

# A Bit About A Digital Future

## FOR THE TRINITY COLLEGE SESQUICENTENNIAL PERSPECTIVES

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**We control our futures, at least partly. Potential digital mischief suggests careful thought and action.**

“Tell us how digital things might be in 50 years.” The assignment might be welcome to someone who earned his keep doing little more than think about the future. There’s a hitch, however; the creators of that future—computer scientists and engineers—have difficulty providing persuasive answers. (The Communications of the Association for Computing Machinery, 44(3), March 2001, contains 56 essays devoted to *The Next 1000 Years*. 8 touch on the theme of the current essay—some slightly and some profoundly.)

Recognizing colleagues that drive change--astounding improvement in persistent storage--we can ask them. For fifteen years, an IBM Almaden Research Center team has raised storage density 60% annually; they have made their marketable product, disk drives, 26% cheaper annually. Asked whether such improvements will continue, they answer confidently that it will be so for five years, and speculatively that it might continue for ten years. Asked about fifty years, their responses are hearty laughs or nervous titters.

You might ask, “What’s so great about 60% density improvement and 26% price improvement?” Wouldn’t you like to invest at such rates, equivalent respectively to 10961% and “merely” 1008% per decade. You can today for \$200 buy a 60 billion byte disk drive whose volume is about 300 cc.; in ten years you might be able to buy a 60 trillion byte unit fitting in 3 cc. for about \$2. So for about \$3, you could buy brain-sized storage small enough for surgical implantation!

How will we use such storage when we can connect it to human nervous systems? Will doing it be a good thing or a bad one? (Those who have read “1066 and All That” will understand that evaluating history consists simply of counting good and bad things.)

### A DELUGE OF DIGITAL DOCUMENTS

The paragraphs above touch only persistent storage. We expect similar changes in other parameters—particularly in communication networks.

Most citizens of affluent nations will experience the deluge at least passively. Estimates suggest that over  $10^9$  digital documents and over  $10^6$  digital services exist today. These numbers are growing rapidly and the rates of growth are increasing. Such estimates, considered together with qualitative differences between digital documents and their paper predecessors, suggest emerging social crises.

The marginal cost of copying a document has become negligible. The cost of transmitting a document is becoming negligible. The ease with which documents can be searched, altered and combined is new. I delight in what such changes allow me to accomplish; I shudder at the mischief into which they might lure you!

The digital infrastructure needs embedded safeguards. Effective measures are beginning to be understood, but more research is needed. However the fabric of the Internet is laughably short of deployed protections.

To a software engineer, active devices (automatic door locks, appliances, payment mechanisms, weapons, ...) and messages that pass among and activate them are similar to digital documents. All can be constrained with a single set of methods. Although I discuss only documents, you can think about whatever digital services concern you most.

Let's consider a few properties.

**Authenticity and reliable provenance:** suppose that your physician is about to medicate you guided by some report from a digital library. He and you assume that the report comes from a known credible author and that the dose it recommends has not been fraudulently increased 100-fold. Being misled could cost you your life, and your physician his license!

**Access control:** some people look forward to the automated home; for instance, you might want to turn on your furnace as you drive home. Would you be happy with a neighborhood prankster's setting the temperature to 85 degrees just after you depart for work? If that doesn't bother you, perhaps you should consider a terrorist's seizing control of a pilotless warplane.

**Ability to administer:** you are surely annoyed at the many passwords you must remember and uneasy about how easily a miscreant can breach them.

If you administer a university service, you may be troubled by the increasing difficulty and cost of limiting it to faculty and students; recall that 20% of this population changes every year. If so, consider that the number of controlled services and the pace of change might increase 10-fold in a decade. If you fall behind, your clientele will experience deteriorating service and the service might be invaded by outsiders.

**Privacy:** global position sensing (GPS) has wonderful applications, such as recording your location into every transaction document. That's helpful because location is a potent aide-memoire for recalling documents. Since GPS devices will soon be inexpensive, we can expect automobile and mobile telephone vendors to include them as no-cost incentive features, which might please you greatly. Or will it? GPS technology can also make it inexpensive for "big brother" to track your location at will. Imagine how helpful the police might find such a record.

## ASSESSMENT

Rapidly improving digital hardware and network infrastructure will make document copying, searching, combining and sharing so convenient and inexpensive that we will do these things more and more, often without noticing it because the actions are hidden within common transactions. However, the same features potentially enable **privacy invasions, criminal activities, and acts of terrorism and warfare.**

The same technologies can be used to mitigate the mischief. However, marketplace incentives do not lead in this direction. The means of mischief are being deployed at a dizzying pace; the potential mitigations receive scant attention.

The potential problems are becoming visible in the press. However, the public is not being told of the pace and scope of the emerging deluge.

Technical protections alone would provide insufficient protection for civil liberties. Legislation and common law, enlightened business practices, and international treaties will surely be needed also. In a democratic society, such measures do not happen without public will, and that does not evolve without public understanding. Thus, if you are concerned about the risks, your first action might be to inform yourself, and your second might be to inform whoever will listen to you.