An IDC Special Edition Executive White Paper

40 Years of IT

Looking Back, Looking Ahead

IDC
Analyze the Future

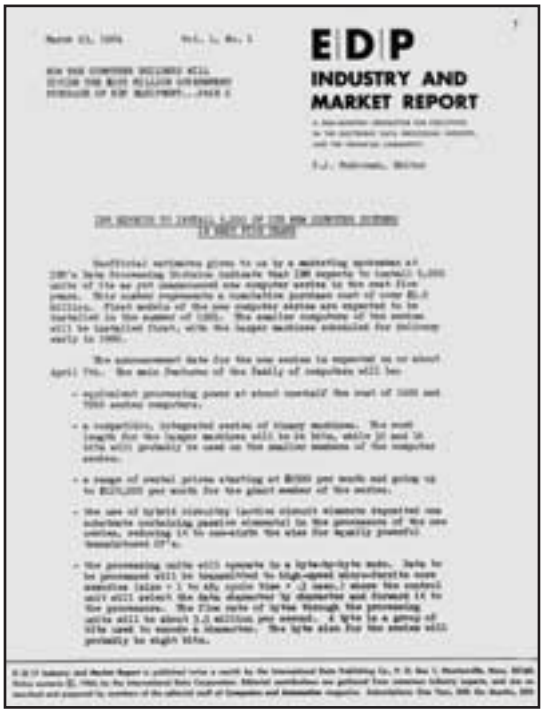
John Gantz
Chief Research Officer

Looking Back

April 7, 1964, was a normal day. Lyndon Johnson was president of the United States and had already declared a war on poverty to go along with the war in Vietnam, the Beatles had four hit records in the top 10, *My Fair Lady* had beaten out *Dr. Strangelove* for best picture at the Oscars, Cassius Clay (now known as Muhammad Ali) was the heavyweight boxing champ, and Jack Nicklaus, who would win the PGA tour that year, was on the cover of *Sports Illustrated.* Martin Luther King Jr. was still eight months from receiving his Nobel Peace Prize. Two important books were receiving final touches for publication later in the year: Marshall McLuhan's *Understanding Media* and Roald Dahl's *Charlie and the Chocolate Factory.* The Dow Jones Industrial Average sat at a dizzying 822 5/8, and a gallon of gas cost $0.30. The word *hippie* had yet to be coined. Russell Crowe was born.

On that day also, a new computer was born — the IBM System/360.[1]

In fact, the System/360 was a whole family of computers, five in all, along with 44 peripheral devices. These five models could all run the same operating system and use the same peripherals. Heretofore, each new computer had been a model unique unto itself. This was the first time a computer manufacturer launched a product that allowed a customer to start small and build up without a total reinvestment in software and peripherals each time one computer was wheeled out and another wheeled in. It would be a year before one would actually ship to a customer, but the announcement was lauded at the time as momentous.


EDP
INDUSTRY AND
MARKET REPORT

For more than 200 executives in the 10-year-old computing industry, however, the news was not a surprise. Two weeks earlier they had been alerted in the inaugural issue of a newsletter published out of Newton, Massachusetts, by a start-up called International Data Corporation (IDC), founded by Patrick J. McGovern. The newsletter was called *EDP Industry and Market Report.* Published on gray paper, it was soon nicknamed *The Gray Sheet.*

Both launches created billion-dollar industries. Big Blue, as IBM came to be called — perhaps because of some of its blue computer casings, its blue logo, or the blue suits worn by executives — dominated the computer industry for the next 20 years and saw its revenue increase from $3 billion to $46 billion, while the industry as a whole grew to over four times that size. IDC's *Gray Sheet* soon expanded into a product line of market research reports, then trade publications and conferences. Other companies entered the business.

Today, 40 years later, IT is a trillion-dollar industry and IT market research is a multibillion-dollar industry. No industry has ever grown as fast as IT.

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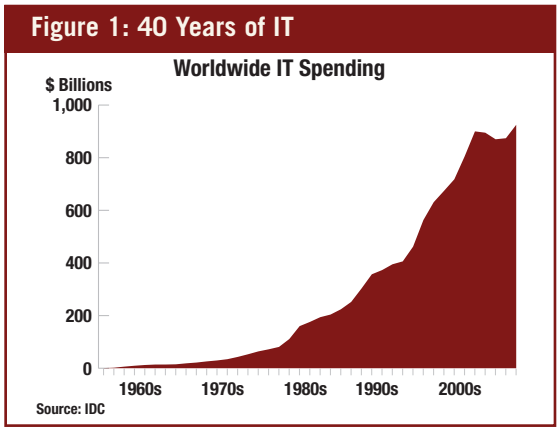
[1] The 360 symbolized the 360 degrees in a circle, emblematic of the comprehensive functionality encompassed in the family. The naming convention morphed six years later, when IBM announced the System/370 in 1970. The System/370s lasted through the 1970s and 1980s, with the System/390 coming out in 1990.

The Launch of Two Billion-Dollar Industries

The Road to 12 Zeros

The IT industry's trajectory to trillion-dollar status seems, in retrospect, one of smooth, rocketing growth. Figure 1 shows the 40-year picture of IT spending.[2]

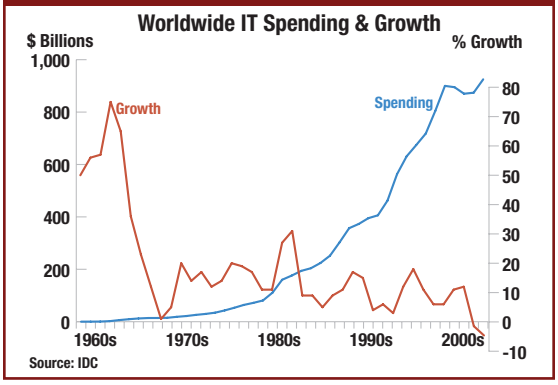
Figure 1: 40 Years of IT



But it wasn't always clear that the IT industry would grow like a weed. *FORTUNE* magazine referred to the IBM 360 as IBM's $5 billion gamble, noting the bet-the-company level of investment in the new product line. And there were computer scientists and users who grumbled because programmers no longer directly manipulated hardware. At the time of the launch of the IBM 360 and of IDC there were fewer than 20,000 computers installed, or about one for every 20 companies that might afford one. The average computer in the 360 line would sell for over $700,000 (in 1964 dollars) and applications had to be hand built. There was no packaged software industry.

In fact, if you look at Figure 2, which overlays the annual year-over-year growth in IT spending, you can see how iffy the industry was in its early days.

Figure 2: 40 Years of Ups and Downs



One sign of the tentative nature of the early computer business can be seen in the number of companies that *left* the business in the first 10 years after 1964. The list includes electronics giants such as RCA, GE, Xerox, Westinghouse, Bendix, and Northrop as well as companies from other industries that got burned seeking greener pastures: Boise Cascade, General Mills, Greyhound, Pillsbury, Sylvania, and Underwood. The computer industry has never been for the faint of heart.

Milestone After Milestone

There were many twists and turns in the 40-year journey from there to here. It wouldn't hurt to have an appreciation for the industry's roots. If we go decade by decade through back issues of *The Gray Sheet* we should be able to pull out the key inflection points, the moments of "aha" that make today's industry what it is and give it its current momentum and angular spin.

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[2] Data was pulled from IDC's *Worldwide Black Book* and back issues of *The Gray Sheet.*

1960s Businesses Get Computers

There was a computer industry before the IBM 360 was announced, but it was never the same after that. Other vendors — Honeywell, RCA, National Cash Register (NCR), Burroughs, GE — were forced to develop computer families of their own. The number of computers installed in business grew from under 17,000 at the beginning of 1964 to 90,000 by the end of 1969.

But there were other key milestones in the 1960s as well:

- In 1964 GE won a key contract to develop a computer system — Project MAC at MIT — that could be shared by different users at the same time. This event legitimized the concept of time-sharing that emerged into a multibillion-dollar business by the late 1970s and helped spur the development of computer networks and, ultimately, the Internet.
- In 1966 the Federal Communications Commission (FCC) began proceedings to evaluate what devices could or could not be connected to U.S. phone systems, ultimately allowing computers to connect without being regulated.
- In 1969 IBM began selling its software separate from its computers. This unbundling helped launch the independent packaged software industry.
- Also in 1969 the U.S. Department of Justice filed an antitrust suit against IBM (after a number of companies had filed private antitrust suits). IBM spent much of the next decade defending its market position in court. The prosecution gave up in 1982, long after many of the issues had been made moot by subsequent marketplace events.

During these years IDC grew as well. It quickly followed its newsletter product with a database product profiling individual computer installations. In the mid-1960s it began offering a newspaper as an incentive to data processing managers who filled out census questionnaires, and by 1967 had turned that into a trade magazine. Thus, *Computerworld* was born, along with what was to become a multibillion-dollar trade publication and conference empire.

In the mid-1960s IDC began offering a newspaper as an incentive to data processing managers who filled out census questionnaires, and by 1967 had turned that into a trade magazine. Thus,* Computerworld *was born.

Image courtesy of IBM

The IBM System/360 Model 50: 1964

1964
IDC is established.

1965
IDC holds first Directions briefing session.

1967
Computerworld is born.

1969
IDC U.K. is established.

1969
IBM unbundles software.

1970s

The Rise of Software, New Computing Styles

The 1970s saw a continual penetration of businesses with general-purpose computers fueled in part by the new and fast-growing packaged software industry. Revenue for software in 1970 was $75 million, while revenue for custom software development, mostly done by the companies that sold the hardware, was five times that. But by the end of the decade, the packaged software industry was a $2 billion market and was bigger than the market for custom software.

In 1970 a small Massachusetts computer company, one-fiftieth the size of IBM, introduced a computer for use in laboratories, factories, and other industrial machines. The company was Digital Equipment Corporation (DEC) and the computer was the 16-bit PDP-11. The computer caught on, and by the end of the 1970s more than 250,000 PDP-11s were installed and DEC was only one-fifth the size of IBM. IDC coined the term *minicomputer* for these types of systems, and by the end of the decade almost a million were installed. In 1977 DEC announced a new 32-bit computer, the Vax 11/780, which quickly became a hot seller. On the strength of the Vax, Digital's revenue grew from a little over $1 billion in 1977 to over $14 billion in 1998, when DEC was acquired by Compaq.

Over time the Vax and others like it from various minicomputer vendors began migrating from labs and factories into other corporate departments and began doing general business data processing at the department level, often to the consternation of the data processing managers manning the air-cooled, raised-floor datacenters in which their IBM mainframes toiled away. But this infiltration of computers into departments was just practice, as it turns out, for the invasion that would take place in the next decade.

Meanwhile, there were other momentous events in the 1970s:

- In 1971 the FCC opened up the market to competitors to the Bell system telephone companies by allowing others to offer data communications services as specialized carriers. A whole packet switching services business grew up in the wake of the decision, which was seen as the beginning of the era of deregulation that culminated in the breakup of AT&T in 1984.
- Also in 1971 Intel introduced the Intel 4004, the first "computer on a chip," a four-bit microprocessor, although it wasn't until 1974 that microprocessors — by then eight-bit — began showing up in hobbyist kits for building personal computers.
- In 1970 the first automated teller machine (ATM) was installed at a bank in Georgia, and in 1973 the grocery industry settled on a common barcode scheme, the Universal Product Code, for use in automated checkout systems. This event, combined with the growth of microprocessor-based point-of-sale (POS) terminals and ATMs, helped change the consumer landscape. By the end of the decade there were fewer than a million POS terminals and ATMs installed. Now they are on virtually every street corner and in most convenience stores.
- In 1974 the first personal computers began appearing, in kit form. One, the MITS Altair 8800, made it onto the cover of *Popular Electronics* in January 1975 and became the first popular personal computer. It was built from a kit that cost $297 and came with 256 bytes of memory, although its memory could be expanded to a whopping 64K. Today $297 could buy 2 million times as much memory. Apple and Tandy Radio Shack both began producing computers in 1977, and by the end of the decade there were hundreds of thousands of personal computers installed.
- Also during the decade IBM, Burroughs, Sperry Univac (now Unisys), and a host of specialty suppliers began selling computers to small businesses. IBM's entry was the System/3, announced in 1970 and designed in a part of the company distinct from that which designed mainframes (and with its own marketing and sales division). At the beginning of the decade IDC counted just a few thousand such small business computers installed; by the end of the decade almost a quarter million were installed. However, by the end of the *next* decade, the discrete small business market was gone, as PCs moved in.

1970
The first automated teller machine (ATM) is installed at a bank in Georgia.

1971
Intel introduces the Intel 4004 microprocessor, the first "computer on a chip."

1973
IDC coins the term *minicomputer.*

1974
The first personal computers begin to appear.

1975
IDC opens offices in Germany and Japan.

IT Changes the Consumer Landscape

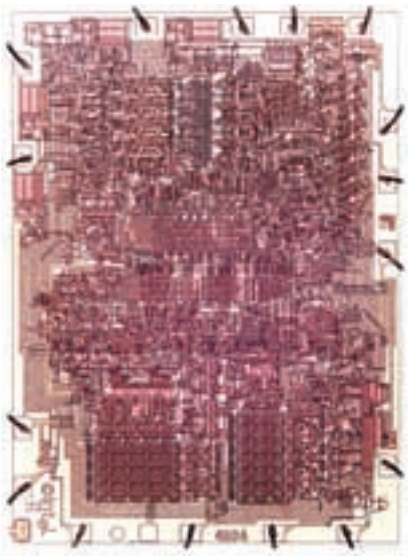


Image courtesy of Intel Corporation

Intel 4004 Microprocessor
1971
2,300 Transistors
108,000 Hertz

Image courtesy of Intel Corporation

Intel Pentium 4 Processor
2000
42,000,000 Transistors
1,500,000,000 Hertz

It was a wild decade. Besides the first microprocessor, first personal computer, and first POS and ATM systems, the decade saw the first virtual storage operating system, the first Ethernet LAN, the first satellite data network, the first computer store, the first floppy disk, the first laser printer, the first videogame *(Pong)*, the first spreadsheet, and the first software "worm."

The 1970s was also a hot decade for IDC. IDC launched dozens more newsletters, its first continuous information services, and its first multiday user conference in Hilton Head, North Carolina, and opened research offices in Germany, Japan, and Australia.

Besides the first microprocessor, first personal computer, and first POS and ATM systems, the decade saw the first virtual storage operating system, the first Ethernet LAN, the first satellite data network, the first computer store, the first floppy disk, the first laser printer, the first videogame* (Pong), *the first spreadsheet, and the first software 'worm.'

1973
The grocery industry settles on a common barcode scheme, the Universal Product Code.

The first virtual storage operating system is introduced.

The first Ethernet LAN is introduced.

The first videogame *(Pong)* is released.

The first floppy disk is introduced.

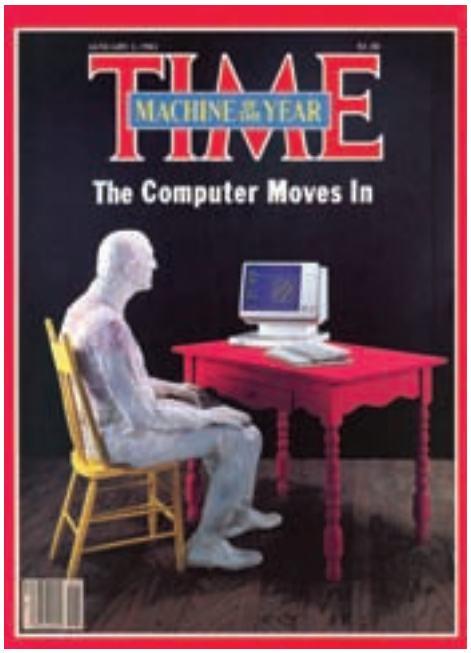
1976
IDC holds its first multiday user conference in Hilton Head, North Carolina.

1978
IDC opens a research office in Australia.

1980s

The Personal Computer Revolution

By 1980 the personal computer was established enough to be a $1 billion business, but the industry didn't really hit its stride until the IBM PC, the first major 16-bit machine, was put on the cover of *Time* magazine in the place of the traditional Man of the Year in 1983. In this case it was called the "Machine" of the Year.



And as they say, the rest is history. PCs swarmed over the workplace, found their way into homes, and even made it to the desks of lucky students. The number of PCs installed grew from less than 1 million in 1980, even counting popular models such as the Commodore PET, to over 100 million by the end of the decade. Along with the PC came an attendant collection of businesses: computer distribution and desktop publishing, training and education, personal finance and tax applications, and, of course, Microsoft.

But the 1980s weren't solely about personal computers. The decade saw the first optical disk (1980), the first movie based on computer graphics (Disney's *Tron* in 1982), the coining of the term *cyberspace* by science fiction author William Gibson (1984), and the first reduced instruction-set workstation (1987). The decade also saw ARPANET morph into what became called the Internet, the first general-purpose visual programming tool in PowerBuilder, and the first truly destructive Internet worm, launched in 1988 by a bored college student (Robert Morris).

Some of the other major events and trends of the 1980s:

- In 1982 IBM reentered the services business, which it had left in 1973 as part of the settlement in a Control Data Corporation (CDC) antirust case. Over the last 20 years IBM has become the predominant computer services firm.
- Relational databases, pioneered by Oracle, which was founded in 1977, caught on. IBM's entrance in 1983 with DB2 helped make the market real.
- Sun Microsystems' formation in 1982 heralded the beginning of the golden age of Unix. In the 1980s, as the cost of R&D on operating systems increased, minicomputer vendor after minicomputer vendor (Prime, Computervision, Hewlett-Packard, Apollo, DEC) either switched from proprietary operating systems to Unix or at least beefed up Unix offerings.

In addition to expanding its product portfolio more than tenfold, IDC made two important moves in the 1980s:

- Acquiring LINK Resources, a boutique research firm based in New York and known for its understanding of the consumer and small business markets as well as markets for online information and entertainment.
- Opening a research office in China in 1986. (By then IDC was operating in 13 countries.)

PCs swarmed over the workplace, found their way into homes, and even made it to the desks of lucky students. The number of PCs installed grew from less than 1 million in 1980 to over 100 million by the end of the decade.

1980
The first optical disk is introduced.

1984
Science fiction author William Gibson coins the term *cyberspace*.

PowerBuilder, the first general-purpose visual programming tool, is introduced.

1987
The first reduced instruction-set workstation is introduced.

1980
IDC acquires LINK Resources Corporation.

1982
Sun Microsystems is formed.

ARPANET morphs into what becomes the Internet.

1986
IDC opens IDC China.

1988
College student Robert Morris releases the first truly destructive Internet worm.

1990s The Web Is Born

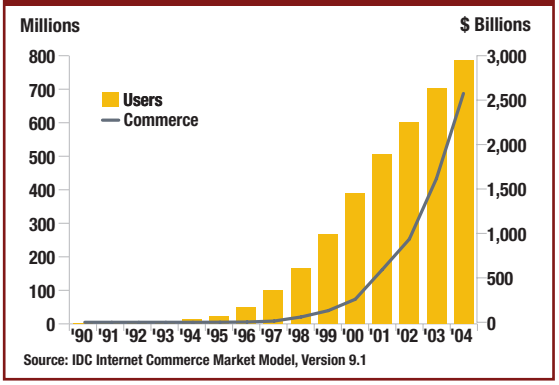
Could the 1990s be anything but the Internet decade? Sure, the term *Internet,* as the collection of networks managed by the National Science Foundation (NSF) and spawned by the Defense Department's ARPANET, came into vogue in the 1980s and the transmission protocol (TCP/IP) had been specified as far back as 1974, but until 1991, when the NSF opened up the Internet for commercial use, it was only used by a few thousand academics and scientists. Two events would change that:

- In 1990 Tim Berners-Lee, a researcher at the CERN institute in Switzerland, developed a system for sharing documents with his colleagues over the Internet. The system included a markup language (HTML) for coding documents, a communications protocol (HTTP) for exchanging them, a browser/editor for viewing and working with them, and a locator (URL) for finding them. He released the system, called the World Wide Web, within CERN in December 1990 and to the rest of the Internet in 1991.
- In February 1993 the National Center for Supercomputing Applications (NCSA) in Illinois released the Mosaic browser for use on machines running Unix. An Apple Macintosh version was released a few months later. Key members of the research team, Marc Andreessen and Eric Bina, left NCSA the next year to found Netscape, which released the first real commercial browser in 1994.

The Web not only caught on, it became a phenomenon, as Figure 3 shows.

Adoption was meteoric. At the start of the decade there were only a few thousand people using the Internet; by the end there were more than 300 million. In addition, there were billions of Web pages, over a quarter of a trillion dollars of Internet commerce, a stock market boom, and a whole new parlance. The populace started calling the Internet "the Web," to lose out to competition from an Internet start-up was to "be Amazoned," to be an Internet start-up was to be a "dot-com," Internet service providers became, simply, "ISPs," to use the Web to trade stocks online frequently was to be a "day trader," and to do anything else using the Web was to "e" it.

Figure 3: Rise of the Internet



Source: IDC Internet Commerce Market Model, Version 9.1

If the decade began with a phenomenon, Berners-Lee's HTML and browser, it ended with another, the dreaded Y2K bug. Through the 1970s, 1980s, and 1990s, programmers often wrote programs with two-digit date fields. Computer specialists had worried for years that this would cause problems when the digits moved from 99 to 00. Most companies started fixing the problem quietly in the 1990s by upgrading software, buying new hardware, and conducting "remediation" projects to ferret out the data fields that were then considered bugs and fix them.

Still, government authorities and a number of computer experts worried that the bugs would not be eradicated in time, and prophesies of doom began to hit the press in the late 1990s. By the fall of 1999 politicians, journalists, and self-proclaimed prophets (some selling consulting) had whipped the public into a frenzy. Citizens were told to store extra supplies of food, water, and cash (in case the ATMs failed). Articles on the Web and in print worried about the myriad control systems with embedded software in them: air traffic control, pipeline

1991
IDC holds its first European IT Forum.

1993
Apple releases the Newton.

1994
Marc Andreessen and Eric Bina found Netscape.

The number of emailboxes grows to 360 million by the end of the decade.

1990–1991
Tim Berners-Lee introduces HTML and the World Wide Web.

1992
IDC establishes offices in Greece, Nigeria, Turkey, South Africa, and Egypt.

Dot-com, ISP, and *day trader* become common terms.

1994
IDC celebrates its 30th anniversary. IDC opens an office in Colombia.

Dot-Coms, the Y2K Bug, and Spam

controls, electricity distribution, and so on. Millions of extra police officers and firefighters were put on watch on New Year's Eve, the new media departed for the island of Tonga (the first land to ring in the new year), and politicians headed for bunkers once intended for use as nuclear fallout shelters.

Nothing happened. The new decade, new century, and new millennium began without any major glitches, as IDC had been telling its clients and members of the press who would listen. Our research showed that not only were most of the critical instances of the troublesome date fields fixed but computer failures wouldn't paralyze companies, the economy, or civilization. In a groundbreaking research effort, called Project Magellan after the famous Portuguese explorer who first circumnavigated the globe, IDC had analysts call in from all major time zones as midnight hit on December 31, 1999, and kept a running commentary up on its Web site. IDC even had an analyst on a flight from Tokyo to Hawaii, which saw the new day and new millennium dawn before Tonga.

The next day, millions, perhaps billions, of people around the world had hangovers. The industry would have a hangover that lasted longer, as customers absorbed the technology they had rushed to buy to prepare for Y2K.

The creation of the World Wide Web and Y2K were bookends for a decade with a lot happening:

- Computer services became a bigger market than computer hardware, reaching 39% of total external IT spending in 1999.
- Sales of large enterprise software applications, such as enterprise resource management and customer relationship management, helped drive growth of 14% in the software industry for the decade.
- Consumer electronics and computer devices began to merge. Smart handheld devices and digital cameras each grew to 10 million units shipped in 1999. Meanwhile, cell phones ended up in the hands of almost half a billion people by the end of 1999.
- Email, once popular only with academics, students, and the tech community, exploded, with the number of emailboxes growing to 360 million by the end of the decade and a new term, *spam,* entering the popular lexicon. Today there are more than a billion emailboxes in use and 6 trillion messages sent a year (including spam, of course).
- Napster, the peer-to-peer MP3 file-sharing system devised in 1999 by a 19-year-old college freshman, became the fastest-growing network service of all time — within 18 months it had 50 million users.

During the 1990s IDC grew faster than the industry, increasing in revenue from $30 million to almost $150 million and in employees from approximately 250 to almost 1,000. By this time IDC offered continuous information services on all aspects of the industry, from semiconductors and peripherals to software, services, and telecommunications.

Yet despite IDC's worldwide reputation as the leading market intelligence and forecasting firm in the business, one of our most important predictions of 1999 was ignored by the public. Our November 1999 IDC Predictions bulletin and Webcast predicted there would be a stock market crash for dot-com companies.

Adoption of the Web was meteoric. At the start of the decade there were only a few thousand people using the Internet; by the end there were more than 300 million.

1995
IDC establishes its first subsidiary in Brazil.
IDC completes its first *Global New Media Consumer Survey.*

1996
IDC opens a Latin America research office in Miami and opens its first dedicated market research center in Moscow.

1997
IDC launches IDCNet Internet service, giving IDC customers 24-hour access.

1998
IDC Asia/Pacific holds its first IT Forum.
IDC holds its first Internet Executive Forum.

1999
Napster is devised by a 19-year-old college freshman.

November 1999
IDC predicts there will be a stock market crash for dot-com companies.

Y2K scare is widespread.

2000+ The Aughts: Correction and Redirection

We need not dwell on the first four years of the current decade; they are still painfully fresh in our minds. Although we had predicted that Internet stocks would fall early in the decade, we didn't predict that they would also drag down the rest of high tech and then the general market.

To be fair to IDC, however, neither did the economists predict the global recession of 2001, government intelligence agencies predict the events of September 11, oil and gas experts predict the 50% rise in oil prices in 2002, or government watchdog agencies predict the scandals of Enron, WorldCom, Tyco, and other companies. This perfect storm of events deepened and elongated the trough of the downturn.

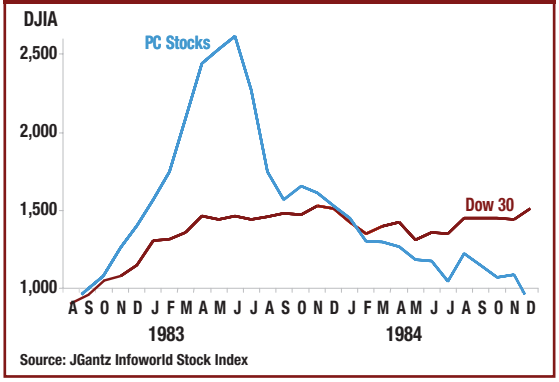
But this was no normal downturn. Early in the down cycle we began alerting clients to the fact that the downturn wasn't a temporary slowdown but part of a long-term boom-bust cycle we had seen before. The signs first appeared in the similarities between the stock crashes of Internet companies in 2000 and PC companies in 1983 (as well as mainframe companies in 1970), as shown in Figure 4.

But knowing you are in a natural boom-bust cycle does little to alleviate the pain a sharp downturn causes.

Our interpretation of this boom-bust cycle is that the boom follows the introduction of a new computing technology — business computers in 1964, PCs in 1977, and the World Wide Web in 1993 — and ends after a period of inflated market expectations. The down cycle is sudden but relatively short, and is followed by a much longer cycle in which the real economic growth from the new technology is actually realized.

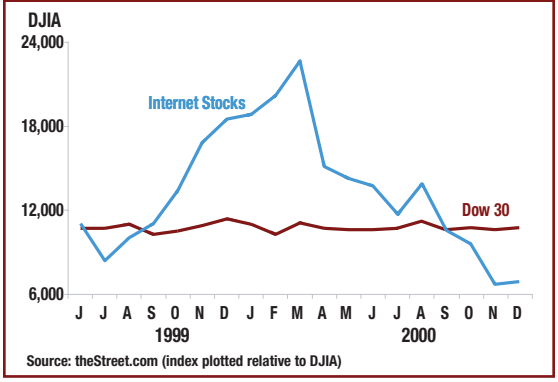
Thus the first 40 years of IT ended — at the inflection point following the third main computing cycle in four decades, the point beyond which the real economic growth brought on by the Internet and World Wide Web will take place, and the point beyond which the industry and the conditions of computer usage will be much changed from the cycle from 1985 to 2000.

Figure 4a: The PC Shakeout



Source: JGantz Infoworld Stock Index

Figure 4b: The Internet Shakeout



Source: theStreet.com (index plotted relative to DJIA)

2000
Internet company stocks crash.

2001
A global recession hits.

Enron, WorldCom, and Tyco corporate scandals surface.

2004
IDC celebrates its 40th anniversary and launches Life Science Insights.

2000
European telecom operators bid over $100 billion for 3G licenses.

2002
Twelve European countries switch to the euro currency.

2002
IDC launches Financial Insights.

Looking Ahead

In 1937 the League of Nations commissioned a study from some of the top scientists of the day to predict the next 50 years of technology. The scientists may have gotten some things right, but the predictions are more notable for what they missed: radar, jets, TV, antibiotics, the atomic bomb, and the Pill.

So looking ahead the next 40 years may be ambitious. But by examining recent trends and putting on our forecasting hats we can develop a picture that might hold true for the next decade.

And surely we are entering an era in which computing gets more mobile and more personal. Call it convergence, call it pervasive computing, call it the age of gadgets, but the desktop computer is no longer the center of the computing universe.

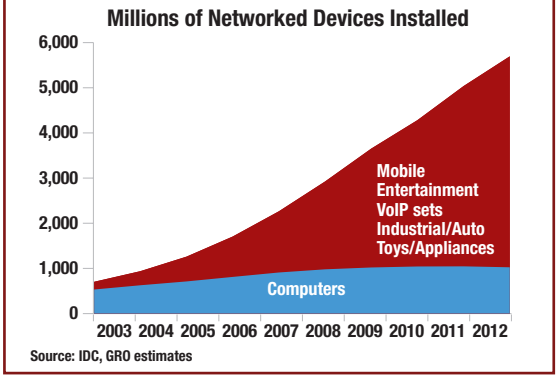
You can see this in specific forecasts:

- By the middle of the decade there will be 2 billion cell phones in use; by the end of the decade, 3 billion. Most of these will be Internet enabled.
- In 2003 the number of "converged devices" — phones that have smart handheld functions, or SHDs that can make phone calls — surpassed the number of standard SHDs. By 2007 more than 70 million of these devices will be shipping a year; by the end of the decade 300 million cell phones could have these advanced functions.
- This year camera phones will out-ship both digital still cameras and analog cameras (except disposables); by 2007 more than 300 million should ship annually.

Figure 5 aggregates a number of IDC forecasts and extends them out past the end of the decade. It looks at the number of *networked* devices we expect to be installed worldwide over the next decade. We have segmented them into two camps: computers and all other devices, including camera phones, communicating videogames, converged devices, VoIP handsets, communicating DVD players and set-top boxes, and even toys and appliances.

The number of computers installed will flatten out as the decade wears on, but the number of other devices — mobile phones with PDA capability and Internet access, networked videogames, digital cameras, and so on — will grow into the billions.

Figure 5: Beyond Computers



Of course, for the full flowering of growth in this part of the new IT cycle we have entered, we will also need new applications and services for these networked devices, new architectures for dealing with transactions and network queries 24 x 7, and new levels of sophistication and performance in the infrastructure serving the workers and consumers using these devices. By just the end of the decade, for instance, we could see 10% of all commerce conducted online, or $1,500 a year for every person on the planet. That could easily drive a tenfold increase in the number of transactions.

"By 2020 China will be the second-largest IT market in the world, after the United States. By 2043 it will still be number 2, but India will be number 3. There will also be a single global currency, and there will have long been a single, global grid-based computing structure." – *Piyush Singh, IDC Asia/Pacific*

"In the next 40 years, IDC analysts will wear clothes that can accommodate all the myriad client interactions and be able to change color, shape, and texture through the use of intelligent fabrics. The clothing will also include embedded computing and communications functions and will generate power from movements of the body. Displays will include eyeglasses, holograms, and just about any flat or visible surface, although some analysts may have displays from direct device-brain connection." – *Chris Christiansen, IDC*

Extending the Edge of the Network

And just as mainframes evolved even as the personal computer revolution was in full blast, high-end architectures and solutions will evolve. We can expect the following:

- The use of standardized hardware, software, and even services platforms will increase, with 2004, a year in which Intel-based standardized servers out-ship in value Unix/RISC servers, serving as a milestone. By 2007 standardized servers will account for 50% of all server shipments.
- Software that manages (or protects) other software will continue to be in demand. Modern corporations have investments in billions, if not trillions, of lines of software code today, and software that preserves or optimizes that investment will be welcomed.
- As the number of end users and computing form factors increases, anything that simplifies or hides complexity will find a market — from collaboration technologies and synchronous communication (e.g., instant messaging) to Web services–based software development and advanced search techniques.
- Voice communication will shift from circuit switched to packet switched. Traditionally, data traffic was carried over voice networks or leased voice lines. Now the reverse is happening: Voice traffic is increasingly being carried over data networks, typically using TCP/IP.
- Globalization will continue to drive offshore sourcing. Just by 2007 IDC expects 25% of all computer services provided to U.S. companies, for instance, to be provided through offshore sources. Within less than 10 years China will be the number 3 country market for IT, ahead of all but the United States and Japan.

And the Decade After?

After the aughts, the age of gadgets, what then?

For the last several years we have proposed to clients at our Directions conferences that we will increasingly see sensors and embedded systems come into play. This year and last, for instance, there has been a significant amount of press about radio frequency ID (RFID) tags, in part because Wal-Mart, Gillette, the U.S. Department of Defense, and others have committed to start using them for item tracking in 2005. These tags emit electronic signals either when probed or on their own with information about the item tagged.

We may have doubts about how fast companies can switch from barcode systems to RFID systems, but over time Moore's law will drive down costs, big suppliers will drive the market, and new applications will come online, spurring even more innovation in sensor-based and embedded applications down the line.

Just a few signs of the future now:

- Hitachi has developed a new chip, the mu-chip, an RFID tag with a built-in antenna that is small enough to be embedded in paper.
- The European Union is experimenting with using RFID tags woven into currency to prevent counterfeiting.
- KSW Microtec now has a machine that can roll-print extremely small and thin batteries, similar to the process of printing batik designs on cloth. The same technology can be used to print smart, and communicating, labels.
- Researchers on Great Duck Island, off the coast of Maine, are using an experimental network of sensors to track conditions in the burrows of storm petrels.

"In the next 40 years, another magnitude of miniaturization will have taken place, and compute devices will be small enough to be inserted in a body using noninvasive techniques. These devices will be used for anything from monitoring body functions to surveying the blood system from the inside." – *Al Gillen, IDC*

"In the next 40 years, battlefield soldiers will be tied to a virtual battlefield system that monitors their exact point in space related to massive models of the battlefield while monitoring their health. This capability will transpose into the civilian world in myriad ways; for example, into a location system and data feed wristwatch on your child for full-time virtual parenting and monitoring." – *Joe Loiselle, IDC*

Growing Demand for Miniaturization and Personalization

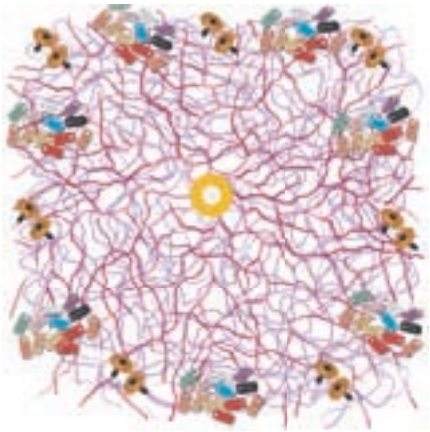
Architecture for the New Era?

As the IT universe expands outward, first to encompass mobile users and later smaller and smaller mobile and embedded devices, surely data architecture, communications, networking, and storage will have to change to accommodate this expansion. The network edge will move outward, as shown in Figure 6.

Figure 6a: Today's Network

Source: IDC

Figure 6b: Tomorrow's Network



Source: IDC

This expansion of the network edge will also cause major changes in computing styles. Embedded systems and sensors will send small signals to local controllers, but there will be trillions of them. And they will be sending data rather than receiving it.

Think what this means for a server. Without counting sensors and RFID tags, over the next 10 years you can expect the number of client devices per server to expand by a factor of 4, to more than 300 or so. If you add in sensors and RFID tags, then the ratio of servers to network edge devices grows by a factor of 400, to more than 50,000. Just keeping track of these network edge devices will be a problem. Yes, they will report to a hierarchy of intermediary servers and controllers, but each will be sending discrete information packets that have to be stored, searched, collated, assembled, analyzed, and otherwise made sense of.

To understand some of how the expanding network edge might affect enterprises, in 2003 IDC conducted an exercise to forecast for an extra five years (to 2012) the number of network-capable devices installed, the number that might actually be networked, and the data traffic to and from these devices.

Figure 7 shows the result of this analysis. Two things stand out: The amount of traffic from the noncomputer devices will increase dramatically, and the information flow will begin reversing from the server to client to the network edge to center.

This uploading and downloading of data at the network edge will translate into demand for storage, processing, content management, switching, security, and all the integration and software to make it work.

If all enterprises had to deal with was an increase in the type and number of network elements and a general increase in the amount of data to be shipped, stored, and managed, that would be one thing. But dealing with different data traffic patterns will be another.

"Forty years from now, people will not carry money or identification. Biometric devices will be used to identify them and enable them to select means of payment in stores, board airplanes, identify themselves to police (such as in traffic stops), enter countries (instead of passports), enter entertainment events or movies (instead of tickets), and so on. Transactional devices such as anonymous currency transfer authorization would be used by stores, ticket takers, and vendors of various kinds. The seller will not need to know the identity of the buyer to validate the transaction." – *Carl Olofson, IDC*

"In the next 40 years, instead of PowerPoint presentation of flat images, we will have dancing holographic projects on walls, tables, and other surfaces — or perhaps a 3D image of the ball field in the living room instead of a flat-screen, high-definition image in a TV. All we need for 3D holographic images are more processing power, data management, and bandwidth." – *Mitchell Rose, IDC CIO*

Increasing Security and Storage Capacity

Figure 7a: Network Edge Payloads* Ahead

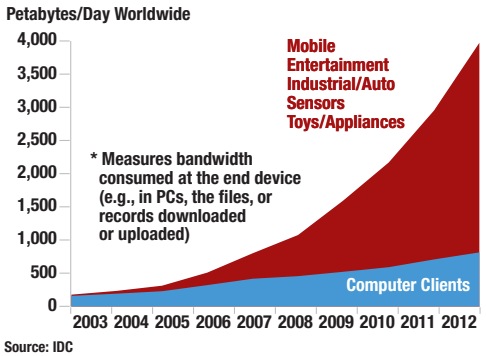
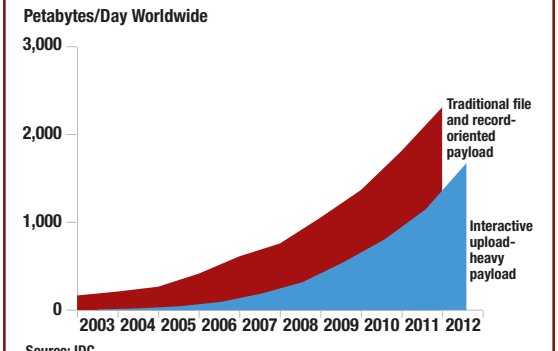


Figure 7b: A New Kind of Traffic



Beyond just payload, we have developed a picture of this change in network traffic by estimating for each device type the percentage of traffic over time that would be interrupt driven or upload heavy. Our assumption is that most client-server data transfers today are record or file oriented and tend to flow from the server to the client. Instant messaging and voice communications, peer-to-peer file sharing, and sensor-driven communication would be upload heavy and interactive. This latter type of traffic could grow from 5% of today's traffic to 40–50% by the middle of the next decade. For the enterprise to deal with this exploding universe of devices it will take new skills, vendor support, and business processes. It will also depend on open standards, flexible and high-throughput systems, and development tools.

CIOs and IT professionals who have just gotten used to wireless networks, Internet commerce, and constant worries over security will have to accommodate scores if not hundreds of new form factors, content types, and traffic conditions. How will enterprises adapt and how will the technology of IT help them? At a minimum, the next 20 years will require the following:

- Fast, plentiful, and scalable servers — most likely standards based and modular, like today's blade servers, to handle rapid change in demand.
- Flexible datacenter architectures and IT strategies — with today's concept of utility computing or computing on demand as another direction that adds flexibility to handle changing compute requirements and lowers costs.
- Vendor support in development, implementation, security, and perhaps even operation. As the network edge proliferates, computing complexity will only increase. Enterprises will need support from companies better able to deploy, manage, and service the different elements from the datacenter to the sensors at the edge.
- New algorithms for sizing and configuring systems; a new understanding of peak-to-average load characteristics and new career dynamics for IT professionals.
- New corporate commitment to matters of IT security and individual privacy. As the technology begins to support presence and location awareness in applications and, in some cases, could be with us 24 x 7, we will need to accommodate personal privacy and information security or the market will rebel.

"In the next 40 years, we'll be using a constellation of dedicated, focused-function 'access point devices' rather than general-purpose computers like PCs. Those will become servers for the other devices. A large portion of the computing load could be done in the network, and we might use scenario-based computing rather than menu-based computing. Technology developed for games could be used in business applications." – *Dan Kusnetzky, IDC*

"In the medium term, technology will provide a communication platform whereby ideas, information, and creativity can flourish in undeveloped areas, like Africa and China. It is not inconceivable that the cure to cancer currently resides in the head of an 18-year-old in Uganda or Shanghai. In the long run, we could have cranial chips, a colony on the moon, enhanced IQ, and passive exercise." – *Mark Walker, IDC South Africa*

Analyzing the Future

- Growing understanding of real-time programming and interrupt-driven processing — a lost art in most companies. As we migrate from transaction processing to real-world telemetry, we will need ways to tell our systems which incoming content streams are the most important.
- System, performance, network, and content management tools that deal with complexity of a new order of magnitude.

Lessons from the Future

Over a century ago two brothers from Dayton, Ohio, launched the aviation industry, and in its first 40 years flying went from a novel concept to a full-blown industry. But it was the *next* 40 years that saw the jet plane, supersonic flight, men on the moon, and the 2oz bag of peanuts. The same is true for the automobile: The first 40 years were exciting, bringing us horseless carriages, the Model T, paved roads, and gasoline stations in every town. But the next 40 years brought us interstate highways, malls, suburbia, drive-through restaurants, three-car garages, and the Beach Boys.

In an opinion poll that IDC conducted in the summer of 2003, we asked top software executives if they could "map the benefits from software innovation that will accrue to society during their lifetime." Almost half said we have seen only 10% of them total so far; a full 50% said we have seen only 25%.

So, if there is any lesson to learn from the future it is this: The next 40 years will be more exciting, more amazing than the last. And IDC will be there to track the IT industry's direction and plot its forward momentum.

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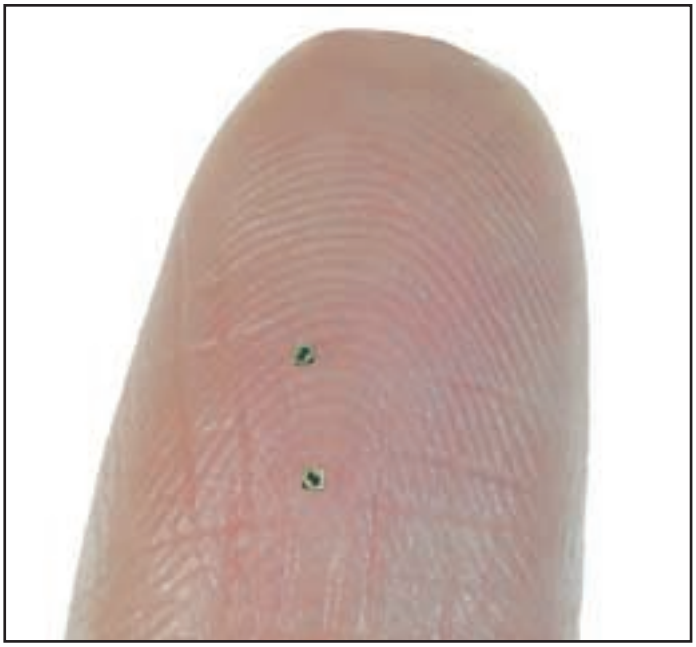

Image courtesy of Hitachi

The Hitachi RFID μ-chip: 2003

"The use of IT in the next 40 years will be surprising — and unexpected. It is almost an impossible task to imagine so far in the future. Weren't we already supposed to have jet-powered, self-driving cars; 3D teleconferencing; plastic dwellings; extensive use of robots; [and] a habitual moon base by now? People tend to imagine future technologies as mere extensions of things that already exist … If we are to make some comment about future technology trends, we need to ensure we are not presenting science fiction as research." – *Phillip Allen, IDC Australia*

"In the next 40 years, checks and cash will be eliminated from transaction payments, with wireless payments the dominant payment methodology. Interactions between customers and financial institutions will be 95% or more through digital media, with face-to-face interaction rare. Access to information and business processes will be via DNA identification." – *Bill Bradway, IDC Financial Insights*

Missteps Along the Way

From the greatest supercomputer that barely worked to the computer art exhibit where gerbils wrecked a robot arm, the computer industry has had its share of gaffes, missteps, blind alleys, and wrong turns. Following are some examples culled from *The Naked Computer,* written in 1983 by Jack B. Rochester and John Gantz, and from more recent press reports.

1945 — The First Bug

While searching for a malfunction, an operator of the Mark II Aiken Relay Calculator at Harvard University found a moth trapped between two relays. The moth was removed, the computer was fixed, and the word *debugged* entered the programming lexicon. The moth was pasted to a page in the logbook and was on display for many years at the Naval Surface Warfare Center Computer Museum at Dahlgren, Virginia.

1968 — The Viatron Everything Terminal

Founded in 1968 as a spinout of MITRE Corporation, Viatron was the brainchild of scientists with a revolutionary idea — a personal computing device. Billed as "The Everything Terminal," it was to cost only $39 a month and was targeted at the average office worker or consumer. It was to be user friendly, ergonomic, compatible with other computers, equipped with a color display, and even made offshore. The company started taking orders in 1969 and by 1970 had $100 million in backlog. Alas, the backlog was so big that customers had to wait months for their terminals, the company hemorrhaged money, and then a recession hit. By 1971 the company was bankrupt and the concept of a personal computer was delayed by almost a decade.

1969 — Xerox and Scientific Data Systems

About a year before the big mainframe crash and before dozens of big companies left the industry, Xerox, the copier giant, entered the business by buying a company called Scientific Data Systems (SDS) for almost $1 billion at 90 times earnings at the height of the bubble. Unfortunately, SDS technical computers were aligned with the space program, which began winding down after Neil Armstrong walked on the moon in 1969, and Xerox was never able to convert the systems to commercial work nor sell them in opposition to IBM. In 1975 Xerox left the business after a write-off of over $1.2 billion.

1967–1975 — Illiac IV Supercomputer

The brainchild of scientists at the University of Illinois, this was to be the world's most powerful supercomputer. Rather than be built as one giant computer, it would be composed of an array of 256 separate machines. Funded by the U.S. Department of Defense in 1967, it was to cost $8 million using the latest advanced technology — thin-film memories and other special circuits — and be completed by 1975. The thin-film memory didn't work nor the advanced circuitry, and the processor had to be redesigned and scaled down to 64 machines. Development was moved to California because of fears of sabotage by antiwar protestors. In 1973 costs were up to $27 million and the computer was failing every five seconds. By 1975 it was able to work 60 hours a week and costs had hit $31 million. It was decommissioned six years later.

1970 — Telemart Home Shopping

Telemart opened in San Diego in 1970 as a "robot supermarket." Customers would call the company and interact with its IBM computers via voice-computer interface to select items. The computer would then spit out a pick list for the warehouse, and groceries would be delivered to the caller's home. The service proved too popular, and the computers couldn't keep up with demand. Customers then stopped calling, and Telemart went bankrupt in two weeks.

1971 — Offshore Programming

A Japanese company called International Logic Control set up shop in Jaffrey, New Hampshire, to manage offshore programming — mostly software conversions from IBM 360 systems to IBM 370s — for U.S. companies. The company would take the order in the United States and ship it to Japan for the actual coding and then return the completed work. The company was merely 30 years ahead of its time and disappeared in 1972.

Precision Instruments Polyester Memory
The company sold a $400,000 mass-memory device, the Unicon 690, that stored data by using a laser to burn holes into a rhodium-coated polyester strip. It was to be able to store over a trillion bits. Some of these devices were delivered to the government but never worked. Of course, Precision Instruments was not alone. Around that time a number of companies explored all sorts of mass-memory techniques. Control Data tried a 5,000ft, 22in.-wide recording tape, Grumman tried using giant audio cartridges, Fujitsu and others tried using holograms, and Burroughs and 3M invested more than $50 million in a mysterious technology called ovonics that would use lasers writing on yet-to-be-invented amorphous semiconductors.

1972

Equity Funding Scandal
This was a $2 billion scam perpetrated by a company called Equity Funding, which used computers to create fake insurance policies that were then resold and used as collateral for other financing.

1973

Trilogy Wafer Scale Memory
Gene Amdahl, the founder of Amdahl Computer and designer of one of IBM's most popular computers (IBM 704), founded a company that was to build supercomputers by making giant pancake-sized chips the same size as their wafer substrates. (Today's chips are made on 8–12in. wafers, but there are many chips on a wafer.) Trilogy raised over $200 million in financing and $60 million in a public offering. Construction of the plant and wafer testing were delayed by weather, and the wafers never worked. By 1985 Trilogy had devolved into a chip design firm. Some of the technology, but none of the invested dollars, lived on.

1981

Mars Climate Orbiter
This is the $125 million Mars probe that crashed on Mars in September 1999 as a result of a navigation failure from a single line of trajectory code. The error in that code stemmed from the fact that the navigation system design team used the metric system in its software and the spacecraft design team used the English system. Although this started as a human error, better software testing would have caught it. Note that software and computer errors on spacecraft are not uncommon. In the 1971 *Apollo 14* a computer failure almost set off an automatic abort of the lunar landing, in a 1997 MIR mission a computer failure turned off the power, and in 2002 a computer crash set the International Space Station adrift for three hours.

1999

Lost Technologies
There have been plenty of technologies that either never made it or were ahead of the times, as Telemart was to eBay and Viatron was to Apple. Besides ovonic memories and wafer-scale integration there were silicon-on-sapphire chips, bubble memory for computers, electron beam memories, 2-1/2in. disk drives, hydraulic computers, artificial intelligence computers, executive workstations, fax-mail (remember FedEx's ZapMail?), and a cute Microsoft user interface for home computers called Bob.

1964–2004

About IDC

IDC is the premier global market intelligence and advisory firm in the information technology and telecommunications industries. We analyze and predict technology trends so that our clients can make strategic, fact-based decisions on IT purchases and business strategy. Over 700 IDC analysts in 50 countries provide local expertise and insights on technology markets. Business executives and IT managers have relied for 40 years on our advice to make decisions that contribute to the success of their organizations.

IDC is a subsidiary of IDG, the world's leading technology media, research, and events company. Additional information can be found at www.idc.com.

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"As more technically naive people interact with them, and as jobs become more time demanding, computers cannot remain as the raw assemblage of applications we see now. The emergence of either a series of computer-based appliances or a more natural interface, facilitated by linguistically based and agent-based technologies, is likely over the next 40 years." – *Sue Feldman, IDC*

NOTES

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40
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