

An Analysis of Dynamic Strategies during the Lifecycle of Software Ecosystems: The DS-SECO Model

Rodolfo V. C. L de Andrade¹, Carina Frota Alves², George Valença^{2,3}

¹FATECS – Centro Universitário de Brasília (Uniceub)
70.790-075 – Brasília – DF – Brazil

²Centro de Informática – Universidade Federal de Pernambuco (UFPE)
50.740-560 – Recife – PE - Brazil.

³Departamento de Informática
Universidade Federal Rural de Pernambuco (UFRPE) – Recife, PE – Brazil

rodolfo.andrade@uniceub.br, {cfa,gavs}@cin.ufpe.br,
georgevalenca@deinfo.ufrpe.br

Abstract. *Software ecosystem (SECO) represents a trend in the software industry, which covers technical, social and business aspects of software development. In a SECO, companies must cooperate and compete to thrive. In this context, establishing an effective business strategy is an essential goal during the lifecycle of a SECO. This paper proposes the DS-SECO (Dynamic Strategies for Software Ecosystems) model, which is based on principles from strategy dynamics and the adoption of biological analogies. This model investigates how strategies can be adopted to increase SECO sustainability and generate performance enhancements that will keep the ecosystem healthy. We illustrate the use of DS-SECO model with an analysis of the iPhone SECO.*

1. Introduction

Software is a highly pervasive sector that influences the characteristics of products, processes and services in almost every industry [Yier et al. 2006]. In the software industry, most organizations do not have all resources needed to satisfy their customers. Organizations must now engage in a new perspective considering both themselves and third parties.

Inspired by properties of Natural ecosystems, researchers have coined a new term to analyse the software industry: Software Ecosystem (SECO) [Messerschmitt and Szyperski 2003]. The advent of SECOs influenced major players in the software industry to rethink their operating practices by opening their platforms to external players to attain business goals [Campbell and Ahmed 2010]. When joining a SECO, companies benefit from cost reduction, risk sharing and higher customer satisfaction [Jansen et al. 2009b]. Nevertheless, being part of a SECO also involves risks and challenges. In this context, establishing effective business strategies is an important goal during the SECO lifecycle.

This paper proposes the DS-SECO model, which considers principles from Strategy Dynamics [Warren 2002] to investigate how strategies can be adopted to increase SECO sustainability. The model provides a dynamic analysis of challenges and opportunities to define and assess business strategies during SECOs lifecycle. An analysis of the iPhone ecosystem is presented to illustrate how the model can be used.

2. Literature review

2.1. Key concepts

Component-based software development became commonplace. Software vendors develop products by integrating components developed by other companies [Santos and Werner 2010]. Moreover, companies can delegate several software development activities to partners [Jansen et al. 2007].

According to [Bosch 2009], a SECO is a set of software solutions that meet customer needs, without putting aside the relationships that exist among the suppliers and the customers. By joining all these viewpoints, it is possible to conclude that a SECO encompasses a strong interaction of several players with common objectives.

Three main roles can be highlighted in a SECO based on the classification proposed by [Iansiti and Levien 2004]. Firstly, **keystones** are companies that act as enablers and stabilizers of the ecosystem. Secondly, **niche players** are the majority of players in the ecosystem and make use of resources provided by the keystone. Finally, **dominators** attempt to control the ecosystem by making use of other companies' resources without a reciprocal benefit.

2.2. Software Ecosystems Lifecycle

Based on evolutionary stages proposed by [Moore 1993], a SECO lifecycle has four stages. The **Birth** stage focuses on the definition of customer needs and involves the initial development of products and services, with potential players joining the ecosystem to participate. The **Expansion** stage involves internal and external battles, the reach of new markets and market share segmentation. The **Leadership** stage happens after the ecosystem proves to be profitable. During this stage, internal disputes may occur among participants to get more power in the ecosystem. Finally, the **Self-renewal** stage means the ecosystem will either die or start a new evolutionary cycle by adopting novel technologies or adapting its business model.

As shown in [Hartigh et al. 2013], the health of an ecosystem is a way of assessing its strength at a specific moment. To measure it, three elements should be considered. **Productivity** indicates ecosystem ability to transform inputs into products and services. **Robustness** indicates the ecosystem capacity to deal with interferences and competition pressure. Finally, **niche creation** represents the possibilities to create opportunities for ecosystem participants.

2.3. Strategy Dynamics

According to [Warren 2002], decision-making needs a fact-based analysis to help increasing business performance. In this sense, strategies are seen as a set of decisions and actions to reach organizational goals that can affect organizational performance.

Strategy Dynamics provides understanding on strategic performance evolution. The approach emphasises building and sustaining resources as well as capabilities for companies to succeed. This is materialised in the Dynamic Resource System View of Strategy (**DRSV**) framework [Warren 1999]. The DRSV is based on the principle that performance is highly influenced by resources, which can be accumulated, consumed, depleted or decayed. The Mystrategy tool [Strategy Dynamics Website 2012] was designed to support DRSV for modelling strategy and performance.

Strategy dynamics proposes two artefacts to examine company performance: resources map and time-path graphs. Based on these artefacts, strategy analysts are able to answer three key strategic questions: **Why** has the historical business performance followed the time-path that it has? **Where** will the path of future performance take us in case we keep up as we are? **How** can we alter that future for the better?

3. The Dynamic Strategies for Software Ecosystems (DS-SECO) Model

As ecosystems are dynamic and change throughout time, the DS-SECO model was developed to enable an evolutionary analysis of the SECO to tackle strategic decisions along its lifetime. The model adopts a four-stage lifecycle and assesses SECO strategic performance in terms of health elements, as described in Section 2.2. To enable DS-SECO application in a feasible manner, the model was divided in five phases. They were adapted from DRSV [Warren 1999][Warren 2002] and should be carried out at the end of each lifecycle stage.

3.1. DS-SECO phase 1: Time-path definition

Initially, it is necessary to establish a time-path graph to analyse performance across time. The DS-SECO uses the lifecycle stages as time scale and SECO health elements as measures. The outcome of Phase 1 consists of three time-path graphs, one for each health element. The analysis of each ecosystem must define appropriate metrics to measure each health element, for instance [Hartigh et al. 2013][Jansen 2014] present a set of health metrics. Each graph has both a desired and feared situation that can change every time phase 1 is executed. Additionally, an analysis point separates past from future analysis. This point should be set at the end of each lifecycle stage to enable full assessment of alternative strategies. It is worth noting that the graphs do not need to have precise measurements as [Warren 2002] states that precise numbers are frequently unknown. In Section 4.1 (Figure 1), a time-path graph is described for the iPhone study.

3.2. DS-SECO phase 2: Resources identification

Key resources must be identified to create the resources list. They are inputs for the productive process and their management is essential for competitive advantage [Hartigh 2006]. In our proposal, resources belong to the SECO as a whole and are not associated with specific firms (as established originally in DRSV). By adopting this view, we focus on the strategies that increase ecosystem health instead of looking at specific strategies for individual companies. Ecosystem resources can come from the keystone, niche players or alliances among SECO participants. They can be tangible (e.g. capital, number of applications) or intangible (e.g. keystone reputation, staff expertise in key technologies, size of user base). Due to resources consumption and development, the resources list can be changed at each lifecycle stage. New resources might arise and they shall be considered as soon as they are available.

3.3. DS-SECO phase 3: Resources flow analysis

This phase aims at establishing a cause-effect representation for the influences among resources. This includes identifying key forces and exogenous items that interfere on resources accumulation. Key forces are internal aspects to the SECO that drive resource flows, such as investments on training and marketing expenditure. As for exogenous items, they represent factors that happen regardless of SECO participants actions, such as

external competition and specific market demands. These items influence the flows by hindering or facilitating resources accumulation. A map example modelled with the Mystrategy tool is presented in Section 4.3 (Figure 2). The simulation functionality was not explored in the current version of DS-SECO model due to the lack of precise data.

3.4. DS-SECO phase 4: Dynamic Questions

External information that is not explicitly present in the resources maps can also be used for answering the dynamic questions. Considering SECO particularities, the DS-SECO model adapted the three questions originally proposed by [Warren 2002], as shown in Table 1. The **why** question focuses on explaining past performance until the analysis point defined in Phase 1. The goal of the **where** question is to focus on predictions and establish a trend in case no action is taken. Finally, the **how** question aims to find answers on how to avoid the feared performance.

Table 1. Three dynamic questions of Strategy Dynamics

	Productivity	Robustness	Niche creation
Dynamic questions	Question 1: Why is productivity following its current path?	Question 1: Why has robustness followed its current path?	Question 1: Why has niche creation followed its current path?
	Question 2: Where is productivity heading if the situation remain unchanged?	Question 2: Where is robustness heading if the situation remain unchanged?	Question 2: Where is niche creation heading if the situation remain unchanged?
	Question 3: How can we design a strategy to improve the performance of productivity, robustness and niche creation in the future?		

3.5. DS-SECO phase 5: Strategy assessment

If SECO health is not presenting the expected performance, strategies must be redefined to generate better outcomes in the following stages. Phase 5 then re-evaluates strategies to revert a poor performance or reinforce positive results by proposing enhancements.

4. Illustration of the DS-SECO Model: the iPhone Ecosystem

Apple has been known as an innovative firm with appealing products and loyal customers. In 2007, the iPhone SECO was born with the launch of iPhone. The main ecosystem players are Apple (keystone), device manufacturers (iPhone is manufactured by OEM), retail chains, telecom operators and independent developers as niche players.

This analysis used data published in whitepapers, IT magazines, blogs and Apple webpage as sources of evidence. All five phases of DS-SECO are applied repeatedly for each stage of SECO lifecycle. Due to space restrictions, we are presenting only a brief analysis of niche creation during self-renewal. Niche creation was chosen because this SECO is strongly dependent on players' relevant contributions to remain sustainable. Hence, we deem niche creation is the most relevant health element to demonstrate. We highlight that productivity and robustness must be equally analysed in every stage. The full application of the DS-SECO model is available at <http://tinyurl.com/nw38a6c>.

We consider that the iPhone SECO is in the self-renewal stage since 2010, with

the development of iOS 4.0 [Macworld 2012]. This stage is characterised by a need for innovations to sustain SECO health, as exposed in 2.2. After its birth, the iPhone SECO was expanded and consolidated. This is evidenced by the undoubted leadership exerted by Apple in relation to niche players and by the absence of destructive competition. From this point onwards, the SECO needed to produce relevant innovations to battle rivalry in terms of hardware and software in order not to die. iPhone 5 was launched in September 2012 and represented a new cycle of the self-renewal stage, where innovation was crucial to sustain iPhone SECO success. As the first cycle of self-renewal occurred in 2010, we decided to conduct the strategic analysis from this point onwards. We believe that the reason for such decision is that self-renewal is considered a critical step during the lifecycle of a SECO, when the keystone faces tough challenges to demonstrate the feasibility of the ecosystem for partners.

4.1. Phase 1: time-path definition

Niche creation was fueled by the launch of iAd, which is an Apple’s platform for advertisements on applications. In addition to it, the increasing number of downloads in Apple App Store indicated a potential market. Both iAd and soaring number of downloads tend to indicate higher probability of business opportunities for niche players. According to [Gottabemobile 2012], Apple had already reached roughly 7 billion downloads in 2010, September. One year later, this number raised to 15 billion [Statista 2015]. In case niche creation did not sustain a desired pace, users and even niche players would be attracted to competitor SECOs and that would severely influence SECO chances of survival, as users and customers might be attracted to the competition as well.

Niche creation – iPhone SECO (Self-renewal)

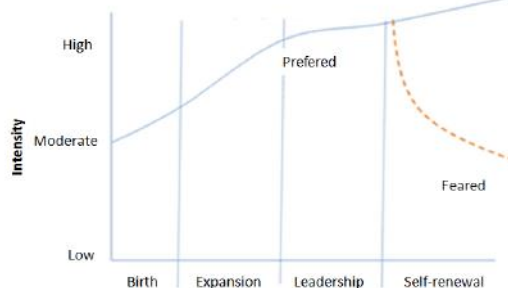


Figure 1. Time-path graph for niche creation during self-renewal

As precise numeric data was not available, the vertical axis of the graph in Figure 1 uses a generic scale for indicating intensity instead of a mathematical one. Niche creation was moderate when this SECO was born, as iPhone was a disruptive innovation at the time of its launch. Otherwise, it would be hard to attract niche players in case they saw no business opportunity. It kept stepping up in the next stages and remained stable during leadership, as this stage focuses on solving internal disputes and consolidating the SECO. To sustain this SECO during self-renewal, motivated niche players are needed. In case they leave the SECO and join competitor ones, the feared performance (i.e. a considerable drop in niche creation level) would be disastrous and that must be avoided.

4.2. Phase 2: resources identification

Potential user base increased, partially driven by the release of new iPhone and iOS versions that enhanced iPhone with new functionalities. However, the stronger threat of the Android SECO affected the growth pace for user base. Expertise on the mobile market increased as Apple consolidated its understanding of several IT consumer markets. Finally, high sales of iPhone and revenues from Apple App Store kept increasing the capital available for investment in innovation.

4.3. Phase 3: resources flow analysis

Investments in marketing and R&D remained high. Market differentials of iPhone relied on iOS and hardware enhancements. Mutualistic partnerships became even more intense, because Apple was able to avoid destructive internal disputes since leadership stage. Although Apple customers remained loyal, a stronger external competition caused some reduction in the user base flow. Investments in R&D led to innovations such as iCloud, iAd, as well as hardware and software improvements. This situation attracted potential partners to the ecosystem. External competition did not influence severely the user base flow. Figure 2 presents the consolidation of niche creation measurement in the form of a resources map. In this resources map, the square elements (capital and potential user base) are resources, while texted elements (e.g. customer loyalty, external competition) are either exogenous items or key forces. Resources influence key forces, which have a positive effect on the user base flow. On the other hand, exogenous items are acting negatively. However, the balance is positive, since potential user base is accumulating and consequently increasing niche creation.

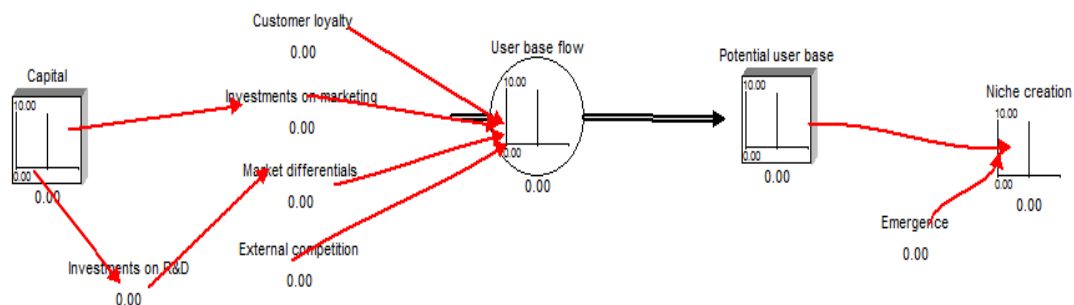


Figure 2. A resources map for niche creation during self-renewal

4.4. Phase 4: dynamic questions

New products such as iAd, iCloud and the increasing number of downloads in Apple App Store acted as *niche creation* drivers (why). In spite of the threat posed by Android, the iPhone SECO provided attractive financial opportunities for ecosystem participants due to the size of user base (where). Apple needed to make the iPhone SECO seem more attractive when compared to competing mobile ecosystems, so that independent developers did not abandon the SECO (how).

4.5. Phase 5: strategy assessment

Based on the outcomes of Phase 4, the main reasons to keep considering the iPhone SECO as a mobile market leader are users' passion for Apple products, frequent innovations in

iOS operating system and devices design. They enabled iPhone to remain competitive and attractive. Another positive strategic outcome was Apple's ability to orchestrate the SECO in a way that participants remained active by receiving financial advantages. Finally, the attraction of customers that used products from different ecosystems led by Apple (e.g. MacBook, iPad, iPod) enabled the company to enhance profitability. To summarise, strategies adopted by the iPhone SECO indicate it is on the right track to ensure sustainable performance in the next cycles of self-renewal.

According to [Apple Culture 2012], Apple earned \$24,4 billion with iPhone in the last quarter of 2011, while Microsoft earned \$ 20,9 billion with Xbox, Windows Phone and Microsoft Office altogether. This shows that Apple properly managed to create a very lucrative ecosystem around the iPhone. The figures presented the results of effective strategies and can be reflected in very good SECO health indicators. However, new cycles of self-renewal need to consider the growth of the Android SECO. This ecosystem has Google as a keystone and involves players such as Motorola and Samsung. In addition, the Windows Phone SECO must also be monitored, as Microsoft acquired Nokia and by doing so, strengthened its position on the mobile market. Therefore, the DS-SECO model shall be applied on upcoming cycles of self-renewal to maintain the iPhone SECO healthy.

5. Conclusions and Future Work

The main contribution of this paper is the DS-SECO model, which may help players to analyse and select strategies during the ecosystems lifecycle. The model considers concepts from biological ecosystems and principles from Strategy Dynamics. The association of knowledge from these fields brings originality and a well established basis to our proposal. To illustrate the application of DS-SECO, we conducted an analysis of the iPhone ecosystem. Unfortunately, it was not possible to conduct interviews with Apple due to difficulties to formally interact with the company. We then acknowledge that our study faces limitations regarding the reliability of collected data. We aimed at illustrating how the DS-SECO model can be used in practice. The current study provided a historical analysis of strategies adopted by iPhone since its official birth in 2007 until the end of the first cycle of self-renewal. Therefore, we plan to conduct in-depth case studies to assess the DS-SECO model in practice. The model can be a useful approach to guide players involved in a SECO to assess and select appropriate strategies to ensure their success and overall ecosystem sustainability. Another future work involves an extensive adoption of strategy dynamics and DRSV, including the collection of real data as well followed by the use of simulation functionality provided by Mystrategy tool. This study was centred on strategic issues. We also regard a study centred on the relation between technical aspects and strategies in a SECO configuration as future work.

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