

## The ARPANET Forerunner of Today's Internet

In late 1968, the Advanced Research Projects Agency (ARPA) put out a Request for Quotation (RFQ) to build a network of four Interface Message Processors (IMPs).

At BBN, Frank Heart assembled a proposal team that included Dave Walden, a young programmer with expertise in real-time systems, Bernie Cosell, an ace de-bugger whom every BBN manager had learned to rely on if their projects got into trouble, Severo Ornstein, a perfectionist hardware ace, Will Crowther, an exceptional programmer who specialized in producing complex, tight code, and Bob Kahn, the consummate theoretician who understood error-control and the problems associated with sending data over telephone lines.

When the BBN team submitted its detailed proposal in September 1968, it filled 200 pages. Flowcharts, equations, and tables detailed timing, routing, transmission delays, and packet queuing. The team was confident that no one else had prepared such a detailed bid, although a dozen companies bid on the contract. When ARPA awarded the contract to BBN in January 1969, the larger organizations who had submitted proposals were stunned.

The team worked with an off-the-shelf Honeywell 516 to design the high speed I/O devices that would need to be added to the basic model and to start writing the code that would reload crashed IMPs, pull packets into the machine, figure out how to route them, and send them on their way. Researchers would not be satisfied with the original proposal, which required connecting only a single host at each site, so the team also redesigned the IMP to handle up to four hosts at each site.

Ben Barker, a Harvard-educated hardware engineer and the newest member of the IMP team, tried loading several pieces of code onto the customized 516 when it arrived. It didn't work and neither did anything else. Barker worked 16 hours a day, unwrapping misconnected wires from their pins, figuring out where they should be connected, and then rewiring the wires on each pin, while Ornstein worked on design corrections, which he then relayed to Honeywell's engineers.

The software team, Crowther, Walden, and Cosell, spent most of the summer devising a routing scheme that would automatically route data packets around troubled links in the network and update itself several times per second. Two weeks before the UCLA installation deadline, the next IMP arrived from Honeywell. The machine incorporated few of the requested modifications. Barker again unwrapped and rewired pins, this time with the advantage of knowing how they should be connected. Within a few days, he activated the IMP's interfaces, but it crashed frequently at random intervals. He had a hunch that the problem lay in the machine's timing chain and designed a fix. The machine had to be shipped to UCLA the next day, leaving no time to test the fix.



**Frank Heart: Father of the ARPANET**

When ARPA's request for proposal arrived at BBN in August of 1968, Frank Heart handpicked a team that combined expertise in real-time systems, hardware, computer science, wireline communications, and debugging to write the winning ARPANET proposal for the first computers connected in a packet-switching network. Heart's knowledge of computer technology, his knack for putting together effective engineering teams, and his insistence on reliability led to the successful, on time installation of the first nodes of the ARPANET nine months later and produced the underpinnings of today's Internet technology.

Barker traveled with the IMP to make sure the airline's cargo crew treated it with the respect it deserved and Truett Thach, a technician in BBN's Los Angeles office, met Barker and the IMP as they deplaned. When the IMP got to UCLA, Barker and Thach attached the cables and powered it up. Instantly, the machine picked up just where it had left off in Cambridge. Barker phoned Heart to tell him the good news and that he would be coming home in the morning. Heart asked Barker to hang around for a few days to see if it crashed. It didn't.

On October 1, 1969, the second IMP arrived at SRI and the first characters were transmitted over the new network. The ARPANET was born. IMPs number three and four were installed at UC Santa Barbara and the University of Utah with little fanfare. IMP installations were beginning to seem routine.

The network expanded to thirteen sites by January 1971 and twenty-three by April 1972 but was still virtually unknown outside of BBN, ARPA, and a small group of researchers. The International Conference on Computer Communication in Washington on October 1972 changed that. The ARPANET was the only demonstration at the conference and by the time it was over the much-maligned concept underlying the project—packet switching—had been vindicated and computer makers began to have an inkling of an emerging market.



The IMP Development Group pictured with the IMP: (left to right) Truett Thach, Bill Bartell, Dave Walden, Jim Geisman, Bob Kahn, Frank Heart, Ben Barker, Marty Thorpe, Will Crowther, and Severo Ornstein.

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BBN Technologies  
10 Moulton Street  
Cambridge, MA 02138  
617-873-8000  
pr@bbn.com

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