Starting in the late 1950s, American computer scientist Paul Baran developed the concept Distributed Adaptive Message Block Switching with the goal to provide a fault-tolerant, efficient routing method for telecommunication messages as part of a research program at the RAND Corporation, funded by the US Department of Defense. This concept contrasted and contradicted the theretofore established principles of pre-allocation of network bandwidth, largely fortified by the development of telecommunications in the Bell System. The new concept found little resonance among network implementers until the independent work of Donald Davies at the National Physical Laboratory (United Kingdom) (NPL) in the late 1960s. Davies is credited with coining the modern name packet switching and inspiring numerous packet switching networks in Europe in the decade following, including the incorporation of the concept in the early ARPANET in the United States.

Packet switching contrasts with another principal networking paradigm, circuit switching, a method which pre-allocates dedicated network bandwidth specifically for each communication session, each having a constant bit rate and latency between nodes. In cases of billable services, such as cellular communication services, circuit switching is characterized by a fee per unit of connection time, even when no data is transferred, while packet switching may be characterized by a fee per unit of information transmitted, such as characters, packets, or messages.

Packet mode communication may be implemented with or without intermediate forwarding nodes (packet switches or routers). Packets are normally forwarded by intermediate network nodes asynchronously using first-in, first-out buffering, but may be forwarded according to some scheduling discipline for fair queuing, traffic shaping, or for differentiated or guaranteed quality of service, such as weighted fair queuing or leaky bucket. In case of a shared physical medium (such as radio or 10BASE5), the packets may be delivered according to a multiple access scheme.

Baran developed the concept of distributed adaptive message block switching during his research at the RAND Corporation for the US Air Force into survivable communications networks, first presented to the Air Force in the summer of 1961 as briefing B-265, later published as RAND report P-2626 in 1962, and finally in report RM 3420 in 1964. Report P-2626 described a general architecture for a large-scale, distributed, survivable communications network. The work focuses on three key ideas: use of a decentralized network with multiple paths between any two points, dividing user messages into message blocks, later called packets, and delivery of these messages by store and forward switching.

Starting in 1965, Donald Davies at the National Physical Laboratory, UK, independently developed the same message routing methodology as developed by Baran. He called it packet switching, a more accessible name than Baran's, and proposed to build a nationwide network in the UK. He gave a talk on the proposal in 1966, after which a person from the Ministry of Defence (MoD) told him about Baran's work. A member of Davies' team (Roger Scantlebury) met Lawrence Roberts at the 1967 ACM Symposium on Operating System Principles and suggested it for use in the ARPANET.

In connectionless mode each packet includes complete addressing information. The packets are routed individually, sometimes resulting in different paths and out-of-order delivery. Each packet is labeled with a destination address, source address, and port numbers. It may also be labeled with the sequence number of the packet. This precludes the need for a dedicated path to help the packet find its way to its destination, but means that much more information is needed in the packet header, which is therefore larger, and this information needs to be looked up in power-hungry content-addressable memory. Each packet is dispatched and may go via different routes; potentially, the system has to do as much work for every packet as the connection-oriented system has to do in connection set-up, but with less information as to the application's requirements. At the destination, the original message/data is reassembled in the correct order, based on the packet sequence number. Thus a virtual connection, also known as a virtual circuit or byte stream is provided to the end-user by a transport layer protocol, although intermediate network nodes only provides a connectionless network layer service.

Connection-oriented transmission requires a setup phase in each involved node before any packet is transferred to establish the parameters of communication. The packets include a connection identifier rather than address information and are negotiated between endpoints so that they are delivered in order and with error checking. Address information is only transferred to each node during the connection set-up phase, when the route to the destination is discovered and an entry is added to the switching table in each network node through which the connection passes. The signaling protocols used allow the application to specify its requirements and discover link parameters. Acceptable values for service parameters may be negotiated. Routing a packet requires the node to look up the connection id in a table. The packet header can be small, as it only needs to contain this code and any information, such as length, timestamp, or sequence number, which is different for different packets.

Both X.25 and Frame Relay provide connection-oriented operations. But X.25 does it at the network layer of the OSI Model. Frame Relay does it at level two, the data link layer. Another major difference between X.25 and Frame Relay is that X.25 requires a handshake between the communicating parties before any user packets are transmitted. Frame Relay does not define any such handshakes. X.25 does not define any operations inside the packet network. It only operates at the user-network-interface (UNI). Thus, the network provider is free to use any procedure it wishes inside the network. X.25 does specify some limited re-transmission procedures at the UNI, and its link layer protocol (LAPB) provides conventional HDLC-type link management procedures. Frame Relay is a modified version of ISDN's layer two protocol, LAPD and LAPB. As such, its integrity operations pertain only between nodes on a link, not end-to-end. Any retransmissions must be carried out by higher layer protocols. The X.25 UNI protocol is part of the X.25 protocol suite, which consists of the lower three layers of the OSI Model. It was widely used at the UNI for packet switching networks during the 1980s and early 1990s, to provide a standardized interface into and out of packet networks. Some implementations used X.25 within the network as well, but its connection-oriented features made this setup cumbersome and inefficient. Frame relay operates principally at layer two of the OSI Model. However, its address field (the Data Link Connection ID, or DLCI) can be used at the OSI network layer, with a minimum set of procedures. Thus, it rids itself of many X.25 layer 3 encumbrances, but still has the DLCI as an ID beyond a node-to-node layer two link protocol. The simplicity of Frame Relay makes it faster and more efficient than X.25. Because Frame relay is a data link layer protocol, like X.25 it does not define internal network routing operations. For X.25 its packet IDs---the virtual circuit and virtual channel numbers have to be correlated to network addresses. The same is true for Frame Relays DLCI. How this is done is up to the network provider. Frame Relay, by virtue of having no network layer procedures is connection-oriented at layer two, by using the HDLC/LAPD/LAPB Set Asynchronous Balanced Mode (SABM). X.25 connections are typically established for each communication session, but it does have a feature allowing a limited amount of traffic to be passed across the UNI without the connection-oriented handshake. For a while, Frame Relay was used to interconnect LANs across wide area networks. However, X.25 and well as Frame Relay have been supplanted by the Internet Protocol (IP) at the network layer, and the Asynchronous Transfer Mode (ATM) and or versions of Multi-Protocol Label Switching (MPLS) at layer two. A typical configuration is to run IP over ATM or a version of MPLS. < Uyless Black, ATM, Volume I, Prentice Hall, 1995>

ARPANET and SITA HLN became operational in 1969. Before the introduction of X.25 in 1973, about twenty different network technologies had been developed. Two fundamental differences involved the division of functions and tasks between the hosts at the edge of the network and the network core. In the datagram system, the hosts have the responsibility to ensure orderly delivery of packets. The User Datagram Protocol (UDP) is an example of a datagram protocol. In the virtual call system, the network guarantees sequenced delivery of data to the host. This results in a simpler host interface with less functionality than in the datagram model. The X.25 protocol suite uses this network type.

AppleTalk was a proprietary suite of networking protocols developed by Apple Inc. in 1985 for Apple Macintosh computers. It was the primary protocol used by Apple devices through the 1980s and 90s. AppleTalk included features that allowed local area networks to be established ad hoc without the requirement for a centralized router or server. The AppleTalk system automatically assigned addresses, updated the distributed namespace, and configured any required inter-network routing. It was a plug-n-play system.

The CYCLADES packet switching network was a French research network designed and directed by Louis Pouzin. First demonstrated in 1973, it was developed to explore alternatives to the early ARPANET design and to support network research generally. It was the first network to make the hosts responsible for reliable delivery of data, rather than the network itself, using unreliable datagrams and associated end-to-end protocol mechanisms. Concepts of this network influenced later ARPANET architecture.

DECnet is a suite of network protocols created by Digital Equipment Corporation, originally released in 1975 in order to connect two PDP-11 minicomputers. It evolved into one of the first peer-to-peer network architectures, thus transforming DEC into a networking powerhouse in the 1980s. Initially built with three layers, it later (1982) evolved into a seven-layer OSI-compliant networking protocol. The DECnet protocols were designed entirely by Digital Equipment Corporation. However, DECnet Phase II (and later) were open standards with published specifications, and several implementations were developed outside DEC, including one for Linux.

In 1965, at the instigation of Warner Sinback, a data network based on this voice-phone network was designed to connect GE's four computer sales and service centers (Schenectady, Phoenix, Chicago, and Phoenix) to facilitate a computer time-sharing service, apparently the world's first commercial online service. (In addition to selling GE computers, the centers were computer service bureaus, offering batch processing services. They lost money from the beginning, and Sinback, a high-level marketing manager, was given the job of turning the business around. He decided that a time-sharing system, based on Kemney's work at Dartmouth—which used a computer on loan from GE—could be profitable. Warner was right.)

Merit Network, Inc., an independent non-profit 501(c)(3) corporation governed by Michigan's public universities, was formed in 1966 as the Michigan Educational Research Information Triad to explore computer networking between three of Michigan's public universities as a means to help the state's educational and economic development. With initial support from the State of Michigan and the National Science Foundation (NSF), the packet-switched network was first demonstrated in December 1971 when an interactive host to host connection was made between the IBM mainframe computer systems at the University of Michigan in Ann Arbor and Wayne State University in Detroit. In October 1972 connections to the CDC mainframe at Michigan State University in East Lansing completed the triad. Over the next several years in addition to host to host interactive connections the network was enhanced to support terminal to host connections, host to host batch connections (remote job submission, remote printing, batch file transfer), interactive file transfer, gateways to the Tymnet and Telenet public data networks, X.25 host attachments, gateways to X.25 data networks, Ethernet attached hosts, and eventually TCP/IP and additional public universities in Michigan join the network. All of this set the stage for Merit's role in the NSFNET project starting in the mid-1980s.

Telenet was the first FCC-licensed public data network in the United States. It was founded by former ARPA IPTO director Larry Roberts as a means of making ARPANET technology public. He had tried to interest AT&T; in buying the technology, but the monopoly's reaction was that this was incompatible with their future. Bolt, Beranack and Newman (BBN) provided the financing. It initially used ARPANET technology but changed the host interface to X.25 and the terminal interface to X.29. Telenet designed these protocols and helped standardize them in the CCITT. Telenet was incorporated in 1973 and started operations in 1975. It went public in 1979 and was then sold to GTE.

Tymnet was an international data communications network headquartered in San Jose, CA that utilized virtual call packet switched technology and used X.25, SNA/SDLC, BSC and ASCII interfaces to connect host computers (servers)at thousands of large companies, educational institutions, and government agencies. Users typically connected via dial-up connections or dedicated async connections. The business consisted of a large public network that supported dial-up users and a private network business that allowed government agencies and large companies (mostly banks and airlines) to build their own dedicated networks. The private networks were often connected via gateways to the public network to reach locations not on the private network. Tymnet was also connected to dozens of other public networks in the U.S. and internationally via X.25/X.75 gateways. (Interesting note: Tymnet was not named after Mr. Tyme. Another employee suggested the name.)

There were two kinds of X.25 networks. Some such as DATAPAC and TRANSPAC were initially implemented with an X.25 external interface. Some older networks such as TELENET and TYMNET were modified to provide a X.25 host interface in addition to older host connection schemes. DATAPAC was developed by Bell Northern Research which was a joint venture of Bell Canada (a common carrier) and Northern Telecom (a telecommunications equipment supplier). Northern Telecom sold several DATAPAC clones to foreign PTTs including the Deutsche Bundespost. X.75 and X.121 allowed the interconnection of national X.25 networks. A user or host could call a host on a foreign network by including the DNIC of the remote network as part of the destination address.[citation needed]

AUSTPAC was an Australian public X.25 network operated by Telstra. Started by Telecom Australia in the early 1980s, AUSTPAC was Australia's first public packet-switched data network, supporting applications such as on-line betting, financial applications — the Australian Tax Office made use of AUSTPAC — and remote terminal access to academic institutions, who maintained their connections to AUSTPAC up until the mid-late 1990s in some cases. Access can be via a dial-up terminal to a PAD, or, by linking a permanent X.25 node to the network.[citation needed]

Datanet 1 was the public switched data network operated by the Dutch PTT Telecom (now known as KPN). Strictly speaking Datanet 1 only referred to the network and the connected users via leased lines (using the X.121 DNIC 2041), the name also referred to the public PAD service Telepad (using the DNIC 2049). And because the main Videotex service used the network and modified PAD devices as infrastructure the name Datanet 1 was used for these services as well. Although this use of the name was incorrect all these services were managed by the same people within one department of KPN contributed to the confusion.

The Computer Science Network (CSNET) was a computer network funded by the U.S. National Science Foundation (NSF) that began operation in 1981. Its purpose was to extend networking benefits, for computer science departments at academic and research institutions that could not be directly connected to ARPANET, due to funding or authorization limitations. It played a significant role in spreading awareness of, and access to, national networking and was a major milestone on the path to development of the global Internet.

Internet2 is a not-for-profit United States computer networking consortium led by members from the research and education communities, industry, and government. The Internet2 community, in partnership with Qwest, built the first Internet2 Network, called Abilene, in 1998 and was a prime investor in the National LambdaRail (NLR) project. In 2006, Internet2 announced a partnership with Level 3 Communications to launch a brand new nationwide network, boosting its capacity from 10 Gbit/s to 100 Gbit/s. In October, 2007, Internet2 officially retired Abilene and now refers to its new, higher capacity network as the Internet2 Network.

The National Science Foundation Network (NSFNET) was a program of coordinated, evolving projects sponsored by the National Science Foundation (NSF) beginning in 1985 to promote advanced research and education networking in the United States. NSFNET was also the name given to several nationwide backbone networks operating at speeds of 56 kbit/s, 1.5 Mbit/s (T1), and 45 Mbit/s (T3) that were constructed to support NSF's networking initiatives from 1985-1995. Initially created to link researchers to the nation's NSF-funded supercomputing centers, through further public funding and private industry partnerships it developed into a major part of the Internet backbone.

The Very high-speed Backbone Network Service (vBNS) came on line in April 1995 as part of a National Science Foundation (NSF) sponsored project to provide high-speed interconnection between NSF-sponsored supercomputing centers and select access points in the United States. The network was engineered and operated by MCI Telecommunications under a cooperative agreement with the NSF. By 1998, the vBNS had grown to connect more than 100 universities and research and engineering institutions via 12 national points of presence with DS-3 (45 Mbit/s), OC-3c (155 Mbit/s), and OC-12c (622 Mbit/s) links on an all OC-12c backbone, a substantial engineering feat for that time. The vBNS installed one of the first ever production OC-48c (2.5 Gbit/s) IP links in February 1999 and went on to upgrade the entire backbone to OC-48c.