Moore's Law evolved the PC industry; Bell's Law disrupted it with players, phones, and tablets: New platforms, tools, and services

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This (his)story is about the establishment of players, smartphones and tablets as three new computer classes i.e. *de facto, standards based "platforms"* for personal computing 2001-2010. The three classes can be explained by Bell's Law, described in Appendix 1: hardware technology, networks, and interfaces allows new, smaller, more specialized computing devices to be introduced to serve a computing need – *in this case, mobile and sensory personal computing*. The cloud computing platform class c2005 played an essential role for anywhere, anytime, anything and personal computing by supplying: robust IP networking via cellular, Wi-Fi, and wire line; storage; processing and supporting user interfaces UIs. A class's origin can be traced to earlier developments combined with recent technology to create a new experience, resulting in new applications that ultimately establish a distinct new industry. The timeline of various events of this past decade saga describing the three classes (players, smartphones and tablets) is given in Appendix 2, for the reader as a "memory refresher" of the events and time scale. Appendix 3 further elaborates more details that have determined these new platforms.

Apple, with a new touch UI standard, innovative processor and large storage, and established a new channel of distribution introduced the: 1. **iPod (2001**) personal media player platform that Sony pioneered as a media or "pod cast" player *"appliance"* with the first Walkman cassette player; | **2. iPhone** (2007) smartphone with touch interface platform that Blackberry, Microsoft and others had introduced; and **3. iPad (2010)** "touch tablet" or digital reader that Microsoft had first introduced as a stylus tablet and Amazon Kindle pioneered for eBooks. Tablets are speculated to substitute for the laptop as the personal computer for many but a few knowledge workers who require keyboards.

The key players in this history are Apple, Google with Android playing the role that Microsoft played as a standards alternative to Apple for the PC, and Microsoft, as a 3rd entrant Gretzky's comment typifies: "A good hockey player plays where the puck is. A great hockey player plays where the puck is going to be." Playing where the puck was, loses. Intel as a strictly PC chip supplier to Microsoft, failed to enter the market for the new platforms. ARM became the de facto architecture for devices. The iPhone/iPad/iPod Touch aka iStuff became the dominant "platform" to attract a range of *"peripherals"* e.g. medical sensors, credit card readers that further extended applications (apps); Android devices from any number of hardware vendors including Amazon and Samsung "fast follow" Apple, by selling more units than Apple. In 2014, which platform dominates depends on the measure: sales, units, apps, user eyeball hours, etc.

By presenting this model of the last decade, the goal is understanding to help navigate the next decade in both a bottom up (component) and top down (use) fashion. Dust sized components will allow everything to be networked. Given the commoditized centralization of cloud services, many new

services will emerge, potentially transforming Microsoft from tool builder selling products to selling storage and services e.g. Office 365.

Apple, Google, and Microsoft; Intel and ARM—The last decade.

This section discusses the behavior of the various players and events that might explain the position and situation that has to be dealt with going forward through 2020. Whether the past is a good indicator of how the players will deal with new technologies and classes that could emerge based solely on chip size X function by 2020 is unclear! Unlike the PC, players, phones, and tablets don't have as much stickiness in terms of data. Furthermore user data is migrating to the cloud for access by whatever—in 2014 this means either a PC or iStuff or droids or Windows devices.

Apple as the innovator and first mover

Introduced and established THREE new classes of personal computing platforms to define and serve three quite segmented functions: 1. **Store/I-O**: for music and media listening; 2.0 **Communication/I-O/Store** for telephony and apps; and 3. **Store/I-O**: reading and apps)resulting in diminution of desk side and laptop PC use. A new class is defined by: function and uses, form factor, price, and platform-ness—ability to build on and create applications and new content. In all three cases—Apple did a masterful, once in a lifetime job of creating and introducing these new classes--even though they were based on previously demonstrated products such as the Sony Walkman, Creative Player, Microsoft's smart phone and stylus tablet. The company introduced leading edge technology i.e. the keyboard-less, touch screen and interface, networking, evolving flash storage, beautiful design (independent of function), and a software and sales/distribution platform with wide applicability for others to build on. In the case of IPod, the company restructured the music industry to supply content via the cloud that heretofore had been done with illegal distributors of music. The Apple stores including iTunes and applications for iStuff and a single programing environment for all three platform's apps and content is a big deal in terms of minimizing user hassle, Apple's support and distribution cost. The "store" created a major business as a marketing and distribution center for quality controlled external app software and digital media i.e. content.

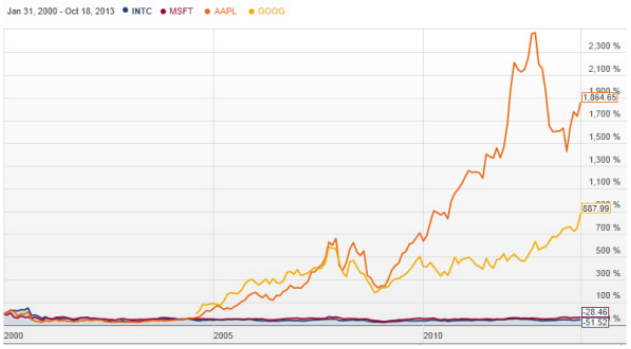

Figure 1 The Stock price of Intel and Microsoft since Jan 31,2000 shows the lock-step synchronization of two, valued stable companies; b. Stock prices of Apple as revenue grew to 170 Billion, with Google ad growth

In creating three fundamentally new businesses, over a decade it changed from a 2003, $5 billion personal computer business based on their Mac computer to a $171 Billion company in 2013 (to become the second largest computing company) selling players, smartphones, tablets, applications, and a wide range of content from newspapers to movies. While in each case, Apple was the second platform entrant, it ended up number one by providing a *complete solution* with elegant designs and the right, hand held form factor. Simultaneously, it created a web or cloud based content distribution and extraordinary application development and channel of distribution—a new industry. The net result was

extraordinary growth in revenue and profit (Figures 1 at the stock price since 2000). In general, the stock market though supportive of Apple, is skeptical of the company's ability to repeat its last decade of innovation again! I will concur… but, I will happily acknowledge and identify it if and when it occurs.

Google Android, an Apple alternative to all comers

Google enabled Apple iPhone hardware competitors to respond by 2008 by providing Android as a "free" software platform in 2007 so as to compete with iPhone and all varieties of Microsoft Windows. Android allowed platform suppliers to create both smartphones and tablets to compete with Apple as well as laptop computers. In essence, Google executed a variant of Microsoft's c1995 software strategy to by making Android available to all hardware comers, in much the same way as Microsoft followed Apple to provide Windows operating system to personal computer makers e.g. Compaq, Dell, HP, IBM. Google/Android became the "Microsoft software standard" for portables, smartphones, tablets and other small scale devices that inevitably will appear. Google's extraordinary performance is not coming from Android, but its monopoly position in ad revenue (see Figure 1). Android appears to be positioned as both a NOT Microsoft, and Microsoft-limiting offensive technology supported by the Google advertising monopoly riding on their "free" search brand.

Microsoft--catching up

With Steve Ballmer's announcement to retire in August 2013 came his mea culpa aka regret of managing a poor Vista introduction and missing the smartphones market—only the second was really important. Critics (Vaughn-Nichols, 2013) have also pointed to a poor Window 8 introduction, missing the player, tablet and cloud computing (it hasn't and it is still too early to tell) markets resulting in less than their sideline spectator desire for better stock performance. While a CEO gets the credit and reward on any upside, they get all the blame if others competitors come into their perceived market. Steve was unlucky and may have suffered both Microsoft hubris and lack of CEO paranoia—i.e. slow reaction time to a clear danger and delegating to a staff that was eventually replaced. In lacking the understanding of Moore's Law and that Bell's Law would enable critical new platforms, Microsoft arguably "played where the puck had been." In 2012 the company threw in the towel re the player aka iPod market by discontinuing its Zune that trailed the iPod introduction by 5 years.

On the other hand, Microsoft had the earliest tablet and smartphone—they just were very slow in adopting the touch UI that almost instantaneously became the de facto interface standard. For example, by a two operating system strategy for the PC and a second, 1996 CE optimized for small memories to track small systems, as Moore's law gave more memory including flash storage, CE quickly became inadequate for the evolving smartphone and the soon to emerge eventual tablet. Tactics, and no doubt politics led to two operating systems—initial reliance on the minimal 1996 CE for ARM and "hand held" sized devices, and its Windows operating system for the X86 personal computer. Finally in 2013 a single operating system emerged as operating system size became irrelevant in an age of large memories. While in hindsight there were no doubt earlier solutions to requiring two hardware platforms that resulted in Windows and CE. Basically mainline Microsoft supported Intel's strategy of being a Moore's Law company to offer more (especially power and performance) each generation to support constant revenue. We can observe that being too early can be a huge curse as it was with tablets by institutionalizing the notion—"no one needs or wants a hand held tablet".

Going from first tablets, smartphones, and touch screens to number three

In 2007, who would have predicted three new personal computing platforms each with greater than Windows 95 capability that was introduced a decade earlier? How could Microsoft who was so early with the tablet, phone, and touch interface gotten so far behind so fast? The situation shows that a first mover advantage in 2 or the 3 classes in 2000 is no guarantee of success in a rapidly evolving consumer mass market—in fact this may have been the greatest impediment to change for a company that is sometimes branded as a follower, albeit not a fast one. Ironically, the follower reputation is largely based on the time between the MAC (WIMP-Windows, Icons, Mouse, Pointer/Pull-down menu) introduction and the Windows adoption of WIMP. However, this followed directly from IBM's 1981 decision to use the Intel limited address 16-bit architecture versus Apple's decision to use the Motorola 68,000 32-bit architecture. Was this déjà vu all over again, by not abandoning the CE architecture for a more robust future or was it believing that mobile computing would not evolve to become the personal computer?

Although Microsoft had done lots of research as evidenced by prototypes, filed patents, and papers about touch devices, and introduced touch screen products—some of the work and products were aimed at large screens. Quite likely it had institutionalized a complete set of rules about how these products should be built—and only with the external reality of a touch aka small fingered device market could it accept a new paradigm.

Tablet: early intro of stylus, not wildly successful, established the fact that a tablet is of limited, specialized use. In 2001 Microsoft licensed Apple several patents using position and motion sensing for the smart phone and tablet. When the Kindle reader arrived as a tablet it was regarded as being of limited use, especially since it has just a poor input keyboard. Microsoft needed a Windows device—but this was impossible based on the hefty X86. In late 2012 the resolution was to introduce RT as a tablet with office functionality sans Outlook (a corporate requirement) that Apple established in 2010.

Jobs' iPod played outside the box by NOT using the X86 enabling a light weight device with a longer battery life.

Smartphone—"I told you so". In June of 2007, the author was able to get only one bet within Microsoft Research against the competitive efficacy of the Microsoft keyboard smartphone that had been successfully marketed since 2004 versus the just introduced 2007 Apple iPhone touch interface—all I required was to try it (as some of my colleagues did who went to a nearby "temple" to became iPhone users *in order to understand the competition*). At the same time a half dozen colleagues, especially those with UI experience, agreed I was completely wrong when I claimed: "the iPhone will be a milestone and revolutionary product unlike any I can recently remember!" In August 2007 having observed the iPhone as a competitor, the head of Windows phone was certain of a two horse race predicting continued Windows smartphone growth based on 140 models, a dozen OEM manufacturers and 125 carrier adoptions—he left the company in March 2008. The blindsided introduction of Android phones in 2008, no doubt helped him decide. By being 3rd in market and mind share, all of us believe that product efficacy, marketing, and developer assistance will allow Microsoft to have a substantial platform for phone, tablet, or a combined "phablet" apps and peripherals. Peripheral hardware is critical to various

appliances in commerce and health. Alternatively, will Microsoft's Surface "convertible" approach of a combined tablet and laptop with its two user interfaces of Windows 8 be adopted? The Surface Pro convertible is a great product, or if you use it like I do, two great products: the Tiles (formerly Metro) tablet and the Desktop for keyboard use.

Intel.

Intel's microprocessor evolution based on Moore's Law unfortunately were unsuited to the audio player, phone and tablet form factors until 2012 when Microsoft required an ARM competitive microprocessor in terms price, power, weight, size, and performance. The notion of Wintel that served both companies for the first two decades of personal computing, became a millstone for Microsoft who unfortunately moved too slowly to eliminate it and become hardware architecture agnostic—something that Apple has accomplished. This can be seen by the fact that Microsoft stock has fluctuated around $29/share since Ballmer became CEO while Intel's stock has had similar and synchronous fluctuations around $24/share during the Barrett and Otellini CEO tenures (see Figure 2). In essence both staunchly observed Moore's Law. History has shown that many companies were tried and died violating Moore's Law[1]—similarly in this case not accepting Bell's Law.

Figure 2 shows the two relatively synchronized stock prices of Intel and Microsoft since January 2000.

Since the introduction of the 8086/8088 adoption in 1981, Intel has developed and introduced microprocessors following Moore's Law of more transistors per x86chip selling at roughly the same price to provide more performance, consume more power, and dissipate more heat as products have evolved from an 8- to 64-bit architecture. This 30 year evolutionary strategy starting with the 20 bit, million byte address[2] of the IBM PC, led to the current 64-bit AMD64 architecture. This strategy in an evolving technology market, risks various forms of disruption as described by Christensen (1997)[3]. Indeed in 2014, this is what occurred when looking at how the entire personal computing industry has evolved since 200x. The Intel focus on performance also accounts for why the personal

[1] The clearest failures centered on the ECL to CMOS transition that occurred between 1984-1995 when computers evolved from a single shared memory, to multiple, microcomputer cluster i.e. multicomputers.

[2] Recall the saying: "no one needs more than 640Kbytes of memory for a program" the remaining 320Kbyte of the 1 Mbyte was used for the OS. The one MByte limit of the 1981 X86 architecture also determined the timescale for the availability of a 1995 Windows architecture.

[3] Christensen used Digital Equipment Corp. as a poster child for the disruptive dilemma based on Andy Grove's belief that Digital failed to adopt the Wintel architecture. In 1999, I assured Christensen this was not the case, but rather one of poor management since so many companies succeeded based on not adopting Wintel. A predictive model of the dilemma existed in 1978 at Digital with plenty of time, i.e. two decades, for avoiding the disaster that claimed its life.

computer is the main, commodity, component for high performance supercomputers and cloud computing by clusters of personal computers. In 2013, has described a small, system on a chip (SOC) to address the ever emerging, 15 year old, Internet-of-Things market.

In pursuing a single track Moore's Law strategy extending the architecture upward, it was necessary to create an architecture capable of utilizing or absorbing the vast number of available transistors by increasing memory accessibility of roughly 1 bit every 18 months. In 1994 HP convinced Intel to create the Itanium architecture that was first delivered in 2001 to address the follow-on market that users expect from Moore's Law. Itanium was also created in order to regain a monopoly position for Intel in the large systems server market that the X86 had evolved to serve. Itanium was a technical tour de force by the fact that it relied on parallel instruction of a half dozen instructions at a time combined with a compiler that set up the instruction packages for parallel execution. Unfortunately, the first implementation in 2001 didn't execute X86 programs effectively, however as a server it was used by HP for the High Performance Computing (HPC) market for a half dozen years. HP became the dominant distributed and it continues to be sold. Microsoft and others have had to continue to maintain Itanium support.

Concurrent with the Itanium, AMD created a relatively straight-forward extension to the X86 in order to serve the existing X86 market and users of PCs. The AMD64 or X86-64 that was delivered in 2003 with adoption by Windows XP, 7, and 8. Four years later, Intel followed by adopting the AMD architecture, thus maintaining a single, more complex, yet evolved and compatible architecture. As Fred Weber, the AMD64 architecture once proclaimed "adding to the X86 is easy…Intel has done it several times….it's just adding more bits to encode more instructions and a 64-bit address space—we don't describe it as elegant".

Will Intel's movement back to a more technical CEO versus a marketing one, regain a wider and more catholic and consumer interest in computing versus PCs and cloud servers that Intel has dominated? Intel speaks about Internet of Things and has all the right research and other tentacles out there to be significant. What's with their Quark chip? What's with these "maker platforms" such as Arduino, Microsoft's Gadgeteer, and Raspberry Pi? These smaller platforms will continue to diminish in size to dust, including becoming wireless sensor networks and proliferate in the billions. Is Intel relevant to future platforms? Based on the vague talks and specs about the Quark (figure 3), SOC its unclear how they play, except in a role reversal competing with the AMD SOCs.

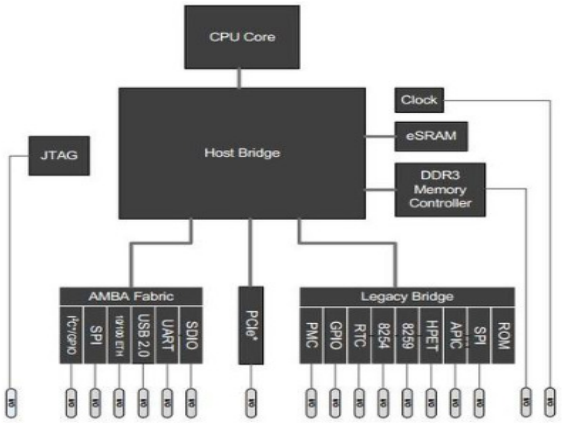

Figure 3 Intel Quark System on a chip, executing X86 code.

The Raspberry Pi computer priced at $25-$50 is shown in figure 4 and block diagram is shown in Figure 5. The three major board systems: Arduino, Gadgeteer, and Raspberry Pi are shown in Figure 6.

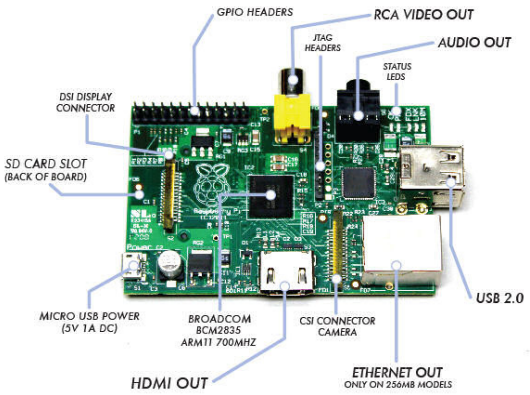

Figure 4 Raspberry Pi Printed circuit board computer with HDMI, USB (for keyboard-mouse) and Ethernet connection.

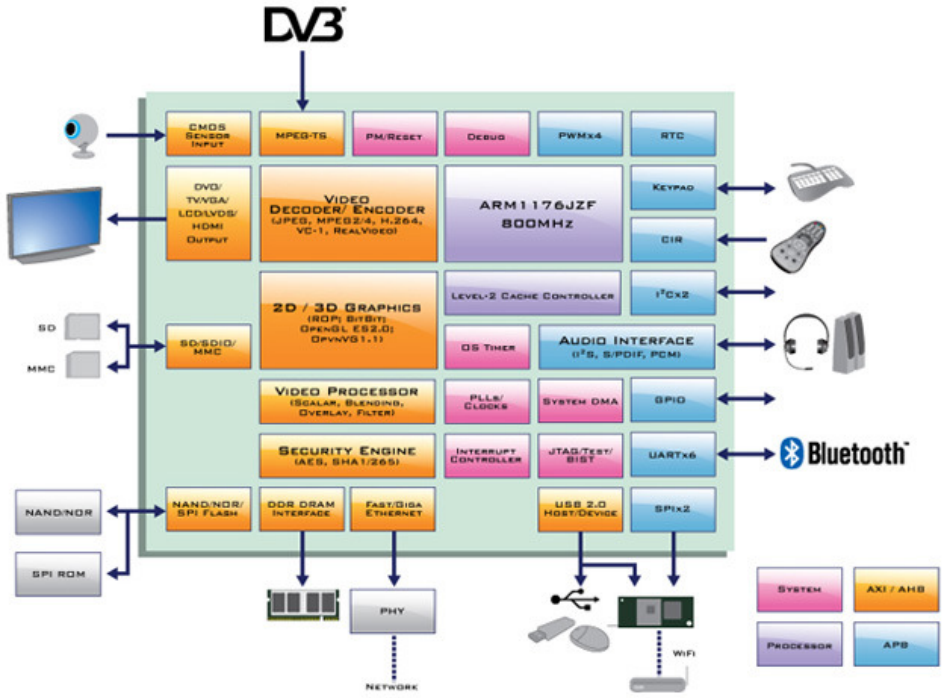

Figure 5. Board level block diagram for the Raspberry Pi based on Broadcom chips.

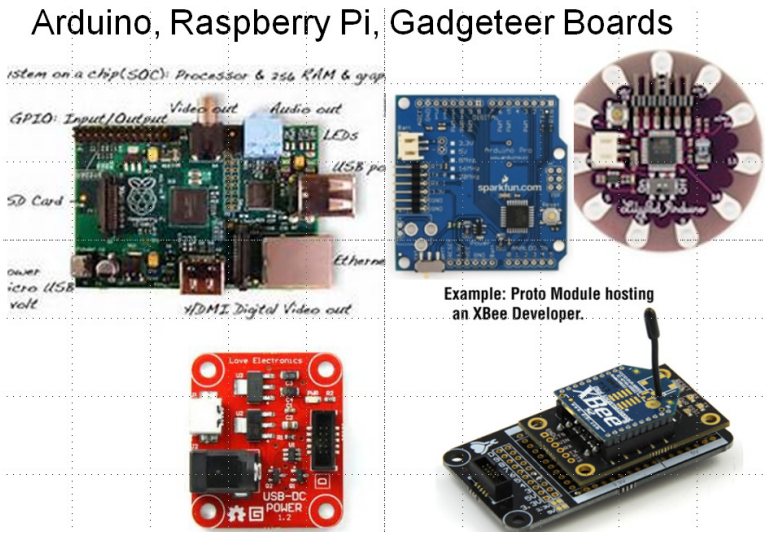

Figure 6. Raspberry PI, Arduino, and Microsoft Gadgeteer Board Level modules for constructing systems and interfaces to other systems.

The next big thing for Microsoft?

By positing and describing some facets of the platform situation that make up personal computing, it raises a lot of questions for the entire computing industry and its constituents. While I have concentrated on history that was Bell's Law related, it is unlikely that we'll see new "personal computing" classes emerge based on size except watches, wearables, and implants . Semiconductor technology will supply dust sized SOCs (systems on a chip). The question is what they will be: Platforms? Peripherals? Or Appliances? And what will they be doing? Wireless Sensor Nets and the networking of everything are clear, but yet to have the right form to emerge e.g. appendages to make everything sensible and controllable so that they can eventually be smart.

The next Microsoft CEO responsible for determining what Microsoft wants to be will be critical. Microsoft is an incredible company with a wide range of products, services, and extraordinary people that has generated great financial results and is most likely to continue to. Ballmer's decision to resign is likely to be a poor one. Better technical leadership might have solved this essential function when Billg retired.

Microsoft was hit by what not even Jobs predicted expected as an inevitable Tsunami of the march of the computers into our lives...the coming innovations with useful, valuable computation and communication that is always available, everywhere. iStuff attracted apps and content that was beautifully exploited and executed as a new channel that resulted in a onetime extraordinary growth that comes from first mover to establish a new computer class. The next CEO is unlikely to be guaranteed to find a new way with platform growth, but instead could be buffeted by financial pressure to become a corporate services like IBM sans consumer products e.g. Xbox or eliminating unprofitable ventures e.g. Bing. "Just persisting" is perhaps Microsoft's great strength.

Transforming Microsoft from Tool Builder to a Cloud Data and Services Supplier

The cloud as a component for support and services is the most important transformer we have had, just as Ray Ozzie predicted in his October 2005 in his disruption essay. It is only just starting with Amazon and SalesForce.com as pioneers who defined the X as a Services spectrum taxonomy, where X = {Infrastructure|Platform|Software}. It was the base technology that allowed the three platforms to form this decade. So far the impact seems to be minimal because a large fraction of products and revenue are from tools e.g. operating systems and Office.

MS is a "power tool builder". We introduce new tools mostly that do the same job as the old tools they replace, characterized by Office that we all know, use, and love!

Microsoft Strength: A tool culture in a data-services era

Snipping …

- **The value is the tools being sold or rented**. As power tool and tool belt craftsmen, we search of work aka data wherever it can be found (i.e. data—in my documents, outlook/exchange, outlook.com, OneNote, SkyDrive, cloud, or wherever it exists e.g. Dropbox). Data is incidental to a tool builder—its just something to work on versus valued. (This is Jim Gray speaking to me.)
- **The value is the Data to be captured, stored, and manipulated for insights.** Tools are supplied to enhance the value of data. The architectures starts with an integrated, open generic and profession-specific work (data) environment. Movement to the cloud means earnings based data X service.

A look at a several service areas including the Internet of Things..

Snipping …. Approximately 8 pages.

Summary

By presenting the history of the last decade where three new computer classes formed based on Bell's Law, the goal was to show that anything is possible if most everyone else pursues a Moore's Law product strategy of faster, better, cheaper evolutionary strategy. I have no doubt that a new class will emerge (bottom up) based on dust sized chips. As a minimum, everything can now be made to be sensible and given instructions from the cloud—i.e. everything becomes intelligent by simply installing an interface to make it smart in anything that can hold it from a light bulb to the cadre of home robots. However, the big transition (top down) for Microsoft will be to become more of a services supplier using its Cloud versus tool builder.

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Appendix 1. Bell's Law of Computer Class Formation (Platforms, Peripherals, and Appliances)

Moore's Law—you get more for the same old class or kind of computer to grow the computer *and run the past software.* In 1971 with the introduction of the first commercial 4-bit 4004 microprocessor by Intel and Moore's Law (1965) predicting the number of transistors per chip would double every 18 months it was clear that the 4 bit microprocessor would be followed with wider word microprocessors with larger address space capability thus evolving more powerful computers. In 1981, and the first IBM aka Windows-Intel aka Wintel personal computer, Intel followed a thirty-year corporate strategy to evolve their 8-bit computer (the 8088) to 8, 16, 32 (and 64-bit (2003) microprocessors. A "Moore's Law strategy" can lead to potential disruption as Christensen (1997) described in the Innovator's Dilemma.

Bell's Law—if you use less, you get a new class or new kind of computer—and new "*platform"*. **Roughly every decade a new, lower priced computer class forms based on a new programming platform, network, and interface resulting in new usage and the establishment of a new industry.** In 1971 Bell (Bell et al) observed that: computers evolved in a constant price band with increasing power with each technology generation; and every decade a new kind of computer or computer class formed to establish a new industry. That new computer is up to 10X less expensive, it performs about the same as decade old computers, it addresses new applications and a new industry forms to build, sell, apply, and create content. It also is the basis for attracting "peripherals" and "applications" from other providers.

Associated with a "platform" are "applications" or "apps" AND "peripherals" these fall outside the original platform provider to make up an industry. "Appliances" are one-off special function devices that perform a specific function e.g. thermostat that may connect to the IP infrastructure; platforms and peripherals are used to build Appliances.

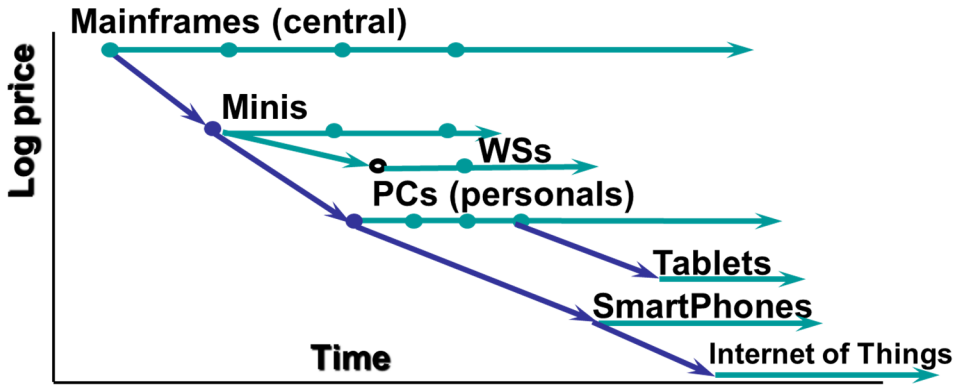

Figure 1 illustrates Bell's Law and how less hardware evolves every decade to create new kinds or classes of computers every decade at a new price level resulting in new industries with peripherals and applications.

In 1971, based on Moore's (1965), a paper about computer evolution into constant price and constant performance (Bell, et al, 1971), the 4004, and clear hindsight, the following 40 year history of computing was predictable to account for workstations, personal computer, tablets, smart phones as well as the destruction of minicomputers, mainframes, supercomputers and even the personal computer of 1981.

Appendix 2. Timeline of four, personal computing platforms & classes: players (pod), phones, tablets, PCs; using Android-iStuff-*Windows O/S's*; and operating on *x86-ARM architectures*

1979 Sony Walkman debut as a portable music playing appliance.

1981/08 **IBM PC intro using Intel 8088 modified 8 bit X86 architecture with 20-bit address**

1985 Death of the Minicomputer class

1988 Gridpad computer with stylus

1993 Apple Newton

1994 HP-Intel partnership announcement to develop 64-bit enterprise architecture

1996 Windows CE, Mobile, and Pocket PC are often used interchangeably. Optimized for small stores.

1997 Christensen publishes Innovator's Dilemma illustrated by "How could DEC's smart managers miss the PC?" with Andy Grove's endorsement. In 1999, Bell attributes DEC demise to simple incompetence since the dilemma was known in 1975.

1993 Apple Newton PDA

1997 Palm Pilot

1999 ***Creative Technology introduces digital audio player***

2001 iPod first release using ARM processors (followed by mini, nano, shuffle, classic …touch) to define digital audio players "pod" class of players using iTunes music library for content

2001 *Itanium first release (Merced)*

2002 ***Microsoft Tablet PC introduced with convertible keyboard and stylus input***

2003 *AMD64 processor and architecture introduction for 64-bit support for X86*

2003/07 ***Windows Mobile introduction for intelligent phone using ARM and CE operating system***

2006 Amazon Web Services Introduction. Public cloud available for Infrastructure and Platform as a Service is available

2006 Microsoft's first Zune pod player and music service. Withdrawn in 2011

2007/1 iPhone introduction with "touch" interface to redefine "smart phone" class

2007 *Apple adopts the X86 architecture for MACs.*

2007/11 Kindle introduction creates "tablet-reader" class (e-Ink, Amazon distributed content)

2007 *Android Open Handset Alliance based on 2005 purchase from Android Inc. and "touch input"*

2007 Netbook introduction

2008/10 Android first phone introduction

2009/08 *Windows 7 release with 32 and 64-bit support*

2010 iPad introduction to create "tablet class" of readers using "touch" input

2010 Windows smartphone intro with touch interface

2011/11 Kindle Fire based tablet on Android introduction

2012 iPad mini introduction

2012 *Itanium fourth release; HP pays Intel to keep Itanium on life support*

2012 *Windows 8 phone based on NT Kernel*

2012- Microsoft Surface RT & Professional, W8 "**convertible**" or "**Pcablet**" (PC & touch tablet) dual interface computers based on the ARM and Intel architectures. The single Window interface, formerly the metro" and the Classic desktop form the two loosely coupled computers

2012/2 Samsung and others introduce "**Phablets"** – large phones that are used as tablets (readers).

2013/08 iPhone5 introduction using 64-bit ARM creates speculation about future use of technology

2013 Microsoft Windows 8 phone; Nokia acquisition by Microsoft.

2013 Intel "Quark" disclosed for low-priced end of AMD's "system on a chip" and Internet of Thing. Will a computer class evolve based on standards?

201x Watch: Watches! Is the watch and wrist class computer going to exist? Is it an appliance? Platform? Or Peripheral?

Microsoft and Intel events

Intel 1987-1998 Grove 1998-2005 Barrett; 2005 -2013 Otellini; 2013 Krzanich Price has been constant at 24 since 1/2001… just as MSFT has been constant at 29

2005/10 GB BET: CPSD (Cell phone sized devices) Will be the dominant platform in 2010/Q4. Will threaten PC use. Bach, Knook agree and believe this is their strategy.

2007/1 GB: "Watch Jobs Video". "I believe iPhone will be a milestone and revolutionary product unlike any I can recently remember!" Steveb admits concern. No one in MSFT Research was willing to bet against me. At least a half dozen researchers, including UI specialists declared that I was dead wrong.

2007/8 Pieter Knook: Mobile is 5. Windows mobile intro 140 models. 18K apps, 125 mobile operators, 10 M units. Microsoft is in a great position relative to Apple.

2008/3 Pieter Knook leaves MSFT as SVP of mobile

2008 *P.A. Semi, founded in 2003 to make low power Power Architecture processors, acquired by Apple; engineers integrated with Apple for ARM to support low power iStuff using ARM*

2010/5 Robbie Bach, head of consume (Zune, Smartphone, and consumer products) resigns.

2012/5 Steveb described changing the top 3 levels of the phone group…apparently too late.

Appendix 3. Commentary on the last decade of new platforms

Phones, Phablets or Fablet, Mini-tablets, Tablets, Convertibles, Laptops, Desktops, etc. evolution -- How many personal computing devices can a person afford?

Forget purchase and operational costs—the human cost to use and manage any personal computing device is very expensive no matter what churches or temples you visit. I am able to argue the merits and uses of all of the above except a yet to emerge phablet. Thus a light user could no doubt function with just the cloud and a phablet (whatever those are)—but most likely benefit by having two devices including the essential phone. If heavy or professional use is a requirement, a desk top work environment (keyboard-mouse-large screen) is essential that can be connected to any of the other computers. So these professionals end up with two, and most likely three devices including a desktop work environment supported by: phone (in the future), phablet, tablet or convertible, laptop or desk side computer.

Why not have peripherals for your smartphone to function as a person's desktop computer? Looking at the smartphone chips. With just an HDMI connected display, keyboard, and mouse, a smartphone has the capability to take on the functions of all five of the above form factors.

With more and more cloud storage and services, a big question arises as to whether or not a person needs any "personal" computing device that holds applications and data stored in folders, files, and associated applications? *Could/should MSR conduct this experiment would be to have "everything" in the cloud?*

Architecture addressability constrains the operating system

The operating system functionality, together with its size determined by addressability is the critical constraint of a class and what it can be. For example the PC went through three major changes based on the OS handling of 20-,32- and 64-bit addresses. New computer classes haven't historically evolved from a previous class because the interface, network, and apps are usually quite different. In the future, just having the current large address spaces won't be class limiting. The market for a new class may start as substitution, but then evolves based on a new breeds of "killer apps". Also the new class is based on less resources e.g. the operating system. Once addressing a program reached the point of being 32 bit Mbytes, the issue of memory size as a constraint to create a new lessor operating system becomes irrelevant. That point was reached in mid-2000s when the operating system size reached Gigabytes. Thus it became irrelevant when almost any size operating system could be used for a phone without a significant cost burden.

Microsoft was the first to have a relatively useful smartphone based on a limited operating system constrained in function and size, if there is ever the case of planning where the memory size and its evolution mattered, it was the smart phone functionality as figure xx shows prior to the introduction of full scale office apps on smart phones that requires all the UI and processing functionality that PCs evolved to.

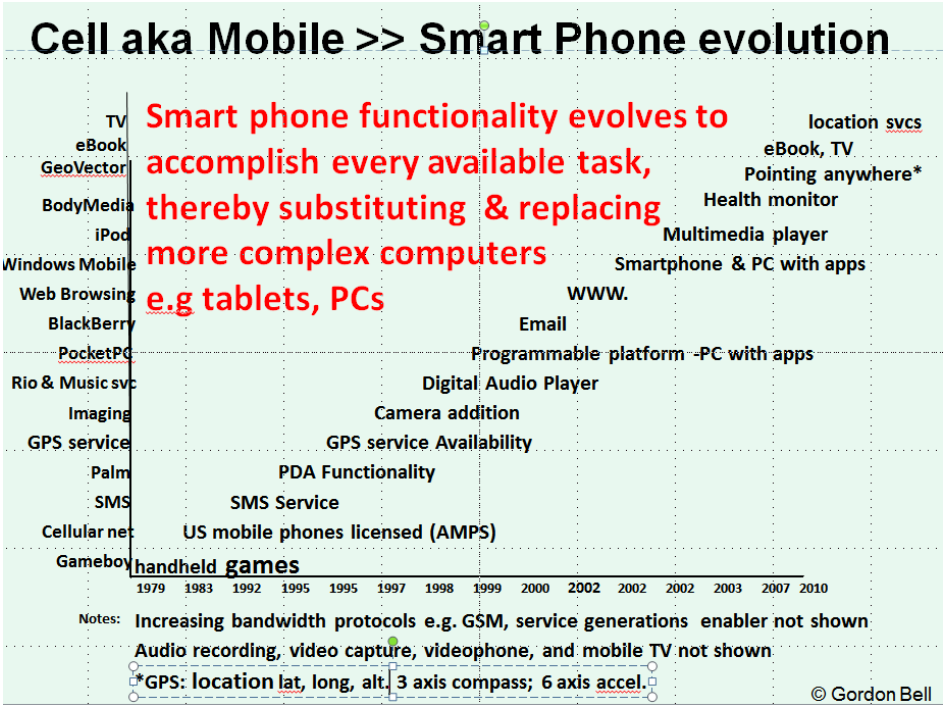

Figure 1. Evolution of the cellphone through the SmartPhone shows the transformation from a simple appliance to the world's most capable, knowledge aware, personal computing platform.

Products may have typically ignored the key aspect of Moore's Law that says you need another bit of addressing every 18 months, or memory quadruples every 3 years, and is 10X larger after only 5 years. Thus the CE with its limited address space, optimized for the memory the "day it was introduced was" terminal just as Strecker and Bell described in 1976: "There is only one mistake that can be made in a computer design that is difficult to recover from – not providing enough address bits for memory addressing and memory management. The PDP-11 followed the unbroken tradition of nearly every known computer." At DEC, PDP-11 was followed by VAX, that similarly erred to be corrected by Alpha.