressing that this conclusion should not be interpreted as the author's general view on industrial policy. In fact, there are many instances in the ICT Ecosystem where industrial policy has been extremely effective, China's Internet content and applications providers in its L3 being a notable example.

³⁵ We have already explained earlier in this paper the shifting and evolving division of labour between these operators in L2 and the ICT equipment providers in L1, a division which determines the boundary between these two layers.

Exhibit 15: Different layers require different capabilities

L3 Digital Service Providers	L2 Network Service Providers
Produced largely by Internet start-ups using Web 2 approaches. These are essentially software companies which create customised software to implement their Internet-based business concepts. Their core assets are people and software. A key focus is on customers and their evolving needs and problems.	The core asset is the network. Well-developed optimisation processes ensure the efficient operation of the network infrastructure. A key focus is the network and its requirements.
Capabilities are mainly software-based making use of both new in-house customised software and open source software. Software methods are adaptive and flexible (e.g. agile). The symbiotic relationship with the customer dominates the relationship with suppliers.	Capabilities are network oriented, both in terms of hardware and related proprietary software. Networks are designed using predictable standardised interfaces. Vendors produce interoperable solutions using these interfaces. The RFI, RFP, RFQ process dominates. Telco's procurement departments are key players. The symbiotic relationship with vendor suppliers dominates the relationship with customers.
Customer tastes, needs, and problems change rapidly. Digital service provider capabilities have adapted accordingly. Examples are market releases based on permanent beta approaches; continuous feedback from users; ability to respond rapidly.	For telcos network quality of service is of the utmost importance. This requires a high degree of predictability. In turn, management and capabilities are rule driven and relatively inflexible in the short run. Response time, accordingly, tends to be slow.

Source: Author's views

However, *innovation platforms* have also been important in L2 even though the characteristics of these platforms are very different from those of the Internet Innovation Platform in L3 analysed earlier. Key examples are the use by Vodafone and Telefonica of their global networks as an innovation platform used to encourage value-adding complementary activities by external players. This was discussed in greater detail earlier in this paper, in the sections dedicated to these telecoms operators.

4.2.2 Layer 1

In L1 there is far greater heterogeneity in type of company-level innovation ecosystem. However, one key distinction is between those companies that have innovation platforms, on which goods and services are produced for which there is substantial demand, and those that do not. These platforms may be closed or open. An example of the former is Apple's iPhone and iPad platform while Google's Android mobile platform is an instance of the latter.

On the other hand, there are ICT equipment providers who either lack an innovation platform on the basis of which to engage complementary value creators or who do have platforms but without substantial demand. On the whole, the major Japanese ICT equipment providers – such as Fujitsu, Hitachi, and Toshiba – fall into this category. Obviously, their lack of viable innovation platforms influences the company innovation ecosystems that they have created. In many cases they have joined the platforms controlled by other companies.

One important characteristic of Layer 1, however, is relatively low entry barriers, relative at least to L2. A notable example of entry into L1, which has had profound consequences over the last decade for the entire layer, is the entry by the Chinese companies Huawei and ZTE. Significantly, their entry has been facilitated not only by relatively low factor prices – e.g. relatively low-paid, by international standards, engineers who work far longer hours than in the US, Europe, and Japan – but also by substantial innovation. Although relatively low price was undoubtedly an initial attraction, Huawei's entry into the European telecoms operator equipment market also required a

credible commitment to becoming not only a reliable supplier but also an innovative one. Huawei is justifiably proud of the way in which it focused on the production of innovative solutions to the problems faced by leading telecoms operators, notably BT and Vodafone in the first instance as well later as many of the other leading European operators. This required the gradual building of close partnerships with these operators. These changes occurred in L1 as a result partly of new entry and consolidation.³⁶

³⁶ Annex 2 offers a brief approach to those developments.

5. Conclusions

5.1 Main insights

The material presented in this paper makes it clear that for large companies knowledge located outside the company and outside the company's country is becoming an increasingly important source of that company's innovation. Although not shown in this paper, the same holds true for small companies, an increasing proportion of which are 'born global'. The emergence of new patterns of organisation for innovation go hand in hand with the globalisation process and the earlier consolidation of global supply chains. These relationships mutually reinforce each other.

Also clear is that new innovative forms of organisation are needed in order to access and use this knowledge effectively to contribute to achieving the company's objectives. Much of this organisational innovation is still of an experimental nature.

However, whilst the increasing use of outside knowledge and experimentation with new forms of organisation to productively use this knowledge seem to be widespread amongst large ICT companies, there is far greater variety amongst them in terms of how reliant a company should be on outside knowledge and how to go about mobilising and using this knowledge.

One important conclusion is that caution is needed when drawing inferences about the importance of R&D as a driver of innovation. This is true at both the company and country levels. Whilst the distinct activities of research on the one hand and development on the other are usually important parts of the innovation process, this process is much wider and involves many other players and processes than those involved in R&D alone.

Furthermore, as shown in this paper, companies are plugging into *global* sources of knowledge, thus reducing the importance of purely national sources of knowledge in general and R&D in particular. One important implication is that policy-makers need to know much more about the Global Innovation Ecosystems that significant companies (both large and small) in their strategic sectors are constructing so that, in the light of this knowledge, they will be in a better position to design supportive innovation-related programmes and processes.

Additionally, policy-makers will need to assess where and with whom innovation creates social or economic value. The current financial, fiscal and other public instruments often support specific companies, ignoring the importance of global innovation networks for the size and location of the impacts.

One of the contributions of the present paper is to demonstrate the necessity, if the process of innovation is to be properly understood, of a simultaneous analysis of Global Innovation Ecosystems at both sector and company levels.

In pursuing access to external knowledge, companies aim at setting up a Global Innovation System capable of answering the three following questions:

1. How should companies access external knowledge and resources and incorporate external players in their Global Innovation Ecosystem in a win-win way?
2. What role should Research play in a Global Innovation Ecosystem and how should it be organised?
3. What do customers want and what will they want?

The analysis shows that there are different kinds of company's Global Innovation Ecosystems in the three layers of the ICT Ecosystem, each of them being different in structure and purpose and still at an "experimental" stage. Those various Global Innovation Ecosystems alternatively show internal or external-to-the-company structures; customer pull versus innovation push; hothouse solutions versus the experimentation with emergent innovation.

This experimental variety, largely rooted in path dependency (the sector and the company existing ecosystem) is expected to benefit from a selective process by the market.

In addition, in Layer 3– the platform, content and applications layer of the ICT sector ecosystem–there seems to be a unique hotbed of Internet-related entrepreneurship and innovation along with massive entry by new companies.

The key determinant for this emergence is seen as the Internet Innovation Platform and its six key characteristics that together make it ideally suited to facilitating the entry of new, innovative companies. These characteristics can be summarised as following:

- Availability of network services,
- Open low-cost access,
- Relatively low fixed costs,
- Very low marginal costs,
- High consumer surplus,
- High scalability.

Finally, although this paper has not shown many examples of the 'growth economies' (i.e. the BRICS + Korea, Indonesia, Turkey and Mexico) providing a significant source of knowledge for companies' Global Innovation Ecosystems, it should be anticipated that this will happen increasingly in the future. Particularly important will undoubtedly be China which is making rapid strides towards becoming a science, technology and innovation-driven economy rather than one solely based on relatively low-cost manufacturing. The innovation 'hot spots' (locations as well as companies) that are already emerging in China will surely become increasingly important as pools of knowledge and resources for global innovation ecosystems as Silicon Valley already is.³⁷

5.2 Future research questions

An important area for future research involves closer examination of these exploratory experiments in order to a) document and categorise what companies are doing in this field, b) evaluate the effectiveness of the resulting innovation and the effects on performance and c) assess how those organisational changes affect the market itself (competition).

Further, a significant question is whether there are systematic differences between large and small companies in terms of the relative importance of outside knowledge (outside both the company and the country) used in the innovation process. Although there are costs in leveraging and using such outside knowledge, the global ubiquity of increasingly powerful ICT equipment and networks reduces some of these costs, increasing the feasibility of the 'outside option' for SMEs. Again, this is an important area for further systematic research.

Another important topic for further research is to establish whether the emerging patterns examined in this paper in the context of the ICT Ecosystem are being replicated in other parts of the tradable goods and services sector or whether there are systematic differences. My hypothesis is that similarities do indeed exist although more evidence is needed to confirm or reject this supposition.

³⁷ For a brief approach to this evolution, see Annex 2

5.3 Implications of Global Innovation Ecosystems for policy making

In this paper it has been suggested that company-level Global Innovation Ecosystems are becoming more important in the ICT ecosystem (and perhaps in other parts of the economy too). Companies are increasingly coming to depend on other players (both company and non-company players) for their innovation and, furthermore, that these players are likely to be spread around the world. In short, innovation is becoming a joint output rather than primarily an activity undertaken by a single company. This challenges conventional thinking in a number of policy areas as will be shown in this section.

5.3.1 Technology transfer

The conventional view of technology transfer is that it involves transfer – of technology, knowledge, skills, ideas or artefacts – from one single unit to another. The transfer in question may be between individuals, companies, countries, or different kinds of organisations (e.g. from universities to companies).

In the case of Global Innovation Ecosystems, however, the transfer, in order to be effective, will often have to involve multiple players thus complicating the exercise and, in some cases, reducing the effectiveness of the transfer.

As always, the existence of tacit knowledge³⁸ may well make the transfer process more difficult and costly. But the problem is likely to be compounded when there are multiple parties to whom transfer is necessary.

In some cases, however, the use of a modular organisational design may mitigate the problem.³⁹ The reason is that modular design may limit the need to transfer knowledge. Producers specialise by module and to the extent that this is realised all they need to do, in order to produce a coherent modularised system, is to have knowledge of the interfaces between their module and the other interoperable ones. The increasing prevalence of GIEs, therefore, may produce incentives for modularisation.

5.3.2 Intellectual property rights

According to the conventional view the key issue is the link between property rights and the incentive to innovate. By restricting the right of others to use the knowledge embodied in the property right the opportunity is given to the creator of that knowledge to appropriate returns from the investment that has been made in producing the knowledge. It is these returns that provide the incentive to create the knowledge in the first place. Hence, it is argued, intellectual property rights must play a key role in any effective innovation system and this explains why some forms of intellectual property right protection has evolved in all countries.

Several complications in the area of intellectual property rights arise with the emergence of Global Innovation Ecosystems. These complications are the result of the *joint* creation of innovation by a number of cooperating players. The numerous patents cases are a testimony to these difficulties

The problem is that at the heart of a Global Innovation Ecosystem lies a significant conflict. This conflict arises from the fact that within GIEs *joint creation of value* is usually accompanied by *unequal appropriation of that value*. For example, ownership of a platform (where ownership is exercised through intellectual property rights), particularly where there is significant demand for the output created by the platform players, may put the owner in a strong position to demand and receive a disproportionate share of that jointly created value.

³⁸ Tacit knowledge – according to Polanyi in his 1958 book, *Personal Knowledge* – exists when we know more than we can tell.

³⁹ Relevant in this context is Herbert Simon's concept of 'near decomposability'. See, for example, Simon, H. (2002). 'Near decomposability and the speed of evolution', *Industrial and Corporate Change*, 11(3), 587-599.

However, the distribution of the jointly created value will determine the incentives of the cooperating players. In deciding on an appropriate distribution rule the dominant player/s will have to estimate the effect that the rule will have on player incentives. Ultimately this potential conflict will have to be negotiated in such a way as to leave all the cooperating players with sufficient incentive to continue effectively producing their jointly created value.

This adds further complications to the IPR-incentive-innovation relationship.

5.3.3 The financing of innovation

As Joseph Schumpeter has pointed out, credit, on the whole, is necessary for innovation. The reason is that innovation requires the acquisition of resources *in advance* of the creation of the innovation and the generation of revenue and profit from it. This requires some form of credit (e.g. venture capital funding, bank loans, investment by private equity, etc.). But acquiring these resources can be a complicated and costly business.

The reason for the complication and cost is that the funder of innovation requires a good deal of information in order to be able to reasonably form expectations regarding the return that might be expected from investing the funds in this way. For example, the funder will want to know about the product/service that is to be produced; the way in which it will be produced and the cost; the demand for the product and the revenue that might be expected; and the risks that are involved.

The obvious source of this information is the innovator and/or the person/people within the firm that will be producing the product who are charged with raising the funds. The problem, however, is that in providing information they might not be 'telling the truth, the whole truth, and nothing but the truth'. Indeed, they are incentivised to 'put a gloss' on the information which they provide in order to improve the chance of obtaining the funds. This may not amount to opportunistic, or indeed fraudulent, behaviour although in some instances this may be the case; it may simply be a matter of over-exuberance which results from the enthusiasm of an innovator. But all these cases may result in an overly positive construction of the information which might mislead the funder.

But how should the funder make allowances for these kinds of influences? The difficulty in answering this question leads to transactions costs and, in some cases, to the failure of credit markets to provide the credit necessary for innovation.

The problem is that where the innovation will be made by a Global Innovation Ecosystem these difficulties are likely to be compounded. The reason, simply, is that the potential lender now must take account, in forming expectations about the likely returns, of not only one borrower-player but multiple players, even if not all of them are borrowers. Since the intended innovation, and the revenue and profit in which it results, is a joint product successful delivery will depend on the contribution of all these players. Clearly, this will require that the lender acquires more information than in the single-borrower case. This, in turn, means higher transactions costs that, all things equal, will mean less aggregate funding for innovation.

5.3.4 Taxation schemes

The conventional view is that a reduction in taxes (e.g. through R&D tax allowances) and/or the granting of subsidies may be used as effective policy tools increasing the incentive to innovate. Fiscal measures, therefore, could be used to supplement the other incentives to innovate.

However, the joint-product nature of GIEs may create problems for fiscal incentives to innovate. The reason is that not only one player-innovator must be appropriately incentivised but all the players whose joint contributions are necessary for creating the innovation and generating an appropriate return from it. The analogy of cogs in a machine is apposite. It is not enough to ensure that one cog is fit for purpose; so must all the other interdependent cogs be if the machine is to do its job.

But this interdependence that lies at the heart of GIEs increases the complexity of the task that confronts the designers of fiscal incentives for innovation. In turn, this raises the costs of fiscal

policy-making in the area of innovation which have to be compared to the benefits, costs which should be taken into account in the policy-making process.

5.3.5 Public procurement

The conventional wisdom is that the prospect of public procurement may be used to increase the incentive to innovate and to encourage kinds of innovation in particular areas.

The problem, however, where the required innovation is to be carried out by GIEs, is again that it may be necessary to incentivise *multiple* players in order to be effective. Public procurement from only one or only a subset of players may fail to deliver or incentivise other players whose contribution to the joint effort is also necessary.

As in the case of the fiscal option, this difficulty may increase the complexity, and therefore the cost, of designing appropriate public procurement policies intended to influence innovation thus raising the cost of using this tool relative to the benefit derived.

5.3.6 Evidence-based policy-making

There are also important implications of the rise of GIEs for data, both for the data that is needed to assist decision-making as well as the cost of collecting this data.

Generally, most data about innovation are collected at firm-level. This is the case, for example, for data relating to R&D expenditure, patents, and science and technology related employment. In short, the single firm is assumed to be the appropriate unit of analysis when it comes to relevant data regarding innovation.

In the case of GIEs, it is the GIE itself that is the appropriate unit. The reason is that it is all the cooperating and competing players who constitute the GIE who jointly create the innovation, as well as the value that results from the innovation, which are the output from the GIE. It follows, therefore, that under these circumstances it is data about the GIE that is required and, accordingly, that it is the GIE that should be seen as the unit of analysis.

But this is only the start of the problems. It is not adequate simply to see the GIE as a number of firms and to proceed to collect the same data as before for each of the firms and then to aggregate this data for the GIE as a whole. The reason is that at the heart of the process of innovation that takes place in the GIE is the *symbiotic relationships* between the players who jointly produce this innovation. We therefore need to know more about these relationships if we are to figure out the possible effects of different measures intended to incentivise innovation.

Inevitably, however, this gets us into the issues of GIE conceptualisation and definition that are discussed in this paper. The problem is that GIEs are not empirically observable entities. Rather they are conceptual constructs that could be constructed in different ways. The result is that it will often be debatable, particularly at the margins of the GIE, regarding which players should be included, and which excluded, from the GIE. This means that the boundary of the GIE will often be ambiguous. So, therefore, will be the set of data needed.

This makes very complicated the question of what data it is necessary to collect in the case of GIEs. The collection of this data also becomes more complex and costly since it must relate to multiple rather than single players. Relationships, between firms as much as individuals, are inherently complex social entities which are subject to differing interpretations. This inevitably complicates the task of data definition and collection.

In conclusion, the essential point is that in company Global Innovation Ecosystems, innovation is a joint product rather than being the result of the effort of a single firm. This means that the designers of policies in these areas must now take account of the incentive effects on multiple rather than single players. Furthermore, they also have to understand the cooperative and competitive relationships between these players if they are to design effective incentives.

Annex 1: R&D versus Innovation: Unsolved Conceptual and Measurement Issues

'Research' and 'development' are routinized concepts. There are well-known and widely-used manuals that define them and data is routinely collected and provided on them.⁴⁰

'Innovation' is more problematical. The most widely accepted definition of innovation, which has been incorporated into the officially-accepted definitions, is that originally provided by Joseph Schumpeter. Schumpeter's definition of innovation included: new products and services; new processes and technologies; new forms of organisation; and new markets or ways of marketing. Clearly, although research and development may constitute activities which result in one or more of these forms of innovation, this will not necessarily be the case. Research and development may be thought of as activities which are intended to bring about innovation but which may not succeed in their intent. In this sense research and development are inputs rather than outputs.

It is important to add that innovation is not necessarily 'good-in-itself'. Novelty per se is not necessarily desirable. Schumpeter himself was careful to stress that from an economic perspective it is not innovation itself that matters but rather the *diffusion* (through adoption) of the innovation that counts.

What is being left out in the conventional measurements of R&D that could help us grasp Innovation (inputs)? Recent work on intangibles assets⁴¹ shows possible ways forward.

Data gathered by NESTA for the UK (2005)⁴² shows, intangible investment (at £137 billion) was more important than tangible investment (£104 billion). Of the intangible investment R&D accounted for £16 billion. But, significantly, this excluded other items of intangible investment that are often crucial inputs into innovation as defined by Schumpeter, for example, software development (£22 billion), design (£23 billion), and 'organisational capital' (£31 billion), new forms of organisation being included as one of Schumpeter's forms of innovation. This, incidentally, also explains the Apple Paradox referred to earlier in this paper. Apple's expenditure on R&D excludes its investments in the key areas of software development, design, and 'organisational capital' that obviously have had an important impact on its innovativeness and on its competitive and financial performance.

What can ICT R&D expenditures data tell us about innovation?

Ideally we would be able to provide, with metrics, a detailed account of the innovation that takes place in the ICT Ecosystem. Unfortunately, however, the above-mentioned measurement and related conceptual problems make this impossible. We will therefore resort to the imperfect (and possibly misleading) practice of relying on what has been measured, namely data on R&D. This data, nevertheless, does point to some important characteristics of the ICT Ecosystem.

Exhibit 16 shows the distribution of R&D by layer in the ICT Ecosystem.⁴³

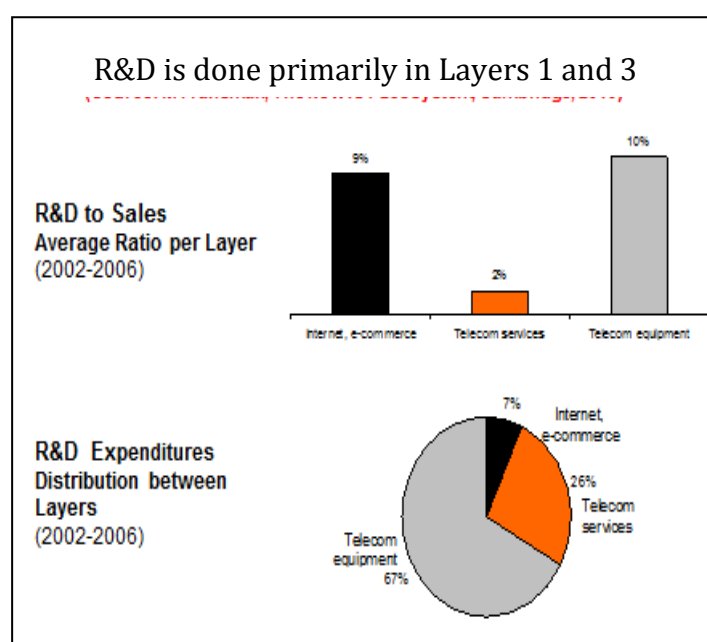
⁴⁰ Observers know that company ingenuity is often exercised in order to include items of expenditure which, although they may bring tax or other benefits from their inclusion, could, arguably, just as easily have been excluded.

⁴¹ See for example SPINTAN (<http://www.spintan.net/>) for estimations of public intangible investments, COINVEST (<http://www.cros-portal.eu/content/coinvest>) for estimations of private intangible investments

⁴² Source: <http://www.bis.gov.uk/assets/biscore/innovation/docs/e/11-1386-economics-innovation-and-research-strategy-for-growth.pdf>

⁴³ This diagram draws on the author's book, *The New ICT Ecosystem*, Cambridge University Press, 2010.

Exhibit 16: R&D in Layers 1 and 3



Source: Fransman. *The New ICT Ecosystem*. Cambridge, 2011

R&D expenditures are not equally distributed among layers

The bottom half of Exhibit 16 shows how R&D expenditure is distributed amongst the three layers of the ICT Ecosystem.⁴⁴ First, it is the Layer 1 companies that do the vast majority of the R&D in the ecosystem. The Layer 2 companies are far behind and the Layer 3 companies even further behind in terms of their share of total R&D in the ecosystem. Second, the top half of the exhibit shows that while the Layer 1 and Layer 3 companies are relatively R&D-intensive the same is not the case for the Layer 2 companies (the network operators).

This second characteristic requires further elaboration since it shows that the innovation behaviour of groups of companies is greatly influenced by their symbiotic relationships with other groups. This highlights the point stressed earlier, namely that it is necessary in order to understand the innovation behaviour of individual companies to understand their interactions with other related companies particularly in their sector ecosystem.

To be more concrete, telecoms operators in Layer 2 are able to enjoy relatively low levels of R&D-intensity because they are able to rely on the R&D performed by their ICT equipment providers from Layer 1. This relationship has evolved significantly over time, changing the boundary between Layers 1 and 2.

Before the liberalisation of telecoms services markets, telecoms operators in some of the leading developed countries up to the mid-1980s – such as AT&T, NTT, and BT – did a good deal of early-stage ICT equipment R&D in their own laboratories (such as AT&T's Bell Labs, NTT's Electrical Communications Laboratories, and BT's Martlesham Laboratories). Most prototypes were developed in such telcos' labs and later passed on to the telcos' favoured (national) equipment providers for further development, scale-up, and manufacture.

Over time, however, buoyed by the increasing innovation-sophistication of the leading global equipment providers and coupled with strong global competition between them, the relationship

⁴⁴ In Exhibit 4, based on data for approximately 200 of the largest ICT companies, 'Telecoms Equipment' companies are a proxy for Layer 1 companies, 'Telecoms Services' companies are a proxy for Layer 2 companies, and 'Internet and e-commerce' companies are a proxy for Layer 3 companies.

between these two key groups of ICT players changed substantially. Not only was more of the research, design, development and manufacture of ICT equipment left by the telcos to their equipment providers, over time the latter also undertook greater responsibility for the management of ICT networks.

The changing nature of this relationship in the ICT Ecosystem is reflected in the falling and absolutely low R&D-intensity of the network operators (not only telcos but also cable and satellite operators and broadcasters). In fact their R&D-intensity is now so low compared to other sectors in the economy that it is justifiable to exclude them from membership of the 'Hi Tech Club' which, apart from ICT companies, also includes companies from other sectors such as pharmaceuticals and cars.

Looking more closely at the level of individual ICT companies, the data is also valuable. The R&D and profitability performance of selected leading ICT companies are shown in Exhibit 17.

Exhibit 17: R&D and Profitability of Selected ICT Companies by Layer, 2012⁴⁵

Layer	Company Name	Overall Rank	R&D Expend. (2011, Euro mill.)	R&D Intensity (Rank)	Profitability (Rank)
I	Microsoft	2	7,583	13.3 (4)	29.9 (3)
I	Samsung	5	6,858	6.2 (8)	9.4 (7)
I	Nokia	15	4,910	12.7 (5)	-2.8 (14)
I	Sony	18	4,311	6.7 (7)	-1.0 (13)
I	Ericsson	29	3,657	14.4 (2)	7.8 (9)
I	Huawei	41	2,907	18.6 (1)	-
I	Fujitsu	49	2,370	5.3 (9)	2.3 (10)
I	Apple	59	1,877	2.2 (12)	31.2 (2)
I	NEC	70	1,611	5.3 (9)	2.2 (11)
I	AVERAGE LAYER I		4,009	9.41	
II	NTT	47	2,664	2.5 (11)	11.7 (6)
II	Telefonica	103	1,089	1.7 (13)	17.4 (5)
II	AT&T	115	925	1.0 (14)	8.0 (8)
	AVERAGE LAYER II		1,559	1.7	12.4
III	Google	26	3,990	13.6 (3)	32.0 (1)
III	Amazon	67	1,637	4.4 (10)	1.8 (12)
III	eBay	100	1,118	12.4 (6)	20.4 (4)
	AVERAGE LAYER III		2,248	10.1	18.1

Exhibit 17 shows some of the main global ICT companies, organised by layer of the ICT Ecosystem, in descending order of rank in terms of their expenditure on R&D in 2012. In addition, data is provided on the R&D-intensity of these companies as well as their performance (measured in terms of profitability, that is, profits divided by sales).

Several important observations may be made on the basis of Exhibit 17.

First, the R&D-intensity of companies is far higher in Layers 1 and 3 than in Layer 2. Second, the average expenditure on R&D is by far the highest in Layer 1, followed some way behind by Layer 3,

⁴⁵ Source: Joint Research Centre, Directorate-General for Research & Innovation, European Commission, 2012. EU R&D Scoreboard. The 2012 EU Industrial R&D Investment Scoreboard. (data for 2011)

with Layer 2 coming last. The explanation for this, as already explained above, lies in the changing nature of the symbiotic relationship between network operators and their equipment suppliers.

Third, and most importantly, there is no observed general correlation between R&D-intensity and profitability. Indeed, the companies fall into the following three groups:

1. High R&D-intensity – high profitability
2. High R&D-intensity – low profitability
3. Low R&D-intensity – high profitability.

Exhibit 18 shows the companies that fall into each of these categories.

Exhibit 18: R&D and Profitability Characteristics of Selected ICT Companies, 2012⁴⁶

Company Characteristics	Company Names
High R&D-Intensity – High Profitability	Microsoft, Samsung, Ericsson, Huawei ?, Google, eBay
High R&D-Intensity – Low Profitability	Nokia, Sony, Fujitsu, NEC, Amazon
Low R&D-Intensity – High Profitability	Apple, NTT, Telefonica, AT&T

Some important questions arise from Exhibit 18. The relationship between R&D-intensity and profitability among the first group of companies is what one would expect if the R&D expenditure succeeds in doing what it is aimed at, namely increasing innovation and therefore competitiveness and profitability.

However, the second group of companies serve as a reminder that there may well be a slip between R&D cup and profitability lip. It is precisely this that makes R&D a poor measure and predictor of the kind of resulting innovation which results in increased competitiveness and profitability.

We take Nokia as an example. The company has for a long time been one of the top spenders in R&D amongst the leading global companies. Even in 2012, despite its mounting difficulties in the mobile phone and smartphone markets, the company managed to be fifteenth in the global R&D league (as shown in Exhibit 17). But this expenditure was insufficient to produce a corresponding performance.

Either because of failures in strategic decision-making or because it had become locked in with no possibility of escaping in the short term, Nokia became stuck with an inferior mobile phone operating system, namely Symbian (although the company did try to make it more open and effective by making it open source). However, relative to iOS and Android, the two dominant operating systems provided by Apple and Google respectively, Symbian was not sufficiently application-developer-friendly. This meant that compared to its two main rivals Nokia was unable to create an innovation ecosystem incorporating app developers effectively. In turn the company was unable to accumulate sufficiently the complementary assets – that is the apps – that would have enabled it to compete better with Apple and Android. Throwing R&D at the problem did not provide a satisfactory solution.

This puts Nokia in the company of unsuccessful Japanese companies such as Sony, Fujitsu and NEC (see the second group of companies in Exhibit 18). Traditionally relatively high R&D spenders, the Japanese companies had run into similar structural problems as a result of their failure to make sufficient headway in the new products that were generating much of the growth in the evolving ICT Ecosystem. Given this failure, R&D was insufficient to provide a solution. In Sony's case, for

⁴⁶ Source: Estimated by the author from data provided in: Joint Research Centre, Directorate-General for Research & Innovation, European Commission, 2012. EU R&D Scoreboard. The 2012 EU Industrial R&D Investment Scoreboard. (data for 2011)

example, its successful innovation-based products (such as its games console) were not enough to compensate for its rapidly declining profit margins from some of its traditional businesses such as televisions and monitors as competitors such as Korea's Samsung and LG stole a march. Similarly, Fujitsu and NEC, formerly amongst the world's leading companies in the field of computers, were unable to keep up with the disruption that occurred with the introduction of smartphones and tablet computers. In telecommunications equipment they were out-innovated by lower-cost competitors, notably Huawei and ZTE from China. The substantial R&D expenditure and capabilities that had long characterised Fujitsu and NEC were of little help.

These observations illustrate that neither spending on R&D nor creating a global innovation ecosystem is sufficient to ensure good company performance. In the last few years before its acquisition by Microsoft, NOKIA had a very sophisticated understanding about global innovation ecosystems. However, this was not sufficient to allow NOKIA to come back competitively. What is needed rather is to design global innovation ecosystems that work effectively to improve innovation, competitiveness and profitability. This is not, obviously, an automatic process and therefore cannot be taken for granted. Success may or may not, come. The challenge for company management is to do the best they can.

We turn now to the companies in the bottom part of Exhibit 18. All these companies have managed to enjoy relative high profitability but with relatively low R&D expenditure and intensity. Three of the four companies are telecoms operators, namely NTT, AT&T and Telefonica. The reason for their low R&D has already been discussed earlier. Essentially, they have been able to outsource much of the R&D-intensive work to their suppliers of telecoms and ICT equipment. Apple's situation is much the same. It too has been able to outsource to other supplying companies much of the R&D needed to bring its products to market. Indeed, Apple has become a paradigmatic case of a successful but not R&D-intensive company that has largely (though not entirely) replaced internal R&D with a company global innovation ecosystem that leverages the innovation contributions of other players in the system as we have seen earlier.

Annex 2: The Changing Distribution of Dominant Companies in the ICT Ecosystem, 2006 - 2010

One way of understanding the changes that have recently been taking place in the ICT Ecosystem is to examine the distribution of the dominant and largest ICT companies amongst the ecosystem's three layers.⁴⁷

This examination will be undertaken in the following way. Starting with the *Financial Times* top 500 companies (measured by market capitalisation) the ICT companies are extracted. They constitute approximately 10% of the total 500 companies. Secondly, these ICT companies are divided by layer of the ICT Ecosystem. Thirdly and finally, they are identified by region, namely the US, Japan, Europe and East Asia. In Exhibits 19 and 20 data are provided for the years 2006 and 2010.

Exhibit 19: Country Competitiveness in the ICT Ecosystem, 2006

Layer	Total number of companies	Number of companies by region
III Content & Apps.	9 (16% of total)	US 6 Japan 2 Europe 1 EastAsia 0
II Network Operators	18 (32% of total)	US 5 Japan 3 Europe 8 EastAsia 2
I ICT Equipment	29 (52% of total)	US 12 Japan 9 Europe 6 EastAsia 2

Source : M. Fransman (copyright), calculated from FT Top 500, 2006

Exhibit 20: Country Competitiveness in the ICT Ecosystem, 2010

Layer	Total number of companies	Number of companies by region
III Content & Apps.	15 (26% of total)	US 11 Japan 1 Europe 2 EastAsia 0
II Network Operators	23 (40% of total)	US 4 Japan 2 Europe 12 EastAsia 3 (Australia 1) (Canada 1)
I ICT Equipment	20 (34% of total)	US 10 Japan 5 Europe 4 EastAsia 1

⁴⁷ This approach ignores the role of smaller companies and it is important to remember that companies such as the ICAPs - including companies like Facebook, Amazon, Google, eBay, etc. - were small not very long ago. Having said this, however, it remains that all three layers of the ICT Ecosystem are dominated by a relatively small number of large companies, providing some justification for the present examination based on market capitalisation.

Several conclusions emerge from these exhibits that may be summarised in the following way:

- Starting with L1, the ICT equipment providers, the number of top 500 ICT companies in this layer decreased between 2006 and 2010 from 52% to 34% of the total number of ICT companies. This suggests that there has been some shakeout in this layer, possibly as a result of the entry of aggressive new entrants such as the Chinese companies, Huawei and ZTE.
- The proportion of companies in L2, the network operator layer, increased slightly from 32% to 40% of the total.
- The most rapid growth, however, occurred in L3 – the platform, content, and applications layer – rising from 16% to 26% of the total number of ICT companies. This growth reinforces the notion that it is this layer that has become the hotbed of entrepreneurial activity in the ICT Ecosystem although this activity has also stimulated that of the other layers.
- Also notable is a) the dominance of Layer 3 by US Internet companies and b) the increase in the number of these US companies from 6 to 11. As mentioned earlier it remains to be seen whether the Chinese Internet companies, whose growth so far has been entirely within China, will in time be able to challenge this near-complete dominance by US companies of the global Layer 3.

Annex 3: Research and Innovation: Some Afterthoughts of the Author

Chasing the ecosystem

It is worth emphasising that an ‘innovation ecosystem’ – whether at national, regional, sector, company, or ‘national challenge’ levels – is not a real-concrete observable. Rather it is an analytical construct, the result of mental activity aimed at elucidating particular selected issues. As an analytical construct it is intentionally structured. A different analyst with different intentions may well come up with a different construct.

This has important implications in attempting to do research on ‘innovation ecosystems’. The problem is compounded by the burgeoning use of these two words and the associations that usually go along with their use. An ‘innovation ecosystem’ is frequently seen as a ‘must-have’, as one of the ‘great goods’. Accordingly, when the researcher sits down with the company interviewee, no matter how senior, there are inherently huge obstacles that initially stand in the way of developing a common understanding of the subject matter of the interview. The problem is made all the worse by the fact that companies (or policy-makers for that matter) have not yet arrived at their own consensus about what they mean by their ‘innovation ecosystem’. (Neither, it may be observed, have they agreed upon what they understand by ‘innovation’.) In many ways, therefore, we are still at a pre-paradigmatic stage in this intellectual endeavour.

The main result – and the present paper is no exception – is that research in this field is bound to be tentative, exploratory rather than definitive. This needs to be pointed out although not apologised for. The reason is that this is how advances in thinking frequently take place. The result, however, is that at the present time we have many more questions than we have answers. But this is no bad thing; the unanswered questions, hopefully, will provoke more effort to answer them.

The providers of knowledge, resources, and rules of the game in innovation ecosystems – the problem of depiction

Another important problem that arises in analysing and elaborating on the applied concept of innovation ecosystems is one of depiction. How should an ‘innovation ecosystem’ be portrayed diagrammatically?

At least three problems arise. The first relates to the components of the ecosystem. What are these components and how do they interact? The second problem is one of complexity. Clearly, an ‘innovation ecosystem’, however conceptualised, is a highly complex entity. Even the focal firm, the centre of analytical gravity in the idea of a Company Innovation Ecosystem, is highly complex. As the Cambridge economist, Edith Penrose,⁴⁸ pointed out, a firm is not an unambiguous, clear-cut thing and it is difficult to define apart from what it does. This complexity is all the greater when all the other components of an ecosystem are added, compounding the problem of depiction.

The third problem is that although innovation ecosystems are in a constant process of *change* (being a key part of the capitalist system characterised by Schumpeter as being incessantly *restless*) any diagrammatic exposition is by its nature *static*, that is captures the system only at a point in time. How to show the dynamics of change? This is the third problem.

It is these problems that lie behind the inadequate depiction of the providers of knowledge, resources, and rules of the game in this paper. They have not, for example, been adequately portrayed in Exhibit 5. Clearly, there are many possible providers whose knowledge may be drawn upon by the players in the innovation ecosystem. Knowledge-creators in universities are only one

⁴⁸ Edith Penrose, (1959). *The Theory of the Growth of the Firm*. Oxford University Press.

example. But it is neither necessary nor possible to include all of them in a diagram. The same goes for the providers of Resources (which may include financial resources as well as other forms of resource such as human resources). And the same is true of the 'institutions' – defined by Douglass North⁴⁹ as the (formal and informal) 'rules of the game' – that shape the actions and interactions of the ecosystem's players. These institutions are a crucial determinant of innovation ecosystems and how they work but it is well-nigh impossible to incorporate all of them into an analysis of innovation ecosystems let alone into a diagrammatic exposition.

Once pointed out, these issues seem obvious. But it is important to draw attention to them in order to avoid misunderstanding.

⁴⁹ Douglass North, (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge University Press.

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