



Founding Father

by Raymond R. Bert, *Massachusetts Alpha '93*

ROBERT E. KAHN, *New York Eta '60*, has only one child and an empty nest. His child is now 30 or so, though its precise age is harder to pin down than a Dominican Little Leaguer's. Robert Kahn's child, you see, is the Internet.

Now president and CEO of the Corporation for National Research Initiatives (CNRI), the not-for-profit firm he founded in 1986, the 63-year-old Kahn is 15 years removed from his days at the U.S. Defense Advanced Research Projects Agency (DARPA), where the Internet was born and steadfastly nurtured for its first 20 years.

In fact, though, Kahn had already begun laying the groundwork for the Internet before coming to DARPA. As a communications specialist at Bolt Beranek and Newman (BBN), a consulting firm in Cambridge, MA, he had become interested in networking computers and helped that firm win the contract to build the ARPANET. "The Internet was an architecture to link together a number of different networks," Kahn says. "It started out as an R&D project to demonstrate the technical capability for *internetworking*, and it eventually turned into something that I think none of us could have imagined when we started."

Though he could easily lay claim to the Internet idea without hesitation, the understated Kahn is loath to claim all the credit, because he knows that there is plenty of credit to go around. As you might expect, official recognition and designation of the Internet's "founding fathers" is somewhat muddled. A rudimentary web search turns up many names. The National Academy of Engineering selected four people on whom to bestow the moniker when they presented the Charles Stark Draper prize in 2001 for technical contributions leading to the Internet. The National Medal of Technology, bestowed by President William J.



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Clinton, honored only two of them. The most commonly cited, though, are Kahn and his one-time colleague Vinton Cerf, with whom Kahn co-authored the TCP/IP protocols that embody the Internet architecture.

There have been people who've had the idea of computer networks going back to the early 1960s. "With something as powerful and successful as the Internet, allowing everyone who has contributed his or her share of the credit is healthy."

You can sense that Kahn has been asked about this subject many times since the Internet boom began in the mid-1990s, that he's looked at the question from all the angles—historical and technological, and that he's comfortable with his own knowledge of the way things happened and the role he played. You note that he is treading carefully—though not *too* carefully—in how he portrays this to others.

The national academies, Kahn says, decided to pick the people who made major contributions that led to the Internet. "I think they did the right thing," he says. "It's like Nixon and Kissinger on opening up China or Watson and Crick on DNA. Teasing that kind of thing apart doesn't always do any good. I was sitting in a position in Washington that had major funding and programmatic responsibility, but I needed help from people in the private sector to do the work."

THE ROAD TO THE INFORMATION SUPERHIGHWAY

The private sector is where Kahn himself first encountered networking—he was not a native of governmental agencies. And, given that the field of computer networking didn't exist in any real sense when he began his career, it seems fair to ask how he ended up at the epicenter of it all.



Kahn attended the City College of New York, where he received the first of what was to be many honors—election to Tau Beta Pi. He graduated in 1960 with a bachelor's degree in electrical engineering. The recipient of a National Science Foundation fellowship, he spent four years at Princeton, earning his M.A. in electrical engineering in 1962 and his Ph.D., also in electrical engineering, in 1964.

Soon after completing his Ph.D., he joined the faculty at MIT. But, at first, he felt a little out of place. "I felt sort of like the coach who's never played the sport he's coaching. The other faculty all had a certain amount of practical experience and savvy in real-world systems," Kahn says. "So I took a leave of absence, figuring that I'd go get myself involved in some practical engineering project, learn how to do something *real*, and then go back to teaching."

Kahn landed at Bolt Beranek and Newman in Cambridge, which at the time was an architectural acoustics firm. "I was the first communications person they'd ever hired," he says. "And I got interested in networking." After a few months, his supervisor mentioned that DARPA was interested in building a national computer network and that Kahn ought to share with them some of the work he'd been doing.

"I had been writing memos on different aspects of networking, such as how to control the flow of traffic through networks, how to do buffer management, and things like that," he says. "DARPA eventually put out a call for proposals to build them a net. I wrote the technical part of the proposal, BBN won the bid, and we ended up getting the contract and building the Arpanet."

During the development and roll-out of the Arpanet, Kahn became so immersed in the project that once it was up and running in 1972, he moved to DARPA himself, eventually becoming director of its information processing technologies office. In that role, he initiated the Strategic Computing Program, a billion-dollar effort that was in its time the largest computer research and development program ever undertaken by the federal government.

Asked if there were a specific moment when he became aware that his career had taken off in a direction he hadn't foreseen, Kahn characteristically shuns a simple yes or no answer. "I like to do whitewater canoeing," he says. "You jump into a raging rapid, and you don't get out until it calms down. My career has been sort of like a 30-year series of successive rapids—there was a recognition that we were on top of something pretty serious."

HUMBLE ORIGINS

The original intent for the internetworking project was not to provide a way to link computers in every home and business around the world. Indeed, the concept of a "personal computer" was still almost a decade away. In the early 1970s, internetworking was just a research project,

an attempt to show that you could communicate among different computers on multiple networks seamlessly. "At the time, none of us thought that this was likely to be of practical use outside the defense or research community," Kahn says. "We thought there might be perhaps a few hundred organizations that could make use of this capability, that there might be half a dozen to a dozen large-scale networks to interconnect someday."

With that in mind, Kahn and his colleague Vint Cerf developed an addressing system—involving what are known as IP addresses—to identify each computer connected to the combined "network of networks" that is now the Internet. They allotted 8 bits of the address to identify the network, giving them the ability to specify 256 different networks. "Since we were only expecting at most perhaps a dozen large-scale networks, that was overkill," Kahn says. But when the Ethernet was invented in the mid-1970s, suddenly there was a demand to identify local

area networks (LANs) as well. The Internet proceeded to spread into the research and education areas, and it wasn't long before the original 8-bit network field, nets, "became one of those predictions like Bill Gates' 64K of memory ought to be enough for anyone," Kahn says with a smile.

"The most surprising thing [*that happened during the Internet explosion*] was when *InfoWorld* magazine [*staff*] notified us that they were making us custodians of their product-of-the-year award," Kahn says. "They gave the award to the Internet, when we thought we had done the work 20 years before. But that was the first time it was visible to them."

And similarly, "I remember the first time I saw NBC news saying 'email us your comments (at *nightly@nbc.com*, if I recall correctly).' And I thought, 'There it is!—the Internet/Arpanet stuff on the TV screen. It made the big time.'"

And just as the touchstones for the Internet's having "arrived" were different for Kahn than for the general public, so too were the keystone events. Although the Internet began as a research project, by the late 1990s it was largely commercial. So, what was the first commercial application on the Net? No, it's got nothing to do with AOL or *Amazon.com*; it was hooking up the MCI-mail system to the Internet in 1989, a job carried out by his firm CNRI. Vint Cerf had previously designed the MCI-mail system while an employee in the mid 1980s, and it was perhaps inevitable that CNRI would undertake this groundbreaking effort after Kahn convinced Cerf to join him at CNRI in 1986. It was also during that timeframe that Kahn saw the dominoes lining up that could make the Internet the economic and cultural force it is today: the National Science Foundation creating a higher speed backbone, known as NSFNET, that eventually superseded the ARPANET and enabled the entire research and educational community to get connected; multiple administrations and the Congress providing continuing federal support for network connectivity; a Virginia congressman in the early

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1990s pushing a bill through the House that allowed NSF to open up its NSFNET to commercial use; and the World Wide Web and *point-and-click* browsers coming along in the mid-1990s.

Kahn seems genuinely bemused at the way his research project from 30 years before has played out and infiltrated people's lives. "I still think that electronic mail is and was the killer application for most people," he says. "But that wasn't our goal in doing it. Our goal was for computers to talk to computers, not for people to talk to people. And now most people use the Net for email and to surf the Web." He shrugs, as if to say, "Who would have guessed those applications would dominate today?"

And just as his excitement about the boom is somewhat muted, so too is his regret about the bust that followed. The crash "got a lot of people out of buying lottery tickets," he says matter-of-factly. "That's what was happening with the valuation run-ups that had no correlation to the basic, underlying business models of the companies. They were selling eyeballs; kids were running businesses out of their bedrooms—there was a sort of hysteria out there. With every new dot.com, people would invest because they never knew which would be next to take off."

NEXT UP FOR THE NET

And what of the Internet in the long term? What's on the horizon?

Kahn has plenty of thoughts on where things may be heading. "Once you get enough bandwidth—mostly an economic issue—then you can send high-quality video around, and people's perceptions of the Internet will change again," he says. "It's something of a double-edged sword; more information means you're not as limited in what you can hear about from other places. But the fact of the matter is that you can have a glut of information, [and] one thing that is unchangeable is the 24 hours in each day."

There are other developments that Kahn sees having major impacts, as well. "Language translation software can make the world look a lot smaller—the way the jet plane did," he says. "But beyond that, who can tell? You can imagine everything being hooked up to the Net, telling your robotic assistant to start up whatever ... but that's mostly dependent on economics and what people want, rather than just what is possible."

One of the areas that Kahn sees growing in importance is something that he's been hard at work on for more than a decade. "I think we're going to see a lot more information management *on* the Net," he says. "I think that's one of the sleeper areas. People today don't really think of using the Net as a way to manage their own information but as a way to access somebody else's. People will need to think very carefully about backing up their information and providing adequate levels of security and availability. Having it on the Net in places, accessible from multiple places with security, is becoming a key objective for many organizations."

Kahn sees corporations thinking about making their active information as well as their archives available in this way—though obviously with tightly controlled access. Network-based information management will become increasingly important over time. And that's where Kahn's latest work on digital object architecture enters.

"With the Internet we didn't say how you should design your networks, where they should be built, who should run them, or what applications should run on them," he says. "We were purposely silent about a lot of the things that were super-important about what you would do with the architecture that we created." Digital object architecture has many of the same attributes. Kahn and CNRI aren't trying to tell people how they should manage their information—they're simply saying that you'd better do so in a methodical, logical way. "My work is focused on the re-conceptualization of the Internet to deal with information as a fundamental commodity," Kahn says. "This is im-

portant because almost everything in the real world has some notion of ownership, but the Internet was never created with that in mind. We have packets moving across the network, but there's fundamentally no way to tell what's what and who's who."

Kahn asserts that anyone who gets something today via the Internet—whether that "object" is a piece of music, a database, or simply some text—generally speaking, has no clear idea what can or cannot be done with that material. And as always, he's not interested in telling people how to do things, but in giving them the structure whereby they can do things the way they choose. "I'm not one that's gotten deep into the issue of enforcement," he says. "My view is more reminiscent of speed limits on a highway. As a creator of intellectual property, I would want people to know what my requirements and/or expectations are—what's allowed and not allowed. Would you want to drive on a highway system where if you went 56 miles an hour, one mile over

the posted speed limit, a giant magnet came out of the sky, grabbed your car, and smelted it? I don't think so."

Among other things, Kahn feels that the intellectual-property community ought to be concerned with protecting copyrighted work or important information from being changed or used without appropriate attributions to the source. Commercial interests will obviously be interested in protecting revenue streams. "But that doesn't necessarily translate one-to-one into locking everything down," he says. As an example, he cites the early experience of the software industry, which took a while to realize that the real business was in upgrades and that people sharing their software was simply good advertising for their product. We may need to develop new business models here.

"It's all about defining expectations," he says. "If you drive on this road, you're expected to drive at least 40 but no more than 55. If you step into a boxing ring, beat the other guy up, but don't kill him. But if you download a file, can you share it or not? Today, nobody knows."

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HONOR ROLL

Here's one thing we *do* know: Robert Kahn is one of the most highly decorated Internet soldiers anywhere. The list of his awards and honorary degrees is so long that—with no explanations, only the name of each honor—it takes up a quarter of his official bio page.

Outside a conference room at his firm, Kahn passes a row of shelves brimming with plaques, trophies, and other spoils. And here again, he displays the same mix of pride and detachment as when he spoke of his status in Internet history: the public nature of the display shows that the awards are meaningful to him, yet he clearly doesn't obsess over them—he has to lift each one and read it to remember who it's from and what it's for.

He will, however, single out a number of awards as *major* acknowledgments of his work: the Marconi International Fellowship Foundation “for the ARPANET and its successor, the Internet”; the National Medal of Technology, the nation's highest honor for technical innovation, which he shared with friend Vint Cerf of MCI for their work in developing Internet protocols; the Alexander Graham Bell medal from the IEEE; and the Charles Stark Draper prize from the National Academy of Engineering for technical contributions leading to the Internet.

And it isn't just award committees, but also colleagues who sing his praises. Dr. Robert W. Lucky, *Indiana Alpha '57*, corporate vice president of applied research at Telcordia Technologies, who has known Kahn for more than four decades—they first met when Kahn was a student working summers at Bell Labs—says that Kahn's work “shows a lot of beauty and brilliance. He's a modest, thoughtful, principled person. Someone that you're proud to know.”

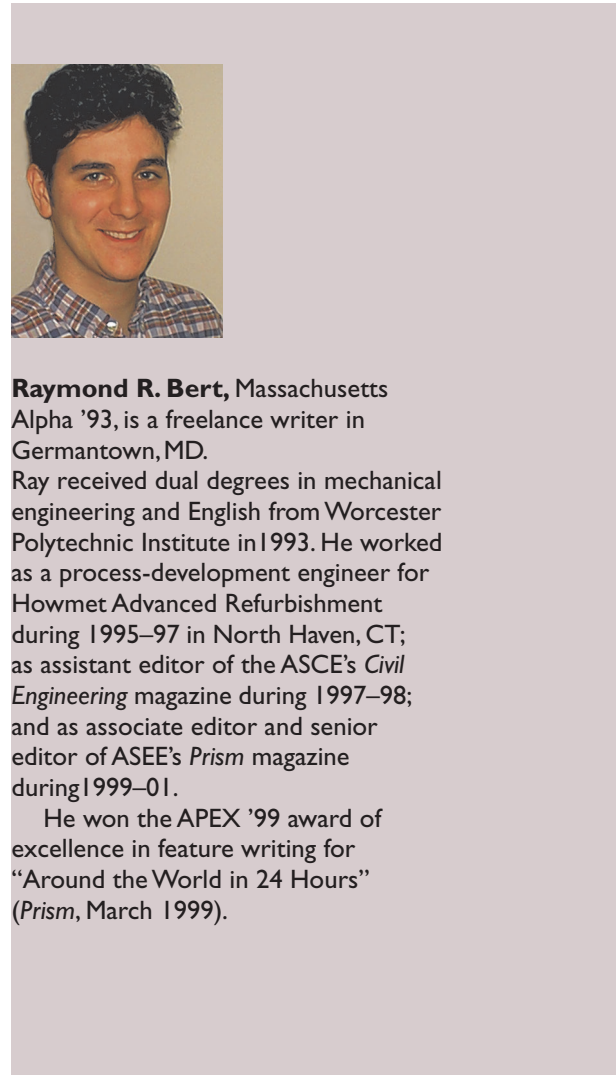
When Kahn left DARPA after serving 13 years at the agency, he told Lucky that he wanted to start a “private DARPA,” which became CNRI. Lucky's first thought was, “What a daring thing to do! But Bob is always looking for ways to champion a national cause.”

Kahn himself says, more simply, that he serves in various capacities—such as with the National Academy of Engineering or the U.S. Government—“to try to be helpful.” CNRI itself, as a not-for-profit corporation, is dedicated to research and funding that will help foster the development of information infrastructure. Recently, Kahn has been serving on the President's Information Technology Advisory Committee, created several years ago. In the last year, Kahn has become co-chair of a new panel on national security within that committee, which has taken on added significance since September 11.

GOING DOWN IN HISTORY

Kahn's life isn't all work, though. He played varsity golf in college and still plays when he can, though “not nearly enough to be any good anymore,” he says. And add skiing trips with his wife to his list of favorite pastimes, “although if one of us breaks a limb, we take a hiatus for a while,” he says with a chuckle. Kahn also did a lot of figure skating and squash playing, both during his college years and after.

Kahn married late in life, in his 40s, while his wife—an intellectual property lawyer—was in her late 30s. Kahn seems utterly content with his life and with his continuing involvement with the Internet and its evolution. Asked if



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He won the APEX '99 award of excellence in feature writing for “Around the World in 24 Hours” (*Prism*, March 1999).

the time were right to pen a book on the genesis of the Internet, Kahn says, “I might in time, but it's still playing out. The last 10 years puts a totally different spin on it. It would be like writing the story of radio in 1917, when everyone had crystal sets and there were only a handful of transmitters in the country. The story hasn't played itself out yet.”

“If you look at the history of the United States from the perspective of 200 years or so, there were a bunch of guys—Jefferson, Washington, Adams, Franklin, Madison—who were all part of that incubation period when the country was formed. The Internet has some of the same dimensions. We did the early technical work on linking networks in the 1970s, following the ARPANET effort that began in the 1960s. The world first discovered the Internet big time in the 1990s. So viewed from a greater distance, networking *happened* in a big way between the mid-1960s and the mid-1980s, and there were a lot of people who were a part of that.”

Many people may have had a hand in creating the Internet, but you can be sure that when the history books are finally written, Kahn will be remembered as one of the most important founding fathers of cyberspace.