App Store, Marketplace, Play! An Analysis of Multi-Homing in Mobile Software Ecosystems

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Abstract. Multi-homing, a strategy where a developer is publishing products for multiple platforms, is studied in this paper using descriptive analysis. The data of over 850,000 applications and their developers were collected from Apple App Store, Google Play, and Microsoft's Windows Phone Marketplace. The developers publishing for several software ecosystems were then identified. The findings show that multi-homing is utilized by only a small set of developers. In addition, the applications available at several platforms do not seem to differ by the type or the popularity from single-homing applications.

Key words: application marketplace, multi-homing, software ecosystem

1 Introduction

During the last few years, software ecosystems have been emerging as a significant part of the mobile domain. The marketplaces of these software ecosystems — e.g. Apple App Store, Blackberry App World, Google Play (formerly Android Market), Nokia Ovi, and Windows Phone Marketplace — offer currently hundreds of thousands of applications from tens of thousands of developers and the ecosystems are in a tight competition. Not surprisingly, the size of the marketplace and the application offering have been used as an argument for the superiority in the struggle of mobile ecosystems. For example, Apple used the phrase *"There's an App for That"* in advertisements of its products in 2009[1].

[1] Brian X. Chen. Apple Registers Trademark for Theres an App for That. Wired. October 11, 2010. http://www.wired.com/gadgetlab/2010/10/app-for-that/ Last accessed on April 3, 2012.

Application stores are working as two-sided markets, where the ecosystem's orchestrator is enticing both the content vendors and users to commit to the mobile ecosystem for achieving a positive feedback loop [1]. In this context, *the orchestrator* is the economic platform provider *i.e.* the keystone player of the two-sided market. From the software developer's perspective, the choice of a ecosystem might be crucial. Some developers have chosen to target to two or more ecosystems, balancing between a greater potential market share and the costs of porting the product for different platforms [2].

In this paper, we present the first results of a study focusing on multi-homing in the mobile software ecosystems. A multi-homing developer here is understood as a developer who publishes its products or services for multiple mobile ecosystems. This kind of publishing strategy is not new and it is known to be utilized in the mobile domain. However, very little is known for multi-homing, and its effects on applications, developers and ecosystems. Although Idu, van de Zande, and Jansen [3] recently studied multi-homing in Apple's ecosystem, their result, due to restricting the analysis on Apple ecosystem, can not be generalized as such. Furthermore, to the authors' knowledge, the effects on to the ecosystems, or the scale of multi-homing in mobile software ecosystems has not been estimated before.

Thus, the main research objective of the on-going research is:

How does the multi-homing affect the mobile software ecosystems?

The mobile ecosystems are a high competition area and the application offering can be used as a tool to distinguish from the competitors. However, if multi-homing is a common strategy for developers, the differentiating is hard. To understand the popularity of the phenomenon, we use quantitative analysis to study the three major application stores. Especially, in this paper we address the following questions:

- How many application developers currently use the multi-homing strategy?
- What type of applications are published for multiple platforms?
- Are multi-homing applications more popular (in the number of downloads and the number of users' ratings) than applications without multi-homing?

We assume that multi-homing strategy might increase the popularity of an application. The effect might be bi-directional, since either an application is multi-homed and therefore gaining more downloads or, due to popularity in a single platform, it is ported to other platforms. Whatever the reasons may be, it is expected that it would be an efficient strategy for a developer to publish the product in multiple marketplaces. This argument is based on the low cost of porting applications from platform to another [4].

In order to assess our research question, we collected data from three dominant mobile application marketplaces: Android operating system's marketplace Google Play; iPhone, iPad, and iPod touch's Apple App Store; and Windows Phone Marketplace. As a total, we parsed the data of more than 850,000 applications. The gathered data was then analyzed for identifying the developers who publish in more than one platform. Furthermore, we identified the multi-homing applications and, from these we investigated the types of these applications.

The findings show that a relatively small set of developers utilizes multi-homing publishing strategy for a small set of applications. Moreover, the application types and popularity are similar to the single-homers. As well, the results serve as a starting point for future research on the topic.

The paper is structured as follows. Section 2 presents briefly the related literature of software ecosystems and multi-homing studies. The research method used is described in Section 3 and the results are reported in Section 4. Section 5 contains the discussion and the last section concludes the study with suggestions for future work.

2 Background

Although software ecosystems existed already in the '90s [5], to the authors' knowledge, the term was first used by Messerschmitt and Szyperski [6]. The new concept was then defined by several scholars and practitioners, *e.g.*, [6, 7, 8]. Jansen, Finkelsten, and Brinkkemper [9] see it as *"a set of businesses functioning as a unit and interacting with a shared market for software and services, together with the relationships among them. These relationships are frequently underpinned by a common technological platform or market and operate through the exchange of information, resources and artifacts."* This definition emphasizes the interactions and common interests of the ecosystem's actors.

In addition to the software ecosystems, the concept of 'mobile ecosystem' has been recently discussed [10, 11, 12]. The mobile ecosystem is a larger network containing *e.g.*, as argued by Basole [10], mobile network operators, cable providers and even silicon vendors. In the case of Android ecosystem, Apple mobile ecosystem and Windows Phone ecosystem, it seems that a software ecosystem partially overlaps with the mobile ecosystem. For example, the silicon vendors are not players in the software ecosystem; although, they are crucial in the mobile ecosystem. In this study, the application platforms are assessed, however, from the software ecosystem point of view, as we focus our discussion specifically on mobile software applications and not on the overall interactions within the mobile device domain.

The application stores in the studied ecosystems are following the theory of two-sided markets. The concept is defined as an economic platform where beneficial cross-group network effects exist [13]. Described in detail through several examples by Rochet & Tirole [2] and Parker & Van Alstyne [14], markets with network effects are often characterized by the presence of two sides whose ultimate benefit comes from the interaction through a common platform. Due to the different needs of the two sides of the platform, the pricing in a two-sided market is challenging and requires a distinct business model [14]. In the case of mobile platforms, the users and content providers are the two sides of the market. It should noted, in the context of this study, the mobile platform is not the mobile device but the mobile application marketplace.

Two-sided markets can be extended by the concept of 'multi-homing' [15]. *Multi-homing* describes a situation where several competing two-sided economic

platforms exist in the same market and the two sides of the market are free to exist in several platforms. As an example, a software developer is utilizing multi-homing publishing strategy when offering products in both Windows Phone and Android ecosystem. Similarly, a user is multi-homing when he adopts mobile devices from several platforms.

Multi-homing in two-sided software ecosystem's markets has been studied before. Burkard et al. [16] researched the phenomena in five SaaS marketplaces. They found only 70 multi-homers from the dataset of over two thousand vendors. Idu, van de Zande and Jansen [3] investigated multi-homing in Apple ecosystem with the top 1,800 applications of three sub-ecosystems — iPhone, iPad, and Mac — and studied whether the developers offer the same product for all or only a few of these. From their result, 182 out of 1,060 developers (17.2 %) published at least for two stores. Only 22 publishers from the studied set have applications in all three stores. As the iPhone and iPad platforms are remarkably similar from the developers point of view (*e.g.* the same APIs and SDK), the share of multi-homing developers is surprisingly low.

3 Research Methods

We chose a quantitative research method to study the phenomenon of multi-homing in mobile software ecosystems. First, we collected data from all marketplaces. This data was used to identify multi-homing applications and developers. Second, we analyze the types and popularity of multi-homing applications. Based on this analysis, we further discuss how the publishing strategy affects the ecosystems.

In order to collect the necessary data, we implemented a set of small scripts (with Java programming language) that gathered the application data in two phases. In the first phase, the scripts collect the unique identifiers of the applications. In the Apple ecosystem, the identifiers were available directly from the marketplace. From Apple's store, we included all mobile applications found. The script went through all categories listing and stored the applications identifiers into text files. In the end of this first phase, duplicates were removed from the list.

In two other cases, third parties' listing services had to be utilized in the first phase due to the lack of easily readable lists in the stores. For Google Play, we used AndroidPIT[2] and for Windows Phone Marketplace, we used Windows Phone AppList[3]. Furthermore, we collected directly from Google Play the most downloaded applications of each categories to ensure that the most popular applications are included into the data. These lists were then combined and the duplicates removed. We consider it noteworthy that the list of Google Play's most downloaded applications did not add new identifiers into the dataset. For

[2] AndroidPIT — `http://www.androidpit.com`
[3] Windows Phone Applist — `http://www.windowsphoneapplist.com/`

the Windows Phone ecosystem, we used only the third party's listing when collecting the unique identifiers.

In the second phase, for each identified applications the scripts collected various attributes from the applications' public web pages at the marketplaces. The gathered attributes varied depending on the stores, but for all marketplaces, at least the name, price and the developer of each application was collected. When possible, the US versions of the stores were used. If an application was not available at a US store, other the stores of other countries were investigated too; however, the scripts were run in a server located in Finland, and thus some applications may have been filtered out by the marketplace due to the IP address used. If an application was not available, the script wrote a note to the text file and the application was assumed to have been removed from the marketplace.

The information was gathered in the end of March (Google Play and Apple App Store) and in the beginning of April (Windows Phone Marketplace), 2012. The data was stored separately for each marketplace to a CSV file. In the analysis, we used IBM SPSS Statistics Version 20 and Microsoft Excel 2010. In order to identify which developers publish on several ecosystems we implemented a script (with Python programming language) that compared the developer or publisher fields from different marketplaces trying to match them against each other. The algorithm utilized exact and approximate matching. In exact matching 'Rovio' (used by the publisher of 'Angry Birds' in Windows Phone Marketplace) and 'Rovio Mobile Ltd.' (used in Google Play and Apple App Store) are considered as two distinct cases. In approximate matching a certain amount of difference in the names is allowed. The reason for using two matching rules is that the exact matching forms the lower bound whereas the approximate matching is closer to the actual number of the popularity of the multi-homing applications.

The evaluation of the multi-homing application types was done by analyzing their categories in the marketplaces. All studied marketplaces offer a categorization for the applications, however, each one uses their own set of categories. For this study, we formed a general categorization and mapped the marketplaces' categories to the general one. The general categorization tries to capture the type of the applications, not the exact content or the target group. For example, a majority of top 'Sports' applications offers news and information of a certain sport, league, or club — the same basic functionality is found also in 'News' and 'Weather' applications. It should be also noted that Android is the only platform with the specific 'Personalization' category due to its highly configurable interface. The general categorization and the mapping are shown in Table 1.

4 Results

4.1 Descriptive Statistics of the Ecosystems

In total, we gathered information of 857,411 applications from the three application stores. The descriptive statistics — number of applications and developers,

Table 1. Mapping of application categories of different marketplaces. The number of subcategories are presented in parentheses following the main category. The percentages of each general category are presented in Table 3.

General Categories	**Apple App Store**	**Google Play**	**Windows Phone Marketplace**
Games	Games (19)	Games (8)	Games (14)
Health	Health & Fitness, Medical	Health & Fitness, Medical	health + fitness (3)
Books	Books, Catalogs, Reference	Books & Reference, Comics, Libraries & Demo	books + reference (4)
Music	Music	Media & Video, Music & Audio	music + video
News	News, Newsstand, Weather, Sports	News & Magazines, Sports, Weather	news + weather (2), government + politics (4), sports
Business	Business, Productivity Utilities	Business, Tools, Productivity	tools + productivity, business
Travel	Travel, Navigation	Transportation, Travel & Local	travel + navigation (8)
Social	Social Networking	Social, Communication	social
Finance	Finance	Finance	personal finance
Education	Education	Education	education, kids + family
Entertainment	Entertainment	Entertainment	entertainment
Lifestyle	Lifestyle	Lifestyle, Shopping	lifestyle (7)
Photography	Photo & Video	Photography	photo
Personalization		Live Wallpaper Personalization Widgets	

percentage of applications that are available for download for free, and percentage of developers with only one application — of the ecosystems are presented in Table 2. Apple's ecosystem is the oldest and clearly the largest one. Windows Phone Marketplace is rather young and small with less than 100,000 applications offered by only a few thousand developers.

Table 2. Descriptive numbers of each application store

	#apps	% free	#developers	Only 1 app
Apple App Store	428,384	46.6 %	117,817	54.5 %
Google Play	363,861	67.2 %	91,514	57.5 %
Windows Phone Marketplace	65,166	66.9 %	18,426	50.7 %
Windows Phone Marketplace (normalized)	72,748	70.4 %		

It should be noted that Windows Phone Marketplace contains built-in support for so called *Free to try* -model where a user can install and use the product for free, but the premium content is a subject to charge. In App Store and Google Play, this feature is not directly supported and thus the developers often offer both a free and a paid version of the same product (see *e.g.* [17]). This feature decreases the total number of applications offered in Windows Phone Marketplace, and it also affects to the ratio of free and paid applications.

We normalize the Windows Phone Marketplace application count by calculating 'Free to try' applications in the marketplace twice (*i.e.* once as a free and once as a paid one). With this, the total number of applications in Windows Phone Marketplace increases to 72,748. Despite the differences in the measurement methods, it is clear that Windows Phone Marketplace is, at the moment of data gathering, far behind its competitors in terms of number of applications. However, the marketplace is rapidly growing [18].

The applications distribution into the general categories (see Table 1) is presented in Table 3. The similarities are noteworthy and the small differences may be due to the differences in the marketplaces' original categorizations. For example, Windows Phone Marketplace has the smallest share of the 'Music' category, however, it is clearly leading in the 'Entertainment' category.

Table 3. A comparision of the categories

	Apple App Store	**Google Play**	**Windows Phone Marketplace**
Games	18 %	13 %	14 %
Health	4 %	3 %	3 %
Books	11 %	9 %	10 %
Music	5 %	6 %	2 %
News	6 %	7 %	11 %
Business	14 %	14 %	18 %
Travel	8 %	6 %	6 %
Social	2 %	5 %	3 %
Finance	2 %	2 %	2 %
Education	10 %	5 %	6 %
Entertainment	10 %	11 %	19 %
Lifestyle	8 %	8 %	5 %
Photography	2 %	1 %	2 %
Personalization	-	10 %	-

4.2 Multi-Homing

We approach multi-homing by identifying both developers and applications present in at least two ecosystems. In developer matching, we utilize exact matching, *i.e.* the names have to be exactly similar, including additional words such as 'GmbH' or 'Inc'.

When identifying multi-homing applications, we are pairing the applications from the different platforms and calculating the unique applications. In application matching, we use two matching strategies for both applications and developers: exact and approximate matching. Exact matching requires that the application names and the publisher names are the same (case-insensitive). Approximate matching requires that the application names are exactly the same, however, a certain amount of difference is allowed in the publisher names. In the approximate matching we used Python's sequence similarity function[4] in the similarity metric. The exact matching gives the lower bound of the multi-homers, and the actual value is estimated with approximate matching.

We tested the approximate matching with several sequence similarity thresholds. The correctness of approximate matching was evaluated only by visual examination; however, we clearly found pairs with small differences in the names such as the lack of postfixes like 'Inc'. Based on this analysis, we found the threshold of 50 % was the lowest value with no significant false positives.

With exact matching of developers, we found 14,451 (6.8 % of all unique) developers publishing in at least two marketplaces. Figure 1 presents a Venn diagram of application developers in the three studied ecosystems. Most of the multi-homing developers (12,338) publish for Apple App Store and Google Play. Approximately as many multi-homers publish only for Android and Windows Phone 7 (796, 0.37 %), and only for iOS and Windows Phone 7 (725, 0.30 %). Only 592 (0.28 %) developers publish for all three ecosystems.

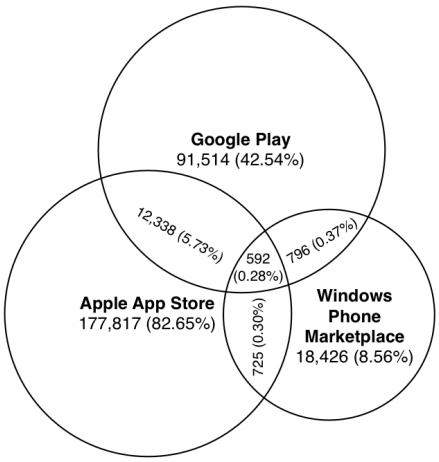

Fig. 1. An approximate Venn diagram of identified multi-homing developers of Google Play, Apple App Store and Windows Phone Marketplace

[4] Python v2.7.3. documentation — `http://docs.python.org/library/difflib.html`

The results of the application matchings are presented in Table 4. With the exact matching, we found 15,205 (1.83 %) multi-homers out of the 828,763 unique applications. Only 268 (0.032 %) applications were found in all three ecosystems. Although the number of found matches increased when the similarity requirement was loosened in the approximate matching, the growth was relatively small and the overall ratio of multi-homers out of all applications remained low. Even at the most relaxed case of approximate matching, without clear false positives, the multi-homing applications present only a mere 3.2 % of all unique applications. As a consequence, multi-homing publishing strategy is used only by a few developers and typically for a small set of applications.

Table 4. Results of application matching with exact and approximative algorithms. The approximative matching was used with several different requirements for the name similarity.

	Unique applications	Apple + Windows	Android + Windows	Android + Apple	All stores	Multi-homers
Exact	828,763	485	1,438	13,014	268	15,205
Approximate (95%)	827,949	559	1,459	14,443	299	16,760
Approximate (85%)	825,031	592	1,541	16,665	341	19,139
Approximate (50%)	813,005	781	2,431	22,036	668	25,916

When comparing the results of the developer and application matching, it was noted that several multi-homing developers had no multi-homing applications. A small set of these were examined by hand. Some developers offer clearly different applications for different marketplaces and some developers had published the same application with a different name. In few cases, it was not clear whether the developer was the same or just the name, *e.g.* two John Smiths, one publishing in Apple App Store and another in the Google Play.

The distribution of multi-homing applications into the categories is rather similar than that of all applications (Table 5). We assume that the differences less than 2 percentage points can can be explained with statistical error. Thus the only significant differences were in 'News', 'Entertainment', and 'Lifestyle' categories. It was surprising that multi-homing is not popular in any single category, *e.g.* we were assuming that the 'News' applications are easily multi-homed.

The popularity of multi-homing applications is assessed in figures 2 and 3. Figure 2 depicts the distribution of the installation proportions of multi-homed applications in Google Play. Because Apple App Store and Windows Phone Marketplace do not reveal the installation numbers, the popularity of the multi-homed applications is illustrated through the distribution of user ratings in Figure 3. From the figures, it can be seen that the application popularity proportions are similar for all and multi-homing applications.

Table 5. The distribution of multi-homing applications' categories and in comparison to the average of all applications

	Multi-homing apps	All apps
Games	14 %	16 %
Health	5 %	3 %
Books	8 %	10 %
Music	4 %	5 %
News	11 %	7 %
Business	14 %	15 %
Travel	9 %	7 %
Social	4 %	3 %
Finance	4 %	2 %
Education	7 %	7 %
Entertainment	8 %	11 %
Lifestyle	11 %	8 %
Photography	1 %	2 %

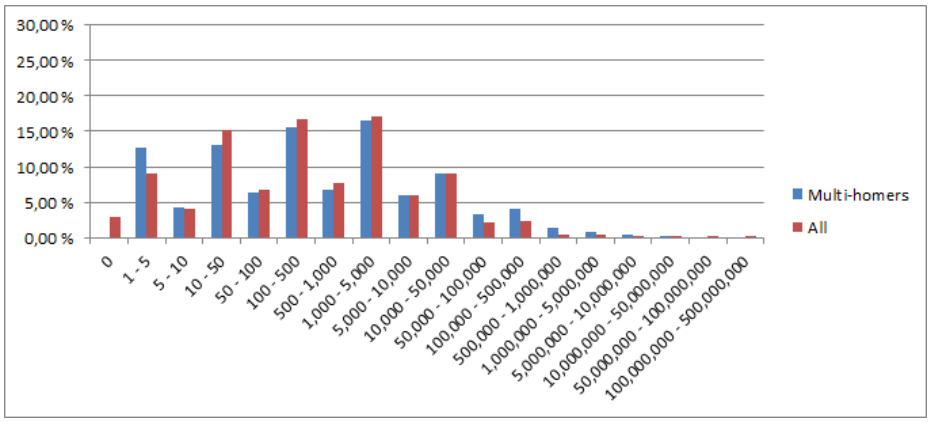

Fig. 2. The distribution of the installation category proportions of multi-homing applications and all application in Google Play

5 Discussion

Although the overall number of applications available at the mature marketplaces is large, the number of multi-homing developers is fairly small. This was expected as the ecosystems seem to contain lots of developers who are publishing just for fun or are lacking a clear monetization plan [19]. The multi-homing developers are expected to be professional ones, and therefore, their presence should be crucial for the ecosystem and its orchestrator.

Based on the gathered data, it seems that a tiny fraction of applications forms the majority of the content used by the consumers in the marketplaces. These applications are usually published by professional developers and they are often offered for several operating systems. These developers are becoming more

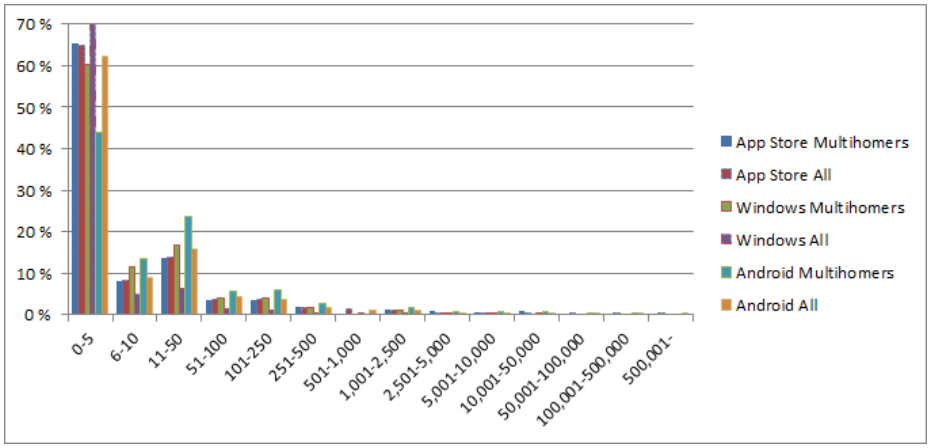

Fig. 3. The distribution of the proportions of users' rating numbers for multi-homing applications and all application in three studied marketplaces

and more critical to the whole ecosystem. Recently, when it was reported that the sequel of a popular mobile game might skip the Windows Phone 7, market analysts suggested that this might hamper the orchestrator's effort to attract gamers[5]. Therefore, the lack of popular developers and applications, such as 'Facebook' or 'Angry Birds', might be a major handicap.

The application ecosystems are primarily tools for ecosystem orchestrators to leverage their main businesses. The intentions are not openly discussed by the orchestrators; however, understanding them is beneficial in assessing the ecosystems. The main objectives seem to be different in all three studied ecosystems: App Store seems to aim at increasing Apple's mobile device sales that have particularly high margins. Google Play seems to extend Google's on-line advertising business into mobile devices. Windows Phone Marketplace and ecosystem more broadly seem to aim at protecting Microsofts software sales in the ongoing mobile-desktop convergence. Generating revenues directly from application sales seem to be, at least for now, a secondary objective. The primary objectives of all three ecosystem orchestrators seem to be to maximize the number of users in their mobile ecosystems. The application stores can contribute by maximizing both the number and quality of available applications, thus making the users value proposition more lucrative. The key to this is boosting the developers' and content providers' interest on the application store.

In the interviews of commercial application developers, the financial aspects were highlighted as one of the major reasons to select an ecosystem [20]. Clearly, the ecosystem orchestrators try to ensure good business opportunities for de-

[5] Jon Erlichman & Diana ben-Aaron. Rovio Executive Says Angry Birds Space Skips Windows Phone. Bloomberg. March 23, 2012. `http://www.bloomberg.com/news/2012-03-22/-angry-birds-space-edition-skips-windows-phone-in-blow-to-nokia.html` Last accessed on May 30th, 2012

velopers and content providers as well as lower the barriers for developing for and publishing in an application store. Thus, these core business forces should favor multi-homing as a strategy for developers, which in turn would diminish the application ecosystems differentiating value proposition for users. In this situation the orchestrators have to carefully balance between these two conflicting outcomes: maximizing developer attractiveness ultimately leads to multi-homing and smaller user attractiveness compared to competing ecosystems. This would weaken the orchestrators' position in the ecosystems and strengthen the positions of developers and other players, like platform independent publishers, syndicators etc.

Control and governance practices are the tool to manage this balance. In practice, the orchestrator can help the developers with various monetization opportunities, distribution means with broader or more focused target segments and application discovery mechanisms, other sales funnel management and analytics services. On the other hand, with content selection and orchestrators own and partner's service offerings, the application ecosystem can differentiated for certain user markets.

We believe that data on multi-homing can be used as an indicator on how different ecosystems are evolving with respect to the conflict of loosing strength while trying to gain it. For instance, a situation where all popular applications are available in all ecosystems, is a clear sign of reduced significance of the application markets as differentiators, whereas strong differences in the distribution of application categories would indicate that the application ecosystems are profiled differently. To our surprise, we found no evidence of increased multi-homing with application popularity and no significant differences in application categories. We were expecting that the multi-homing applications are popular in all marketplaces, and that the majority of multi-homed applications act as front-ends for other services. However, the results suggest that the application stores, as for now, are strongly differentiated with respect to developers' value proposition or that the cost to developers for multi-homing is prohibitive in many cases.

In order to really gain insight on how the ecosystems are controlled and governed and what are the developers' and content providers' varying business objectives in the ecosystems, more sophisticated indicators are needed. As an example, data on where applications are first published and how soon they migrate to other ecosystems gives insight on which ecosystem provides the most innovative new applications for users, which is certainly one possible way to enhance the user attractiveness of an ecosystem. Reflecting this level of insight on application ecosystems back to the ways how different orchestrators leverage their main businesses could give us understanding on the health and success of the application ecosystems, as well as trending data as the indicators are analyzed over time. These topics will be considered in our future research.

The first results of our work-in-progress research on the application platform multi-homing are presented in this paper. There are some factors that might affect the generalization of these results. For example, the third parties' listing

services were utilized when collecting the application identifiers for Google Play and Windows Phone Marketplace. Therefore, it is likely that the gathered set does not contain every single product of the marketplace. However, in these cases, the number of missing applications should be rather small. It should also be noted that the collected data only presents the situation of one day. For example, during a period of one month, Google Play lost over 7,000 applications while almost 19,000 new application were published [19]. Furthermore, the important applications, the most downloaded ones, are most likely included in the dataset.

Recently, Apple's press release[6] stated that the marketplace has more than 550,000 applications. Our dataset of over 428,000 applications is not necessarily complete and it is most likely missing applications that are not offered for our geographic area. We also have no knowledge on how the number of 550,000 has been computed. However, we believe that the most important applications are included. Finally, since the marketplaces are growing rapidly, we believe that the exact numbers should not be as interesting as the trends and the overall picture.

6 Conclusion

In this paper we presented the first results of our on-going research on multi-homing in application platforms. We studied three dominant application platforms by collecting the data of over 850,000 applications. The results show that the multi-homing publishing strategy is utilized only by a small set of developers (6.8 %), and that there is no significant difference in the multi-homing *vs.* all applications' popularity and type. Based on our finding, we discussed the potential effects of multi-homing for the ecosystems. Further work includes a qualitative study of multi-homing developers and applications to explore the difference to single-homers. A survey study could also explain better the motivations and strategies of the companies working in the multiple ecosystems. Furthermore, this paper presented a general view on the ecosystem; an analysis from the user's, the orchestrator's and the developer's point of views are another important topic for further research.

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