Internet Chronology

Lawrence G. Roberts

- Jul-61 First Paper on Packet Switching Theory, Leonard Kleinrock, "Information Flow in Large Communication Nets.", RLE Quarterly Progress Report. This was the theoretical work that convinced Roberts that packets could be used for the Internet.

- Aug-62 First Paper on Internet Concept by J.C.R. Licklider & Welden Clark, "On-Line Man Computer Communication".

- Oct-62 ARPA Computer Program Begins, J.C.R. Licklider becomes first ARPA IPTO Director. Writes internal papers on Galactic Network. Lick leaves in 64. It was Licklider's concept, which spurred Roberts to build the Internet.

- 1964 Book - Communication Nets by Leonard Kleinrock provides the network design and queuing theory necessary to build packet networks. This work was a major factor in designing the communications network for the ARPANET. It shows that packet switching would work, whereas until the ARPANET was built in 1969, most communications experts claimed that packet switching would never work.

- Mar-64 First Paper on Secure Packetized Voice, Paul Baran, "On Distributed Communications Networks", IEEE Transactions on Systems. It is from this paper that the rumor was started that the Internet was created by the military to withstand nuclear war. This is totally false. Even though this Rand work was based on this premise, the ARPANET and the Internet stemmed from the MIT work of Licklider, Kleinrock and Roberts, and had no relation to Baran's work.

- Sep-64 Ivan Sutherland becomes second ARPA IPTO Director. Ivan leaves in 1966. Ivan believed in the importance Licklider's Internet concept and funded the first network research (Roberts @ MIT) and then tried to hire Roberts into ARPA.

- Nov-64 Homestead Meeting between J.C.R. Licklider and Lawrence Roberts sparks Roberts to undertake the creation of the Internet. This was the critical turning point where Lick's Internet concept is transferred to Roberts to be implemented.

- Feb-65 First Network Experiment Contracted, Ivan Sutherland, ARPA, gives contract to Lawrence Roberts at MIT Lincoln Labs.

- Jul-65 Contract to Tomas Marill at CCA from Roberts at Lincoln Lab to program the network experiment. Tom Marill had also been convinced by Licklider to pursue networking.

- Oct-65 First Actual Network Experiment, Lincoln Labs TX-2 tied to SDC's Q32, Lawrence Roberts, MIT Lincoln Labs. This experiment was the first time two computers talked to each other and the first time packets were used to communicate between computers.

- Oct-66 First Paper on Network Experiments, Thomas Marill & Lawrence Roberts, "Toward a Cooperative Network of Time-Shared Computers", Fall AFIPS Conf.

- Aug-66 Robert Taylor becomes third ARPA IPTO Director and hires Roberts. Taylor and Sutherland tried to hire Roberts throughout early 1966. When Roberts refused, Taylor appealed to ARPA Director Charlie Hertzfeld who then put pressure on the Director of Lincoln Labs who then convinced Roberts to take the ARPA job. Taylor also obtained a preliminary budget approval for a network experiment from Hertzfeld.

Internet Chronology
Lawrence G. Roberts

- Dec-66 ARPA Communications Program Begins, Lawrence Roberts becomes ARPA IPTO Chief Scientist and begins the design of the APRANET. The ARPANET program as proposed to Congress by Roberts was to explore computer resource sharing and packet switched communications and had nothing to do with nuclear war or survivability. Reliability, however was one of the key network issues that dictated packet switching.

- Apr-67 ARPANET Design Session held by Roberts at APRA IPTO PI meeting in Ann Arbor MI. It was at this meeting that Wes Clark suggested the use of mini-computers for network packet switches instead of using the main frame computers themselves for switching.

- Oct-67 Original ARPANET Design Paper, Lawrence Roberts, " Multiple Computer Networks and Intercomputer Communication ", ACM Gatlinberg Conf.

- Oct-67 First Introduction of the word "Packet", Donald Davies, Roger Scantlebury et all, "A digital Communications Network for Computers …", ACM Gatlinberg Conf. Donald Davies work at the UK's National Physical Laboratory explored packet switching in their laboratory, but Donald could not convince the British to fund a wide area network experiment. His papers, however, did show the importance of packet switching for computer communication. This effort had been going on in parallel with the MIT efforts during 1966.

- Oct-67 The 3 Independent Packet Research Efforts (MIT, Rand, NPL) Meet, Roberts and Scantlebury meet. Scantelbury tells Roberts about Baran and the Rand work. After the Gatlinberg meeting, Roberts read the Rand work and met with Baran. Although the UK work convinced Roberts to use higher speed lines (50 KB) and to use the word packet, the Rand work had no significant impact on the ARPANET plans and Internet history.

- Aug-68 Request For Proposals released for ARPANET by Lawrence Roberts, ARPA. The RFP mandated the main packet switching design elements for the ARPANET. This RFP was to contract out the packet switch development. Roberts did the overall network design. network economic analysis, line optimization, and the selection of computer sites to be connected.

- Sep-68 ARPANET RFP Responses received. Evaluation was by Roberts, ARPA staff, and a group of APRA contractors.

- Oct-68 Network Measurement Center at UCLA contracted by Roberts at ARPA to Leonard Kleinrock at UCLA to undertake ARPANET measurement. Kleinrock was chosen because of his previous queuing theory work on networks and his ability to then measure the real network and from this verify or fix the theory. A sound, proven theory was critical for future networks.

- Dec-68 APPANET Packet Switch Contract Awarded to BBN.ARPA, under Robert leadership, awarded contract to Frank Heart’s group at BBN to build the ARPANET Interface Message Processors (IMP’s). The BBN group proposed to use Honeywell 516 mini-computers for the Interface Message Processors (IMP's). The team included Bob Kahn, Severo Ornstein, Dave Walden and many other key individuals.

- Apr-69 Host to IMP Spec. 1822 Released, written by Bob Kahn at BNN. This spec. detailed the interface between ARPANET host computers and the Interface Message Processors. The IMP's needed to be connected to each computer with this unique hardware interface. It needed to be designed and built for each different computer attached.

- Apr-69 Request For Comments (RFC) #1, "Host Software" Released, written by Steve Crocker, covering Host-to-Host protocol, the first output of the Network Working Group (NWG). Crocker had been asked by ARPA to collect a team, the NWG, to design and specify the first Host Protocol. This was a major undertaking, requiring considerable foresight into the applications that might be forthcoming on the Internet.

- Sep-69 First Node of ARPANET Installed at UCLA Network Measurement Center where Len Kleinrock's group connected the IMP to their Sigma 7 computer.

- Oct-69 Second Node of ARPANET Installed at SRI where Doug Engelbart's group connected it to their SDS 940 computer. The first ARPANET messages passed that day.

- Sep-69 Taylor leaves ARPA and Roberts becomes fourth Director of IPTO.

- Nov-69 Third Node of the ARPANET Installed at UCSB making the first redundant network.

- Dec-69 Fourth Node of the ARPANET Installed at the University of Utah.

- Mar-70 ARPANET First Spans the US connecting BBN into the net.

- Mar-70 First Report on ARPANET at Spring AFIPS with paper by Lawrence Roberts and Barry Wessler, "Computer Network Development to Achieve Resource Sharing" and others.

- Jul-70 First Packet Radio -ALOHANET operational at U. Hawaii under Norm Abramson using the ALOHA concept of random packet transmission.

- Dec-70 Network Control Protocol (NCP), the first host-to-host protocol, completed by Steve Crocker and NWG.

- Jul-71 Packet Satellite Technique Published by Lawrence Roberts suggesting Slotted Aloha for short traffic and Packet Reservation for long blocks.

- Sep-71 First Terminal Interface Processor (TIP) in ARPANET permitting terminals to directly dial into the network, greatly increasing the network growth.

- Mar-72 First basic Email Programs, SNGMSG and READMAIL written by Ray Tomlinson at BBN. Mail spooled out like a teletype printout.

- Jul-72 First Email Management Program, RD written by Larry Roberts at ARPA to list incoming messages and support forwarding, filing, and responding to them. This spurred many other mail programs, however the descendents today (like Eudora) still operate in basically the same way as RD.

- Jul-72 FTP Protocol Specification (RFC 354) released by Jon Postel, the editor of the Request For Comments, and Abhay Bhushan, the chairman of the Network Working Group.

- Oct-72 First APRANET Public Demonstration at ICCC in Washington organized by Robert Kahn of BBN. Show was a major success. Kahn was then hired by Roberts into ARPA.

- May-73 First Ethernet Operation at Xerox PARC designed by Robert Metcalfe. Bob had expanded the ALOHA packet radio concepts and applied them to cable.

- Oct-73 Roberts leaves ARPA, joining Telenet, the first packet switching carrier, as CEO. Licklider returns to ARPA as Director IPTO. Telenet proved that packet switching was far more economic than the telephone network for data. Telenet created a way to connect computers to the network without a specialized hardware interface by introducing and standardizing X.25 for network to host computer interfacing.

- Apr-74 BBN released revised ARPANET Routing after complete rewrite by John McQuillan fixing many long standing bugs and greatly speeding up routing.

- May-74 First Internetworking Protocol, TCP outlined in a paper by Robert Kahn and Vinton Cerf, "A Protocol for Packet Network Interconnection". Kahn and Cerf started design in 1973.

- Jul-75 ARPANET Transferred to DCA, the Defense Communications Agency.

- Jul-76 Vinton Cerf joins APRA as program manager of the packet radio, packet satellite and packet research programs. Vint stayed until 1982.

- Oct-77 First TCP Operation over ARPANET, Packet Radio Net, and SATNET (the satellite network).

- Nov-77 Complete Email Specification (RFC 733) released by two Email pioneers, Dave Crocker and John Vittal.

- Mar-78 TCP Split into TCP and IP, where TCP was the end-to-end process and IP was the network routing process by Vint Cerf, Jon Postel, and Danny Cohen.

- Jul-80 NSF Organizes CSNET increasing it to 70 sites by Jun-83 and integrating most computer science sites by 1986.

- 1983 DCA Splits MILNET off of ARPANET leaving 68 nodes on ARPANET and 45 on MILNET, the military network.

- Nov-83 Domain Name System (DNS) Designed by Jon Postel, Paul Mockapetris, and Craig Partridge to support the Email addressing space, creating .edu, .gov, .com, .mil, .org, .net, & .int.

- 1986 NSF Organizes NSFNET backbone to connect five supercomputing centers and interconnect all other Internet sites at 56 KB.

- 1986 First Interop Conference organized by Dan Lynch.

- 1987 NSF upgrades NSFNET to T1 speed lines.

- 1989 Internet opened to commercial mail through MCI Mail

- 1991 NSF Opens Internet to commercial use.

Future Projections

- 2001 - Finally the Internet gets Quality of Service (QOS) with guaranteed rate service for voice and video plus minimum rate guarantees for interactive data activities like the WWW. This permits the ISP's and carriers to charge higher flat rates for premium service and then add the bandwidth

necessary to support these users. Also, the Internet gets explicit rate flow control available end-to-end by downloading a small change to TCP. This dramatically improves the WWW page access delay, reducing it to less than a second per page.

- 2005 - The service quality and security on the Internet has increased to the point where there is a major trend of both home and office users to use the Internet for their primary voice service, their high quality TV and radio service, as well as their data service. This trend will slowly eliminate all the other communication nets like the current telephone network over the next decade. The inherent cost of the Internet is dramatically less than today's voice net, due to the elimination of per call billing and the use of packet switching, which is orders of magnitude less expensive than circuit switching. Thus, both cost and new data related features will move users over quickly once the quality is fixed.