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An evolutionary framework**

Isckia, Thierry; De Reuver, Mark; Lescop, Denis

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Digital innovation in platform-based ecosystems: an evolutionary framework

Thierry Isckia
Institut Mines-Telecom Business
School
Evry, France
thierry.isckia@imt-bs.eu

Mark de Reuver
Department Engineering Systems
and Services
Delft University of Technology
Delft, The Netherlands
g.a.dereuver@tudelft.nl

Denis Lescop
Montpellier Business School
Montpellier, France
d.lescop@montpellier-
bs.com

ABSTRACT

Creating a digital platform to leverage the potential of an ecosystem is recognized as an effective strategy to optimize innovation efforts in the digital era. In this paper, we analyze how platform-based ecosystems can ensure the commercialization of a constant flow of digital innovations. Our contribution focuses the role of platform-owners and the way they orchestrate the coupling process between two subsystems of the ecosystem: the innovation factory (IF) and the business development (BizDev). We apply a life-cycle perspective, analyzing how the relationships between platform design, value creation and knowledge are dynamically aligned. Existing accounts of ecosystem dynamics are quite scarce in the academic literature and they do not systematically acknowledge these two subsystems. By considering the two parts of ecosystems, we contribute to a better understanding of platform-based ecosystem evolution's process. Three case studies illustrate platform-owners' choices regarding the management of the coupling process.

CCS CONCEPTS

• Social and professional topics~Information system economics

KEYWORDS

Ecosystem, Platform ecosystem, Innovation ecosystem, Business ecosystem, Open innovation

ACM Reference format:

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1 Introduction

Platform-based ecosystems have become a recurrent way of organizing innovation [3, 4, 7, 8, 18, 19, 20]. Platform-based ecosystems create value through processes involving various actors, communities, activities and resources. With the massive use of digital technologies, the pace of innovation is constantly accelerating, driven by exponential combinations and recombination of resources and knowledge that flow through the platform [21]. On-boarding a platform-based ecosystem allows companies to optimize their innovation effort because ideas, knowledge and resources can cross-fertilize more easily and at a large scale, which is enabled by digital platforms. The number of possible combinations of ideas grows exponentially as new ideas come in.

Our paper proposes to detail the evolution of platform-based ecosystems through a conceptual framework that bridges a number of currently separated subfields of ecosystem studies including platform design and governance, value creation and knowledge [2, 14, 15]. In the first part, we will present our conceptual framework focusing on the coupling mechanisms that bring innovations to market. In the second part, we analyze throughout the platform's lifecycle the key features of the whole system and the implications in terms of strategy, knowledge management, value creation and platform design. We then analyze three case studies through this framework to develop a better understanding of platform-based ecosystems core mechanisms and dynamics.

2 Theoretical background

Our work relies on the concept of platform-based ecosystems, a subset of business ecosystems [12, 13, 16]. In this paper, we adopt an "ecosystem-as-affiliation" perspective [1] in-between the *engineering view* of platforms which emphasizes that platforms are technological architectures that facilitate innovation [3, 4, 7, 9] and the *economics view* which considers platforms as a vehicle for market exchange and interactions [5, 6, 8]. After defining core concepts (2.1), we elaborate a framework (2.2) underlying the

links between the two main subsystems of a platform-based ecosystem throughout the ecosystem life cycle (2.3).

2.1 Platform-based ecosystems and digital innovation

Platform based-ecosystems are a special kind of ecosystem that relies on digital platforms [7, 10, 11, 12, 13, 19]. These digital architectures draw a picture of the innovation factory with smooth information processes, facilitation of creativity and innovativeness, and smart solutions promoted through digital platforms. The platform owner provides the digital architecture *i.e.* components, interfaces and data. Partners can gain advantages and value by joining the ecosystem and therefore let platform owners benefit from extracting a fraction of it.

We assume [5, 6] that one-sided platforms enable interactions between the users of the platform who form one distinctive group of consumers, which exhibit direct network externalities. They differ from the two-sided platforms that enable interactions between two distinctive user groups (consumers and merchants) with strong indirect network externalities and from the multi-sided platforms that facilitate interactions between participants of more than two distinct groups or communities. In this perspective, the evolution from a one-sided platform to a two-sided platform and then to a multi-sided platform illustrates how platforms develop and grow over time by adding new sides and functions to their initial value proposition.

Platforms are complex digital architectures that evolve gradually over time [3, 4, 11, 19]. This process is triggered by technology disruption, which changes the number and the variety of actors and spurs new modes of interaction by transforming the competitive dynamics of the surrounding environment [5]. This position is in line with the view that technology development is an evolutionary process punctuated by rapid discontinuous change and the perspectives on dominant design that focuses on rivalry among alternatives.

Platform architecture and governance directly influence the value co-created within the ecosystem [3, 12, 19]. Platform's architecture is made of systems of modules connected through standardized interfaces. Modularity ensures flows of incremental innovation and complements. Interfaces play a key role since they define how modules interact. Interfaces are able to connect a wide variety of components and therefore of contributors. From this point of view, modularity acts as a coordination engine for partners. Modularity implies interoperability, which guarantees diffusion, sharing and access to all improvements, innovation and knowledge in the ecosystem [7]. Contributors can get access to shared digital resources (software development kits, libraries, data, computing power, storage capabilities, simulation tools, etc.) and create new services, products or complements that in turn will increase the platform's value both internally and externally. The growth of the internal value improves the loyalty and the adherence of the current partners and communities whereas the gain of external value may attract new contributors.

Digital innovation refers to the use of digital technology during the process of innovating. These digital technologies can be combined with almost any physical component [21]. Their unique properties enable to innovate the innovation processes breaking up of vertical industry silos and creating business ecosystems where different players come together and innovate by combining and recombining their digital technology components and knowledge. Following [21], platform-based ecosystems promote experimentations that give rise to new ideas and concepts that may be embodied in new artifacts. This unlimited generativity is made possible by the specific nature of these artifacts and by the architecture of collaboration that facilitates their creation *i.e.* the platform. Generativity means that digital artifacts can be combined in a chaotic or unexpected way into new artifacts to deliver a service radically different from what they were originally designed for. The intrinsic generativity of digital technologies is an essential feature that explains the proliferation of new products and services [21]. It should be noted that there exist a fundamental distinction between modularity and generativity: the goal of modularity is to control or contain complexity and flexibility while the goal of generativity is to introduce or create variety.

2.2 From innovation to market: coupling the two sides of platform-based ecosystems

Platform-based ecosystems display a high degree of heterogeneity in their structures and evolutionary paths. Nevertheless, they usually exhibit two interrelated dimensions: innovation or technology development (*the innovation factory* - IF) and business development (BizDev) or technology commercialization (*path-to-market*). These two dimensions are two sides of the same coin. Indeed, this distinction is quite common in the field of innovation studies, from first generation innovation models up to current models of innovation. New digital artifacts will not yield value unless they are commercialized, which requires a close coupling of the developer of the new digital artifacts to the user. These coupling and feedback mechanisms must operate efficiently to ensure commercial success of innovation. Figure 1 schematizes our framework.

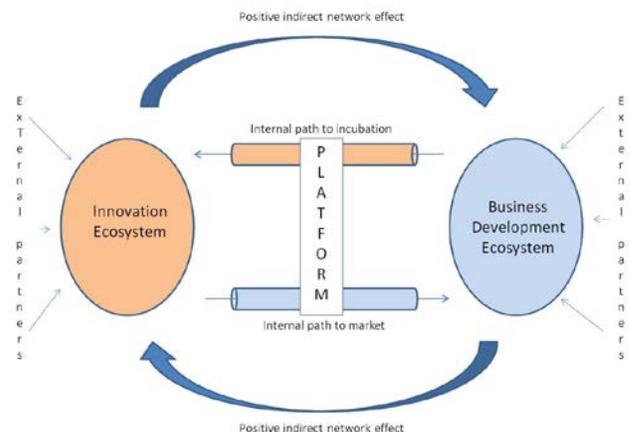


Figure 1: A framework for platform-based ecosystem

The right-hand side of the diagram represents the business development side of the ecosystem (BizDev). This side gives access to the final consumers and refers to the commercialization part of the platform-based ecosystem. This side is where the revenue streams come from. The BizDev functioning relies on the digital platform which provides members with tools and functionalities to interact with the audience. The BizDev part contains user groups that the platform mediates, like buyers and sellers. Members of the BizDev are complementors who will jump on the platform to deliver their products and services. The platform owner, the complementors and the consumers interact on the platform and create indirect network effects: the more the consumers, the more the complementors; the more the complementors, the more the consumers. Indirect externalities profit the platform owner by enhancing the net value of the platform (externally by attracting new participants, and internally by reinforcing the loyalty of participants). The members of the BizDev part come mainly from outside the system but also from the other side of the platform *i.e.* the *innovation factory* (IF).

The left-hand side represents the innovation ecosystem or what we call the innovation factory (IF). The IF refers to user groups or communities that actively change the functionalities of the digital platform like developers and other independent workers or creative professionals. Members of the IF are often enrolled via open innovation strategies. On the IF side, the platform owner opens part of its knowledge, resources, and skills to the participants. In our view, this side works like the ecosystem' incubator and its main objective is to improve customer experience, knowledge sharing while experimenting new value propositions. From this point of view, the IF can be considered as the antechamber for the BizDev side. The path to the market for innovations, ideas or concepts developed within the IF are tunneled through the digital platform.

IF members come either from outside the business ecosystem or from the BizDev side. The members coming from the BizDev part are brought to the IF by the platform owner. The whole functioning creates a positive indirect effect between the BizDev part and the IF, which reinforces the robustness and the coherence of the whole platform-based ecosystem. If the BizDev part grows, then new ideas will benefit from a larger audience: this will attract more innovators on the IF. Conversely, if the IF side grows and provides the system with lots of digital innovations and improvements, then this will attract more consumers on the BizDev side and in return more complementors. The platform is creating positive externalities within the BizDev part and the IF part, and between them. Both the BizDev and the IF sides require the ability to manage complex interactions between heterogeneous players and contributors, including small size players [11, 12, 13]. Their willingness to jump on a particular platform depends on the nature and the availability of digital resources promised by the platform and the platform-owner vision.

2.3 Business ecosystem life-cycle

The nature of the links between the platform-owner and the various communities, the intensity of interactions, the

attractiveness of the platform, the architecture of the platform and even the strategy of the members may differ along the stage of evolution of the ecosystem [18]. Ecosystem's life cycle is divided into four stages summarized below in Table 1: birth, expansion, leadership, and self-renewal - or, if not, death [7]. These stages have different competitive but at the same time collaborative challenges [7]. At each stage, governance, architecture and strategy must be aligned [3, 11, 12, 19].

<p>In stage 1: Everything has to be in place. Players search for new opportunities to reinvent value proposition for customers, designing a convenient and appealing platform. Identifying a suitable platform <i>i.e.</i> a platform that eliminates pain points or frictions between different groups or communities may attract a large audience.</p>
<p>In stage 2: The platform expands either through its BizDev or IF. Business ideas will capture value for a large number of customers and make it possible to scale up the concept to a broad market. This choice depends on which side drives the market space: IF or BizDev? This stage is about attracting outsiders and reaching a critical mass.</p>
<p>In stage 3: Value-adding components and processes are stable and leaders set a direction to encourage partners to work together to reach maturity developing its second side. External partners are developing as well and may wish to explore new business opportunities embarking on other competing platforms (multi-homing).</p>
<p>In stage 4: The ecosystem will start shrinking if nothing is done to rejuvenate it. In this renewal stage, multi-homing may be a rule, creating huge outflows of value, skills, competences and capabilities. New business ecosystems will emerge from the mature business communities.</p>

Table 1: Ecosystem life-cycle

3 Designing a framework for platform-based ecosystems

This section will first present our methodology (2.1). Then, we conduct our analysis of the different stages of development of platform-based ecosystems follows from birth (2.2) to renewal (2.6).

3.1 Methodology

We elaborate our framework with the goal of better understanding how platform-based ecosystems evolve over time and how the interactions between user groups or communities, platform design and platform owners' choices explain the different outcomes of generative capacity. We follow an abductive reasoning strategy based on contextualization that uses inference to the best explanation (IBE) to develop potential explanations for the observed phenomenon. Inference to the best explanation (IBE) refers to the abductive process of reasoning that takes place when researchers compare potential theoretical explanations of a phenomenon. Within this process, data and theoretical concepts are intertwined and have been examined simultaneously and

discussed until we found a plausible explanation. This explanation must satisfy criteria for plausibility, simplicity, novelty and interestingness. Because IBE is a context-dependent reasoning process, we clearly acknowledge a certain level of subjectivity in our approach.

We choose to focus our analysis on three cases namely Amazon, eBay and Apple for their inherent interest and use in the literature. We collected information over the period 2007-2016 mainly from publications (industry studies, books, articles, press releases, financial reports, activity reports...) as well as from writings by experts and consultants specialized in digital platforms. We capitalize on these case studies merely to elaborate a conceptual framework of platform-based ecosystem evolution.

We designed our sampling plan to embrace ecosystems heterogeneity and their evolution paths. We only select cases that have passed at least the first three stages in order to appropriately cover our framework. We are in-between literal replication since we chose the cases in order to predict similar results, and theoretical replication since these cases also predict contrasting results but for anticipatable reasons. The cases have been purposively chosen to replicate previous cases (the situation of each company regarding its original architecture of participation i.e. one-sided platforms vs two or multisided-platforms) and to fill theoretical categories providing examples of polar types (the respective contribution of the two subsystems i.e. the innovation side, the ecosystem development side or both in its evolution). Thus, we do not use these case studies for inducting theory but rather for designing a comprehensive framework that clearly states the conditions under which the phenomenon under scrutiny is likely to be found as well as the conditions when it is not likely to be found.

3.2 Birth stage: find who needs whom and why

The emergence of a platform illustrates the need for coordination expressed by two or more players groups that stems from the existence of frictions or market failures [5, 6, 18].

At this stage, the value proposition is not necessarily two-sided as illustrated with our cases (Table 2).

Firms	Amazon	eBay	Apple iPhone
Market Failures	The brick and mortar bookshops do not offer enough titles	Second-hand products are not easy to sell since the supply cannot reach a sufficient demand	The mobile Internet is locked by mobile network operators
Value proposition	Offering a large amount of titles and helping the consumers in the discovery procedure of their choices (long tail strategy)	Offering a market place where people can sell their objects with a secured transactions systems and a way to access the quality of members	Creating a device able to provide customers with ubiquitous Internet
Two-sided platform	No	Yes	No

Table 2: Market failures and value proposition

In a two-sided context, the platform owner should identify the community that will bring the biggest flows of externalities and

consequently which subsystem or side to develop first. This problem raises the chicken and egg dilemma. When indirect network externalities exist, the participation on one side depends upon the participation on the other side. Some questions arise then: how to attract one side without developing the other? Who should be embarked first?

Amazon's case is quite straightforward: Amazon.com started as a cyber-bookstore i.e. a merchant selling only books - especially best sellers - to its customers thanks to partnerships with big editors. Then the company progressively morphs into a network of merchant sites, thanks to the Amazon Associates Program designed to increase book sales but also to improve the value proposition for Amazon customers i.e. a larger selection. In Amazon's case, customers were already on board since they used Amazon web site for shopping purposes. Editors should then be given an incentive to participate. The cyber-bookstore had to keep its promise: to offer the world's largest books selection. Amazon progressively enrolled new partners (small and/or independent editors using a Long Tail strategy) who were interested in the visibility offered by Amazon's platform and the prospects for additional revenues and business opportunities. These opportunities were materialized later through the successive launch of Merchant@ program and Amazon Enterprise Solutions. Amazon clearly chose to develop first the BizDev part of its juvenile ecosystem increasing selection and then sales. As illustrated with Amazon, platform owners should find a way to enroll potential partners. Free access to all the resources or to a set of resources can create such incentives. However, things are not always that simple: attracting on the platform the engine-community (the one that will create the biggest externalities) is not an easy task. The platform owner should find the strategic leverages that will motivate participation, that is, digital resources or combination of resources coveted by partners or able to generate externalities and value for the whole ecosystem. Strategic leverages can be any tangible assets such as user base, data, functionalities, computing capacities and software development kits.

During the birth stage, the digital platform has to be designed. Its main function is the coordination of participants in order to strengthen and develop the value proposition of the whole system. The way the platform is designed imposes choices and hence elimination of some opportunities. Said differently, platform's design entails a particular path of development in the future. The digital architecture of the platform is obviously a key element. However, the platform-owner's vision is also important. Platform architecture and governance are deeply interrelated. The governance is the expression of the platform-owner vision in designing its leadership and its attitude towards members. Architecture, in return, allows for the implementation of particular governance: a fully open architecture will not work well with rigid governance aiming at capturing the whole value of the platform-based ecosystem [3, 12, 19]. The same architecture under different forms of governance will lead to different results. Conversely, a particular architecture cannot support all type of governance. These two elements can reinforce each other or not. Hence,

governance and architecture must be aligned [19] to ensure a smooth functioning.

In summary, at the birth stage, the platform-based ecosystem is designed as a private club with some partners selected by the platform owner. The ecosystem appears therefore intentionally closed: entry is discriminatory and under the sole discretion of the platform owner. This closure is necessary as it avoids/limits early imitation [17]. Value creation is the central strategy of the platform owner and embodied in a unique value proposition: it is implemented through a series of explorations, experimentations and tests with core partners and early users. While eBay started as two-sided platforms, Amazon and Apple on contrary started as merchants or one-sided platforms.

3.3 Expansion stage: search for critical mass

The objective of the expansion stage is to increase platform's thickness and to maintain a critical mass of participants, either on the IF side or on the BizDev side. The first challenge is to identify and to focus on the main driver of the whole ecosystem: innovation (IF) or transactions (BizDev). Table 3 exhibits some characteristics found in our cases that illustrate the link between expansion strategy and value proposition, and the main driver of the ecosystem expansion in each case (IF or BizDev?).

The identification of the subsystem to develop relies on a correct analysis of the way the platform performed in the previous stage. For Amazon and eBay, increasing and developing exchanges and transactions in the BizDev part was a key success factor for their expansion strategy for at least two reasons: (1) it allows for economies of scale as it increases the number of interactions, (2) it triggers economies of scope by bringing new partners (hence new products and services) on boards [6].

Firms	Amazon	eBay	Apple iPhone
Expansion strategy	Reinforcing economies of scope by finding new partners	Reinforcing economies of scope by finding new partners	Some developers create a system (Cydia) to crack the iPhone and to install new apps. This expresses a need for innovation to allow customization of the phone
Value proposition	Offering to partners the access to the audience of the Amazon web site and the possibility to sell their own products using the Amazon system	Authorizing the sale and the visibility of new products and brands through eBay	Creating a virtual place (App Store) where developers can develop and propose their apps to the iPhone owners
Main driver	BDE	BDE	IE

Table 3: The main BDE drivers in the expansion stage

Platform's expansion raises the question of the openness. The platform owner has to exercise less control on the profiles of members as to make entry more fluid and faster. Contracts with members should be standardized and follow a "take it or leave it" rule: potential participants accept the terms of the contract or not. No discussion on the terms of the contract is possible. Contracts are automated and are most of the time online. Menus of contracts can be created so as to provide potential participants with different level of commitment or involvement in the BizDev side. This

portfolio of contracts provides different levels of access which are often associated with a specific usage of digital resources hosted on the platform. Participants can choose a particular level and eventually upgrade or downgrade it (Affiliated merchants program of Amazon). Every potential participant is given the same opportunity to participate or not to the platform: access becomes non-discriminatory. These contracts also include pricing and hence establish the legal foundations for value capture in a standardized non-discriminatory way.

During the expansion stage, the platform becomes hence open encouraging niche players to enter the system [11, 17]. Niche players participate actively to the ecosystem's evolution by enlarging the possibility of interactions with other participants, thus pushing outwards the frontier of the BDE. Their ability to explore new business models nurtures the expansion of the system. This group of players encompasses start-ups, community of developers, established firms in adjacent markets (side-player), quasi-competitors. With the transition from the birth stage to the expansion, the role of the platform owner shifts from a position of project manager to a position of a network orchestrator that addresses a complex and dynamic set of interactions and interdependencies.

In summary, at the expansion stage, the platform-based ecosystem works as an open club with non-discriminatory membership. The ecosystem appears therefore intentionally open. This opening increases the number of participants and deepens the complexity of the networks of interactions. Governance and control mechanisms play a central role in the monitoring of the whole system. If value creation is still central to ensure platform's thickness, value capture remains important especially to maintain the level of investments in the infrastructure. BizDev-focused platforms may more easily start as multi-sided businesses than IF-focused platforms. Apple iPhone started out as a merchant with a one-sided product, and the other side of the ecosystem (developers) came on board only once there is a critical mass of end-users. Clearly, eBay started as two-sided platform in the birth stage. In this case, the platform was designed as an engine for growth to full BizDev since the two groups were already on board. On the contrary, during the expansion stage both Amazon and Apple upgraded their platforms architecture in order to support collective innovation (starting with the developers' side for Apple and with affiliates and later third-party players for Amazon). From this point of view, they had first to get a critical mass of users on one side to attract other groups of players on other sides or their platforms thus igniting network externalities.

3.4 Maturity & Leadership: clustering and multi-homing

At this stage, the platform has reached its critical mass and is supporting a wide and complex network of interactions between members and communities. The growth eventually starts to decelerate. Moreover, as the number of participants increase, the influence of the platform owner on the BizDev side withers. Hence, the main objective of the platform owner is to maintain

leadership and to sustain growth. The implementation of these objectives may take different path as shown in Table 4.

Firms	Amazon	eBay	Apple iPhone
Leadership strategy	Sustaining growth and leadership through the creation of a IE and new services	Sustaining growth and leadership through the creation of a IE and new services	Sustaining growth with technological and functional evolution of the platform
Implementation	Developing IE by introducing API and SDK	Developing IE by introducing API and SDK	Implementing evolutions of iOS to spur new developments
	Developing ubiquity (M-Commerce)	Developing ubiquity (M-Commerce)	Implementing evolutions of the devices
	Developing new services to other firms (e-commerce technologies, cloud computing, etc.)	Developing new services to other firms (e-commerce technologies, CRM, Marketing solutions, etc.)	Transforming App Store (IE) into a IE-BDE
BE	BDE+IE	BDE+IE	BDE+IE

Table 4: Leadership strategy

Amazon and eBay have followed the same strategy, expending their ecosystem by nurturing their IF side. In these cases, the IF side provides developers and partners smooth access (APIs), data and SDKs to build on e-commerce solutions that will improve operations on the platform. eBay more particularly focused on development for the mobile app market (M-commerce). Once the BizDev side is created, developing the IF at the leadership stage maintains the flow of digital innovations and ensures value creation and diversity. It also attracts new players with new ideas and new business models.

By supporting an IF and BizDev, the platform strengthens its market power. As shown in Figure 1, there is a positive ripple effect between IF and BizDev: innovations on the IF induce more products, services and functionalities on the platform which attract more members on the BizDev side. In return, the increase of the audience in the BizDev side attracts more innovators on the IF. To benefit from this effect, the platform owner has to create bridges between the IF and BizDev in both directions in order to ensure a path to market (to the BizDev) for innovators in the IF (or eventually outside) and a path to incubation (IF) for participants in the BizDev side. The path from the IF to the BizDev allows for experimentations and tests via the digital platform. Innovators may also come from the BizDev side. The platform owner must be able to identify them building exchange zones with the IF. It can take the form of innovation contests, App contests, Startup week-ends, etc...

In the Apple case, the IF evolved progressively in its functions towards operating as BizDev. The IF and the BizDev sides overlap: the App Store is a place for innovators but also a place for merchants (games) which can work and exchange with developers. It is today hard to distinguish at first glance these two parts. By coupling BizDev and IF through strategic tunneling, the platform owner reinforces its control of the ecosystem and the main outputs: innovations and revenues. By doing so, the platform owner develops a real business ecosystem intelligence which

gives him a strategic advantage over ecosystem' members and competing ecosystems.

However, a business ecosystem is not evolving in a static environment: outsiders and insiders are strategic players. Competitors may be attracted by the success of the platform and enter the market in search of business opportunities. Some leaders in adjacent markets can leverage their own platform to enter very quickly and fiercely (for instance, Microsoft in the game console market, Apple in the mobile device market) changing routines and dominant logic. This side-competition is one of the great threats of platform at the leadership stage.

Participants in the BizDev side evolve too. They thrive for their survival and success. Some of them are able to attract other participants and to create subsystems of innovation or business development around their own digital products, services or even platforms. Then, the BizDev side starts to cluster and grapes of interdependent innovations, developments, interactions, services and products grow here and there in the BDE. The ecosystem does not appear anymore as a network centered on the platform of the founding company. Constellations (clusters) of digital innovations are now structuring it.

Clustering is not a problem per se. In any growing complex system of interactions, clusters occur. Clustering means that ecosystem's survival does not only depend on the founder's platform but also on other core partners contributions. Like platform-owners, these core partners fight for the development and survival of the whole ecosystem: they act cooperatively by supporting a part of the system on their own. The platform-owner cannot act against clusters without jeopardizing the dynamics of the ecosystem. Clustering is the consequence of the ecosystem expansion. From this point of view, clusters call for decentralization and delegation of power in the BizDev side.

However, some players may wish to go further than clustering: they may multi-home. Multi-homing refers to the situation in which some members of an ecosystem also participate in competing ecosystems to ensure a large audience for their products and services. Multi-homing has several negative consequences on the ecosystem. If a participant multi-home, its economic activity on the original platform is no longer distinctive for this platform. Commoditization then occurs and the relationships with platform's owner may change drastically. Commodities so created do not benefit to any ecosystems, rather they only benefit to their owner. A commodity is not distinctive but rather a must have to remain competitive: no one can imagine an App store without social games like Clash of Clan or Candy Crush. When possible (for instance, if the commodity is a functionality of the platform), the platform owner can envelop it and standardize it. Whatever the strategy of the platform owner, multi-homing means outflows or destruction of value and innovation in its ecosystem.

In summary, during the leadership stage, the business ecosystem is still structured as an open club with non-discriminatory membership. However, clusters appear that may make part of the knowledge more private or dedicated to the clusters. Some parts of the ecosystem can even be fully closed.

With clusters also emerges multi-homing strategies and competitive pressure. Multi-homing implies frictions in the ecosystem as multi-homers do not act cooperatively anymore: the platform is just one of their delivery channels and their fate does not rely anymore on one platform in particular. At this stage, attracting and retaining participants is crucial in order to maintain platform's staying power. The platform owner should fully embrace its role of leader providing the participants of the BizDev side with vision and guidance for future developments.

3.5 Renewal: expanding the horizons

During the renewal stage, if nothing is done, the ecosystem will slowly decay. Some players (among which those who build clusters) will stop investing in the BizDev, will leave it or will develop their own platform by separating their cluster from the rest of the ecosystem. The platform owner may be tempted to use a value dominator strategy [9] draining the whole remaining value from the ecosystem, hence accelerating the attrition process. To avoid this attrition, the platform has to enter a new cycle of development. The renewal stage is the premises of this cycle and looks like a rebirth stage. However, the platform owner can now rely on its fully functional and mature ecosystem. Table 6 illustrates some renewal strategies found in our cases.

The main challenge at this stage is to avoid the disintegration of the interactions forged during the previous stages: renewal is essential to ensure survival of the ecosystem. In the renewal stage, the ecosystem becomes mature and large parts of it are now stabilized (for instance, Amazon as an online store, as an ASP) delivering comfortable flows of revenue and profits.

Renewal stage relies on the leader's capabilities to leverage its own digital platform to find new paths of development and to project its platform into new market spaces.

Firms	Amazon	eBay	Apple iPhone
Renewal strategies	Finding new ways to deliver products (drones) Creating new devices (FireTV)	Becoming a ubiquitous digital wallet for consumers and merchants	Working on new devices, new screen and new design
With Partners	Yes	Yes	Yes and No

Table 5: Renewal strategies

Leveraging a platform can take different forms as illustrated in Table 5. For instance, Amazon chooses to enter the entertainment markets by creating a new line of products and services, among which *Fire TV*, *Amazon Game Studios* and more recently *Amazon Video* and *Amazon Music Unlimited*. *Fire TV* and *Amazon Game Studios* were clearly two strategic moves to prepare the release of a 3D smartphone launched in summer 2014 and Amazon's entry in the mobile device business.

eBay follows a more classical renewal strategy by focusing its effort on one part of its platform-based ecosystem: payment services. eBay works in the development of Paypal as a ubiquitous digital portfolio for any consumers and merchants in partnership with financial institutions around the world. Paypal expands way beyond eBay ecosystem boundaries.

Apple follows its usual strategy of embarking its whole ecosystem in the renewal of the hardware: new screen, new devices, new design and functionalities. In the renewal stage, platform owner's dynamic capabilities are essential to identify and create new opportunities of development for the ecosystem. The renewal stage also depends on the vision provided by the leader during the leadership stage.

The renewal stage is in essence a phase of ideation and exploration. The first challenge is to maintain participants in the ecosystem. The platform owner should capitalize on existing knowledge and relationships to foster the emergence on new ideas around its vision. As in the birth stage, platform-owner needs to identify key partners that will support new projects. This relational strategy maintain vibrant clusters in the ecosystem. Exclusivity contracts can help sealing the relationships. Then, the leader can implement a new structure in the ecosystem: platform of platform (PoP). The original platform can run as a host for other platforms supporting a constellation of clusters or juvenile platforms: clusters will then be able to develop on their own. Platform-owner has to choose the best options for the ecosystem to be developed, dynamically reallocating bundles of digital resources.

In summary, during the renewal stage, the leader leverages its platform to enter new paths of developments. The ecosystem changes its structure and becomes mainly an open club with non-discriminatory access, but containing private clubs (clusters) managed by the platform leader. The future developments of the platform are nested or embedded in these innovative clusters.

4 Conclusions

Platform-based ecosystems exhibit new types of innovation processes that are particularly fast and difficult to control and predict [21]. Therefore, platform-leader wannabes need dynamic tools to support them in managing their digital innovation efforts. To this end, our framework focuses on platform-owner ability to couple two subsystems of platform-based ecosystems designed to support interactions and interrelationships among multiple, autonomous players such as individuals, communities and organizations. The main contribution of our framework is that it allows conceptualizing the dynamic interplay of the coupling of two subsystems of the ecosystem. The design of a vibrant platform-based ecosystem is not limited to facilitation of interactions, but must also stimulate the evolving process of interactions among these individuals, communities and organizations. As the platform-based ecosystems develop, their complexity increase which pushes the ecosystem to evolve from a centered network to a decentralized structure of platform of platforms (PoP).

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