



Paul Baran

PAUL BARAN

1926–2011

Elected in 1996

*“For the concept of packet-switching and for its
technical development and utilization.”*

BY VINTON G. CERF

PAUL BARAN was born in Grodno, Poland (which is now in Belarus), on April 29, 1926. He was the youngest of three children. His family moved to the United States on May 11, 1928, settling in Boston. Later, in Philadelphia, his father, Morris Baran (1884–1979), opened a grocery store. Paul graduated from the Institute of Technology (now Drexel University) in 1949 with a degree in electrical engineering. He received an M.S. in engineering from the University of California in 1959 and honorary doctorates from Drexel University in 1997 and the Pardee RAND Graduate School in 2000. He passed away on March 26, 2011.

Baran joined the Eckert-Mauchly Computer Company upon graduation from Drexel. There he did technical work on UNIVAC models, the first brand of commercial computers in the United States. He moved on to Raymond Rosen Engineering Products in 1950. There he designed circuits to correct tape speed errors for FM telemetry recording. In 1955 he moved to Los Angeles to work for the Hughes Aircraft Company on radar systems.

Baran joined the RAND Corporation in 1960, two years after the invention of the integrated circuit. There he blazed a new trail in digital communication systems, with a broad exploration of the problem of maintaining command-and-control capability in the event of a nuclear attack. Baran explored the possibility of digital communication in hostile

environments by using “addressed message blocks” and a “hot potato” routing method. He envisioned the use of omni-directional antennas, such as those provided by existing AM radio stations, to construct a highly resilient, distributed communications network. His seminal work, first published in a series of RAND studies from 1960 to 1962, was documented in a multivolume study entitled “On Distributed Communications,” published in 1964.^{1,2} Baran’s ideas were considered radical at the time and were met with resistance from proponents of conventional circuit switching, which was used in the telephone network.

The basic idea of such communications networks was also explored in independent research on queuing systems by Leonard Kleinrock, whose doctoral dissertation considered the mathematical properties of such systems.^{3,4} At the National Physical Laboratory (NPL) in Teddington, England, Donald W. Davies pursued similar ideas in the mid-1960s, ultimately christening the switching method “packet switching” and building a one-node local network at NPL to prove the idea.⁵ Subsequently, packet switching was the switching technique used in the development of ARPANET and many other computer communications networks, such as Ethernet. Today, the Internet enables the interconnection of such networks with myriad computer systems and services in use worldwide.

It is illustrative of Baran’s wide-ranging interests that he created many other innovations, such as a “doorway gun detector,” and that he developed an early working model to discriminate between guns and other metal objects that might be carried on one’s person.

In 1968, Baran left RAND to help found, with RAND colleagues, the Institute for the Future. The focus of this nonprofit institute, which began with a grant from the Ford Foundation, was to facilitate the transition of various research results into public and business sectors. That Baran resonated strongly with this idea is evident from the 10 companies that he founded or cofounded over the years. In surveying his remarkable ability to sense when technology might support new ways to design products and services, one is struck by his “readiness radar.” He seemed to have a keen awareness of the ripeness of technology to be exploited.

In 1972, Baran founded CableData to explore the idea of moving data on conventional cable television networks. CableData spawned multiple companies, including Comprint (computer printers); Equatorial Communications Company (using Baran's small dish satellite transceiver and one of the first nonmilitary spread spectrum applications); Telebit (manufacturer of high-speed modems for impaired dial-up telephone lines); Packet Technologies (interactive cable TV and fast packet switching for voice and data on T1 lines); and Com21, an early producer of cable modems. In 1986, Baran cofounded Metricom, Inc. (electric/utility industry remote metering and distribution automation), which led to the Ricochet wireless data communications system. In 1989 he founded InterFax, Inc. (interactive facsimile). Eventually, Packet Technologies was acquired by StrataCom, and its ideas were used in the design of asynchronous transfer mode (ATM) systems.

In a classic Baran sequence, when he founded Packet Technologies to explore the possibility of achieving interactive television, a new and radical idea of his led him to found Telebit Corporation (across the street!). The Telebit TrailBlazer modem took advantage of the decreasing cost and increasing speed of digital processing, extracting data rates on the order of 18 kilobits per second when contemporary modems were delivering 2400 bits per second. The design was particularly audacious: it divided the 3000-Hz telephone bandwidth into 512 six-baud channels and modulated each at 0, 2, 4, or 6 bits per Hertz, depending on their measured signal-to-noise ratio. The TrailBlazer was succeeded by a number of ambitious Telebit devices with greater speed and functionality using the OFDM (orthogonal frequency-division multiplexing) methods pioneered at Telebit.

Following the founding of Com21, Baran founded and was chairman of GoBackTV, which specializes in personal TV and cable IPTV infrastructure equipment for television operators. Most recently, he founded Plaster Networks, which provides an advanced solution for connecting networked devices in a home or small office through existing wiring.

Baran never sought the limelight, but his remarkable contributions were recognized in many ways. He received the

Silver Medal for Product Excellence (for the Telebit TrailBlazer Modem) from *PC WORLD* (1986); the Edwin H. Armstrong Award from the Institute of Electrical and Electronics Engineers (IEEE) Communications Society (1987); the UCLA Advanced Computing Technologies Act One Pioneer Award (1989); the Alexander Graham Bell Medal of the IEEE (1990); the Electronic Freedom Foundation Award (1993); the Nippon Electronics Corporation's Computers & Communications Award (1996); the Franklin Institute Bower Award for Science (2001); and the National Medal of Technology and Innovation (2007) and was named UCLA Engineering Alumnus of the Year in 2009. Baran was also a fellow of the Marconi Society (1991), the IEEE (1993), the American Association for the Advancement of Science (1994), the American Academy of Arts and Sciences (2003), and the Computer History Museum (2005). Baran was inducted into the National Academy of Engineering in 1996. In 2007 he was inducted into the National Inventors Hall of Fame.

Baran obtained his master's degree in engineering in 1959 (with Professor Gerald Estrin as his adviser) after taking night classes. His thesis was on character recognition. Estrin said that Baran was the only student of his who actually went to the Patent and Trademark Office in Washington, D.C., to see whether his master's thesis was patentable! "From that day on, my expectations of him changed," Dr. Estrin said. "He wasn't just a serious student, but a young man who was looking to have an effect on the world."

In a remembrance of Bill Houser, Paul Baran related these stories:

Many, many years later, Bill and I started a new company in the cable TV space called Com21, Communications for the 21st Century. At this time in the mid-1990s Bill and I were quite old but still active. Bill was living in Alexandria [Virginia] at the time. I was living in Silicon Valley and we would meet at different places in the country depending on who we were visiting. Both of us were frugal with company money so we traveled by Delta Airline senior citizen tickets. These tickets were \$99, allowing senior citizens to fly anywhere in the US for \$99. The kicker was that standby was risky

to travel because you never knew if there would be a seat for you or not. Your cheap choice was to either make a reservation weeks in advance or gamble on standby.

Bill's only known character defect was that he liked desserts and could eat them without ever gaining weight. Once on the airplane and seated, Bill would suggest to the stewardess that if she had trouble with too many unserved chocolate desserts in First Class, he was willing to do his part to help. It always worked for Bill. By the end of the meal a stewardess invariably appeared with an extra dessert for Bill. I couldn't take the calories so always I took a pass, but Bill invariably would suggest two spoons so that I could take a taste. I always said "no" but would usually weaken for a few calories.

I learned a lot from Bill. I remember a late connecting flight from San Francisco by way of Denver. The last plane was leaving and there was a screaming crowd of passengers wanting to go on the flight rather than have to spend the night at the airport. Rather than wading into the angry crowd, Bill smiled and motioned to me to come with him as he took off down the empty airport corridors until he found a single agent at an empty counter closing up for the evening. Bill then turned on the Houser charm that came on so naturally, asking if there were any closed flights that hadn't yet left. "Yes, but you can't make it." Bill responded, "Well, I sure would love to give it a try posed as a bet."

I never ran so hard in my life following old Bill with suitcase in hand until we reached the closed gate. As this was in the days before "security," Bill got to the closed airplane door and pounded. It opened and we were let in and the plane immediately took off. As we caught our breath, Bill smiled at the stewardess with his offer to take the extra unserved chocolate dessert in First Class off her hands. Damn, it worked every time. Bill sure taught me a lot about people.

Baran himself recalled:

Jerry Estrin convinced me that since I had so many courses out of the way, why not go on for a Ph.D.? RAND allowed me to take time off during the day, but

business travel was increasing at the time, causing me to have to miss more and more lectures. But the final decision was made one day when I drove in to UCLA from RAND and couldn't find a single parking spot in all of UCLA and the entire adjacent town of Westwood. At that instant I concluded that it was God's will that I should discontinue school. Why else would He have found it necessary to fill up all the parking lots at that exact instant?

Baran also said:

My experience with innovations is that everything has a predecessor event or events. Generally when the next generation of ideas and effort comes along, what has gone before becomes irrelevant. Then the following generation comes along and there is the same shift of focus. The process of technological developments is like building a cathedral. Over the course of several hundred years, new people come along and each lays down a block on top of the old foundations, each saying, "I built a cathedral." Next month another block is placed atop the previous one. Then comes along an historian who asks, "Well, who built the cathedral?" Peter added some stones here, and Paul added a few more. If you are not careful you can con yourself into believing that you did the most important part. But the reality is that each contribution has to follow onto previous work. Everything is tied to everything else.⁶

Mike Cassidy wrote in the *Mercury News*:

Baran wasn't interested in fame. And he apparently wasn't afraid of death. When I first met him in 2008, he mentioned that his wife had died the year before. I offered my condolences. "It's a perfectly normal part of life," Baran said. "You're only around for a fixed time. I think people make entirely too much of it."⁷

Mike Malone writes of Baran in *Forbes*:

He remained audacity personified right up to the very last day of his life, when he was simultaneously

working on a new invention and preparing for a business presentation to one of the world's biggest companies... In the end, he also taught us how to live our own lives, from beginning to end, in the Internet age.⁸

Ever modest, Baran never failed to minimize his own credit and gave much to others. He was at his best working in partnership with creative, smart, and adventurous colleagues, overcoming obstacles with a calm panache that made him unique. Bob Kahn sums it up in an elegant way: "Paul was one of the finest gentlemen I ever met and creative to the very end." He will be missed but long remembered.

Paul Baran married Evelyn Murphy in 1955 and moved to Los Angeles. Sans Ph.D. himself, Baran often remarked that Evelyn (with her Harvard Ph.D. in economics) was the better educated but, thankfully, she did not remind him of this. Another favorite tale of his was that when someone phoned asking for "Dr. Baran," he would say, "Just a moment, I'll get my wife." Evelyn passed away in 2007, after their 52 years of marriage. Baran is survived by his son David, three grandchildren, and his companion of recent years, Ruth Rothman. Of Ruth, Baran confided that she had been his prom date many years ago.

Notes

- 1 Reliable Digital Communications Systems Using Unreliable Network Repeater Nodes, P. Baran, Report P-1995, The RAND Corporation, 1960.
- 2 On distribution communications: Introduction to distributed communications networks, P. Baran, Report RM-3420, The RAND Corporation, 1964.
- 3 L. Kleinrock, "Message delay in communication nets with storage," Ph.D. dissertation, MIT, Cambridge, MA, 1962.
- 4 L. Kleinrock, *Communication Nets: Stochastic Message Flow and Delay*, McGraw-Hill (New York: 1964).
- 5 D. W. Davies, K. A. Bartlett, R. A. Scantlebury, and P. T. Wilkinson, "A Digital Communications Network for Computers Giving Rapid Response at Remote Terminals," unpublished paper presented at the ACM Symposium, Operating Systems Problems, Oct. 1967.
- 6 <http://www.cbi.umn.edu/oh/pdf.phtml?id=295>.
- 7 http://www.mercurynews.com/mike-cassidy/ci_17719914?nclick_check=1.
- 8 <http://blogs.forbes.com/mikemalone/2011/03/30/entrepreneur-for-life/>.