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PERSONAL COMPUTING AND COMMUNICATIONS

DENNIS LONGLEY &
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A

abbreviated addressing In programming, a process that enables a user to employ an address having fewer characters than the full address. It provides a faster means of processing data because the shorter address requires less time to decode. *See* ADDRESSING.

ABEND In operations, an ABnormal END of a task prior to its completion on a mainframe because of an error. A microcomputer in emulation mode should be programmed to handle this in a controlled manner. *See* TERMINAL EMULATION.

abort In operations, to terminate, in a controlled manner, a processing activity in a computer system because it is impossible or undesirable for the activity to proceed.

abscissa In mathematics, the horizontal axis of a coordinate graph. *Compare* ORDINATE. *See* CARTESIAN COORDINATES, COORDINATE GRAPH.

absolute address In programming, (1) an address in a computer language that identifies a storage location or a device without the use of any intermediate reference, (2) an address that is permanently assigned by the machine designer to a storage location, (3) a pattern of characters that identifies a unique storage location or device without further modification. *See* ADDRESS.

absolute assembler In programming, a specific type of assembly language program designed to produce binary programs containing only absolute addresses and address references. *See* ABSOLUTE ADDRESS, ASSEMBLING.

absolute code In programming, a code that uses computer instructions with absolute addresses. *See* ABSOLUTE ADDRESS.

absolute loader In programming, a routine that reads a computer program into main memory, beginning at the assembled origin. *See* ASSEMBLING, LOADER, MAIN MEMORY.

absolute value In mathematics, the value of a number regardless of a prefixed plus or minus sign, i.e. the absolute value of -5 is 5.

abstract data type In data structures, a data type that is defined solely in terms of the operations that can be performed on objects of that type and the range of values that it can take, without regard to the method of representation of the value. *See* TYPE.

AC *See* ACCUMULATOR, ALTERNATING CURRENT.

ACC *See* ACCUMULATOR.

acceleration potential In electronics, the voltage between the cathode and the face of the tube which attracts the beam of focused electrons, causing them to impinge on the phosphor dots. *See* CRT, PHOSPHOR DOTS.

acceptance testing In operations, a series of tests designed to demonstrate the functional capabilities of a new computer system. It is usually conducted by the manufacturer to show the customer that the system is in working order.

ACCESS US Army Automated Catalog of Computer Equipment and Software Systems.

access In programming, the manner in which files or data sets are referred to by the computer. *See* DIRECT ACCESS, RANDOM ACCESS, SEQUENTIAL ACCESS.

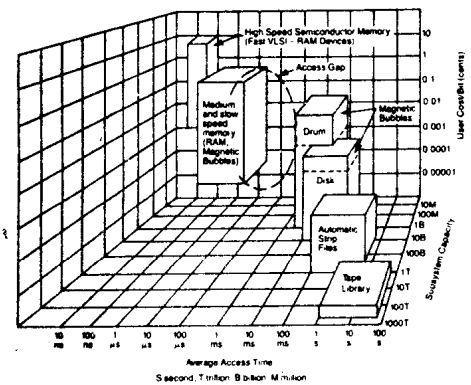
access arm In backing storage, a mechanical device in a disk drive that positions the reading and writing mechanisms. *See* DISK DRIVE, HEAD.

access barred In data communications, a data facility that permits a terminal installation to make outgoing, or receive incoming, calls but not both.

access control (1) In computer networks, the control of system usage, imposed by hardware, software and administrative controls. Such controls include system monitoring, user identification, ensuring data integrity, recording system access and changes and methods for granting user access. *See* HARDWARE, SOFTWARE. (2) In databases, the control of the use of the database information. Access to a particular user may be restricted both in terms of the data items that may be made available and the operations that may be performed on it, e.g. read, update etc.

access line In data communications, a telecommunication line that continuously connects a remote station to a DSE. A telephone number is associated with such lines. *See* DSE.

access time In backing storage, the time interval between the instant that data is requested from the storage device to the instant that it is delivered to the CPU, and vice versa. The average access time for magnetic disk systems is usually based upon the assumption that the read/write heads will have to move over one-third of the maximum number of tracks in a random seek operation. *Compare* SEEKS PER HOUR. *See* CPU, MAGNETIC DISK, READ/WRITE HEAD, TRACK.



access time
Memory cost/performance trade off.

accidental destruction In data security, the unintentional overwriting or deletion of data, e.g. by faulty hardware or software. Backup is needed for recovery. *See* BACKUP COPY.

accordion fold In printing, a method of folding paper in which each fold is in the opposite direction to the previous one. A printer can be fed with accordion-folded paper without continuous operator intervention.

accumulator In architecture, a device that functions as a holding register for arithmetic, logical and input/output operations. In some CPUs, data words fetched from memory are loaded into the accumulator and words to be stored into memory are first loaded into this register. *See* CPU, INPUT/OUTPUT, REGISTER.

accuracy In mathematics, the degree of exactness of an approximation or measurement. It denotes the absolute quality of the result with respect to its true value, as compared with precision which is concerned with the amount of detail used in specifying a result. Thus a two-digit result may be more accurate than an incorrect three-digit result, but it will be less precise. *See* PRECISION.

Aces In computer languages, a continuous simulation language. *See* CONTINUOUS SIMULATION.

achromatic color In computer graphics, an intermediate gray level in the monochromatic gray scale. *See* GRAY SCALE.

ACIA *See* ASYNCHRONOUS COMMUNICATIONS INTERFACE ADAPTOR.

ACK *See* ACKNOWLEDGE CHARACTER.

acknowledge character In data communications, a character transmitted by a station as an affirmative response to the station with which the connection has been set up. *Compare* NEGATIVE ACKNOWLEDGEMENT. *See* ACKNOWLEDGEMENT, STATION.

acknowledgement In data communications, the transmission by a receiver of acknowledge characters as a response to a sender. *See* AFFIRMATIVE ACKNOWLEDGEMENT, NEGATIVE ACKNOWLEDGEMENT.

ACK0 *See* AFFIRMATIVE ACKNOWLEDGEMENT.

ACK1 *See* AFFIRMATIVE ACKNOWLEDGEMENT.

ACM *See* ASSOCIATION FOR COMPUTING MACHINERY.

acoustic coupler In data communications, a device to interface an item of equipment, producing digital signals, to a telephone network. Sound transducers in the acoustic coupler produce sound tones corresponding to the digital signals; a telephone handset is placed in contact with the sound transducers so that these tones can be input into the telephone network. *See* MODEM, TRANSDUCER.

action message In operations, a message issued because of a condition that requires an operator response.

activation In computer networks, the process by which a component of a node is made ready to perform the functions for which it was designed. *See* NODE.

active device In electronics, a circuit that contains an amplifier providing gain. *Compare* PASSIVE DEVICE. *See* AMPLIFIER, GAIN.

active file In data structures, a permanent or temporary file, having an expiration date that is later than the job date. *See* JOB.

active state In microelectronics, the digital state that causes a given action to occur. It may be either the high state or low state, depending on the circuit and pin in question.

active wire concentrator In computer networks, cabinets with star connection to individual nodes. In some local area networks, they are connected in a ring, thus providing a combined ring/star configuration. *See* LOCAL AREA NETWORK, NODE, RING, STAR.

activity In data processing, the percentage of records in a file that are processed in a run. *See* VOLATILITY.

activity loading In data processing, a method of storing records on a file in which the most frequently processed records can be located most readily. *See* RECORD.

activity ratio In data processing, the ratio of the number of records in a file that are in use to the total number of records in that file. *See* RECORD.

ACTSU US Association of Computer Time Sharing Users.

actual data transfer rate In data communications, the average number of bits, characters or blocks, per unit time, transferred from a data source and received by a data sink. *See* DATA SINK, SOURCE.

actuator In hardware, a device that is capable of mechanical action under the control of a signal. *See* INDUSTRIAL ROBOTS.

ACU *See* AUTOMATIC CALLING UNIT.

Ada A trademark, in programming, a language named after Augusta Ada, Countess of Lovelace who assisted Babbage.

(a) Main applications. Ada was developed for use in computer control and communication systems, where instruments or systems are monitored or governed by a program. Typical uses include factory production lines, data recording in laboratories, navigational systems, networking and interfacing of multiple processors. Ada is aimed at installations with a long lifespan where software modification and maintenance are of major concern.

(b) Originated in the US Department of Defense in the late 1970s.

(c) Facilities. Ada is essentially derived from Pascal. This entry will therefore concentrate upon those additional features that are unique to it. Heavy emphasis is placed upon program readability; it is considered that it is more important for the program to be easily understood than rapidly written. In many applications the cost of maintenance can be an order of magnitude greater than that of the original production. The language is therefore rigidly structured and data typing is strongly enforced; even simple operations require a substantial block of code. Machine independence is assisted by the modular nature of Ada, ensuring that

implementation details are confined to a few specialized interface packages.

An unusual feature of this language lies in its provision for programmable exception handling. Whereas most languages assume the correctness of finished programs, and exceptional conditions are detected and handled by the operating system, Ada recognizes that the nature of realtime operation, hardware communication and large sections of code render total reliability unattainable, and so allows for the software detection and correction of errors without recourse to human intervention. In many control applications, e.g. those involving heavy machinery, it is vital that the advent of a run time fault does not cause the software to cease to operate.

Concurrent programming is supported to permit the control of parallel processes, through the declaration of tasks whose execution is interleaved. Tasks may communicate, usually by means of a rendezvous, and nondeterministic operation is permitted. Ada programs may not be necessarily supported by an operating system in the host computer, and they must therefore take command of the necessary input/output and housekeeping operations. Hence a specialized support environment for developing and testing code has been investigated for the language.

In Ada the major units of program structure are the package and the procedure. Packages may be separately compiled but where this is done the package must come in two parts: the specification part, which defines the package interface; and the body or implementation part. The purpose of the separation is to permit the compiler to check for valid interface usage in the same way as languages such as Pascal do within a single compilation unit. The package constructed thus assists in the correct implementation of very large programs and provides a framework for the creation of abstract data types.

(d) Syntax. Ada is a block-structured language that centers upon the nesting of statement sequences, successive statements being separated by semicolons. A substantial amount of data and control declarations are required by the compiler, and, as for Pascal, the precise rules are described by a complex set of graphic syntax diagrams.

(e) Sample program. The following complete program declares two integers, reads them as input and prints out the largest, having invoked the package TEXTI0 to perform input/output operations.

```
with TEXT I0; use TEXT I0;
procedure DEMO is
pragma main;
P,Q: integer range 0..100;
begin
GET(P);GET(Q);
NEW LINE;
if P>Q then PUT(P);
else PUT(Q);
end if;
end DEMO;
```

(f) Comments. Ada is a relatively new language whose real worth may not become apparent for some years. While it has many advantages in the programming of control computers and other realtime activities, with associated ease of software maintenance, it is highly verbose and unlikely to compete with the established block-structured languages for more mundane tasks.

(g) Similar to Pascal, C, PL/1. *see* ABSTRACT DATA TYPE, BLOCK STRUCTURE, C, COMPILER, CONCURRENT PROGRAMMING, DATA ACQUISITION, DATA TYPE, DECLARATION, HISTORY OF COMPUTING, HOST COMPUTER, HOUSEKEEPING, NEST, PARALLEL PROCESSING, PASCAL, PL1, REALTIME, RENDEZVOUS, SOFTWARE MAINTENANCE, SYNTAX.

ADAPSO US and Canada Association of Data Processing Service Organizations.

adaptive channel allocation In communications, a method of multiplexing where channels are allocated according to demand rather than on a fixed, predetermined plan. *See* FREQUENCY DIVISION MULTIPLE ACCESS, MULTIPLEXING, TIME DIVISION MULTIPLE ACCESS.

adaptive routing In data communications, a routing scheme for packets or messages in which the behavior adapts to network changes such as line failures or variation of the traffic pattern. *See* MESSAGE SWITCHING, PACKET SWITCHING, ROUTING.

adaptive systems Systems that display the ability to learn to change, alter their state or otherwise react to a stimulus.

ADC *See* ANALOG TO DIGITAL CONVERTER.

ADCCP *See* ADVANCED DATA COMMUNICATIONS CONTROL PROCEDURE.

A/D converter *See* ANALOG TO DIGITAL CONVERTER.

addend In mathematics, the operand of the addition operation, the number added to the augend to form a sum. *See* AUGEND, OPERAND.

adder In architecture, a device that forms an output resulting from the sum of two or more numbers presented as inputs. *See* FULL ADDER, HALF ADDER.

add-in In hardware, an expansion card that slots into a microcomputer to provide additional facilities. This is a very simple method of enhancing a microcomputer. The boards available allow for additional RAM, additional operating facilities, particularly CP/M, enhanced graphics, modems, instrumentation etc. *See* CP/M, EXPANSION CARD, MODEM, RAM.

address In programming, (1) a character or group of characters that identifies a register, a particular part of storage, or some other data source or destination, (2) to refer to a device or an item of data by its address. (3) In communications, the part of the selection signals that indicates the destination of a call. (4) In word processing, the location, identified by an address code, of a specific section of the recording medium or storage.

addressability In computer graphics, the number of addressable points within a specified display space or image space. *See* DISPLAY SPACE, PICTURE ELEMENT.

address bus In buses, a unidirectional bus over which digital information is transmitted to identify either a particular memory location or a particular input/output device. *Compare* CONTROL BUS, DATA BUS. *See* BUS, INPUT/OUTPUT DEVICE, MICROCOMPUTER.

address field In programming, the specific portion of a computer word that contains either the address of the operand or the information necessary to derive that address. *See* OPERAND, WORD.

address format In programming, the arrangement of the parts of a simple address, such as those required for identifying a channel, module or track on a magnetic disk. *See* ADDRESS, MAGNETIC DISK, TRACK.

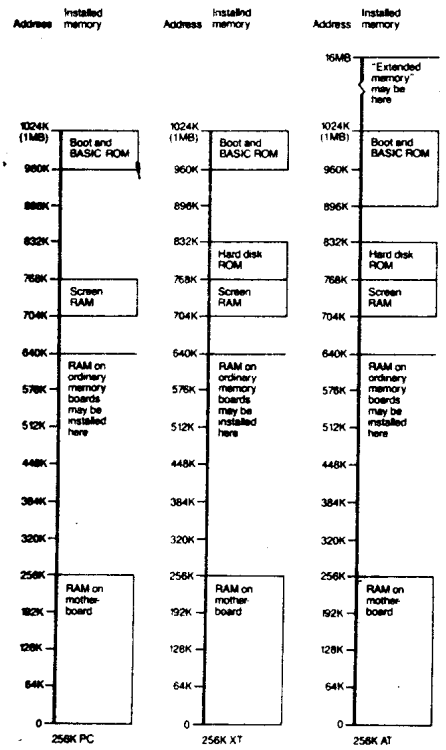
addressing (1) In programming, the assignment of addresses to the instructions of a program. (2) In communications, the means whereby the originator or control station selects the unit to which it is going to send a message. *See* STATION.

addressing mode In programming, the method of specifying the location of data during the execution of a machine code instruction. At the simplest level the operand may contain the actual address of the data or, in the immediate mode, the data itself.

Locating the absolute address in the operand, however, is uneconomic, inflexible and inefficient for many operations. Uneconomic because with a 1-Mbyte address space each operand of each instruction would need to be 20 bits long. Inflexible because there would be no straightforward method of using the same instruction to access successive locations in successive invocations, e.g. in a loop performing a table lookup. Inefficient because every data operation would involve transfer of data between main memory and the CPU. The major disadvantage and restriction to this mode, however, is that the program can only be executed from one position in memory.

With relative addressing the operand contains a quantity that represents a displacement from the current value of the instruction pointer. This is often used in jump instructions and has both the advantage that the displacement requires fewer bits than the absolute address and that the instruction will function correctly if the program is relocated.

Register addressing is employed to enhance the power of instruction sets. Register addresses may be implicit with the instruc-



address spaces in an IBM-PC, XT and AT

tion or a particular register may be specified with a few bits of the instruction. Data moves from one register to another are fast and efficient because they require no traffic on the data bus. More importantly, however, register addressing provides both high flexibility in programming and facilitates memory management. Indexed addressing provides a data address by combining the contents of an index register with the fixed value of an operand; this technique is essential to update addresses in loop operations.

Indirect addressing implies that the memory location accessed contains not the required information but the address of that information; this technique provides for considerable flexibility in programming because the location of the requisite information can be changed during program execution. 16-bit microcomputers provide for very sophisticated addressing modes; the Intel 8088/8086 has 25 such modes. A range of registers is employed to facilitate segmentation, program relocation and the accessing of sophisticated data structures. For example, an address in an 8088/8086 instruction may involve the contents of segment register, a base register, an index register and a displacement. *See* ABSOLUTE ADDRESS, ADDRESS, BIT, BYTE, CPU, DATA BUS, DATA STRUCTURE, IMMEDIATE ADDRESS, INDEXED ADDRESS, INDEX REGISTER, INDIRECT ADDRESS, INSTRUCTION COUNTER, LOOKUP TABLE, LOOP, MACHINE CODE INSTRUCTION, MEMORY MANAGEMENT, MEMORY ORGANIZATION.

address modification In programming, an action that causes an address to be altered in a prescribed way by an arithmetic, syntactic or logic operation. *See* ADDRESSING MODE.

address register In architecture, a special register used by the CPU to store the address of data to be fetched from, or stored in, the computer memory. *See* CPU, REGISTER.

address space In architecture, the number of memory cells that may be accessed by the CPU. If an 8-bit processor employs a 2-byte address then the address space is 65,536 cells, and each cell normally holds 1 byte. With 16-bit microprocessors the address bus normally has 20 lines giving an address space in excess of 1 Mbyte. Bank-switching techniques can be employed to reduce the disadvantages of a small address space. *See* BANK SWITCHING, BYTE, CPU, 8-BIT MICROPROCESSOR, 16-BIT MICROPROCESSOR.

address track In backing storage, a track on a magnetic disk containing the addresses of files, records etc. stored on other tracks of the same device. *See* MAGNETIC DISK, TRACK.

add time In performance, the time required by a particular CPU to add two multidigit numbers, not including the time taken to read the numbers or store the result. Microcomputers are often rated by comparing add times as a criterion of their relative speed. *See* MICROCOMPUTER.

ADIS Automatic Data Interchange System.

adjacency In character recognition, a condition in which the character spacing reference lines, of two consecutively printed characters on the same line, are separated by less than a specified distance.

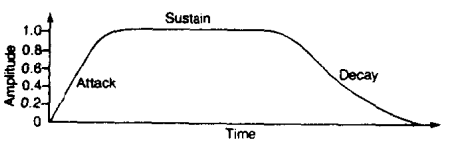
adjacent channel In communications, the next channel, or the one in close proximity, either physically or electrically, to the one in current use. *See* CHANNEL.

adjust In word processing, an editing feature in which the system automatically adjusts the right-hand margin for insertion or deletion of copy during playback. Word, and sometimes page, wraparound is automatically performed as needed. *See* WRAPAROUND.

ADLC *See* ADVANCED DATA LINK CONTROL.

ADP *See* AUTOMATIC DATA PROCESSING.

ADSR In man–machine interfaces, Attack Decay Sustain Release; the shape of the envelope that modulates the amplitude of a periodic waveform such as a sawtooth or sine wave. The sound generator chip of a microcomputer can be programmed to produce music by varying the ADSR and the modulating waveform. *See* MODULATION, MUSIC SYNTHESIZER, SAWTOOTH, SINE WAVE.



ADSR
Typical amplitude envelope shape for a musical note.

advanced data communications control procedure In data communications, pertaining to the operation of a data link using an advanced (SDLC, HDLC) protocol. *See* HDLC, PROTOCOL, SDLC.

advanced data link control In data communications, a link protocol used in HDLC and SDLC systems. *See* HDLC, SDLC.

AECT US Association for Educational Communication and Technology.

affine closure In mathematics, a representation of infinity in which the positive and negative infinities are considered to be at opposite 'ends' of a line of all real numbers. *Compare* PROJECTIVE CLOSURE. *See* INFINITY, REAL NUMBER.

affirmative acknowledgement In data communications, the replies ACK0 and ACK1 in binary synchronous transmission indicate that the previous transmission block was accepted by the receiver and that it is ready to accept the next block. ACK0 and ACK1 sent alternately provide sequential checking for a series of replies. ACK0 is also used as an affirmative reply to station selection signal in a multidrop circuit, or to an initialization sequence in a point to point operation. *See* BINARY SYNCHRONOUS COMMUNICATIONS, MULTIDROP CIRCUIT, POINT TO POINT.

AFIPS American Federation of Information Processing Inc. A federation founded in 1961 which includes the American Society for Information Science, American Statistical Association, Association for Computing Machinery, Association for Education Data Systems, Data Processing Management Association, IEEE Computer Society, Instrument Society of America, Society for Computer Simulation, Society for Industrial and Applied Mathematics, Society for Information Display. It is the US member of IFIP. *See* IFIP.

AFNOR Association Française de NORmalisation — the French standards organisation.

afterglow *Synonymous with* PERSISTENCE.

after image In databases, a copy of a record after it has been modified by a user, or program. If there is a system failure the after images can be used to update the database from a previous dump. *Compare* BEFORE IMAGE. *See* DUMP, TRANSACTION.

AI *See* ARTIFICIAL INTELLIGENCE.

air gap In backing storage, the very narrow gap between the two elements of a magnetic recording or playback head. *See* HEAD.

alarm In operations, a visual or audio signal to signify that an error has arisen or an abnormal situation exists.

ALGOL In programming, ALGOrithmic Language, an early block-structured language providing many elegant features that were lacking in other early high-level languages. It has been largely superseded by Pascal. *See* HIGH-LEVEL LANGUAGE, PASCAL, PROGRAMMING.

algorithm In progamming, a finite set of well-defined rules for the solution of a problem in a finite number of steps; for example, a precise description of the steps involved in determining the record with the highest value of a specified numerical attribute. *See* ATTRIBUTE, PROGRAMMING, RECORD.

algorithmic language A computer language designed for expressing algorithms. *See* ALGOL.

algorithmic pattern generation In memory systems, a method of testing RAM in which a binary pattern is written and the RAM is subsequently read to verify that it was written correctly, and that the writing into one area of RAM did not affect the data stored in another section. *See* FIXED PATTERN TESTING, GALLOPING PATTERN TESTING, RAM.

alias In operating systems, a Unix shell command that enables the user to set up another name for a Unix program, e.g. the user could replace 'ls' with the more mnemonic term 'list directory'. *See* LS, SHELL, UNIX.

aliasing (1) An effect that occurs when a signal is sampled at a rate less than twice the highest frequency present in it. When a subsequent signal is recovered from the samples it will not contain the high-frequency component of the original signal, and it will instead display a false low-frequency signal. *See* NYQUIST SAMPLING THEOREM. (2) In computer graphics, an effect that occurs when a computer attempts to handle detail of a diagram which exceeds the basic resolving power of the system, e.g. the staircase effect produced when a low-resolution computer graphic system attempts to display a diagonal line. *Compare* ANTI-ALIASING.

aligning edge In optical character recognition, the edge of a form which, in conjunction with the leading edge, serves to position correctly the document that is to be scanned. *See* SCAN.

alignment pin In electronics, any pin or device that will ensure the correct mating of two components designed to be connected.

allocate In operating systems, (1) to assign a resource, such as a disk or a diskette file, to a specific task. *See* FILE, MAGNETIC DISK, TASK. (2) To assign memory allocations to main routines and subroutines. *See* SUB-ROUTINE.

allophone In man–machine interfaces, a manifestation of a phoneme in a speech signal. A phoneme may be acoustically different depending upon word position and an allophone is a positional variant of the same phoneme. *See* PHONEME, SPEECH SYNTHESIZER.

Aloha In computer networks, a packet-switched system at the University of Hawaii which uses radio broadcast techniques.

alphabet (1) An ordered set of all the letters and associated marks used in a language or work. (2) An ordered set of letters used in a code language, e.g. the 128 characters of the ASCII alphabet. *See* ASCII.

alpha beta technique In artificial intelligence, a technique used in game-playing routines to determine the best set of moves for a given player. The player will pick the set of moves to maximize his score while the adversary will always attempt to select moves that will minimize his losses. The successive set of moves can be represented by a tree structure, one player having the choice of branches from one level and the adversary the choice at the next level. The alpha beta technique eliminates subtrees to be searched from the tree, on the basis that both players using optimal strategies would never employ such subtrees, thus reducing

the effort of searching for optimum moves. *See* TREE STRUCTURE.

alphabetic character set A character set that contains letters but not digits. The set may contain control characters, special characters and the space character. *Compare* ALPHANUMERIC. *See* CONTROL CHARACTER.

alphabetic shift In peripherals, a control for selecting the alphabetic character set in an alphanumeric keyboard printer.

alphabetic string A character string consisting of letters from the same alphabet. *See* STRING.

alphageometric In computer graphics, a standard in which the codes can instruct the terminal to produce line drawings, fill areas with color etc. in addition to normal character display modes. *Compare* ALPHAMOSAIC. *See* NAPLPS, VIDEOTEX.

alphamosaic In computer graphics, a standard in which the codes determine the alphanumeric character or mosaic pattern to be displayed in a character space. *Compare* ALPHAGEOMETRIC. *See* ALPHANUMERIC, CHARACTER SPACE, VIDEOTEX.

alphanumeric Pertaining to a character set that contains letters, digits and usually other characters, e.g. punctuation marks.

alphanumeric character set A character set that contains both letters and digits and may contain control characters, special characters and the space character. *See* ALPHANUMERIC.

alphanumeric data Data represented by letters and digits and perhaps special characters and the space character. *See* ALPHANUMERIC.

alphanumeric display device *Synonymous with* CHARACTER DISPLAY DEVICE.

alphanumeric keyboard In videotex, a keyboard used for entering letters, numbers and special characters. It is required by IPs for creating frames. Users with this keyboard can send messages via electronic mail or fill response frames with alphanumeric information. Users who are only equipped with numeric keypads enter such information in a format determined by a predefined menu selection. *See* ALPHANUMERIC, ELECTRONIC MAIL, FRAME, IP, KEYPAD, RESPONSE FRAME.

alphanumerics mode In videotex, the display mode in which the display characters are those of the alphanumerics set. *Compare* GRAPHICS MODE. *See* DISPLAY MODE.

alphanumerics set In videotex, the set of 96 display characters comprising all the alphanumerics characters. *See* DISPLAY CHARACTER.

alphaphotographic In videotex, a method of displaying alphanumeric characters and picture quality graphics from individually transmitted and stored picture elements. *See* PICTURE PRESTEL.

alpha testing In programming, the in-house testing of a package by a software house prior to beta testing. There are a wide variety of conditions under which a software package is used, and the testing phase of product development can be as much as three times as expensive as the development phase. *Compare* BETA TESTING. *See* SOFTWARE HOUSE.

Altair bus *Synonymous with* S100.

alternate route In communications, a secondary or backup route that is used if normal routing is not possible.

alternate track In backing storage, a track on a magnetic disk or other storage device, which is automatically substituted for a damaged track. *See* MAGNETIC DISK, TRACK.

alternating current In electronics, electric power supply in the form of a sine wave, normally a frequency of 60 Hz in the USA, and 50 Hz in the UK. *Compare* DIRECT CURRENT. *See* Hz.

ALU *See* ARITHMETIC LOGIC UNIT.

Alvey A programme, named after Mr John Alvey, of pre-competitive research in ad-

vanced information technology costing some £300 million over five years. *See* ESPRIT.

AM *See* AMPLITUDE MODULATION.

ambient noise level In electronics, random, uncontrollable and irreducible noise level at a location or circuit. *See* NOISE.

American National Standards Institute A body that organizes committees formed of computer users, manufacturers etc., to develop and publish industry standards, e.g. ANSI FORTRAN, ANSI Standard Code for Periodical Identification.

ampere In electronics, the basic unit of electrical current. *Compare* VOLT. *See* CURRENT.

amplification In electronics, (1) the strengthening of a weak signal, (2) the ratio between some measure of the output signal and the input signal of a device. *Compare* ATTENUATION.

amplifier In electronics, a normally unidirectional device that increases the power or amplitude of an electrical signal. *See* AMPLITUDE.

amplitude In electronics, the magnitude of the greatest deviation from the midpoint value of a periodic signal or phenomenon. *See* FREQUENCY, WAVELENGTH.

amplitude modulation In communications, a form of modulation in which the amplitude of the carrier signal is varied in accordance with the amplitude of the modulating signal. *Compare* FREQUENCY MODULATION, PHASE MODULATION. *See* CARRIER, MODULATION.

analog In computing and communications, pertaining to the form of continuously variable physical quantities. *Compare* DIGITAL. *See* ANALOG SIGNAL, TRANSDUCER.

analog channel In communications, a data channel in which the amplitude of the signal transmitted can take any value between the limits defined for the channel. Voice-grade channels are analog channels. *See* ANALOG.

analog computer A device that performs mathematical functions on continuous variables, usually voltages, and produces a solution in the form of an analog signal. They were used extensively in the study of dynamic systems and as simulators. The basic building block of the analog computer was the operational amplifier, used to produce the mathematical functions of addition, subtraction, integration and multiplication. Non-linear effects, e.g. saturation, were also effected with special diode units. Unlike digital computers they were parallel in operation, easy to program for their class of problems and relatively fast. They did not benefit, however, from the rapid advances in digital technology, and they are now obsolete except for special purpose applications. *See* DIGITAL COMPUTER, HYBRID COMPUTER, OPERATIONAL AMPLIFIER, SIMULATION.

analog data Data represented in a continuous form.

analog flux copier *Synonymous with* BIT COPIER.

analog signal A signal that varies continuously according to the information in transmission, e.g. sound waves. *Compare* DIGITAL SIGNAL.

analog to digital converter In control and instrumentation, a device that accepts a continuous analog signal and produces a stream of digital signals corresponding to values of the analog signal at sampling instants. The speed of conversion of the sampled signal may vary from less than 1 microsecond to up to 100 milliseconds. The converter may operate by successive approximation or integration.

The successive approximation method requires a period of 1 to 25 microseconds; the converter successively approximates the digital bits until an internally generated digital to analog converter output equals the analog input. The analog input must be held constant during the conversion period by a sample and hold device. This type of analog to digital converter is used for high sampling rates where the noise rejection is not a major problem.

The integration converter is used when the analog signal is subject to noise and high

sampling rates (i.e. greater than 1000 readings per second) are not required. The analog to digital conversion integrates the analog signal over a period of several milliseconds, thus averaging out the effects of noise. *Compare* DIGITAL TO ANALOG CONVERTER. *See* COMPUTERIZED INSTRUMENTATION, SAMPLE AND HOLD CIRCUIT.

analog transmission In communications, the transmission of information by analog signal. *See* ANALOG SIGNAL.

analysis The methodical investigation of a problem, and the separation of the problem into smaller related units for further detailed study. *Compare* SYNTHESIS. *See* SYSTEMS ANALYSIS.

analyst A person who defines problems and develops algorithms and procedures for their solution. *See* SYSTEMS ANALYSIS.

ancillary equipment In communications, equipment located in a subscriber's premises, e.g. answering devices, automatic dialers, to provide a greater utility of a communications channel for individual subscribers.

AND A logical operation, A AND B has the result true only if both of the logical variables A and B are true. The corresponding truth table is:

A	B	A AND B
0	0	0
1	0	0
0	1	0
1	1	1

Compare OR. *See* BOOLEAN ALGEBRA, TRUTH TABLE.

AND gate In electronics, a logic unit that produces an output signal that is the logical AND of the input signals. *Compare* OR GATE. *See* AND.

angstrom A unit of measurement equal to 10 to the power of minus 10 meters, i.e. one ten-millionth of a millimeter. Commonly used in the measurement of wavelengths of light.

animation In video and computer graphics, the projection of a continuous sequence of related images, at a speed that matches the human eye's inherent persistence of vision, to create a flicker-free image. At the average cinematic screen illumination the human eye detects no flicker for frequencies of intermission above approximately 16 per second. American television generates images at 30 frames per second, while the European standard is 25 frames per second. Conflicts arise in the television and video recording of films employing 24 frames per second. American television uses three two pulldown. British television transmits the film at 25 frames per second giving a speed increase of 4 percent and a rise in the sound pitch. *See* PERSISTENCE OF VISION, THREE TWO PULLDOWN.

anisochronous signal In electronics, a signal that is not related to any clock and in which transitions could occur at any instant. *See* ANISOCHRONOUS TRANSMISSION, CLOCK.

anisochronous transmission In data communications, a form of data transmission, similar to asynchronous transmission, but in which there can be variable time intervals between the bits within a character as well as between the characters themselves. *Compare* ISOCHRONOUS TRANSMISSION. *See* ASYNCHRONOUS TRANSMISSION, BIT.

A/N *See* ALPHANUMERIC.

annotation symbol In programming, a symbol used to add messages or notes to a flowchart. *See* FLOWCHART.

anode In electronics, the positive terminal of a device. *Compare* CATHODE.

ANSI *See* AMERICAN NATIONAL STANDARDS INSTITUTE.

ANSI MC11-1975 In buses, another designation for GPIB. *See* ANSI, GPIB.

ANSI-SPARC In databases, pertaining to schemata developed as a general standard for the description of database management systems. The standard defines three schemata: (a) a conceptual schema which provides a logical description of the data; (b) one or more user schemata which represent the users' views of the data; and (c) a physical schema which describes the manner in which the data is stored in the computer. *See* SCHEMA.

ANSI X3H3 In computer graphics, the ANSI Technical Committee on Computing Graphics Programming Languages. *See* ANSI.

answer back In data communications, a signal sent by a receiving unit to the sending station for identification or to indicate it is ready for transmission. *See* VOICE ANSWER BACK.

answering In data communications, the process of responding to a calling station to complete the establishment of a connection between data stations. *See* STATION.

answering time The time between the appearance of a signal and the response made to it.

anti-aliasing In computer graphics, a method of disguising the aliasing errors introduced by low-resolution graphics displays. The jagged edges produced by boundary pixels may be softened by adjusting the shading intensities to create a smoother transition of color changes. *Compare* ALIASING. *See* PIXEL.

anticipatory staging In operating systems, a technique in which blocks of data are moved from one storage device to another, with a shorter access time, in anticipation that they will be required by the program and before the program actually requests them. *Compare* DEMAND STAGING.

anticoincidence circuit In hardware, a logic circuit that only provides an output if different signals are received on the input lines. *Compare* COINCIDENCE CIRCUIT.

Antiope The French standard for character coding and display for videotex terminals.

APA In computer graphics, All Points Addressable. *Synonymous with* PIXEL.

APD *See* AVALANCHE PHOTODIODE.

aperture In architecture, a part of a mask that permits retention of the corresponding portions of data. *See* MASK.

APL In programming, A Programming Language.

(a) Main applications. APL is an unusual language in that it began life as a functional notation to express mathematical algorithms and was subsequently adapted for use as a programming language. It is extremely concise and has found favour mainly in mathematical applications, although it has also been used for tasks such as data retrieval, teaching and simulation. As an interactive, and interpreted, language it is more suited to one-off jobs and experimental tasks than large program construction.

(b) Originated from IBM in the late 1960s from Iverson's notation.

(c) Facilities. APL allows the expression of complex mathematical functions in a very compact manner, employing a special character set to this end. Whereas most languages can only operate directly upon single variables, APL handles complete data structures (arrays) with its primitive operations and thus offers a great saving of effort in many situations. Indeed, the whole language is based around the use of numeric and character arrays alone, providing simplicity at the cost of more elegant data structures.

APL provides a powerful range of mathematical and logical array functions, generator operations which permit sophisticated array manipulation and rather limited input/output facilities; its mathematical derivation gives rise to certain peculiarities such as right to left evaluation of expressions. The program constructs are rather weak; they are centered on the GO TO statement, but provision is made for recursive subprogram calls with parameter passing and local variables.

The interactive operation of APL is one of its most important features, the language is well suited to the rapid development of small programs for experimentation, or single runs of data processing. The user is allocated a temporary workspace for the creation of programs and variable storage, which can be loaded from, or stored into, a system library. The user is also afforded intimate control of code execution within this environment, to the extent that there is no real concept of a main program but rather a collection of subprograms which can be called into action, interrupted and rearanged at will.

(d) Syntax. The syntax is straightforward and homogeneous. A piece of code comprises a set of independent subprograms,

each composed of statements numbered by their order of execution. A statement may only be a single expression, although the variety is somewhat bewildering due to the many operators available.

(e) Typical program. An APL program for operations on the rows of a two dimensional array would have more the appearance of a complex mathematical expression than a statement of computer instructions.

(f) Comments. APL may perhaps be better described as a programming environment, than a language, since it is ill-equipped for the production of finished programs intended for intensive use. The dense code allows good execution speeds but also permits the construction of single statements that are almost unintelligible even to the highly experienced programmer. The impoverished program and data structures also restrict its range of applications, whereas the requirement of a special character set restricts its use on many computers. *See* ARRAY, DATA STRUCTURE, GO TO, INTERPRETER, LOCAL VARIABLE, PARAMETER PASSING, RECURSIVE ROUTINE, SYNTAX, SYSTEM LIBRARY, VECTOR, WORKSPACE.

application interface In distributed processing, a routine that enables a program in a microcomputer to communicate with the microprocessor on an emulator expansion card. This routine could be a sequence of operator commands for automating file uploading to the host. *See* EXPANSION CARD, HOST COMPUTER, SCRIPT, TERMINAL EMULATION, UPLOAD.

application layer In data communications, the topmost layer in the ISO Open Systems Interconnections model. The content of this layer is left to the users, and it is expected that standard protocols for specific industries will be developed. *Compare* DATA LINK LAYER, NETWORK LAYER, PHYSICAL LAYER, PRESENTATION LAYER, SESSION LAYER, TRANSPORT LAYER. *See* OPEN SYSTEMS INTERCONNECTION.

application-oriented language In programming, a language that has facilities or notations useful for solving problems in one or more specific classes of applications, e.g. numerical analysis, business data processing, simulation.

application program In programming, a program, usually written in-house, for a specific user application, e.g. payroll. *Compare* OPERATING SYSTEM, SOFTWARE PACKAGE, SOFTWARE TOOL. *See* IN-HOUSE.

architecture The specification of the relationships between parts of a computer system. All generations of computers prior to the fifth generation were based upon Von Neumann architecture. This architecture was the turning point in computer design because it incorporated the concept of stored program control, thus decoupling the hardware design from the detailed consideration of algorithms relating to applications and providing the incredible flexibility of modern computers. The traditional Von Neumann computer contains: (a) a single computing element incorporating a processor, communications and memory; (b) a linear organization of fixed-sized memory cells; (c) a one-level address space of memory cells; (d) a low-level machine language; (e) sequential centralized control of computation; and (f) a primitive input/output capability.

The Von Neumann architecture was the keystone of computer development for over 40 years, but it was designed in an era when electronic devices were expensive, large, relatively unreliable and dissipated considerable thermal power. Moreover the computer applications in the 1950s and 1960s were relatively straightforward and amenable to design by conventional high-level languages. The situation changed during the late 1970s; the software crisis can be, at least in part, attributed to the fact that relatively simple architectures can only be induced to perform complex processes by the design of sophisticated software. Moreover the massive advances in microelectronics have provided architecture designers with powerful, cheap, fast processors and memories. The wheel has thus undergone a complete revolution, and it is now more economical to design hardware modules for classes of problems.

The perceived shortcomings of current architectures are given below.

(a) They are not equipped with the necessary functions to process non-numeric data: sentences, symbols, speech, graphics and images. These function as are essential for user friendly man–machine interfaces.

(b) They are unable to provide the level of performance demanded by a wide range of

current problem areas.

(c) Decentralized computing is expensive and difficult to implement.

(d) System performance with conventional architectures appears to be close to a plateau.

(e) It is not clear that VLSI technology can be efficiently exploited with multimicrocomputer architecture.

Von Neumann architectures operate upon the cycle: control unit sends one instruction at a time to the ALU, the ALU performs one instruction at a time on a single piece of data extracted from memory for that purpose. This mechanism is very inefficient for modern applications, e.g. controlling the multifarious aspects of a sophisticated robot, analyzing images from TV cameras. Parallel processing is essential for these and many other modern areas of computer application. Attempts to develop parallel processor architecture have been made, e.g. ICL distributed array processor and London University College CLIP-4 machine. With the ever-decreasing cost of processors, multiprocessor architectures providing true parallelism, i.e. operating on multiple instruction streams and multiple data streams, with possibly hundreds or more processors, can be expected. Such machines could provide the high degree of redundancy essential for realtime processing.

New forms of architecture have moved away from the control flow characteristics of Von Neumann machines. Thus in data flow architecture, instructions are actuated when the required input data is available and are well geared to parallel processing. Distributed function architectures are designed with modular facilities allowing specialized machines to perform their specific functions, e.g. database management, computation, man–machine interface operations, network control, with high efficiency. The fifth generation of computers will necessarily embody novel architecture to achieve their objective. *See* ALU, DATABASE MANAGEMENT SYSTEM, DATA FLOW, FIFTH-GENERATION COMPUTER, HISTORY OF COMPUTING, INDUSTRIAL ROBOTS, LOW-LEVEL LANGUAGE, MAN–MACHINE INTERFACE, MULTIPROCESSING, PARALLEL PROCESSING, PROCESSOR, VLSI.

archiving In operations, the storage of backup files and associated journals, usually for a given period of time. *See* FILE, JOURNAL.

ARDIS US Army Research and Development Information System.

area In databases, the CODASYL definition of an area is a named subdivision of the addressable storage space in the database which may contain occurrences of records and sets, or parts of sets of various types. *See* CODASYL, RECORD, SET.

area infill In computer graphics, a technique used with pixel-based systems in which a defined area of the screen is filled with a specified color or pattern. *See* PIXEL.

areal density In backing storage, the number of bits per unit area that can be stored on a recording device. In magnetic and optical disk systems, it is equal to the product of bits per inch and tracks per inch. *See* BITS PER INCH, MAGNETIC DISK, OPTICAL DISK STORAGE, TRACKS PER INCH.

argument (1) Any value of an independent variable. (2) In programming, a parameter passed between a calling program and a subprogram or statement function. *See* SUBROUTINE.

arithmetic (1) The branch of mathematics concerned with the study of the positive real numbers and zero. (2) In programming, the operations of addition, subtraction, multiplication and division.

arithmetic capability In word processing, the ability of a system to be used as a calculator or adding machine.

arithmetic instruction In programming, an instruction in which the operation part specifies an operation that follows the rules of arithmetic. *See* INSTRUCTION.

arithmetic logic unit In architecture, the unit in which arithmetic, logic and related operations are performed. *See* CENTRAL PROCESSING UNIT.

arithmetic mean In mathematics, the average value of a number of values of a variable. It is calculated by summing all the