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Role of Platform Providers in Service Networks: The Case of Salesforce.com App Exchange

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TEMEP Discussion Paper No. 2014:112

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Finally, the current editor of this series would like to thank Prof. Dr. Almas Heshmati for establishing this working paper series in January 2009 and for guiding its development during the course of the first 55 issues. In particular, Prof. Heshmati provided invaluable contributions for setting up the local IT infrastructure, registering the series with RePEc, disseminating the working papers, and setting the quality requirements.

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Role of Platform Providers in Service Networks: The Case of Salesforce.com AppExchange

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May 2014

Abstract: As IT technology advanced, a new style of innovation emerged, in which a leading innovation company invites end-users to its open software service platform. With respect to this type of innovation, a lot of innovation studies were performed to understand the structure of the interaction among users and the platform provider from the perspective of network science. By concentrating only on the internal mechanisms among agents, the previous studies miss to consider innovation through collective intelligence. A platform provider plays an important role in the innovation. In this research, we investigate the structure of a service network with empirical data gathered from Salesforce.com AppExchange and discuss the role of a platform provider in innovation through collective intelligence. Our results suggest that the platform provider led the innovation in the initial period and, then, third party developers became gradually innovation leaders. Our findings are expected to re-orient the research focus from internal mechanisms to the role of platform providers.

Keywords: Software Service Platform, Platform-as-a-Service, Network Analysis, Salesforce.com, Open Innovation.

JEL Classification Numbers: D85, L14, L15, L86, O31, O32.

1. Introduction

One of the most important features of todays software innovation is that software vendors provide platforms to attract end-users to their innovation environment for benefiting from the collective intelligence of the platform users [1, 2]. Collective intelligence is a pool of innovation agents voluntarily engaged in the cooperation with each other for innovation in an open environment, in which the platform provider and the innovation agents share their knowledge and innovation resources [1, 3]. With collective intelligence applied to an open platform, old ideas can be reused to create new ideas, which are unable to emerge by a software vendor alone due to the limitation of understanding users demand [4].

Since software users interact with each other on an open platform and their interaction leads to innovation, a lot of studies investigated the structure of service networks representing their interactions in a variety of contexts [5, 6, 7]. For example, in the first research, a service network is defined as an extension of a value chain model between service providers and users [5]. Another study defines a service network, in which new services link existing services through their combination [8]. Previous innovation studies of service networks also investigated the structure and evolutionary pattern of networks [9, 10, 11], and the relationship between network characteristics and innovation performance [12, 13].

In this prior research on service networks, the assumption is hidden that a service network evolves only by the interaction among agents, who participate in innovation through collective intelligence. This assumption is the fundamental idea in network science that a complex network evolves by a simple rule correlating with the interaction among the nodes such as preferential attachment and random rewiring models [14, 15]. However, the assumption in the prior research is very far from reality of innovation through collective intelligence. It is common in real business that a platform provider strives for motivating the collective intelligence to innovate [16]. For example, Google provides its users with software development tools and an infrastructure to build a community of users, attracting users into its Android ecosystem [17]. In conclusion, previous research requires the understanding of the contributions of a platform provider to service networks that evolve through collective intelligence. It reflects the real innovation from a traditional network perspective.

In this research, we investigate the structure of a service network to discuss the effort of a platform provider in utilizing its users as a source of collective intelligence for software innovation. A service network is defined as a set of nodes and links. A node represents a software service. A link represents a users co-installation of software services by him in his environment. The service network characterizes the complementary relationship between the services.

We try to answer two sets of research questions on service networks. The first set of research questions is about validating our analysis on the basis of the techniques of prior research. What topology does the service network has? Is it scale-free or a normal complex networks? The second set is about discussing the contribution of platform provider on the evolution of service networks. Where does a platform provider position its services in the service network? Does the location of services released by a platform show any difference to the location of the services released by the third party providers?

In order to achieve the research objective, network analysis has been conducted, using empirical data gathered from Force.com, an open platform published by Salesfroce.com. It is a customer relationship management system (http://www.salesforce.com). By analyzing the empirical data gathered from the open platform, we explore what a platform provider endeavors for promoting the growth of its software innovation ecosystem evolving its platform.

For answering the first set of research questions, we statistically test if the cumulative degree distribution, $P(k_>)$, is scale-free or exponential, where $P(\cdot)$ means the frequency of its argument and $k_>$ the degree larger than k. Then, we identify the network position of services with the help of betweenness centrality and degree centrality. For this, we compare the network position of services released by the platform provider with the one released by the third party providers.

Our main findings show that Salesforce.com released more services than the other developers in the initial periods. However, its share of released services gradually decreased over time. Third-party developers dominated the platform in the last periods, and some of them even achieved a hub position. Finally, the results show that the applications released by Salesforce.com are connected with applications released by third-party developers rather than with other applications of Salesforce.com. Our results suggest that the innovation was led by the platform provider in the initial periods and the third party developers gradually contributed more to innovation in software in a later phase. The results are expected to make innovation studies from a network perspective interested in the platform side as well as the third-party side. This would help discussing the factors correlating with the survival of a platform and its sustainable growth.

The remainder of this paper is organized as follows. The next chapter introduces the conceptual background of network analysis. Section 3 demonstrates how the empirical data has been collected from the data source. Section 4 illustrates the analysis results and a discussion of the results. Finally, section 5 concludes this paper.

2. Theoretical Background

2.1. Software Service Platforms

As IT technology advances, an IT service user utilizes a computing service provided by a software vendor remotely through the Internet. This type of computing delivery is called cloud computing [18, 19]. A cloud computing provider achieves economy of scale by operating a large data center distributed over the world [20]. And with cloud computing a software user can reduce the cost to computing by renting the data storage, computation power and network capacity from the cloud provider [21]. Moreover, the user is able to aggregate existing services to create new service provided by several cloud computing providers [22, 23].

Cloud computing delivers services for software, platforms, and infrastructure [24], and they are called Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS). In the PaaS model, a cloud computing vendor provides a platform and environment for software development. The platform is represented on a browser and the complexity of virtualized infrastructure is hidden. Therefore, the platform users can concentrate on developing and commercializing their applications [25, 26]. By using the online resources furnished by the platform provider, platform users reduce the costs and the risks of software development and system maintenance. A platform provider gains its profit from the activity of the platform users [27].

Salesforce.com is one of the examples of PaaS. Salesforce.com is a company that provides a Customer Relationship Management (CRM) system. It provides its applications as SaaS services as well as a platform for application development and customization [28]. In other words users participate in the innovation as well as utilize the output of the innovation from the open platform provided by Salesforce.com. Therefore, Salesforce.com and its users form a service ecosystem, or "software ecosystem" used in [29] and "digital ecosystem" in [30], in which service innovation is performed by the cooperation and interaction among the platform provider and users.

Fig.1 describes the service ecosystem of Salesforce.com. The ecosystem consists of a platform provider (Salesforce.com), and the platform users. A platform user is categorized into a developer (i.e., a user engaged in the application development) and a customer (i.e., a user consuming the application created by developers). A user can be both a developer and a customer. Salesforce.com provides two types of platform for developers and customers. The use of the platform for customers is charged based on the usage of the platform, and the use of the platform for developer is for free. On the platform for developers, a developer can provide its applications either with or without charge. And a developer can utilize the application created by another developer for a fee or without a charge for free applications. If a developer charges an application fee to customers, Salesforce.com requests from the developer a security check fee. Salesforce.com also participates in creating applications with the name of Salesforce Lab (SFL).

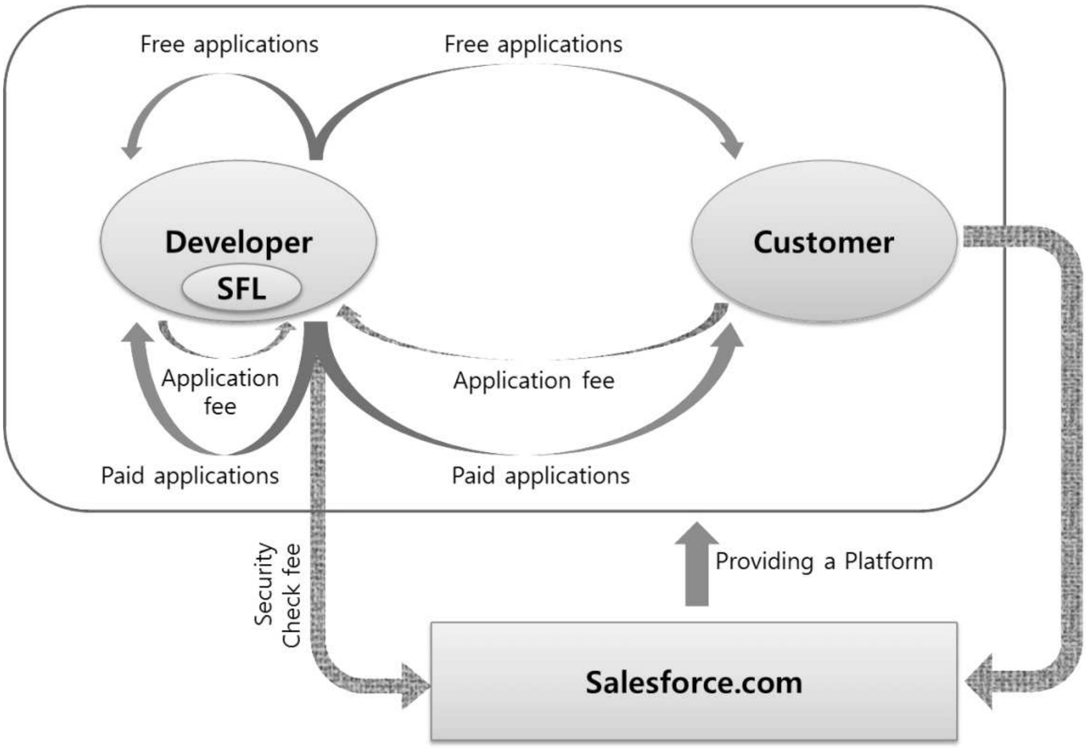

Figure 1. The Ecosystem of Salesforce.com

2.2. Open Innovation in a Software Service Platform

The innovation in the service ecosystem of Salesforce.com is one of the examples of "open innovation", a new trend of innovation introduced in early 2000s [3]. In open innovation, a company, which wants innovation, invites third-party companies to its innovation process to aggregate the innovation resources. The classical innovation process develops a product from R&D. The product is commercialized by the company that invested in the R&D [3]. By providing a platform, on which third parties can utilize the resources published by the platform provider, leading companies in Information Technology (IT) could achieve their innovation. For example, Intel focused on developing and upgrading CPUs but opened its interface so that the third party innovators can get access to its core technology [16].

The success of open innovation relies on how vigorous the third-party developers participate in the innovation on the basis of a platform that a leading company provides [31]. The platform provider opens the access to its innovation resources that users can utilize for free (i.e., can reuse the resources for innovation and collaboration with each other) [16]. In this way, the platform provider harnesses the third party as collective intelligence to achieve its innovation with low cost [1, 32]. On the other hand, the third-party developers might collaborate with each other without benefit to the platform provider [33, 30]. To address this, some platform providers separate a commercial side of the platform from a free side of the platform. This allows them to gain benefit from the commercial side without limiting the innovation through collective intelligence [19].

2.3. Service Networks

Prior research in natural science and social science has investigated the structure of real networks, its rule of evolution, and the relation between the network structure and innovation performance. Among them a series of empirical research in a variety of areas showed that the network structure is more inhomogeneous than theoretical research had assumed [14, 34, 35]. That is, the degree distribution in real networks decays by a power function, $k^{-\gamma}$, of degree k. Therefore, the tail of the distribution is fatter than an exponential function, $\exp -k$, which theories had assumed. It means that there are a few hubs, which have a large node degree, while a majority of nodes have small node degree [36].

As the interaction among third-party agents leads to innovation, innovation studies applied the approach of network studies to service systems. The service network studies explored the structure of a variety of societies, in which platform users cooperate to innovate using the infrastructure and tools provided by the platform provider. The keywords and authors network of Wikipedia shows that the degree distribution is scale-free [37, 38]. The developers and project network of open source software development and Web2.0 service networks also show the scale-free property [10, 39]. In addition to this, these service networks also have hemophilic and assortative properties [10, 40], and the node position varies while keeping the network topology [8].

Innovation studies considered that the network position could affect the innovation performance, if the network structure is inhomogeneous [41]. One of the most popular techniques of measuring network position is using centralities: degree centrality, betweenness centrality, and closeness centrality [42]. These indicators measure how central a node is embedded in a network. Degree centrality is the number of links that a node has with its neighbors. Betweenness centrality is based upon the frequency, with which a vertex falls between pairs of other vertices on the shortest path linking them. Closeness centrality is the inverse of the sum of the distances of a node to the other nodes in a network. Degree, betweenness and closeness centralities measure the strength (e.g. social power, influence, advantage in information flow) of each node in the network according to its own connectivity, its mediation among others, and its reachability to others, respectively.

The network position of a node is identified with its centrality values. For example, in prior research, Everard and Henry (2002) used degree and betweenness centralities to examine a pattern of interlocked directorates among the top 50 e-commerce firms and analyzed how this network is different from the network of other dominant firms [43]. The links connecting the nodes, which have low degree centrality but a high betweenness centrality, are called weak ties, which play an important role in innovation [12]. The effect of network position is also dependent on the context of innovation. For example, a central position enables a high performance, if the innovator has a good capacity for absorbing the innovation resources [13, 44].

3. Methodology

3.1. Data Collection

The empirical data of the analysis was gathered from the open platform of Salesforce.com. The information about application specifications was gathered from the marketplace of Salesforce.com (i.e., AppExchange (http://appexchange.salesforce.com)). AppExchange is a marketplace of applications. A customer purchases and downloads applications s/he needs, and a developer uploads and sells them. The information includes the list of applications and each application contains information on the provider, released date, pricing, categories, reviews, and rating. Among them, the information used in the analysis is application name, the provider of the application, and its released date. The information of application co-installation by a user-developer was gathered from the platform for developers, provided by Salesforce.com (http://appexchange.salesforce.com/developers). The data involves developers name (i.e. their Salesforce.com account) and the applications each developer installed in its system.

With the gathered data, we form a service network, which is defined as a set of nodes and links representing the application operating on the Salesforce.com platform and their co-installation in a developers system, respectively. Fig.2 shows an example of the service network. In the example (Fig.2 left), Salesforce Lab, a developer operated by Salesforce.com, releases two applications (App1 and App2), and the other developers release the other two applications (App3 and App4). User A installs App1 and App2, and User B installs App2, App3, and App4. Then, the example leads to a network of 4 applications, linked between App1 and App2, App2 and App3, App3 and App4, and App4 and App2 (right hand side of Fig.2).

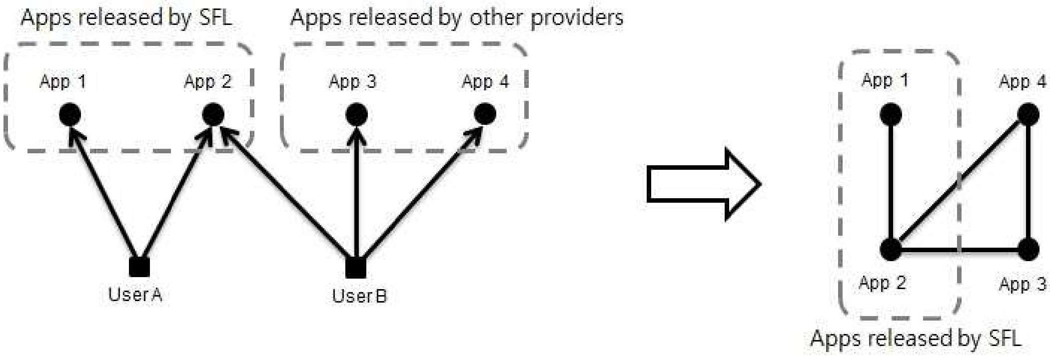

Figure 2. Example of the Service Network of Salesforce.com

3.2. Method Applied for Analyzing Network Topologies and Agent Positions

Centralities indicate the network position of nodes. There are a variety of centralities including degree centrality and betweenness centrality [42]. As the degree centrality of a node measures the number of nodes connected with the node, it is most intuitive and simple way to measure how deep the node is embedded in its network. In mathematical terms, the degree centrality $C_D(p_k)$ of the k-th node p_k in a network with size n is defined as $C_D(p_k) = \sum_{i=1}^{n} a(p_i, p_k)$, where $a(\cdot, \cdot)$ represents the link between two nodes. That is, $a(p_i, p_k) = 1$, if p_i and p_k are connected, otherwise 0. $C_D(P_k) = 0$, if a node is isolated from any other nodes.

Betweenness centrality, which is based on the number of geodesics, is also a popular indicator for measuring network position [42]. It is the number of shortest paths passing through a certain node among all possible shortest paths, and implies how much the node interconnects the other nodes. Similar to the definition of degree centrality, the betweenness centrality $C_B(p_k)$ of node p_k is defined as $C_B(p_k) = \sum_{i,j<i}^{n} b_{ij}(p_k)$, where $b_{ij}(p_k)$ is the ratio of the number of geodesics between any combination of nodes p_i and p_j passing through node p_k to the total number of geodesics between nodes p_i and p_j. By definition, $C_B(p_k) = 1$, if all the geodesics pass through node p_k, and 0, if there is no geodesic traversing the node.

The distribution of degree centralities in a network is used to measure the topology of a network, while a node centrality identifies the position of a node. The degree distribution is represented by the frequency $P(C_D)$ of a certain degree centrality value C_D. According to empirical network analysis in prior research, the degree distributions of real networks decays by a power function, or $P(C_D) \sim C_D^{-\gamma}$, instead of an exponential function, or $P(C_D) \sim exp\{-\beta C_D\}$ [14]. The power function and exponential functions are invariant in integration and the integration reduces the fluctuation in high degree area, Newman (2005) suggested cumulative degree distribution $P(C_{D>})$ for testing the power law of a network [45].

Another way to represent the network topology is using a centrality map, the space scaled by betweenness centrality and degree centrality locates nodes of a network. The network position of a node is classified into four categories: hubs, cores, bridges, and periphery. First, a node with both high degree centrality and high betweenness centrality is a hub, which connects the entire network with short paths [14]. Second, a node is a bridge, if its betweenness centrality is high but its degree centrality is low [43]. Third, a node with high degree centrality but low betweenness centrality is a core. A core could locate at the center of a cluster, but it does not connect the entire network. The remaining nodes are periphery, which means that those nodes are not central in the network. The criterion dividing the categories is flexible. If the degree and betweenness distributions of a network are Gaussian, the criterion for the classification could be the median, average, and the 4th-quartile. If the distribution is scale-free, the nodes with largest degree centrality and betweenness centrality could be selected.

4. Analysis Results

4.1. Descriptive Analysis Results

According to the data gathered, 74 developers published their installation information among 1000 developers registered on the platform. The 74 developers utilized 205 applications, which are released on the platform to create new applications. 99 developers participated in the innovation. During the study period, from July 2005 to April 2013, the number of released applications increased ceaselessly. Among the 205 applications, 74 applications were provided by Salesforce Lab, the developer account of Salesforce.com. However, the contribution of Salesforce.com decreased gradually with respect to releasing new applications.

Fig.3 shows the trend of the contribution of Salesforce Lab (SFL) and third-party developers (non-SFL) with respect to applications releases. The number of applications released by Salesforce Labs (SFL) steadily increased from 9 in January 2006 to 28 in January 2008. Compared to this, the increase of the number of applications released by the third party developers was tardy in these periods. The number of applications released by third party developers was 4 and 16 in January 2006 and January 2008, respectively, and boosted around January 2009 and their contributions surpassed the number of applications released by Salesforce Lab in April 2010. The numbers of applications of third-party developers were 24 in January 2009 and 127 in February 2013, and the applications of Salesforc Lab were 36 and 74 in the same periods.

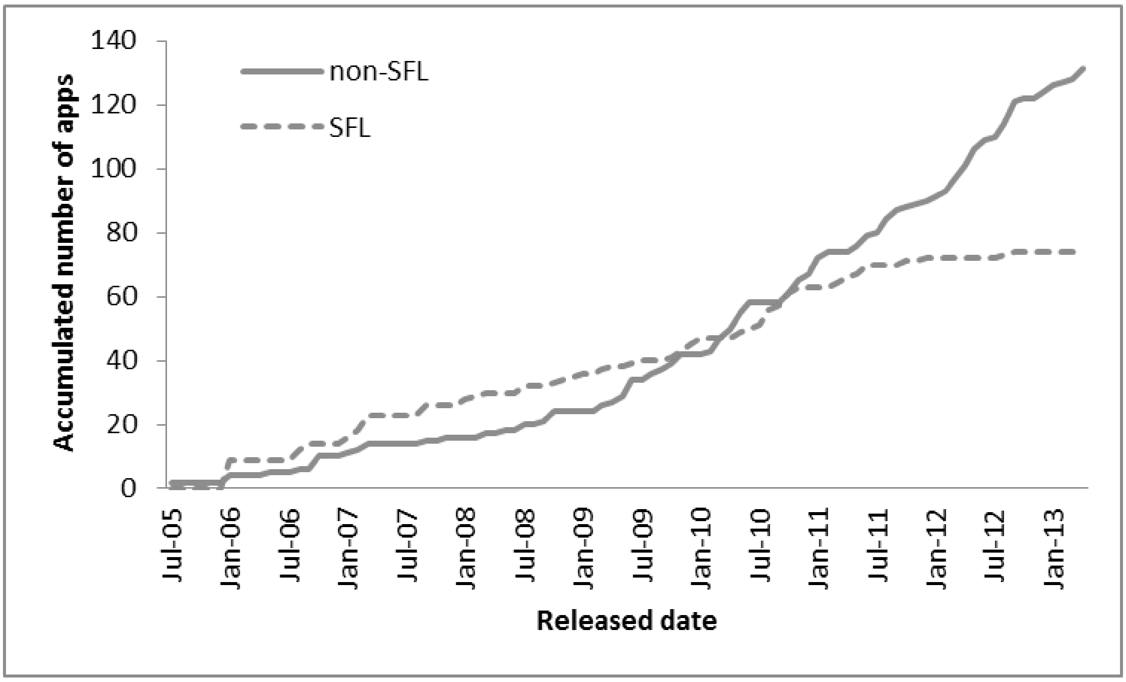

Figure 3. Growth of the Service Network of Salesforce.com AppExchange

4.2. Network Topology of Service Network

The analysis results of cumulative degree distribution are described in Fig.4 and Fig.5. In Fig.4 the relation between the degree centrality and the number of nodes, whose degree is not less than the degree considered, is described in log-log scales. The results of the ordinary least square (OLS) regression to the cumulative degree distribution in log-log scales shows that the slope of the function is -1.0412, the t-test statistic of slope is 0.000, and the adjusted R^2 is about 0.799. The results say that the correlation between the two variables is very significant. The statistical test results suggest that the service network is scale-free. However, according to the plot of the data points, it is hard to tell that the service network decays by a power function. A power function should be linear in log-log scales.

Fig.5 depicts the cumulative degree distribution in log-linear scales. The distribution in the figure looks decaying by a linear function, except for the five outliers whose degree centrality is larger than 55. The OLS regression of the cumulative degree distribution (excluding the five outliers) in log-linear scales shows a slope of 0.0347. The t-test statistic of the slope and the adjusted R^2 are 0.000 and 0.993, respectively.

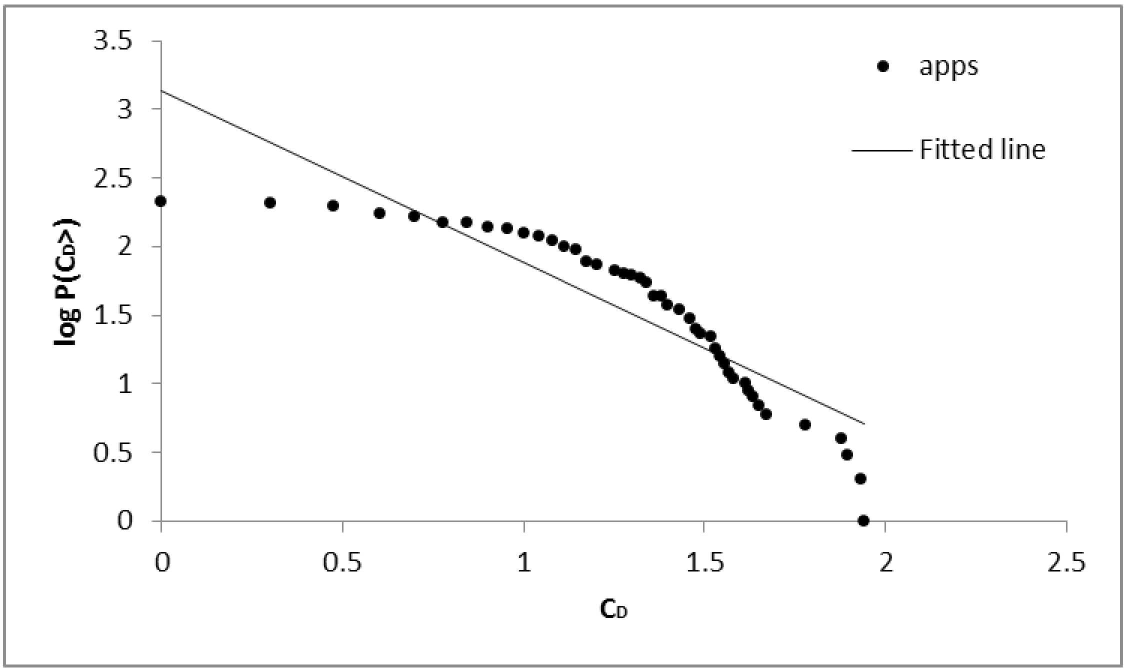

Figure 4. The Cumulative Degree Distribution in Log-Log Scales

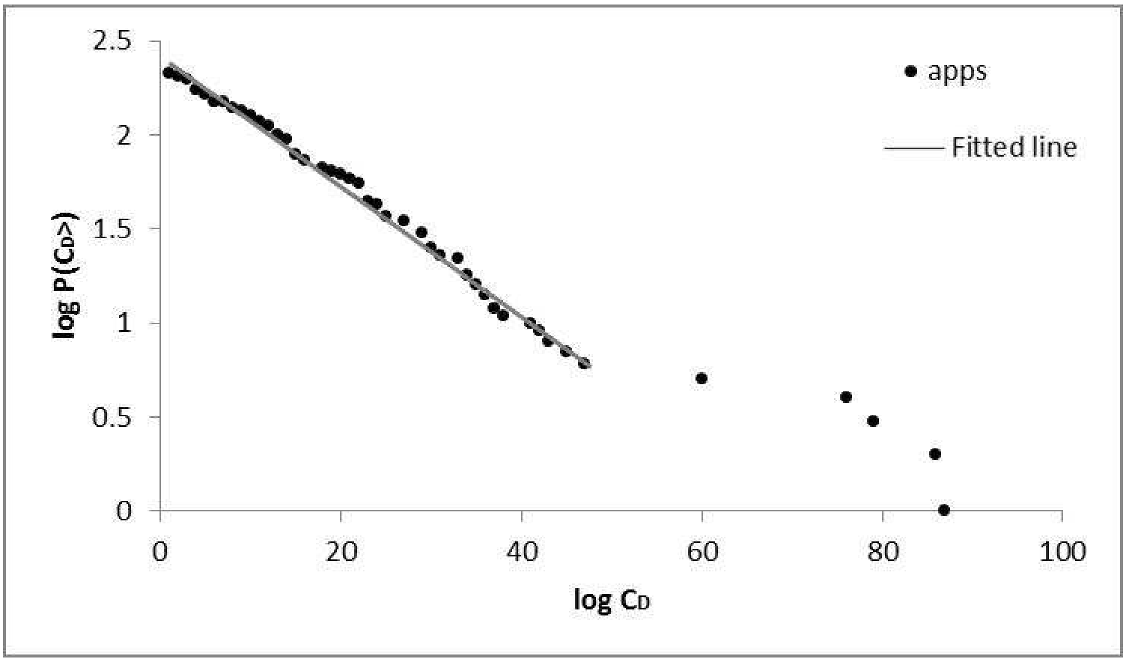

Figure 5. The Cumulative Degree Distribution in Log-Lin Scales

The results suggest that the degree distribution of the service network fits to an exponential function with higher significance and explanation power than a power function, if the five outliers are ignored. The results are extraordinary compared to the traditional discussion of complex network analysis. Prior research normally distinguishes scale-free networks from random networks [14, 46]. Scale-free networks consist of a few hubs, which connect the entire network through their large number of links, and peripheral nodes, which are connected with other nodes through a few hubs. Random networks do not have hubs (i.e., nodes with extremely large number of links). However, our results show that the degree distribution in the service network looks mostly exponential but involves a few very important outlier nodes with an extraordinarily large number of links. The results imply that the evolution of the service network might be more complicated than described in prior research. That is, the service network evolves by two rules: one for peripheral nodes locating at the exponential part of degree distribution and the other for the five outliers.

4.3. Network Position of Applications

Fig.6 depicts the node positions of the service network on the centrality map spanned by betweenness centrality and degree centrality. The five outliers in Fig.5 deviated clearly from the other nodes in the betweenness-degree centralities map. The network positions are divided by two lines at $C_B = 1600$ and $C_D = 55$. Four of the five outliers occupy the hub position. They are "Inside View Free", "Conga Composer", "Appirio Cloud Sync for Google Apps", and "Field trip". The remaining outlieris at a core position. It is "Mass Update And Mass Edit From List View" released by Salesforce Lab. The nodes apart from the outliers locate in the section with low degree and betwenness centralities. There is no node in the bridge section.

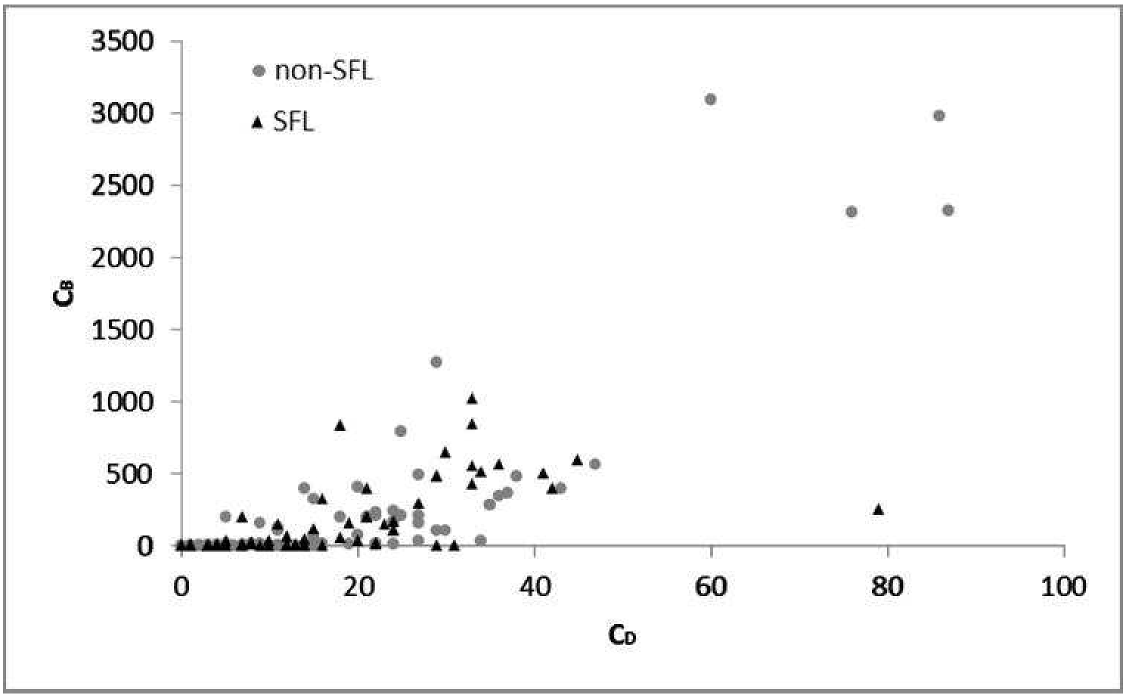

Figure 6. Betweenness-Degree Centralities Map

In the peripheral area ($C_D < 55$ and $C_B < 1600$), Fig.6 does not show the clear difference between the network position of services released by Salesforce Lab and those released by the third party developers. For statistical rigidity, we compared the means of the degree centrality and the betweenness centrality of Salesforce Lab services with the ones of the third-party services. As the data set does not satisfy the assumptions of homogeneity of variance and normality, which are the prerequisite for the F-test, one-way analysis of variance is not appropriate to test the difference between the two groups mean values [47]. For this reason, we apply the Kruskal-Wallis test to the degree centrality and the betweenness centrality over Salesforce Lab and the third-party groups

[48]. Kruskal-Wallis test is a non-parametric test for comparing multiple groups using the rank of cases. The null hypothesis of Kruskal-Wallis test is the two groups are identical, and the null hypothesis is rejected when the significance probability approaches zero. The Kruskal-Wallis test results between Salesforce Lab and the third-party groups over degree centrality and betweenness centrality are 0.155 and 0.103, respectively. The results suggest that the network position of Salesforce Labs services is not distinguished from the one of the third partys services according to 10% of significance level.

The results imply two propositions. One is that the platform provider contributes to the service network by providing a lot of services. The other proposition is that the service network is led by the third-party developers. The two propositions show what the role of the platform provider in open innovation through collective intelligence is. If the platform provider yields directly towards developing services, it can also receive benefit indirectly from the services the third-party developers release (as we can see in Fig.1). The third partys participation in innovation widens the scope of services running on the platform with low cost to innovation [3]. However, the incentives for third-party developers to participate in the innovation on open platform are low, if the utility of their services is not high enough due to the lack of complementary services. Therefore, a platform provider needs to release a lot of services to attract third-party developers.

5. Discussion and Conclusion

In this research, we analyzed the structure of a service network consisting of applications and their co-installation. The data has been gathered from Salesforce.com. The analysis results show that the platform provider released a majority of services, especially in the initial time period of the platform. However, the service network involves hub nodes, which are released by the third party developers. The results suggest that the effort of platform provider for attracting third-party developers constitutes an important role in the evolution of the service network, although the current network is led by third-party developers.

The results have both academic and practical implications. From an academic perspective, the findings steer service network studies into considering the effort of platform providers to motivate the participation of third-party developers. The prior research of innovation in service networks emphasizes only that service networks evolve into complex structure by third partys participation in innovation as collective intelligence. It is basically assumed that the network evolution is governed by an internal mechanism such as preferential attachment [49] and random rewiring [15]. Under this assumption, a platform provider does not contribute to the network evolution, except for providing and managing the platform. However, the results of our research show that the platform provider also contribute to the network evolution as well as the platform management, and the contribution motivates third-party developers to participate in the innovation on the platform.

The academic implication above is also relevant for platform providers from a managerial perspective. In the current models of software innovation using collective intelligence, the roles of a platform provider are separated from the role of the third-party developers. According to the model, the third-party developers share their innovation resources, reuse, and recombine them for innovation, while the platform provider simply prepares the ecosystem, in which the developers work (e.g., the ecosystem according to open innovation allows third partys access to core technology of platform providers [16]). However, the platform providers preparation of an ecosystem does not certainly lead to the success of innovation through third-party developers. Our empirical analysis results show that there is the participation of the platform provider in the innovation in early time periods of the platform, motivating third-party developers in their innovations.

Our findings say that a service ecosystem evolves with the effort of the platform provider as well as third parties. This is a fact that prior research has missed. Therefore, our findings are expected to re-orient the research interest of innovation studies on network perspectives from purely analyzing the behavior of people (collective intelligence) to analyzing the effort of a platform provider.

However, we need further studies, in order to explain our results in more detail and address two limitations of our study. First, we did not investigate the mechanism producing the exponential cumulative degree distribution with outliers nor did we explain the implication of the unusual structure. Second, it is hard to generalize the role of a platform provider from analyzing a single open innovation platform (Salesforce.com).

6. Acknowledgement

This research has partly been supported by Basic Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (grant number: 2013R1A1A2058665), and the ITEA 2 Project 10014 EASI-CLOUDS funded by the Korea Institute for Advancement of Technology (KIAT).

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