The Future of Personal Computing
Strategic Analysis through Speciation
and Scenario Planning

Sujoy Banerjee
The Wharton School
University of Pennsylvania
Mack Center for Technological Innovation
Acknowledgements

This paper is the product of research done during the author’s second year of the Wharton School’s MBA program and was funded by a generous grant by the Mack Center of Innovation at the University of Pennsylvania through the Ford Fellowship. I would specifically like to thank Dr. Paul Schoemaker for his mentorship and advice during the semester. This was a great opportunity to implement a number of interesting frameworks regarding managing emerging technology to an industry that is of great interest to me.

This paper is also the culmination of a number of secondary resources as well as a handful of interviews. I’d like to thank Ravi Raman and Tom Mereckis from Microsoft, Chris Lattner from Dell and Microsoft, and Jason Parekh from Google. Their contributions have helped bring this paper to life.
Executive Summary

For the past fifteen years, the personal computing industry has grown and changed. Be it the advent of cheaper desktops, the Internet, or laptops, constant shifts have continued. However, throughout that time, certain constants have persevered: Microsoft has dominated the operating system market with their flagship Windows product; Linux and Apple have essentially remained niche players; and original equipment manufacturers have cranked out largely undifferentiated desktops and laptops. However, several key trends are looking to shake up the personal computing industry: netbooks have marked a drastic transformation in consumer preferences from the processor-intensive and memory-heavy mindsets of incumbent computer manufacturers; the virtual cloud is growing in strength and viability, providing rich services for all to use; emerging user interfaces are creating new experiences for consumers across platforms; and the speed of convergence between mobile phones and computers continues to increase. So what will personal computing look like in 2020? And what does this mean for the current PC producers incumbent in the market?

These questions will largely depend on a number of key trends. This paper will aim to isolate the most important and influential key trends through the use of Technology Speciation and Scenario Planning, two key frameworks presented in George S Day’s and Paul J Schoemaker’s collection “Wharton on Managing Emerging Technologies.” By applying these two frameworks, this paper will analyze the past
and present trends in computing to determine forces that are shaping the industry today. It will then take a look at two key forces to come up with four potential scenarios to describe the future of personal computing in the next five to ten years. Once these scenarios have been defined, the paper will present some thoughts on how various players in the industry can position themselves to best prepare for the potential scenarios. Although it is impossible to predict exactly which scenario will fully emerge, it is possible to create strategies to help mitigate against a number of the factors present in a number of the potential scenarios.
Personal Computing Ecosystem

The personal computing ecosystem consists of a few layers that can be grouped in various ways. For the purposes of this paper, I will group them into three distinct categories: Producers, Distributors, and Customers.

Figure 1 – Personal Computing Ecosystem

Personal computers have largely fallen into two camps when it comes to production process. The first type of computer is produced by Original Equipment Manufacturers (OEM), who assemble pieces from Independent Software Vendors (ISV), Independent Hardware Vendors (IHV), and Operating System Software Vendors (O/S). An example of this would be a laptop assembled by Dell (OEM) that uses Windows 7 (Microsoft O/S), Intel Atom chips (IHV), and Norton Antivirus software (ISV). These types of computers, dominated by Intel chips and Microsoft
operating systems, are by far the most common and have historically made up approximately 90% of the market (ComputerWorld). It is well understood in the industry that the ubiquity of Intel chips and Microsoft Windows has largely commoditized the PC industry, resulting in some of the pressures faced by the industry today.

The second type of personal computer comes from an Integrated Manufacturer who largely designs and builds their own components. Apple Inc is the best example of this type of producer. Apple has selectively been giving up control over some aspects of their machines recently, going with Intel chips for example. However, the biggest aspect on which Apple refuses to compromise is control over the Operating System. Because of this, as well as their ability to produce eye-catching designs, Apple has created a differentiated product, which allows them to serve a small segment of the market at high premiums to the rest of the industry. In fact, Apple’s average selling price for a notebook computer was $1500 in August of 2008; more than double that of Windows notebooks which came in at around $700 (Gizmodo). Furthermore, Apple owned a 91% market share for PCs priced $1000 or above (Silicon Alley Insider).

The landscape of distribution has been shifting in recent years as well. The classic channel choice for computers has always been through brick-and-mortar stores, generally retailers. Dell, however, popularized the internet channel in the early 2000’s, reducing cost with their just-in-time supply chain process. The late 2000’s
have given rise to a renaissance in personal computing retail and self-branded stores, thanks in large part to Apple's successful initiation of Apple Stores. However, there is a new distribution model that is currently threatening to emerge. In a world where network connectivity is vital to many computing activities, telecom service providers are bringing a new model to PCs that parallels that of smartphones; heavily discount the device while bundling a wireless data package. This has worked very well with smartphones, however it is still too early to determine how successful this new distribution model for PCs will be.

In the third and final part of the ecosystem, we have the customers: consumers and enterprise customers. This has been the traditional highest level segmentation in the PC industry. In the past, computers and software were designed with the enterprise in mind, and then shifted over to consumers with minor modifications. With the rise of netbooks and Apple's ability to create brand associations with PCs, the consumerization of PCs is just beginning. Clearly a few new consumer segments have emerged, including design-conscious consumers will to pay for a premium product and low-end basic internet users. However, will there be more segments to emerge? Are the needs of a teenager in high school different from that of a middle-aged professional? They certainly are, and it’s likely a matter of time that more segments begin appearing in the consumer marketplace. In this paper, I will focus mainly on consumers. The reason for this is that the paradigm has shifted. Whereas five or ten years ago, the enterprise drove innovation and consumers were afterthoughts, today the consumerization of IT is well underway, meaning that
enterprise are now being forced to think of their employees as consumers, and these consumers will drive how PCs are used in the enterprise going forward.
Methodology

Personal computing is transforming from a number of different angles. The cloud is putting more of an emphasis on services rather than local applications. Netbooks are accelerating drops in average selling price for OEMs and operating system producers. Wireless companies are beginning to treat computers like smartphones, offering discounted laptops with a bundled service agreement. And smartphones are growing despite the worst recession since the Great Depression, a testament to the value users see in them.

In such an ambiguous and shifting environment, we will need to use frameworks that help put structure around some of the key questions we will need to answer. Below are the two key questions that will be addressed in this paper and the frameworks best suited to answer them.

1. How has the industry gotten to this point, and where is it going?
   a. Technology Speciation and the Path of Emerging Technologies

2. What is the range of possible future scenarios, and how can firms plan for them?
   a. Scenario Planning for Disruptive Markets
A deeper analysis of these three frameworks will illustrate how they will create a coherent and logical story about the world of personal computing. For each of the frameworks listed above, I will discuss why it will be useful in the context of this paper, what it entails, and how it will be implemented with regards to personal computing.

**Technology Speciation and the Path of Emerging Technologies**

Before making any predictions about where personal computing is headed in the future, we need to understand some of the underlying trends and occurrences that have made personal computing what it is today. Technology Speciation allows us to, first, look backwards to determine the historical events that led to today’s personal computing environment, and second, look forward to determine what future trends or events might be on the horizon.

Technology Speciation treats the emergence of new technologies and new applications as evolution treats the emergence of new adaptations in nature. The theory states that significant drivers of technological change come about due to pressures or shocks, and are not gradual as most people may like to believe. An example shared in the book is that of the Internet, which started off as a way for government researchers to communicate. However, once the browser was created, the fundamental usage of the Internet transformed from a private conversation to a worldwide superhighway of information.
For this paper, I plan on creating a high-level technological evolution to try to demonstrate how personal computers, media, telecom, and the Internet have grown side-by-side in the past. This will allow me to see a more holistic picture, which will help demonstrate where potential future trends may come up and how other seemingly unrelated innovations could change the face of personal computing.

**Scenario Planning for Disruptive Markets**

After I examine current and future consumer segments and preferences, I would like to take a detailed look at possible future scenarios and how firms can best prepare for and compete within them. Scenario Planning will allow me to take into consideration all of the current trends for the various parts of the ecosystem and determine how they will interact and combine to make distinct scenarios. For painting a picture of what personal computing will mean in the future, Scenario Planning is the best tool and should provide some very interesting insights.

The fundamental concept behind Scenario Planning is that emerging technologies are unpredictable. It is nearly impossible to predict exactly what will happen with a high level of certainty. To overcome this, we should think about the various trends and pressures in the market and try to come up with some likely situations that might arise. We can then determine what strategies work in each of these scenarios, and which strategies do the best across scenarios. By weighting each scenario by
their likelihood of occurrence, we can come up with a picture of which strategies will be best catered to this group of scenarios.

For this paper, I will come up with trends and uncertainties that surround every aspect of the ecosystem, including hardware, software, internet, distribution, wireless, and consumers. From this, I will look for trends that will work together, such as wireless providers offering bundled wireless packages with computers and the proliferation of wireless broadband. After I group some of these scenarios, I will be able to come up with a few distinct scenarios that may occur in the future. From there, I will take the viewpoint of a number of players in the market and determine what strategies would be available to these firms and which of the strategies are best suited to perform across scenarios.

**Framework Selection**

When selecting these three frameworks, there were a number of criteria that I felt were very important.

1. Relevance – Each framework will be used to answer a specific question. Without the necessary relevance, it's clearly very difficult to get the necessary value out of the framework. That’s not to say that there weren’t other frameworks that were also relevant. Some of the others that I won’t use in full, but may touch on, have to do with public policy and more tactical
concepts like corporate decision-making or organizational design. These tactical concepts are more likely to play a role after the strategy is defined in determining next steps for execution.

2. Applicability – Each framework was chosen because I could easily visualize how it would be applied to the personal computing realm. There were certain frameworks which I struggled to see how they would be applicable in such an ecosystem, such as Managing Real Options and Appropriating Gains from Innovation.

3. Fit with overall story – The final decision was whether it would fit into the ultimate story that I am trying to highlight. I believe the two frameworks selected come together to tell a very logical story about the past, present, and future of personal computing.

From this selection criteria emerged Technology Speciation and Scenario Planning. I believe that these three frameworks will provide a robust and logical storyline which will help explain where personal computing has been, where it will be going in the future, and how firms can plan and execute in this uncertain environment.
Analyzing Technology Trends through Speciation

Technology speciation provides us a framework to analyze past trends in various industries and how they’ve merged to create new products and markets. By analyzing the past and seeing how trends have merged, we can make more educated guesses about how the future for personal computing will evolve.

The following diagram is a high-level view of some of the forces that have created the personal computing industry today. Blue boxes are from the past, and red boxes are hypothetical future products, systems, or services. We can see personal computers have or will likely be influenced by things as far reaching as telephones, music players, televisions, calculators, and modems. We can also see that the concept of personal computing, where one sits in front of a desktop or laptop, is evolving into a more ambiguous form.

When thinking about the Personal computing industry in the future, there are a few elements that we need to take into account. These include the shift to netbooks, the proliferation of smartphones, the growing availability of wireless connections, and the experimentation with alternative user interfaces.
The Shift to Netbooks

Netbooks have taken the personal computing world by storm, quickly becoming the fastest growing segment in the business. Although still a small percentage of overall sales, IDC projects netbook unit sales to reach over 25 million by 2010, which is close to around 15% of the overall laptop market. The shift to netbooks has shown that many users are interested in owning a device that is under-powered, but is still sufficient for browsing the web and running basic applications. Although the overall industry is worried that these netbooks will begin cannibalizing laptop sales, Intel has claimed the cannibalization rate is currently around 20%, far lower than original concerns (ChannelInsider).

So what does this mean for the industry? Well for starters, it means that consumers are interested in lightweight, highly portable devices that are connected to the web.
Furthermore, it means that people are spending a lot of their PC time on the web, meaning they may not need faster and stronger computers in the future. In an industry where computers aren’t getting faster, how does Intel create new products? How do OEMs get people to buy the newest computers? For Intel, it likely means that they will have to innovate by making chips smaller and more energy efficient. For OEMs, they will have to focus on new user interfaces, better battery life, lighter laptops, brighter screens, etc. The fundamental upgrade cycle, however, seems to be on the verge of disruption.

**The Proliferation of Smartphones**

After spending a few years as digital leashes for executives, smartphones made their way into the hands of mainstream consumers in rapid fashion. It may not be clear yet why smartphones are part of this discussion, however the more mature smartphones get, the more they will act (and possibly look) like computers. Twenty years ago, telephones made calls. That was all they did. Ten years ago, cell phones allowed people to leave their home and still make calls. Soon after, text messaging was introduced. Then photos, internet, games, and video all made their way onto modern phones. Nowadays, a smartphone performs many of the same functions of a computer, and in some ways performs them better. Why use a computer to look up a map when you can look the directions up on your phone? Why check your email through your computer when you can read the email when it arrives? Smartphones are absolutely a small computer in your pocket, and that could mean big changes for the PC industry.
If one thinks about smartphones as small computers, it’s not hard to think that in five or ten years, smartphones will be powerful enough to be our main computers. If Intel really does focus on making chips smaller and more energy efficient, and consumers no longer demand heavy-duty processors, there are clearly reasons to believe smartphones will achieve such a state. Clearly smartphones have their own drawbacks as well. Primarily, they have small screens and small keyboards. However, that’s true of netbooks and some laptops today. Consumers get around this problem with a docking station. Why can’t a future desktop computer really just be a smartphone docked with a monitor and a keyboard? If storage of consumers files and data moves to the cloud, this scenario gains even greater credence.

The Growing Availability of Wireless Networks

The internet has become an absolutely essential part of our lives. As the internet has grown in importance, it has become clear that wireless connections to the internet drive productivity and efficiency. Furthermore, as smartphones have proliferated, so have data package offerings from wireless carriers, providing another new method of reaching the internet. With the introduction of services such as Clear, a new WiMAX service that allows you to have wireless internet for your computer, it is clear that the push for ubiquitous wireless internet is still strong. As the wireless coverage grows and our PCs and phones are constantly connected to the internet, more and more services and storage will shift to the cloud.

This shift further drives the lack of consumer demand for high-end machines and the high consumer demand for portability. As the cloud grows in importance, the
need for stronger computers diminishes, and the computer can potentially become a thin-client, used mainly to access the web. Already, much of a computer’s functionality is compromised without a network connection. Furthermore, as more applications and data are run and stored on the cloud, portability and the ability to access applications and data from anywhere will begin to grow in importance.

**The Experimentation with Alternative User Interfaces**

Ever since Apple created the first graphic user interface for a computer, operating systems have largely stuck to the tried and true interface of using icons with textual input from a keyboard and point-and-click input from a mouse or touchpad. There has always been talk of new user interfaces, and we often see them in futuristic movies: touch, voice recognition, audio commands, hand gestures, eye-tracking, etc. Slowly we are starting to see some of these interfaces reach the mainstream market. Apple clearly brought touch to the forefront of user interfaces with the iPhone, which has quickly been mimicked broadly around the mobile phone industry. The PC industry is currently abuzz about tablet computers, computers that allow for stylus handwriting input, especially because Apple is rumored to enter the space.

As these various interfaces mature, it is likely that different devices will adopt whichever interface best fits. This also means that if operating systems want to own the entire scenario experience, they will have to be able to adapt to multiple interfaces.

**Speciation Insights**
From the Technology Speciation process, we see a number of important trends which create some important uncertainties that will influence how the personal computing industry will evolve in the future. Will devices continue to converge, or will we see specific devices for entertainment, education, business, etc? Will the computer become resigned to a thin-client while the cloud stores all applications and data? Or can the cloud and client software harmoniously co-exist? Will netbooks cannibalize laptops and desktops, dropping average selling prices further? Will wireless networks become pervasive? These are all very important and impactful uncertainties, which will be used as inputs into the Scenario Planning analysis.
Scenario Planning for Personal Computing

Taking the inputs from speciation as well as recent forces from around the personal computing industry, scenario planning can be used to isolate the most significant forces and come up with key trends that will work to shape the future landscape of the industry. Insights here come from various secondary sources such as blogs, market research reports, industry reports, and news articles, as well as a few primary sources from companies such as Microsoft and Dell. From these various sources, the following list of forces has been created:

<table>
<thead>
<tr>
<th>Forces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor power growth is slowing</td>
</tr>
<tr>
<td>New UIs are being introduced</td>
</tr>
<tr>
<td>Broadband’s reach is increasing</td>
</tr>
<tr>
<td>Smaller PCs are gaining popularity</td>
</tr>
<tr>
<td>Average selling prices are falling</td>
</tr>
<tr>
<td>Smartphones are proliferating</td>
</tr>
<tr>
<td>Customization of PCs is increasing</td>
</tr>
<tr>
<td>Wireless providers are selling laptops</td>
</tr>
<tr>
<td>SAAS is emerging in the consumer space</td>
</tr>
<tr>
<td>Laptop sales are strong in developing markets</td>
</tr>
<tr>
<td>Memory / processor prices are declining</td>
</tr>
<tr>
<td>Governments are sponsoring broadband</td>
</tr>
<tr>
<td>Desktop sales have been surpassed by laptops</td>
</tr>
<tr>
<td>Cloud is growing in importance</td>
</tr>
<tr>
<td>Developers are migrating to web and mobile platforms</td>
</tr>
<tr>
<td>Convergence between phones, laptops, cameras, and GPS is occurring</td>
</tr>
<tr>
<td>Network connections are becoming more ubiquitous</td>
</tr>
<tr>
<td>Mobile apps have gained popularity</td>
</tr>
<tr>
<td>Consumers expect free things on web</td>
</tr>
</tbody>
</table>
Social media has reached mainstream consumers. Computers are used for larger variety of tasks.

Table 1 – Key forces impacting personal computing

These twenty forces describe a great deal of what is currently transpiring in the industry. Many of them are interrelated, and it can be very difficult to determine which ones are the most significant underlying drivers. However there are two drivers that I believe are playing the largest roles in creating these 20 forces. They are the growing ubiquity of network connections and the potential convergence of devices.

**Growing Ubiquity of Network Connections**

Today there seems to rarely be a computer or smartphone without some connection to the external internet. Although in the early days, the internet was considered a simple communication device fit for reading websites and articles, it has clearly morphed into a much stronger force. Today, cloud computing and web 2.0 are shaping our personal computing experiences. Consumers spend at least half of their PC time on a browser on average (paidcontent.org), but that number is rising. There is certainly a segment that spends upwards of 80% of their PC time in a browser, meaning client software is already taking a backseat for some consumers. All of this is only made possible if speedy, reliable networks are abundant.
The growing abundance of wireless network connections is also making it possible for new devices that are weak in terms of processor power and memory, but focus on simple use cases and mobility, such as netbooks and tablets. These devices are providing new price points previously unheard of in the PC world. Netbooks have made PCs accessible to a number of emerging economies and have provided the potential for a second or third computer in many developed countries. As more people connect to the internet, the power of the web grows exponentially. Already, web user statistics are astounding. Facebook recently announced crossing 350 million unique users for its popular social networking site (facebook.com), nearly the size of the entire US population! With numbers like this accessing the web, it is clear that a large part of the value a PC provides consumers today is related to its ability to access the web.

As networks continue to expand, the value of storing data and running applications on the cloud increases rapidly. Continuous reliable network connections allow users to access the cloud whenever they want, thus making it almost unnecessary to store anything but the most private data locally. Furthermore, processor intensive applications can be run on a strong central server instead of at each local machine, resulting in less of a need for fast processors and high memory capacities in laptops or desktops. This becomes an issue for hardware vendors such as Intel, who have historically made their living off of producing faster and faster processors. In such a world, Intel will likely have to focus on making their chips more energy efficient and
smaller in physical size instead of trying to improve power and speed. This may push computers to become even smaller and more portable.

A number for factors will drive the overall ubiquity of network connections. The first is the business model behind future wireless networks. Today, network providers are trying very hard to avoid becoming dumb pipes. However, concerns about net neutrality are keeping network providers from managing traffic and charging premiums for their networks, thus dis-incentivizing network investment. The second factor will likely be government involvement. There are many nations today that have much more reliable and expansive high-speed wireless network coverage than the United States. Although it might still be too early to determine whether this can be a competitive advantage for a nation, it will likely be shown in the future that technical and wireless infrastructure can play a large role in our digital economies. The third might be interest from large Internet players like Google, who have a deep interest in undermining the current software business model and moving more consumers on to high-speed wireless connections. Google recently announced its foray into testing “ultra high-speed” fiber optic networks for exactly this purpose. If there is one private company outside of the network providers that wants to see ubiquitous wireless proliferate immediately, it is Google.

Convergence of Devices

For years, people have spoken of convergence. Devices have slowly been merging to create powerful mixes of popular electronics. The best example of this until now has
been the smartphone: a device that merges features from cell phones, computers, cameras, handheld gaming devices, and mp3 players. Analysts are already making doomsday predictions regarding the future of standalone mp3 players, and devices like the iPhone have certainly drawn the attention of Nintendo (makers of the portable game system DS) and Sony (PSP). But can convergence really continue to occur? Do consumers really want an all in one device, or are certain functions best left to themselves?

Predicting convergence is difficult due to the many complexities of the various use cases in question. For example, music didn’t make much of a move to phones until Internet connections became more common and hard drives were of reasonable capacity at a small enough size to be meaningful. In contrast, most productivity scenarios, such as word processing, have made limited inroads with phones because of small screens, cramped keyboards, and heavier processor requirements.

That said, the phone is quickly becoming the center of our technological lives. Users of smartphones are often criticized for being too attached to these devices, checking email or sports scores during dinner mid-conversation. Because the smartphone is with the user at all times, it is the best candidate to be the center of convergence. In fact, I would argue that currently, if you asked most smartphone users which they would rather give up, their phone or their laptop, they would struggle to choose one. Do they have to choose one though? For now, consumers seem content not choosing between the two. However, if we picture a world where smartphones can be docked
to a monitor and keyboard and processor speeds have improved to the point that phones can accomplish the majority of tasks, why would a consumer purchase a laptop or desktop? Consumers will always look to maximize value received, and thus will look for the cheapest ways to reliably accomplish their goals. Given these few things happen, it is hard to see why someone would need to spend money on both a smartphone and a laptop.

Along with convergence, there is the potential for divergence as well. It is likely that certain devices are best used separately and add little to no value on a converged all-in-one device. For example, it is quite possible that TVs will always remain a separate device, with potentially their own computer, hard drive, memory, and internet connection built-in. Although video will likely be available on smartphones, it may not be convenient enough to hook up a phone to the TV each time you want to watch television. In such cases, it’s possible that a converged device could act as a remote to control the device, rather than have that specific functionality.

The underlying drivers for convergence are more difficult to isolate. There are many considerations that must be analyzed when trying to determine the likelihoods of having convergence or divergence. The first of all is user experience. Whenever a device has high flexibility, the product will likely sacrifice simplicity and ease of use. This is why a smartphone might be good for lots of things, but it might not make the best calls or have the best cameras. Are users willing to sacrifice on quality to have all of their features in one device? Secondly, for divergence to take place, the cloud
must take on a much more central role. However, the cloud’s emergence itself depends on some significant concerns, such as privacy of data, security, and open standards. These will play a large role in whether divergent technologies are able to communicate with each other and participate in a shared ecosystem. Because user’s demands are so uncertain (at this stage most user’s largely don’t know what they want) and the future of cloud computing is still less than imminent, it is very difficult to determine whether convergence to a central device will continue or whether divergent technologies will be able to continue along their unique paths.

**Potential Scenarios**

Given that the Ubiquity of Wireless Networks and Device Convergence seem to be two of the most important and influential trends facing the personal computing industry, a two by two matrix can be created demonstrating the potential scenarios which may occur between any combination of wireless network growth and device convergence.

Figure 3 – Four Potential Scenarios
This framework highlights four potential scenarios that can occur based on how wireless networks and convergence progress. Each scenario will have its own unique impacts, opportunities, and challenges for each type of player in the industry. A detailed analysis of each of these scenarios will demonstrate consistent trends throughout the scenarios and will help determine ideal strategies for some of the key industry players.

Human’s Best Friend

A scenario characterized by Convergence and Private Wireless Networks will lead to a dominant device which monopolizes the users computing time. In this scenario, there are multiple pressures driving the importance of this device. Convergence means that one device will have the diverse functionality to be the user’s primary device while private networks will limit the move of data and applications to the cloud. In a scenario such as this, the converged device would likely be a smartphone,
as smartphones are with users throughout the day and already provide many features such as cameras, mp3 players, and web browsing. It is highly likely that in this scenario, smartphones would become more powerful and have more local storage than today, mimicking technical specifications that we find in laptops today.

The likely impacts and consequences of such a scenario are clear: PCs will lose importance and the real battle will be that over the smartphone. Mobile operating systems will be extremely important as they will have the most control over the user experience. In such a world, one would expect a few mobile operating systems to gain significant market share at most. However, it is also possible that a scenario like this produces a winner-takes-all outcome, leaving one dominant player standing at the end and capitalizing off of the surrounding ecosystem, much like Windows has done for the past 20 years.

Thinking back to Figure 1 – Personal Computing Ecosystem, it is clear that certain players in the ecosystem will struggle and others will prosper in this scenario. The opportunities in this scenario are clearly in smartphone hardware, operating systems, and applications. Although web development will likely continue to be important, this scenario, characterized by fragmented network access, will likely remain highly dependent on client-side mobile applications, such as the iPhone App Store or Google Android apps. This means that whichever companies can take a solid lead in the mobile world will likely be in better shape. Companies like Google, Apple, and RIM certainly have a head start in this space, however it is still early and
it’s possible other players can still make an impact. This scenario does not bode well for Microsoft however, as this scenario has the center of digital lives moving away from the PC, which Microsoft dominates, to the smartphone where Microsoft’s Window’s Mobile is badly lagging. Windows Mobile is a core investment area where Microsoft is working to catch up, however after taking an early lead in the smartphone space, they have dug themselves quite a hole in terms of both sales and brand.

Outside of operating systems, chipmakers will have to adjust their strategies. In an increasingly mobile world, the focus will be making chips more energy efficient and smaller. There should still be strong demand for chips and companies like Intel and AMD should still be able to prosper, as smartphones will likely have even larger reach than laptops could have ever hoped to achieve.

OEMs however face a new challenge. With smartphones emerging as the center of users’ digital worlds, the OEM’s focus will have to shift from laptops and desktops to smartphones. However, there are a number of firms already competing in this space, which will likely make this shift a painful one for many firms. This process is already underway, as a number of companies have started producing both computers and smartphones, such as Samsung and Apple. Dell has announced their plans to create a smartphone as well. Differentiation in this industry will come from hardware design, user interfaces (voice and touch), and branding.
On the distribution side, the wireless telecom providers would be ecstatic in such a scenario. Their power over both phone producers as well as the ability to charge for lucrative data packages would make for a strong growth phase. Wireless providers will likely continue to try to add value through services, however it is difficult to determine how successful these attempts will be. More likely, to create differentiation, they will work more closely with phone developers to develop exclusive phones for their own networks, as AT&T did with Apple. Retailers like Best Buy will have to turn up the focus on phones as well, which is not necessarily their strong point as the carriers sell their own phones with voice and data packages directly to the consumer.

For the consumer, this scenario has both positives and negatives. On the positive side, they will likely be able to consolidate much of their technology spending into one device. Competition in the smartphone market should also continue to drive prices down and functionality up, creating a cutthroat industry for competitors but offering consumers many different quality choices at low prices. However, on the wireless side, consumers are sure to feel stifled by the lack of ubiquitous wireless networks and the power of the large wireless companies.

The Primary Port of Entry

A scenario characterized by Convergence and Ubiquitous Wireless Networks will lead to a primary device which accesses data and applications through the web. In this scenario, although there are pressures to use one device, that device may
remain fairly light in terms of both processor and memory. Reliable, ubiquitous wireless networks will allow users access to a huge variety of services and websites for cheap, if not free. Although much like the “Human’s Best Friend” scenario, in this scenario there will be room for more mobile operating systems and hardware vendors because the network effects propagated by shared operating systems and app stores will be negated by the dominance of the Internet as the primary provider of both data and services.

The impacts of such a scenario will be felt strongly by the operating system producers who will likely be commoditized by their inability to create differentiation when most of the value user’s extract from their devices is through the web. In such a case, the operating system producers will have to compete on price, user experience, security, reliability, and speed. They will no longer be able to claim to have the best base of applications or differentiating network effects. The race will truly be on to see who can provide the best web experience, and this increases the importance of the browser and mobile browser wars between Internet Explorer, Safari, Chrome, Firefox, and Opera.

Outside of the software arena, the big winners here are web developers. Instead of having to write code multiple times for multiple different operating systems using multiple application stores, web developers can focus on creating a single website using the HTML standards which will be usable across devices and platforms. However this web world does not come without drawbacks. On the web, developers
have trouble charging for their work and there isn’t an easy way to attract attention and stand out from the millions of websites. The application store made it easy for users to determine what apps to install through organized search results, ratings, and comments. On the web, most websites are found through search.

Speaking of search, another big winner in this scenario is clearly Google, whose search engine will be used by millions of smartphone users around the world to determine what sites and services they should use. Chances are, if we gave every PC user access to the web 24 hours instead of limiting them to when they are at their laptop or desktop, Google would see a very nice spike in traffic. Thus it is clear that Android and Chrome operating systems are simply plays to accelerate the move to a completely web-based world, where the best tool users have to find new websites is Google’s search engine. This doesn’t mean that search will always be the best way to navigate the web. It simply means that it is the best today.

On the hardware side, this scenario presents a problem for the Intel’s of the world. Again, Intel will have to shift away from creating faster processors to focusing on energy efficiency and physical size. However, in this scenario even the converged devices don’t require much processor power or memory due to the focus on the web. This is similar to what is occurring today with netbooks. As for OEMs, it will become even more difficult to differentiate products from each other since most devices will simply be web access devices. Again, OEMs will have to focus on design, innovative user interfaces, and branding to keep consumers interested. In this
scenario, there is more likely to be a price war as well, so it’s quite possible that this scenario would help drive convergence in the OEM arena.

Distribution for devices will continue to be split between retailers and telecom providers. However, in this scenario, telecom providers lose some of their leverage over device and operating system manufacturers because, with ubiquitous wireless connectivity, private networks will not be as important. However, in this world they may be providing the ubiquitous wireless networks or may begin charging for various speeds or limits on data transfers.

This scenario is one of the best for consumers. Consumers can still have a solid experience with a device that becomes an integral part of their digital world with access to data and services anywhere and at any time. They will likely be able to access more free applications, as most websites are built on the advertising business model. It is quite likely that they will still be able to use functionality such as GPS, however GPS integrated with a web experience could potentially provide an even richer and more relevant experience.

**Land of the Silos**

A scenario characterized by Divergence and Private Wireless Networks will lead to an industry that is most similar to what we are experiencing today, and is likely to be the worst scenario for consumers. In this scenario, consumers still own and use multiple devices for many of their common uses, such as a smartphone for mobile
computing, a desktop at home, a netbook when they need to produce work on the road, a digital camera, an mp3 player, and a handheld gaming device. Because wireless networks are still private and fragmented, little data and services have moved to the cloud, creating relatively disparate and isolated experiences across devices. This means that your handheld gaming device is not playing massively multiplayer games wirelessly; that you cannot download a song you’re hearing at Starbucks through your mp3 player; that you cannot work on your netbook, rush off to a meeting, and then access that document from your work laptop.

This scenario is likely the easiest for most companies to handle, as it is the scenario that best allows them to protect their respective silos and maintain business as usual as much as possible. In this scenario, operating system producers can continue focusing on their own markets and creating incremental annual updates to keep generating cash each year. The web, although important, does not become the center of the user’s digital world. Smartphones, laptops, desktops, and other devices are all used by the majority of users.

This scenario is very beneficial for one group of players that have not been previously discussed: storage accessories. Makers of external hard drives and USB flash memory sticks will be thrilled with this scenario, as the fragmented wireless networks still allow room for a reliable method of data transfer.
OEMs and hardware vendors will also enjoy this scenario, as they will continue to service a number of devices with hardware products. The ability to produce for laptops, smartphones, and other devices should help build scale for hardware vendors, and keep overall revenues growing rapidly. In this scenario, there is little cannibalization of PCs by smartphones, and thus growth of smartphones and laptop sales worldwide helps grow revenues across the board for hardware vendors. OEMs will continue to try to differentiate on design, a fairly new phenomenon inspired by Apple’s ability to charge exorbitant premiums over their competitors through the use of eye-catching design and proprietary software and user interfaces. However, there will continue to be room at the lower end of the market, and thus we should expect to see consolidation and cost reduction to help create more offerings in the $300-500 netbook space, a product that is especially lucrative for OEMs when considering the millions of customers in emerging economies who may be able to afford a PC at these low prices.

Wireless providers will likely continue to create walled gardens as much as possible, protecting their own revenue streams while frustrating their customers. This scenario is largely made possible by unwillingness to open up wireless networks. Although this may help protect wireless providers revenue streams, it also most likely inhibits the adoption of the mobile web, which can prove to be a very lucrative business as seen by data packages sold to iPhone users. Growth of wireless networks and competition between the oligopoly wireless providers would go a
long way to help consumers achieve the best experiences possible from their devices.

Consumers, as stated before, get the short end of the stick in this scenario. Although there is competition in many aspects of the industry, consumers are still required to make multiple investments in devices, be it laptops, netbooks, smartphones, gaming devices, cameras, etc. As a consumer traveling on vacation, for example, it is possible that one may be carrying as many as four or five devices, all serving different purposes. The lack of ubiquitous wireless networks grows the consumers’ pain further, as it will be very difficult to have any kind of integrated experience among these various devices. Luckily for consumers, there are already signs that this scenario will not be in play five to ten years down the road, as evidenced by the convergence driven by smartphones. However, it is always possible that devices revert into divergence because devices become too complicated or simply can’t be great at every single function, such as taking pictures and listening to music.

**A Cloudy Future**

A scenario characterized by Divergence and Ubiquitous Wireless Networks will lead to consumers owning and using multiple devices that have an integrated and coordinated experience across the web. This scenario would likely create the best experiences for consumers, as products can be tailored to fit the specific experience needed. For example, the user may use their smartphone to look up directions home, but once home a computer in the home puts on their favorite music and
controls the lighting system as they move from room to room. In this situation, the user may still have a device that is with him or her all day, however it’s not the only device they are reliant upon.

This scenario puts a large emphasis on the web-based world. With ubiquitous wireless networks, many devices will take advantage of the open communication waves to synchronize and coordinate with other devices. This will help provide users the greatest experience among devices. This scenario thus puts websites in a great position, as they will most likely dominate the application and services space.

For operating system vendors, this scenario again presents a problem: what does an operating system need to do if everything is generally web-based? Operating systems will have to work to be lighter, quicker, more secure, and provide the best web experience. To do this, operating systems will likely work to blur the lines between websites and applications, trying to take advantage of the best of both worlds. In such a situation, however, it’s quite possible that operating system producers will struggle to maintain pricing premiums, as it will be difficult for operating systems to clearly differentiate themselves. Google continuing to supply operating systems for both the PC and smartphone markets will also clearly put downward pressure on prices in the operating system space.

For hardware vendors, this scenario presents numerous opportunities. As devices proliferate and find new niches, there will be a great variety in the needs for
memory, processors, etc. This should present opportunities for companies like Intel and Samsung, as their products will find their way into many various devices. From the OEM standpoint, this scenario also presents many opportunities to create new devices, and eliminates the dependence on strong operating systems or other externalities that could have pressured margins. OEMs will also have many axes for differentiation among these various devices, but will again likely have to focus on design, user interfaces, and branding. It is possible, however, that OEMs will pick specialty areas in which they can deliver extra value, as each segment of the device market will surely drive its own competition. Thus certain OEMs might stick with laptops, while others might move towards netbooks, smartphones, gaming devices, or other potential devices.

From a distribution standpoint, the wireless telecoms will continue to play a large role for a number of devices, however this is probably the best scenario for retailers such as Best Buy because, with the proliferation of various types of devices, customers will still need a central, trustworthy retailer to help educate them on all the various new gadgets and their potential uses. Furthermore, consumers may need places to touch and feel the devices as well as see how devices might potentially work together.

Consumers will be the big winners in this scenario. Not only do they have access to ubiquitous wireless networks, but they will have many various devices competing for their time based on user experience for specific functional uses. These devices
will likely be easier to use and better at their aimed functions than a single converged device could hope to be. Furthermore, there will be competition among device manufacturers in multiple device industries, among operating system producers, and among the various wireless carriers.

**Scenario Planning Conclusions**

Clearly the four scenarios presented here are possibilities that have very different implications for the players within the ecosystem. As a management team, the difficulty is to determine which of these scenarios to plan for. Nobody, today, can predict which of these scenarios will occur and how exactly everything will eventually play out. That said, there are certain strategies that can address two or three of the four scenarios and are better bets than strategies that cater to individual scenarios. A few of these strategies are outlined for some of the major players in the personal computing industry:

1. **Intel** – Focus on making chips smaller and more energy efficient. The need for the strongest chips among personal computers has declined, leaving the best ways to differentiate in size and energy efficiency of chips. As devices grow, either through netbooks or smartphones, there are clearly many opportunities out there, even if they are different from past opportunities. The key will be Intel’s ability to continue driving chips forward in different directions to maintain their ability to charge similar prices as they have in the past.
2. **Microsoft** – Embrace web services and mobile. Smartphones will grow to be a huge market, regardless of whether they turn into completely converged devices or not. Microsoft’s Windows Mobile is the laggard in this market, which is a highly strategic one for the future of personal computing. Microsoft must also establish Windows as the optimal portal or “window” to the web in consumer minds. Recent missteps with Vista and Windows Mobile are dangerous, as they hurt the Windows brand and allow competitors an opportunity to take share. Furthermore, Microsoft already has a significant problem in two key markets within personal computing: the younger generations and the $1000+ market. Walking around a college campus will demonstrate the first point: students clearly have a higher preference for Macs than other age groups. As these students get older and join the workforce, they may begin to demand Apple products in the workplace, which would be the first signs of erosion in Microsoft’s enterprise market share. Furthermore, PCs are embroiled in a serious price war, as Intel and Windows have combined to largely commoditize the PC business. Microsoft must make sure to protect their Windows brand and drive home the value they bring to consumers as their primary portal to the web in order to maintain their dominant position.

3. **Dell** – Focus on design while exploring other devices, such as tablets and smartphones. Apple has proven the value of sleek and elegant designs. These days, consumers tend to view PCs as they do their cars: the PC you own says something about who you are. OEMs in general have to be looking for
ways to differentiate their offerings. The price war that has taken place is unsustainable. Dell should look to innovate within new products such as tablets or smartphones to help provide some high-growth areas for the company where premiums may be easier to generate. Consolidation may also be an option to drive down overall costs.

4. **Apple** – Focus on growing iPhone and maintaining price premiums. Apple is arguably one of the best-positioned companies in the personal computing industry, a far cry from their precipitous position on the edge of bankruptcy just a few years ago. It is testament to Apple that they have come through the recession so strongly despite playing in the premium segment of the PC market (CNET). However, after being saved by the iPod, Apple has created a new paradigm industry by focusing on premium users through branding, slick designs, and differentiated software. Apple seems to have the magic touch these days, bringing out product innovations that consistently catch eyes and attract consumers with deep wallets. While other companies spend much more on R&D, Apple has managed to bring out some of the best backlit displays, long battery lives, multi-touch screens and track pads, and other various features that help drive their price premiums. What remains to be seen is how long Apple can keep their magic touch. As the smartphone market gets more crowded, will Apple be willing to reach farther for market share by becoming more accessible? On one hand, this would help them dominate this space. On the other, one must worry whether they will be successful, because they will almost certainly dilute their brand. Innovative
products like the iPad, a slate computer, will help keep it at the forefront of technological design, and will also help maintain their strong brand.

5. **Google** – Focus on the web experience and driving traffic to search. Google is not an operating system company. Google’s goal is to commoditize operating systems as much as possible and drive users to the web so that they will have easy access to their web properties, particularly search, at all possible times. Google has made it clear that they plan to give the Android and Chrome operating systems away for free to whoever will take them for their mobile or computing products. Although in smartphones, they could potentially make a play for revenues through the app store, it seems that Google is content on waiting for their long-term strategy to kick in, where all mobile and PC search will be directed through their search engine. This should be very disturbing to Microsoft, as it is very easy for Google to undercut Microsoft on both operating system and productivity software, but it’s hard for Microsoft to fight back in search because Google’s brand is so top-of-mind for consumers.

**Conclusions and Further Research**

The personal computing industry continues to move towards rapid change. The industry has become largely commoditized, but with more of a need for differentiation, consumers are likely the ones to win with lower prices and better products. Many of the incumbents will be forced to change the way they currently do business in the market, with some looking to diversify while others look to
consolidate. The next five to ten years should prove to be fascinating as smartphones proliferate, tablets make their entry again, wireless networks struggle to keep up with demand, and various new user interfaces begin making inroads.

Although this paper presents four scenarios, there are certainly more issues that I would have liked to explore. I believe as users get used to having a computer with them all the time, the time will be right for the advent of wearable computing and augmented reality. Wearable computing is carrying a portable computer that is built into your glasses or watch or some piece of clothing which gives you access to PC technology around the clock. Augmented reality would allow computers to enhance the real world. For example, glasses that would allow you to identify a building just by looking at it and pressing a button. These technologies are just starting to appear, but will likely not reach the mainstream for at least another decade. I also believe that home technology and LCD screens will begin proliferating as well. Our world will likely become truly digital and interconnected in the next decade.
http://www.informationweek.com/blog/main/archives/2010/01/ballmer_calls_a.html;jsessionid=XYLTNY01C05TQE1GHPSKHWATMY32JVN
http://www.computerworld.com/s/article/9121938/Windows_market_share_dives_below_90_for_first_time