Crafting IP Strategies to Tailor-Fit the Industry Evolution

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***Abstract*--As cloud-computing technology becomes mature and accepted by the public, more players are joining the game, especially small and medium-sized enterprises (SMEs). It would be essential for SMEs to understand the cloud value network and where the battlefields are in the whole value network so that they can equip themselves strategically.**

In this research, we will analyse the technology evolution of cloud computing from a network and historical perspectives. We summarise the existing literature on cloud value chain and value network and derive the patent portfolios of some players involved in the value network. We also identified the key turning points in the development of cloud computing and correspond them to the respective timeline in the patent landscape. As intellectual properties, especially patents, are critical elements in technology development, this correspondence between the technology milestones and patent landscape will provide new insights into the technology development. Through this, we aim to exemplify the IP strategies used by the cloud-computing players in the value network. We propose that the IP strategies should co-evolve with the development of the technology and should take into account of the newer players, especially SMEs, in the whole value network. This new IP strategy involves the interplay between the incumbents and SMEs and the close unique co-opetitive relationships between them.

I. INTRODUCTION
THE CLOUD VALUE CHAIN

Definition of cloud computing. According to Leimeister, et al. [1], "Cloud Computing is an IT deployment model, based on virtualization, where resources, in terms of infrastructure, applications and data are deployed via the internet as a distributed service by one or several service providers. These services are scalable on demand and can be priced on a pay-per-use basis". A comprehensive concept of value chain was described by Porter [2]. His model categorized between primary activities, such as inbound logistics, operations, outbound logistics, marketing & sales, services and supporting activities such as firm infrastructure, human resource management, technology development and procurement. He also added a value margin.

We have reviewed some leading magazines and articles describing the value chain of cloud computing. Belmans and Lambrette [3] from a Cisco whitepaper in 2012 described the cloud value chain as shown in Figure 1.

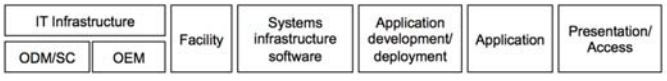


Figure 1 Reproduced from Cisco IBSG, 2012

As cloud computing is more sophisticated and involved more fragmented players, some researchers argued that the more appropriate unit to describe the value flow is cloud value network. A value network is a "set of relatively autonomous units that can be managed independently, but operate together in a framework of common principles and service level agreements (SLAs)" [4]. In the cloud computing value network identified by Böhm, et al. [5], the composite actor cloud computing service are provided by the infrastructure provider, platform provider, application provider. There is also a market platform through which these cloud services can be requested. Consumers may request any kind of services (SaaS, PaaS, IaaS) directly from one or more service providers or via the Market Platform. Both Aggregators and Integrators receive services (SaaS, PaaS, IaaS) from the composite actor to offer their value-added service to the Consumer. Their relationships are shown in Figure 2.

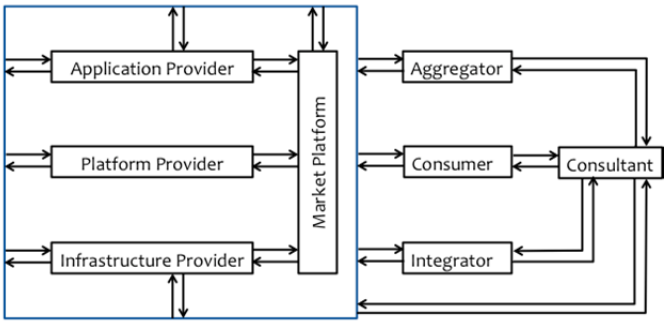


Figure 2 Cloud Computing Network reproduced from Böhm, et al. [5]

In this paper, we combined this value chain and value network to form a more comprehensive view of the cloud computing value chain. Therefore, we based our analysis on a whitepaper from Jaekel and A [6]. The value network is then reproduced in Figure 3.

With this value chain as the framework, we first identified the major players in this value network and look at their patent portfolios in order to understand their IP strategies. The major players in the value network are shown in Figure 4.

II. CLOUD COMPUTING HISTORY

Cloud computing originated from the idea of an "intergalactic computer network" that was introduced in the sixties by J.C.R. Licklider. He was responsible for enabling the development of ARPANET (Advanced Research Projects Agency Network) in 1969 [7]. Some experts in cloud computing, however, attribute the cloud computing concept to the computer scientist John McCarthy. He proposed the idea of computation being delivered as a public utility, similar to the service bureaus that date back to the sixties.

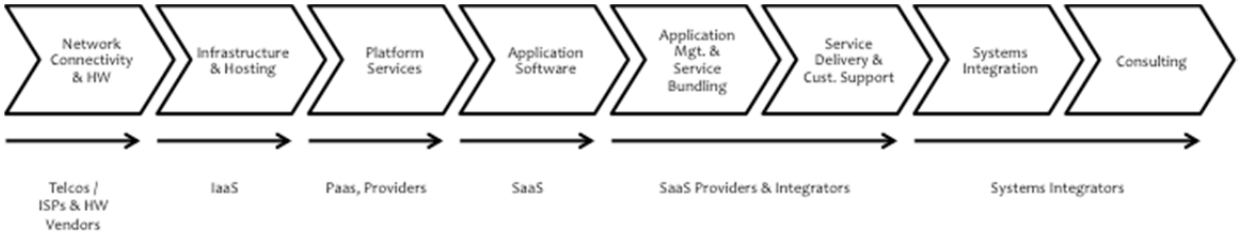


Figure 3 Value chain reproduced from Jaekel and A [6]

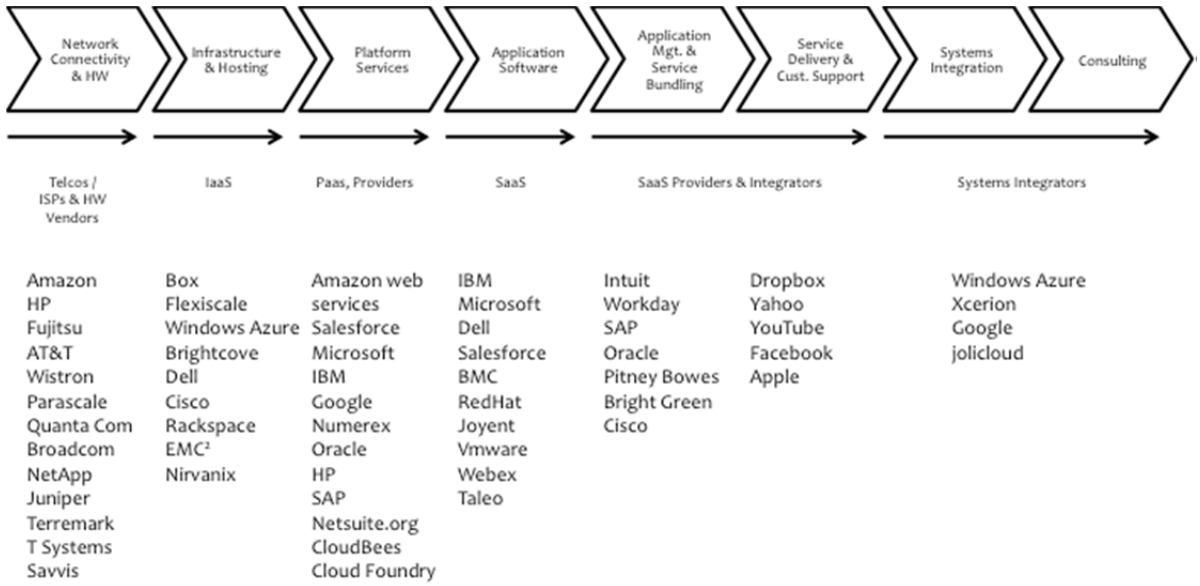


Figure 4 Major players in the value network

The word ‘cloud computing’ was first coined by Information System Profession Ramnath Chellappa in 1997 [8].

The next milestone for cloud computing was the launch of Napster from Salesforce.com that deliver enterprise applications through a simple website in 1999. This was then followed by Amazon Web Services, which launched the Amazon Mechanical Turk in 2002. This was a suite of cloud-based services including storage, computation and even human intelligence [9]. Later in 2006, Amazon further provided the infrastructure to make cloud computing further accessible by launching its Elastic Compute cloud (EC2). It is a commercial web service that allows small companies and individuals to run their own computer applications by renting computers to them.

In 2009, Web 2.0 became more popular, Google, Microsoft and others giants started to offer browser-based enterprise applications, through services such as Google Apps.

At this stage, virtualisation technology, the development of high-speed bandwidth and the evolution of universal software interoperability standards have also matured enough to enable cloud computing to become more accessible.

The timeline of this cloud computing development is shown in Figure 5.

III. PATENT PORTFOLIOS OF THE KEY CLOUD COMPUTING TECHNOLOGY

ARPANET

As understood from the history of cloud computing, the first major technology that has enabled the cloud computing to flourish is the development of "Advanced Research Projects Agency Network" or ARPANET. We did a search of patents filed between 1960 and 2010 that has the words "Advanced Research Projects Agency Network" or ARPANET in their descriptions. We found 739 issued and applied patents. In order to understand the technology life cycle of the ARPANET, we plotted a graph of number of patents against company count. We noticed that the number of companies researching in ARPANET started to increase dramatically from 1999 to 2006. Year 2002 was the peak in this development. After 2006, the number of companies researching in this technology declined drastically. Today, the technology is almost at its end. The technology life cycle of ARPANET is shown in Figure 6.

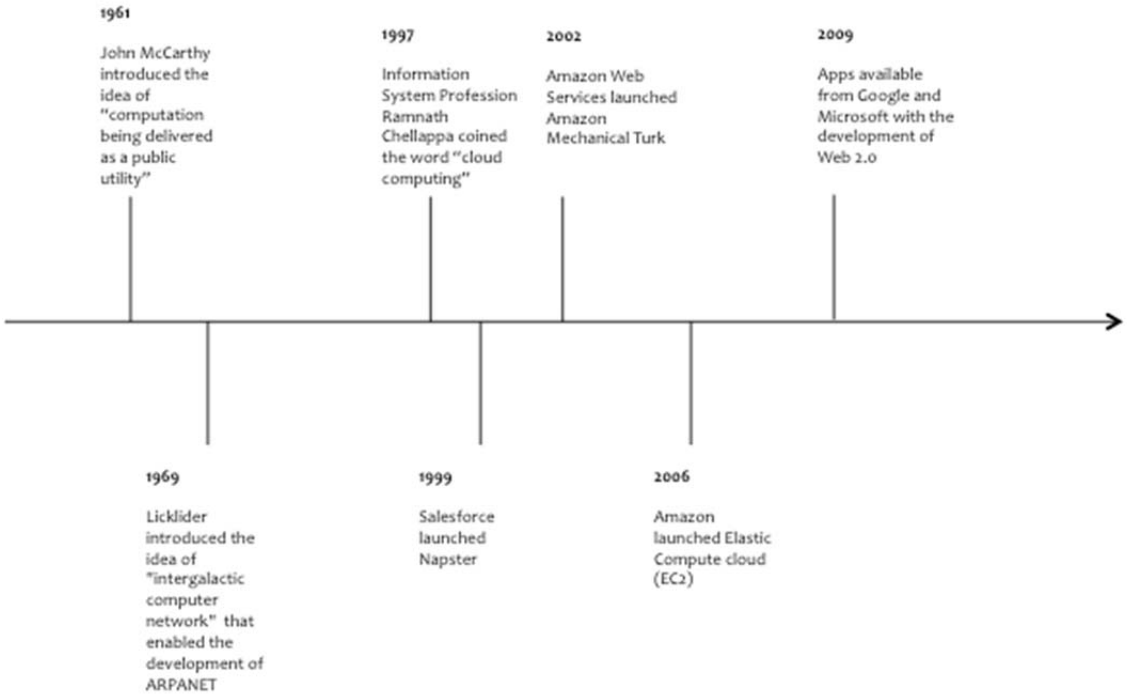


Figure 5 History of cloud computing

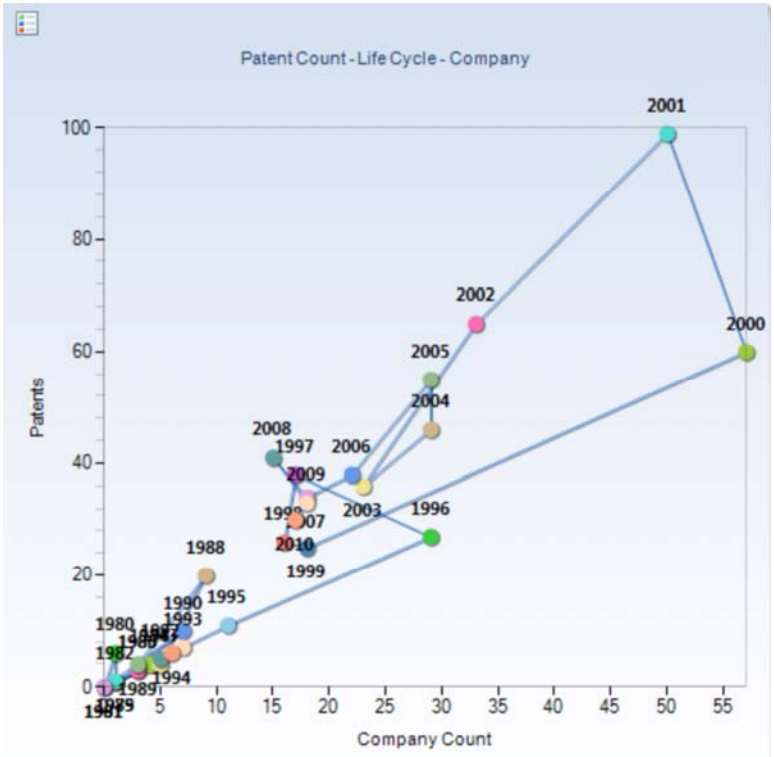


Figure 6 Technology life cycle of ARPANET

The major players in ARPANET are shown in Figure 7. An early player in this technology was Bell Laboratories. It filed the majority of the patents in early 1990s. However, its development was not as strong as the later players. Today, Bell Lab is no longer in the value chain of cloud computing. The latecomers at that time are Verizon, Hewlett-Packard and IBM. These are still strong players in providing the network facilities for cloud computing nowadays. From the chart of company trend for ARPANET, Palto Alto came into this area only after the others, a further check on this company's patent

portfolio revealed that this company is focusing on providing enterprise security platform.

An analysis of this ARPANET patent portfolio (Figure 8) of these 5 major players revealed that Palto Alto's patent portfolio is mainly in G06F 15/16 – "Combinations of two or more digital computers each having at least an arithmetic unit, a programme unit and a register, e.g. for a simultaneous processing of several programmes". This is the area of modern cloud computing. On the other hand, Bell and Verizon's patent portfolio are in the original ARPANET technology – H04L 12/66 – "Arrangements for connecting between networks having differing types of switching systems, e.g. gateways" Verizon was originally formed from Bell, therefore the research direction was similar to Bell and it enjoyed an early advantage in early 1990s. Along this line of research, Verizon evolved into researching in the LAN [Local Area Networks] or WAN [Wide Area Networks] (wireless communication networks) area.

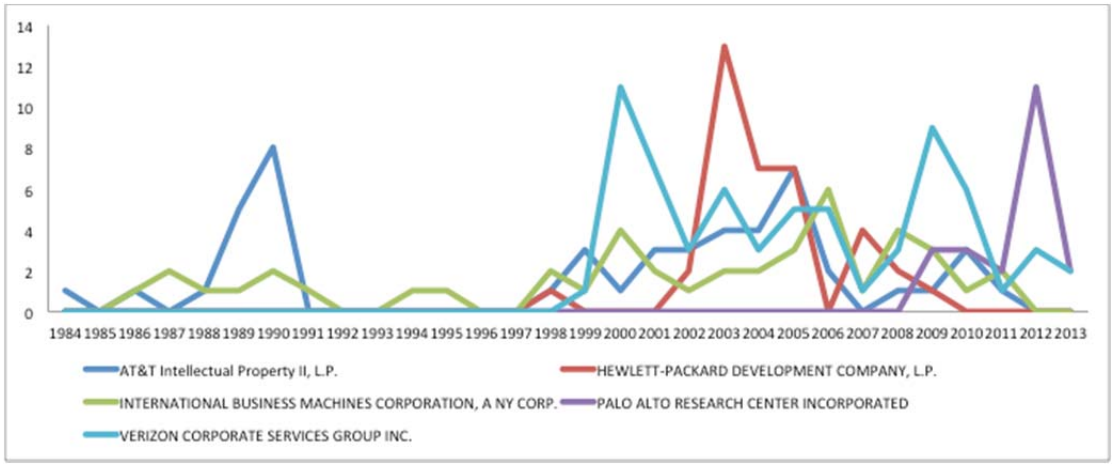
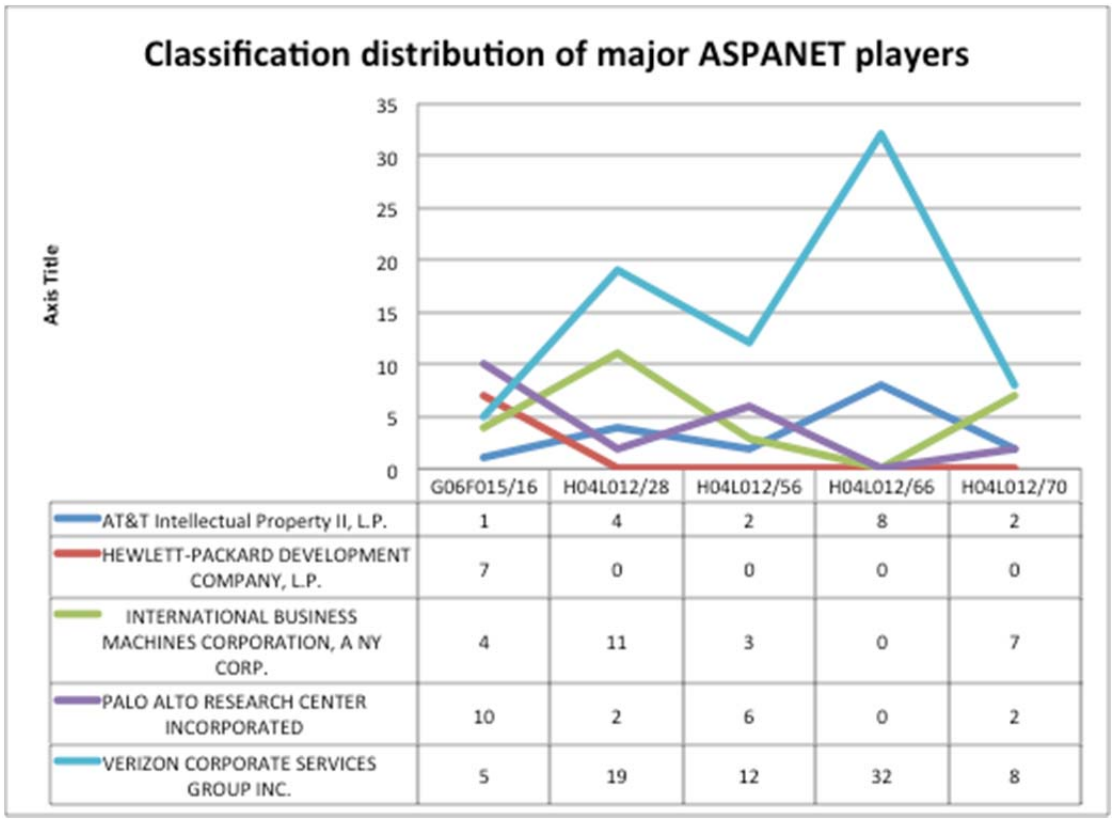


Figure 7 Key players in ASPANET



	G06F015/16	H04L012/28	H04L012/56	H04L012/66	H04L012/70
AT&T Intellectual Property II, L.P.	1	4	2	8	2
HEWLETT-PACKARD DEVELOPMENT COMPANY, L.P.	7	0	0	0	0
INTERNATIONAL BUSINESS MACHINES CORPORATION, A NY CORP.	4	11	3	0	7
PALO ALTO RESEARCH CENTER INCORPORATED	10	2	6	0	2
VERIZON CORPORATE SERVICES GROUP INC.	5	19	12	32	8

Figure 8 IPC distribution of the ASPANET players

IV. ENTERPRISE APPLICATIONS

The second milestone in the cloud computing history is the arrival of Salesforce.com in 1999. Salesforce pioneered the idea of delivering enterprise applications via a simple website. This has paved the way for software firms to deliver applications over the internet. A search was done for patents that described "enterprise" and "applications" and "website". This provides 25, 418 patents between 1970 and 2014.

It can be seen from Figure 9 that patents related to this area started to surge in 1998, just before Salesforce launched the website applications in 1999. They are dominated by the mainstream software firms like Microsoft, IBM and AT&T as shown in (b). Those patents as shown in (c) are in G06F17/30 - "Information retrieval; Database structures therefor" and H04L29/06 – "Protocol arrangement". They are the platform and service providers, which are mainly the upstreamers.

In 2001, there is another peak. There are more big software companies coming into this patent landscape as shown in (d). There are also other new players such as Restaurant Services, whose patents are mainly in the supply chain management area. Web Access' patents focus on data management. This shows that the milestone in 1999 has spurred the development of more web applications for enterprises and encouraged more new players into the field. The patents applied in this period are also more cloud computing related. For example in (e), G06F15/16 – "Combinations of two or more digital computers each having at least an arithmetic unit, a programme unit and a register, e.g. for a simultaneous processing of several programmes" and G06F15/173 - "using an interconnection network, e.g. matrix, shuffle, pyramid, star, snowflake". The key patent applicants are the network, platform and applications providers. They are upstreamers and some are in the midstream value chain.

After 2002, which is the year when Amazon introduced the Amazon Web Services, which provided a suite of cloud-based services including storage, computation and even human intelligence through the Amazon Mechanical Turk, number of patent applications increase at great rate. At the peak of 2007, the patent landscape has transformed. More players in the downstream of the value network come into the picture, e.g. Yahoo as shown in (f). Majority of these patents from Yahoo are in G06F17/30 – "Information retrieval; Database structures therefor" and G06Q30/00 – "Commerce, e.g. shopping or e-commerce" as shown in (g). This is in the service delivery sector of the value network. In fact, these are also the two main IPCs in Year 2007's patent landscape. This service delivery is in the downstream.

In 2011, with the development of Web 2.0 from Google, there are even more downstream players coming into the landscape. Players such as American Express, Research in Motion and Bank of America are starting to file for patents in enterprise applications and web applications as shown in (h). Other than the generic downstream technology sectors, there are also other sectors that are more related to the big data industry. In this case, it is the G06Q40/00 - "Finance; Insurance; Tax strategies; Processing of corporate or income taxes".

Therefore, as time progresses, there is a shift of patent applications from the upstream technology to the downstream technology. This also shows an evolution of the cloud computing industry.

V. PATENT PORTFOLIOS OF MAJOR PLAYERS

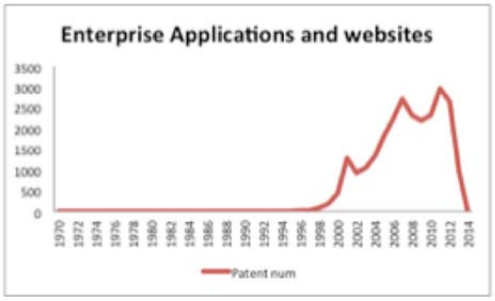
With the understanding of the value network and the historical development, we identified the technologies developed by Salesforce, Amazon and Google that have been instrumental to the growth of cloud computing. Therefore, we further analysed the patent portfolios of these three companies and find out the patent landscape around those critical time slices. We first looked at the applied patents for the past 20 years from these three companies in order to understand their research directions in those years. As these companies may be providing products and services that are not related to cloud computing, we identified the IPCs that are related to cloud computing and extract the patent portfolios from these companies with such cloud computing IPCs. Those IPCs that are related to cloud computing were identified using the Cooperative Patent Classifications (CPC) search from the European Patent Office website.

VI. SALESFORCE.COM

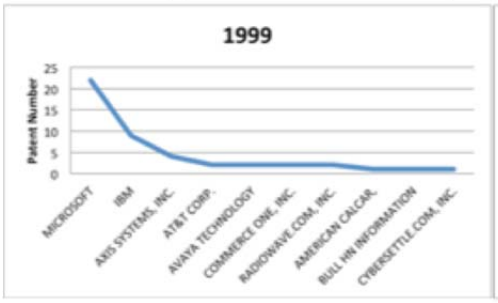
Using Assignee Name as Salesforce, we found 1045 US issued and applied patents. The IPC distribution of these patents is as shown in Figure 10.

In year 1999, Salesforce did not have any patents even though they made the cloud computing milestone in 1999. In 2001, Salesforce's patent filing was mainly in the IPC area of G06F015173 – "using an interconnection network, e.g. matrix, shuffle, pyramid, star or snowflake" and G06F01516 – "Combinations of two or more digital computers each having at least an arithmetic unit, a programme unit and a register, e.g. for a simultaneous processing of several programmes". They are providing the infrastructure and the platform for cloud computing, which are in the upstream segment. Similarly, there are focusing IPCs in G06F00946 – "Multiprogramming arrangements", G06F01100- "Error detection; Error correction; Monitoring" and G01R031/08 - Locating faults in cables, transmission lines, or networks. They are in the Network connectivity, infrastructure and platform services segment of the value chain, which are upstream technologies.

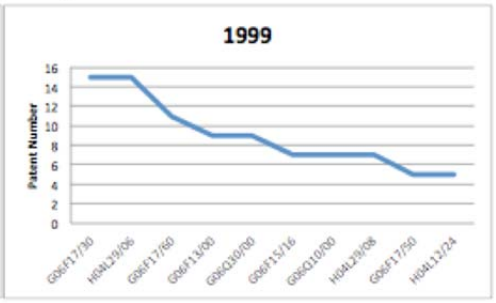
In 2007, there are common cloud computing areas, such as G06F01730 – "Information retrieval; Database structures therefor" and other typical upstream segments such as G06F01700 – "Digital computing or data processing equipment or methods, specially adapted for specific functions" and G06F00300 – "Input/Output arrangements for transferring data to be processed into a form capable of being



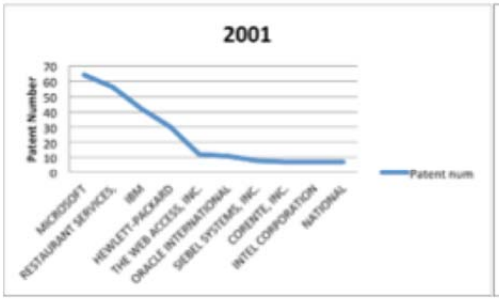
(a) Patents that describe "enterprise and applications and websites"



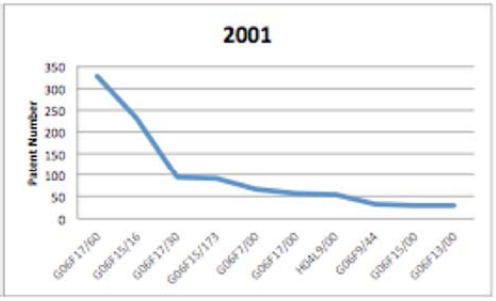
(b) Top applicants in Year 1999.



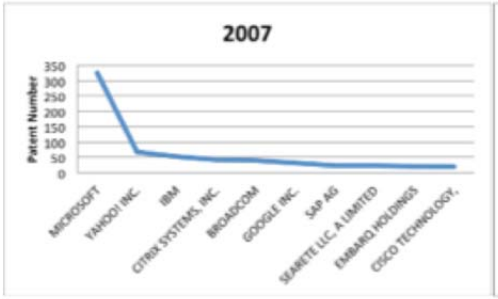
(c) Top IPC in Year 1999.



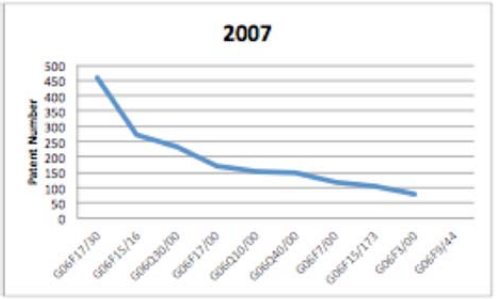
(d) Top applicants in Year 2001.



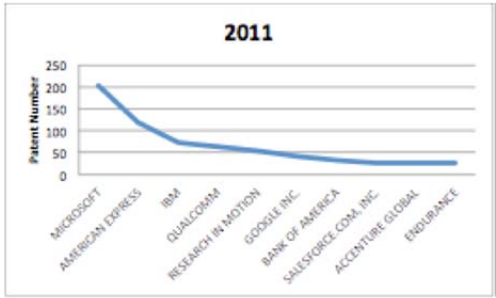
(e) Top IPC in Year 2001.



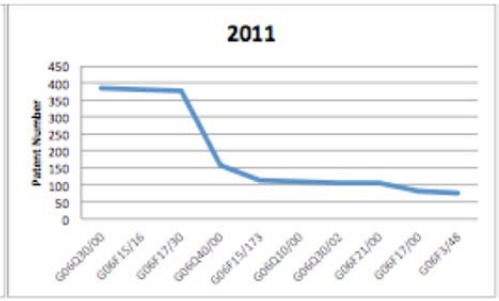
(f) Top applicants in Year 2007.



(g) Top IPC in Year 2007.



(h) Top applicants in Year 2011.



(i) Top IPC in Year 2011.

Figure 9 Patent portfolios of enterprise applications

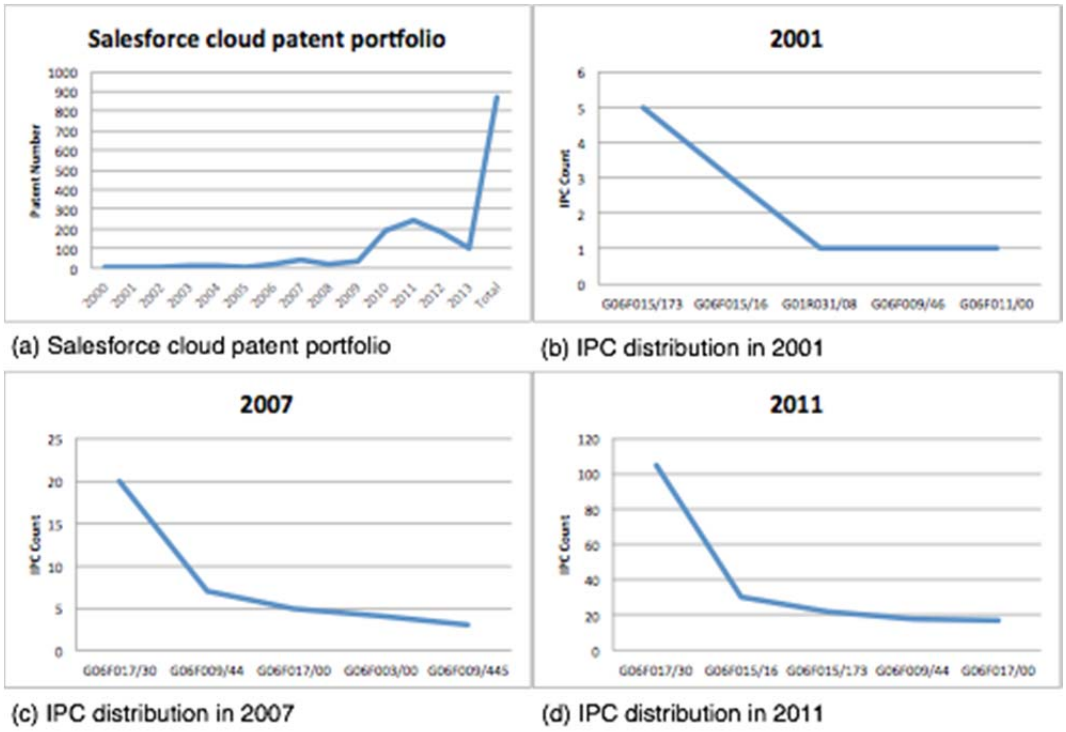


Figure 10 Salesforce cloud computing patent portfolio patent analysis

handled by the computer; e.g. interface arrangements". There are also patents in G06F00944 - "Arrangements for executing specific programmes" and G06F009445 - "Programme loading or initiating", which are in response to the Web services from Amazon. This is also in the midstream of the value network.

In 2011, besides the basic IPC of cloud computing, such as G06F01516 – "Combinations of two or more digital computers each having at least an arithmetic unit, a programme unit and a register, e.g. for a simultaneous processing of several programmes" and G06F01730 – "Information retrieval; Database structures therefor", the new focus is in G06F015173 – "using an interconnection network, e.g. matrix, shuffle, pyramid, star or snowflake". This is moving to the downstream segment of system integration.

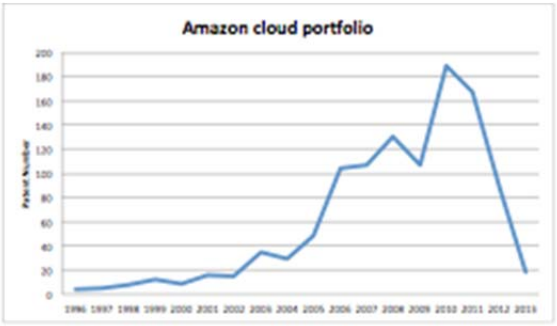
VII. AMAZON WEB SERVICES

Using Assignee Name as Amazon, we found 2030 US issued and applied patents. The IPC distribution of these patents is as shown in Figure 11. In year 1999, Amazon's patent filing was mainly in the IPC area of G06F01730 – "Information retrieval; Database structures therefor" and G06F01516 – "Combinations of two or more digital computers each having at least an arithmetic unit, a programme unit and a register, e.g. for a simultaneous processing of several programmes". There is also G06F00700 – "Methods or arrangements for processing data by operating upon the order or content of the data handle". They are the similar technology as the top IPCs of Salesforce patent portfolio. They are providing the infrastructure and the platform for cloud computing, which are in the upstream segment. However, one special area specific to Amazon's patent portfolio at that time is G06Q01000 – "Administration; Management".

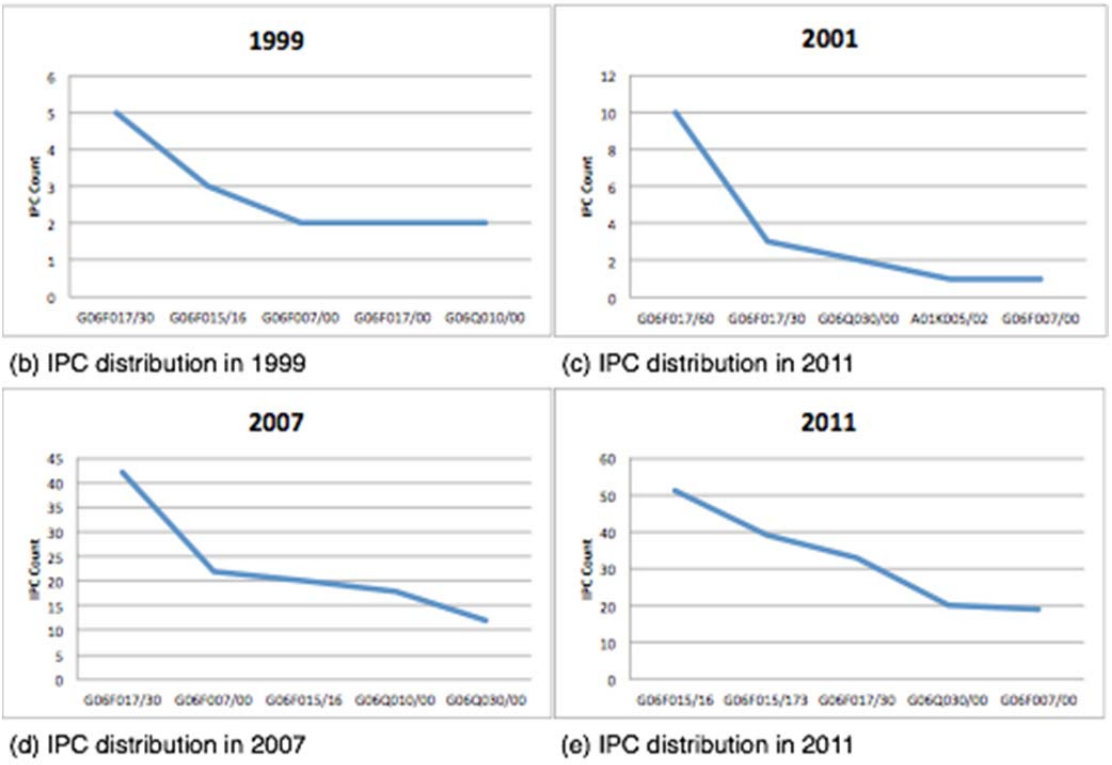
In 2001, there are new areas of interest: G06Q03000 – "Commerce, e.g. shopping or e-commerce" and A01K00502 – "Automatic devices". These are some special areas of application software. This also reflects Amazon's launch of Mechanical Turks that co-ordinate the use of human intelligence to perform tasks that computers are currently unable to do. This is also in the midstream of the value network.

Since 2007, on top of the basic areas of cloud computing, Amazon's focus is in the area of G06Q01000 – "Administration; Management" and G06Q03000 – "Commerce, e.g. shopping or e-commerce". This is in line with the cloud computing development and launch of Amazon Web services at that time. This is moving towards application management, the midstream segment.

In 2011, besides the basic IPC of cloud computing, such as G06F01516 – "Combinations of two or more digital computers each having at least an arithmetic unit, a programme unit and a register, e.g. for a simultaneous processing of several programmes" and G06F01730 – "Information retrieval; Database structures therefor", the new focus is in G06F015173 – "using an interconnection network, e.g. matrix, shuffle, pyramid, star or snowflake". This is moving to the downstream segment of system integration.



(a) Amazon cloud computing patent portfolio



(b) IPC distribution in 1999

(c) IPC distribution in 2011

(d) IPC distribution in 2007

(e) IPC distribution in 2011

Figure 11 Amazon cloud computing patent portfolio patent analysis

VIII. GOOGLE

Using Assignee Name as Google, we found 14486 US issued and applied patents. The IPC distribution of these patents is as shown in Figure 12. Majority of the patents belong to G06F01730 – "Information retrieval; Database structures therefor". This is followed by G06F01516 – "Combinations of two or more digital computers each having at least an arithmetic unit, a programme unit and a register, e.g. for a simultaneous processing of several programmes", G06F00700 – "Methods or arrangements for processing data by operating upon the order or content of the data handled" and G06F01700 and "Digital computing or data processing equipment or methods, specially adapted for specific functions". Both of these classifications are related to data processing, esp. Big data. These are the fundamental IPC for cloud computing. The special areas of interest in this time period is the G06F015173 – "using an interconnection network, e.g. matrix, shuffle, pyramid, star or snowflake" and the G06F00944 - "Arrangements for executing specific programmes" area. They reflect the network connectivity focus and the application management focus in the value network.

In year 2001, the fundamental research areas are still IPC G06F01516, G06F01730 and G06F01700. However, there are other groups G06F01750 – "Computer-aided design" and G06F01500 - Digital computers in general that came up in the patent landscape. The research is moving to more generic application software.

In year 2007, a new area of research from Google came up. That is in the area of G06F00300 – "Input/Output arrangements for transferring data to be processed into a form capable of being handled by the computer, e.g. interface arrangements". The focus of Google patent portfolio is moving to the downstream area of service delivery.

IX. EVOLUTION OF PATENT PORTFOLIO

As can be seen in the time slices of the patent portfolios of Salesforce, Amazon and Google, their patent portfolios have evolved from the initial upstream technologies to mid-stream and then downstream. And these changes were marked by the various milestones in the cloud computing history. Salesforce is a relatively focused and niche company concentrating on cloud computing technology. It does not have many patents and in fact, no patents filed at the time when it launched its Nepster applications in 1999. Its patent portfolios within the upstream, midstream and downstream are also diverse, spanning over several IPCs that are away from the mainstream software companies such as Amazon and Google.

Amazon and Google have very similar patent portfolios landscapes evolution. Besides seeing the evolution from a patent portfolio focusing on upstream segment to now the downstream segment, we also see that their patent portfolios focus on certain common cloud computing IPCs and in the evolution, the patent portfolio grew around these existing areas. This may suggest that they have a patent strategy of flooding the patent landscape [10]. Unlike Salesforce, it maybe is having a surround strategy in every stage of the evolution.

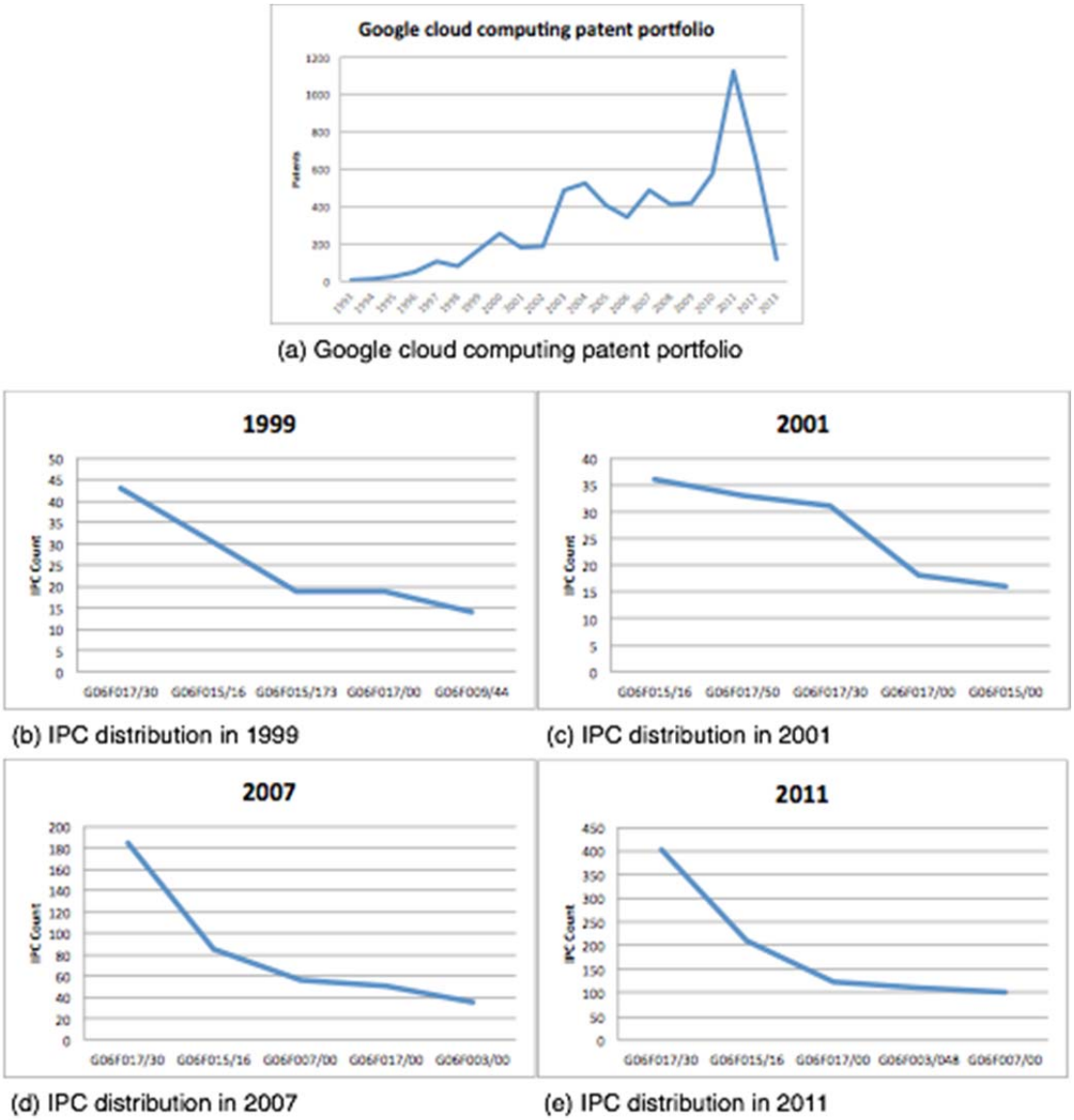


Figure 12 Google cloud computing patent portfolio patent analysis

X. CO-OPETITIVE RELATIONSHIPS BETWEEN INCUMBENTS AND SMES

We can also see from the development of ASPANET and enterprise web applications that each milestone enabled more players into the industry to help developing the cloud computing industry and push it to the next milestone. In the cloud computing industry development, an upstream player can reach the end consumers through a less complicated route by providing storage to customers as we have seen in the cloud computing value network in Figure 2. It can also develop products that help other companies to further develop applications to solve the various needs in the market. Each milestone is like a main branch in a tree on which smaller branches can spout out. In this case, there is not much an effect of early mover advantage in this cloud computing industry. In contrast, every milestone provides the opportunities for expanding the addressable market and moving the profits in the value network towards the downstream segment. Among the incumbents, there may be competitions. However, among the incumbents and SMEs, they are not exactly in a competitive relationship. They are in fact, co-operating with each other to help each other to gain a larger market size.

XI. CONCLUSION

We saw that the incumbents and the smaller entities are using different patenting strategies to survive in the evolution of the technology. The bigger companies such as Amazon and Google have the resources to apply for many patents to flood the patent landscape to build up their patent portfolios. The smaller companies such as Salesforce diversity their patent portfolio strategically to stay in the value network. It uses the surrounding patenting strategy to build fences around its core technology. This helps it to survive the waves of competitors coming into the industry.

Through the history of the cloud computing technology, we have also seen that in the cloud computing technology, incumbents and SMEs can be in harmony because the value network allows the upstream players to reach the consumer directly. It also has the option to co-operate with the SMEs to extend the value chain and increase the value network.

XII. POTENTIAL CONTRIBUTIONS TO FUTURE APPLICATIONS

In the knowledge economy, the traditional understanding of value chain and relationships between the players along the value chain needs to be revised to accommodate the change in the nature of the "product" [11]. Traditional products require long time and establish facilities to manufacture. In this new era, the products are very often services or some "soft" products, such as software development. These products can reach the end consumers in a more direct manner. Therefore, there is a need to understand how the research direction should head in view of the modified value chain or in the whole value network. Cloud computing is one such technology. We can apply similar understanding to other sectors in the knowledge economy.

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