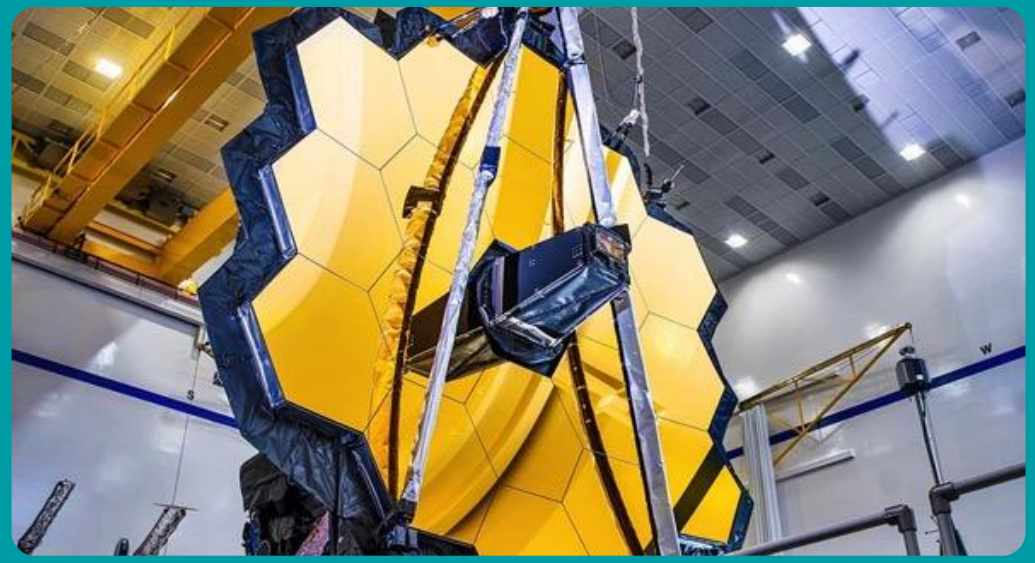
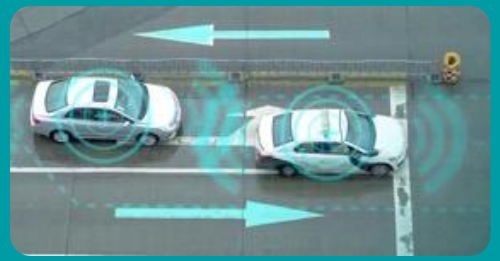
IEEE Hawaii
75th Anniversary

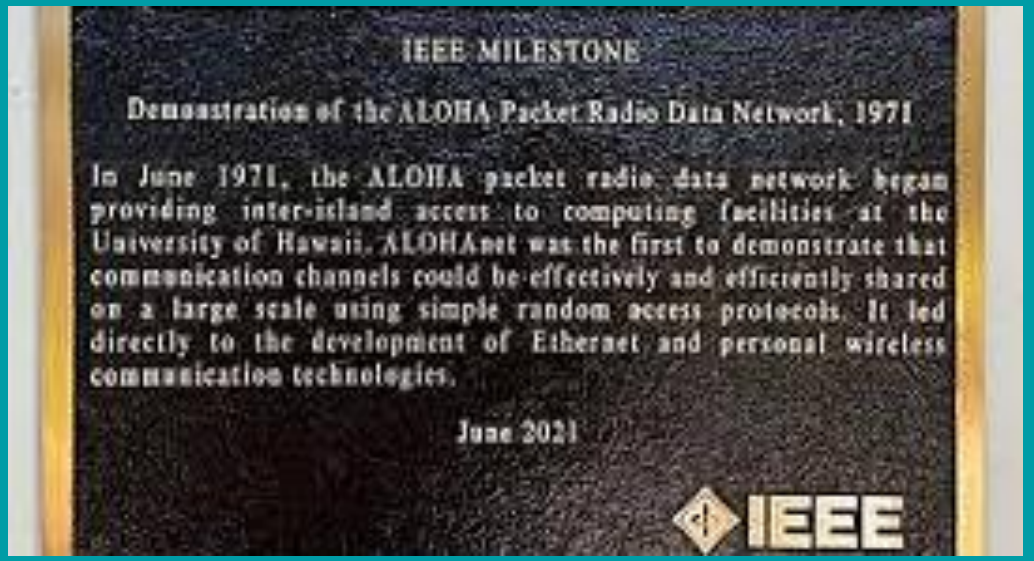
Thursday, November 13, 2025

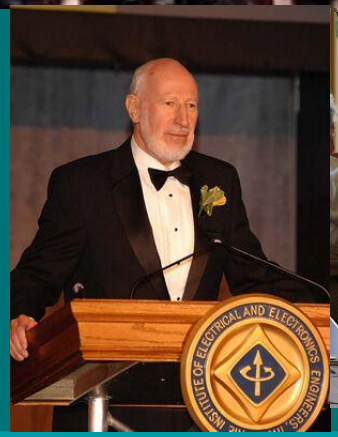
IEEE Milestone: ALOHAnet

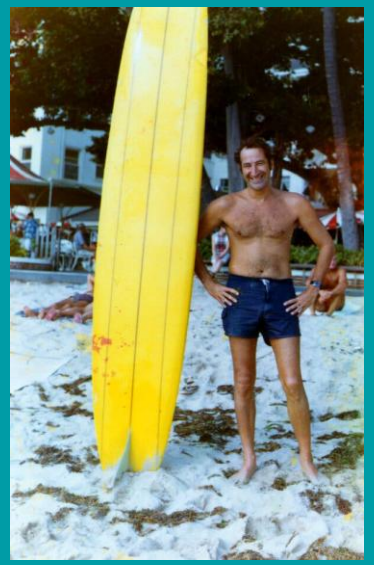
In Memoriam
David Wax – October 29, 2025

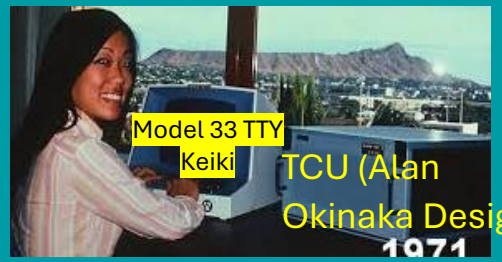






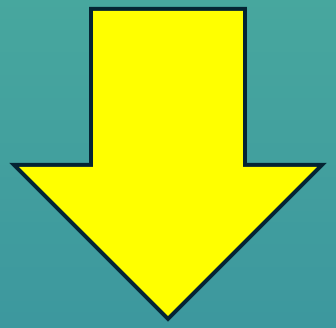






LIGHT BULB MOMENT

Learning of a newly created ARPA program named THEMIS – whose mission was to support research at "second tier" universities – Abramson and two of his fellow professors, Wes Peterson and Ned Weldon, joined forces to create a team with both communications and computer background. Abramson recalls:



So we cast about for a research topic that we thought would make sense to the Department of Defense, that we would be interested in, and said: 'Well, communications for computers makes sense.' The telephone system appeared not to make sense at that time, especially in Hawaii, and we thought we had something that was intellectually stimulating and a package that we could sell to ARPA. That's how it all started.

Design Team

Dr. Norman Abramson
- Co-PI; Project Founder and Director

Dr. Franklin Kuo
- Co-PI; Project Manager; Implementer
- Abramson's "theory"

Richard Binder
- Original developer and implementer of the ALOHA software protocol, design of central controller software, and network protocols

David Wax
- Designed and implemented ALOHAnet radio system and components

Chris Harrison
- Designed and implemented radio, minicomputers, and electronics with David and Alan

Alan Okinaka
- Designed TCU

Aloha Communications System Connects Hawaii to Arpanet

By Sasha Yasinin
CW Hawaii Correspondent

HONOLULU — The University of Hawaii's Aloha system is scoring innovative advances in satellite computer communications with an experimental satellite system which went on-line here recently.

The university also is involved in a joint study with the Advanced Research Projects Agency (Arpa), Bolt Beranek and Newman, Xerox and UCLA to design

Experimenting With Aloha

suitable protocol for packet communications via satellite.

As part of this project, Aloha becomes the first subscriber to a digital communications subsystem installed between the Comsat ground stations at Paumalu, Hawaii, and Jamesburg, Calif., last year.

With this installation Aloha becomes the first operational satellite node on Arpanet, via the Intelsat IV satellite over the Pacific.

The Comsat system enables data to be transmitted at the rate of 50 kbit/sec over a single voice-grade channel.

The single satellite channel can provide two up-link and two down-link data channels and each of these four channels could he simultaneously available to any Comsat ground station in sight of the satellite.

Aloha's director, Norman Abramson, sees this use of voice-grade channels as a big money-saver for computer communications.

As an example of the system's cost-saving potential, Abramson pointed to the possibilities in the next generation domestic satellite system.

"Each of these satellites," he told *Computerworld*, "will have 12 transponders with a bandwidth of 45MHz or so. If one of the potential carriers were to devote one transponder on the satellite to packet communications, it would be possible to transmit data at about 10 million baud. This single transponder could handle some five million on-line terminals.

"Converting to this kind of communications could save a lot of money. For example, Arpa spends in excess of $1 million per year for line charges. With this much money it could buy a transponder on a domestic satellite.

"If computer users are ever going to be free of incredibly high costs of transmitting data, some system similar to this has got to be set up," Ahramson said.

But Abramson foresees difficulties with potential carriers in the next generation system devoting a transponder to packet data communications. He sees problems with regulatory agencies in determining how to charge for the service.

PROJECT TEAM (in addition to Design Team)

Dr. Wesley Peterson

Dr. Shu Lin

Dr. E.J. (Ned) Weldon

Dr. Thomas Gaarder

Charlie Bass

Dennis Streveler

ALOHA System → ALOHAnet

The ALOHA multiplexing technique was a foundational concept in computer networking, directly influencing the development of Ethernet, satellite communication systems, and modern wireless networks

MULTIPLEXING IN THE ALOHA SYSTEM: MENEHUNE - KEIKI DESIGN CONSIDERATIONS,

Oct 31, 1969

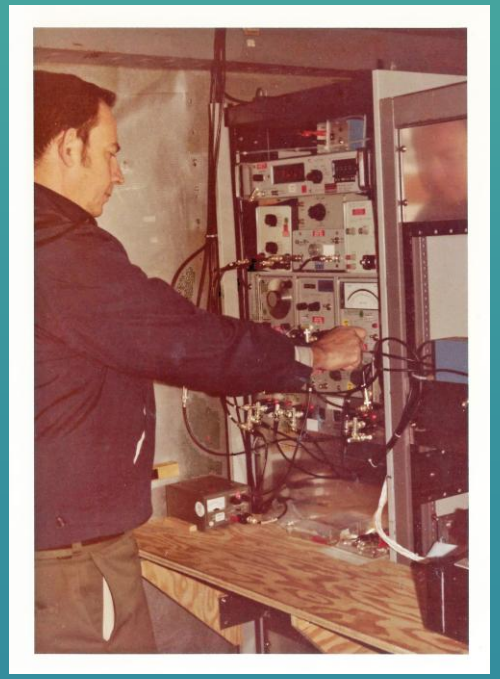
Richard Binder

In September, 1968, the Information Sciences Program and the Electrical Engineering Department of the University of Hawaii began work on a research program aimed at (a) developing a system of radio-linked consoles to be integrated into the present UH time-sharing system and (b) strengthening research in information processing at the University of Hawaii through projects which will develop and use the on-line and interactive graphics features of the system. Since the primary goal of this program is to add radio links connecting various units of the University of Hawaii throughout the state to the existing UH on-line computer system, the project has been named the Additive Links on-Line Hawaii Area System - The ALOHA System. The report presents the results arrived at so far in the definition of the multiplexor (MENEHUNE) and user terminals (KEIKI) portions of the system.

- Different timing characteristics for:
  - CRTs
  - TTYs
  - IMLAC
    - Dr. Wes Peterson had unique primitive graphics terminal

THREE PARTS

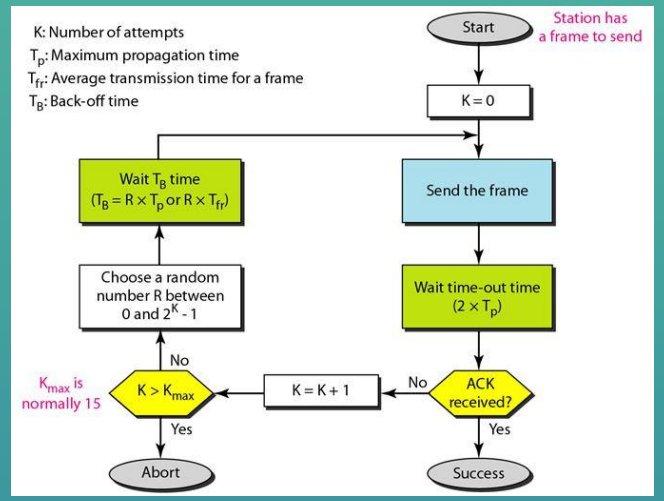
RADIO

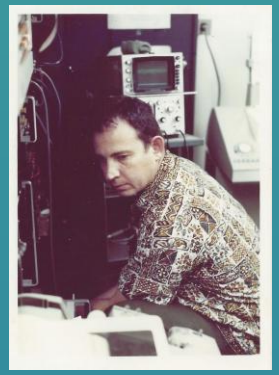


ALOHA packet radio data network

PACKET

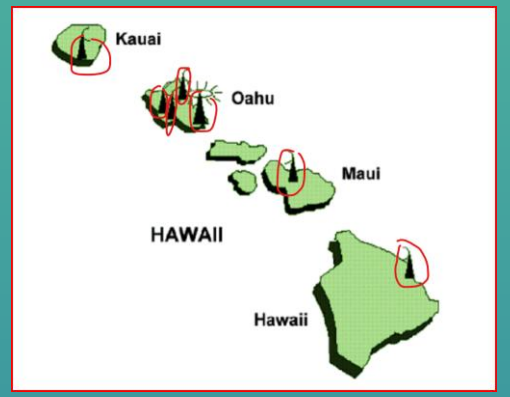
ALOHA Protocol





DATA NETWORK

ALOHAnet



RADIO

Terminal Control Unit (TCU)
- 5 cards
  - 4 custom designed cards (Alan Okinaka)
  - 1 modem
- Against backplane, mounted RF equipment, power aps, IFs, etc.

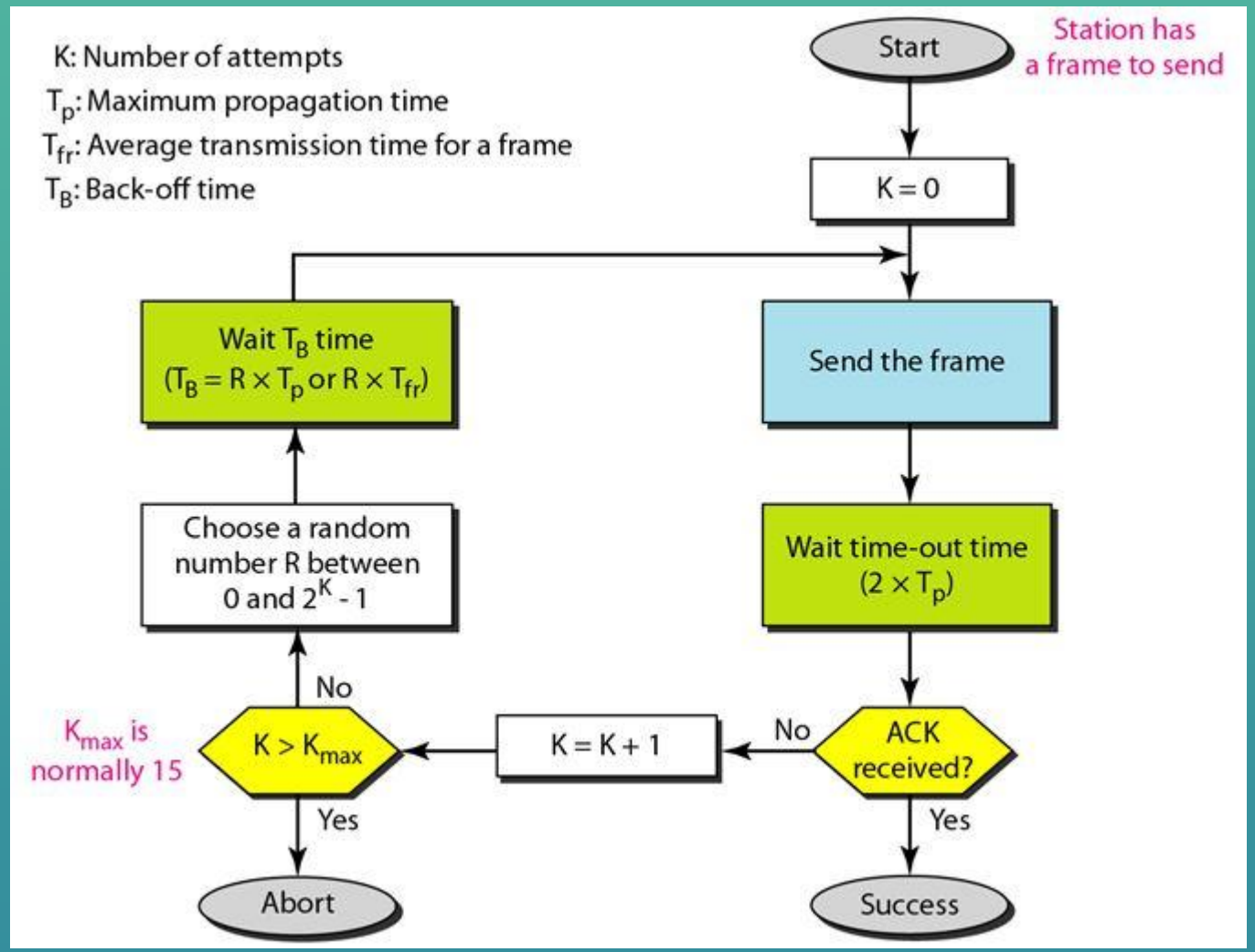
Funding: Project THEMIS (USAF)
Later funding: ARPA

Allocated portion of USAF Military Frequency
- Dr. David Braverman (Hughes Aircraft Corporation)
- Two 100 kHz BW channels
  - 407.350 MHz; uplink; remote user to central computer
  - 413.475 MHz; downlink; central computer to remote user
- Challenging! Note only 6.125 kHz gap in days of vacuum tubes for radios

Initially used Motorola push-to-talk radio on Keiki (user terminals) and Menehune (central controller)
Later used Lenkurt radios at Menehune

Standalone Lockheed System-User-Engineered (SUE) minicomputer:
- Integrated into existing radio network
- Standalone computing facility
- ALOHAnet simulation facility
- Source of file traffic for ALOHAnet

PACKET -> ALOHA PROTOCOL



a foundational multiple-access method in computer networking that allows multiple devices to share a single communication channel. It operates on the principle of a random access network, where devices transmit data whenever they have it, without first checking if the channel is busy. If two or more devices transmit at the same time, their signals collide and are corrupted. The protocol handles these collisions by having the sending device wait a random amount of time before retransmitting the data.

Significance

- The ALOHA protocol, first developed in the 1970s, was a pioneering technology for wireless and shared-medium networks.
- It laid the groundwork for modern networking technologies like Ethernet and Wi-Fi.
- Its success demonstrated the feasibility of random access for large-scale shared networks without a central coordinator.

ALOHA Protocol

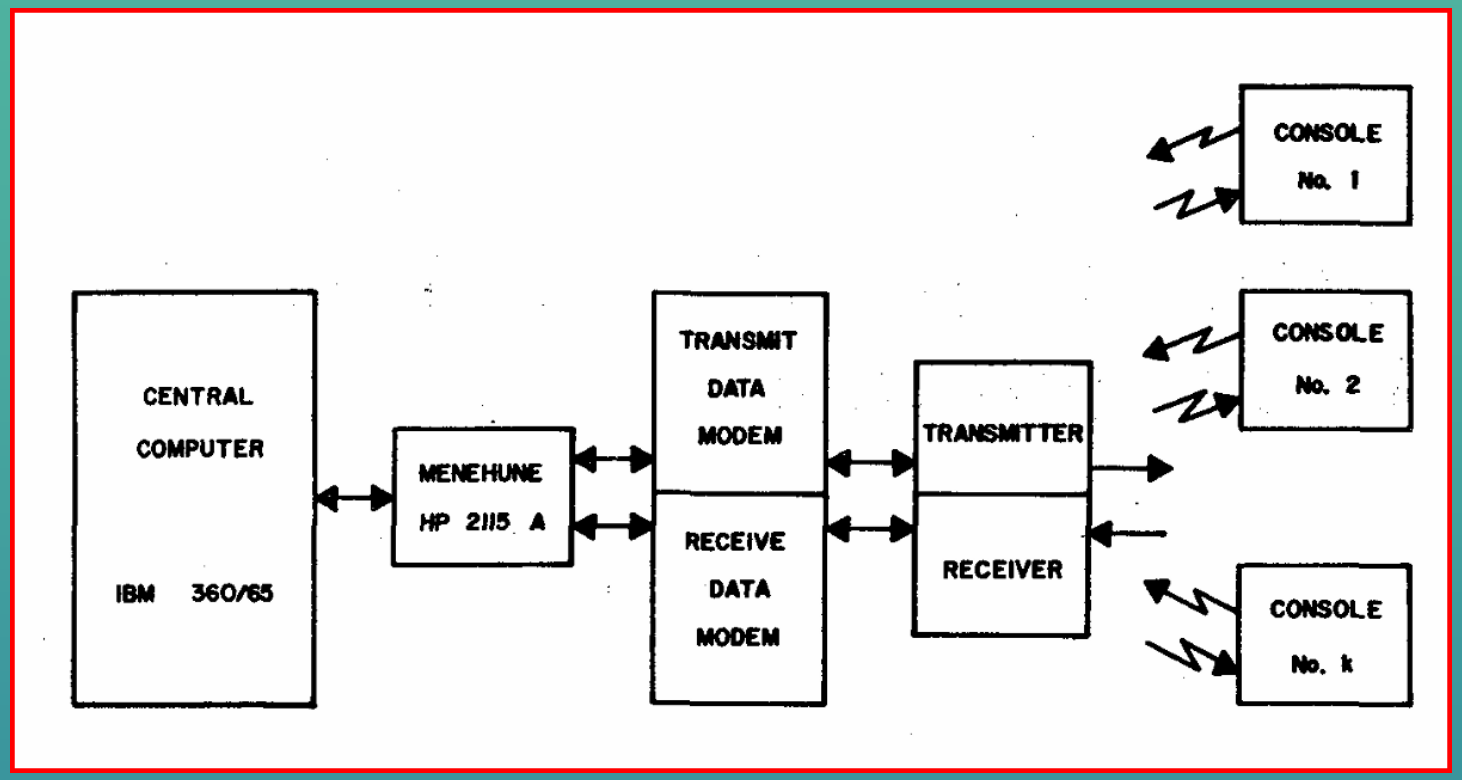
Chris Binder
- Design the positive acknowledgment for the channel
  - Channel instability; bi-point operation; curve that was developed by Dr. Abramson but in the 1970 paper on the behavior of random accessing channel – stopped

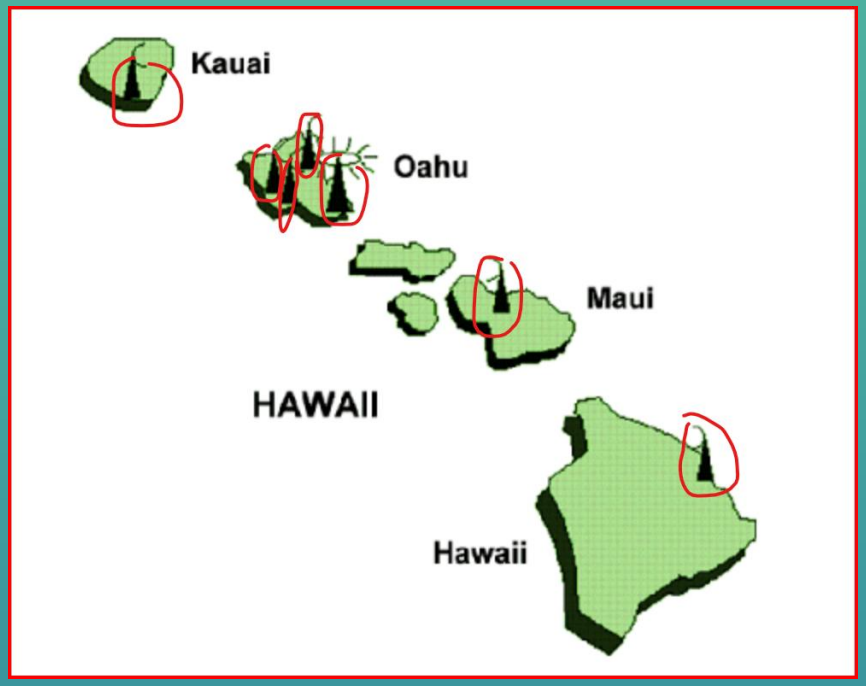
Alan Okinaka
- Design Terminal Control Unit (TCU)

Garner: Yeah, it's interesting. You do recall that on very first meeting he understood that the network could become locked up at a stable point. Yeah, but he never wrote about it in any of his papers.
Binder: Well, he maybe avoided writing it in-- talking about it in the 1970 paper. He did include the curves.
Garner: But they always cut off, right, when it starts to [decrease in throughput and lock up]…

Binder: He'd stop it right at the max point of goodness. But at that meeting, he talked at length about the instability of the channel, the bi-point operation and all of that.

DATA NETWORK -> ALOHAnet





The ALOHAnet system, using a 9600 bits per second (bps) channel, had a theoretical capacity to support between **100 and 500 active teletype users**. In practice, it supported around **forty users** at its peak across several locations on the islands of Oahu and Maui.

COMMUNICATIONS EVOLUTION BASED ON ALOHANET AND ALOHA PROTOCOL

- **1968:** Development of the ALOHA network begins at the University of Hawaii, funded by DARPA, with the goal of connecting computers on different islands using radio equipment.
- **1970:** Norman Abramson publishes a landmark paper analyzing the ALOHA channel protocol.
- **June 1971:** ALOHAnet becomes operational and provides the first public demonstration of a wireless packet data network. The first connection was established between the computer on the main UH Mānoa campus on O'ahu and a terminal in Abramson's home a mile away.
- **Late 1971:** Connectivity is provided to four remote terminals, soon expanding to several hundred users.
- **1972:** Robert Metcalfe visits Hawaii to study ALOHAnet, which inspires his work on a wired local area network (LAN) system at Xerox PARC.
- **1973:** Metcalfe and David Boggs adapt the ALOHAnet random-access method to the "Ethernet" wired LAN.
- **1970s (Mid-late):** The ALOHA random access protocols are applied to early satellite networks and research continues in packet broadcasting.
- **1980s:** The Ethernet standard (IEEE 802.3) is formally introduced.
- **1985:** The U.S. Federal Communications Commission (FCC) makes unlicensed spread spectrum available in the Industrial, Scientific, and Medical (ISM) bands, setting the stage for future Wi-Fi technology, which heavily utilizes the ALOHA protocol's principles.

- **Late 1980s:** The European GSM group greatly expands the use of ALOHA channels for mobile telephony.
- **1997:** The first 802.11 protocol (Wi-Fi) is released, leveraging the fundamental ALOHA random-access techniques.
- **October 2020:** ALOHAnet is recognized as an IEEE Milestone for its foundational impact on modern data networking.
- **June 2021:** A virtual symposium is held at the University of Hawaii at Mānoa to celebrate the 50th anniversary of ALOHAnet's debut.

SNIPPET OF ALOHAnet IEEE Milestone Proposal

Year or range of years in which the achievement occurred:

1968 - 1971. Activated June 1971

Title of the proposed milestone:

Demonstration of the ALOHA Packet Radio Data Network, 1971

Plaque citation summarizing the achievement and its significance; if personal name(s) are included, such name(s) must follow the achievement itself in the citation wording: *Text absolutely limited by plaque dimensions to 70 words; 60 is preferable for aesthetic reasons.*

In June 1971, the ALOHA packet radio data network began providing inter-island access to computing facilities at the University of Hawaii. ALOHAnet was the first to demonstrate that communication channels could be effectively and efficiently shared on a large scale using simple random access protocols. It led directly to the development of Ethernet and personal wireless communication technologies.

Real-world Application of ALOHAnet and ALOHA Protocol

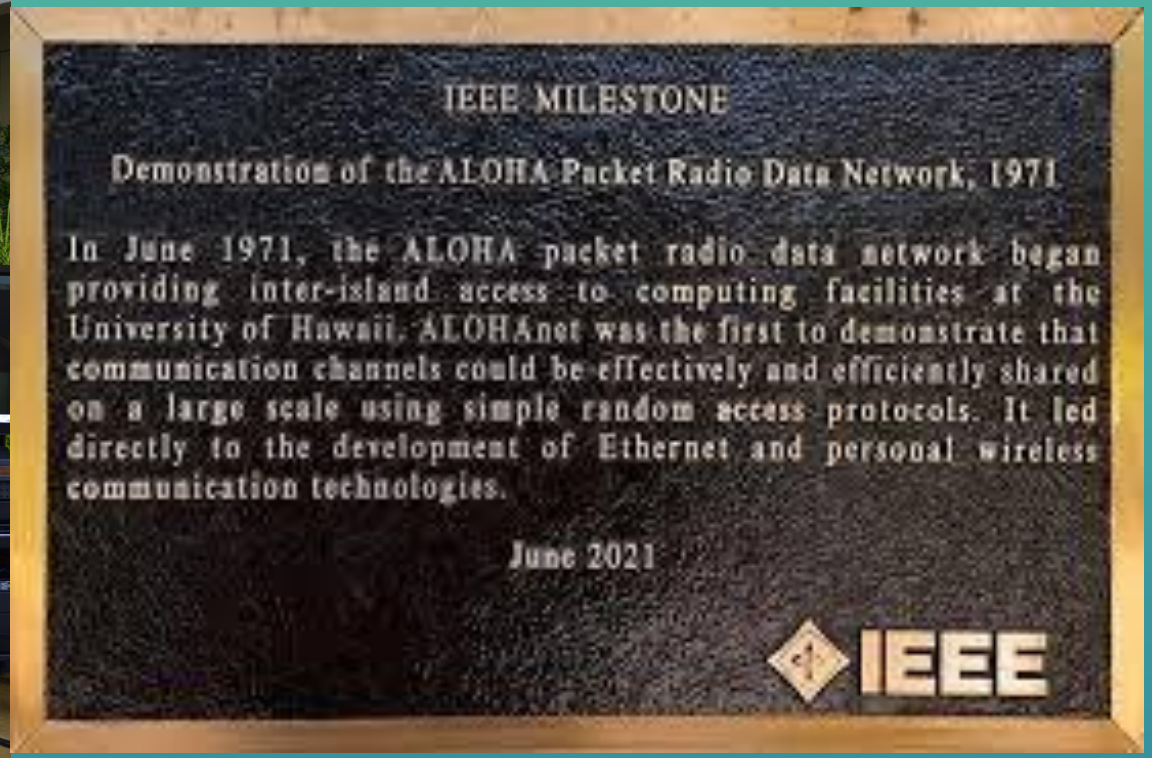
ALOHAnet introduced **random access protocols** for shared media, which became fundamental to Ethernet, Wi-Fi, and cellular networks, while PRNET expanded these concepts with repeaters for mobile coverage and was a direct descendant of ALOHAnet's innovations.

ALOHAnet was connected to ARPANET via satellite in December 1972 under the guidance of the U.S. Defense Advanced Research Projects Agency. The connection allowed for reliable computer communications throughout the United States, according to the Wiki entry.

ALOHAnet used a VHF transponder in 1973 to connect to an experimental NASA satellite in order to demonstrate PacNet, an international satellite data network. The demonstration connected the NASA facility in California with five universities in Australia, Japan, and the United States, the Wiki entry says.

In summary, the PEACESAT ALOHA protocol was the practical application of the ALOHA random access method to enable satellite-based data communication across the Pacific region, pioneering wireless packet data networks.

Unveiling of IEEE ALOHAnet Milestone Plaque



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