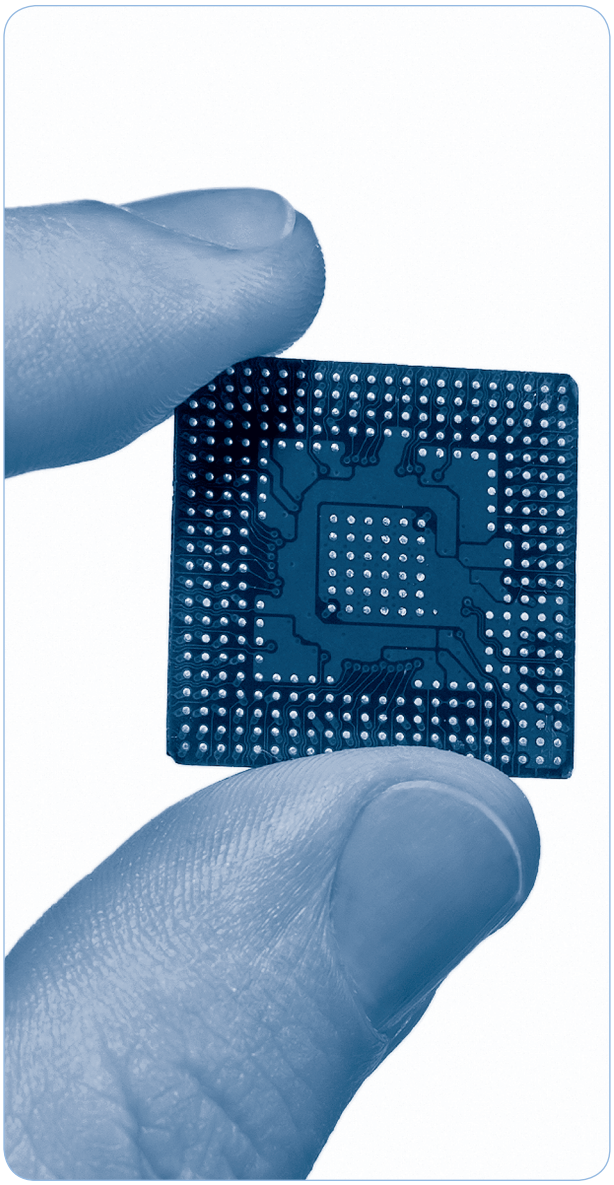
# 2. Why Is the Digital Information Revolution Happening Now?

Why is the information technology (IT) revolution creating a global information society now and not 20 years ago or 20 years from now? The answer is simple: Moore's Law. In 1965, Intel cofounder Gordon Moore observed that as transistors got smaller, the number of transistors that fit onto an integrated circuit grew exponentially. Moore challenged the semiconductor industry to continue this exponential growth—a challenge the industry has risen to time and again. In practical terms, with innovation, capital expenditure, and risk, the result has been that the computing power of a chip has doubled every 18 months.

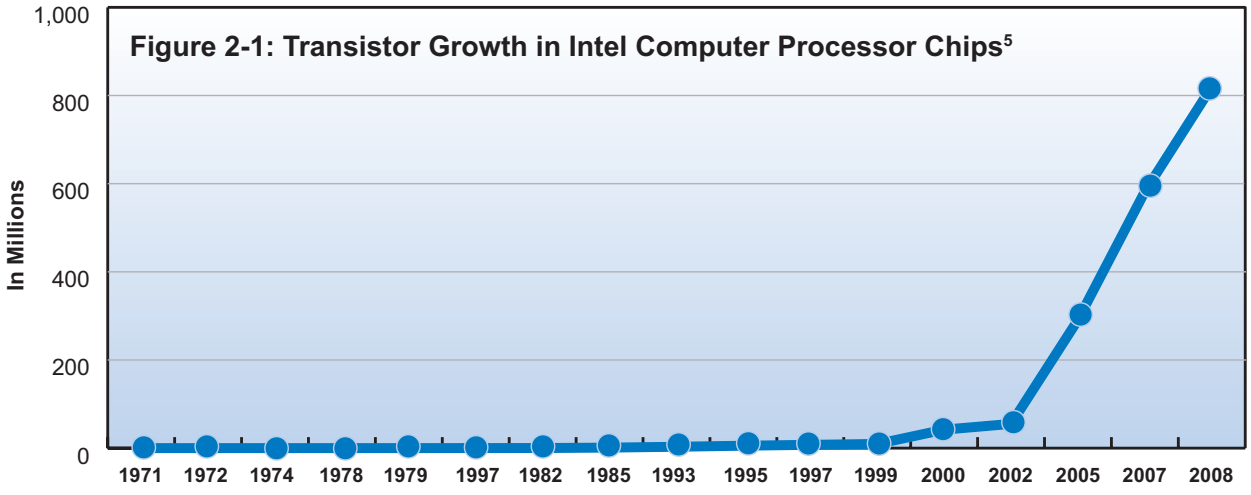


But it was not until the improvements inherent in Moore's law had reached a critical inflection point, around the mid-1990s, that we could speak of an IT revolution. Even after 25 years of steady progress, the digital technology of the early 1990s was still not powerful enough, cheap enough and easy enough to use to power an information revolution. In 1990, the cost of the Intel processor had fallen to around $20 per million instructions per second (MIPS), down from $480 in 1978. But this was still too expensive to enable the kinds of low-cost, high-performance devices and applications needed to make the world alive with information. Just 13 years later, in 2003, the cost per MIPS (of the Itanium 2 processor) had fallen by a factor of 10 to $2.[1] One reason for this change was the ability to pack even more transistors onto microprocessors (see Figure 1).

Exponential progress was not confined to processors—it extended to many other core IT technologies, including memory, storage, sensors, displays, and communications.[2] The real price of servers fell approximately 30 percent per year between 1996 and 2001. Hard-drive storage capacity has doubled every 19 months while the cost of a stored megabyte of data has fallen 50 percent each year. As a result, the cost of storing 1 megabyte of information fell from 17¢ in 1999 to half a cent in 2002 to less than 1/10th of a cent today. With these kinds of historically unprecedented price declines, it is now easy and cheap to do things that a decade ago were neither. Currently, for example, Microsoft provides around 5 gigabytes (5,000 megabytes) of free storage for users of its free MSN e-mail service, enough to store four or five full-length movies. If Microsoft were to provide this service today using 1995 technology (in 2008 prices), it would cost the company more than $5,500 per user. Today the company can provide the storage service for less than $1 per user.

Not only has IT become cheaper and more powerful, it has become much easier to use.[3] Through the mid-1970s, computers were considered complex devices that could be operated only by trained professionals. Operating a computer was often compared to flying a commercial jet because an operator needed years of training and a license—and anyone who took a close look at hardware and software prior to 1970 would have to conclude as much. But beginning in the mid-1970s and accelerating with the introduction of Apple's first Macintosh computer with a graphical user interface, things dramatically changed. Computers and their software were now designed for ease of use, which has made it possible for non-highly-trained people to exploit the benefits of IT. The trend toward more user-friendliness has continued and accelerated to this day, and IT is now moving in the direction of intuitive devices that will not even require familiarity with a mouse or a keyboard, only the ability to speak.

IT is even creating new ways to display and convey information. Cheap displays allow almost any device to output digital information, such as refrigerators that display recipes, shopping lists, and the "use by" date of the food stored inside. In some instances, the very concept of having an information-rich screen that users can actively interact with is being reworked to create products intended to integrate information seamlessly into daily life. One such product designed by engineers is an umbrella



that uses a wireless data radio to get the forecast and then glows when it is supposed to rain so it does not get left behind. Another device, the Ambient Orb, is a frosted glass ball that can be set up to glow different colors based on a preselected variable, like showing one color if the stock market or a particular stock is up and another if it is down. The same concept can also be applied to products that utilize data like the forecast, pollen count, and traffic congestion.

Two other key developments are enabling this digital information revolution: cheap networked sensors and global positioning systems (GPS). The availability of cheap, powerful sensors that can detect everything including chemicals, temperature, traffic, sounds, wind, and images means that it is easier to detect and process information about the environment. In addition, the availability of low-cost GPS devices means that devices can move beyond stationary data collection and allow mobile data collection where information can be associated with a specific time and place.

One final piece of the puzzle that enables the emergence of the information society is now being put in place: lots of bandwidth at low costs. It is one thing if IT is easy to use and cheap, but unless information can be cheaply transmitted, both wirelessly and by wire, information flows will be severely limited. Luckily, bandwidth costs have fallen significantly. In Japan, the average consumer can subscribe to 100 megabits per second (Mbps) fiber-optic cable service for around $40 per month. In 2001, a 1.5 Mbps per month T1 line in the United States could cost as much as $1,000 per month.[5] Seven years later, U.S. consumers can get broadband speeds 10 times as fast for 1/25th of the cost.

In sum, it was only when dramatic reductions in costs and improvements in the usability of IT occurred that the digital information revolution really began to take off in this decade.

## Endnotes

1. Gordon Moore, "Intel Keynote Transcript," speech presented at the 2003 IEEE International Solid-State Circuits Conference, San Francisco, California, February 10, 2003 <www.intel.com/pressroom/archive/speeches/moore20030210.htm> (accessed July 27, 2008).

2. John Van Reenen, "The Growth of Network Computing: Quality-Adjusted Price Changes for Network Servers," *The Economic Journal* 116 (February 2006): F29 <ideas.repec.org/p/cep/cepdps/dp0702.html> (accessed July 27, 2008).

3. A Little Technology Shop, LLC, "Historical Notes about the Cost of Hard Drive Storage Space," updated January 21, 2008 <www.littletechshoppe.com/ns1625/winchest.html> (accessed July 27, 2008).

4. Moore, "Intel Keynote Transcript," 2003.

5. Tom Spring, "Broadband: Beyond DSL and Cable,"August 7, 2001 <archives.cnn.com/2001/TECH/internet/08/07/fiber.optics.idg/index.html> (accessed July 27, 2008).

## About the Information Technology and Innovation Foundation

ITIF is a non-profit, non-partisan public policy think tank committed to articulating and advancing a pro-productivity, pro-innovation and pro-technology public policy agenda internationally, in Washington DC and in the states. Recognizing the vital role of technology in ensuring American prosperity, ITIF focuses on innovation, productivity, and digital economy issues.

Technological innovation, particularly in information technology, is at the heart of America's growing economic prosperity. Crafting effective policies that boost innovation and encourage the widespread "digitization" of the economy is critical to ensuring robust economic growth and a higher standard of living. However, as in any new and changing situation, policymakers have varied awareness of what is needed and what will work. In some cases legislators have responded to new and complex technology policy issues with solutions more suited for the old economy. And as the innovation economy has become increasingly important, opposition to it from special interests has grown. Finally, the excitement that the press, pundits and decision makers showed toward the information technology (IT) revolution in the 1990s has all too often been replaced with an attitude of "IT doesn't matter." It is time to set the record straight—IT is still the key driver of productivity and innovation.

As a result, the mission of the Information Technology and Innovation Foundation is to help policymakers at the federal and state levels to better understand the nature of the new innovation economy and the types of public policies needed to drive innovation, productivity and broad-based prosperity for all Americans.

ITIF publishes policy reports, holds forums and policy debates, advises elected officials and their staff, and is an active resource for the media. It develops new and creative policy proposals to advance innovation, analyzes existing policy issues through the lens of advancing innovation and productivity, and opposes policies that hinder digital transformation and innovation.

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