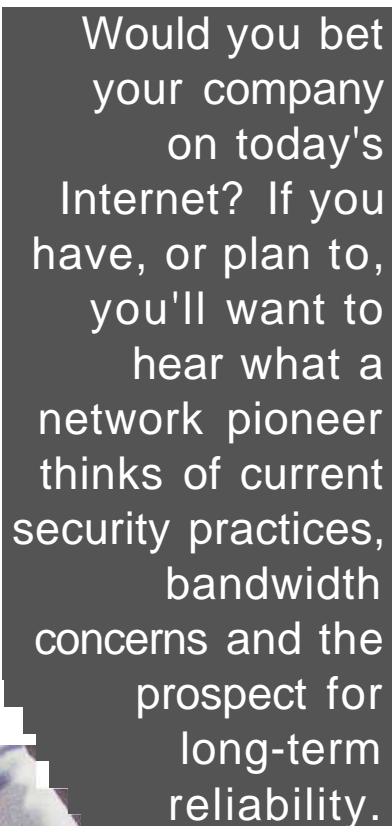


PHOTOGRAPHS BY **SETH RESNICK**



Would you bet your company on today's Internet? If you have, or plan to, you'll want to hear what a network pioneer thinks of current security practices, bandwidth concerns and the prospect for long-term reliability.

by **Simson L. Garfinkel**

B Bob Metcalfe has been attracting a lot of attention in the popular press lately. That's because Metcalfe, who is the inventor of Ethernet, the founder of 3Com Corp., a columnist for *InfoWorld* and a general "elder statesman" of the Internet, has made something of a cottage industry out of forecasting what he says is the Internet's impending crash. So I went to Metcalfe's townhouse in Boston's Back Bay to ask him what's really wrong with the Internet. Where is it going? And why are we headed for disaster?

"You wrote an article about spamming—about on-line junk mail," Metcalfe says, referring to an article I had written a few months back about Spam King Jeff Slaton. "He [Jeff] said it's just as easy to send out 1 or 8 million pieces of email, because of the unusual economics of the Internet. Implicit in that statement, by my reading, is that someone believes [that there is something fundamentally different about the economics of the Internet]. I call these people the Bioanarchic Intelligentsia. They believe that these strange economics of the Internet are immutable, and it's up to the world to get it."

"Get it!" he says. "My position is that the current economics of the Internet are broken and they need to be fixed, as opposed to everyone else 'getting it.' Now here's that very problem-junk

mail. The answer is fix the economics so it is not as economic to send to 8 million as it is to send to 1 million. Thank god we have postage on the U.S. postal service. If we didn't, the junk mail would be higher than here!" he says, pointing to his belt. "So what's wrong with the Internet today?" I ask him. Surely, junk mail couldn't be the only problem.

"It was built by people who did not intend that it be used the way it is being used. Therefore, we should not be surprised that it is not up to the new purposes that we have for it," he says, pressing his lips together and looking thoughtful. "It was never built to be as large as it is. It was never built to be managed properly because the people who built it weren't interested in management, because management is boring."

The people who built the Internet, Metcalfe says, got to pick their own research projects. They were, after all, researchers. So they didn't build a network that could be managed. They didn't build management tools. They didn't build in a pricing mechanism to recover costs, because all of their costs were paid for out of contracts that were ultimately paid by the federal government. And finally, they didn't build in security.

"If you read *Wired* magazine, you get the impression that the reason we don't have security is the NSA and the laws against it. Security has long been a known problem on the Internet. I wrote an RFC in 1973—RFC602—complaining about security problems. The reason we don't have a secure Internet is not Big Brother or the NSA. It's that security wasn't interesting to the people who built the Internet, which is ironic because it was funded by the Department of Defense. But it was done by university and research people, to whom security wasn't that interesting.

"The other sad news is that customers for computer products have not been interested in buying security products," he says, shaking his head. "It's gotten to the point that the NSA is an obstacle to security, but that's not the real reason why the Internet needs to be fixed."

I look around at the couch, the fireplace and the pure white walls. "So you think that the most important thing is adding price?"

"I think so," Metcalfe says. "You need all of them [price, security and management], of course. But the reason that we have the Internet bogging down—and I get almost universal agreement that it is bogging down, people having a harder and harder time, people believing that it is going to collapse—is that there is no pricing mechanism to put a damper on demand.

"You have got demand going up because of the great

success that we have built," says Metcalfe. "But you have performance going down. Just like old time-sharing systems that we had to replace with PCs. They were forever bogging down because the economics didn't work out."

So I ask Metcalfe about some Internet providers, like BBN, that have introduced high-speed connections that are metered. If you send a lot of data, you pay more. If you don't send a lot, you pay less. Metered pricing allowed BBN to introduce the industry's first T1 for less than a thousand dollars back in 1995. UUNET Technologies followed a few months later, I was told.

"That's good," says Metcalfe. "But that's a recent development. We are beginning to break through the capacity billing—the naive, simplistic way of doing it in the past, that the Internet culture thought was correct. It was not correct because it didn't closely enough mirror the underlying prices of transporting data. The price has got to be a reflection of value and/or cost. Capacity billing was not accurately enough related to the underlying costs or values."

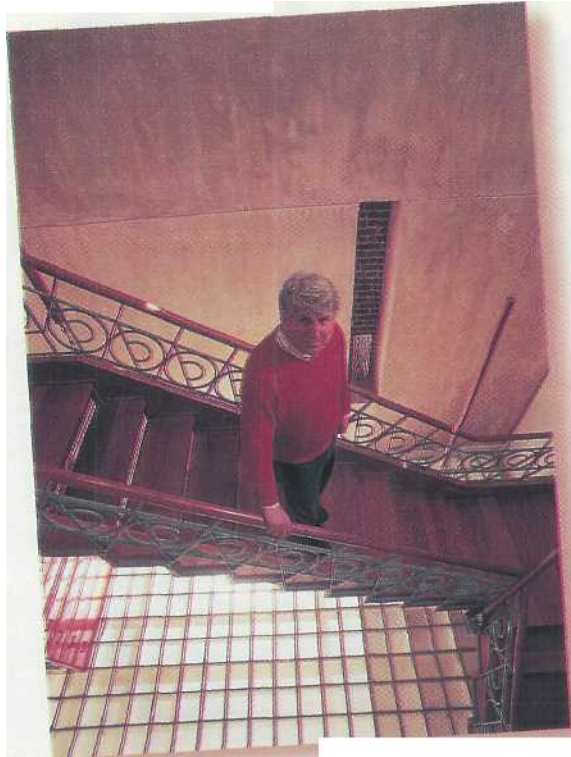
Capacity billing, of course, is what most Internet providers sell. For example, a dial-up connection costs \$20 per month, no matter whether you are on-line an hour a week or 160 hours a week. A 56-Kb/s Frame Relay connection might cost \$125 per month, and a T1 cost \$1,300

per month. From the provider's point of view, this pricing is crazy, according to Metcalfe. As soon as you sell somebody an Internet circuit, "then it is in your interest that they not use it, which is backwards. If you are a network supplier, you should benefit from it. Not say, 'Gee, I hope they don't use it too much.'"

The Role of the Telcos

Metcalfe and I talk for a few minutes about the phone company's hand in Internet growth, and I learn something very important about him: He's a rabid deregulationist and in favor of the U.S. Government stepping in and breaking up monopolies. "Another big problem we have are the telco monopolies, which must be broken, because they are currently the major factor holding back the Information Age."

Metcalfe says he asked the readers of *InfoWorld* what they needed: computers that are twice as fast, or twice as much bandwidth. Everybody voted for bandwidth. But how to get it? Many people thought the Telecommunications Deregulation Act of 1996 would help solve the problem by forcing telephone companies to compete with cable companies in offering new services to consumers. But it didn't. "It's made it worse. Now the telcos, instead of trying to compete



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with each other, are trying to buy each other up. So I am looking forward to the Demonopolization Act of 1997. Deregulation was the wrong short-term goal. You want to get deregulation, before you get there, you have to go through demonopolization."

Trying to run the topic back to the Internet collapse, I ask Metcalfe what his concerns are on the sustainability of long-term Internet growth.

"My simplistic model is that we are going to go through these collapses and discredit the Bioanarchic Intelligentsia currently running the Internet, and having discredited them we will dump them and move on. And it's already happening to a degree. And we will end up with the next-generation, industrial-strength Internet. And then the sky's the limit. It is really the Information Age in front of us. Although I've been portrayed as Chicken Little, I'm really a big fan."

I asked Metcalfe if IP Version 6, the latest version of the Internet Protocol, would make a difference. "IPv6 is an inadequate response to the needs of the growth of the Internet," he tells me quite firmly. "It solves some problems, like the addressing problem, but it doesn't solve the security problem and it doesn't solve the money problem and it doesn't solve the management problem."

"I thought that IPv6 contained IPsec," I say. IPsec provides end-to-end encryption over the Internet, but only for applications that choose to use it. "It's not enough. Doing

Version 6 won't solve the problem. And it will take a very long time to do v6. But it's not enough. It doesn't give you the management," he says.

So What's a Collapse?

"OK," I say, looking back to my list of questions. "Are you worried about congestion? Is it a temporary thing, or do you see long-term problems?"

"Ah, the coming collapses," he says. "My readers, by the way, don't distinguish between the brownouts that most people are experiencing and collapse." Either means loss of service.

So what's a collapse? I ask. "Collapse means not just that everything bogs down, but that large numbers of people are denied Internet access for long periods of time. The FCC requires telcos to report when 50,000 or more people are denied telephone service for an hour or more. When I first started talking collapse, what I had in mind was the blackout of '65. The power blackout. Something bigger than 50K for hours is what we are headed toward. Repeatedly. There will be a collapse. Operations will resume. There will be another collapse. Operations will resume. And while these collapses are occurring, there will be people scurrying around [trying to fix the problems]."

The main cause of these collapses, Metcalfe tells me, will be the lack of capacity. And the strain on the resources will show up in different ways at different times. One day it may

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just be a massive circuit overload, causing gridlock. But on another day, it may be that a router fails—"a backhoe tears up key fibers that had all foolishly been put in the same conduit"—and the remaining system can't handle the resulting load. Or else there will be bugs in the software that runs the Internet—bugs that will be tickled by increasingly higher traffic.

Bugs are one of the most vexing problems that Metcalfe mentioned. That's because increasingly there is but a single software vendor that's making the programs that run the Internet's backbones. That company is Cisco Systems. The great long-distance collapse of 1991 happened because of a

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three-line bug in the Signaling System 7 software that was installed on AT&T's latest-and-greatest electronic switches.

These scenarios aren't so unrealistic, in retrospect. Last summer, Netcom On-Line Communication Services Inc. and America Online Inc. both had major outages lasting more than 12 hours and affecting hundreds of thousands of users. In both cases, they were caused by router configuration errors.

"The fourth possibility is sabotage," he says. "The crackers turn their attention to the routers and start bringing them down. They write some sort of worm virus that goes out there [and shuts down the backbones]."

Packet Counting

The interesting thing about talking to Metcalfe is that he can't stay fixed on technical issues: He wants to talk about the user experience, or about business. Perhaps that is why 3Com was so successful while he was there. So before I know it, we are talking about price again. And specifically, Metcalfe wants to find a way to make users pay for what they use.

"It really does cost more in resources to move information from Cambridge to Paris than from Cambridge to Martha's Vineyard," he says. I have a house on Martha's Vineyard, and my Internet packets come from a firm in Cambridge, so Metcalfe's example was clearly tailored for my personal network topology. Your mileage may vary. And Metcalfe would want you to be charged for it as well. He wants the entire Net wired to record how many "giga-packet-meters" each person expends.

What's a giga-packet-meter? It's the equivalent of sending a billion packets one meter, or sending one packet a billion meters—roughly to the moon, back to the earth, and then back to the moon again. In real terms, it's equal to sending a 256-KB JPEG file from San Francisco to Boston.

But even if it costs more to move packets a long distance than a short one, how do you recover those costs? There is a technique called "settlements" that is used in the telephone world. Phone carriers keep track of who sends how many calls to whom, and at the end of the year everybody gets together and figures out who owes how much and to whom. One of the big fears about adding a settlements mechanism to the Internet is that it might double the cost—that is, for every packet that's sent, you might need to have a billing packet sent as well.

"Even accepting that as true, it would be fine with me," says Metcalfe. Then again, it's not his money that he's talking about—it's everybody's. On the other hand, it's possible that better solutions could be found. "People say that the telephone company behaves this way," he says. But Metcalfe went and spoke with some telco executives. "They say it's not true. They say that billing doesn't cost them half of what it costs to send the data."

So perhaps we would program routers to send one billing packet for every 50 data packets. That would probably work, as long as you didn't have to send billing packets for the billing packets.

"There are two kinds of people," he continues. "The kind of people who,

when they get off their flight and go to get a rental car and look at the long row of rental car agencies and outside see all of the buses running around. The one kind of person looks at that and says: 'What a waste of resources! We should have one rental car company, and then there would be one desk and one bus. Look at the economics!'

"Those people," says Metcalfe disdainfully, "are Socialists.

"Then there are people who look [around] like me and say: 'What great service I'm getting from the rental car companies! They are busy slitting each other's throats. I end up way ahead because of the economic pressures.'"

In other words, according to Metcalfe, even if it did cost twice as much to charge people for each packet—which he doubts—he would still rather live in a world in which people were charged by the packet. Because there would soon arise a competitive market, and companies would be so busy slitting each other's throats that sending packets would become cheaper and cheaper.

Metcalfe wants the Internet to be a place where every URL has two parts: an address and a price. That price would automatically be deducted from your electronic wallet. But unlike other people who have made a similar suggestion, the money wouldn't compensate authors. It would go to pay for the network. Right now, he says, "when you click on a URL, it's not clear what's going to come into your machine. It could be another location on the same page, or it could be a 10-MB file from Singapore that you are about to download.

"We need something like that to work for mail to solve the Jeff Slaton problem," he says, referring to the Spam King whose name he mentioned when I walked into his house. "One of the ways [to eliminate junk email] is to make it cost something to send mail to people." ■