

Mobile Phone Patent Analysis

MIS 480/580 - USPTO Knowledge Management Final Project

5/14/2009

Adam Aronoff

Ben Gray

Preston Troy

Table of Contents

Introduction	2
Objective	3
Research Questions	3
Hypotheses	3
Literature Review	4
Baby Boomers are Adapting	4
A Steady Transition from Cell Phone 1.0 to Cell Phone 2.0	4
Mid-Tier Phones are Dwindling	5
Research Method	5
Keyword Creation	5
Extract Data through Spidering USPTO	6
Parse Extracted Patents	6
Create and Populate Database	6
Data Analysis	7
Bibliometric Analysis	7
Total Number of Patents per Country per Year	7
Total Number of Patents per Company	10
Classification Analysis	11
Citation Analysis	11
Top Seven Most Cited Patents	11
NetDraw Visualization	12
Lessons Learned	13
Conclusion	14
References	15

Introduction

With a total of over 3.5 billion cellular subscribers worldwide, the cellular phone industry is constantly growing. A cell phone is a portable electronic device that can be used for voice or data communication. Recently, technologies have been added to cell phones that allow the user to send text messages, emails, access the Internet, and play games among many other things.

The first mobile radiotelephone was created in 1946, but was limited in technology and was completely tethered to an individual tower. In 1957, Bell Labs began materializing the first cell phone concept, which would utilize revolutionary directional towers that created a hexagonal service area. This new design would allow mobile phones to be “handed off” from one tower to the next, allowing a handset to go virtually anywhere seamlessly. Though this innovative technology could alter communications worldwide, the Federal Communications Commission (FCC) believed that the necessary spectrum of waves was better utilized by expanding television, and did not allocate any frequencies to the mobile phone industry until the early 1970s. As soon as the 115 Mhz spectrum could be used, both AT&T and Bell labs began testing both new towers and their accompanying handsets.

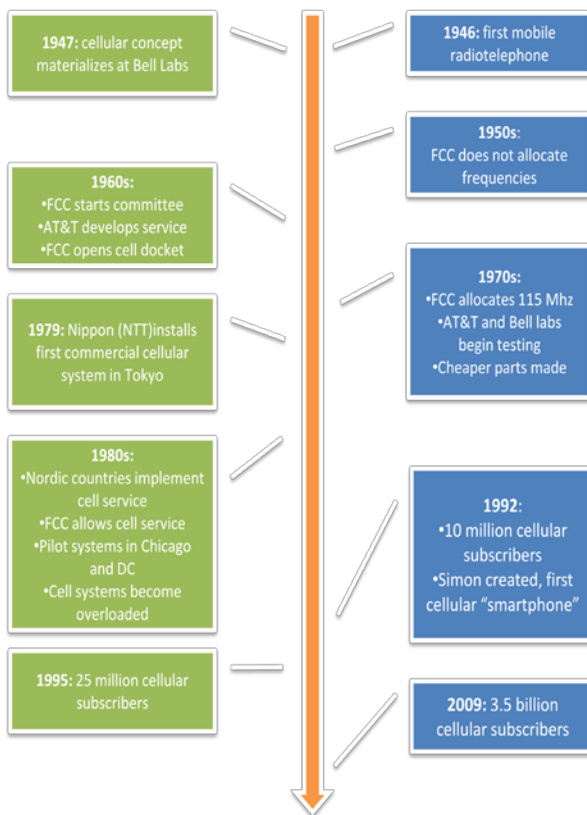


Figure 1. Mobile Phone History Timeline

The most pivotal leap in technology since the original design of the cell phone was in 1979, when Nippon Telegraph and Telephone (NTT) established the first commercial cellular system in Tokyo. Soon after, the Nordic countries developed their own services, giving rise to such companies as Nokia. The United States eventually began implementing pilot systems in Chicago and DC in the mid to late 1980s, which were so popular that the services soon ran into capacity issues.

By 1992, the cellular industry had exploded to ten million worldwide subscribers, which jumped to 25 million in a mere three years. With a continual expansion of technology, components, and capabilities, the cellular industry now has 3.5 billion subscribers around the world.

Objective

The objective of this report is to investigate patent trends within the Mobile Phone Manufacturing industry and extrapolate their causes and effects in order to better educate potential entrants into this market.

In order to complete this objective, a vast amount of patents regarding mobile phones from the United States Patent and Trademark Office (USPTO), from 1976 to the present, were analyzed. Once collected, we designed and populated a MySQL database with the extracted patents. Our team then used the following analysis techniques to identify trends and connections within the data:

- Bibliometric Analysis
 - Total Patents per Year
 - Total Patents per Country
 - Total Patents per Company
 - Total Patents per Country per Year
- Classification Analysis
 - Top 10 Patent Classifications
- Citation Analysis
 - Top 7 Most Cited Patents

Research Questions

Our team has designed the following six questions to frame and structure our project:

1. Is there a correlation between manufacturer's market share and their number of patents?
2. When will we see surges of cell phone patents?
3. Who will hold a majority of the cell phone patents?
4. What types of patent classifications will cell phones encompass?
5. What is the primary advancement in technology and are all companies pursuing this venture?

Hypotheses

Based off of our team's background in the industry coupled with a portion of our literature review, we hypothesize that our analysis will lead to the following results:

1. There is a direct correlation (ratio) between a manufacturer's market share and their total number of patents.
2. Surges of cell phone patents would be seen in 1979, 1985, and 1993
3. The top 5 manufacturers will have almost all of the patents
4. Most of the patents will be classified as Telecommunications
5. All of the major manufacturers, except Motorola, will have an explosion of smartphone patents.

Literature Review

A number of primary and secondary sources were analyzed during the literary review:

Baby Boomers are Adapting

"Interest in Cell Phones for Entertainment is Picking Up" by Joseph Palenchar

This article talks about how Baby boomers are quickly picking up Generation Y habits. Baby boomers are beginning to play video games on the go and listening to music on quick portable devices.

The article mentions that in a survey done by Accenture, the "percentage of people using cell phones to access Web-enabled services rose from 8%, to 23%."

As more and more people are willing to use the web, listen to music, and play games on their phones, technology will keep increasing in those areas. We expect to see some patents geared towards the software and entertainment aspect of new phones.

A Steady Transition from Cell Phone 1.0 to Cell Phone 2.0

"Where Motorola Blew It" by Jonathan L. Yarmis

The majority of this article talks about how Motorola has been slipping behind competitors in the world of smart-phones. That author believes that the most recent misstep was not engaging in the trend from Cell Phone 1.0 to Cell Phone 2.0.

Cell Phone 1.0 is the belief that the cellular phone is simply a communication device. That device can be used for entertainment but it was still only a "phone". Motorola came out on top with its creation of the Razr phone. It was simple and sleek and was a perfect fit for the Cell Phone 1.0 era.

As technology increased, Cell Phone 2.0 came into the picture. This is the thought that the cellular phone can be used as a computing platform. The perfect example of this is the smart-phone in that a user can check e-mails, edit word documents, play games, and do most things a normal pc can do.

This confirms our belief that smart-phone patents should be increasing in the most recent years.

Mid-Tier Phones are Dwindling

“The Decline of the Mid-Market Cell Phone” by Jay Yarow

This article from Business Week Online talks about how the increases in cell phone technology have move people from using mid-tier phones to using more “high-tech” phones.

According to ABI Research mid-tier phones have dominated the market and in 2007 they had 74% of the total sales while smart-phones only had 10% and low-end phones had 16%. This is predicted to change in 2013 where mid-tier phones will only account for 23% of sales with smart-phones at 13% and low-end phones at a high 46%.

Kevin Burden, the director of mobile services at ABI, believes that as smart-phones drop in price, they will increase in popularity. This will cause them to take up more and more of the percentage of sales.

We believe that we will see an increase in the number of smart-phone patents in the last few years as more and more customers demand the power of a computer at their fingertips.

Research Method

Keyword Creation

Based on the literary review, a basic set of keywords was established. At first, these keywords included actual cell phone manufactures, but this created an issue for discerning who the large patent holders were. Having the manufactures as part of the search gave them disproportionate weight in the search, and led to a skewed dataset. Instead, the keywords were changed to spider for a more balanced dataset. The final keywords selected were:

- “Cell Phone”
- “Cellular Phone”
- “Mobile Phone”
- “Smartphone”
- “Smart Phone”
- “Handset”

Extract Data through Spidering USPTO

Using several simple perl scripts, the USPTO database was spidered around the keywords selected. To accelerate the process, the keywords were split among several computers, so that the spidering process for different words was done concurrently. An initial spidering returned the search results pages from the USPTO, while a second perl script actually captured the individual patents. The first script usually took around 30 minutes to execute, while the second took upwards of a full day depending on the number of results. Our final extraction pulled a combined 68,344 patents (“cellular phone,” 20,080; “handset,” 18,821; “mobile phone,” 17,518; “cell phone,” 10,737; “smart phone,” 838; and “smartphone,” 350).

Parse Extracted Patents

After the patents are all downloaded from the spidering process, a simple Java program parsed the files into a number tab delimited text files. To aid in the configuration of the Java program, the Eclipse development environment was utilized. It allowed for the fine tuning of the Java versions required to execute the Java code. The parsing was incredibly fast, parsing over ten thousand patents in a only a few minutes.

The Java program left nine text files, each one representing a future table within the database. Only 8 of the files were used however, as the Patent Content file, which held the long text descriptions of the patents, was left out due to space constraints and the lack of clear need.

Create and Populate Database

The initial database selection was Microsoft SQL Server Express 2008 edition, but was quickly abandoned because of poor text file importing capabilities. Instead, MySQL was used. Using a combination of the command line editor and MySQL Query Browser software, all the tables were established. After several attempts to import the data from the text files, it became evident that the data had too many anomalies for straight importation.

The tables were all emptied, and the individual text files were loaded into Microsoft Excel 2007, and all formatting was redone. An additional advantage of using Excel was the ability to properly format the date fields for SQL, which has a very particular format. This would prove very valuable later on, as several of the queries later on relied on the date field.

Once the text files were reformatted in Excel, the importation proceeded smoothly.

After removing duplicate patents and some filtering, 52,082 patents remained.

Data Analysis

Once the database had been populated with our final patent information, we analyzed the data with a variety of different techniques: bibliometric, classification, and citation.

Bibliometric Analysis

Bibliometric analysis is a research technique that attempts to quantify the links between text and literature. When applied to patent studies, bibliometrics allows for researches to connect patent impacts to various firms, assignees, countries, and other reference data.

Total Number of Patents per Country per Year

The most significant bibliometric chart that we created was Total Number of Patents per Country per Year (Figure 2). This yearly chart allows for a representative view of patents that were issued from 1976 to 2009, both for the top-generating 5 countries and as a total. Because of the representative characteristic of this chart, our team was able to identify, and then research and explain, a multitude of over-arching trends throughout the history of mobile phone manufacturers. The sharp decrease in 2007 is explained through this depiction only taking into accounts patents that were issued, and not filed.

Each of the top five countries' positions are easily explainable: US (companies such as Motorola, IBM, AT&T, and many more), Japan (companies such as Sony Ericsson), Finland (companies such as Nokia), Taiwan (there ever-growing manufacturing companies), and Korea (companies such as Samsung). Interesting to note is the lack of China in the top five patent-holding companies, yet this can be contributed to their lax enforcement of copyright and patent protections.

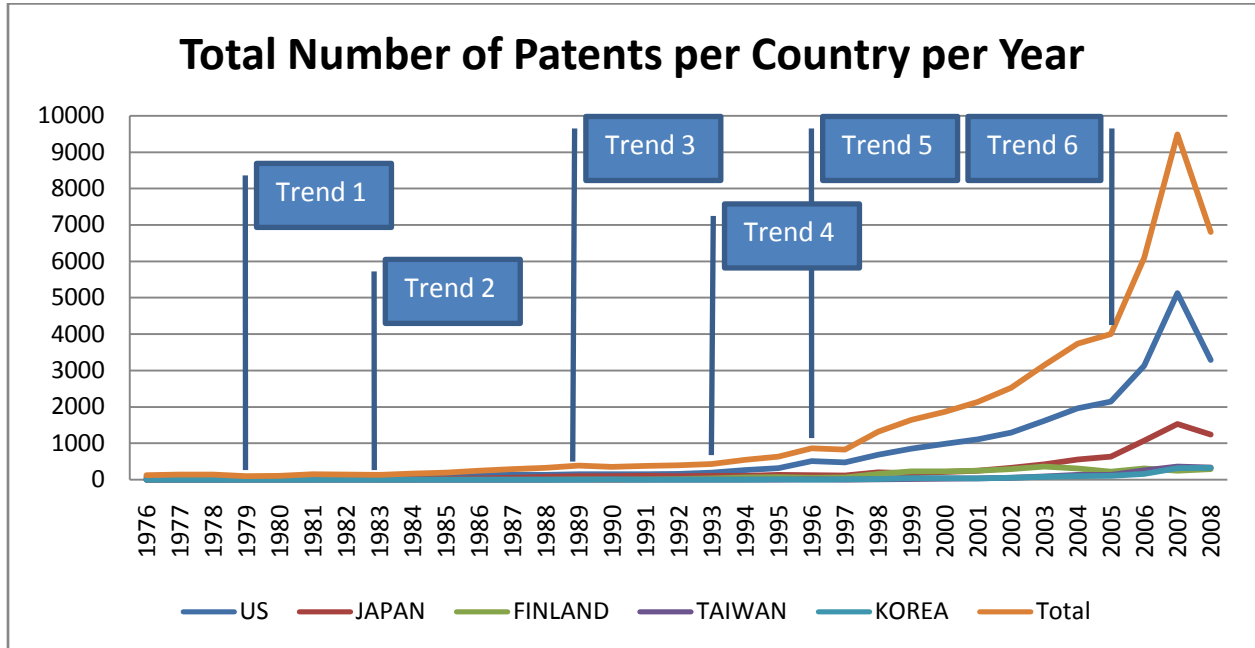


Figure 2. Total Number of Patents per Country per Year

Trend 1 – First Cellular Network in Tokyo

In 1979, Nippon Telegraph and Telephone developed the very first area-wide cellular system in Tokyo. Between the years 1947, when the first cell phone concept was materialized, and 1979, there had been a very slow and gradual growth of patents issued (The USPTO only allows full text searching of patents since 1976). The small hill of patents between 1976 and 1979 were largely related to the initial development of NTT’s cellular service. Directly after 1979, there is a decline of patents issued, which can be attributed to the fact that many of the resources of the companies that were filing these mobile phone-related patents were being diverted to set up and implement the service.

Trend 2 – First US Pilot Cellular Network

Even though Bell Labs designed the first cell phone concept, the United States, through the FCC’s decisions, believed it more pertinent to allocate airwave spectrum among television networks than allow any mobile phone manufacturers to utilize it. After the FCC’s “cell docket” in the late 1960s, the FCC finally began allowing testing in the United States, which culminated with the permission to build pilot services in Chicago and Washington DC in 1983. Once the pilot systems were in place, a multitude of technology and telecommunication companies began filing for patents, which can be identified by the very steady increase of total patents from 1983 to 1989. For more detail regarding the United State’s increase in patents, please see Figure 5.

Trend 3 – Towers Reach Saturation

Because of the widespread popularity of the cellular network, towers were built around the United States with the notion that they had unlimited capabilities. During the late 1980s, though, manufacturers began identifying that the cell towers were actually beginning to be over-saturated. This caused manufacturers to shift their primary focus to the building and development of new towers, and away from mobile phone technology. This trend can be recognized by a fairly stagnant period of patent issuances between 1989 and 1993. By the early 1990s, cell towers had been sufficiently upgraded and allowed for a much larger capacity.

Trend 4 – First Smartphone Introduced

While many of the patents filed up until 1993 were primarily based on upgrading the initial cell phone design's telecommunication capabilities, the focus soon shifted to encompass a plethora of different technological advances built for the user. IBM designed the first smartphone called Simon and displayed the concept product in 1992. It allowed users to access addresses, a calendar of events, a clock, a calculator, and many more functions that are standard on cell phones today. Even though these functionalities in today's term would be considered cell phone 1.0, it was the initial push towards furthering the capacities of a cell phone. This caused the largest increase in cell phone related patents thus far, and, ultimately, the ever-constant growth we still see today.

Trend 5 – Code Division Multiple Access Developed

In 1994, Qualcomm developed a proprietary cellular operating system called Code Division Multiple Access (CDMA), which allowed individual transmission to be spread across the bandwidth. In the time period leading up to 1994 was patent-heavy, while the time period after CDMA was implemented there was a slight decline. This somewhat confusing trend is very similar in nature to Trend 3 – Towers Reach Saturation, as many patents were issued in order to create the operating system, but once the system needed to be implemented, there was a decline.

After about a year of implementation, CDMA was not nearly as well accepted as Qualcomm had originally planned. The more popular Global System for Mobile Communication (GSM) operating system was seen to be superior and already in use throughout Europe. This accounts for the sharp increase in total patents around 1997.

Trend 6 – Smartphone Explosion

From 1998 through 2005, the mobile phone industry saw a virtual explosion of cell patents issued. This surge correlates to the growth of many periphery technologies relating to cell phones 2.0. In 2005, though, we see an even sharper increase in the slope of total patents issued. After much research, this trend is easily explainable: the design of cutting edge smartphones, including the Apple iPhone, the Blackberry Storm and Bold, and a series of smartphones from Samsung and HTC. These radical mobile devices pushed, and continue to push, the boundaries of what a “phone” actually is, as they not contain Web 2.0 access (built-in java and flash), high megapixel cameras, push e-mail accounts, and many other computer features.

Total Number of Patents per Company

Figure 3 depicts the total number of patents per company that are in some way connected to mobile phone manufacturing. While none of the top companies come as a surprise, especially the American-based companies (Motorola, AT&T, IBM, Intel, etc.), it is very interesting to note that the Finland-based Nokia has by far the most patents as a single assignee. This is somewhat shocking considering Finland has only the fourth most patents worldwide.

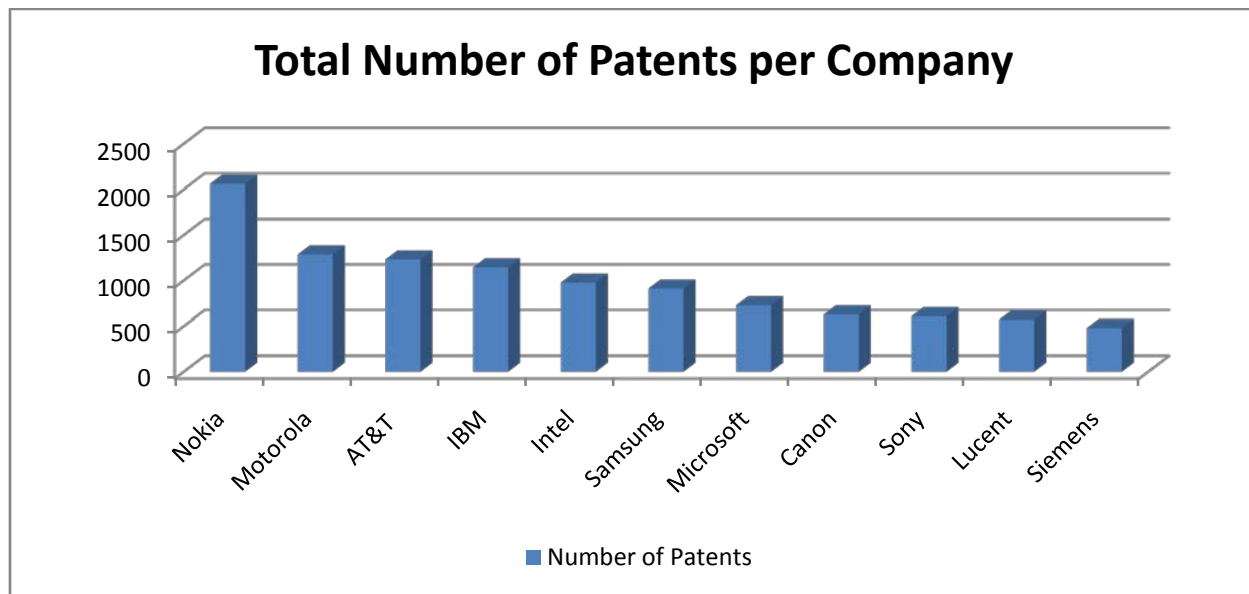


Figure 3. Total Number of Patents per Company

Classification Analysis

To reach a better understanding of the various classifications of patents within the cell phone industry, we categorized the top 257 total classification. Because of this staggering number, Figure 4 gives a visual representation of only the top 10 classifications. While Telecommunications is by far the most prominent classification, it makes up only a total of 17% of the whole.

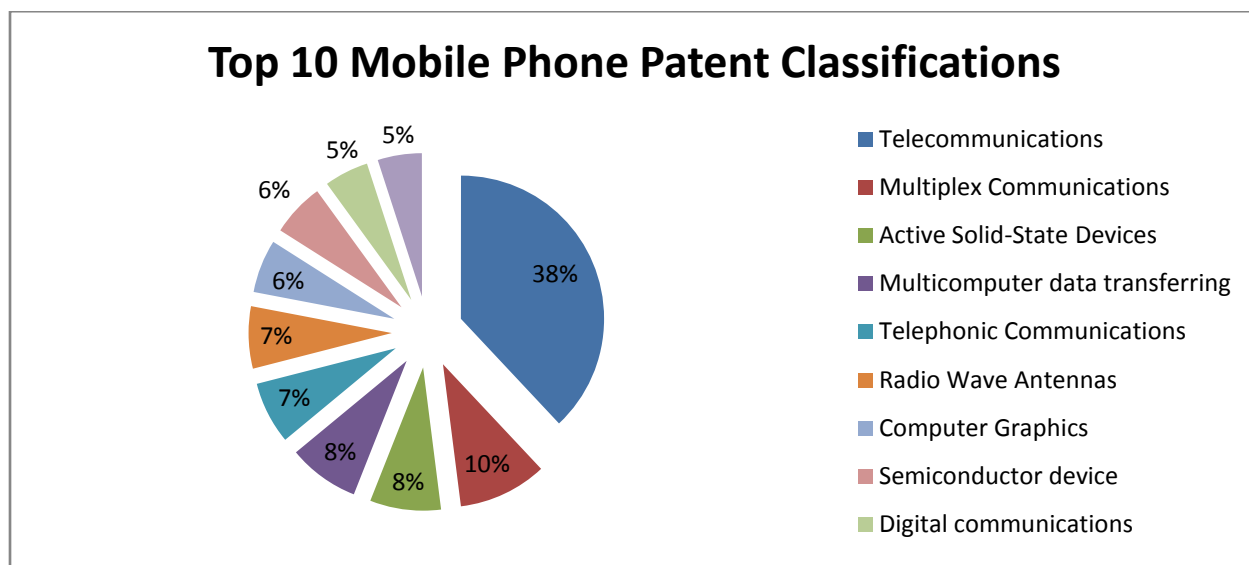


Figure 4. Top 10 Mobile Phone Patent Classifications

Citation Analysis

Top Seven Most Cited Patents

We extracted the number of references for each individual patent in order to investigate which documents and types of technologies were being cited most often. Figure 5 below illustrates the top seven most cited patents within the mobile phone industry, including the patent's title, author, and the number of times it was cited by other patents.

After reading through the content of each of the most cited patents, there are a couple trends that reveal themselves:

- Each of the authors that were originally independent inventors have since had either their idea or their labor purchased by a larger company.
- The top patents span a variety of core components that are used in every cellular device today, from e-mail/text messaging to caller ID.

Patent ID	# Cited	Patent Title
D289896	74	<i>Pocket Telephone</i> by Technophone
RE34034	57	<i>Cellular telephone data communication system and method</i> by Spectrum
4456793	37	<i>Cordless telephone system</i> by Bell Telephone
D388784	36	<i>Portable Telephone</i> by Nokia
5101501	32	<i>Method and system for providing a soft handoff in communications in a CDMA cellular telephone system</i> by Qualcomm
5493692	32	<i>Selective delivery of electronic messages in a multiple computer system based on context and environment of a user</i> by Xerox
4266098	32	<i>Device to automatically screen incoming telephone calls, determine the identity of the caller and process the call accordingly</i> by Albert Novak

Figure 5. Top 7 Most Cited Patent Documents

NetDraw Visualization

In order to create a visual representation of the interconnecting transmissions of knowledge relative to the USPTO, our team utilized an application called NetDraw. By running the data from the database through the program, several graphics were created to allow for visual interpretation. The most pertinent one (figure 7), shows the multidimensional scaling of geodesic distances. The data that was feed it was how often patents from a given country were cited by a patent from another country. The US, which was the most cited, is right near the middle, with the most number of nodes, and very close to several other countries.

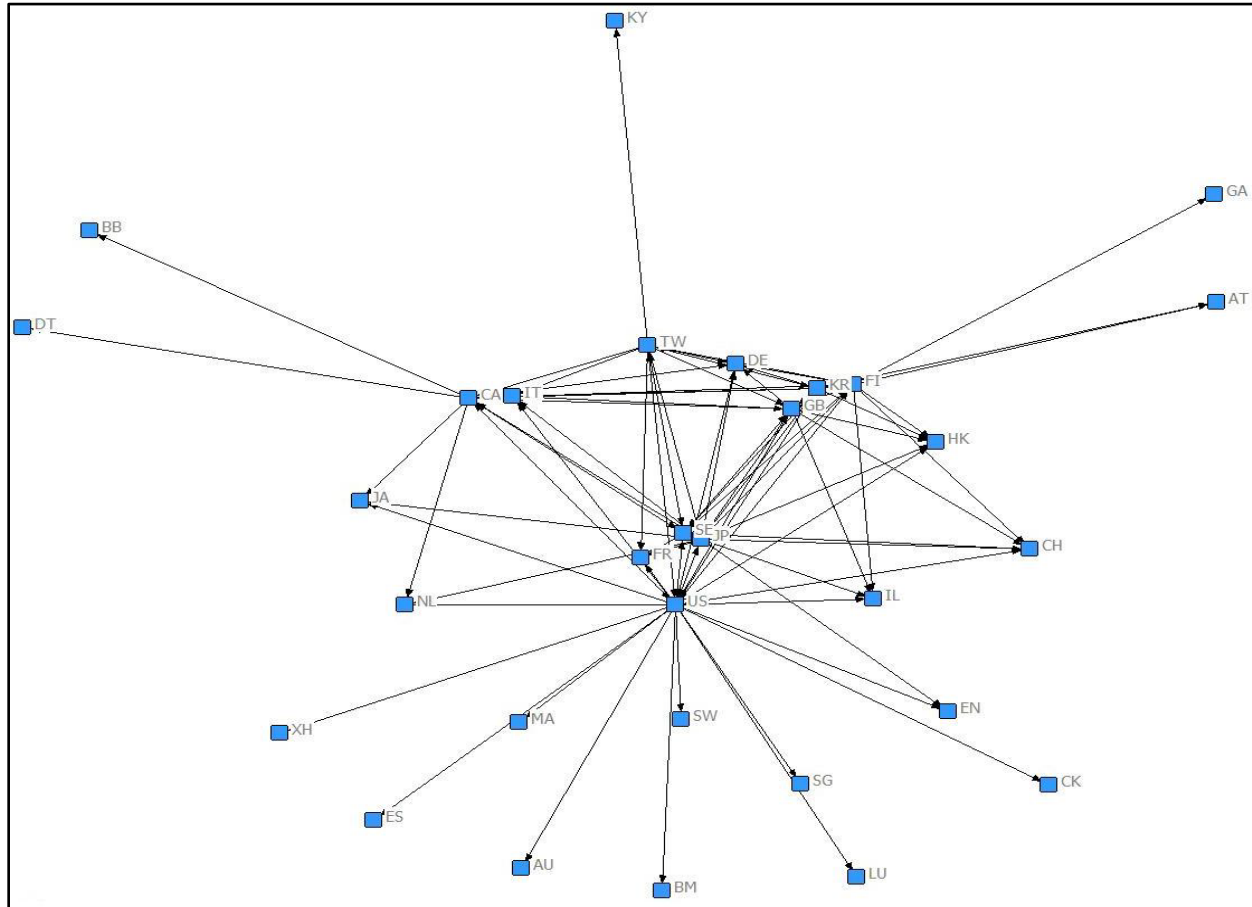


Figure 6. Multidimensional Scaling of Geodesic Distances from NetDraw

Lessons Learned

Comparing the initial hypotheses to what actually was observed reveals some surprising results:

1. **There is a direct correlation (ratio) between a manufacturer's market share and their total number of patents.**

The hypothesis is surprisingly incorrect. While a number of top cell phone manufactures are in the top 5 patent holders, a number of non-cell phone manufactures reside in the top 10.

Looking closer, it becomes apparent that many diversified engineering and electronics companies hold patents to technology that is relevant to cell phones, but are not actually cell phones. This can include things such as LCD touch screens, memory units, processors, cameras and software. With that in mind, the presence of companies such as IBM, Intel and Microsoft is logical.

2. Surges of cell phone patents would be seen in 1979, 1985, and 1993.

While there is an increase in patents in each of these years, they appear to be part of a greater trend line that is keeps climbing. This also maybe skewed by the turnaround time of the USPTO, as patents take a variable amount of time to be approved, and sometimes takes several years.

3. The top 5 manufacturers will have almost all of the patents.

An extension of hypothesis one, this is also incorrect, for the same reasons.

4. Most of the patents will be classified as Telecommunications.

By far, telecommunications was the dominant classification for cell phone related patents, with 38% of the patents. Telephonic communications takes up 7%, while digital communication is another 5%. In all, there were 252 different classifications for patents related to cell phones.

5. All of the major manufacturers, except Motorola, will have an explosion of Smartphone patents.

There is a growing trend in the market place of smart phones replacing simpler phones. In fact, the literary review reveals that it is the only market segment that is growing. In addition, regular phones are creeping towards convergence with cell phones, as they incorporate more and more features common to smart phones (email, web browsers, etc).

Conclusion

Our detailed analysis of the cell phone industry patent collection within the USPTO was not only very interesting, but also helped to display a number of growing trends and explanations. The United States is the clear leader in issued patents and the total number of patents for the cell phone market is growing substantially, especially due to the cell phone 2.0 and smartphone revolution. While not all of our hypotheses proved correct, they certainly led us to some very telling results.

References

- Ataa, Aamir. "Cellular Subscriber's Stats for March 2009 – ProPakistani." ProPakistani - Pakistan's Telecom and IT News. 03 May 2009 <<http://www.propakistani.com/2009/04/17/cellular-subscribers-stats-for-march-2009/>>.
- "The history of UMTS and 3G development." UMTS World. 03 May 2009 <<http://www.umtsworld.com/umts/history.htm>>.
- Measuring the Information Society. Publication. International Telecommunication Union. 3 May 2009 <http://www.itu.int/ITU-D/ict/publications/idi/2009/material/IDI2009_w5.pdf>.
- "The Role of NSF's Support of Engineering in Enabling Technological Innovation - Phase II." SRI International - an independent, nonprofit R&D organization dedicated to client success. 03 May 2009 <<http://www.sri.com/policy/csted/reports/sandt/techin2/chp4.html>>.
- Palenchar, Joseph. "Accenture: Interest In Cellphones For Entertainment Is Picking Up." TWICE: This Week in Consumer Electronics 24.7 (30 Mar. 2009): 14-14. Academic Search Complete. EBSCO. University of Arizona Library, Tucson, AZ. 3 May 2009 <<http://ezproxy.library.arizona.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=37601752&site=ehost-live>>.
- Yarmis, Jonathan L. "Where Motorola Blew It." Business Week Online (04 Feb. 2009): 19-19. Academic Search Complete. EBSCO. University of Arizona Library, Tucson, AZ. 3 May 2009 <<http://ezproxy.library.arizona.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=36422764&site=ehost-live>>.
- Yarow, Jay. "The Decline of the Mid-Market Cell Phone." Business Week Online (10 July 2008): 4-4. Academic Search Complete. EBSCO. University of Arizona Library, Tucson, AZ. 3 May 2009 <<http://ezproxy.library.arizona.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=33236750&site=ehost-live>>.