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Robert J. Spinrad

Technophilia.com: *Techno—technology*
philia—the love of
.com—the Internet (and all that it implies)

The Internet has changed the industrialized world in fundamental ways! Its mechanisms, both powerfully revolutionary and subtly insidious, will continue to alter the landscape of communications, commerce and community for years to come. The evolving structures of the less developed nations will, themselves, be altered by the spread of this global blanket of information and empowerment.

The Internet is more than just another expansion in communications capability. It has introduced tools and processes that are qualitatively different from those that have come before. It is:

- Effortlessly global
- Conveniently one-to-one and one-to-many
- Abundant in resources of storage and bandwidth
- Transparent and searchable
- Highly supportive of commerce

The existing Internet structure is already explosively expanding. There are, however, some new developments—in both tools and technologies—that can be expected to further alter and extend the current patterns. There are advances in wireless and satellite communications, in guaran-

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Robert J. Spinrad retired from the Xerox Corporation as vice president, technology strategy. This article draws on material written by the author and provided to the National Academies' Computer Science and Telecommunications Board for use in the "Global Networks and Local Values" project (CSTB-L-97-06-A).

tees of privacy and the imposition of controls, in expanding opportunities for remote collaboration, in the increasing ubiquity of things on the net, in the availability of semi-autonomous knowbots and of compact, versatile files of personal information. I discuss just a few of them here.

Wireless Connections

More than half the people in the world have never made a telephone call.

Large portions of the populated world are still not adequately served by the kinds of wired telecommunications infrastructures that are taken for granted in the developed nations.

In these poor environments (where sometimes even existing wires are stolen for their black-market salvage value), wireless communications systems have gained a substantial presence. Over the last few years, it has become much less capital intensive to install a cellular telephone system to serve a moderately populated area than to build a wholly new wire-based phone system. Cell-phones have enfranchised a newly emerging cohort in the global economy.

The cell-phone is, however, not suitable for sparsely populated areas, for geographically remote sites, for largely inaccessible locations—or, most importantly, for the kind of very high-bandwidth communications that animates our digital age. Satellite systems promise to fill these significant service gaps.

There are, basically, two kinds of communications satellites: GEOs (Geosynchronous Earth Orbit satellites) and LEOs (Low Earth Orbit satellites). GEOs, which hover over the same spot on earth at an altitude of 35,800 km, are used mainly for heavy-duty, high bandwidth, (mostly) one-way transmissions (e.g. television signals and high volume commercial data transfers). LEOs, moving rapidly around the earth at an altitude of about 1,500 km are intended more for two-way, low-latency (short time delay), point-to-point transmissions. It is the LEOs that are expected to fill the need for high-bandwidth, two-way service to remote sites.

Since it is continually moving in a relatively low orbit around the earth, a single LEO satellite cannot satisfy the demand for ubiquitous access. Rather, 100s of LEOs are launched to form a constellation of satellites circling the globe. Linked to one another and to the ground, they create such a continuous communications blanket that almost any spot on the globe (95% of the landmass) is always within sight of one or more of the orbiting satellites.

The LEOs' relatively low orbits both reduce the latency (time delay) of the signals and limit the receiver's power requirements. This enables them to serve as substitutes for traditional wire or fiber-optic systems for fixed sites or as high-bandwidth communications servers for mobile voice/data/fax phones.

We can anticipate the seamless linking of these LEO satellite constellations into the existing, worldwide communications infrastructure. With that done, even the most humble village in central India can have a new window into the global digital world.

The exploding size of this worldwide Internet has astonished its early developers. There are far more computers—and far more things that are not computers—being put on-line than they ever imagined would be the case.

Naming Things

In the earliest days of networking it became clear that computers had to have identifiers—not the simple descriptions that people used, but numbers (like license plates) that could unambiguously identify them to one another. These numbers—called "addresses"—allowed for the precise and orderly transmission of data and references (and, sometimes, control processes) among computers.

When TCP/IP (the Internet's transmission protocol) was first established, its designers had to decide how large the "name-space" would be (i.e. how many different computers could be uniquely identified). They thought boldly, with an eye to the future, and decided to allow the designation of up to four billion separate machines. That seemed, at the time, to be almost ludicrously overspecified. Now, however, with about 350 million personal computers in the world, that name space is being fast used up—and, at the expected rate of expansion, will all too soon exceed its capacity.

This problem is being substantially compounded by an extremely important new phenomenon in networking: the naming of everything. The idea is bold, but simple. Computers are growing smaller and more powerful and are, increasingly, being used in an extraordinary range of everyday devices, to perform an astonishingly diverse set of functions. Computers (or, more accurately, computer chips) are found in automobiles, in telephones, in microwave ovens, in copying machines, in running shoes—and even implanted in the human body. Imaginative product planners envision putting them in refrigerators, in belt buckles, in lawn mowers, in theatre tickets, in medicine bottles—even in cereal boxes.

In every case, the purpose is to have the imbedded chip perform some useful function—often previously unimagined. In many situations the value of these new functions or services is dependent on the actions of other imbedded chips, in other devices—i.e. on an interacting group of such devices. So, the idea is to network them all—often using wireless technologies. (This expansive vision is frequently called ubiquitous computing.)

But, to network virtually everything, as this scenario implies, virtually everything must have an individual name (or, more accurately, a unique address). So the original TCP/IP namespace—already under strain from the explosive growth of networked computers—becomes totally inadequate for the future world of ubiquitous computing.

In an effort not to repeat the previous mistake, the Internet Engineering Task Force (IETF) has recently issued a new Internet Protocol, version IPv6, with an address length of 128 bits (compared to the previous 32 bits). The new address space is now comprised of over 300 undecillion unique identifiers—a three followed by 38 zeros! Theoretically, this can provide over 600 sextillion unique addresses for each square meter of the surface of the Earth. This new standard is now being deployed. Its designers are sure that the Internet will never again run out of addresses.

Another casualty of the digital age is the sense of mastery over ones' professional and personal domain. With the on-line availability of seemingly everything, it becomes apparent that old techniques of search, sort and set-up are not adequate to the task. (In a sense, they never were; it is just that we did not know how much there really was "out there.") Can computers—which caused the problem—help solve the problem?

Digital Agents

The high expectations for Artificial Intelligence (AI) in the early 60s were certainly not met. Developing systems that perform with even a rudimentary level of general intelligence or "common sense" (like R2D2 in *Star Wars*) has proved, so far, to be a nearly intractable task.

Prodigious feats of "cognition" like the performance of IBM's "Deep Blue" in defeating world chess champion Gary Kasparov are accomplished by brute-force computers working in extremely narrow problem domains.

But the failure of these broadly self-sufficient AI systems has masked a smaller, but important accomplishment—the widespread development and deployment of simple, but useful, digital "agents," sometimes called "bots."

The lesson learned was that computer systems worked most "intelligently" when operating in a symbiotic relationship with the human user. The computer could rapidly and effectively perform a set of relatively simple but tedious tasks (searching, sorting, comparing, etc.), but needed to rely on the human to establish the context and evaluate and steer the process. The computer program did the "dogwork;" the human provided the "sense." So, the spelling checker in a word processor rapidly searches and reports on words not listed in its internal dictionary. But the human user decides whether or not that usage is satisfactory.

Similarly, calendar scheduling and coordinating programs can determine available meeting times, but the human is needed to understand that it may not be wise to schedule a minor meeting immediately after, say, an important conference with the Board of Directors.

Every year these agents become more sophisticated and capable. There has been no particular technological breakthrough. Rather, each year tasks become better understood, algorithms are improved and computers become faster. This is a cottage industry, with newly useful agents coming onto the market from small companies, from young people in garages as well as from the major corporations.

For example, recent advances have provided tools for "summarizing" documents. These agents examine the text and look for a statistically higher than normal incidence of words and phrases as a means of identifying possible key words. They look for the descriptive words that follow text like, "So, in summary . . ." They infer meaning from section titles. They use these and other clues to select phrases and sentences from the document that might serve to "summarize" it. The results are sometimes absurd—because there is no real "intelligence" involved. (Like Deep Blue playing chess.) But the output is, in general, good enough to be useful.

And if the "summaries" are useful, their "translation" into another language can also be useful. These machine "translations" are, of course, awkward and often comically incorrect—but still of some help. And every year the algorithms become better.

Another area where agents are already proving useful is in "clustering"—the sorting of large bodies of information into similar or related groupings. They may be text files or number sets or fingerprints. The speed of modern computers enables this kind of processing for data sets far too large for humans to handle. In keeping with the symbiotic man-machine pattern, the system draws the apparent inference and then the human judges the result and steers the next steps.

Just appearing now are mobile agents—software programs that are launched onto the Internet and told to perform a specific (simple) task. For example, instead of downloading (copying) a large database from some other geographical location, an agent may be dispatched to that site (or to many sites) to do a search, or to create a connection, or to abstract some data.

These agents are becoming ever more available. It is likely that, without our noticing it, our working habits will become slowly and continuously transformed by a host of these new tools. Looking back, ten years from now, we will wonder how we got along without them.

Clearly, each of these individual developments—and others that I have not been able to touch on—is empowering. But it is their interaction—and the speed with which they are combined—that make our newly networked world so truly astonishing. It is, indeed, a Technophilic age.