White Paper

Is the end of the Microsoft-Intel era approaching?

Very likely! There are a number of signals pointing in this direction. 1) The gradual and then steep downturn of the IT industry of the past 18 months. 2). The growing awareness of the enormous risks associated with the fragile word-wide IT infrastructure. 3) The general lack of investor confidence in the IT industry. 4). The open source movement gaining momentum. 5). The antitrust cases. 6). The confession, by IBM Research Director, Paul Horn, of the past complexity sins of the computer industry as well as his recipe for cleansing the sins.* 7). Most importantly, the resistance in investing in new general-purpose computer related products and services.

*(http://www.infoworld.com/articles/hn/xml/01/10/15/011015hnautonomic.xml)

Given these factors, it is hard to see how Wintel (Microsoft and Intel) can lift itself from the current situation by continuing to deliver unnecessarily complex insecure platforms of hardware and software to a broad marketplace. The industrialized world is, and should be, awaiting the arrival of significantly improved computer industry products and services.

So, what types of new products and services are required? Who can provide the new products and services? These central questions are addressed in this paper. It is contended that the most beneficial path to new vitality in the marketplace requires *a rebirth of the computer industry*. Ideally, the rebirth would facilitate competition between a plurality of global actors who become involved in producing and marketing quality products and services. In lieu of a rebirth, there are other potential scenarios that can as well result in a moving towards the end of current Wintel dominance.

To understand the need for as well as the means of achieving a rebirth, it is vital to understand how the general-purpose computer industry has wound up in the current situation.

In 1943, IBM's Thomas Watson predicted that there was a world market for about five computers. However, by 1947 the computer industry was born in Philadelphia when J. Presper Eckert and John Mauchly created the privately financed Eckert-Mauchly Computer Corporation in order to develop UNIVAC general-purpose commercial computers. During the fifty-four years since this origin, the products and services delivered by the industry have led to radical changes in our society that has become totally dependent upon the availability of the industry products and services. Thus, it is high time to perform a critical evaluation of the maturity of the computer industry and to consider it's future directions.

Industry products and services

The core business is supplying platforms of hardware and system software (operating systems and compilers) with related utility programs as well as platform related services. The platforms that provide processing and storage facilities are supplied to the developers of applications (let us call it "Valueware") the value added software products and services that make computers useful. In most cases, the computer industry suppliers also develop

Valueware products and services for their own platforms. However, the main thrust is to provide platforms that can be used by others to create Valueware (either as end users or as third party suppliers). During its fifty-four year history, the industry has successively delivered platforms for mainframes, mini-computers, personal computers, and network servers.

Is the industry mature?

There are a variety of questions that could be formulated in evaluating an industry's maturity, however, to go directly to the essential aspects, the following are most relevant:

1. Does the industry consistently produce stable high quality products and services?

2. Does the industry take responsibility for the products and services that it delivers?

These critical questions can be affirmatively answered for many industries such as automotive, aircraft, medical instruments, home appliances, and construction. Until these two questions can also be answered in the affirmative for the computer industry, it must be considered to be immature. Intel Fellow Robert Colwell verifies this immaturity via the following comparison.

"… Users will require better dependability and security. Antilock brakes that "mostly work" or "hardly ever crash" wouldn't be acceptable, but that describes general-purpose computing today. … Ultimately the lack of system dependability could well become industry's concern because it will become society's burden."

This immaturity has during the Wintel era become society's burden and will most likely only be remedied by a rebirth of the general-purpose computer industry.

Computer industry eras

To really understand the immature state of the general-purpose computer industry, we must delve deeper into the industry history. It is useful to divide the fifty-four year history into three eras of approximately 18 years each; namely Adolescence (1947 – 1965), the IBM Era (1965 – 1983), and the Wintel Era (1983 – present).

Adolescence

A few years after the industry birth in 1947, it was recognized that the digital computer was a revolutionizing development and a number of actors entered into the marketplace. During adolescence the Eckert-Mauchly Computer Corporation continued to develop via ownership changes and by the end of the era became Sperry Univac. The most important competitor in these early days was the International Business Machines Corporation. However, there were many other actors including RCA, General Electric, Burroughs, Bendix, Control Data, Honeywell, Philco and Sylvania. In Europe, companies like English Electric, Marconi, Bull, and Siemens got involved. In the Soviet Union and Japan there were beginnings of their own computer industry. While IBM attained a strong foothold in the industry, there was significant competition in supplying computing platforms.

A variety of hardware architectures evolved and each supplier developed its own set of system software, utility programs and services. There was a tendency to separate scientific and technical computing from administrative computing and provide separate platform types to cater to the special needs of these areas.

During this era, the needs of military and space programs, particularly in the USA and the Soviet Union, led to significant public spending and consequently technological advances in the industry. In 1960, together with strong US Government support, the industry developed its first important verifiable computer industry standard; namely, the COBOL programming language.

After experiencing an active competitive environment in the 1950s and early 1960s, the industry has consolidated resulting in the emergence of dominant actors in the following two eras. Their dominance became so strong that they can be, and have been, declared to be monopolies.

The IBM Era

Driven by the belief that a single platform architecture for almost all forms of computing was essential, IBM developed the System/360 line of computers and its system software; namely Operating System/360 with supporting compilers, utilities and services. With the results in hand, it can be constituted that this altruistic vision turned out to become the beginnings of a march toward the "black hole of complexity". The common 360 hardware architecture, being a compromise, was an equally poor basis for all types of computing thus requiring significant quantities of code to accomplish computing tasks. Further, the demands placed upon OS/360 led to an unprecedented complex suite of system software, developed by a cast of thousands around the world, that nobody completely understood. Every release of the operating system both corrected and introduced new software "bugs".

Via the extremely strong IBM marketing organization with its extensive contact net in the private and public sector as well as a growing demand for computing services, the System/360 and its unstable operating system was more or less forced upon the world, despite the obvious poor platform quality.

A side effect of the significant quantity of "unnecessary complexity" in the IBM products was the birth of many new spin-off companies. These IBM "followers", introduced better versions of parts to the IBM system software products, provided consulting help to 360 customers that did not have a chance of mastering 360 complexity, and made fortunes on related education and training. "There is definitely lots of money to be made in complexity."

In the mid-1970s, the US Government permitted IBM to license its System/360 products to the Soviet Union. An intensive multi-country effort was established to produce a line of 360 compatible computers. Though "perhaps" not planned to be so, it turned out to be an ingenious intelligence move since it probably set Soviet computing back at least 15 years. They have never really managed to fully master the complexity of OS/360 and the suite of related system software despite tremendous investments.

In Japan, the computer industry first tried to produce System/360 "like" computers with their own suites of platform software. This backfired due to the strong IBM foothold and finally the Japanese vendors produced completely compatible System/360 hardware and through

dedicated, but expensive, large programming team efforts managed to tame the OS/360 complexity.

At the end of the IBM era, IBM cooperated with the then relatively unknown Seattle company; Microsoft. Thus, IBM entered the next era by incorporating a poorly conceived operating system DOS in its newly started line of personal computers.

The Wintel Era

The IBM plans to continue their market dominance into the pc era backfired and instead a new combined actor moved towards dominance (Microsoft and Intel) that is, Wintel. Dominance in the personal computer marketplace was, once again, not based upon quality products and services; purely being based upon the fact that there was something new in the IBM product line that was much cheaper and could be sold to a much larger marketplace.

The Intel hardware architecture evolved from its early 1970 days of 4004, 8008, 8080, x86, to the Pentium line. During the 1970s, the Intel products where deployed in rather simple systems and provided a usable base hardware technology. As the Wintel era unfolded, the same primitive hardware architecture was evolved in rapid steps to become the basis for the extremely complex system software products developed by Microsoft. Thus, a spiral developed: more complex software –> demand for greater hardware performance and storage capacity - more hardware performance and storage capacity available -> even more complex software often filled with unnecessary functionality.

As a measure of the growing complexity of today's Intel hardware, it has been reported that the number of design errors discovered in the development of the Pentium 4 exceeded 6000 prior to producing the first silicon chips. Thus, the spiral has not only lead to unnecessarily complex software; the hardware has also become unnecessarily complex.

The insanity in the hardware-software spiral that has led the world deeper and deeper into the "black hole of complexity" should be self-evident. The Wintel complexity has had an even stronger side effect than in the IBM era in the form of Wintel "followers" making fortunes as complexity ombudsmen in the form of consultants, educators and trainers.

A primary reason for the real success of Wintel has been the commercialization of Internet. This made Wintel completely non-reliant upon IBM as their marketer. Many new actors like Compaq and Dell started supplying commodity personal computers and eventually servers with Wintel licensed products. A naive marketplace, driven by strong feelings that a revolution was taking place and not wanting to fall behind, swallowed the complexity that was delivered. Further, as new versions of products where released (often with marginally useful functionality improvement), Wintel customers where quick to update their hardware and software resulting in enormous profit margins.

On the plus side, very useful Valueware products have arisen during the Wintel era including e-mail, web browsers, word processing, power point presentations, and advanced spreadsheets to name a few. The almost mass hysteria around these products has caused users to accept (often with many curse words interjected) the poor and inadequate quality of platforms. The costs and frustrations of rebooting, loss of critical information, poor security leading to hacker attacks, criminal acts, and so on are accepted as common daily phenomena. Absolutely astounding!!!

Is the 18 year period of the Wintel era coming to an end? As noted above, very likely! It's time for a new era. The major question is - What will follow? Prior to considering potential scenarios, it is vital to understand the devastating consequences of the two monopolistic eras the world has lived through.

Consequence of the Monopolies

The most important consequence of the monopolistic IBM and Wintel eras is that they have hindered better solutions from gaining a foothold in the general-purpose platform marketplace. Via acquisition and other manipulations, they have managed to retain their monopolistic power. The most frustrating aspect of the domination is that there have been several developments during all three eras that could have led to significantly more stable platforms of hardware and system software for general-purpose computing.

The continuing growth of unnecessary complexity in platforms during the IBM and Wintel eras has led to the need to cope with the complexity when developing value added products and services (Valueware). Thus, a serious supplier of good Valueware is forced to expend significant resources in mastering what can be called "Busyware". Once again, taking advantage of the fact that there is money to be made in complexity, there has arisen programs to achieve "certification" in handling unnecessary complexity (Masters of Busyware). Such expensive "expertise" has become critical for Valueware providers as well as for end users of Wintel products. While not the sole factor leading to the large number of failures in the majority complex IT projects, the quantity and complexity of Busyware is most certainly a significant contributing factor.

During adolescence and even during the IBM era, there was significant governmental spending leading to advances in the computer industry. Thus, there was at least one dominant customer that industry suppliers listened to. During the Wintel era, the government has given up their efforts to influence the industry and has become just another customer willing to accept poor quality platforms from the dominant supplier.

It is amazing that intelligent generals and admirals can make decisions to incorporate such poor quality products in mission critical applications. A prime example is the usage of Windows NT for controlling critical functions of the Aegis guided missile cruiser Yorktown. Windows NT platform bugs have disabled the ship and resulted in towing it into port. This is a prime example of an otherwise well engineered system that failed due to bugs in the platform. To cite a Peter, Paul and Mary song "When will they ever learn."

There are many such tragic examples that can be cited. It simply points to the extreme vulnerability of our society. Consider such bugs arising at critical moments in the power or transport industry or the financial sector. The mind shudders. Thus, we continue to live in an environment of system crashes, hacker attacks and computer crimes, the total global cost of which has already become far greater than the cost of a rebirth of the computer industry to correct the situation. It has been estimated the global costs due to computer viruses is in the neighborhood of 15 billion dollars a year. The costs of the recent Code Red virus of approximately 2 billion dollars gives some indication of the order of magnitude of the problem.

Moving to maturity

What is needed to move the computer industry towards maturity? It will not be achieved by a move to the open source products and services that are currently available. The fundamental problem is that nobody orchestrates the holistic aspects of computing. As a result, nobody assumes responsibility for driving the world of computing deeper and deeper into the black hole of complexity. On the contrary, the complexity is exploited in profit making ventures.

There have been several "single-point" advances during the fifty-four year history; however as Professor Fred Brooks, chief architect of the IBM/360, points out, there is no single silver bullet that will cure all of the problems. Intel Fellow Colwell indicates the fundamental problem:

"…This situation arises because we do not design hardware in conjunction with software, application developers don't design software with the OS, and companies place less emphasis on the overall hardware-software system reliability than in getting to market quickly."

Achieving stable, trustworthy, holistic products for general-purpose platforms is completely within the realm of known technology. The key is to employ an architecture that is based upon well structured function distribution between hardware and software as a means of reducing total system complexity and assuring security. The world is awaiting the actor(s) to accomplish this task and move the industry towards a new era of mature trustworthy systems.

In line with Colwells comment, industry maturity can be measured to some extent when the hardware level, amongst other high level instructions, implements an OPEN file instruction with arguments providing access rights and user keys. Such an instruction implemented in read-only microcode memory would absolutely exclude hacker manipulation of hundreds (even thousands) of lines of complex program code. One important example of providing trustworthy systems by proper function distribution.

Venture capitalists – here is an opportunity; the future is there for the taking. The demand for reliable, trustworthy computing will certainly not decrease in the years ahead. Find the actor(s) that can get a holistic solution together.

Gven the critical role of computing in our society there is still and will continue to be an enormous market for trustworthy Valueware and platforms. To be successful, the platforms must be transformed from the current unnecessary complexity Busyware situation to what can rightly be called "Stableware." How can this be achieved? As mentioned earlier, the most ideal situation involves a rebirth of the industry; however, there are other potential scenarios that could result in moving to trustworthy products and services.

A dominant new actor?

One possible scenario is that a new dominant actor emerges and reigns in the next era. The actor sees the holistic aspect of the hardware-software spectrum and integrates efforts to reduce complexity and market Stableware platforms. Certainly, with all of the major advances in the area of Valueware (for example in business-to-business applications), with heavy dependence upon stable, trustworthy platforms, this would be a most welcome development.

Will it be an American actor? Maybe not. There are several other countries that possess the technical ability to achieve a holistic solution. Ideally, this would be a perfect challenge for European industry. However, it is not clear that they can collectively get their act together; the track record in this regard is not promising. It could happen in a single European country, like Sweden or Finland. The Indian, and to a growing extent the Chinese, computing industry have most of the prerequisites to take on this role. They are not burdened by the poor complexity track record of the American computer industry; they have basic hardware technologies available, inexpensive and highly qualified software talent as well as a cadre of ex-patriot experts. The Japanese and or Korean industry could be another alternative, but given current financial problems, this is not as likely. The Russian computing industry, prior to the import of System/360 technology, was developing a holistic hardware-software approach.

All of these countries possess the technical talent. However, all of them lack sufficient world-wide marketing clout. A great opportunity for forward thinking partners that can take on the marketing role and see to it that proper venture capital is available.

A dominant customer?

An alternative scenario is that a dominant acquirer with sufficient financial resources through "intelligent acquisition" provides the impetus for change. As mentioned, during the adolescence era, government spending, particularly for military and space applications led to industry advances. With the absolute requirement to produce trustworthy Stableware platforms based upon well defined hardware and software architectures, it could be done, at least in the USA; perhaps in Europe. Even though the current market situation is not at all like it was in the first two eras, serious computer industry suppliers would listen to a large customer.

This scenario could well be politically initiated in response to a major catastrophe; for example, in transportation, power, finance, national intelligence systems or other critical areas. From a statistical point of view, we can constitute that the probability of a major catastrophe continues to grow in proportion to the amount of unnecessary complexity in computer based systems.

Recent international tensions have caused the leading politicians of the world to think seriously about the strong possibility of terror attacks upon the fragile IT-infrastructure.

Rebirth of the computer industry?

By far the most beneficial scenario is a rebirth of the computer industry where the goals of producing and marketing Stableware products and services in a highly competitive environment dominates. In this scenario, industry standards for system software, in particular for properly structured secure operating systems, very high level programming languages and databases, evolve. These standards are verifiable and suppliers must have their products third party certified before they can be approved for the marketplace. Such certification is performed in other critical industries by testing agencies and there is no reason why it could not be done for the computer industry. As mentioned earlier there is a history of doing this for the COBOL programming language. Certification resulted in significant competition in providing good COBOL compilers. Industry standards of the current era such as Ethernet and TCP/IP and more recently XML have also succeeded in stimulating useful competition.

In all three of the vital areas (operating systems, very high level programming languages and databases) an effort is required to define exact syntax and semantics in the form of high level machine instruction sets that are verifiable and lead to a rational basis for certification. Given such publicly available definitions, appropriate architectural distributions between hardware and software levels become readily apparent and a plurality of suppliers can enter the marketplace. While each implementation can be made company proprietary, the core aspects must abide by verifiable standards.

There are current developments in all three of these areas that can be used as starting points for moving towards the desired standardization. XML is fast becoming an industry standard in the database era. For very high level programming languages, UML, although containing unnecessary complexity, has a core that could be used as a basis for achieving a significant lift in abstraction level. Alternatively, there are interesting web programming languages evolving. The current dominant programming languages, namely Java, C, and C++ are simply too low level.

The toughest nut to crack is the operating system area. Developments must lift above the Windows-Linux debate and result in a stable basis leading to a verifiable open standard. In principle, we are now waiting for the generic network-operating system. Who is going to provide it? Perhaps a highly modified version of Linux would be a useful starting point. Otherwise, the most impressive operating system ever provided for general purpose computers; namely, MULTIX, developed at MIT in the late 1960s would be an excellent candidate for inspiration.

Microsoft .NET

Microsoft via .NET is attempting to take the lead in defining some of the core technologies for developing future network platforms and platform services. After discounting much of the hype around .NET it is evident that Microsoft wants to integrate around Internet and has an ambitious plan to do so. They have even presented key technologies from .NET like MSIL (Microsoft Intermediate Language) and their new programming language C# (C-sharpe) for ECMA (European Computer Manufacturers Association) standardization. In the case of MSIL, it is in fact in the form of an instruction set for an abstract higher level language machine. Bravo, Microsoft! Concepts from the late 1960s and early 1970s are finally catching hold. It's about time!

It remains to be seen if the .NET technology will serve as a basis for true open competition. Since the high level .NET concepts can, in principle, run on top of non-Microsoft operating systems such as Linux and Solaris, it may just be a catalyst to move from the Microsoft dominance. Due to the openness of Microsoft in respect to .NET, one can speculate that Microsoft strategy involves a retreat from being the dominant platform supplier with the plan to be a supplier of high quality Valueware (network applications). This would be beneficial for all vested interest parties and certainly ease the burden upon Microsoft in respect to antitrust regulations.

IBM autonomic computing

As noted early in the paper, it seems that IBM has awoken to the black hole of complexity problem that they originated during the second computer industry era. As a measure of IBMs

current complexity problems, Research Director Paul Horn notes that IBM has been adding about 15,000 people per year to its service organization to assist customers in dealing with the IBMs complex platforms. This cannot continue. Horn has proposed an ambitious university research program as well as an inter-company effort based upon standards that will lead to providing Stableware platforms. This "grand challenge" effort is underway and is being based upon an intelligent middleware that promotes flexibility in providing IT services in a "utility like" manner. They seem to have also understood that this middleware can be used as a basis for function redistribution between hardware and software. Bravo IBM, it is about time that you woke up to the true needs of platform customers.

Regardless of whether Microsoft, IBM or other parties establish the basis for rebirth, this scenario would stimulate world-wide competition in providing highly integrated hardware-software solutions for Stableware platforms. At the same time, having standardized platforms available that do not require significant attention to expensive Busyware, the market for good Valueware would explode, with Microsoft as one important supplier. Stableware and Valueware competition would provide opportunities for existing as well as new suppliers around the globe. If this transpires, the general-purpose computer industry would be well on its way to maturity and society would be the benefactor of trustworthy products and services. Further, there would be a strong motivation to upgrade from existing industry products and services.

Venture capitalists – The next, highly competitive, era of computer industry would evolve and push the industry to new highs. A dedicated investment effort started now could well contribute to rebuilding investor confidence in the industry.

In conclusion

There are several paths that can well lead to the successive reduction of Wintel dominance as the dominant computer industry supplier of platforms. So, let us hope the days of the march into the "black hole of complexity" are numbered. The complexity of many of the applications for which Valueware is constructed is quite significant. We do not need to continue to compound the complexity by utilizing unnecessarily complex unstable and insecure platforms of the Wintel era of the past eighteen years.

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2001-10-18