Advanced and Emerging Communications Technologies

Series Editor Saba Zamir

FIBER OPTICS ILLUSTRATED DICTIONARY

Comprehensive Encyclopedic Reference

Julie K. Petersen

CRC PRESS

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CSU/DSU Channel Service Unit/Data Service Unit.
CSUA See Canadian Satellite Users Association.
CT 1. Call Type. 2. Cordless Telephone. 3. Conformance Test. A test to determine whether an implementation complies with the specifications of, and exhibits behaviors mandated by, a particular standard.
CT Innovation Alliance CTIA. A nonprofit trade organization of computer telephony developers and systems integrators, founded in March 1999. The Alliance was established by the Quebec Ministry of Industry and Commerce to position the province of Quebec as a center with global scope for computer telephony research and development. R&D areas include call accounting, voice and facsimile over Internet Protocol (IP), speech recognition, unified messaging, and others. http://www.ctinnovation.net/
CT3IP Channelized T3 Interface Processor. A Cisco Systems commercial fixed-configuration interface processor used with Cisco 7*xxx* series routers. The CT3IP provides 28 T1 channels for serial transmission of data, each with $n \times 56$ kbps or $n \times 64$ kbps bandwidth. Unused bandwidth is filled with idle channel data. The CT3IP does not support multiple T1 channel aggregation (bonding).
CTCA See Canadian Telecommunications Consultants Association.
CTD 1. See cell transfer delay. 2. Conditionally Toll Denied. 3. conductivity, temperature, and depth. Electronic devices that measure these variables are used in water sampling. 4. Continuity Tone Detector.
CTI 1. Call Technologies, Inc. 2. See Computer Telephony Integration. 3. See Critical Technologies Institute.
CTIA 1. See Cellular Telecommunications Industry Association. 2. Computer Technology Industry Association.
CTL See Complex Text Layout.
CTS 1. See clear to send. See RS-232. 2. Communication Transport System. 3. Conformance Testing Services.
CTSS Compatible Time-Sharing System. A developmental computer time-sharing system from the early 1960s.
CTTC coax to the curb. Coaxial cable installed into residential areas. See fiber to the home.
CTX See Centrex.
CU-SeeMe A Macintosh- and IBM-licensed PC-based videoconferencing program from Cornell University. It supports video, audio, and other utilities over Internet, with plans to make it Mbone-compatible. The encoding is proprietary. See Cameo Personal Video System, Connect 918, MacMICA, IRIS, ShareView 3000, VISIT Video.
cube 1. In geometry, a three-dimensional structure with six equally sized flat square planes all interconnected with each edge in full contact with an edge of each of the adjacent planes. Thus, the point at which the edges join forms a corner from which the cube may be referenced along three mutually perpendicular axes. A cubic structure may be real or imaginary and does not necessarily specify the size of the component planes, which may be infinite. 2. *colloq.* An early model of NeXT computer that was shaped like a black cube, essentially a tower model, for easy access and upgrade. The shape of the NeXT later went to a more conventional thin slab, which could sit under the monitor.
cubic Embodying the geometric structure of a cube in one or more of its aspects. The simplest structure in a crystal is cubic, with atoms uniformly spaced along three mutually perpendicular axes. A regularly cubic crystalline structure is one that is isotropic, with the atoms spaced equidistant along each axis. In terms of the index of refraction of a dieletric material, most solids used in the optics industry are isotropic in any given plane (e.g., glass). However, it is possible to fabricate materials that are anisotropic (varying in density or composition) in order to control their refractive properties. See cube.
CUG closed (telephone) user group (e.g., as in ISDN Q.85 and Q.735 community of interest services).
cure *v.t.* To process so that the essential properties of a substance are changed, usually to improve them, as in curing a metal to give it strength or resilience, or curing a hide to preserve it.
curie A unit used for describing the strength of radioactivity, which is equal to 3.7×10^{10} disintegrations per second. It is named after Nobel scientists Pierre and Marie Curie, who did substantial pioneer work in radiation.
Curie point, Curie temperature A temperature at which peak levels of a dielectric constant occur in ferroelectric materials.
current (*symb.* – I) Movement of electrons through a conducting medium, usually expressed in amperes. Electricity moving through a wire or cable is current. See ampere.
current amplifier Any natural, mechanical, or electronic device that provides greater output of an electrical signal than the input signal. A public address system (PA) is a type of current amplifier, as are other microphone and speaker combinations.
current cell rate CCR. In ATM networking, a traffic flow control concept that aids in the calculation of ER and may not be changed by the network elements (NEs). CCR is set by the source to the available cell rate (ACR) when generating a forward RM-cell. See cell rate for a chart of related concepts.
curing oven A specialized heating device used in fiber optics cable assembly to cure bonding agents (e.g., epoxy) faster than by air drying, for example.
customer access line charge CALC. The charge for connecting a private branch phone exchange (PBX) to the central office exchange (Centrex).
Customer Owned And Maintained COAM. This designation is often used to describe customer-owned telephone devices, for example (a designation that became more important when the phone company no longer owned and controlled the phones within a customer's premises).
customer record information system CRIS. Also known in the general sense as CIS, customer information system, it is a computerized database for tracking customer contact, credit, and purchase

adapted and used in network and modem technologies, but the early versions were not developed for the demands of multimedia networks with widely ranging data characteristics (which scarcely existed at the time). Another limitation of the original Lempel-Ziv techniques was in performing efficient searches for previous matching strings. Enhancements and variations are addressing some of these limitations and adaptations to special circumstances. In 1994, Jung and Burleson proposed a parallel algorithm, architecture, and implementation for Lempel-Ziv compression exhibiting a scalable, regular structure suitable for VLSI array implementation. This has practical applications for data compression in portable digital data communications and wireless local area networks (LANs) where effective compression/decompression schemes can significantly improve throughput and reduce connection time costs. See Ardire-Stratigakis-Hayduk, differential Ziv-Lempel, LArc, LHarc.

Lempel-Ziv-Stac LZS. A data compression system developed by Stac Electronics, Inc., largely based upon the LZSS algorithm. See Lempel-Ziv-Storer-Szymanski.

Lempel-Ziv-Storer-Szymanski LZSS. A sliding dictionary compression scheme descended from LZ77 by Lempel and Ziv. LZSS was developed in the early 1980s by James Storer and Thomas Szymanski. Storer filed for a patent for data compression/decompression in 1987 (U.S. #4,876,541). LZSS differs from its predecessor mainly by using bit flags to identify the subsequent data as a literal or an offset, which can result in more compact data compression and faster decompression. A number of developers developed variations and optimized versions of LZSS, one of which evolved into LArc. See LArc.

Lempel-Ziv-Welch LZW. A dynamic dictionary, lossless data file compression scheme based on the Lempel-Ziv method, first described by Terry A. Welch in 1984 following the publication of the Lempel-Ziv format in the late 1970s. The developer community generated a substantial amount of debate over use of LZW, since it was distributed as an open standard for many years before the community at large was informed that LZW was being patented. Many programmers incorporated LZW into their software, thinking it was in the public domain. LZW has been incorporated into ARC and PKZIP. PKZIP is a particularly widespread archiving utility.

A patent for the technology is held by IBM (U.S. #4,814,746), with a similar one held and enforced by Unisys Corporation (U.S. #4,558,302). Some claim these two patents cover virtually the same technology, or that the Unisys patent is a subset of the IBM technology. A similar patent has also been held since 1989 by British Telecom.

The enforcement of the patent rights caused ripples of unease in the programming community, as several modem file protocols use LZW. Many graphics interchange formats incorporate LZW compression, including TIFF, which is widely used in desktop publishing programs, and the Compuserve 8-bit GIF format popular on the Web.

In telephone technology, LZW is used in Northern Telecom's Distributed Processing Peripheral (DPP) for the transmission of compressed data. At one point, Unisys issued a statement exempting freeware authors from paying license fees on the use of LZW in their programs in order to quiet the concerns of software developers who were distributing software without commercial gain. Later, Unisys asserted that *all* software developers would be subject to a minimum royalty ($.10) in order to protect the patent, with exceptions only for charitable institutions. See Ardire-Stratigakis-Hayduk, Lempel-Ziv, LZC.

lens A component with optical properties such that it lets light pass through while altering its path. A magnifying glass is a simple convex lens that spreads the light coming through from the object observed such that the object appears larger when it hits the human eye or an imaging apparatus. There are many different types of lenses. A prism is a type of lens that separates white light into its wavelength components so that the colors may be seen. A Fresnel lens diffracts light to concentrate or diffuse it.

Lenses may be combined in linear or planar arrrays to control light passage over a larger area than would be possible with one lens. It is usually not practical to make a single optical lens larger because the curvature causes image aberrations nearer the edges.

In free-space optics (FSOs), where diode lasers transmit signals through the air to connect buildings with one another or with a nearby fiber backbone, a lens can spread the light beam so that birds, tennis balls, or other obstacles that may briefly interrupt the transmission are likely to only pass through part of the beam rather than obstructing it completely. See faceplate; fiber optic; Fresnel lens; lens, lenticular; transfer lens.

lenticular Historically, lenticular meant having a lens shape, especially a lentil-shaped, double-convex lens as in a traditional magnifying glass. The term is now more often applied to lens configurations with arrays of closely aligned lens shapes designed to refract light at particular angles in succession as the viewer or the lens is rotated through a plane. It also no longer necessarily implies a double convex lens and some lens arrays with straight surfaces have been called lenticulars, though they are probably better referenced as gratings. See lenticular lens

lenticular image A specialized optical image imprinting technique in which a series of two or more related 2D images is interlaced and embedded under a ridged surface such that the net viewing effect is similar to a stereographic image or animation exhibiting depth or movement.

Early commercial lenticular images (sometimes called lenticulars) bonded an image that was printed on card stock behind the refracting lens. Now, with computerized image processing techniques, it is possible to take successive frames of an image, interlace the image at tolerances to match the lens density and imprint them on the back of the lens material itself such that the strips of the frame associated with the

get the funding and other resources necessary for various computer pioneers to build the stuff of dreams.

LIDB See Line Identification/Information Database.

LIFO last in, first out. A descriptive term for the order in which data are processed in a queue. For example, picture a stack of dinner plates in a plate well in a buffet; when the stack is refilled by the restaurant staff, the last plate on the stack (the one on top) is the first one removed by the next customer. Data can be handled in the same way. See FIFO, FILO, GIGO, LILO.

light Radiant energy visible to the human eye having wavelengths in the approximate range of 390 to 750 nm, that is, the transition to ultraviolet at one end of the spectrum and infrared at the other end. The phrase *white light* is used to describe light with a mixture of frequencies. The speed of unimpeded light is 3.00×10^{-8} meters per second, symbolized as *c* in mathematical calculations.

It was discovered that light could be broken up into its component wavelengths with prisms, and this aided researchers in understanding the nature of light and the colors associated with particular frequency ranges. The visible spectrum is specific to human perception; other mammals and insects have broader, shifted, or more specific perception of color ranges. A flower that to humans appears yellow may have other colors in the ultraviolet or infrared spectrum that are perceived by pollinating insects. Most dogs and cats are insensitive to colors as humans perceive them (Siamese cats reportedly can perceive color).

Light is the primary stimulus for sighted individuals sense to forms, other beings, and their orientation and movement in three-dimensional space. The interaction of the light waves hitting various objects, bouncing back through eyes and processed by a brain, constitutes the complex phenomenon called sight. Some creatures can see beyond the range of human-visible light. Dolphins use sonar (sound waves) to detect objects which may not be visible to humans, and thus can "see" inside some objects in a way not possible for humans without mechanical aids. See fiber optic, infrared, lamp, laser, light-emitting diode, spectrum, ultraviolet.

light guide Light-conducting material such as an optical fiber. The material provides a conduit or channel by which the light can be directed. The idea is similar to the concept of wave guide.

light path In general, the path traveled from one specified point to another by electromagnetic radiation in the optical freuquencies. In general, light travels in a straight line, but multiple reflected straight line segments can be combined to form a curved path. See lightpath.

light piping Bringing light into an area through fiber optic cables. Laser light will travel along a filament the size of a hair, and filaments can be bundled to provide more light. This is very handy for illuminating hard-to-reach places like small pipes or inside the human body for medical research or procedures.

light pulse The basic information-carrying transmission medium in a fiber optic network. Coded electrical pulses from computer systems, existing phone systems, and other sources are used to stimulate a light source such as a light-emitting diode (LED) or an injection-laser diode (ILD) to generate the light pulses that are then funneled through a lens, corrected with prisms, if necessary, and transmitted through a cladded (shielded) fiber waveguide. The light propagates through the waveguide through a process called total internal reflection (TIF). The cladding layer around the fiber reflects beams that are within a certain range of angles back into the fiber core, preserving the signal over distance. At the receiving end, the light pulse is usually translated back into an electrical signal for digital decoding and other processing. Along the transmission path, the light pulse may be amplified or regenerated through a variety of electrical or optical means. See light-emitting diode.

light speed The speed of light in a vacuum is 186,292 miles/sec (299,800 kilometers/sec). When traveling through air, water, a fiber optic waveguide, or other dielectric (conductive) material, the matter will impede the speed of light and slow it down. In fiber optic cables, for example, the propagating light travels about 124,100 miles/sec.

In general, the higher the refractive index of a material through which the light travels, the more it impedes the propagation of light. This characteristic can be exploited in cable construction. The cladding around an optical fiber core is made from a material with a slightly lower refractive index than the core such that the light beams are reflected back into the core (within certain effective angles). Sometimes, as in multimode cables, the refractive index is graded to selectively control light speed based upon its distance from the core, in order to compensate for certain types of frequency dispersion. See dispersion, graded index, stepped index.

light-emitting diode LED. An inexpensive semiconductor p-n junction structure used in many electronic displays, particularly small ones. The LED lights up when a current is provided. LEDs are common in digital clocks, calculators, microwave readouts, electronic instrument displays, and much more. The LED typically resembles a small illuminated knob with a semiconductor within the knob (which is actually a lens), and leads coming out from the semiconductor/knob arrangement into the device circuitry.

LEDs are now also used to provide the light rays for certain types of fiber optic transmissions, especially in multimode cables (more precise and more expensive laser lights are used for single mode fiber).

light-guide interconnect cable LIC. Also called light-guide cable interconnect (LCI). A light-guide is a conduit for directing and containing a light-based transmission and an interconnect cable is one which specifically interconnects various equipment and devices. LICS are used in fiber optics transmission networks and typically have connection ends that can be more readily connected and disconnected for the purposes of installing and reconfiguration network physical topologies. See loose cable.

optical coupler module OCM. A component that provides functions in conjunction with coupled fiber optic cables such as branching/joining, multiplexing/demultiplexing, and filtering. OCMs are often modular and may be customized for operating wavelength and the size and number of fiber filament.

optical cross connect OXC. Optical connection components of telecommunications carrier networks that help operators manage the larger amounts of bandwidth enabled by newer capacity-increasing technologies. OXCs began to become generally available in the late 1990s.

OXCs can facilitate network administration by enabling a network to be more readily reconfigured or restored using optical switches. OXCs can handle data streams in the terabit ranges and work with a range of wavelengths and bit rates, making it easier to quickly effect rerouting. Currently OXC components are part of the optical portion of mixed wire and optical fiber networks, but as the optical market grows, demand for OXCs will likely increase. See lambda switching.

optical detector A substance or circuit which detects and converts electromagnetic waves in the form of optical waves. Solar panels contain substances that allow the conversion of light into electricity, which are widely used in the satellite industry to provide power for telemetry adjustment of orbits. See solar panel.

optical disc Any of a number of technologies used to store digital data which is subsequently accessed by light, usually a laser beam pickup. The information on an optical disc is commonly stored in a series of pits, that is, indentations in a metal disc coated with a plastic substrate. The placement, size, and proximity of these pits is defined in part for the specification for the type of optical technology. Newer technologies have been developed to increase the information capacity of a disc, as in digital videodiscs (DVDs) that are slightly thicker, to bring the disc closer to the laser pickup, with slightly smaller, tighter pits. Compact discs, videodiscs, PhotoCDs, and DVDs are popular forms of audio and visual storage media. Optical discs are also used for computer data storage, particularly for backups.

optical document recognition ODR. A software process or combination of hardware scanning devices and software, which evaluates the various elements on a page to determine whether they are distinguishable as text, images, symbols, or lines, and identifies them accordingly. The ODR in its simplest sense does not interpret the text into characters; it merely identifies page layout elements: images, columns, page numbers, text, etc. However, in commercial products, it is commonly combined with optical character recognition (OCR) capabilities in order to optically identify and interpret areas that are text into characters that can be edited with a word processor, text editor, or desktop publishing program. ODR is a somewhat more complex process than OCR; together they comprise powerful tools which are a part of image document management and processing.

ODR is particularly valuable for converting archived image information (e.g., microfiche) into documents that can be desktop published, or archived in databases for faster and more efficient search and retrieval. See image document management, optical character recognition, scanner.

optical eye pattern measurement procedure An optical fiber test procedure standardized within TIA/EIA-526, developed by the Optical Fiber Communications System subcommittee. It describes parameters for measuring the repetitive temporal characteristics of a two-level intensity-modulated optical waveform at an optical interface. Rise time, fall time, overshoot, and extinction ratio may be determined from the measured eye pattern. The waveform itself may be tested against a reference waveform mask to determine standards compliance.

optical fiber A flexible, light-conducting, filamentous plastic or glass medium used for optical signal transmissions. Optical fiber is typically from 2 to 125 µm thick, and is capable of carrying a variety of high-speed, wide bandwidth transmissions with relatively low loss, when correctly installed. Unlike wire, fiber is not subject to electromagnetic interference or most of the types of radiant eavesdropping techniques that can be used on wire. This has made it very popular for backbone, hazardous area, and multimedia installations. It also does not present the same potential fire hazard as wire electrical cables.

Two common types of optical fiber include step-index fibers and graded-index fibers. Step-index fibers have two layers: a lower refractive outer *cladding* layer and an inner core with a high refractive index. Graded-index fibers also are less refractive toward the outer edge, but rather than being two layers sandwiched together, as in the step-index fibers, the refractivity in the material overall decreases gradually in relation to its distance from the innermost point of the cylinder.

Fiber can be bundled without the electrical interference common to bundled wires; a group of fibers works together to provide greater capacity. Single-mode fiber transmissions, in which the signal can only follow one path through the filament, can travel greater distances without repeaters. See multimode optical fiber, single mode optical fiber.

optical fiber cable See fiber optic cable.

optical fiber ribbon A bundled fiber assembly in which individual fibers are laid side-by-side to form a flat ribbon or strip. This is convenient if they are to be installed in narrow areas such as inside walls or under carpeting. This way of arranging fibers is less common than bundling them into a cylindrical shape.

optical handwriting recognition OHR A specialized form of character recognition designed to separate joined shapes and recognize variations of particular letters, in addition to other generalized optical character recognition (OCR) functions. Most OHR systems have to be trained to recognize a particular style of handwriting, since there is so much variation in the letter forms in the way different people write.

optical insertion loss OIL. The coupling-associated

pulse modulation A simple means of modulating a signal by applying pulses of current (often just on or off) without changing the frequency of the signal. See pulse code modulation, pulse width modulator.

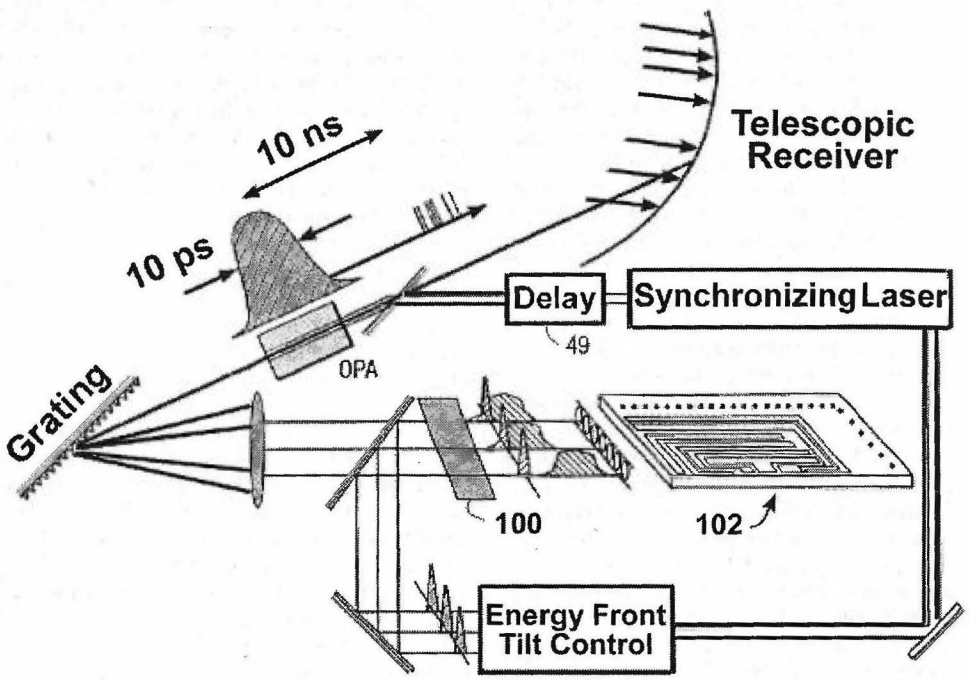
pulse repetition frequency PRF. The number of pulses which occur in a unit of time, such as the number of pulses per second or minute. Pulse repetition frequency is important to many technologies, especially those that involve signaling or synchronization.

pulse width modulator PWM. An electronic circuit that can be configured to produce a pulse with desired characteristics (period, cycles, etc.). Thus it is essentially a component that regulates an electromagnetic pulse. There may be more than one modulator on a circuit board and each modulator may have different characteristics (e.g., 8-bits with 4 channels or 16-bits with 2 channels).

A PWM can be used for a variety of purposes, including device control (DC motors and servos), power bridge switching, light intensity control, and the modulation of transmission signals.

There are now all-digital PWMs, implemented as

Diode-Pumped Laser Optical Communications Receiving System



This diagram illustrates solid-state fiber lasers incorporated into an optical communications system and the close relationship between wired and wireless communications. It illustrates many fundamental optics concepts described in this reference. J-C. Diels et al. have developed a laser communication system that uses multiple lasers, lenses, diffraction gratings, and a modulator to disperse and modulate light pulses into coded words that are recombined, then sent and received by telescopic transceivers. A second laser generates reference pulses. When the references and main signal coincide, they are combined by a nonlinear crystal, with a detector recording the combined signal.

Fiber sources, pumped by diode lasers enable much shorter pulses to be generated which, in conjunction with faster modulation technologies, are well-suited for optical communications systems. Diode laser pumping is becoming more cost-effective and has a long lifetime compared to some pumping technologies.

In one embodiment of the system, a laser generates a fast pulse in the femtosecond-range, along with a synchronization signal. The laser pulse is reflected off a dispersion grating. The pulses are converted by a modulator into a string of pulses representing coded words. The second grating recombines the coded words after which they are sent by a telescopic transmitter to a telescopic receiver. A reference laser receives the synchronizing signals from the main laser and generates reference pulses, the original and reference signals are combined by a nonlinear crystal and the output signal sent only if they coincide. The output is sensed and recorded by a detector. The diagram illustrates the optical detection system that processes the received signal. Parametric gain is used to select the appropriate channel for the incoming spectrum and to amplify the signal. The laser emits a synchronized train of pulses at a wavelength shorter than the incoming signal at the same repetition rate. The pulse from the grating serves as a pump for a parametric amplifying crystal. A Fourier transformation is performed on the amplified signal to regenerate the pattern of the originally transmitted pulse. Detection is then handled by a cross-correlator (100) and a detection array (102). [Image adapted from USPTO patent #6,421,154 filed October 2000.]

CMOS circuits, suitable for precision pulse width and pulse position modulation for computer peripherals and laser printers and copiers. See delta-sigma modulation.

pulsing Using discrete bursts of sound or electromagnetic energy to send signals through a communications medium. The strength or duration of the pulses may have relevance, depending upon the system. In older phone systems, pulses were used to indicate the number dialed. Beacons often use pulses to signal their presence and location. See pulse dialing.

pump, laser A device to create molecular action resulting in photons emitted as a laser beam. There are many types of lasers, and each may be used for different purposes, however, in general, the purpose of a laser pump is to stimulate a bound electron to go from one quantum level (usually from a *ground state*) to a higher quantum level, such that, when the excited electron decays, energy is emitted in the form of light. Since light is continuously pulsed or stream-emitted from the laser cavity, there needs to be a way to replenish the expended energy. The repetitious nature of the energy replenishment is what inspired the term "pumping." Pumping may be along the same axis as the resonating mechanism (longitudinal) or transverse to the axis of the active lasing medium.

In traditional lasers, the excitation is usually achieved by optical or chemical means. A ruby laser is optically pumped, while a helium-neon laser is chemically pumped. Electricity can also be used to stimulate a semiconductor to higher energy levels or to ionize gases. More recent laser diode components may use fiber amplifier or solid-state pumping.

Xenon flashlamps are common for pumping, or a laser diode or traditional laser may pump another laser. In a helium-neon (He-Ne) laser, helium pumps the electrons (excites them) into a metastable state of neon. A nitrogen, Nd:YLF, or Nd:YAG laser may be used to pump a dye laser. See laser. See Diode-Pumped Laser Communications diagram.

punch *v.* 1. To prod, poke, or perforate. 2. To perforate small regular holes in paper, card, fine metal, or other similar flat surfaces in order to create a semipermanent record of a code. Early gramophone cylinders, player pianos, patterned looms, music boxes, and punch card reading computers employed this technique to encode and store information intended to be read back later. See Hollerith card. 3. To apply pressure to an enclosure in order to pop out a small section, to enable the threading of circuit lines. 4. To apply pressure with a punchdown tool to a wire and terminal block. See punch down, punchdown tool.

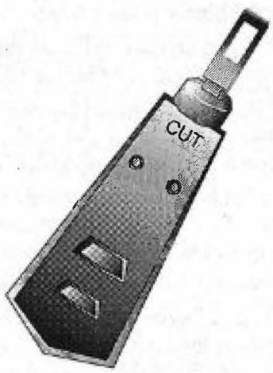
punch card Any sturdy paper or card stock in which parts of the card are punched out according to a code that can later be reread and decoded to produce the original meaning. Punched codes in various media have been around for centuries, with early ones incorporated into music boxes. The Jacquard loom incorporated punch cards to store loom patterns in the early 1800s, revolutionizing the textile industry and causing a substantial uprising among human weavers, whose jobs were obsoleted by the automation. Punch cards can be used to store many sorts of codes and variations of the concept are used in music boxes, player piano rolls, older computing devices, etc. See Hollerith card, zone punch.

punch down *v.* To apply pressure, usually with a specialized punchdown tool, to wires looped around a terminal block to strip insulation from the end of the wire, and insert the conductive surface between the prongs of the terminal in order to make a solid, clean connection. [The verb form is two words, the noun form often combined into one word.] See punchdown block, punchdown tool.

punchdown block, terminal block, cross-connect block A multiterminal block designed to facilitate electrical cross connections, especially those which may change from time to time or where future expansion is planned. Very common in telephone installations where a multiline wire is threaded into a building and then, at the punchdown block, is split into pairs to wire several individual phones in different locations. See punchdown tool.

punchdown tool A handheld wire installation device that resembles a screwdriver with an extremely short, notched shaft. The handle may be spring-loaded. The ends are designed to fit particular sizes of terminals and used to quickly connect wires to a punchdown block. The wire is looped over the prongs of one of the terminals in the block, and the punchdown tool is pushed against them to spread the prongs and snap the wire securely into place. Some punchdown tools will punch and cut. See punchdown block.

Punchdown Tool



Telecommunications wires can often be attached to wiring blocks with screwdrivers and pliers, but the task becomes tedious if there are many wires to connect. A punchdown tool is specialized for attaching and trimming the wires more quickly and readily than general-purpose tools.

Pupin, Michael Idvorski (1858–1935) An Eastern European-born American inventor and educator. He studied low pressure vacuum tube discharges and X-rays, and invented an electrical resonator and inductive loading coils, paving the way for long-distance wired transmissions.

transcontinental telegraph The first American transcontinental telegraph line was initiated by Hiram Sibley, with encouragement from Ezra Cornell, in the mid-1800s. Sibley, the founder of what was to become Western Union, made a reasonable estimate that it would take 2 years and about $1 million to complete the project.

The telegraph line had a significant impact on the new Pony Express service, which had been in operation for less than 2 years when it shut down in October 1861, after inducements to stay in service at least until the telegraph line was completed.

Not surprisingly, problems other than weather plagued the construction of the line. Buffalo discovered that telegraph poles made good scratching posts, sometimes bringing down the poles in their enthusiasm. Native Americans sometimes made off with the wires because the lines stretched through their treaty lands; within days or hours, exquisitely woven copper wire bracelets would appear in local trading markets. Remarkably, despite the great distance, harsh conditions, and the small size of the work crew (only about 50 line workers), the transcontinental telegraph was completed in October 1861. It had taken only 4 months at a fraction of the projected cost, one of the most stunning achievements in western engineering.

transducer A general term for a device which converts one form of energy to another, a process used throughout communications. When sound waves from a telephone conversation come in contact with a telephone mouthpiece diaphragm, the diaphragm causes small polished carbon granules to cohere and the energy is converted to electrical impulses that are transmitted along the phone line. When the mechanical movements of a phonograph stylus are turned into electrical impulses, and then, at the speaker, converted again to audible sound waves, the signal has gone through (at least) two transducers.

transfer lens A lens that propagates light in a useful direction and may also concentrate or diffuse the light, as needed. The *effecitve plane* or *working plane* is that region over which the propagated light is optimized for the needed purpose, which is often uniformity and consistency of the light beam (usually perpendicular or nearly so to the plane of the light beam).

In the context of light transfer from an illuminator to a fiber optic lightguide, a lens designed to propagate the light from a laser or light-emitting diode into an optical fiber core with a minimum of feedback to the laser. If the laser light hits the fiber lightguide in such a way that it reflects back, it can cause jitter or fluctuating performance in the laser.

A hyperbolic lens surface, for example, can collimate laser light and further may transmit the light towards the fiber lightguide at angles that are efficiently related to the axis of the fiber and the angle most likely to reduce reflections from the end of the fiber. Thus, there are compromises in which the most efficient balance of factors is sought.

Toroidal, circular, or spherical lenses may be used as transfer lenses, depending upon the type of assembly, power of the laser light, and diameter of the lightguide. The precision of the application (e.g., high-speed telecommunications) dictates, in part, how sophisticated or efficient the transfer lens may need to be, as will the degree of curvature of the fiber filament endface.

A transfer lens may also couple photomultiplier tubes to CCD components in instruments such as spectrometers. Since traditional optical lenses for this purpose tend to be expensive and bulky, some instruments now use a fiber optic faceplate to provide a lighter, thinner coupling interface. Depending upon any size differences between the coupled parts, the fiber array may use fiber tapers rather than straight fiber filaments to guide all the light into a smaller or larger CCD components. See diffusion; face plate, fiber optic; Fresnel lens.

transformer An electrical device for changing the qualities of a current by mutual induction. Transformers did not come into wide use until the early 1900s, gradually superseding spark coils for providing power for communications and electronic components. They were similar to spark coils in that they had a core surrounded by conductive windings. However, the core used soft iron sheets rather than a bar. Like a spark coil, two sets of windings, one within the other, were commonly used. The core could be closed or open. Transformers required alternating current and direct current was still prevalent at that time, but the use of alternating current allowed the elimination of a vibrator, as the natural alternations of the current caused inductive discharge. This was more compact and practical than a spark coil.

Since many modern electronic appliances (modems, printers, answering machines, model trains) have electrical requirements different from that which comes out of a household socket (110 or 220 AC), the power cord may be equipped with a transformer which modifies the current to the needs of the device being powered (9 or 12 V is common). It is important to use the correct transformer; if the voltage is too high, it will likely blow the components.

Transient Mobile Unit A mobile communications term for a unit that communicates through a foreign base station.

transistor A small device developed in the late 1940s which provided a means to amplify signals with very low power consumption and very little heat. The name, derived from "trans-resistor," has been attributed to John R. Pierce who worked with Schockley at Bell Labs. The importance of the transistor to the development and evolution of electronics cannot be overstated. A new world of tiny components opened up, including portable radios, hearing aids, computers, satellites, and much more. See transistor history.

transistor history The invention of the transistor in 1947 is widely attributed to William Shockley, John Bardeen, and Walter H. Brattain of Bell Laboratories, although Ralph Brown is sometimes also mentioned. Starting in 1951, when they began to be commercially produced, transistors replaced large, power-hungry, cumbersome vacuum tubes, enabling electronics to