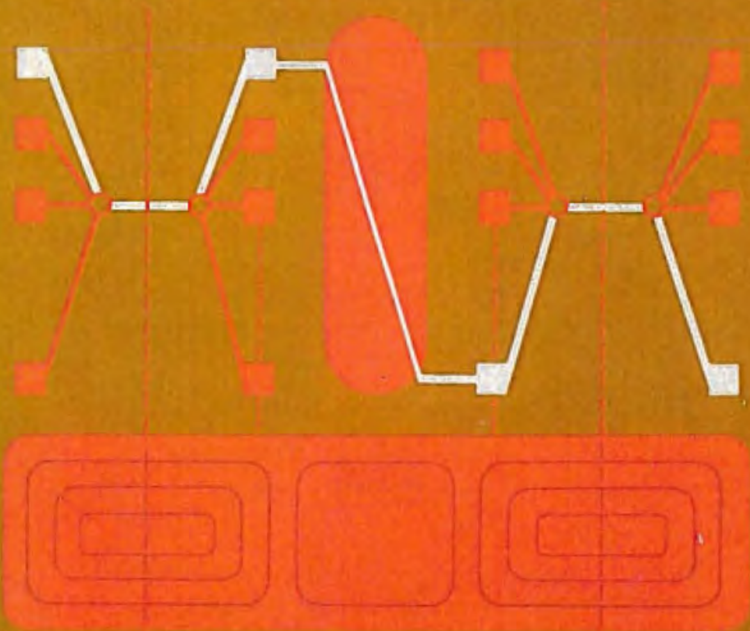
COMPUTER NETWORKS AND THEIR PROTOCOLS



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This book follows on from the book on *Communication Networks for Computers* by Donald Davies and Derek Barber, published in 1973.

The development of networks has put emphasis on formal protocols and standard interfaces, which are fully described in the new book. The different viewpoints of the two books complement each other so that, together, they form a comprehensive treatment of a most important area of information processing where computers and communications meet.

Contents

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terminals are intended to be located very close to broadcast systems user devices, thus obviating the need for long and expensive land-based connections of comparatively limited capacity. Such packet terminals can even be mobile, mounted on vehicles, an important consideration in military and other contexts. The greatest portability is possible in packet radio systems, where hand-held or pocket terminals are quite feasible.

The technology of all broadcast systems, whatever their nature, has a great deal in common, though the problems of contention resolution are somewhat different and require different techniques for their resolution. Much of today's technology has sprung from developments of the ALOHA system, which is a ground radio system. We shall therefore consider this system first, then proceed to a discussion of the more complicated ground radio systems; this will be followed by an account of satellite broadcast systems and cable broadcast systems.

5.2 PACKET RADIO SYSTEMS

The ALOHA system is essentially a UHF packet broadcast system created for very pragmatic reasons (including the poor quality of local telephone lines) by a team at the University of Hawaii; it first became operational in 1970. The system covers the Hawaiian Islands, Figure 5.2, and is centred on the island of Oahu. Inexpensive access is afforded to central time-sharing computer systems for several hundred terminal users. In the first instance communication was limited to a large group of terminals in the Honolulu district within direct radio range of the central station. User-to-user communication is also catered for.

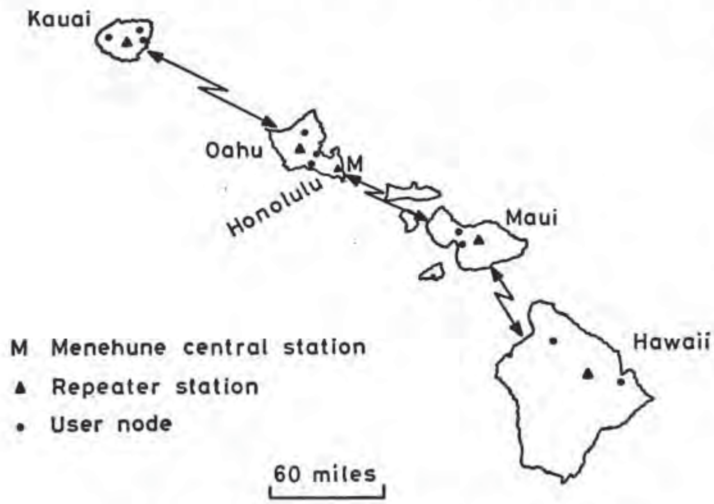

Figure 5.2 The ALOHA network coverage

The Basic ALOHA System

The aim of the ALOHANET is to provide cheap and easy access for a large number of terminal users to central computing facilities. A summary of the ALOHA project may be found in Binder *et al.*[2] User-to-computer communication is via a 100 kHz random-access channel at 407.350 MHz; the broadcast return channel, computer-to-user, is also of 100 kHz bandwidth at 413.475 MHz. Direct user-to-user communication is not catered for (user-to-user communication is possible by transferring data to the central switch and then forwarding it to the destination user) and, until the addition of packet repeaters, the system was logically equivalent to a star-connected network. The central communications processor, the *Menehune* (or packet station), located at Honolulu on Oahu, which receives packets from users and is responsible for sending packets to them, is an HP 2100 minicomputer. Menehune is a Hawaiian name for an imp—a reference to the ARPA node. The packet transmission data rate is 9600 baud, packets consisting of a header (32 bits), a header parity check field (16 bits), and up to 80 bytes of data, followed by a data parity check field (16 bits). Maximum size packets are therefore 704 bits in length and take about 73 milliseconds to transmit; propagation time is negligible in comparison.

Control of the broadcast channel from the central computer to the users presents no problem, because only one transmitter is using the channel. Packet headers contain user addresses which enable individual receivers to identify the traffic intended for them. The user-to-computer channel, referred to above as random-access, could have been apportioned to individual users by a fixed allocation scheme, such as frequency division multiplexing or time division multiplexing. However, the nature of terminal traffic is almost always bursty and a fixed allocation would hardly make the best use of the communication medium, hence the choice of a random-access scheme.

This scheme, known as pure ALOHA, allows a packet terminal to transmit packets at times which are completely independent of packet transmissions from other terminals. A natural consequence of this independence of action is that packets from different sources may be transmitted at the same time and therefore collide or overlap as they arrive at the Menehune central station; an overlap that affects only the smallest fraction of transmission time has the same effect as an overlap of complete packets; both packets are irretrievably corrupted. Figure 5.3 indicates the way in which overlaps may occur. Packets subject to such overlap are rejected by the Menehune and the fact of overlap is made known to the respective transmitting terminals by absence of the acknowledgement signal which would otherwise be sent by the Menehune to the packet terminals. Packets refused by the Menehune on account of an overlap are retransmitted by the packet terminals after a time-out period. It is plainly obvious that an immediate retransmission of packets by these terminals, or, indeed, retransmission after a fixed, uniform time interval, would just result in

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