A

A (Ampere) See *ampere*.

AAL (ATM Adaptation Layer) In the ATM reference model, a layer that comprises two sublayers. The Convergence Sublayer (CS) functions are determined by the specifics of the service class supported by that particular AAL. The Segmentation and Reassembly (SAR) sublayer functions to segment the user data into payloads for insertion into cells, on the transmit side. On the receive side, the SAR extracts the payload from the cells and reassembles the data into the information stream as originally transmitted. There exist defined AAL Types 1, 2, 3/4, and 5, each of which supports a specific class of traffic. See also *ATM*, *ATM reference model*, *CS*, and *SAR*.

AAL1 (ATM Adaptation Layer Type 1) Supports Class A traffic, which is connection-oriented constant bit rate (CBR) traffic timed between the source and the sink. Such traffic is stream-oriented and intolerant of latency. Isochronous traffic such as digitally encoded, uncompressed voice is supported via AAL 1, which essentially supports the emulation of a T/E-carrier circuit. All such traffic is carefully timed and must depend on a guaranteed rate of network access, transport, and delivery. Such traffic is marked as high-priority in the cell header, as transmission delays could considerably impact presentation quality. See also *ATM*, *CBR*, *cell*, *compression*, *connection-oriented*, *E-carrier*, *emulation*, *header*, *isochronous*, *latency*, *sink*, *source*, *stream-oriented*, and *T-carrier*.

AAL2 (ATM Adaptation Layer Type 2) Supports Class B traffic, which is connection-oriented, real-time variable bit rate (rt-VBR), isochronous traffic timed between the source and the sink. Compressed audio and video are Class B. See also *ATM*, *cell*, *compression*, *connection-oriented*, *header*, *isochronous*, *rt-VBR*, *sink*, and *source*.

AAL3/4 (ATM Adaptation Layer Type 3/4) Supports Class C or Class D traffic, which is non real-time variable bit rate (nrt-VBR) data traffic with no timing relationship between the source and the sink. Class C traffic, such as X.25 and frame relay, is connection-oriented VBR traffic with no timing relationship between source and sink. Class D traffic, such as LAN and SMDS, is connectionless VBR traffic that is sensitive to loss, but not highly sensitive to delay. Message mode service is used for framed data in which only one interface data unit (IDU) is passed. Streaming mode service is used for framed data in which multiple IDUs are passed in a stream. See also *ATM*, *Class C ATM traffic*, *Class D*, *connectionless*, *connection-oriented*, *frame relay*, *IDU*, *message mode service*, *nrt-VBR*, *streaming mode service*, and *X.25*.

AAL5 (ATM Adaptation Layer Type 5) Supports Class C traffic in message mode, only. Such traffic is variable bit rate (VBR) traffic with no timing relationship between the source and the sink, and consists of only one interface data unit (IDU). AAL Type 5 also is known as *Simple and Efficient AAL* (SEAL), as some of the overhead has been stripped out of the Convergence Sublayer (CS). AAL 5 also supports Class X traffic, which is variable bit rate (VBR) and specifically either unspecified bit rate (UBR) or available bit rate (ABR), and is either connection-oriented or connectionless in nature. AAL 5 is used in support of a wide variety of data traffic, including LAN Emulation (LANE) and Internet Protocol (IP). See also *ABR*, *ATM*, *Class C ATM traffic*, *Class X ATM traffic*, *connectionless*, *connection-oriented*, *CS*, *IDU*, *IP*, *LANE*, *message mode service*, *sink*, *source*, *UBR*, and *VBR*.

AAV (Alternative Access Vendor) Synonymous with Competitive Access Provider (CAP). See *CAP*.

abbreviation A shortened form of a word or phrase. P-phone, for example, is an abbreviation of Proprietary phone. Acronyms, contractions, and initialisms are special forms of abbreviations comprising the initial letters or other parts of several words that constitute a term. See also *acronym*, *contraction*, and *initialism*.

Abilene Project A high-performance network by the University Consortium for Advanced Internet Development (UCAID) in support of Internet2. Abilene infrastructure comprises high-speed routers connected to several dozen GigaPOPs (Gbps Points of Presence) interconnected over fiber optic transmission systems (FOTS) operating at speeds up to 10 Gbps. See also *FOTS*, *GigaPOP*, *Internet2*, and *router*.

ABM (Asynchronous Balanced Mode) A peer-to-peer mode of asynchronous communications in which either of a pair of devices can initiate a transmission and send data over a point-to-point link at any time. ABM is a communication mode used in High-level Data Link Control (HDLC) and derivative protocols, such as Link Access Procedure-Balanced (LAP-B). See also *asynchronous*, *HDLC*, *LAP-B*, *link*, *master/slave*, and *point-to-point*.

Above 890 Decision In the United States, the Federal Communications Commission (FCC) decision (1959) that granted private microwave radio access to a dedicated portion of radio spectrum above 890 MHz. The decision also permitted construction of such networks, regardless of the economic impact on the established common carrier. See also *common carrier*, *FCC*, *microwave*, *radio*, and *spectrum*.

ABR (Available Bit Rate) Also known as *best-effort ATM*. In asynchronous transfer mode (ATM), a class of traffic in which the network attempts to pass the maximum number of cells, but with no absolute guarantees. Subsequent to the establishment of the connection, the network may change the transfer characteristics through a flow control mechanism that communicates to the originating end-user device. This flow control feedback mechanism is in the form of resource management cells (RM-Cells). During periods of congestion, the network can buffer cells and advise the sender to throttle back on the rate of transmission. ABR supports variable bit rate (VBR) traffic with flow control, a minimum transmission rate, and specified performance parameters. Traffic parameters include peak cell rate (PCR), cell delay variation tolerance (CDVT), and minimum cell rate (MCR). No quality of service (QoS) commitment is made. ABR traffic examples include bursty LAN traffic and e-mail, neither of which requires guarantees of network access, but rather can deal with time slot access on an as-available basis. ABR service is not intended to support real-time applications. ATM also defines constant bit rate (CBR), non real-time Variable Bit Rate (nrt-VBR), real-time Variable Bit Rate (rt-VBR), unspecified bit rate (UBR), and variable bit rate (VBR) traffic classes. See also *ATM*, *buffer*, *CDVT*, *cell*, *e-mail*, *flow control*, *LAN*, *MCR*, *nrt-VBR*, *PCR*, *QoS*, *RM-Cell*, *rt-VBR*, *time slot*, *UBR*, and *VBR*.

absorption The irreversible conversion of some or all of the energy of an electromagnetic wave to another form of energy as a result of its encounter and interaction with matter through which it is propagating or upon which it is incident. Generally, the sum of the electromagnetic energy converts to thermal energy, i.e., heat, which transfers to the matter, and which results in some amount of signal attenuation. An electrical signal propagating through a copper conductor, for example, attenuates as some electromagnetic energy is converted to thermal energy due to the vibration of free electrons in the copper. Similarly, an optical signal propagating through a glass optical fiber (GOF) suffers some attenuation as the photons interact with the crystalline silicon dioxide and dopants that comprise the fiber and convert to thermal energy. Radio waves also suffer considerably from absorption, which in fact is used to advantage in microwave ovens. See also *attenuation* and *propagation*.

abstruse Difficult to comprehend because of complexity and intellectual demands. See also *obtuse*.

AC (Alternating Current) Current is the flow of electrons through a metallic circuit, with the direction of flow being from positive (+) pole to negative ( ) pole outside of the source (generator or battery). Direct current (DC) travels in one direction, only, while alternating current (AC) travels in both directions across the circuit. A continuous flow of AC current travels first in one direction and then reverses polarity and flows in the opposite direction. See also *current*, *DC*, and *polarity*.

A Carrier See *non-wireline carrier*.

acceptance angle See *angle of acceptance*.

Access BPL (Access Broadband over Power Line) An access, or local loop, technology that runs over medium voltage (MV) power lines in the power utilities distribution networks. At utility substations, the high voltage (HV) lines, which run at 165,000 765,000 volts, are stepped down to medium voltage, which runs at up to 7,200 volts, for the distribution network (see Figure A-1). At the substation, the BPL provider typically terminates a fiber optic network connection in a device that accomplishes the opto-electric conversion process. Inductive couplers wrapped around the power lines, without touching them, serve both as injectors for downstream transmissions and as extractors for upstream signals. The injectors and extractors share a common frequency band on the MV power lines for both upstream and downstream communications through the use of a version of orthogonal frequency division multiplexing (OFDM) specially tailored for powerline environments, the radio frequency (RF) carrier supporting the communications signals can share the same line with the electrical signals. The BPL signal uses the frequency band between 2 MHz and 80 MHz, and repeaters must be spaced at intervals of 300 meters or so. Extractors remove downstream signals from the distribution power lines just ahead of the remote transformers that step the voltage down from MV to the low voltage (LV) level of 110/220 volts used within the premises. The connection to the premises can be over the LV lines, or via IEEE 802.11 wireless local area network (WLAN) technology, also known as Wi-Fi. Within the premises, communications can make use of In-House BPL or more traditional technologies. See also *FOTS*, *In-house BPL*, *local loop*, *OFDM*, *RF*, *transformer*, *volt*, *voltage*, *Wi-Fi*, and *WLAN*.

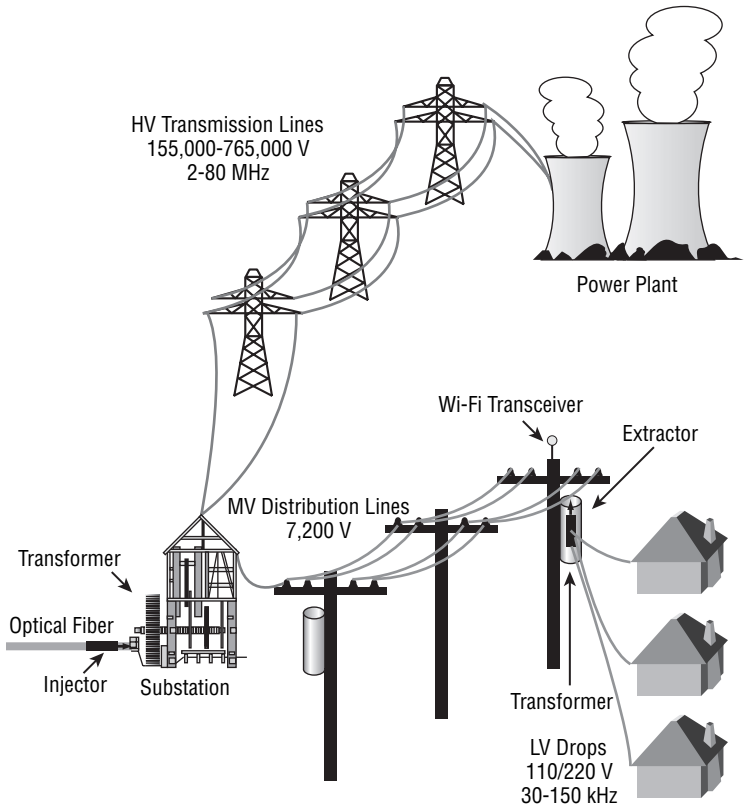

Figure A-1

access broadband over power line (Access BPL) See *Access BPL*.

access charges Charges imposed by the local exchange carrier (LEC) to compensate it for the cost of providing equal access capabilities, which enable a subscriber to access any competing interexchange carrier (IXC) with equal ease to place a long distance call. Although the structure of access charges varies from country to country, all include some combination of a Subscriber Line Charge (SLC) and Carrier Access Charge (CAC). In the United States, the LEC bills the monthly SLC to the subscriber. The LEC also bills the IXC for the CAC. See also *CAC*, *equal access*, *EUCL*, and *SLC*.

access circuit An access circuit is one used to gain access to, or entry to, a Wide Area Network (WAN) or Metropolitan Area Network (MAN). An access circuit usually is described as a local loop that connects a customer premises to a switch, router, multiplexer, or other device at the edge of the carrier or service provider network. See also *local loop* and *transport circuit*.

Access Manager An authorization mechanism that uses an application program interface (API) for application development, employing scripting. See also *API*, *authorization*, and *scripting*.

access node Synonymous with *service node* and *edge switch*. In packet networks, the outermost device on a carrier network, an access node is a switching point that comprises a point of end user access to the network. See also *edge switch* and *node*.

access point (AP) See *AP*.

access rate The maximum data rate of a channel between a user site and a network, as defined by the bandwidth of the access link available for data transmission.

access service A service that provides access to a network. Access services include residential lines, business lines, and PBX trunks for access to the public switched telephone network (PSTN). Broadband access services include broadband over power line (BPL), digital subscriber line (DSL), cable modem service, and passive optical network (PON). See also *BPL*, *cable modem*, *DSL*, *line*, *PON*, *PSTN*, and *trunk*.

access tandem switch A switch in the public switched telephone network (PSTN) that serves to connect the local exchange carriers (LECs), i.e., local telephone companies, to the interexchange carriers (IXCs), i.e., long distance carriers. See also *carrier*, *IXC*, *LEC*, and *PSTN*.

account code A code that a user enters via the telephone keypad when placing an outgoing call, particularly a toll call, through a PBX or KTS telephone system to track calling activity and to aid in client billing for time and expenses. Some users may be required to enter an account code, known as a *forced account code*, in order to place a call. Some systems allow a user to enter an account code for incoming calls, as well.

accounting management An element of network management, accounting management is the process of keeping and maintaining records. The call accounting module of a telemanagement system, for example, keeps track of network usage based on call detail recording (CDR) records output by the telephone system. On the basis of that data, the call accounting system can calculate calling costs, which it passes to a cost allocation module that creates reports of calling activity and associated costs by individual, station number, work group, department, project, division, etc. In another example, a RADIUS server gathers and maintains records of end user remote access to internal company resources and networks. See also *CDR*, *network management*, *RADIUS*, and *telemanagement software*.

ACD (Automatic Call Distributor) A system or application software program that serves to route incoming calls to the most available and appropriate agent. Incoming call centers make extensive use of such specialized software to enhance customer service. An ACD typically uses an automated attendant (i.e., front-end interactive voice processor) to answer incoming calls and provide callers with menu selections to guide the call through the system, perhaps sorting them into multiple queues associated with special-

ized agent groups according to the nature of the call and the caller. High priority calls (e.g., orders rather than returns) and calls from high priority callers (e.g., frequent customers) can be advanced to the head of the queue or placed in special queues. The routing of the call to an agent can be on the basis of next available, longest time since last call, least number of calls answered, or some other fairness routing algorithm. ACDs can be in the form of a specially equipped and partitioned PBX. Intensive call center applications typically make use of specialized ACDs that function as highly intelligent switches equipped primarily for the processing of incoming calls. An ACD is similar to, but much more sophisticated than a uniform call distributor (UCD). See also *call blending*, *PBX*, and *UCD*.

ACELP (Algebraic Code Excited Linear Prediction) A voice compression algorithm defined in ITU-T G.729, ACELP improves on CELP through the algebraic expression, rather than the numeric description, of each entry in the codebook. ACELP yields quality that is considered to be as good as ADPCM, but requiring bandwidth of only 8 kbps, which yields a compression ratio of 8:1. CS-ACELP is geared toward multi-channel operation. See also *ADPCM*, *algorithm*, *bandwidth*, *CELP*, *channel*, *compression*, *CS-ACELP*, *ITU-T*, and *LD-CELP*.

ACK (ACKnowledgement) **1.** A transmission control character sent by a station indicating that it is ready to receive a transmission. In ASCII, ACK is represented by the bit pattern 0110000. See also *ASCII*. **2.** A positive acknowledgement that a message, block, or frame has been received without error across a communications circuit, that the data set can be erased from buffer memory, and that the next data set can be sent. See also *block*, *circuit*, *data set*, *frame*, *message*, *NAK*, and *station*.

acknowledgement (ACK) See *ACK*.

ACL (Asynchronous Connectionless Link) A Bluetooth link option intended for packet data transmission. Bluetooth specifications also define a synchronous connection-oriented link (SCO) for real-time packet voice. See also *asynchronous*, *Bluetooth*, *connectionless*, *link*, and *packet*.

acoustics The branch of physics dealing with sound and its transmission.

ACR **1.** Attenuation-to-Crosstalk Ratio. Also known as *headroom*. The level of signal attenuation divided by the near-end crosstalk (NEXT), expressed in decibels (dB). If the level of crosstalk equals the level of the attenuated signal at any point in the cable, the signal is lost. See also *attenuation*, *crosstalk*, *dB*, *NEXT*, and *signal*. **2.** Anonymous Call Rejection. See *anonymous call rejection*.

acronym A pronounceable word formed of the initial letters or other parts of several words. An acronym generally comprises all upper case letters. SONET, for example, is the acronym for Synchronous Optical NETwork, a North American standard for fiber optic transmission systems. SONET became internationalized as SDH, an unpronounceable initialism for Synchronous Digital Hierarchy. Acronyms occasionally comprise all lower case letters. For example, bit is the acronym for binary digit, which is the basic unit of information in a binary numbering system. Bit also is a word unto itself, and with multiple meanings, including a small piece of something. Acronyms sometimes comprise both upper case and lower case letters. Sesame, for example, is the acronym for Secure European Systems for Applications in a Multivendor Environment. See also *abbreviation*, *anacronym*, *backronym*, *contraction*, *initialism*, and *portmanteau*.

acrylate coating Referring to a layer of polymer (a type of plastic) surrounding a glass optical fiber (GOF) to protect the glass from physical damage. See also *GOF*.

AC-3 (Adaptive Transform Coder 3) A specification from Dolby Digital and the Advanced Television Systems Committee (ATSC) for audio compression. The audio sampling rate is 48 kHz, and the system supports six channels in the Dolby Digital surround format. That format specifies multiple channel outputs, including center, left and right center, left and right surround, and low-frequency enhancement (LFE), also known as *subwoofer*. AC-3 is specified by the ATSC for use in high definition television (HDTV) and standard definition television (SDTV). See also *ATSC*, *audio*, *channel*, *compression*, *HDTV*, and *SDTV*.

active Energized, i.e., electrically powered, and in a state of readiness to perform a function such as amplifying a signal, detecting and correcting for errors in received data, retiming a signal, or retransmitting a signal. An amplifier or repeater, for example is an active device, but a reflector is passive. See also *passive*.

ACTS (Advanced Communications Technologies and Services) A European Union (EU) research and development program, ACTS addresses several hundred projects, including asynchronous transfer mode (ATM). ACTS is the successor to the Research for Advanced Communications in Europe (RACE) program. See also *ATM* and *RACE*.

adaptive differential pulse code modulation (ADPCM) See *ADPCM*.

Adaptive Transform Coder 3 (AC-3) See *AC-3*.

ADC (Analog-to-Digital Converter) A device in the form of a chipset that receives analog signals, measures the input at a regular sampling interval (or on command), and reports a digital output of the results. In a typical application, an ADC samples the analog signal at a fixed interval with enough resolution to accurately describe the analog waveform. In a typical voice application, for example, an ADC samples the audio stream 8,000 times per second at a precise interval of 125 microseconds (1/8,000 of a second) and reports a 14- or 16-bit value per sample. A digital signal processor (DSP) or other hardware then encodes the signal into pulse code modulation (PCM) format, employing an appropriate algorithm such as A-law or mu-law to produce a standard output like a DS-0 channel. At the receiving end of the connection, a matching DSP or other hardware and a digital-to-analog converter (DAC) reverses the process. See also *A-law*, *algorithm*, *analog*, *channel*, *digital*, *DSP*, *DS-0*, *encode*, *mu-law*, *PCM*, and *signal*.

ADCCP (Advanced Data Communications Control Procedures) An early synchronous data communications standard from the United States National Bureau of Standards (NBS), now the National Institute of Standards and Technology (NIST). ADCCP was a predecessor to the High-Level Data Link Control (HDLC) standard subsequently developed by the International Organization for Standardization (ISO). See also *HDLC* and *ISO*.

add/drop multiplexer (ADM) See *ADM*.

address The coded representation of the physical or logical location of a source or destination resource, such as a register, a memory partition, an application, or a node or station. An address may be contained in an address field associated with a data unit, such as a block, cell, frame, or packet, in order that switches, routers, and other devices can forward the data unit to the destination device across a network. Alternatively, an address might be used to set up a path between originating and destination devices, such as voice telephone sets, to connect a call. A PSTN telephone number, for example, is a logical address associated with a physical port on a physical central office (CO) switch connected to a physical copper circuit terminating in a physical device such as a PBX, key system, or telephone set at a fixed physical location. A cellular telephone number is a logical address associated with a physical station that typically is mobile, perhaps across networks. An Internet Protocol (IP) address is a logical address associated with a data terminal or other physical network element that may be either fixed in location or mobile, perhaps across networks. See also *E.164*, *IP address*, *logical*, and *physical*.

address book A typical feature of e-mail systems is the ability to create personal and corporate address books, perhaps importing them from other applications, for use in addressing outgoing mail. Address books typically provide links to a personal contact list that contains greater detail about each individual, including detailed contact information and free-form comments. E-mail systems also may support searches of Lightweight Directory Access Protocol (LDAP) Internet directories. See also *e-mail* and *LDAP*.

Address Resolution Protocol (ARP) See *ARP*.

ad hoc mode In wireless local area networks (WLANs), a temporary manner of operation that allows devices such as laptop computers to spontaneously discover each other and communicate directly, without the involvement of a centralized hub, or access point (AP). IEEE 802.11b and Bluetooth both include provisions for ad hoc mode. See also *802.11b*, *AP*, *Bluetooth*, *infrastructure mode*, and *WLAN*.

adjunct From the Latin *adjunctus*, meaning adjoin. Something added to something else, but secondary or not essential to it.

adjunct processor (AP) See *AP*.

ADM (Add/Drop Multiplexer) Multiplexers that have the capability to insert and extract individual lower speed channels (e.g., DS-1, DS-2, or DS-3) into a higher speed aggregate bit stream. ADM (see Figure A-2) offers considerable advantage over traditional time division multiplexers (TDM). The process of bit stuffing to adapt to slight clocking variations can require that a DS-3 frame be demultiplexed into its DS-2 and then DS-1 frames, which must be broken down into 24 DS-0 channels in order to extract and route an individual DS-0 channel. When that is accomplished, the process must be reversed to reconstitute the DS-3, minus the extracted DS-0. Contemporary T-carrier muxes are capable of add/drop multiplexing in the absence of stuff bits. Used extensively in SDH and SONET networks, ADMs perform the additional functions of dynamic bandwidth allocation, providing operation and protection channels, optical hubbing, and ring protection. In wavelength division multiplexing (WDM), an optical add/drop multiplexer (OADM) performs the same add/drop function on individual wavelengths. See also *channel*, *DS-1*, *DS-2*, *DS-3*, *hub*, *multiplexer*, *OADM*, *SDH*, *SONET*, *T-carrier*, *TDM*, *wavelength*, and *WDM*.

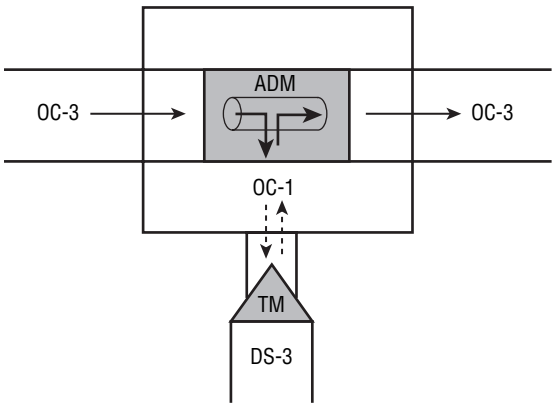

Figure A-2

ADPCM (Adaptive Differential Pulse Code Modulation) A voice encoding technique used to convert analog signals to digital format. ADPCM improves the quality of DCPM by adapting to the incoming signal, without increasing the bit requirement. ADPCM increases the range of signal changes that can be represented by a 4-bit value, thereby adapting to provide higher quality for voice transmission. ADPCM also overcomes the deficiency of DPCM with respect to support of modem transmissions. A modem transmission is characterized by abrupt shifts in amplitude and frequency levels that DPCM cannot accommodate. ADPCM can distinguish the presence of a modem tone, and can adapt by reverting to a channel width of 64 kbps, or by forcing the modem to adapt to a lower speed. ADPCM operates at 64, 56, 48, 40, 32, 24, and 16 kbps, with 32 kbps being the most commonly used. As central office (CO) exchanges are based on PCM rather than ADPCM, it is necessary to use a bit compression multiplexer (BCM) be used to insert two 32-kbps compressed voice conversations into a single PCM channel. See also *analog*, *BCM*, *digital*, *DPCM*, *encode, modem*, and *PCM*.

ADSL (Asymmetric Digital Subscriber Line) A broadband access technology designed to support voice, high speed Internet access, entertainment television over embedded telco unshielded twisted pair (UTP) local loops up to 18,000 ft in length. One of a family of xDSL standards, ADSL was developed by Bellcore (now Telcordia Technologies) at the request of the Regional Bell Operating Companies (RBOCs) in the United States, and was later standardized in 1999 by the American National Standards Institute (ANSI) as T1.413 and by the ITU-T as G.922.1. The term asymmetric refers to the fact that, in consideration of FEXT and NEXT crosstalk issues, ADSL offers considerably more bandwidth in the downstream direction than in the upstream direction. As ADSL employs discrete multitone (DMT) modulation, it sometimes is referred to as, G.dmt. Also known as *orthogonal frequency division multiplexing* (OFDM), DMT splits the signal over 256 narrowband subcarrier channels, within each of which quadrature amplitude modulation (QAM) is employed.

ADSL involves a pair of matching modems, with the ADSL Transmission Unit-Centralized (ATU-C) located at the central office (CO) or other headend location, and the ADSL Transmission Unit-Remote (ATU-R) located on the customer premises. The ATUs multiplex voice, data, and sometimes video signals over three separate frequency channels. A bi-directional voice grade analog channel at 0 4 kHz is provided for full duplex (FDX) voice and facsimile applications, that is, POTS service. Upstream data transmission is over what technically is a bidirectional channel provided in increments of 64 kbps, up to 640 kbps, in a frequency band from 26 140 kHz. Downstream transmission is in increments of 1.536 Mbps up to 6.144 Mbps, based on T1 specifications, in a frequency band that runs from approximately 140–552 kHz. (*Note:* The downstream increments are stated in maximum transmission rates. The available rates may be much lower, depending on carrier network design considerations and local loop characteristics.) In the context of the OSI Reference Model, ADSL is primarily a Layer 1 (Physical Layer) specification, although it includes Layer 2 (Data Link Layer) elements. The telcos currently avoid video over pure ADSL, although some provide video over hybrid fiber/ADSL loops in deployment scenarios known variously as fiber-to-the-curb (FTTC), fiber-to-the-neighborhood (FTTN), and fiber-to-the-node (FTTN). Table A-1 provides a comparative view of ADSL maximum downstream data rates and distance limitations based on acceptable options for wire gauges.

Table A-1: ADSL Maximum Data Rates

Maximum Data Rate	*American Wire Gauge (AWG)*	*Maximum Distance (ft.)*	*Metric Gauge*	*Maximum Distance (km.)*
1.544 Mbps (T1)				
2.048 Mbps (E-1)	24	18,000 ft.	0.5 mm	5.5 km
1.544 Mbps (T1)				
2.048 Mbps (E-1)	26	15,000 ft.	0.4 mm	4.6 km
6.144 Mbps (4 x T1)	24	12,000 ft.	0.5 mm	3.7 km
6.144 Mbps (4 x T1)	26	9,000 ft.	0.4 mm	2.7 km

Source: DSL Forum

Since the original ADSL standards were released in 1999, development efforts have continued and several enhanced versions have been released in the forms of ADSL2 and ADSL2+. See also *ANSI*, *asymmetric*, *AWG*, *bandwidth*, *Bellcore*, *broadband*, *channel*, *CO*, *crosstalk*, *Data Link Layer*, *DMT*, *downstream*, *DSL Forum*, *E-1*, *FEXT*, *frequency band*, *FTTC*, *FTTN*, *FTTP*, *G Series*, *headend*, *ITU-T*, *local loop*, *metric gauge*, *narrowband*, *NEXT*, *OFDM*, *OSI Reference Model*, *Physical Layer*, *POTS*, *QAM*, *RBOC*, *symmetric*, *T1*, *transmission rate*, *upstream*, *UTP*, *voice grade*, and *xDSL*.

ADSL2 (Asymmetric Digital Subscriber Line version 2) Specified by the ITU-T in Recommendations G.992.3 and G.992.4 (July 2002), ADSL2 supports increased data rates of as much as 12 Mbps downstream and 1 Mbps upstream, depending on local loop length and quality. ADSL2 achieves the higher downstream data rates by increasing the frequency band from 552 kHz (ADSL) to 1.1 MHz, and improving modulation efficiency through the introduction of trellis-coded modulation (TCM) quadrature amplitude modulation (QAM) constellations. In combination, these modulation techniques yield higher throughput on long loops with low signal-to-noise ratio (SNR). ADSL2 also uses receiver-determined tone reordering of the discrete multitone (DMT) channels to spread out the noise from AM radio interference and, thereby, to realize greater coding efficiency, which yields higher throughput. ADSL2 systems feature reduced framing overhead, enhanced power management, faster startup, seamless rate adaption, and improved diagnostics. ADSL2 also features an all-digital mode, in which the analog voice channel can be used for digital data transmission, thereby increasing aggregate upstream data transmission rates by as much as 256 kbps. ADSL2 adds a packet mode capability that enables packet-based services such as Ethernet. On long loops, ADSL2 can increase the data rate by as much as 50 kbps and extend the reach by about 600 feet (200 meters). ADSL2 supports bonding in asynchronous transfer mode (ATM) mode, based on the MFA Forum specification for Inverse Multiplexing over ATM (IMA). This allows two ADSL pairs to be bonded together to yield roughly double the single-pair rate. See also *ADSL*, *AM*, *analog*, *ATM*, *channel*, *digital*, *DMT*, *downstream*, *Ethernet*, *frequency band*, *IMA*, *interference*, *local loop*, *MFA Forum*, *modulation*, *overhead*, *QAM*, *rate adaption*, *SNR*, *TCM*, *throughput*, and *upstream*.

ADSL2+ (Asymmetric Digital Subscriber Line version 2 plus) Specified by the ITU-T in Recommendation G.992.5 and G.992.4 (January 2003), ADSL2+ doubles the downstream data rate, in comparison to ADSL2, to as much as 24.5 Mbps over local loops up to approximately 5,000 feet (1,500 meters) in length. The upstream rate remains at a maximum of 1 Mbps. In order to achieve this enhanced data rate, ADSL2+ increases the downstream frequency range to 2.2 MHz and increases the number of subcarriers to 512. The analog POTS channel remains at 4 kHz and the upstream data channel remains capped at 140 kHz. See also *ADSL*, *ADSL2*, *analog*, *downstream*, *frequency*, *local loop*, *POTS*, *subcarrier*, and *upstream*.

ADSL Lite (Asymmetric Digital Subscriber Line Lite) See *G.lite*.

ADSL transmission unit-centralized (ATU-C) See *ATU-C*.

ADSL transmission unit-remote (ATU-R) See *ATU-R*.

Advanced Communications Technologies and Services (ACTS) See *ACTS*.

Advanced Data Communications Control Procedures (ADCCP) See *ADCCP*.

Advanced Encryption Standard (AES) See *AES*.

advanced intelligent network (AIN) See *AIN*.

Advanced Mobile Phone System (AMPS) See *AMPS*.

Advanced Program-to-Program Communications (APPC) In the IBM Systems Network Architecture (SNA), Logical Unit (LU) 6.2. See *LU*.

Advanced Research Project Agency Network (ARPANET) See *ARPANET*.

advanced telecommunications capability The U.S. Federal Communications Commission (FCC) defines high-speed services as supporting a data rate of at least 200 kbps in at least one direction and advanced telecommunications capability as at least 200 kbps in both directions. See also *broadband* and *FCC*.

Advanced Television Systems Committee (ATSC) See *ATSC*.

adware **1.** A type of spyware that records search information and forwards it to an advertising agency or market research firm that later uses it to tailor pop-up ads for delivery to users without their knowledge or consent. See also *spyware*. **2.** Hardware, firmware, and software as it is advertised rather than as it exists. Unfortunately, truth in advertising is not a given. Always read the fine print and check references, especially for users of similar size, using the product in similar configurations with similar intensity in similar applications. Brochureware is a type of adware that you pick up at a trade show and take with you. See also *fine print*.

aerial cable An outside plant (OSP) communications cable designed to be suspended from poles or other overhead structures. As they are exposed to the elements, aerial cables must be well protected by cable jackets or sheathes, and from critters by armoring. As their hanging weight can be considerable, they also must incorporate load-bearing strength members. Aerial cables also are often pressurized to protect them from moisture in the event of failures in splice cases or insulation. Alternatively, a water-blocking gel or moisture-activated powdered gel can be used for moisture protection. See also *cable*, *icky-pic*, and *OSP*.

.aero (aeronautics) Pronounced *dot aero*. The generic Top Level Domain (gTLD) reserved exclusively for aeronautical interests. This domain was created in 2002 under the sponsorship of the Société Internationale de Télécommunications Aéronautiques (SITA). See also *gTLD*, *Internet*, and *sponsored domain*.

AES (Advanced Encryption Standard) A symmetric key encryption algorithm that supports key lengths of 128, 192, and 256 bits. AES superseded Triple DES (Data Encryption Standard), which has a 128-key length and is considered too slow and processor-intensive. Developed by the National Institute of Standards and Technology (NIST), AES has been adopted by the United States government for use with sensitive unclassified documents. See also *algorithm*, *DES*, *encryption*, *key*, *NIST*, and *Triple DES*.

AF (Assured Forwarding) The Differentiated Services (DiffServ) protocol identifies two primary types of per-hop behaviors (PHBs), representing two service levels, or forwarding classes. Expedited Forwarding (EF) provides minimal delay, jitter, and loss. Assured Forwarding (AF) comprises four classes, each of which contains three drop precedences and allocates certain amounts of buffer space and bandwidth. AF traffic exceeding the profile may be either dropped or demoted during periods of network congestion. See also *bandwidth*, *buffer*, *congestion*, *delay*, *DiffServ*, *EF*, *jitter*, *PHB*, and *protocol*.

African Network Information Center (AfriNIC) See *AfriNIC*.

AfriNIC (African Network Information Center) The Regional Internet Registry (RIR) responsible for assigning Internet Protocol (IP) addresses variously to National Internet Registries (NIRs) or directly to Local Internet Registries (LIRs) on the African continent. See also *IP*, *IP address*, *LIR*, *NIR*, and *RIR*.

AGC (Automatic Gain Control) Referring to the manner in which amplifiers adjust for amplitude variations of the input signal to ensure that the outgoing signal is of a constant strength. See also *amplifier*, *amplitude*, *gain*, and *signal*.

AIN (Advanced Intelligent Network) Bellcore built on earlier work done by Bell Labs on the intelligent network (IN) and defined AIN in the early 1980s (see Figure A-3). The initial AIN release was intended to provide a generic and modular set of tools to enable the creation, deployment, and management of services on a flexible basis within the public switched telephone network (PSTN). The software tools yielded a suite of service offerings accessible to all network switches, but operating independently from the switch logic. The services, therefore, can be defined, developed, and deployed quickly, and in a multivendor environment. Subsequent releases defined switching and database functions and the interactions between them. AINs include service creation toolkits, which enable the creation of centralized logic residing in centralized databases for the development and delivery of features across the network. AINs support all ISDN features and are intended to provide support for personal communications services (PCS), which permit subscribed features to be supported across networks of all types.

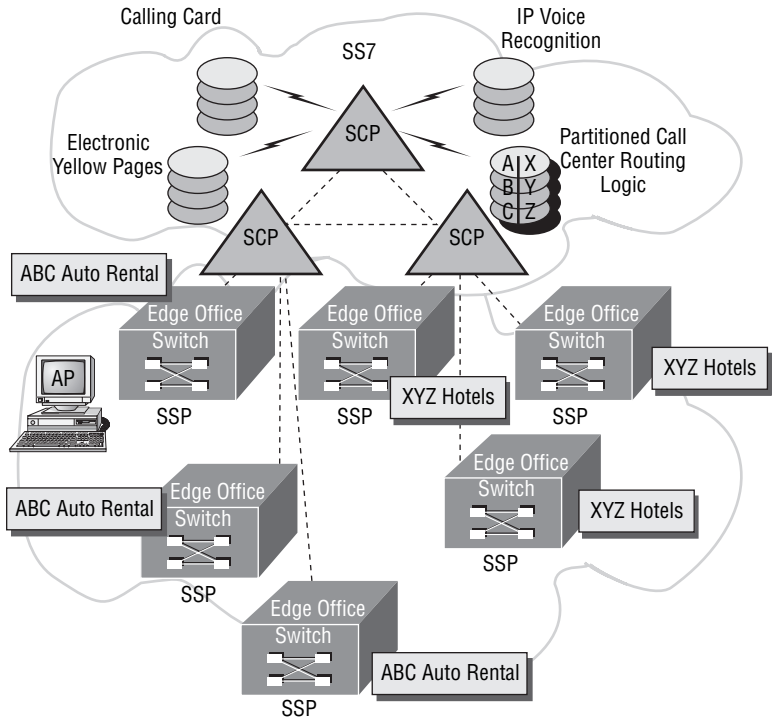

Figure A-3

The AIN architecture, as illustrated in Figure A-3, requires Common Channel Signaling System 7 (SS7). In addition to SS7, AIN comprises the following components:

- **Service Switching Points (SSPs):** PSTN switches that act on the instructions dictated by AIN centralized databases. SSPs can be end offices or tandem switches.
- **Signal Transfer Points (STPs):** Packet switches that route signaling and control messages between SSPs and SCPs, and between STPs.
- **Service Control Points (SCPs):** Nodes that contain all customer information in databases residing in centralized network servers. SCPs provide routing and other instructions to SSPs.
- **Service Management Systems (SMSs):** Network control interfaces that enable the service provider to vary the parameters of the AIN services. Under certain circumstances, the user organization may be provided access to a partition of the SMS.
- **Adjunct Processors (APs):** Decentralized SCPs that support service offerings limited either to a single SSP or to a regional subset of SSPs. APs might support routing tables or authorization schemes specific to a single switch or regional subset of switches.
- **Intelligent Peripherals (IPs):** Nodes that enhance the delivery of certain services by offloading processing demands from the SCPs and providing a basic set of services to the SCPs. The role of the IP typically includes collection of digits, collection and playing of voice prompts, collection of voice responses and their conversion to digits, menu services, and database lookups.

AIN services include find-me, follow-me, call pickup, store locator, multilocation extension dialing, call blocking, caller name, enhanced call return, enhanced call routing, call completion, and number portability.

air interface Referring to the radio portion of the link between wireless devices, such as a cellular telephone and a base station. In the context of the OSI Reference Model, the air interface operates at the Physical Layer and the Data Link Layer. See also *cellular radio*, *Data Link Layer*, *link*, *OSI Reference Model*, *Physical Layer*, *radio*, and *wireless*.

Airline Line Control (ALC) See *ALC*.

Airline Link Control (ALC) See *ALC*.

airwave transmission Synonymous with wireless transmission, as the term suggests open space rather than closed or confined space. Airwave is a bit of a misnomer, however, as the term also suggests transmission through the air, or atmosphere we breathe, which fortunately just happens to be there for us and the other living critters that share the Earths surface. Wireless transmission, however, definitely does not benefit from the atmosphere. Whether radio or optical in nature, wireless transmission suffers from any encounters with physical matter (e.g., atomic, molecular, and particulate matter) serving only to attenuate, impede, diffuse, distort, and otherwise interfere with the radio or optical signal. See also *free space* and *transmission medium*.

aka (also known as) Synonymous with, or having the same meaning as, another term. For example, software program is synonymous with software.

A-law A voice companding technique specified in the ITU-T G.711 Recommendation for pulse code modulation (PCM). This technique, which is used in the European digital hierarchy, converts 13-bit linear PCM samples into 8-bit compressed samples. Mu-law (μ-law) is a similar, but incompatible, companding technique used in the North American (T-carrier) and Japanese (J-carrier) digital hierarchies. In an international call, A-law is used if at least one of the national networks involved in the call uses A-law. See also *companding*, *E-carrier*, *G.711*, *ITU-T*, *J-carrier*, *mu-law*, *PCM*, and *T-carrier*.

ALC (Airline Line Control or Airline Line Control) An IBM protocol used in airline reservations systems such as American Airlines SABRE System and United Airlines APOLLO. Both ALC and P1024B, the Unisys version, employ a de facto standard six-bit coding scheme. See also *coding scheme*, *standard*, and *protocol*.

alchemy An early, unscientific form of chemistry practiced in the Middle Ages with aims including turning base metals into gold and discovering the elixir of perpetual youth, a universal cure for disease, and a universal solvent. Many alchemists were intelligent, well-meaning men and even distinguished scientists. Sir Isaac Newton, for example, was an alchemist. Pair-gain technologies such as ADSL do not involve alchemy, although sometimes they are characterized as turning copper into gold. See also *pair-gain*.

Algebraic Code Excited Linear Prediction (ACELP) See *ACELP*.

algorithm A logical, systematic, step-by-step procedure for solving a mathematical problem.

aliasing A phenomenon that occurs when different analog continuous signals overlap and become indistinguishable. If the sampling of the analog waveform is too infrequent (less than half the highest frequency present), the digitally encoded signal cannot reliably be decoded faithfully. Rather, it can be reconstructed as an alias of the true signal. Aliasing is a major concern in the digital encoding of analog audio and video signals. Aliasing in video signals results in artifacts in video images that can manifest as jagged blockings or a tiling effect. See also *analog*, *digital*, *encoding*, *PCM*, and *waveform*.

Alliance for Telecommunications Industry Solutions (ATIS) See *ATIS*.

Aloha From the Hawaiian *aloha*, meaning *hello* and *goodbye*. Also known as *pure Aloha*. A protocol developed at the University of Hawaii in the early 1970s as a contention management mechanism for use in inter-island wireless networks. Aloha is a very simple protocol in which the source just sends a frame of data whenever it desires. A target receiver confirms a frame whenever it receives one, and the source sends another whenever it desires. If the target receiver does not confirm the receipt of the frame within a specified time, the source resends it until it receives a confirmation. Pure Aloha is simple and inexpensive, but not useful in managing contention in large, complex networks. See also *AlohaNet* and *slotted Aloha*.

AlohaNet A packet radio system technology developed at the University of Hawaii in 1970. AlohaNet packet technology subsequently was incorporated into the first local area network (LAN) technology, which became known as *Ethernet*. See also *Aloha*, *Ethernet*, and *LAN*.

alpha Referring to a product, usually a software product, that is ready for initial testing, in-house and possibly under laboratory conditions. An alpha product generally is unstable and does not include all planned features or functionality. See also *beta* and *software*.

alternate mark inversion (AMI) See *AMI*.

alternating current (AC) See *AC*.

Alternative Access Vendor (AAV) Synonymous with Competitive Access Provider (CAP). See *CAP*.

Altos Aloha Network The original name for Ethernet. The experimental technology originally connected Altos computers through a network based on the AlohaNet packet radio system technology developed at the University of Hawaii. In 1973, it became known as Ethernet, from *luminiferous ether*. See also *ether* and *Ethernet*.

ALU (Arithmetic Logic Unit) The portion of the central processing unit (CPU) of a computer that performs mathematical calculations. See also *CPU*.

always on Referring to a continuous Internet connection. Such a connection is always available from the computer through the service providers central office (CO) or headend and to the Internet. Therefore, there are no dial-up delays such as those experienced when using a conventional modem to establish a circuit-switched connection to the Internet over the public switched telephone network (PSTN). The term generally is used to describe xDSL or cable modem services. See also *cable modem*, *circuit-switched*, *CO*, *headend*, *Internet*, *modem*, *PSTN*, and *xDSL*.

always on/dynamic ISDN (AODI) See *AODI*.

AM (Amplitude Modulation) Synonymous with ASK (Amplitude Shift Keying). A signal modulation technique in which the amplitude of the analog carrier sine wave is modulated to represent one or more 1 bits or 0 bits. The transmitting computer outputs a baseband electrical signal, defining 1 bits and 0 bits as discrete voltage levels. Using a unibit (single-bit) AM technique as illustrated in Figure A-4, each 1 bit entering the transmitting modem is expressed as one or more relatively high-amplitude sine waves, and each 0 bit is expressed as one or more low-amplitude sine waves. The high and low levels are defined in terms of a reference level or by the relative difference between the levels. At 2400 baud, this unibit technique yields a transmission rate of 2400 bps, with one bit transmitted per baud, that is to say that the bit rate equals the baud rate. In a dibit coding scheme, it is possible to express 2 bits with a single baud by defining 4 levels of amplitude, so the bit rate is double the baud rate. A tribit coding scheme expresses 3 bits per baud by defining 8 levels of amplitude, and a quadrabit coding scheme expresses 4 bits by defining 16 levels of amplitude. Amplitude modulation often is used in conjunction with frequency modulation (FM) and phase-shift keying (PSK) in electrically based networks. Digital fiber optics transmission systems (FOTS) use amplitude modulation. See also *AM*, *amplitude*, *analog*, *baseband*, *baud*, *baud rate*, *bit*, *bit rate*, *carrier*, *digital*, *FOTS*, *modem*, *PSK*, and *sine wave*.

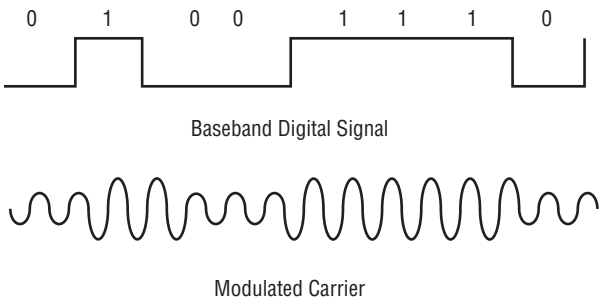

Figure A-4

amateur radio service Frequencies in the VHF, UHF, and microwave ranges above 30 MHz variously have been set aside in the United States and other countries for the use of radio hobbyists, or hams, for two-way voice and telegraphy communications. Some hams use inexpensive equipment operating in the unlicensed 2.4 GHz band for local communications, whereas others invest in more serious equipment for long distance, and even intercontinental, communications. Amateur radio service also is known as *ham radio*, in reference to the term *ham* that has long been applied to the hand of inept amateur telegraphers, and shortwave radio, in reference to the short wavelength (high frequency) of the permitted signals. See also *ham*, *UHF*, *VHF*, and *wavelength*.

American Registry for Internet Numbers (ARIN) See *ARIN*.

American Telephone and Telegraph (AT&T) See *AT&T*.

AMI (Alternate Mark Inversion) A line coding technique used in T1 networking. AMI is a bipolar transmission method that reverses the polarity of alternate marks, or 1 bits, expressing the first as a positive voltage of +3V, the second as a negative voltage of 3V, the third as +3V, and so on. Zero bits are coded as 0V. See Figure A-5. See also *bipolar*, *mark*, *polarity*, *signal*, and *voltage*.

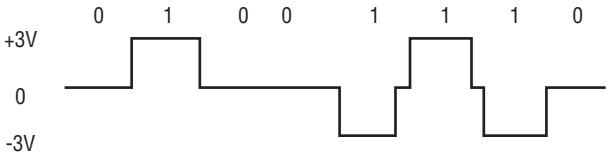

Figure A-5

AMIS (Audio Messaging Interchange Specification) A standard, published (1992) by the Industry Information Association, for networking voice mail systems, and specifying message file formats, addressing conventions, and message transmission.

amp (ampere) See *ampere*.

ampere (A) Abbreviated amp. **1.** The unit of electric current equivalent to the flow of one coulomb of charge per second past any cross section at any point in a circuit, with a coulomb being 6.24×10^{18} electrons. The ampere is named for AndrÈ-Marie AmpËre (1775 1836), who first distinguished the difference between electrical current and voltage. See also *current*, *sine wave*, and *voltage*. **2.** The steady flow of one volt (V) across a resistance of one ohm (Ω). **3.** The unit of constant electrical current that, when maintained in

two straight parallel conductors of infinite length and of negligible circular cross section, and when placed one meter apart in a vacuum, would produce between the two conductors a force equal to 2×10^{-7} newtons per meter of length.

American National Standards Institute (ANSI) See *ANSI*.

American Standard Code for Information Interchange (ASCII) See *ASCII*.

American Wire Gauge (AWG) See *AWG*.

amplifier A device that actively boosts, or amplifies, a signal so that the output signal is a function of, and is of greater strength than, the input signal. An amplifier is a relatively simple device that transfers energy, at a controlled level, from an independent power source to an incoming signal in order to increase the strength of an outgoing signal. The increase, or gain, in signal strength usually is measured in positive decibels (+dB). Amplifiers are extensively used in analog networks to overcome the effects of signal attenuation, much as an amplifier in a radio receiver or TV set serves to boost a weak incoming signal to a level acceptable to the receiver. Amplifiers are spaced every 18,000 feet or so in a typical analog voice grade, twisted-pair telco local loop, for example. The exact spacing is sensitive to factors such as the transmission medium and the carrier frequency employed. Amplifiers are used in systems employing all transmission media, including not only twisted pair, but also coaxial cable, microwave radio, and optics.

An amplifier simply boosts the strength of a signal. So, whatever signal arrives at the amplifier leaves it with greater strength. In addition to attenuating, a signal accumulates noise as it transverses the network. The amplifier boosts the noise along with the signal. If there are multiple, cascading amplifiers in a long haul circuit, noise is compounded, thereby creating the potential for significant accumulated noise at the receiving end of the transmission. The resulting Signal-to-Noise Ratio (SNR) can be unacceptable.

Several types of optical amplifiers are employed in fiber optic systems. Erbium-Doped Fiber Amplifiers (EDFAs) amplify light signals falling in a narrow optical frequency range, performing much more cost-effectively than optical repeaters. Raman amplification makes use of pump lasers that send a high-energy light signal in the reverse direction (i.e., the direction opposite the signal transmission).

Digital transmission systems generally make use of regenerative repeaters, rather than amplifiers. A repeater not only amplifies, but also retimes and regenerates a signal. In combination, those processes serve to eliminate any accumulated noise, which improves signal quality considerably. See also *attenuation*, *dB*, *distributed amplification*, *EDFA*, *gain*, *lumped amplification*, *Raman amplifier*, *repeater*, and *SNR*.

amplitude The extreme range, or magnitude, of a fluctuating value such as an acoustic or electromagnetic signal, amplitude is measured perpendicular to the to the time axis of a time-plot, i.e., frequency, of a sine wave. Amplitude is a measure of the intensity, loudness, power, strength, or volume level of a signal. In an electrical circuit operating on alternating current (ac), amplitude is measured as the Voltage (V) level and is expressed as +V and V, depending on the direction of the current. See also *sine wave*.

amplitude distortion See *amplitude noise*.

amplitude modulation (AM) See *AM*.

amplitude noise A type of noise that occurs when the amplitude of the signal output by an amplifier or other device is not a linear function of the input amplitude. See also *noise*.

amplitude shift keying (ASK) Synonymous with amplitude modulation (AM). See *AM*.

AMPS (Advanced Mobile Phone System) A 1G analog cellular radio standard developed by Motorola and AT&T, and operating on 50 MHz of spectrum in the 800 MHz band. In the United States, 25 MHz and 333 (416 in some areas) channels each were provided to the A Carrier, or non-wireline carrier, and the B Carrier, or wireline carrier. Of the total number of channels awarded to each carrier, 21 channels are non-conversational channels dedicated to call setup, handoff, and teardown. The remaining

communications channels are split into 30 kHz voice channels using frequency modulation (FM). As an analog system, AMPS derives channels using frequency division multiple access (FDMA) and bidirectional communications is achieved through frequency division duplex (FDD) with the downlink in the 869–894 MHz band and the uplink in the 824–849 MHz band. AMPS supports low speed modem transmission at rates generally limited to 6.8 kbps. Although once widely deployed in the United States, Australia, the Philippines, and other countries, AMPS has almost entirely been replaced by digital technology. Australian regulators mandated a cutover from analogue (Aussie for analog.) AMPS to digital GSM and CDMA, beginning December 31, 1999, in Melbourne, and gradually extending throughout the country during 2000. Motorola subsequently developed Narrowband AMPS (N-AMPS), which improved system capacity. In the United States, the Federal Communications Commission (FCC) authorized carriers to cease support for analog systems as of March 1, 2008. Digital AMPS (D-AMPS), standardized as IS-54 and IS-136, is essentially a digital version of AMPS. See also *1G*, *A Carrier*, *analog*, *B Carrier*, *carrier*, *CDMA*, *cellular radio*, *D-AMPS*, *digital*, *downlink*, *FCC*, *FDD*, *FDMA*, *FM*, *GSM*, *handoff*, *modem*, *N-AMPS*, *non-wireline carrier*, *uplink*, and *wireline carrier*.

anacronym (anachronism acronym) A portmanteau of anachronism and acronym that describes an acronym or initialism that has been used so long and become so ingrained in common language that its original spelled-out meaning is unknown to many, if not most. As examples, consider ASCII (American Standard Code for Information Interchange), radar (radio detecting and ranging), SCSI (Small Computer System Interface), scuba (self-contained underwater breathing apparatus), and sonar (sound navigation and ranging). See also *acronym*, *initialism*, and *portmanteau*.

analog **1.** A continuously present and continuously variable signal. In their native, or original, forms, audio and visual signals are analog. An active audio signal is a stream-oriented, i.e., continuously present, acoustic signal. A visual signal is a stream-oriented optical signal. Audio and visual signals travel in a waveform that can vary continuously and infinitely along two parameters amplitude and frequency. Amplitude refers to signal intensity or signal strength, which manifests as volume in audio signals and brightness in visual signals. Frequency refers to the number of waveforms per second, or cycles per second (cps), known in contemporary terminology as Hertz (Hz). Frequency manifests as pitch, or tone, in audio signals, and as color in image and video signals. All electromagnetic energy travels in continuous waveforms. The portions of the electromagnetic spectrum currently usable for telecommunications include electricity, radio, and infrared light. See also *digital*, *electromagnetic spectrum*, and *Hz*. **2.** Pertaining to the representation of data in the form of a continuous signal. Transmission of voice, image, and video information are relatively straightforward as they are analog in their native forms. Appropriate conversions to electrical, radio, and optical energy must be made, of course, and adjustments must be made in terms of amplitude and frequency levels, but the native signals and electromagnetic transmission signals are quite compatible in terms of their common analog nature. In order to accomplish the transmission of these native analog signals, the carrier signal (i.e., information-carrying signal) of the transmission system is modulated (i.e., varied, or changed) in order to create an analog of the original information stream. The transmission of digital computer data over an analog network is quite another matter, as a fundamental conversion in signal format must be made through a modem. To accomplish this conversion over an electrified analog network, the ones (1s) and zeroes (0s) of the digital bit stream must be translated into amplitude and frequency variations of the carrier signal. The electromagnetic sinusoidal waveform, or sine wave, can be varied in amplitude at a fixed frequency, using Amplitude Modulation (AM). Alternatively, the frequency of the sine wave can be varied at constant amplitude, using Frequency Modulation (FM). Additionally, both frequency and amplitude can be modulated simultaneously. Finally, the position of the sine wave can be manipulated (actually, can appear to be manipulated), adding the third technique of Phase Modulation, also known as *Phase Shift Keying* (PSK). See also *carrier*, *digital*, and *modem*. **3.** Something that is continuously present and continuously variable. For example, the shadow cast by the gnomon on the flat plate of a sundial is continuously present and continuously variable, at least during the daylight hours. Similarly, the hands of an analog clock, watch, or fuel gauge are continuously present and continuously variable, or essentially so. **4.** Something that is analogous to or similar to something else. The electrical waveform of a voice transmission over an analog network is

analogous to the waveform of the native acoustic voice signal. The movement of the hour hand of an analog watch or clock is analogous to the movement of the shadow cast by a sundial.

analog-to-digital converter (ADC) See *ADC*.

analogue The British English spelling of analog. Analogue has two extra vowels, which seems like an awful waste. See *analog*.

angled physical contact (APC) See *APC*.

angle of acceptance The angle within which the core of an optical fiber will accept light injected by a light source, the boundary of the angle of acceptance is equal to the critical angle. Illustrated in three dimensions, the angle of acceptance becomes the cone of acceptance. Within that angle, a light source can inject an optical signal into the fiber core and the signal will remain in the core, reflecting off of the interface between the core and cladding, as illustrated in Figure A-6. At a more severe angle, i.e., outside the cone, the signal will penetrate the interface and enter, and perhaps be lost in, the cladding. The angle of acceptance and, therefore, the cone of acceptance are determined by the difference in index of refraction (IOR) between the core and cladding. The mathematical sine of the angle of acceptance is known as the *numerical aperture* (NA). See also *cone of acceptance*, *critical angle*, *IOR*, and *numerical aperture*.

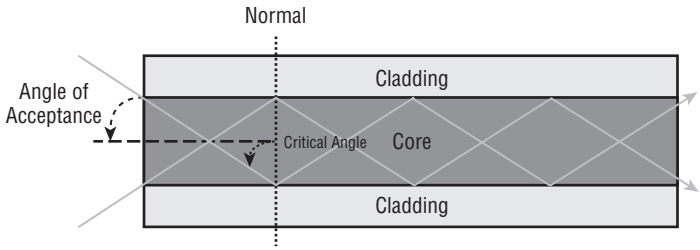

Figure A-6

angle of incidence The angle at which an incoming light ray strikes a reflecting or refracting surface. The angle is measured at the boundary, or interface, between two media, such as the core and cladding of an optical fiber. The angle is measured from the normal, which is a right angle to the surface. See also *cladding*, *core*, *critical angle*, *reflection*, and *refraction*.

ANI (Automatic Number Identification) A feature of the public switched telephone network (PSTN) that transmits the originating telephone number in advance of connecting the call. ANI is used by telephone companies for tracking and billing purposes. PBXs equipped with proper software and with special trunking arrangements (all at additional cost) can appear to the network as a central office (CO) switch and, therefore, can gain access to ANI information. This approach offers advantages compared to calling line identification (CLID), which the callers can block, and is often used by incoming call centers. ANI is available to interexchange carriers (IXCs) subscribing to Feature Group D (FGD) termination. See also *CLID*, *CO*, *FG*, *IXC*, and *PSTN*.

anonymous call rejection (ACR) A network-based CLASS service of the public switched telephone network (PSTN). The feature allows the subscriber to reject all calls from callers who have blocked the display of their calling identification information (calling number and calling name). Such calls are diverted to a recorded message advising the caller that the called party does not accept anonymous calls and to unblock the caller identification information before attempting the call again. See also *calling name and number blocking*, *CLASS*, and *PSTN*.

annotation A feature of voice mail systems that allows a message recipient to add critical or explanatory audio notes to a voice message before archiving it or forwarding it to another system user. See also *voice mail*.

ANSI (American National Standards Institute) ANSI coordinates the development and use of voluntary consensus standards in the United States across a wide variety of business sectors, and represents the needs and views of U.S. stakeholders in international standardization forums. Founded in 1918, ANSI membership comprises government agencies, private organizations, companies, academic and international bodies, and individuals. ANSI is the official U.S. representative to the International Organization for Standardization (ISO) and, via the U.S. National Committee, the International Electrotechnical Commission (IEC). See Appendix A for contact information. See also *EIA*, *IEC*, and *ISO*.

ANSI/EIA/TIA-568 A United States industry standard published jointly by ANSI and the EIA/TIA specifying a generic structured cabling system for commercial buildings. Intended to support a multivendor environment, the standard specifies cable physical attributes and performance characteristics for unshielded twisted pair (UTP), shielded twisted pair (STP), and screened twisted pair (ScTP) cabling categories. The initial standard was released in 1985, and has been modified and updated several times since. Category (Cat) 3, 4, 5, 6, and 7 cables have been defined. Cat 1 and Cat 2 are not formally defined under this particular standard. The most recent (as of Spring 2007) and most capable standard is Cat 7, which supports bandwidth of up to 600 MHz and data rates up to 10 Gbps. The standards also have been internationalized as ISO/IEC 11801. See also *ANSI*, *Cat*, and *EIA/TIA*.

ANSI/ICEA S-80-576 The standard published by the American National Standards Institute (ANSI) and the Insulated Cable Engineers Association (ICEA) for Category 1 (Cat 1) and Category 2 (Cat 2) individually unshielded twisted pair (UTP) indoor cables for use in communications wiring systems. See also *ANSI*, *Cat 1*, *Cat 2*, *ICEA*, and *UTP*.

ANSI/ICEA S-91-661 The standard published by the American National Standards Institute (ANSI) and the Insulated Cable Engineers Association (ICEA) for Category 3 (Cat 3), Category 5 (Cat 5), and Category 5e (Cat 5e) individually unshielded twisted pair (UTP) indoor cable for use in general purpose and LAN communication wiring systems. See also *ANSI*, *Cat 3*, *Cat 5*, *Cat 5e*, *ICEA*, *LAN*, and *UTP*.

ANSI/ICEA S-101-699 The standard published by the American National Standards Institute (ANSI) and the Insulated Cable Engineers Association (ICEA) for Category 3 (Cat 3) individually unshielded twisted pair (UTP) indoor cable for use in general purpose non-LAN telecommunication wiring systems. See also *ANSI*, *Cat 3*, *ICEA*, *LAN*, and *UTP*.

ANSI NFPA 70 American National Standards Institute (ANSI) National Fire Protection Association (NFPA) publication 70. Synonymous with National Electrical Code (NEC). See also *NEC*.

answering machine A relatively simple machine that answers incoming calls after a user programmable number of rings. Answering machines are customer premises equipment (CPE), owned or leased by the end user and located on the customers premises. Answering machines largely have been replaced by central office (CO) based voice processors. See also *voice processor*.

antenna A device comprising an arrangement of wires, metal rods, and so on for radiating and receiving radio signals. A transmitting antenna converts electrical current to electromagnetic radio waves projected into free space or a waveguide. A receiving antenna converts electromagnetic radio waves into electric current. An antenna commonly performs both transmit and receive functions. The transmitters and receivers used in free space optics (FSO) also can be characterized as antennas. See also *free space*, *FSO*, and *waveguide*.

Antheil, George (1900–1959) The self-proclaimed *bad boy of music*, Antheil was a serious composer of significance and, later in life, a successful composer of film scores. In telecommunications, he and Hedy Lamarr, a famous beauty and film star, co-invented spread spectrum (SS) radio, which is the basis for code division multiple access (CDMA). See also *CDMA*; *Lamarr, Hedy*; and *SS*.

anycast In IPv6, a transmission mode in which a packet is delivered to the closest (in the sense of routing cost) interface with that address. See also *anycast address*, *cost*, *interface*, *IPv6*, and *packet*.

anycast address In Internet Protocol version 6 (IPv6), an address that is assigned to multiple interfaces, typically on multiple nodes. A packet with an anycast address is delivered to the closest interface with that address, as determined by the routing by the routing protocols measure of distance. Anycast addresses are allocated from the unicast address space. See also *interface*, *IPv6*, *IPv6 address*, *node*, *packet*, *protocol*, *router*, *unicast*, and *unicast address*.

AODI (Always On/Dynamic ISDN) An ISDN basic rate interface (BRI) service that maintains an always-on connection to an ISP server, or perhaps a corporate intranet server, using only the D channel. The D channel maintains the always on logical link between the client and the server systems, enabling the transfer of packet data, such as e-mail, at rates of up to 9.6 kbps over an X.25 switched virtual circuit (SVC). The always-on nature of the connection avoids the call set-up time required for a circuit-switched connection. From the end user terminal adapter (TA) to the central office (CO), the multilink point-to-point protocol (MPPP) is employed over the D channel. As the signaling and control requirements of BRI are relatively light, there is sufficient capacity on the D channel to reliably support AODI and the packet data transfers it occasions, as long as they do not exceed 9.6 kbps. See also *always on*, *BRI*, *circuit switching*, *client*, *CO*, *D channel*, *intranet*, *ISDN*, *ISP*, *MPPP*, *server*, *SVC*, *TA*, and *X.25*.

AP **1.** Application Processor. A computer that processes data associated with an end user application, such as e-mail, navigation, payroll, or voice mail. This is in contrast to a computer that performs utility or control functions, such as a front-end processor (FEP) that manages traffic, or a processor dedicated to load balancing or storage management. **2.** Access Point. In wireless local area networks (WLANs), a centralized hub through which computers and peripherals interconnect and intercommunicate in infrastructure mode. Terminal devices generally connect to the APs using unlicensed RF bands, although infrared (IR) sometimes is used. APs can interconnect directly over RF links, but generally are hardwired to switches. In terms of functionality, APs can be fat or thin. A fat AP is sufficiently intelligent to act independently, while a thin AP must act under the supervision of a controller. See also ad hoc mode, fat AP, hardwired, IR, RF, thin AP, unlicensed, and WLAN. **3.** Adjunct Processor. In the advanced intelligent network (AIN) architecture, a decentralized service control point (SCP) that supports service offerings limited either to a single service switching point (SSP) or to a regional subset of SSPs. An AP might support routing tables or authorization schemes specific to a single switch or to a regional subset of switches. See also *adjunct*, *AIN*, *SCP*, and *SSP*.

APC (Angled Physical Contact) A type of optical fiber connector that joins two fiber endfaces at a slight angle to minimize attenuation and back reflection. See also *attenuation*, *back reflection*, *connector*, and *optical fiber*.

APD (Avalanche PhotoDiode) A type of diode used as a light detector used in high speed, long haul fiber optic transmission systems (FOTS) employing laser diode light sources and single-mode (SMF) glass optical fiber (GOF) media. APDs are especially sensitive detectors as they use a strong electric field to accelerate the electrons flowing in the semiconductor. As a result, an APD generates an avalanche of electrons with a multiplication factor that can be in the range of 70, i.e., an APD can generate 70 electrons from 1 photon. Therefore, a very weak incoming light pulse will create a much stronger electrical effect that can be interpreted more effectively and understood more clearly. So, an APD can be characterized as a very high gain photodiode receiver, i.e., a one-way photonic receiver with a high ratio of (electrical) output power to (optical) input power in the range of 70:1. Although more sensitive and more effective than PIN detectors used in lesser systems, APDs require more electrical power to operate, are more sensitive to extremes of ambient temperature and are more expensive. See also *diode*, *FOTS*, *gain*, *GOF*, *laser diode*, *light detector*, *light source*, *PIN*, and *SMF*.

API (Application Program Interface, aka Application Programming Interface) **1.** A set of routines by which an application program can call specific programs or services of a computer operating system (OS) or network operating system (NOS). See also *application*, *NOS*, *OS*, and *routine*. **2.** A set of routines by which an application program allows another application program to work directly with it. See also *application*, *program*, and *routine*.

APNIC (Asia Pacific Network Information Center) The Regional Internet Registry (RIR) responsible for assigning Internet Protocol (IP) addresses variously to National Internet Registries (NIRs) or directly to Local Internet Registries (LIRs) in the Asia-Pacific region. See also *IP*, *IP address*, *LIR*, *NIR*, and *RIR*.

APON (ATM-based Passive Optical Network) The original PON specifications set by FSAN and ratified by the ITU-T as G.983.1 (1998). APON specifies asynchronous transfer mode (ATM) as the Data Link Layer protocol. APON runs in asymmetric mode at a signaling rate of 622 Mbps downstream and 155 Mbps upstream, or in symmetric mode at 155 Mbps. The more contemporary broadband passive optical network (BPON) is an APON variant. See also *asymmetric*, *ATM*, *BPON*, *Data Link Layer*, *downstream*, *G Series*, *PON*, *protocol*, *signaling rate*, and *upstream*.

app (application) See *application*.

APP (Atom Publishing Protocol) An Application Layer protocol for publishing Web resources associated with periodically updated Web sites. APP builds on the RSS protocol. The Atom Syndication Format is documented in the IETF RFC 4287 (2005). See also *Application Layer*, *IETF*, *protocol*, *RSS*, and *WWW*.

APPC (Advanced Program-to-Program Communications) In the IBM Systems Network Architecture (SNA), Logical Unit (LU) 6.2. See also *LU*.

application A program designed to perform a function or suite of related functions of benefit to an end user, with examples being accounting, mathematical analysis, video editing, and word processing. Application software differs from utilities, which are devoted to system management tasks. See also *utility*.

Application Layer Layer 7, the highest layer, of the Open Systems Interconnection (OSI) Reference Model. Software at the Application Layer provides support services for user and application tasks such as file transfer, interpretation of graphic formats and documents, document processing, and user authentication in remote access applications. X.400 e-mail messaging, for example, takes place at Layer 7. TCP/IP application protocols such as Simple Mail Transfer Protocol (SMTP), Telnet, and File Transfer Protocol (FTP) also take place at this layer. See also *e-mail*, *FTP*, *layer*, *network architecture*, *OSI Reference Model*, *SMTP*, *Telnet*, and *X.400*.

application program interface (API) Synonymous with application programming interface. See *API*.

application programming interface (API) Synonymous with application program interface. See *API*.

application processor (AP) See *AP*.

application service provider (ASP) See *ASP*.

application software See *application*.

application-specific integrated circuit (ASIC) See *ASIC*.

appointment call An international long distance calling method that requires the caller to make an appointment for an international operator to seize an international trunk and place an international call at an appointed time. Appointment calling largely has been replaced by international direct distance dialing (IDDD). See also *IDDD*.

APS (Automatic Protection Switching) An automatic service restoration function by which a network senses a circuit or node failure and automatically switches traffic over an alternate path. SDH and SONET specifications require APS in order that the self-healing fiber optic network can recover from a fiber or node failure. The physical topologies specified in SDH/SONET standards are path-switched ring and line-switched ring. See also *circuit*, *line-switched ring*, *node*, *path*, *path-switched ring*, *SDH*, *self-healing*, *SONET*, and *topology*.

aramid (aromatic polyamide) Invented by Dupont, which markets it under the name KEVLAR™, aramid is a poly para-phenyleneterephthalamide, and is more properly known as a para-aramid. Belonging to the family of nylons, aramids are chemically and thermally stable, strong, lightweight, and resistant to impact and abrasion damage. Aramids also are dielectrics, or non-conductors of electric current. Uses for aramid include protective equipment (e.g., body armor such as bulletproof vests and helmets), fire-blocking fabrics, tire reinforcements, high-performance composites for aircraft, and strength members for telecommunications cables. See also *KEVLAR™* and *strength member*.

Archie A corruption of *archive*. An Internet browser based on the File Transfer Protocol (FTP). Archie enables the user to search for a file (exact name unknown) on a file server (name unknown) somewhere on the Internet. Archie servers contain directory listings of all such files, updated on a monthly basis through a process of polling file servers. Archie provides a user definable number of file hits, as well as file names, server names, and directory paths to access each listed file. Archie capabilities are limited to specific search strings, thereby providing little flexibility. Archie was first deployed in 1991 and currently is often integrated into Gopher or WWW clients and activated when the user accesses an Archie server. See also *browser*, *client*, *FTP*, *Gopher*, *Internet*, *polling*, *server*, *string*, and *WWW*.

architecture **1.** The organizational structure of an entity, such as a computer, data processing, or communications system. **2.** The organizational structure of a protocol suite or protocol stack, such as the OSI Reference Model. See also *OSI Reference Model*, *protocol stack*, and *protocol suite*.

archiving A feature of a messaging system (e.g., e-mail or voice mail) that allows the recipient to archive, or save, messages, usually for a limited amount of time unless they are resaved. Messages may be archived on an external storage medium for longer periods of time, perhaps to comply with document retention laws. For example, telephone companies in the United States must archive recorded user confirmation statements for long periods of time when effecting a change of carrier. Similarly, stockbrokers and certain telemarketers must retain confirmations associated with solicited trades or sales. See also *e-mail* and *voice mail*.

ARCNET (Attached Resource Computer NETwork) A popular LAN protocol developed by John Murphy at Datapoint Corporation in 1976, ARCNET was one of the first networking solutions for microcomputers. ARCNET employed coaxial cable to connect host computers, workstations, and peripherals through hubs in a star configuration. ARCNET employed a deterministic token passing bus medium access control (MAC) protocol, operated at signaling speeds up to 2.5 Mbps, and supported as many as 255 devices over link lengths up to 2,000 feet. More recent versions deliver 20 Mbps and 100 Mbps, although they have never been in great demand and are not widely available. ARCnet resembles, but does not adhere to, the IEEE 802.4 specification. ARCNET also is CamelCased as ARCnet. See also *802.4*, *CamelCase*, *coaxial cable*, *deterministic*, *IEEE*, *MAC*, *star*, and *token passing*.

area code Also known as the *Numbering Plan Area* (NPA). In the North American Numbering Plan (NANP), the three-digit number that corresponds to a geographic area within the area loosely defined as North America. The NPA follows the pattern NXX, with N indicating that only digits 2 9 are allowed, as 0 or 1 would confuse the network, and X indicating that any digit is allowed. The area code originally was used only when a call crossed an area code boundary. In such a case, the dialing sequence is 1.NNX.NNX.xxxx. the 1+ identified the call as long distance and triggered the involvement of an interexchange carrier. Where overlay area codes have been implemented, however, it is necessary to dial a full 10-digit number (NNX.NNX. xxxx) within a geographic area. Also, cellular networks treat area codes differently in terms of dialing pattern and rating. Cellular networks do not require 1+ dialing, and generally

bill only for airtime, regardless of whether calls are local or long distance in nature. As a great many individuals subscribe exclusively to cellular service, area codes largely have lost their significance to those users in terms of calling costs, and many of them retain their old telephone numbers even when permanently moving their residences across area code boundaries. See also *NANP*, *NPA*, and *overlay area code*.

ARIN (American Registry for Internet Numbers) The Regional Internet Registry (RIR) responsible for assigning Internet Protocol (IP) addresses variously to National Internet Registries (NIRs) or directly to Local Internet Registries (LIRs) in Canada, many Caribbean and North Atlantic islands, and the United States. See also *IP*, *IP address*, *LIR*, *NIR*, and *RIR*.

arithmetic coding A technique used for lossless data compression that establishes a model of the entire data set and establishes probabilities of the occurrences of symbols and patterns or sequences of symbols that can then be expressed in the form of a single number. Arithmetic coding is much more efficient than a run-length encoding algorithm such as Huffman coding, which uses a discrete number of bits for each symbol, but is more processor-intensive. See also *algorithm*, *compression*, *Huffman coding*, *lossless compression*, *run-length encoding*, and *symbol*.

arithmetic logic unit (ALU) See *ALU*.

armored cable Cable armored to protect against cable-seeking backhoes, posthole diggers, cable-loving rodents, and other adverse forces of man and nature. The armor may be in the form of lead or lead alloy sheathing, or interlocking aluminum or galvanized steel cladding.

ARP (Address Resolution Protocol) A protocol that translates between network addresses, such as between Ethernet and Internet Protocol (IP) addresses or between asynchronous transfer mode (ATM) and Ethernet addresses. See also *ATM*, *Ethernet*, and *IP*.

.arpa (address routing and parameter area) Pronounced *dot arpa*. The generic Top Level Domain (gTLD) reserved exclusively for Internet infrastructure purposes. This is an unsponsored domain named for the Advanced Research Project Agency (ARPA). See also *ARPANET*, *gTLD*, *Internet*, and *unsponsored domain*.

ARPANET (Advanced Research Project Agency NETwork) Generally accepted as the first (1971) sophisticated packet network architecture, ARPANET was designed to link computers on a time-share basis in order to share computer resources more cost-effectively in support of various defense, higher education, and research and development organizations. In 1983, the majority of ARPANET users spun off to form the Defense Data Network (DDN), also called MILNET (Military Network), which included European and Pacific Rim continents. Locations in the United States and Europe that remained with ARPANET then merged with the Defense Advanced Research Project Agency Network to become DARPA Internet.

ARPA protocol suite See *TCP/IP protocol suite*.

ARQ (Automatic Repeat reQuest) An error control protocol that automatically initiates a request to repeat the transmission of any packet or frame not acknowledged as received correctly, in other words, to retransmit the last errored or lost frame or packet and any transmitted afterwards. Incremental redundancy (IR), also known as Hybrid ARQ II, is an enhanced ARQ technique employed in EGPRS (Enhanced General Packet Radio System), the packet-switched mode of Enhanced Data rates for GSM Evolution (EDGE) cellular radio networks. See also *EDGE*, *EGPRS*, *error control*, *frame*, *IR*, *packet*, and *protocol*.

ARS (Automatic Route Selection) Also known as *Least Cost Routing* (LCR). An optional, programmable PBX software feature that enables the system to route a call over the most appropriate carrier and service offering based on factors such as the type of call (e.g., local, local long distance, or long-haul long distance), the Class of Service (CoS) of the user, the time of day (e.g., prime time and non prime time), and the day of the year (e.g., weekday, weekend day, or holiday). In countries where there are lower rates for cellular-to-cellular calls than for calls between cellular phones and landlines, ARS sometimes is used to route the landline leg through a cellular interface to take advantage of the lower rates. ARS is of greatest

value if the telecom environment is liberalized or deregulated and there are multiple competing carriers and rate plans from which to choose. In practice, ARS generally is on the basis of a table lookup rather than a hierarchical parsing of a dialed telephone number and calculation of a least cost route. See also *carrier*, *cellular radio*, *CoS*, *landline*, *local long distance*, *long distance*, *parse*, *PBX*, and *software*.

artifact Unintended and unwanted distortions or other aberrations in reproduced audio or video due to transmission errors or signal processing operations. Artifacts often result from the use of lossy compression algorithms at high compression ratios. Artifacts in video images can manifest as jagged blockings or a tiling effect known as aliasing, banding of colors, white spots, and even dropped frames. See also *aliasing*, *compression*, *distortion*, *lossy compression*, and *signal*.

AS (Autonomous System) Referring to a group of routers within the same administrative domain. The term is used in exterior protocols such as the Exterior Gateway Protocol (EGP) and the Border Gateway Protocol (BGP). See also *BGP*, *domain*, *EGP*, and *router*.

ASCII (American Standard Code for Information Interchange) A standard coding scheme specifically oriented toward data processing applications, ASCII was developed in 1963 and modified in 1967 by the American National Standards Institute (ANSI). ASCII employs a 7-bit coding scheme, supporting 128 (2^7) characters, which is quite satisfactory for both upper case and lower case letters of the English alphabet and similarly simple Roman alphabets, Arabic numerals, punctuation marks, a reasonable complement of special characters, and a modest number of control characters. As ASCII was designed for use in asynchronous communications (involving non-IBM computers, in those days), relatively few control characters were required, making a 7-bit scheme acceptable. IBM computers, which were relatively complex mainframes, required the 8-bit EBCDIC coding scheme to accommodate the necessary complement of control characters. Table A-2 shows the ASCII code.

Table A-2: ASCII Code

Bit positions 1, 2, Ï3, 4	*Bit positions 5, 6, 7*							
	000	*100*	*010*	*110*	*001*	*101*	*011*	*111*
0000	NUL[1]	DLE	SP	0	@	P		p
1000	SOH[2]	DC1	!	1	A	Q	a	q
0100	STX[3]	DC2		2	B	R	b	r
1100	ETX[4]	DC3	#	3	C	S	c	s
0010	EOT[5]	DC4	$	4	D	T	d	t
1010	ENQ[6]	NAK[7]	%	5	E	U	e	u
0110	ACK[8]	SYN	&	6	F	V	f	v
1110	BEL[9]	ETB[10]	`	7	G	W	g	w
0001	BS	CAN[11]	(	8	H	X	h	x
1001	HT	EM[12]	)	9	I	Y	i	y
0101	LF	SUB[13]	*	:	J	Z	j	z
1101	VT	ESC[14]	+	;	K	[	k	{
0011	FF	FS	,	<	L	\	l	|
1011	CR[15]	GS	-	=	M	]	m	}
0111	SO	RS	.	>	N	^	n	~
1111	SI	US	/	?	O	_	o	DEL

Although the full explanations of all control codes are outside the scope of this book, the following control characters are representative:

1. **NUL (NULl):** A transmission control character used to serve a media-fill or time-fill requirement, i.e., a stuff character or padding character.
2. **SOH (Start Of Header):** A transmission control character that indicates the start of a message heading.
3. **STX (Start of TeXt):** A transmission control character that alerts the receiving device to start the reading, transmission, reception, or recording of text.
4. **ETX (End of TeXt):** A transmission control character that alerts the receiving device to terminate the reading, transmission, reception, or recording of text.
5. **EOT (End Of Transmission):** A transmission control character that alerts the receiving device to terminate a transmission that may include one or more texts or messages.
6. **ENQ (ENQuiry):** A transmission control character to request a response from a station to which a connection has been established. The request may be for the station identification, type of equipment, and station status.
7. **NAK (Negative AcKnowledgement):** A transmission control character sent by the receiving device to the transmitting device to indicate that a received block of data contained one or more errors. A NAK will trigger the transmitting device to retransmit that errored block.
8. **ACK (ACKnowledgement):** A transmission control character sent by the receiving device to the transmitting device to indicate that a received block of data contained no errors.
9. **BEL (BELl):** A transmission control character that alerts the receiving device that causes a bell to ring or activates some other audio or visual device to gain the attention of the operator at the receiving station.
10. **ETB (End of Transmission Block):** A code-extension character used to indicate the end of the transmission of a block of data.
11. **CAN (CANcel):** A transmission control character indicating that the associated data is in error or is to be ignored.
12. **EM (End of Medium):** A control character indicating the physical end of a data storage medium, or the usable portion of the medium.
13. **SUB (SUBstitute):** Used in place of a character that is known to be invalid, i.e., in error. Also used to indicate a character used in place of one that cannot be represented on a given device, e.g., *e* may be used in place of ε (epsilon) or *d* may be used in place of Δ (delta).
14. **ESC (ESCape):** A code-extension character used to indicate a change in code interpretation to another character set, according to some convention or agreement. This is much like the use of the shift key in Baudot code to indicate a shift between figures and characters.
15. **CR (Carriage Return):** A format-control character that causes the print or display position to move to the first position, or left-hand margin, of the screen or print medium. Now often associated with an LF (Line Feed), which moves the print position down to the next line

In Unicode terms, ASCII is known as Unicode Transformation Format-7 (UTF-7). See also *asynchronous*, *code set*, *EBCDIC*, and *Unicode*.

Ashbacker Radio Corporation vs. the FCC The United States Supreme Court ruling (1945) that established that radio spectrum allocation is to be on the basis of comparative hearings. See also *spectrum management*.

Asia Pacific Network Information Center (APNIC) See *APNIC*.

ASIC (Application-Specific Integrated Circuit) A semiconductor integrated circuit designed for a specific application. An ASIC, for example, can be designed specifically a real-time processing task such as running a particular type of encryption, or running a cell phone or personal digital assistant (PDA). Contemporary ASICs often contain complete processors, and RAM, ROM, Flash, and other types of memory. See also *encryption*, *flash*, *memory*, *RAM*, *ROM*, and *semiconductor*.

ASK (Amplitude Shift Keying) Synonymous with AM (Amplitude Modulation). See *AM*.

ASP (Application Service Provider) A company that provides access to Internet-based software for a fee that generally is based on the number of users. See also *Internet* and *software*.

aspect ratio In video display, the relationship between the width and the height of the image. The NTSC standard, for example, specifies a 4:3 (4 wide to 3 high) aspect ratio. See also *NTSC* and *video*.

assured forwarding (AF) See *AF*.

asymmetric Lack of symmetry, i.e. lack of balance or proportion. **1.** In telecommunications, a link that supports more bandwidth in one direction than another. Asymmetric digital subscriber line (ADSL), for example, supports more bandwidth downstream than upstream. Bluetooth supports an asynchronous data channel that can operate in asymmetric mode at up to 721 kbps in either direction and 57.6 kbps in the reverse direction. Alternatively, the Bluetooth data channel can operate in symmetric mode at speeds of up to 432.6 kbps. See also *ADSL*, *asynchronous*, *bandwidth*, *Bluetooth*, *channel*, *downstream*, *symmetric*, and *upstream*. **2.** In compression, a process that is not equally time-consuming and processor-intensive in terms of compression and decompression. See also *compression*.

asymmetric digital subscriber line (ADSL) See *ADSL*.

asynchronous From Latin and Greek origins, asynchronous translates as not together with time. Referring to signals or events that bear no relationship to timing and, therefore, can be considered occurring at random instants and, for recurring events, at random intervals. See also *asynchronous transmission* and *synchronous*.

asynchronous balanced mode (ABM) See *ABM*.

asynchronous connectionless link (ACL) See *ACL*.

asynchronous transfer mode (ATM) See *ATM*.

asynchronous transmission Also known as start-stop transmission. Data transmission that is not synchronized between two or more computers across a circuit. The transmitting device sends data intermittently, rather than in a steady stream or at regular intervals. Such transmission is characterized as character-framed, as each character is preceded by a start bit that alerts the receiving computer of its arrival and succeeded by one or two stop bits that signal the end of the character. As illustrated in Figure A-7, an optional parity bit may be included for error control. Multiple characters commonly are organized into blocks, with an additional error control mechanism, such as a cyclic redundancy check (CRC), for improved error performance. Kermit, XMODEM, and ZMODEM are examples of asynchronous protocols. See also *asynchronous*, *CRC*, *error control*, *frame*, *Kermit*, *parity bit*, *synchronous*, *synchronous transmission*, *XMODEM*, and *ZMODEM*.

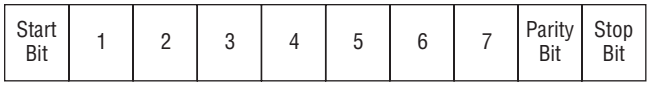

Figure A-7

AT&T (American Telephone and Telegraph) On July 9, 1877, the Bell Telephone Company was formed as a voluntary, unincorporated association. In 1878, the company split into the New England Telephone Company, charged with licensing telephone operating companies in New England, and the Bell Telephone Company, charged with licensing operating telephone companies elsewhere. In 1879, the two companies recombined to form the National Bell Telephone Company, which reorganized in 1880 and became known as American Bell Telephone Company, a Massachusetts corporation. Restrictive Massachusetts corporate laws forced American Bell to merge with its long distance subsidiary, the American Telephone and Telegraph Corporation (AT&T), a New York corporation. On December 30, 1899, the last business day of the nineteenth century, AT&T became the new parent company. AT&T grew to become the largest company in the world, employing over 1,000,000 people, and with a solid reputation for providing the best telephone service in the world. In 1984, the company was forced under the terms of the Second Computer Inquiry to spin its 22 wholly owned Bell Operating Companies (BOCs) into 7 Regional Bell Operating Companies (RBOCs).

AT&T reorganized into two business units. AT&T Long Lines became AT&T Communications, operating as an interexchange carrier (IXC). AT&T Technologies was formed of Western Electric, the manufacturing arm of AT&T, and AT&T Bell Telephone Laboratories (Bell Labs), the research and development organization. AT&T did very well over the next 13 years, focusing on its core businesses, although it did acquire and later divest NCR Corp. in a failed and costly attempt to get into the computer business. IBM previously experienced a similarly dismal failure with its acquisition of ROLM Corp., an almost legendary PBX manufacturer, which it subsequently sold to Stromberg-Carlson at a substantial loss.

On January 1, 1997, AT&T conducted the largest voluntary breakup in history. The US$75 billion company split into three market-focused companies, also selling AT&T Capital Corp., its captive financing business. Approximately 8,500 employees, all in the Global Information Solutions (GSI) computer business, lost their jobs fairly immediately. GSI resulted from the NCR acquisition, which did not live up to expectations. Hundreds of thousands of others lost their jobs over time. The post-divestiture AT&T boasted assets of US$79.2 billion, annual revenues of US$75.1 billion, and a total workforce of 303,000, which was down from over 1,000,000 prior to divestiture.

AT&T then went on a spending spree, variously acquiring and merging with a number of companies. In 1999, AT&T acquired MediaOne, which previously had been spun off from US West, in a bidding war against Comcast Corporation. The winning bid was in the form of AT&T stock worth US$58 billion at the time, plus the assumption of US$4.5 billion in debt. Together, these acquisitions formed AT&T Broadband, the largest CATV provider in the United States. Under extreme financial pressure due to the inflated cost of its acquisitions and the high costs of upgrading its CATV systems, AT&T Broadband agreed to merge with Comcast to form AT&T Comcast in a deal that initially valued AT&T Broadband at US$72 billion and later shrunk to US$53 billion, which did not compare favorably with the US$110.5 billion AT&T spent to form the company.

In 2006, the tattered remnants of AT&T were acquired by SBC for approximately US$16 billion, which named the combined entity AT&T. In just over 20 years, one of the oldest, largest and most respected companies in the world was reduced to a property for acquisition. On a personal note, I am so very glad that I was not there to see it up close. I left the Bell System of my own free will long, long before AT&T collapsed. Heck, I never did fit in, anyway.

AT&T Bell Telephone Laboratories (Bell Labs) See *Bell Labs*.

AT&T Technologies The company formed of Western Electric, the manufacturing arm of AT&T, and AT&T Bell Telephone Laboratories (Bell Labs), the research and development organization, as a result of the Modified Final Judgement (MFJ) that broke up the AT&T Bell System in 1984. AT&T Technologies later became Lucent Technologies, which was acquired by the French company Alcatel in 2006. The combined company is known as Alcatel-Lucent, as of Spring 2007. See also *Bell System* and *MFJ*.

ATIS (Alliance for Telecommunications Industry Solutions) Formerly the Exchange Carriers Standards Association (ECSA) A U.S. organization that develops and promotes technical and operations standards for the telecommunications and related information technology industries. ATIS standards activities address both wireless and wireline networks and include interconnection standards, number portability, improved data transmission, Internet telephony, toll-free access, telecom fraud, and order and billing issues. ATIS is accredited by the American National Standards Institute (ANSI). See also *ANSI*.

ATM (Asynchronous Transfer Mode) A fast-packet, connection-oriented, cell-switching technology for broadband signals. ATM was an outgrowth of the ITU-T development efforts towards broadband integrated services digital network (B-ISDN). Although B-ISDN faltered, ATM became the switching technology of choice in the broadband backbone of the public telephone network, at least for a time. ATM is designed to accommodate any form of data, including voice, facsimile, computer data, video, image, and multimedia, whether compressed or uncompressed, whether real-time or non-real-time in nature, and with guaranteed quality of service (QoS). ATM generally operates at minimum access speeds of DS-1 (e.g., T1 at 1.544 Mbps and E-1 at 2.048 Mbps) and DS-3 (e.g., E-3 at 34.368 Mbps and T1 at 44.736 Mbps). Designed to operate at very high speeds, ATM benefits from fiber optic transmission systems (FOTS) and commonly is provisioned over SDH/SONET networks. Access circuits operating at OC-3 (155 Mbps) are not unusual and backbone transmission rates generally are OC-3, at a minimum. ATM traffic consists of three basic types.

- **Constant Bit Rate** (CBR) traffic requires access to time slots at regular and precise intervals. Real-time, uncompressed voice and video, and circuit emulation are examples of CBR traffic.
- **Variable Bit Rate** (VBR) traffic, such as compressed voice and video and bursty data traffic, requires access to time slots at a rate that can vary dramatically from time to time but each logical connection is guaranteed a level of service defined by burst size, average bandwidth, etc.
- **Available Bit Rate** (ABR) traffic, also known as best-effort ATM, supports bursty LAN traffic and other traffic that can deal with time slot access on an as-available basis.

ATM organizes data into cells, as illustrated in Figure A-8. Each cell comprises a header of 5 octets and payload of 48 octets, with the payload including some amount of overhead attributable to Convergence Sublayer and Data Link Layer and Network Layer headers. Although the total overhead is in the range of 10 percent, the small cell size offers the advantage of effectively supporting any type of data. The fixed cell size offers the advantage of predictability, very much unlike the variable-length frames associated with services such as X.25, frame relay, and Ethernet, or the variable-length packets associated with the Internet Protocol (IP). This level of predictability yields much improved access control and congestion control. ATM multiplexes the cells, which contend for access to a broadband facility that ideally is SDH or SONET in nature. ATM also is used in some passive optical network (PON) local loops.

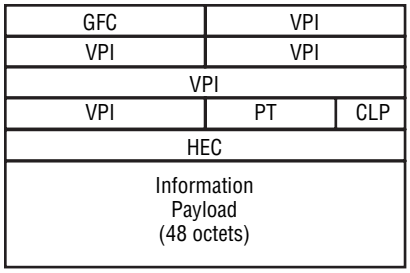

Figure A-8

The ATM cell header provides limited Data Link Layer functionality, managing the allocation of the resources of the underlying Physical Layer of the transmission facility. The ATM cell switches also perform Layer 1 functions such as clocking, bit encoding, and physical-medium connection. The header also is used for channel identification, thereby ensuring that all cells travel the same physical path and, therefore, arrive in sequence. The header is structured as follows:

- **Generic Flow Control (GFC):** 4 bits that provide local flow control.
- **Virtual Path Identifier (VPI):** 8 bits identifying the Virtual Path (VP).
- **Virtual Channel Identifier (VCI):** 16 bits identifying the Virtual Channel (VC). Together, VPI and VCI constitute the cell address, which has only local significance. That is, each switch maps the address on an incoming port to an address on an outbound port, so the local address changes on each hop.
- **Payload Type Indicator (PTI):** 3 bits distinguishing between cells carrying user information and cells carrying service information.
- **Cell Loss Priority (CLP):** 1 bit identifying one of two priority levels of the cell to determine the eligibility of that cell for discard in the event of network congestion.
- **Header Error Control (HEC):** 8 bits providing error checking of the header, but not the payload. Errored cells are discarded. There is no provision for error correction, which is handled at higher layers.

ATM standards largely are outgrowths of B-ISDN standards set by the ITU-T. The ATM Forum, now merged into the MFA Forum, developed interoperability specifications. The Frame Relay Forum (FRF), also now merged into the MFA Forum, worked with the ATM Forum in the development and publishing of joint Implementation Agreements (IAs) that specify the protocol interworking functions between frame relay and ATM networks. The Internet Engineering Task Force (IETF) also got involved in standards development as ATM has significant implications relative to the Internet backbone. ITU-T Standards Recommendations of significance include the following:

- I.113: B-ISDN Vocabulary
- I.121: Broadband Aspects of ISDN
- I.150: B-ISDN ATM Functional Characteristics
- I.211: B-ISDN Service Aspects
- I.311: B-ISDN General Network Aspects
- I.321: B-ISDN Protocol Reference Model
- I.327: B-ISDN Functional Architecture Aspects

- I.361: B-ISDN ATM Layer Specification
- I.362: B-ISDN ATM Adaptation Layer Functional Description
- I.363: B-ISDN ATM Adaptation Layer Specification
- I.413: B-ISDN User-Network Interface
- I.432: B-ISDN User-Network Interface-Physical Layer Specification
- I.555: Frame Relay and ATM Internetworking
- I.610: B-ISDN Operations and Maintenance Principles and Functions

See also *ABR*, *backbone*, *B-ISDN*, *broadband*, *CBR*, *cell*, *cell tax*, *channel*, *compression*, *congestion*, *connection-oriented*, *Data Link Layer*, *encode*, *Ethernet*, *FOTS*, *frame*, *frame relay*, *header*, *IETF*, *Internet*, *IP*, *ITU-T*, *MFA Forum*, *multiplex*, *Network Layer*, *non-real-time*, *packet*, *payload*, *PON*, *real-time*, *SDH*, *SONET*, *VBR*, and *X.25*.

ATM Adaptation Layer (AAL) See *AAL*.

ATM-based passive optical network (APON) See *APON*.

ATM Forum A not-for-profit special interest group of manufacturers, vendors, carriers and others with interests in the development and promotion of asynchronous transfer mode (ATM) technology. The ATM Forum merged with the Frame Relay Forum and MPLS Forum to form the MFA Forum. See also *ATM* and *MFA Forum*.

ATM reference model A multidimensional model, with three planes and four layers, as illustrated in Figure A-9. The lower two layers of this reference model loosely compare to the Physical Layer of the OSI Reference Model. As in the OSI model, each layer of the ATM model functions independently, yet all layers are tightly linked and the functions are highly coordinated. The layers of the ATM reference model are the Physical Layer, the ATM Layer, ATM Adaptation Layer, and higher layers and functions.

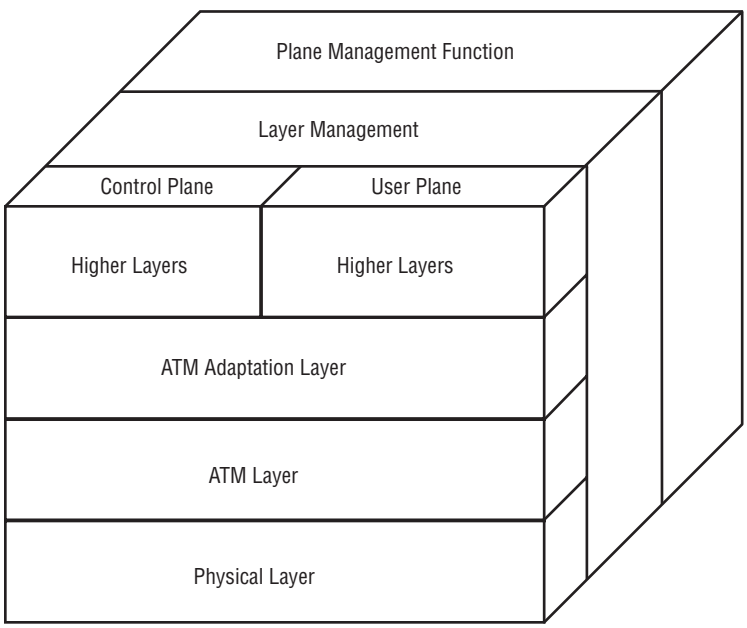

Figure A-9

- **Physical Layer (PHY)** functions are addressed through two sublayers: the Physical Medium and Transmission Convergence. The ATM Forum specifications for various User Network Interfaces (UNIs) address the implementation of the Physical Layer. The B-UNI, or Public UNI, is the specification for carrier internetworks. The UNI and DXI are Private UNIs, describing the implementation specifics for user access to the ATM network. Physical Medium (PM) sublayer specifies the physical and electro-optical interfaces with the transmission medium. The PM also provides timing functions. The Transmission Convergence (TC) sublayer handles frame generation, frame adaption, cell delineation, header error control (HEC), and cell rate decoupling.
- **ATM Layer (ATM)** functions include multiplexing of cells, selection of appropriate Virtual Path Identifiers (VPIs) and Virtual Channel Identifiers (VCIs), generation of headers, and flow control. At this layer, all multiplexing, switching, and routing takes place for presentation to the appropriate Virtual Paths (VPs) and Virtual Channels (VCs) of the SONET fiber optic transport system, which interfaces through the Physical Layer.
- **ATM Adaptation Layer (AAL)** functions are divided into sublayers. The Convergence Sublayer (CS) functions are determined by the specifics of the service class supported by that particular AAL. The Segmentation and Reassembly (SAR) sublayer functions to segment the user data into 48-byte payloads for insertion into cells, on the transmit side. On the receive side, the SAR extracts the payloads from the cells and reassembles the data into the information stream as originally transmitted, e.g. IP packets.

The planes include the Control Plane, User Plane, and Management Plane. See also *AAL*, *B-UNI*, *cell*, *CS*, *flow control*, *frame*, *header*, *HEC*, *OSI Reference Model*, *Physical Layer*, *PM*, *Private UNI*, *Public UNI*, *SAR*, *TC*, *VC*, *VCI*, *VP*, and *VPI*.

atmosphere The mixture of gases that surrounds and is retained by the gravity of a celestial body such as the Earth. The atmosphere is denser near the Earths surface, and becomes gradually thinner until it fades away into space. Particularly near the Earths surface, the physical matter in the atmosphere attenuates electromagnetic signals due to absorption, refraction and other phenomena. At the outer limits of the atmosphere are four layers of the ionosphere, which is useful for skywave radio propagation. See also *attenuation*, *ionosphere*, *propagation*, *refraction*, and *skywave*.

A-to-D (Analog-to-Digital) See *codec* and *modem*.

Atom Publishing Protocol (APP) See *APP*.

ATSC (Advanced Television Systems Committee) An ad hoc advisory group formed by the United States Federal Communications Commission (FCC) for the purpose of reviewing, testing, and documenting digital television (DTV) standards recommendations developed by the Grand Alliance. Specifically, standards recommendations were developed for standard definition television (SDTV) and high definition television (HDTV). The ATSC completed its work in the summer of 1995 and the standards were approved by the FCC in December 1996. See also *digital*, *DTV*, *FCC*, *Grand Alliance*, *HDTV*, and *SDTV*.

Attached Resource Computer Network (ARCNET) See *ARCNET*.

attachment unit interface (AUI) See *AUI*.

attendant access A feature of voice mail systems that allows a caller to reach a live human attendant or alternative answering point if the caller does not want to leave a message. Attendant access usually is presented as a menu option, at least by companies that place any value on customer satisfaction. Companies that do not care about customer satisfaction are happy to condemn the caller to voice mail jail. See also *human*, *voice mail*, and *voice mail jail*.

attenuation Loss in signal power. Electromagnetic signals tend to weaken, or attenuate, over a distance. Some of the signal is absorbed and converted to thermal energy as it interacts with the physical matter between the transmitter and receiver. Some of the signal is absorbed at the molecular level, and some of the signal is emitted and scattered in all directions, some of it at different frequencies. Twisted-pair copper wire systems attenuate electrical signals due to factors including the interaction of the signal with the copper in the conductors as the described by the level of resistance or impedance in the wire, and the tendency of the signal to radiate, or spread out, from the wire. Signal attenuation occurs in terrestrial radio systems due to interaction with the physical matter in the air and the tendency of the signal to disperse, or spread out.

Attenuation is a relatively minor issue with respect to satellite radio systems, at least with respect to signal propagation in the vacuum of space, where there is no physical matter to interact with the signal. The portion of the satellite link that travels through the atmosphere is very much subject to attenuation, however. Attenuation also affects fiber optic systems, as some optical energy is absorbed at the molecular level, some is converted to thermal energy, some is dispersed, and some suffers frequency shifts. In some fiber optic systems, some amount of optical energy can be lost in the cladding that surrounds the crystalline core. (*Note:* Glass actually is not crystalline, but is an extremely viscous fluid.)

Attenuation is sensitive to carrier frequency. In electrical and radio systems, for example, higher-frequency signals generally attenuate more than lower-frequency signals. The same phenomenon generally holds true in fiber optic systems, as well, although the measurement is in wavelengths, rather than frequencies, i.e., longer wavelength signals (lower frequency) signals attenuate less than shorter wavelength (higher frequency) signals. All else being equal, the impacts of attenuation increase with distance, and can become so severe over a long distance that the receiver cannot interpret the signals correctly. A variety of measures can be employed to overcome the effects of attenuation. Most commonly, amplifiers and regenerative repeaters are placed on circuits. The level of attenuation is described as insertion loss and is measured in decibels (dB) or decibels per kilometer (dB/km). See also *amplifier*, *dB*, *dB/km*, *frequency*, *gain*, *insertion loss*, *repeater*, and *wavelength*.

attenuation-to-crosstalk ratio (ACR) See *ACR*.

attenuator A passive optical component used to intentionally decrease the level of optical power propagating in an optical fiber.

ATIS (Alliance for Telecommunications Industry Solutions) Formerly the Exchange Carriers Standards Association (ECSA) A U.S. organization that develops and promotes technical and operations standards for the telecommunications and related information technology industries. ATIS standards activities address both wireless and wireline networks and include interconnection standards, number portability, improved data transmission, Internet telephony, toll-free access, telecom fraud, and order and billing issues. ATIS is accredited by the American National Standards Institute (ANSI). See also *ANSI*.

ATU-C (ADSL Transmission Unit-Centralized) An asymmetrical digital subscriber line (ADSL) modem located at the telco central office (CO) or other headend location. The ATU-C is the line side interface of a digital subscriber line access multiplexer (DSLAM). A matching modem, known as an ADSL transmission unit-remote (ATU-R) is located on the customer premises. See also *ADSL*, *ATU-R*, *CO*, *DSLAM*, *headend*, and *modem*.

ATU-R (ADSL Transmission Unit-Remote) An asymmetrical digital subscriber line (ADSL) modem located on the customer premises. A matching modem, known as an ADSL transmission unit-centralized (ATU-C) is located at the telco central office (CO) or other headend location. See also *ADSL*, *CO*, *headend*, and *modem*.

audio Sound. Generally referring to sound *recorded* and reproduced, including voice and music. Unwanted audio is noise. See also *noise*.

Audio Messaging Interchange Specification (AMIS) See *AMIS*.

audiotex Also known as audiotext. A simple voice processing technology that is essentially a voice bulletin board, audiotex allows callers to select prerecorded messages from a menu. Audiotex is used to provide information that seldom changes or that must be available to large numbers of callers. Examples of such messages include time and temperature, hours of operation, travel directions, facsimile (fax) numbers, web addresses, and school closings.

audiotext See *audiotex*.

AUI (Attachment Unit Interface) A standard that defines the manner in which an Ethernet cable, especially a coaxial cable, physically attaches to a network interface card (NIC). See also *coax* and *NIC*.

authentication Security measures designed to verify or validate the identity of a user or station prior to granting access to resources. Authentication mechanisms include passwords and intelligent tokens. See also *intelligent token NAS*, *password*, *RADIUS*, and *RAS*.

Autonomous System (AS) See *AS*.

authorization The process of granting approval or permission to a person or device seeking access to a resource, such as a database or network. Authorization involves complex software that resides on every secured computer on the network. Authorization systems include Access Manager, Kerberos, and Sesame. See also *Access Manager*, *Kerberos*, *security*, and *Sesame*.

authorization code A code that a user inputs to a system in order to gain access to resources such as applications, files, or networks.

auto dialer (automatic dialer) A peripheral device that connects to a telephone set and that automatically dials a telephone number.

automated attendant An application in which an interactive voice processor automates many of the functions of a human attendant, answering an incoming call and prompting the caller through a series of spoken menu options to directly access a department or station through touchtone or speech input. In the event that the caller does not know the desired station number, an automated directory can provide that information on the basis of a name search. When the station number is identified, the voice processor signals the telephone system (e.g., KTS, PBX, Centrex, or CO), instructing it to connect the call. See also *audiotex*, *human*, *voice mail*, and *voice processor*.

automatic callback Also known as call return. A network-based CLASS service of the public switched telephone network (PSTN). When activated by the caller who reaches a busy line, the central office (CO) monitors the target telephone number for a period of time, e.g., 30 minutes, and advises the caller with a (usually distinctive) callback ring when that line becomes available. When the caller answers the ringback call, the CO automatically redials the target number. See also *CLASS* and *PSTN*.

automatic call distributor (ACD) See *ACD*.

automatic line selection A key telephone system (KTS) feature that automatically selects an outside line when a station user picks up the telephone receiver.

automatic number identification (ANI) See *ANI*.

Automatic Protection Switching (APS) See *APS*.

automatic route selection (ARS) See *ARS*.

automatic repeat request (ARQ) See *ARQ*.

automatic set relocation Also known as customer rearrangement. A PBX administrative feature that allows the end user to accomplish set relocations without technical assistance. The user simply takes the phone from one location to another, plugs the set into the wall jack and dials a relocation code. The set identifies itself to the PBX, which changes the station port assignment and reassociates the station number and all assigned features to the new port. The feature considerably simplifies Move, Add, and Change (MAC) activity and lowers the associated costs.

available bit rate (ABR) See *ABR*.

avalanche photodiode (APD) See *APD*.

AWG (American Wire Gauge) The standard measurement of gauge in United States for all metals other than iron and steel. The gauge numbers are retrogressive; in other words, the larger the number, the thinner the conductor. The AWG number indicates the approximate number of wires that, laid side-by-side, span one inch. Historically, the AWG number indicated the number of times during the manufacturing process that the copper wire was cold drawn through the wire machine, with each draw involving a die of slightly smaller diameter in order to reduce the diameter of the wire a bit more. The contemporary process involves many fewer draws. A 24-gauge (AWG) wire, for example, has a diameter of 0.0201 in. (0.511mm), a weight of 1.22 lbs/kft (1.82 kg/km), maximum break strength of 12.69 lbs (5.756 kg), and DC resistance ohms of 25.7/kft (84.2/km). Twisted-pairs commonly employed in telco networks vary from 19 to 28 gauge, with the most common being 24 gauge. Table A-3 provides diameter, weight, and resistance comparisons of bare copper wire gauges. AWG originally was known as Brown and Sharp (B&S) Wire Gauge. See also *gauge*, *Imperial Standard Wire Gauge*, and *metric gauge*.

Table A-3: American Wire Gauge (AWG): Select Physical Attributes

AWG	*Nominal Diameter*	*Nominal Weight*	*Nominal Resistance*			
	Inches	*Millimeters*	*lb/kft*	*kg/km*	*Ohms/kft*	*Ohms/km*
10	.1019	2.60	9.55	46.78	0.9989	3.2763
11	.0907	2.30	7.57	37.09	1.2596	4.1328
12	.0808	2.05	6.00	29.42	1.5883	5.2086
13	.0720	1.83	4.76	23.33	2.0028	6.5698
14	.0641	1.63	3.78	18.50	2.5255	8.2820
15	.0571	1.45	2.99	14.67	3.1845	10.444
16	.0508	1.29	2.37	11.64	4.0156	13.172
17	.0453	1.15	1.88	9.219	5.0636	16.610
18	.0403	1.02	1.49	7.313	6.3851	20.942
19	.0359	0.912	1.18	5.807	8.0514	26.407
20	.0320	0.812	0.939	4.600	10.153	33.292
21	.0285	0.724	0.745	3.649	12.802	41.984
22	.0253	0.643	0.591	2.895	16.143	52.939
23	.0226	0.574	0.468	2.295	20.356	66.781
24	.0201	0.511	0.371	1.820	25.669	84.197
25	.0179	0.455	0.295	1.443	32.368	106.17

continued

Table A-3: American Wire Gauge (AWG): Select Physical Attributes *(continued)*

AWG	*Nominal Diameter*	*Nominal Weight*	*Nominal Resistance*			
27	.0142	0.361	0.185	0.9077	51.467	168.82
28	.0126	0.320	0.147	0.7198	64.898	212.87
29	.0113	0.287	0.117	0.5712	81.835	268.40
30	.0100	0.254	0.0924	0.4531	103.19	338.50
31	.0089	0.227	0.0733	0.3577	130.12	426.73
32	.0080	0.203	0.0581	0.2847	164.08	538.25
33	.0071	0.180	0.0461	0.2250	206.90	678.63
34	.0063	0.160	0.0365	0.1790	260.90	855.75
35	.0056	0.143	0.0290	0.1415	328.99	1079.1
36	.0050	0.127	0.0230	0.1126	414.85	1360.0
37	.0045	0.113	0.0182	0.0890	523.11	1715.0
38	.0040	0.102	0.0145	0.0708	659.63	2163.0

axis **1.** In geometry and optics, a straight line, either real or imaginary, around which a body or figure, or parts thereof, are symmetrically or evenly arranged or composed. In an optical fiber, for example, the axis is the centerpoint of a cross-section. **2.** In optics, an imaginary line perpendicular to the center of a lens or mirror.