

A UCLA Professor and Net Pioneer Paves the Way for the Next Big Thing

Leonard Kleinrock is getting ready for the era of ubiquitous computing

BY FLORENCE OLSEN

OH, YOU WANT to get to D? Well, next you go to C—hop, hop, hop." The man making the sound effects is Leonard Kleinrock, whose pen is busy rapidly drawing loops and lines on a scrap of paper. He is explaining how packets of data are routed inside a computer network.

Well into the second of his two careers devoted to Internet research, Mr. Kleinrock, who is 65, can't stop teaching—or inventing. Although he is "semiretired" after 36 years as a computer-science professor at the University of California at Los Angeles, he is still advising graduate students and working on new algorithms for network communications.

In the 1960's, Mr. Kleinrock was the first to describe the queuing principles still used today in designing every type of computer network, from a campus Ethernet to the global Internet. He is also one of the few engineers from the Internet's early days who opted for a university career.

At U.C.L.A., where he is credited with producing dozens of sought-after Ph.D. graduates, Mr. Kleinrock's dedication to teaching is legendary.

"I never planned to teach, but I just loved it," he says.

"I'll tell you all the things I love about being a professor," he says without a pause. "You're working with young people—keeps you fresh, you have to stay sharp. You have no boss. You do research in any field you like. You travel a lot. The best minds in the world come to the university to lecture or visit. It's a prestigious job. The salary is not bad. If you work harder, you can get more. But it's the independence that I really liked."

A BUSY RETIREMENT

Mr. Kleinrock is busier in semiretirement than most people are when working full time. On days when he is not at U.C.L.A., he is behind a desk in his sunny office here, having given up the title "department chairman" to become a corporate chairman instead.

Joel Short, one of his recent Ph.D. graduates, is down the hall. Teacher and former student have formed a company, Nomadix, to invent and manufacture communications devices for the next wave of Internet use.

Mr. Kleinrock and Mr. Short are paving the way for what they say will be the Internet's next big thing, what Mr. Kleinrock



Leonard Kleinrock, with a U.C.L.A. graduate student: "I've always enjoyed thinking about large systems with thousands or millions of participants."

and many others call nomadic computing—and the next big thing after that, which is ubiquitous computing.

"Let me give you the vision thing first," Mr. Kleinrock says. The vision thing is his "farthest-out idea of where the Internet is going."

The Internet will be available everywhere—and always "on," he says. Sensors will be embedded throughout the physical world and connected wirelessly to the Internet, or whatever its successor is called in the future.

"Walls and desks will be full of actuated sensors, logic, memory, processing, cameras, speakers, microphones, displays, and communications," he says. "So when you walk into a room, the room will know you just walked into it, and you can talk to the room and say, 'I'd like some information about *The Chronicle of Higher Education*.'"

Between where computing is now and that ubiquity, he says, will be nomadic computing: Wherever people go, they will be able to gain access to information over the Internet using a variety of handheld devices.

Mr. Kleinrock's company is designing new algorithms, or instructions, which will go into network hardware that lets people

stay connected to the Internet, no matter where they are.

'A GOLD RUSH'

For anyone interested in the Internet, these are exciting times, Mr. Kleinrock says. If fewer computer-science and business undergraduates are choosing to go on to graduate school, who can blame them? "It's a gold rush," he says. Some students simply feel "the opportunity cost is too high to spend another year or two in graduate school—in Internet time, that's an eon."

The lure is more than just money, he says. "They're looking for positions in start-ups. They're willing to take a chance."

In his own career, he has never shied away from taking chances. Mr. Kleinrock graduated from the Bronx High School of Science in 1951, and earned his bachelor's degree in electrical engineering by taking evening classes at the City College of New York. After graduating at the top of his class, he earned a scholarship to attend the Massachusetts Institute of Technology, where he received a master's and a Ph.D. in electrical engineering.

Today, he enjoys an unofficial role as historian for the small group of engineering scientists who, 30 years ago, were his colleagues in building a network that was the Internet's precursor.

Mr. Kleinrock was in graduate school at M.I.T. when he got to know Claude E. Shannon, the mathematician who discov-

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Mr. Kleinrock used queuing theory to understand the optimal ways of sending and receiving messages in computer networks, which were then only theoretical.