

# The Washington Post

## Exabytes: Documenting the 'digital age' and huge growth in computing capacity

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Thursday, February 10, 2011; 11:17 PM

Megabytes are dead.

Gigabytes are passe.

So much digital data now moves around the globe that those who endeavor to measure it employ a new - or new to non-nerds - term.

Meet the exabyte.

How much data is an exabyte? It's a billion gigabytes - and it signifies just how digital and data-intensive the world has become.

In 2007, the global capacity to store digital information - on computer hard disks, smartphones, CDs and other digital media - totaled 276 exabytes, a new report finds.

How much is that? Imagine a stack of CDs - each holding an album's worth of digital music - shooting from the top of your desk to 50,000 miles beyond the moon.

But not everyone has equal access to those resources. In fact, the digital gap between rich and poor countries appears to be growing, said Martin Hilbert of the University of Southern California, who led the audacious effort to tally all of civilization's information and computing power.

In 2002, people in developed countries had access to eight times the bandwidth - or information-carrying capacity - of people in poorer nations, Hilbert said, citing data he will publish soon. By 2007, that gap had almost doubled.

"If we want to understand the vast social changes underway in the world, we have to understand how much information people are handling," Hilbert said.

To address that question, Hilbert and co-author Priscila Lopez spent four years poring over 1,110 sources of information spanning from 1986 to 2007, including sales data from computer and cellphone makers and the music and movie industries.

In 1986, a year after digital CDs widely debuted, vinyl records still accounted for 14 percent of all data on Earth, with audiocassettes holding an additional 12 percent.

By 2000, digital media accounted for just 25 percent of all information in the world.

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After that, the prevalence of digital media began to skyrocket. In 2002, digital storage capacity outstripped the non-digital variety - mostly paper and videotapes - for the first time.

"That was the turning point," said Hilbert, who published the report in the journal *Science*. "You could say the digital age started in 2002. It continued tremendously from there."

By 2007, the last year documented in the study, 94 percent of all information storage capacity on Earth was digital. The other 6 percent resided in books, magazines and other non-digital formats, particularly videotape, Hilbert and Lopez found.

But despite the forecasts of futurists, a paperless world has not arrived. Although stupendously outstripped in growth by digital media, the amount of paper produced for books, magazines, newspapers and office use climbed steadily over the two decades of the study.

As for computing power - the number of calculations per second available in all of the computers in the world - that grew faster than even information storage, muscling ahead at an average annual growth rate of 58 percent over 21 years. Information storage, in contrast, grew at a rate of 23 percent.

Of course, for anyone tethered to an iPhone, Gmail and Facebook all day, all of this probably comes as no surprise.

That daily digital activity contributes to a churning information tsunami. Humans generate enough data - from TV and radio broadcasts, telephone conversations and, of course, Internet traffic - to fill our 276 exabyte storage capacity every eight weeks, Hilbert said. Of course, most of the digital traffic is never stored long term, evaporating into the ether.

The study prompts deep questions, one of which Hilbert plans to explore soon: How much of this data deluge is truly useful? Or, as Hilbert distilled it, "What's the value of watching a silly cat video versus reading an overpriced book?"

While we wait for an answer, social scientists worry that the mounting data carry a hidden cost: disconnection from one another.

"We'd like to think that [information technology] changes everything, that the amazing statistics these authors cite mean that our society has fundamentally and irreversibly changed," said Thomas J. Misa, who studies the history of technology at the University of Minnesota. "I'm a bit more skeptical." After all, Misa said, "there are still secret prisons in Cairo where government agents savagely beat people. Cellphones and social media didn't change that."

Perhaps not, but widespread reports from Egypt suggest that online social networking contributed to - or even prompted - the ongoing demonstrations there.

The study also found that Earth had 3.4 billion cellphones in 2007, with telecommunications traffic growing at an average rate of 28 percent per year between 1986 and 2007. That's a lot of minutes on your plan.

In a second report Hilbert plans to publish in a few months, he found that an ever-increasing slice of our daily data resides not on home computers and the smartphones in our pockets, but in giant data warehouses owned by Google, Facebook, Citibank, the federal government and other huge entities. Microsoft's recent ad campaign touts the benefits of moving all of your personal data to "the cloud," invoking white puffs that magically - and cleanly - store our home photos.

The reality is much dirtier. In 2006, the nation's "server farms" - the home of the cloud - sucked down 1.5 percent of all electricity in the United States, double the amount used in 2000, the Environmental Protection Agency reported. Congress ordered the report out of concern that our insatiable demand for Facebook and [YouTube](#) would push the United States to build 10 new pollution-spewing coal plants.

But Hilbert offers a humbling comparison. Despite our gargantuan digital growth, the DNA in a single human body still stores far more information - and a single human brain computes far more calculations - than all the technology on Earth.

"Compared to Mother Nature," Hilbert said, "we are humble apprentices."

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