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ТОМСКИЙ УНИВЕРСИТЕТ СИСТЕМ УПРАВЛЕНИЯ И РАДИОЭЛЕКТРОНИКИ

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СБОРНИК ТЕКСТОВ И УПРАЖНЕНИЙ ДЛЯ ОБУЧЕНИЯ ТЕХНИЧЕСКОМУ ПЕРЕВОДУ СТУДЕНТОВ ТЕХНИЧЕСКИХ СПЕЦИАЛЬНОСТЕЙ

Учебно-методическое пособие

СОДЕРЖАНИЕ

ТЕКСТЫ ДЛЯ ЧТЕНИЯ

3-D OPTICAL MEMORY

A new kind of photorefractive effect has been discovered by two physicists at the Racah Institute of Physics at the Hebrew University. With further work, this effect will possibly be used for the development of holographic-type memories and other optical computing devices.

In contrast with ordinary disk or tape memories of computers where the information is stored on the surface of a magnetic film, holographic memories store information in the volume of special types of crystals. The information is written in and read out using laser beams.

Scientists in many laboratories have realized the distinct advantages of such memories and are looking for ways to put them into effect. The information density of such memories is enormous, and large quantities of information can be written and read in parallel using one flash of a laser beam. In these memories, it is possible to store directly both numbers and pictures without the need to translate the pictures into numbers first, as is done in present computers. The information is stored in such a way that defects in the crystal and small scratches do not spoil any part of the information. They just increase the intensity of the light which is needed to write the information.

The most promising way to write the information into the crystals is to use the photorefractive effect. This effect is simply the change in the refractive index of the crystal by the absorption of light in it. Experimental holographic memories using the photorefractive effect have been built, but the information stored in the memory is usually erased when the memory is read. This is a fundamental problem resulting from the very nature of the classical photorefractive effect.

Professor Yacoby proposed a new mechanism for a photorefractive effect which has been experimentally demonstrated and investigated by Agranat. The new photorefractive effect is at least as efficient as the classical effect and

holograms written into the crystal are not erased when the information is read. Thus, this new effect may open a new way to utilize holographic computer memories.

Even though the Hebrew University scientists still have a long way to go to produce a practical device, they draw confidence from the fact that they have already demonstrated the existence of their new photorefractive effect and have the ability to produce the type of crystals that they need.

PROTECTING MASTS

The triangular steel masts widely used for broadcasting and communications are vulnerable to corrosion and to lightning strikes, with the major potential hazard from indirect lightning strikes being the possibility of damage to any solid-state equipment connected to the antenna system. Despite the claims of solid-state transmitter manufacturers that their equipment is fully protected this in practice depends, particularly in the case of medium-wave equipment, on the installation being adequately earthed, both in respect of the antenna system and the power-supply system. An indication of the extent to which this may need to be taken is underlined in a recent 127-page publication of the European Broadcasting Union "The protection of broadcasting installations against damage by lightning" compiled by specialist engineers of Italy, Germany and Austria.

One problem is that v.h.f. and u.h.f. transmitting stations are often built on hills or mountains where the earth conductivity is very poor and various systems of "earthing improvement" are necessary. This may include increasing soil conductivity by injecting highly conducting solutions in order to reduce the contact resistance of the earth electrodes. The authors point out that, formerly, use was made of saline solutions, but these contributed to corrosion. More recently hygroscopic emulsions have been developed. In order to permit the emulsion to penetrate the rock, blasting may be necessary. Emulsion injection can result in

lower earthing resistance, independent of fluctuations in air temperature and humidity and provides a useful degree of corrosion prevention.

The ABU Technical Review includes a report from China on metallic corrosion in medium-wave antenna masts. There are over 550 m.f. and h.f. transmitting stations in China. Serious corrosion has been found a problem at a site close to an industrial city in south-eastern China, where there are relatively lightweight steel triangular masts 106.5m and 147m high. The segments most affected were at altitudes of about 65 to 108m. Microanalysis of the corroded sections showed an abundance of sulphur which was deemed to come from sulphur dioxide pollution from local power stations and factories. Harmful smog from many chimney stacks does not diffuse quickly under low wind speeds and high humidity.

The Chinese broadcast engineers have concluded that careful attention needs to be paid to the question of air pollution when choosing sites and that metal protection needs to be considered in relation to environmental conditions. Techniques such as surface blasting, hot spraying immediately with an Al-Mg alloy coating with a sealed layer painted over the coating are recommended in polluted areas. In less polluted environments masts can be sprayed with a non-metallic paint on the steel base after blasting. The Chinese plan in future to use aluminized coating and steel base combined metallurgically, with resulting stronger bond strength. The aluminized coating with an inside layer of ferroluminium and an outer layer of high concentration aluminium will, it is claimed, be more resistant to atmospheric corrosion.

LEAP IN THE LIGHT

By the middle of the decade international carriers will be able to draw on trans-Pacific optical transmission systems carrying 2,4GBit/s. This represents the equivalent of over 300,000 simultaneous telephone calls per pair of optical fibres. The world’s first transatlantic optical cable which went into service in 1990 can carry 40,000 simultaneous telephone calls.

The new systems will carry 600,000 simultaneous conversations on a single four-fibre cable. Scientists in the research laboratories of AT T and British Telecom have already demonstrated the high-speed optical transmission techniques required in terrestrial systems.

However, transferring these to the special demands of an undersea system presented special problems.

In optical communications systems digital information is carried as a train of light pulses through the fibre. To support the 2,4GBit/s transmission rate these light pulses need to be very short. As the optical pulses travel through the fibre they weaken in signal strength and become stretched, making the information they carry indecipherable. The signals in existing submarine systems operating at 140Mbit/s need to be electronically reconstituted every 40 miles or so. A 2,4GBit/s transmission rate would be impractical with conventional systems as it would require too many repeaters on the sea bed.

To overcome this, researchers have developed an all-optical amplifier which can reconstitute the optical signal without the need for electro-optic conversion on the ocean-floor. The optical amplifiers developed by BT boost the optical signal as it travels through a short length of fibre which contains traces of the element erbium. The signal gains its optical energy from a high reliability semiconductor laser that ‘pumps’ the amplifier.

The high efficiency of these optical amplifiers means that there will be fewer ocean-floor repeaters; even with a transmission rate of 2,4GBit/s amplifiers can be over 100km apart.

Another important property of optical amplifiers is that they give the network designers complete freedom to upgrade the capacity of the system without modification. Unlike conventional electronic repeaters, optical amplifiers can support a number of data rates. Last year, BT demonstrated a land-based system using erbium amplifiers that transmitted a data rate of 20GBit/s over 100m. The company expects the first practical implementation of such as high capacity system in a submarine cable before the end of the century.

Scientists have looked even further into their crystal ball with a laboratory experiment which demonstrated that it was possible to send ultra narrow optical pulses – each less than one trillionth of a second in duration, called solitons – 6000km in a loop of erbium doped fibre acting as its own regenerator.

Scientists are rising to the challenge of underwater telecommunications systems. There is now the possibility that optical signals will one day cross the Atlantic in a single leap without any need for sea bed regeneration. Then the engineers might have invented themselves out of a job.

TRANSPUTER IN THE DRIVING SEAT

Dr Barry Thomas and Professor Erick Douglas of Bristol University are developing a transputer-based expert system for the control of unmanned vehicles. The three-year project will lead to a fully engineered vision system together with the control software necessary to drive a robot vehicle accurately and smoothly.

By human standards, the driving ability will be unspectacular; the robot is expected to be able to drive itself along an empty road and to turn right and left as necessary. Yet even this modest capability will require real-time algorithms capable of analyzing each separate frame from a video camera mounted on the vehicle. Dr Thomas is developing the software to run on a bank of between 10 and 20 transputers which, unlike existing vision systems, will take the video signal directly without any external frame store.

The Bristol system is expected to be an order of magnitude more responsive than that of other robot vehicles, which up till now haven’t been able to drive safely at more than a few km/h. Nor have they been able to distinguish the road from the verge by its texture alone.

In answer to the obvious question of why such large sums are to be spent in doing what a human being can do far better, Dr Thomas points to the possibility of having a military surveillance vehicle that could explore dangerous enemy territory

entirely by passive sensing. There would be no need for give-away emissions or jammable radio links.

Ultimately, however, its true value is seen as “enabling technology”. A real time vision analyzer could equally well act as a security guard or a method of checking goods on a production line… or eventually perhaps as a means of getting you home safely from the pub.

RADIOACTIVITY AND SOFT FAULTS

Studies at the University of Southampton have investigated in detail the phenomenon of “soft” errors in dynamic rams due to alpha particles. Ever since the introduction of high density rams alpha sensitivity has been widely reported, though there has always been some uncertainty over which parts of the chips are most sensitive.

What the Southampton researches did was to take samples of 65K nmos drams from three different manufacturers and prepared them by removing their lids and protecting coatings. Then, by using masks and an alpha source, they were able, selectively, to expose different areas of the chips to radiation.

With each different position of the masks, the rams were then subjected to a sequence of write/read cycles, with the error rates being noted in each case. These tests showed quite clearly that alpha hits cause the most errors, not when they hit a memory cell, but when they hit a bit line. In fact, for chips from all three manufacturers, hits on the bit lines provided the only significant source of alpha-induced soft errors. Cells, sense amplifiers and peripheral circuitry appear to make a negligible contribution.

The Southampton workers provide evidence that the increased sensitivity of the bit lines, compared with other components is, in all probability, a reflection of nothing more than their greater collecting area.

A NEW APPROACH TO SHORT TERM WEATHER FORECASTING

The UK will soon benefit from a new approach to precision weather forecasting. FRONTIERS, an advanced image manipulation system originally developed by Logica for the Meteorological Office, is to enter service at the Met. Office Headquarters, Bracknell.

FRONTIERS is the result of some five years research at the Met. Office laboratories at Malvern. Logica supported the evolution of the system throughout the research program and has recently been contracted to build the operational version.

The FRONTIERS concept allows meteorologists to study and correct data from a network of weather radars covering England, Wales and Ireland. The detailed rainfall maps provided by the radars are further enhanced by merging in satellite-derived imagery, giving rainfall fields accurate in both intensity and location. The latter are used to predict the movement of the rain areas for the next six hours.

The system has a high resolution and uses measurements made in real time, updated every 15 minutes. This permits more accurate and detailed short-term rainfall forecasts than was previously possible. The system uses high-resolution graphics and a variety of input devices, including touch-sensitive screens, to provide meteorologists with easy access to the image manipulation facilities.

ATOMIC PARTICLES BREAK ENERGY RECORD

Researchers at CERN, the European Laboratory for Particle Physics, have accelerated atomic nuclei to the highest energy ever achieved in the laboratory. CERN’s machines, which extend for many kilometers underground, normally work with protons, but to extend their studies of matter, the physicists chose to work with oxygen ions which are 16 times heavier and which carry a double charge. To

provide these ions, one of CERN's injector accelerators was adapted in collaboration with the German Gesellschaft fur Schwerionenforschung and the Lawrence Berkeley Laboratory in California. Both these research teams have a strong tradition if research with ion beams, but only CERN's system of interlinked accelerators could provide the energy levels needed.

After leaving the injector, the ions passed through several accelerators, ending up in the Super Proton-Synchrotron (SPS) with an energy level of 3.2TeV. In absolute terms this isn't a huge amount of energy, but carried on oxygen nuclei, it represents a huge concentration of energy.

Using the ion beams, CERN physicists will search for signs of the so-called "quark-gluon" plasma, a state of matter thought to exist under extreme conditions where protons and neutrons fuse into a "soup" of the constituent quarks and gluons. This state of matter is thought to have existed in the first second after the Big Bang that created the Universe and before matter condensed to form atoms and molecules. Preliminary experiments with oxygen ion beam have already demonstrated that useful results will be achieved when the experimental program gets fully under way.

CERN's track record with high energy research is already impressive. It was in the SPS accelerator that proton/anti-proton collisions revealed evidence of the W and Z particles. These are the particles that mediate the so-called 'weak force', the agent of radioactive decay. The same experiment later provided evidence for yet another building brick of matter, one of the predicted family of 5 quarks, the component parts of neutrons and protons.

NEW M.F. BROADCASTING ANTENNA DESIGNS

The US National Association of Broadcasters (NAB) is planning practical tests on two new types of m.f. broadcasting antenna, designed to minimize unwanted skywave. Current antennas, mostly vertical towers of wires, radiate less than 15% of their energy into usable groundwave – the signal that provides the primary

service for the listener. Not only is this inefficient, it can also lead to problems after dark when the spurious skywave is reflected back to earth by the D layer of the ionosphere. This can result in co-channel interference hundreds or thousands of kilometers from the primary service area of the transmitter. One of the new antenna designs, by Richard Biby of Communications Engineering Services, is based on a conventional vertical monopole, surrounded by a number of short vertical auxiliary radiators. These are placed to increase the ground wave and to cancel out unwanted skywave.

The other novel design to be tried by the NAB is by Ogden Prestholdt of A.D. Ring, Washington. It employs a combination of vertical, horizontal and diagonal elements to give, it's hoped, separate control over ground wave and skywave components of the signal.

Construction of both experimental antennas is expected to take a year, after which there will be another year of comparative field tests.

FIRST ERROR-FREE MICROPROCESSOR

Ferranti Electronics has produced samples of what it claims to be the world's first microprocessor with guaranteed error-free design. Known as Viper (verifiable integrated processor for enhanced reliability) the new device is a 32bit microprocessor designed by the Royal Signals and Radar Establishment for applications requiring high operational integrity such as aircraft autopilot systems, missile systems and nuclear power plants.

Viper's operation can be formally specified and verified using mathematical techniques to ensure that a completely predictable system can be implemented for such safety-critical applications. This "provably" correct operation has not been possible with previous microprocessor systems. The 5000-gate logic design was simulated and implemented in silicon by Ferranti using the u.l.a. "silicon compiler" software system.

Ferranti Electronics was one of two companies selected to manufacture the first Viper chips, now delivered to RSRE for evaluation. Although the device is designed to operate in a military environment and is resistant to high radiation levels, it is expected to have many civil applications, and Ferranti will be marketing the microprocessor commercially as the VIP1.

The device is fabricated using Ferranti's latest 1.5 micron double-layer metal advanced bipolar process and will be supplied in a Jedec standard 84-pad chip carrier.

FIRST ALL-OPTICAL REGENERATION

The first all-optical light regenerator for use in optical communications has been demonstrated by British Telecom Research Laboratories at Martlesham Heath. The regenerator – still in the experimental stage – both amplifies and retimes light pulses directly without converting them from light to electricity, as occurs in conventional repeaters.

All-optical regenerators, when developed commercially, promise considerable savings in the cost of optical communications links which presently need regenerators every 30km or more, especially for undersea systems. Regenerators will be significantly cheaper and simpler to make, and their power requirements will be reduced.

The all-optical regenerator was developed by two British Telecom research engineers, Rod Webb and John Devlin. Its key component is a microlaser which under certain conditions can behave like an optical logic switch. An optical clock signal is fed to the laser to hold the switch state just in the "off" condition. When a pulse of light from the incoming fibre arrives at the laser it has sufficient energy to switch on the laser but only when the optical clock signal is present. This triggers the laser to generate a more powerful burst of light in synchronism with the clock which is then injected into the outgoing fibre.

The BT all-optical regenerator differs from previously demonstrated optical amplifies in two important respects. Bistable operation leads to a signal output level that is relatively constant over a range of input levels; and secondly the signal is retimed by an optical clock.

It is based on the principle that a Fabry-Perot semiconductor laser has non-linear transfer characteristics because its effective refractive index varies with optical power level. At some wavelengths this nonlinearity leads to bistability.

To form a regenerator, an optical clock waveform consisting of a train of pulses with peak power just below the bistable threshold is combined with the data stream and coupled into the amplifier. When a pulse is “low”, a slightly amplified clock pulse appears at the output, and when ‘high’ the additional power is sufficient to exceed the threshold and the output jumps to a higher level, which is insensitive to the data power, and reverts to low only at the end of the clock pulse. The output is the regenerated data in return-to-zero form, retimed by the clock.

SUPERDEFORMED NUCLEI

Results obtained recently from the Nuclear Structure Facility (NSF) at the Science and Engineering Research Council’s Laboratory represent the final step in a long search for atomic nuclei with a superdeformed shape. Theory predicts that under conditions of extreme stress caused by rapid rotation some nuclei will suddenly adopt a fixed, superdeformed shape. This shape, which is similar to a rugby ball, has a 2; 1 major-to-minor axis ratio and is stable under these extreme stress conditions.

Over the past 15 years, confirmation has been sought by many groups worldwide and previous reports by scientists from Daresbury and Liverpool University have already hinted at a breakthrough. In a recent series of experiments at the NSF using high-resolution spectroscopy, scientists have now, for the first time, produced a spectrum showing the sequence of discrete gamma rays emitted as a rapidly rotating superdeformed nucleus (dysprosium 152) slows down.

Almost 2% of the dysprosium 152 nuclei, produced by bombarding a palladium 108 target with beams of calcium 48, were formed in the superdeformed shape. The spectrum shows a series of 19 gamma rays, each separated by an energy of 47 keV, which slow down the nucleus from an angular momentum of 60 units to 22 units. This observation of nuclear states up to 60 units is itself a great leap forward: the previous record was 46 units and previous advances have been in steps of only a few units; in addition, 60 units is very close to maximum possible angular momentum for any nucleus before it breaks up under rotational stress.

In superdeformed nuclei the emitted gamma rays, which arise from transitions between a sequence of states, are predicted to have very short lifetimes caused by the large quadrupole moments of the highly deformed shape. The lifetimes of these gamma rays have now been measured by scientists from Daresbury and Liverpool University. These measurements established that the quadrupole moments are indeed extremely large, confirming that this nucleus is the most deformed nuclear shape found so far.

These observations open up new possibilities for studying the nucleus – nature's only strongly interacting, many-body quantum system – under novel conditions. Such studies are already being started at several European and American Laboratories.

LASER ALTIMETRY DETECTS THINNING ICE

It's probably a good idea to hold off buying that beachfront cottage, at least until the effects of global warming are better understood. Using an aircraft-mounted laser altimeter and a global positioning system, a group of NASA scientists has determined that the ice in Greenland is melting, contributing to rising sea levels.

"Our measurements show little change in high-elevation parts of the Greenland ice sheet, but the margins are undergoing significant thinning", explained William

Krabill of the Laboratory for Hydrospheric Processes at NASA's Wallops Flight Facility.

In some places, the ice in Greenland is more than 4000m thick. The group estimates that approximately 51km^3 of ice is lost per year, raising sea level by 0.13mm per year – or roughly 7 percent of the rise observed during the study. It estimates that the sea level could rise worldwide by as much as 7m if the Greenland ice sheet were to melt.

Krabill and his colleagues, on repeat flights over Greenland between 2000 and 2005, used a laser altimeter to monitor the thickness of the ice. The NASA groups are pursuing methods of mapping changes in the ice sheet that may indicate global climate change.

The altimeter operates in the visible range, at 532 or 523nm. "We have a heritage of working in the visible spectrum because of early studies in developing laser bathymetry," Krabill said. "We continued to use the hardware we already had."

The researches made time-of-flight measurements of the laser pulse from the aircraft to the surface and back. Measurements were converted to distance by including a range vector that accounted for the aircraft's pitch, roll and heading.

Krabill said that the system has more precision than other ranging technologies, and that it is more time-and cost-effective than photogrammetry. Like other systems, however, it is unable to penetrate foliage and operate in inclement weather.

Although their findings indicate that the margins of the ice sheet are thinning, the researches can not explain why. It is not caused by increased melting or less snow accumulation, because the ice sheet was in a state of equilibrium when yearly temperatures were even warmer. Moreover, regional temperatures in the late 1980s and early 1990s were actually cooler than 96-year average temperature. The group's future projects include the use of a space-based laser altimeter and additional work on Antarctic ice.

FLUORESCENCE IMAGER EXAMINES OCEAN FLOOR

The sea is the Earth's ultimate repository. It swallows natural and artificial matter alike – both from rivers and directly from above – and cloaks its holdings in silt and gloom. Much of interest lies beneath the waves, but attempts to image what is on the ocean floor are hindered by absorption and scattering in ocean water. One way around the problem of scatter is the use of a pulsed laser as an illuminator and a time-gated receiver as an imager. Because lasers excite fluorescence, such a system can collect hyperspectral data that reveals the makeup of objects lying in the field of view.

Researchers have developed a particularly compact and simple sea-floor hyperspectral imager designed for use with an underwater vehicle or glass-bottomed boat. The instrument has no moving parts and creates a linear scan of the ocean floor, with the orthogonal scanning movement provided by vehicle motion.

The light source is a Q-switched, frequency-doubled, diode-pumped Nd:YAG laser that produces 3.8mj of optical power per pulse at 200Hz, or an average output of 0.75W. The 4.5-ns pulses are passed through a cylindrical lens to create a 35° fan of light. The returning fluorescence-containing signal passes through a grating prism that disperses the light spectrally without changing the direction of the optical axis. The grating prism disperses the signal in a direction perpendicular to the laser scan. A lens focuses the output onto a 3.5:1 fiberoptic reducing taper; an image intensifier and 1024 x 1024-pixel charged-coupled-device camera complete the setup.

The gating of the camera is set to coincide with the return of the laser pulse so that ambient light is largely rejected. In operation, image information falls along the pixel rows of the camera, while spectral information falls along the columns. The spectral resolution of the system is 5.2nm/pixel. Reflected laser light as well as fluorescence is recorded by the sensor, with the reflected light used to construct a traditional image.

The instrument was tested in a boat at Catalina Island off California. The boat speed was typically 3 knots. Although the imager can be used with an inertial measurement unit to compensate for the pitch and yaw of the boat, the test images were not corrected for boat motion, says David Sitter, one of the researchers. A variety of natural and man-made objects were imaged, including sea-floor plants.

"We think that the instrument might be useful for locating man-made objects – for example, underwater mines or wreckage – in the presence of naturally occurring ocean plant life," explains Sitter. "The fluorescence of underwater vegetation can be used to provide this discrimination. The second area that we think the sensor could be useful is for monitoring the health of coral reefs."

The instrument was also tested on man-made objects including a resolution target and nylon rope. All tests were done in clear water. Turbid water would degrade both the spatial and spectral information, say the researchers. An airborne version of the compact hyperspectral instrument is under development.

PHOTOREFRACTIVE CRYSTAL HELPS CLASSIFY DATA

Using optically interconnected electronics, researchers in France have constructed a type of self-organizing neural network called a Kohonen map. The network is constructed around a holographic refractive crystal. The team of researchers showed that the system could correctly classify 100 items, each with more than 100 features. Though the system suffers from problems often associated with sensitive photorefractive materials (such as hologram erasure, low diffraction efficiency, and material nonuniformity), it demonstrates that optoelectronic approaches can produce interesting and high-capacity results. Even in this demonstrator, more than 10^6 weights are updated per second.

Unlike conventional supervised neural networks, Kohonen maps do not take new inputs and label them based on similar objects that have already been classified (where the location of the output peak indicates the label to be used).Instead, in the first learning iteration, the inputs from a given data set are

randomly assigned a position in the output (classification) plane. As the data is represented (usually in a different, random, order), the system is designed to update itself in such a way that similar inputs are encouraged to move closer to each other in the output, and orthogonal inputs to move further away. After many iterations, a two-dimensional map of the feature space is produced. Though nothing is labeled, the similarity of a new object to one that is known can be understood by simply looking at their distance apart.

The optoelectronic implementation consists of four basic elements. The first two are beams split off from an argon-ion laser that emits at 515nm. These beams enter the third main component, a copper-doped bismuth germanium oxide crystal (chosen for its high sensitivity) at 90° to each other. The first part of the beam, the reference, consists of vectorial encoding of the features of the items to be classified; for example, the encoding of a set of animals by their physical characteristics. This encoding consists of a black and white pattern imparted by a liquid-crystal spatial light modulator (LC-SLM).The second beam, the learning beam, is also patterned by an LC-SLM, but is not on all the time. Finally, light diffracted from the crystal is detected by a charge-coupled device camera that performs thresholding functions.

After using the reference and learning beams to record a null hologram (in which both beams are uniform), the reference beam is sent in with the first data vector. As it illuminates the hologram, the diffracted light is detected by the camera; the brightest point on the plane is then identified as the winner. The learning beam is switched on, creating a hologram that is centered on the winning spot but extending to some radius from it. The learning beam enhances the winning hologram as well as its nearest neighbors, so similar inputs will tend to produce winners in that area. The process then continues with different vectors each writing and rewriting their own holograms (an erasing beam is also used to improve the rewriting performance) until the network converges on a single, unchanging map.

In their experiments, the researchers were able to show that the network could indeed learn which elements in a data set were more or less similar to each other.

For instance, in the animal classification experiment they performed, the network was able to recognize birds, carnivorous mammals, and herbivorous mammals as three separate groups. Furthermore, it was able to recognize that birds of prey were more similar to carnivorous mammals than nonpredatory birds. Commercialization may be possible if the remaining problems associated with the photorefractive material are solved.

BUTTERFLY EFFECT

In 2005, Alexei Erchak at the Massachusetts Institute of Technology, in Cambridge, unveiled a groundbreaking light-emitting diode that suffered none of the light losses that can plague ordinary LEDs. Erchak's device was modified with a special reflective layer and an optical structure, known as a photonic crystal, that together captured light that would otherwise have been lost and channeled it into a useful beam. The design funneled six times as much light into its beam as an unmodified one, an improvement that astounded LED researchers at the time.

Now a UK team says the structure that makes Erchak's LEDs so special is not unique after all. Look hard enough and you can find it in the fluorescent wings of male African swallowtail butterflies. What is more, the structure of these wings is subtly different from the MIT design in a way that may offer clues for improving LEDs further.

This butterfly is found in eastern and central Africa and has dark wings with patches of bright blue-green markings. The markings are not highly unusual in the butterfly world, but the way in which they produce their light is. "This butterfly is unique, as far as we know, in the way it produces color," says Peter Vukusic, an optical physicist at the University of Exeter, in southwest England, who has been studying the scales that make up the brightly colored regions of the creature's wings. These scales contain a pigment that absorbs light at wavelengths of around 420 nanometers – roughly sky blue – and radiates it at 505 nm in the blue-green region where butterfly eyes are particularly sensitive.

The trouble with this mechanism is that while half the fluorescent light radiates away from the butterfly, the other half radiates into the wing structure. That half of the light would be lost were it not for the extraordinary structure of the scales.

Vukusic discovered that the base of each scale is a highly efficient three-layered mirror – a structure known as a distributed Bragg reflector. Light from the pigment bounces between these layers, interferes constructively, and then escapes in the direction it came from.

Distributed Bragg reflectors are not perfect, however; some light always becomes trapped on the surface of the reflector and is lost. But the butterfly has another neat trick to get around this. Vukusic and his colleague Ian Hooper discovered that in each scale, sitting just above the mirror, is a slab of material filled with hollow cylinders of air that run perpendicular to the mirror. These cylindrical holes channel the light away from the reflector, preventing it from getting trapped. The slab, says Vukusic, is what optical physicists call a photonic crystal.

The end result is a highly specialized structure that converts skylight into blue-green light, captures this light, and finally channels it out to act like plumage to attract female butterflies.

Designing LEDs, Erchak solved essentially the same problem by placing a distributed Bragg reflector beneath his LED and a photonic crystal above it – just as nature has done for the butterfly. “Who knows how much time could have been saved if we’d seen this butterfly structure 10 years ago” says Vukusic.

This butterfly may have more to teach. In Erchak’s LED, with its perfectly periodic crystal, light is better transmitted at some angles than others. But there may be a work-around in the quasiperiodic structure of the butterfly’s photonic crystals.

SCIENTISTS BUILD ULTRALIGHT SPACE TELESCOPE MIRROR

Telescopes of the future will require larger apertures to gather more light than the existing Hubble Space Telescope. The challenge to designers is to create mirrors of larger apertures that can withstand the rigors of a space-shuttle launch and meet the restrictions on size and mass. In a step toward meeting this need, scientists at the Optical Science Center and Steward Observatory at the University of Arizona, have built and tested an ultralightweight mirror designed for use in geosynchronous Earth-imaging.

The mirror represents an important milestone for the University of Arizona. Other lightweight mirrors have been developed at the university using the lightweight-mirror design, which includes an ultrathin glass membrane, a lightweight support structure to provide stiffness, and actuators to control and maintain the accuracy of the optical surface. But with this mirror, the team has achieved an areal density of 5.2 kg/m^2 ,the lightest mirror ever made at the state-of-the-art Optical Sciences Center using the active mirror design.

“Compare that to the Hubble primary with an areal density of 180 kg/m^2”, said graduate student Dave Baiocchi, who assembled the mirror. An areal density of 5 kg/m^2 is estimated for a successful geostationary telescope. In comparison, the next-best areal density achieved at the center, the Next Generation Space Telescope (NGST) mirror type designed to replace the Hubble, is 12.4 kg/m^2.

The team led by James Burge, assistant professor of astronomy and optical sciences, designed the lightweight composite support structure using carbon fiber, ideal for its stiffness and low weight The front and back faces are a mere 0.38 mm thick, joined with a webbing only 0.25 mm thick The structure is further reduced in mass by strategic placement of holes cut into the front/back faces and ribs. The actuators, each weighing 5g each, are mounted in 31 reinforced holes normal to the glass.

The optical surface is a thin, concave glass shell, polished using conventional techniques. A large blank of high-quality Zerodur was chosen because of its low coefficient of thermal expansion. To further process the glass, the polished surface was then attached to a stiff, granite blocking body using pitch, and excess glass

was removed using a standard generating machine. To separate the glass from the blocking body, a three-footed load spreader was bonded to the glass with Dow Corning adhesive, and the whole part was placed in a large oven at the Steward Mirror Lab for 10 hours at 200 C, enabling the glass to slide off the granite stone.

The resulting optical surface is 0.5 m in diameter and only 1 mm thick. The mirror, including associated actuators, load spreaders, reaction structure, and wiring has a mass of only 1.17 kg. To compensate for system instability, fabrication imperfections and deployment errors, the actuators can be adjusted to control the optical surface to 0.248 wvs rms (wavefront error, root mean square) and 1.960 wvs P-V (peak-to-valley; HeNe).

Although the current test version of the ultralightweight telescope mirror is too small in diameter to be of practical use in space, future plans may enable 100-m class telescopes, to be fabricated and launched in segments for assembly in space.

FIRST OPTICAL LINK BETWEEN SATELLITES USES LASERS

For the first time, an optical data link between satellites orbiting Earth was established in November 2003 using laser beam as a signal carrier. The satellites were able to transmit images from space to the ground in real time, promising much more timely delivery of data in the future. The experimental optical data link was provided by the Semiconductor Laser Intersatellite Link Experiment (SILEX) communications terminal on the French Space Agency's Earth observation satellite, SPOT-4. The SILEX terminal transmitted to a similar terminal onboard the Artemis satellite at 50 Mbit/s with a bit-error less than 10^{-9}. Both terminals were built by Astrium (Toulouse, France), Europe's prime space contractor. The Artemis satellite, launched by the European Space Agency, is temporarily in a parking orbit at 31,000 km, while the SPOT-4 is orbiting Earth at the lower altitude of 800 km.

For one terminal to locate the other, a 779-nm optical scanning beacon sent out a search signal. When the light was received at the second terminal, it sent back a

signal at a wavelength around 802 nm to establish two-way contact. The subsequent data transmission used 60-mW gallium-arsenide-based diode lasers operating from 843 to 852 nm, allowing for high-frequency direct modulation. The test established four links, two of which lasted 20 minutes. The links were particularly remarkable for the microradian pointing precision required. Because the two satellites were 30,000 km apart and moving at a relative speed of 7 km/s, pointing ahead of the target was necessary.

These conditions were worst – case conditions for the experiment, as Artemis is in a lower parking orbit, circling the Earth once every 19 hours. Once the spacecraft has been propelled into its final geostationary orbit at 36,000 km, the link between the two satellites will be established five times a day.

Through the laser link, high-definition video images of Earth taken by SPOT-4 can be transmitted via Artemis to the image-processing center on the ground, which is possible whenever the satellites are in line of sight. Without the Artemis relay, the images are stored onboard in the memory of SPOT-4 and dumped to the ground stations. With the Artemis relay in place, SPOT-4 is expected to spend significantly less time transmitting data and more time recording IR images related to agriculture and the environment.

Optical data links also allow smaller antennas and use less power than conventional radio frequency links, translating into a significant savings on mass and volume for launch. Moreover, because the radio frequency window of Earth’s atmosphere is so crowded by broadcasts and communications of every type, the optical window allows an open link, relatively free of interference.

Built in Europe by a consortium of companies for launch from the European launch base in Kourou, French Guiana, Artemis is a satellite for testing and operating new telecommunications services. Its dual purpose is to demonstrate affordable, wide-coverage mobile communications satellite services, and to test direct satellite-to-satellite communications, including this revolutionary link.

DESIGN SOFTWARE

Fast personal computers will use 21st century software to solve many optical design problems at once. No one can doubt that the single most important factor driving optical design software is the availability of very inexpensive, very fast personal computers. When it was first released, the IBM PC could have traced about 200 rays per second through a 10-surface optical system. Today a $1000 PC can trace well over a million rays per second.

Where will this take us in the 21st century? The scientists think that the days of "Let's do what we used to do on mainframes, but let's do it on a PC" are over. Now we are looking at producing fully integrated codes capable of optimization, tolerancing, illumination, scattering – in short, a complete solution in one package.

A few years ago, what you would have bought was a software package – and a good package, mind you – that assumed your optical system was composed of a series of surfaces, hanging in midair, with all the interesting stuff being refraction, reflection or diffraction at the surfaces. What you'll get now is quite a lot more exciting. Any designer knows that real lenses aren't just surfaces; they are whole objects with edges, bevels, scratches, bubbles and so on. In real optical systems some light always reflects when it should refract, and that light has the annoying habit of getting where it shouldn't.

Twenty-first century optical design software can model a system as a group of optical objects, not just surfaces. These objects can have a complex set of properties, including scattering, that change just where the light hits. You can design these objects, like lenses, mirrors and diffraction gratings, within the lens code, or you can make them completely arbitrary in shape and just import them from a computer-aided design program.

What's more, the object scene that your system is looking at is a lot more realistic. Instead of calculating based on simple point sources, you can use 24-bit color images or even measured data taken from a real lamp source. And you can get output in candela, watts per square meter, lux and so on. You can use as many sources as you like, with as many detectors as you like, wherever you like.

TESTING IMPERFECTIONS

Another area where software is evolving is in tolerancing a system. This is where you have to face up to the fact that nobody can make a perfect system, so you need to understand what happens when things aren't perfect. This used to be done on a surface-by-surface basis, but now you can write an alignment procedure and execute it just the way the technician will when she builds the system.

For example, imagine building and aligning a system as follows: You adjust lens element №2 up and down so that you can center a test laser beam on the image. You then remove the laser beam and insert a white light source. Then you shift element №4 along the axis until you achieve the proper magnification. You reject any lens that fails this test. Then you adjust the back focus to maximize the on-axis modulation transfer function, and you reject anything that doesn't meet your criteria. Next, you measure distortion and reject anything that is over a limit that you have set. Finally, you measure the modulation transfer function at five field points and write the values on the test sheet.

When you can do all of this in one sitting, you're not just tolerancing the surfaces, you're tolerancing the entire system and your alignment procedure. This is many times more complex than simple surface tolerancing. So where is optical design software heading? Expect to see even more realistic modeling of everything. Expect to see features that used to be in two or three separate codes appearing in a single program. And best of all, expect to get more for your money.

ETHERNET WINS OVER INDUSTRIAL AUTOMATION

Pronouncing "Ethernet" in the same sentence as "automation" was heresy just a few years ago. Now, it seems, every process control system, every programmable logic controller, and every form of remote I/O can be connected with some form of Ethernet. All of the fieldbus consortia are racing to redefine their basic protocols so

that they work over Ethernet and the Internet protocols. They are now all based on some Internet protocol over Ethernet. What happened?

First came the resolution of the “determinism” problem. The original Ethernet protocol adds a delay before resending a message after detecting a collision between it and other messages sent at the same time. So a measurable probability exists that any given message will be delayed by the network itself. Since the delay, as well as how long it would take a message to be received, is not predictable, the network is nondeterministic.

The answer is to avoid all collisions by using a switched architecture, one that creates a private network segment for the computer/terminal node and the switch. With only a single Ethernet address on each segment, there can be no collisions, and therefore , the network is deterministic. Ethernet switches have been very expensive; now they are not, thanks to cost reductions of very large scale integrated circuits and fast RISC computers.

Once determinism is assured, the high Ethernet speed at 100 Mb/s and low cost outshine the low speed and high cost of all proprietary networks and all fieldbus networks. However, secondary problems must still be addressed. These include the common industrial practice of powering field devices from the data cable; the fragility of common RJ45 connectors, used with office Ethernets; lack of hardware safety validation; and the overhead of the Internet protocols. The process industries also have some concern over the lack of intrinsic safety barriers for Ethernet. Each of these problems is being eagerly tackled by companies and consortia, so alluring are the low-cost and high-speed benefits.

FIELD INSTRUMENTS AS WEB SERVERS

The primary push toward Ethernet in industrial automation is the desire to increase the bandwidth to the end device, enabling it to become a participant in the World Wide Web. Many have asked why a field instrument needs to be a Web server. There are probably thousands of ways to add to the value of field devices,

but only the Internet route provides such broad support without requiring any custom host software.

The Web server model provides a platform-independent visual interface and an assortment of scripting languages such as Perl and Java. Extensive computations, such as dynamic graphics, can also be configured for client-side execution so that the field instrument does not need a powerful microprocessor. Hot links to vendor servers for maintenance and repair literature are easily supported, eliminating the need to store and update these manuals locally.

All these functions have been available for several years, but have not been practical with slow communications links. Now, with high-speed Ethernet, they have become very practical.

FIBER OPTIC AMPLIFIERS

Optical amplifiers will soon become smarter. To meet dense wavelength division multiplexing needs, erbium-doped fiber amplifiers boost optical signals across multiple wavelengths. As communications systems add more wavelength, however, erbium-doped fiber’s challenges are becoming increasingly apparent.

Erbium-doped fiber amplifiers are assemblies, including pump lasers, passive components, erbium fiber and a microprocessor. As such, their manufacture represents an inherently difficult, labor- and test-intensive assembly process. They are also expensive and noisy. When they manage substantial traffic at speeds of 2.5 to 40 Gb/s, as in long-haul communications, their cost is reasonable.

THE METROPOLITAN DIFFERENCE

In metropolitan area networks, optical losses occur not because of distance but because of switching and wavelength management. Because these networks cover

short distances today, amplifier cost is still critical. However, as channels increase, the focus will turn from cost to efficiency and capacity issues, mirroring trends in the long-haul business.

In the future, the goal is to create an optical amplifier manufacturing platform that integrates individual optical components such as isolators, wavelength combiners and splitters, and pump modules. This would produce devices that can accomplish such tasks as power monitoring with photodetectors. Future manufacturing must be flexible enough to satisfy diverse customer specifications while achieving economies of scale in the manufacturing process. To do this, the manufacturing must be automated, modular and repeatable.

Furthermore, the devices will be “smart”, featuring dynamic gain control capabilities across various architectures. The platform will control optical add/drop or gain flatness variations from different types of fiber or span adjustments in the system. A feedback loop will monitor channels so the smart amplifier can control gain and maintain gain flatness within a very small range despite optical add/drops and varied system architectures. This will ensure that the gain will always remain flat.

Ever-increasing channel densities may require new sources of gain, beyond what an erbium-doped fiber amplifier can practically achieve. Higher optical power and lower noise will result when Raman amplifiers become more prevalent. Today erbium-doped fiber amplifiers with continuous-wave sources use external pumps to create a gain medium for amplifying the optical signal. A Raman amplifier uses a nonlinear effect with an embedded fiber base as a gain medium. A high-power laser pumps the fiber in the reverse direction from the signal, and the nonlinearity of the fiber amplifies it. The advantage is a very high pump power gain with very low noise.

Raman amplifiers have not been feasible because they require pump lasers that can provide on the order of 500 mW. Soon, however, these pump modules will become cost-effective to build and manufacture. Then, Raman amplifiers will become an increasingly important aspect of 10 - and 40 - Gb/s optical amplified

systems. Like erbium-doped fiber amplifiers, Raman amplifiers will perform dynamic gain control to maintain gain flatness.

SEMICONDUCTOR AMPLIFIERS

Another technology will also make its debut within the next several years: semiconductor optical amplifiers. These devices, based on indium – phosphide technology, add amplification where it is needed, down to per-channel amplification. The gain medium and amplification are at the chip level. Typically, a very small chip would be incorporated into a laser package, receiver package, optical switch, multiplexer or demultiplexer to overcome optical losses.

These devices will add gain quickly and inexpensively when and where it is needed. They will meet the evolving performance, cost and size criteria, surpassing erbium-doped fiber amplifiers in functionality. Eventually, intelligent optical amplifiers will evolve to in-line, per-channel amplifiers comprising a transmitter, receiver and preamplifier. They will become so low-cost that a high-performance optical amplifier will always be readily available.

INDUSTRIAL LASERS

The market for industrial lasers has largely been dominated by high-power CO2 and lamp-pumped Nd:YAG lasers. These devices have provided cost-effective access to high-power infrared and visible laser emission for applications that include cutting, drilling, welding, heat treating and marking.

In the coming years, the laser marketplace will see significant gains for three relative newcomers in the industrial laser gallery: High-power semiconductor lasers, diode-pumped solid-state lasers and ultrafast lasers will all make inroads in industrial infrared and visible laser applications.

HIGH-POWER, SMALL BOX

Semiconductor lasers are being scaled to high power using multibar modules, two-dimensional stacks of 40-W bars emitting hundreds to thousands of watts of near – infrared power from one package. Their compact size and electrical efficiency make them very attractive for industrial applications. Kilowatt diode stacks are small and light enough so that the package can be integrated directly into robotic arms. This eliminates the need to install complex and expensive beam delivery systems.

In addition, their electrical efficiency (approximately 50 percent) is much higher than gas and lamp – pumped solid-state counterparts. The low utility consumption is especially beneficial for factories that use many laser systems.

Diode stacks do have limitations. The spatial beam from diode stacks is highly multimodal, and working distances are relatively short. This limits their ability to process fine structures. In addition, semiconductor lasers do not store energy and therefore can not produce high energy pulsed output.

Still, kilowatt diode stacks are nothing short of a revolution in industrial laser technology. They are quickly finding applications for heat treating and welding. Commercial products are available from a few laser manufacturers, and research institutions are building impressive portfolios of industrial applications for diode stacks.

DIODE-PUMPED LASERS

For applications requiring better mode quality, high pulse energies or alternative output wavelength, users are increasingly turning to diode-pumped solid-state lasers. These devices have been available for slightly more than 10 years and have penetrated the market for low-power (less than 20 W) devices.

Because of their high pulse stability, good mode quality and long maintenance intervals, they have filled a niche for precision materials processing applications. These “high finesse” applications include memory repair, hard disc texturing, fine

circuit trimming, solar – cell scribing and precision marking. In some cases, the lasers have become enabling devices, opening up applications that other types of lasers cannot address.

Diode-pumped solid-state lasers in the 20- to 100-W class will become prevalent in the next few years for general-purpose marking and materials processing.

Because CO2 and lamp-pumped Nd:YAG lasers dominate these applications, cost is a main driver, and laser manufacturers will respond with more cost-effective diode-pumped laser designs. In fact, a few commercial laser manufacturers have already announced diode-pumped products with power levels exceeding 1 kW. These systems are more efficient than their lamp-pumped counterparts and provide better spatial mode output, making them attractive laser sources for industry.

Another trend for diode-pumped lasers is the focus on industrial packaging. Conventional solid-state lasers have been designed for regular and frequent maintenance. Because users replace arc lamps every 200 to 1000 hours, they have become accustomed to regular cleaning and realigning of optics. With lifetimes of thousands of hours, field-replaceable diode-pumped sources require minimal maintenance and their ultimate replacement requires no optical realignment, allowing the cavity to be environmentally sealed. A sealed optical cavity eliminates contamination as a failure mechanism. These new design philosophies further reduce maintenance and cost of ownership and bring the diode-pumped solid-state laser closer to becoming a black box.

ULTRAFAST LASERS

Although farther out on the commercial horizon, ultrafast laser systems with subnanosecond and subpicosecond pulse durations will start to find a niche in some micromachining applications.

Typical ultrafast systems are based upon mode-locked solid – state oscillators, often coupled with an amplifier system to provide high peak powers for material

removal. Short pulses minimize the heat – affected zone in the material, which benefits certain microdrilling and microstructuring applications. The electronics and medical device manufacturing industries may find requirements for such capabilities soon.

Ultrafast laser systems are new to the industrial arena and so far are limited to manufacturing research centers. They have yet to find mainstream acceptance in industrial applications, where manufacturers will face the challenge of producing lasers that live up to industrial design and packaging expectations.

UV LASERS

Predicting the future can be a treacherous affair in this technological age because each advance creates a universe of unforeseen applications. Nevertheless, companies need to navigate technological discontinuities to complete in the 21st century, and that means knowing how to spot and react to market trends.

One application trend vital to the future of UV lasers makers has been the miniaturization of electronic devices brought on by an explosive demand for communications and information technology. As demand increases for portable gadgets such as palm-top computers, personal organizers, cell phones and pagers, circuit designers are dreaming up ways to squeeze more electronics into less space on a mass-produced scale.

The demand from electronics manufacturers has created impetus for evolution in lasers. The complementary technologies of excimer, diode-pumped solid – state and argon-ion lasers should continue to be a hard combination to beat in the UV, whether it's drilling micro – via holes in printed circuit boards, direct – imaging printed circuit boards, writing fiber gratings or drilling microholes in angioplasty balloons and marking catheters. Together, these lasers will meet many of the challenges of 21st century mass production.

UV lasers are uniquely suited for fabricating the microscopic features in high-density circuits because the shorter – wavelength light focuses into a smaller spot.

Moreover, the high energy of UV photons severs the chemical bonds of many materials rather than thermally ripping them apart. This “cold” process of photoetching – called photoablation – produces features with very clean edges. Because most materials readily absorb UV light, UV lasers can often perform materials processing that is impossible with infrared or visible lasers.

EXCIMER DOMINANCE

Excimer lasers have long dominated UV materials processing and will continue to play an important role. Because these lasers generate high peak energy and average power, they are a logical choice for drilling, marking and microlithography.

Because the focused spot size from an excimer is limited by poor beam quality, manufacturers typically use photomasks or reticles to define micromachined patterns. The toxic gases and large footprint of excimers also can be a concern in manufacturing environments.

Frequency – tripled, neodymium – doped solid – state lasers deliver much better beam quality in the UV, but until recently they lacked the average power, repetition – rate flexibility and system reliability essential for cost – effective micromachining on a mass scale. Recent developments have changed the situation:

1. Long-lasting laser diode bars efficiently pump laser media.
2. High-efficiency frequency-tripling crystals exhibit better than a 1000 – hour – lifetime – per – crystal spot.
3. Manufacturers have developed permanently aligned, hermetically sealed laser heads.

With these improvements, the average power output from a diode-pumped solid-state laser can exceed 3 W at 355 nm and a pulse rate of 15 to 20 kHz. Furthermore, automated control of internal optics can ensure optical performance and beam quality at pulse rates from single shot to 100 kHz with no tweaking or adjusting.

The resulting power and reliability have transformed UV diode – pumped solid – state lasers into compact, powerful and dependable work – horses for round – the – clock manufacturing operations without sacrificing the flexibility and beam quality needed for many applications, such as micro – via drilling and flex – circuit patterning.

LIF**ETIME OF RELIABILITY**

Laser systems that can function for more than 10,000 hours without servicing can be buried deep inside automated production machinery, and that makes them viable tools for mass-produced microelectronics. For example, the Avia 355-3000 from Coherent Inc. can drill 30-mm via holes in printed circuit boards at a rate of more than 400 holes per second, 24 hours a day, seven days a week. A user can also vary the pulse rate on the fly for optimal micromachining of multilayer materials.

The same doctrines of reliability, versatility and hands – off control will continue to govern materials – processing applications for UV argon – ion lasers too. Circuit - board manufacturers already rely on the stable, high – power continuous – wave output of UV argon – ion lasers in the direct imaging of circuit boards with features of 50 mm and smaller.

Frequency – doubled ion lasers with output at 244 nm are the reference standard for writing Bragg gratings into optical fiber. These gratings are used in a variety of telecom applications, most notably dense wavelength division multiplexers. Plasma – tube consistency and lifetime, as well as intelligent user interfaces and programmable control, will remain important laser considerations for these applications.

ETHERNET’S WINNING WAYS

Ethernet networks are winning big in manufacturing automation and process control – and for good reasons: they save money and they simplify operations. By 2007, the market for Ethernet networks that connect the factory to the higher levels of business operations and supply chain management is expected to reach US $3 – 5 billion, according to Paul Scanlon, senior program manager of a newly formed joint venture, that designs, installs and services industrial networks. The company projected that the manufacturing and process control market "will be nearly 100 percent Ethernet within the next four years."

Already, at least 5 percent of the manufacturing and process plants have Ethernet based systems on the production floor. While this is still a small percentage, Ethernet capability is becoming such an important factor in the industry that the various industrial fieldbus consortia are redefining their communications protocols to work with both the Ethernet and the Internet.

The advantages in using Ethernet-based networks in manufacturing speak for themselves. Not only are they faster than most proprietary systems, but they are also distinctly cheaper. An off – the – shelf board for connecting a PC to an Ethernet costs anywhere from $20 to $50, versus $300 to $900 for a board for a proprietary system. Furthermore, Ethernet connectivity is available at data rates of up to 1 Gb/s, and 10Gb/s is under development. The speediest proprietary systems, by contrast, top out at 12Mb/s.

The industry has seen a lot of Ethernet progress in the last two years. The technology has been making inroads particularly in the lowest levels of the manufacturing automation and process control hierarchy, where actuators and sensors, control, and data acquisition call for millisecond decisions. At the higher levels of operations, such as scheduling and supply chain management, where decisions are made typically in a matter of hours, the technology has been in use for several years.

A fringe benefit of the Ethernet's growing acceptance is a wealth of new automation products, each Web-enabled and with its own Internet protocol (IP) address. Among them are programmable logic controllers, power monitors, panel

meters and signal conditioners. The units respond to the seven – layer standard of the Open System Interconnect networking protocol for layer 1 (the physical layer) and layer 2 (the data-link layer). With this capability, plant operators and managers can gain access from anywhere on the Internet to data on plant operations, as well as, to units on the factory floor.

Making the Ethernet more attractive for factory automation, too, is its update to a switched Ethernet – that is, the network now allows a direct connection to be established between the sending and receiving nodes. This advance eliminates the collision of messages that can occur in an ordinary Ethernet network where all the nodes are connected to the same link. In this network, a message from node A to node B will collide with a message sent at the same time from node C to node B. The sending nodes then must stop and resend their messages at a randomly determined later time, an obvious problem in a factory automation system.

Other useful features of the enhanced Ethernet include its ability to support a large number of ports and devices, and its versatility in running on low – cost twisted pair cable, noise – immune optical fiber, or coaxial cable.

One example of a recent Ethernet application that has worked well is a pilot project on the production line for vinyl windows in Germany. The entire production line is based on Ethernet technology: machine tool controllers on the factory floor communicate directly with a higher, supervisory – level network in which the company's enterprise resource planning (ERP) data – base resides. Instructions for the controllers on the floor are sent from this database.

For example, after a window frame has been welded, the corners must be cleaned of welding debris by a numerically controlled milling machine. To do this, the dimensions of the frame are sent over an Ethernet connection from the ERP and fed into the control algorithm that guides the milling machine.

The production line uses six prototypes of Ethernet – based controllers, made in Germany. A program for the production process is distributed to each controller, and each carries out its part of the program. The units control such actions as measuring the vinyl stock, cutting to size the four pieces for each frame,

positioning and clamping the pieces before welding, and controlling the welding temperature.

In this distributed intelligence architecture, each controller is essentially an Ethernet switch connected to I/Os and servo controllers. One such controller runs a 13-axis milling machine that cleans the four corners of the window frames after the welding. Each controller has its own IP address and built – in Web server, and all the controllers are interconnected through a 100-Mb/s Ethernet run with a TCP/IP protocol. With this setup, any authorized computer user with a browser anywhere can access the network, send and receive data, and even modify control tasks. Access to the plant takes place via a bridge or router with a firewall.

In contrast, typical factory automation systems often have programmable logic controllers from different vendors, each with its proprietary fieldbus. Each controller has to be programmed for the tasks at hand, including communication with each other and with the enterprise's software at a higher level. Such a customized setup is a labor intensive and time – consuming. Commercial production of the controllers is expected to begin in the first quarter.

Ethernet control schemes are best used in new facilities rather than for retrofitting existing plants, where it may not be worthwhile to replace existing control equipment.

NANOTECHNOLOGY: WHAT WILL IT MEAN?

Nanotechnology will make us healthy and wealthy though not necessarily wise. In a few decades, this emerging manufacturing technology will let us inexpensively arrange atoms and molecules in most of the ways permitted by physical law. It will let us make supercomputers that fit on the head of a pin and fleets of medical nanorobots smaller than a human cell able to eliminate cancer, infections, clogged arteries and even old age. People will look back on this era

with the same feelings we have toward medieval times – when technology was primitive and almost everyone lived in poverty and died young.

Besides computers billions of times more powerful than today's, and new medical capabilities that will heal and cure in cases that are now viewed as utterly hopeless, this new and very precise way of fabricating products will also eliminate the pollution from current manufacturing methods. Molecular manufacturing will make exactly what it is supposed to make, no more and no less, and therefore won't make pollutants.

When nanotechnology pioneer Erick Drexler first dared to publish this vision back in the early 1980s, the response was skeptical, at best. It seemed too good to be true, and many scientists pronounced the whole thing impossible. But the laws of physics care little for either our hopes or our fears, and subsequent analysis kept returning the same answer: it will take time, but it is not only possible but almost unavoidable.

The progress of technology around the world has already given us more precise, less expensive manufacturing technologies that can make an unprecedented diversity of new products. Nowhere is this more evident than in computer hardware: computational power has increased exponentially while the finest feature sizes have steadily shrunk into the deep submicron range. Extrapolating these remarkably regular trends, it seems clear where we're headed: molecular computers with billions upon billions of molecular switches made by the pound. And if we can arrange atoms into molecular computers, why not a whole range of other molecularly precise products?

It has taken decades for the bulk of the research community to accept the feasibility of this vision. But when the President of the United States in 2005 called for a US $500 million National Nanotechnology Initiative, we knew nanotechnology had reached critical mass.

VISIONS OF GOOD, VISIONS OF HARM

Some people have recently realized that nanotechnology might create new concerns that we should address. Any powerful technology can be used to do great harm as well as great good. If the vision of nanotechnology sketched earlier is even partly right, we are in for some major changes – as big as the changes ushered in by the Industrial Revolution, if not bigger. How should we deal with these changes? What policies should we adopt during the development and deployment of nanotechnology?

One solution to these potential problems, proposed by Bill Joy, cofounder and chief scientist of Sun Microsystems Inc., would be to "relinquish" research and development of nanotechnology to avoid any possible adverse consequences.

This approach suffers from major problems: telling researchers not to research nanotechnology and companies not to build it when there are vast fortunes to be made, glory to be won, and national strategic interests at stake either won't work, or will push research underground where it can't be regulated. At the same time, it will deprive anyone who actually obeys the ban of many benefits nanotechnology offers.

If a ban won't work, how should we best address the concerns that have been raised? The key concerns fall into two classes: deliberate abuse and accidents.

Deliberate abuse, the misuse of a technology by some small group or nation to cause great harm, is best prevented by measures based on a clear understanding of that technology. Nanotechnology could, in the future, be used to rapidly identify and block attacks. Distributed surveillance systems could quickly identify arms buildups and offensive weapons deployments, while lighter, stronger, and smarter materials controlled by powerful molecular computers would let us make radically improved versions of existing weapons able to respond to such threats. Replicating manufacturing systems could rapidly churn out the needed defenses in huge quantities. Such systems are best developed by continuing a vigorous R&D program, which provides a clear understanding of the potential threats and countermeasures available.

Besides deliberate attacks, the other concern is that a self – replicating molecular machine could replicate unchecked, converting most of the biosphere into copies if itself.

While nanotechnology does propose to use replication (to reduce manufacturing costs to a minimum), it does not propose to copy living systems. Living systems are wonderfully adaptable and can survive in a complex natural environment. Instead, nanotechnology proposes to build molecular machine systems that are similar to small versions of what you might find in today's modern factories. Robotic arms shrunk to submicron size should be able to pick up and assemble molecular parts like their large cousins in factories around the world pick up and assemble nuts and bolts.

Unfortunately, our intuitions about replicating systems can be led seriously astray by a simple fact: the only replicating systems most of us are familiar with are biological self – replicating systems. We automatically assume that nanotechnological replicating systems will be similar when, in fact, nothing could be further from the truth. The machines people make bear little resemblance to living systems, and molecular manufacturing systems are likely to be just as dissimilar.

An illustration of the vast gulf between self – replicating biological systems and the kind of replicating robotic systems that might be made for manufacturing purposes is exponential assembly, a technology currently under investigation at the company, Zyvex Corp., in Richardson, Texas. Zyvex is developing positional assembly systems at the micron, submicron, and molecular scale. At the micron scale, using existing microelectromechanical systems technology, the company is developing simple pick-and-place robotic arms that can pick up relatively complex, planar, micron-scale parts made with lithographic technology and assemble those planar parts into simple three-dimensional robotic arms that have the ability to pick up specially designed microelectromechanical systems parts. Called exponential assembly, this replicative technology starts with a single robotic arm on a wafer

that then assembles more robotic arms on a facing wafer by picking up parts already laid out in precisely known locations.

While the number of assembled robotic arms can increase exponentially (up to some limit imposed by the manufacturing system), this assembly process requires (among other things) lithographically produced parts, as well as externally provided power and computer control signals to coordinate the complex motions of the robotic arms. Cut off from power, control signals, and parts, a micron-sized robotic arm would function about as well as one of its larger cousins taken from one of today's automated assembly lines and dropped into the middle of a forest.

GUIDELINES TO PRINCIPLED DEVELOPMENT

To avoid any possible risk from future (and perhaps more ambitious) systems, the scientists have written a set of draft guidelines to inform developers and manufacturers of molecular manufacturing systems how to develop them safely. The guidelines include such common sense principles as: artificial replicators must not be capable of replication in a natural, uncontrolled environment; they must have an absolute dependence on an artificial fuel source or artificial components not found in nature; they must use appropriate error detection code and encryption to prevent unintended alterations in their blueprints; and the like.

The guidelines have been reviewed at two subsequent conferences. Since our understanding of this developing technology is evolving, and will continue to do so, the guidelines will evolve with it – representing our best understanding of how to ensure the safe development of nanotechnology.

Nanotechnology's potential to improve the human condition is staggering: we would be shrinking our duty to future generations if we did not responsibly develop it.

DEREGULATION MAY GIVE A BOOST TO RENEWABLE RESOURCES

Power industry deregulation has confronted the average consumer with yet another set of problems, including confusion about whom to buy power from – or even what that means. So far, benefits seem elusive. Under regulation, some public utility boards had adopted modest incentives to encourage use of renewable forms of energy. Under deregulation, the consumer must decide whether to use renewable resources. So there may be more demand for green power in the energy mix. At least, environmentalists hope so.

Green power is the general term for energy from renewable resources. The exact definition, however, can vary by state and country. Green power is consistently considered to include energy from solar panels, the wind, and hydroelectric and geothermal generating facilities, and not to include energy from nuclear power or oil- or coal-powered generating facilities.

Today, the main sources of green power available to consumers around the world are hydro, biomass, and geothermal. But the fastest – growing green source, in the United States and internationally, is the wind. In California, one of the first states to open its utilities to competition, companies are opting to pay green power companies to provide their electricity. By last summer, green power was being competitively marketed to retail customers in five states.

NO GREEN ELECTRONS

Physically, consumers of green power get it down the same wires as their brown power neighbors; nothing distinguishes “green” electrons from their counterparts generated in less environmentally friendly way. So how do they buy green power?

Typically, a customer opting for green power pays two charges: one for transportation, to the company distributing power locally, and the other for generation to a green power company. Traditional power consumers pay a fee to one regional power company that covers both generation and distribution. The

green power company then must put onto the power grid the same number of kilowatt – hours of electricity from a renewable source as it has sold. In effect, it must constantly up its investment in renewable energy as it grows its customer base.

So far, of nine million residential power customers in California eligible to buy green power, only 2 percent have. In Pennsylvania, of more than five million power customers eligible to buy green power, 10 percent have done so, because market rules there do more to encourage switching. Can these percentages have an environmental impact? “It has a great impact,” says Joe Costello, an energy consultant with the Center for Energy Efficiency and Renewable Technologies.

First, he explained, giving people an opportunity to shop for electricity forces them, for the first time, to think about where it comes from. Second, the ability to market green power gives the renewable energy industry a new revenue stream. Previously, this industry had only the utilities to rely on for financing, and the utilities had not been very enthusiastic about alternative sources of energy.

The first customers to purchase green power were the classic early-adopters. But as people warm to the idea of selecting a power provider, more are expected to choose green power, even though it may cost more. Costello believes that since the early adopters of green power have had to make an extra effort to purchase it, at a premium cost, they are likely to become lifelong customers as the costs go down.

These early customers have caused a modest increase in the amount of energy produced by renewable resources. One company, for example, has installed a number of new generators as a result of green power orders from customers: three 600-kW wind turbines in California, a 10-MW wind farm in Pennsylvania, and three photovoltaic systems, the largest, in Berkley with a 100-Kw capacity.

“Think of the power grid as a pool of water being fed from streams that are dirty and streams that are clean”, said Terry Peterson, green power marketing manager at the Electric Power Research Institute. “If you turn up the flow from the clean streams, the water in the pool gets cleaner.” Initially, growth in demand for electricity will mean that more gas-fired power plants will be built. But, Peterson

projected, when the total green power market has risen to some 20 percent of the total power market, the need for nonrenewable energy will be cut by some 15 percent, as compared to a business – as – usual future. And if costs of renewables go on declining, as many expect, the renewables content of total energy use may be 50 percent by 2050.

THE MYTH, THE LAW, AND THE SPECTRUM

The cost of spectrum has risen to stratospheric levels because of the myth that it is scarce. Yet, there has never been a true shortage – one in which services were withheld from the public solely because no spectrum was available. And there never will be such a shortage, at least not during the lifetime of anyone reading this magazine.

Despite the cellular industry's explosive growth, large segments of the radio-frequency spectrum are still unused or underutilized. One reason is outdated utilization rules. The rules for television, for example, were created over 50 years ago, based on then-current technology. Once modern digital technology is adopted, two-thirds or more of that spectrum could be made available for other uses.

Such freeing-up of spectrum is not new. When Marconi conducted the first radio transmissions in 1895, the energy from his spark gap transmitter occupied the entire usable radio spectrum. The first transatlantic transmission in 1901, which blanketed an area of millions of square miles, was capable of sending only a few bits per second. In fact, only a single such transmission could be accommodated on the surface of the earth using that technology.

How things have changed!

We can now conduct a million voice conversations, or equivalent data exchanges, in the usable radio spectrum in one location. A voice channel with a bandwidth of 30 kHz can now deliver about 10 kb/s. Furthermore, cellular systems today allow the radio spectrum to be reused 10 times or more within the boundaries of a single large city.

One way to measure the improvement in usage is to compare the number of voice conversations or equivalent data transactions that theoretically can be conducted in all of the useful radio spectrum over a given area at a given period in time. It may amaze you, as it did me, to learn that, on average, the number of channels has doubled every 30 months for the past 105 years. According to this observation, there are 40 doublings in the number of channels in a century, which means that the effectiveness of spectrum utilization in personal communications has improved by a factor of about a trillion since 1901.

Focusing on the most recent period, it improved a million times since 1950. Of that million-times improvement, roughly 15-times was the result of being able to use more spectrum (3 GHz vs. 150 MHz) and 5-times was from using frequency division, that is, the ability to divide the radio spectrum into narrower slices (25-kHz channels vs. 120-kHz channels). Modulation techniques – like FM, single sideband, time-division multiplexing, and various approaches to spread spectrum – can take credit for another 5-times or so. But the lion's share of the improvement – a factor of about 2700 – was the result of effectively confining individual conversations to smaller and smaller areas – what we call spatial division, or spectrum reuse.

In the future, spectrum reuse will be even more important than this 2700 factor reflects. For one thing, the gains from other techniques can be costly, and often compromise voice quality. For another, we have extracted about as much in spectrum efficiency as we can from improved frequency division and modulation methods.

Shannon's Law, which states that channel capacity is directly related to the product of bandwidth and the log of the signal – to – noise ratio, teaches us that there is only so much information that can be delivered in a given bandwidth with a given signal – to – noise ratio. That is a brick wall, and all the hyperbole in the world cannot penetrate it.

There is no such limitation on the reuse of radio spectrum. If we are clever enough, we can create reliable, broadband wireless connections between any pairs

of points we choose – even if the points are separated by only a few feet. Doing that would increase the effectiveness of spectrum use by 10 million times over today's capabilities.

If we approached that 10 million times improvement at the current rate of doubling every 2.5 years, it would take 58 years, at which time we would have the capability of delivering the entire radio frequency spectrum to every single individual.

Is this all fantasy? Not at all! Thanks to advances in digital signal processing (both hardware and software), there are today more than 50 000 personal communications base stations that use adaptive array processing to enhance capacity, reduce cost, and improve robustness of communications for some millions of subscribers.

In adaptive array processing systems, a traditional single antenna is replaced by an array of antenna elements. The output of these elements is digitally processed in real time to determine how to combine the received and transmitted signals of each antenna element to best support a desired conversation while rejecting all others.

Instead of broadcasting an individual user's information all over the map, the array effectively delivers RF energy to that use alone; it avoids sending energy to other receivers using the same radio channel. (Reception is reciprocal; the adaptive processing system listens only to desired signals and rejects others.) The result is the ability to conduct many more conversations in any given area and with a given amount of radio spectrum.

The technology will extend its commercial reach into Internet access systems and GSM cellular networks this year and into third-generation cellular systems by 2007.As it becomes more pervasive, it will help deliver new and valuable services to more and more people, thereby improving their productivity and raising their standard of living.

CHANGING THE STRATEGY FOR EXPLORING SPACE

Published in 1968, a year before a man set foot on the moon, Arthur C. Clarke's "2001: A Space Odyssey" seemed to offer a glimpse of the future. Well, 2001 has arrived, and we have yet to accomplish the feats Clarke mentioned in his science fiction masterpiece. Unlike his HAL, no computer can carry on an intelligent conversation with a human being. Nor do small scientific settlements exist on the moon. And we haven't built a spaceship to transport ourselves to other planets. Instead, unmanned spacecraft have made, and will continue to make, the major discoveries in space exploration.

What went wrong? Should we abandon our dreams to use humans to explore space? The odds are that machines alone can do the job. So the answer is: probably yes, but possibly no.

HUMAN SPACE FLIGHT

In May 1961, President John Kennedy challenged the United States to "…commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to Earth." NASA was given a blank check for the task, and succeeded magnificently in July 1969.

Since then, why have no programs built on Apollo II and gone beyond the moon? The answer lies in why Kennedy wanted to go there in the first place. It wasn't to explore space, but to gain international prestige. The entire program was an exercise in symbolism, melodrama driven by the Cold War rivalry between the United States and the Soviet Union.

Had the Soviets gone on to land a cosmonaut or two on the moon after Apollo II, then we would probably now be celebrating the anniversary of the first American walking on Mars in the 1980s. However, the Soviets never got to the moon, so the United States never attempted to go to Mars. In July 1969, the space race abruptly ended. NASA was praised, and rewarded with drastic budget cuts during the 1970s, proving that even in space, what goes up can come down.

Since then, little has happened in human space flight. The Space Shuttle has flown more than a hundred times, and we are on the verge of permanently occupying an International Space Station in low Earth-orbit. Compared to Apollo, what NASA has accomplished on the space station is embarrassing.

The earlier program was launched when we knew very little about space, yet was completed in eight years. The International Space Station was begun in 1984 – more than a decade after NASA's first space station, Skylab, was built – and was supposed to be completed by 1994. The estimated completion date is now 2007. Unfortunately, NASA today isn't the same organization that it was in the 1960s, and it has apparently lost its ability to manage such large, complex projects in a reasonable manner.

In parallel with its activities in human space flight, but with much less fanfare, NASA launched a series of robotic spacecraft to explore the solar system. The 1960s and 1970s have rightly been called the golden age of planetary exploration. US spacecraft have visited all but one of the planets and their largest moons, and sent back tremendous wealth of data; and a close-up look at the exception, Pluto, may not be far away.

NASA's Jet Propulsion Laboratory in Pasadena has proposed an unmanned reconnaissance mission to fly by Pluto and its moon, Charon, and also pass through the recently discovered Kuiper Belt beyond the orbit of Neptune. It is estimated that the belt contains at least 70 000 short-period comets and icy planetoids having a diameter larger than 100 km.

Thus, the initial phase of the exploration of the solar system has been accomplished almost entirely by unmanned spacecraft, a fact unlikely to change in the years ahead. During the 21st century, capabilities in robotics and artificial intelligence should increase substantially, making it even less likely that large numbers of humans will ever be needed to explore space. And while HAL doesn't exist now, he probably will some time during the first half of the 21st century, for it is estimated that, 30 years from now, computer chips will be a million times more powerful than they are today.

Given these facts and these prospects, where should we go from here?

THE MONOLITH

To me, and I suspect to many others, the most important reason to explore space is to answer a single question: are we the only intelligent beings in the universe, or can we find the equivalent of the jet – black monolith that Clarke described? In Clarke's novel, a number of monoliths were supposedly placed in our solar system 3 000 000 years ago by an advanced race of extraterrestrials. The purpose of these machines was to guide the transition from apes to humans and from humans to immortal beings.

It would have been great to find evidence of an existing or past advanced civilization on the moon, or even just one or two little green men standing in front of one of the unmanned Viking landers on Mars in 1976, but we didn't. Nor has data received so far even hinted at the existence of any extraterrestrial intelligence equal to, or greater than, our own in the solar system. This isn't all bad. If we ever do decide to develop the solar system, we won't have to worry about impacting the lives of native inhabitants.

While we will continue to build ever more sophisticated machines to further our understanding of the birth and evolution of the Sun, planets, moons, asteroids, and comets that populate our solar system, we probably have discovered all the major facts about it. From here on out, we will probably find only more detail.

At the same time, the door of galactic exploration is swinging open. Sometime during this century, as our exploration of the solar system comes to an end, the action will gradually shift to our galaxy, the Milky Way. Searching its several hundred billion stars for an electromagnetic signal indicating the presence of an advanced civilization will take time. If any signals are found, deciphering what each means will be even more difficult, but the reward would almost certainly be well worth the effort.

HUMANS OR MACHINES?

In the final analysis, whatever the United States tries to accomplish in space must be something worth doing. There must be a payoff, either in terms of international prestige, scientific knowledge, national security, or commercial profit. The fact that space is more hostile to people than to machines tilts our activities toward the use of machines. Thus, humans will only be used when their presence is absolutely required for a specific mission, such as being the first to walk on the moon or Mars, or to do something that a machine cannot do.

For the United States to become a true spacefaring nation with a significant number of Americans in space, at least two things are needed. First, the cost of transportation from Earth to low Earth – orbit and from low Earth – orbit to the moon and Mars must be substantially reduced. NASA has recognized this need.

Second, a good reason is to send large numbers of people to the moon and then go on to Mars. One reason, and possibly the only one, is tourism. However, even if the price is right, few may want to take the trip because of the grim living conditions that await humans in space.

Granted, there are other possible reasons for sending humans into space, such as building and maintaining solar power satellites in Earth – orbit, or an antenna farm on the back side of the moon to search for extraterrestrial intelligence. However most, if not all, of these projects will probably be more cost effective if they rely primarily on intelligent machines, and employ people only for activities that can’t be done well by machines, such as responding quickly to an unanticipated emergency.

Living at the North Pole or in the Sahara Desert is a snap compared to living on the moon or Mars. In space there is very little, if any, water, no air, and high levels of radiation. This last could prove fatal either quickly, if an astronaut is caught

outside a heavily shielded shelter during a solar flare, or slowly over many years, because the effects of lower levels of radiation are cumulative.

In summary, our exploration of the solar system will continue to be done almost entirely by machines, not humans. Space flight in the solar system for large numbers of people will not be feasible until the cost of space transportation is significantly reduced, and a good reason is found to send them there. And as our exploration of the solar system draws to a close sometime during the 21st century, we should take the next step and begin to search the Milky Way systematically for any sign of intelligent life.

ULTRAFAST LASER FREES PREHISTORIC FOSSILS

A technique based on a scanning, ultrafast laser could soon prove invaluable to paleontologists attempting to liberate fossils entombed in surrounding rock. Physicists from Lawrence Livermore National Laboratory, working on their own time, have refined a system that monitors the composition of the target and cuts power to the laser when it detects fossilized bone. The result could be a dramatic improvement over the current mechanical cleaning method used by paleontologists, which is both delicate and painstaking. It often takes months to prepare small fossils and years for entire dinosaurs.

The new method involves the use of a powerful, ultrafast laser emitting at 800 nm that is capable of producing a train of 1000 1-mJ pulses per second. “The laser system being used is a homegrown one – a “kid brother” of the petawatt laser system first developed at Lawrence Livermore as a part of the National Ignition Facility program,” said Lowell Wood of Livermore.

Since the pulses are too short, the top layer of the target absorbs nearly all the energy, leaving those below unscathed. This permits the automated, raster – type scanning of a large surface to remove one 1-mm layer after another as deep as may be desired.

EMISSION SPECTRUM

The system determines the composition of the material by analyzing the emission spectrum of the vapor plume. To do this the researchers use optical spectrographic monitoring to observe the ablated material on the fly as well as to map the object in either two or three dimensions. The laser switches off as soon as it detects phosphorus – an element rare in ordinary rock but a primary component of fossilized bone. This sensitivity enables the user to preserve the fossil's surface structure to a degree previously impossible.

The scientists hope to present several fossils prepared with the technique at next year's annual meeting of the international Society of Vertebrate Paleontology. Wood predicts that the method, with its high – speed and high – resolution pixel – by – pixel composition analyses, could find extensive commercial applications in the next 10 years, although specifics of other mainline applications are not publicly available.

SUBMARINE FIBER NETWORKS

Submerged in the world's oceans are well over a million kilometers of submarine cable – enough to circle the globe 30 times – forming a network of arteries that carry huge volumes of traffic between continents. Although satellite communications can provide traffic to many locations, it plays a complementary role to cable technology, which has the volume capacity necessary for the bulk of international communication (speech, fax, data and Internet protocol).

Electro-optic repeaters and fiber optics were introduced in the 1980s, before which coaxial cables were used. The introduction in the 1990s of optical amplifiers that could process multiple wavelengths opened the door to wavelength division multiplexing (WDM) and signaled a capacity explosion. At the same time, deregulation created a much more competitive environment where the demand for capacity has increased faster than ever. Today a single fiber can provide 640 Gb/s

- more than 1000 times the capacity of the last coaxial cables and roughly equivalent to 8 million uncompressed (64 kb/s) speech circuits. Each cable can contain several fibers.

One might imagine that a submarine cable system should be much like a land cable system except for the rather obvious requirement that it be waterproof. In practice, there are many differences, most of them due to the depth and size of our oceans.

Ocean depths may approach 8 km with pressures of 800 atmos at the extreme. Cables and optical repeaters must not only be able to withstand these pressures, but also be robust enough to survive the marine installation. Conditions at sea are such that one cannot guarantee gentle treatment. Once a system is installed, however, deep water is a benign environment.

Should cable damage occur, submarine cables are slower and more expensive to repair than are land systems. The time between damage and repair can be several days, depending on the location of the fault and the availability and position of a suitable ship. With ship operations costing as much as $50 000 to $100 000 per day, repair costs can approach $1 million – not to mention the potential loss of revenue.

With the penalties of cable breakage so high, it’s clear that component failures are equally expensive and the reliability targets for submerged components are much more demanding than those for land systems. On a land system, for instance, it is possible to replace components on a single fiber path without affecting the other fibers. Repairs to the wet parts of a submarine link, however, always require the cable to be cut, thus affecting all the fibers in the system.

The ocean’ width (6000 to 7000 km across the Atlantic and 9000 to 11 000 km across the Pacific) requires submarine systems to span much greater distances between terminal points than terrestrial systems. Terrestrial links seldom have more than 10 in-line amplifiers, whereas submarine links frequently have 100 to 200. This further increases the need for very reliable components to ensure that the overall link is reliable.

RELIABLE REDUNDANCY

Consider a link of 150 amplifier pairs; if each amplifier pair has a failure rate of just 10 FIT (1 FIT is 1 failure in 10^9 hours), then the possibility of failure during a year is only 1 percent.

All components except the control electronics and the pump lasers are passive devices that are relatively simple and therefore highly reliable. Two or more lasers emitting at 980 or 1480 nm serve as the pump power to excite the erbium – doped fiber. They are combined and fed to both Go and Return amplifiers. At input and output, low – loss couplers monitor signal levels that are used by control circuitry, which determines the current required to drive the pump lasers.

Pump redundancy is the only way to reach the reliability levels needed, because single units need to have FIT values of around 1 FIT or lower. Duplicated devices can have FIT values of 50 to 100. It is difficult not only to make very reliable devices, but also to demonstrate that they meet the targeted standard. For example, 95 percent confidence that a component will meet 1 FIT level requires 3 billion device-hours of testing without a failure. This clearly requires large numbers of components and lots of time; in some cases, however, tests at higher temperatures can accelerate the aging effects, thus easing the process.

The 980-nm pumps are technically desirable because they reduce the noise factor of the amplifier and consume less power than 1480-nm devices. Early lasers suffered from poor reliability, and the problems have abated only recently. If the target had been 1 FIT, suppliers would have needed 340,000 device-years of testing. But by aiming for 50 to 100 FIT, only a few thousand device-years were needed – expensive, but not excessive.

TRAVELLING LIGHT

Making high – reliability, high – performance optical units is only part of the challenge. Transmission of WDM signals over long spans also poses some interesting issues. Light attenuates as it propagates through a fiber, eventually dropping to a level where recovery of the signal is impossible. But a number of other effects become important.

The first is that an optical amplifier generates noise, which accumulates as the number of amplifiers increases and becomes significant at the end of the system.

Another important effect is that of dispersion. A single-mode fiber supports two modes of propagation, one vertically polarized, one horizontal. If the fiber were perfectly circular, these would propagate at exactly the same speed. Real fibers, however, are not perfect, and there is a small speed difference between the two modes. As they propagate, power is coupled between them in a somewhat random fashion. The result is a pulse broadening or dispersion that increases with the square root of the total transmission length. Fiber suppliers have managed to minimize this effect to the point where it isn't significant for 10-Gb/s systems. But for 40-Gb/s systems, where the dispersion targets are four times harder, this may well prove a problem.

Chromatic dispersion, where different wavelengths travel at different speeds, also causes problems. It's possible to design fibers with very low chromatic dispersion, but surprisingly, this isn't a good idea: it makes closely spaced wavelengths propagate together, which in turn increases interaction between them. Higher dispersion reduces this effect but causes the signal pulses to broaden. Dispersive fiber with periodic compensation is a solution to this problem and is used in all types of WDM systems, although the fiber characteristics for long submarine systems are different from those for land systems.

This isn't a complete solution to the problems caused by nonlinear effects. It is merely a way to reduce the effects. Increasing the effective area of the fiber offers a further reduction in nonlinear penalties, because it reduces the optical power density. But such fibers are generally more sensitive to microbending, thus making cable a headache to manufacture.

Effects in the fibers are not the only issues. With a cascade of 100 to 200 amplifiers, transmission of around 100 wavelengths – the current target – requires each amplifier to provide the same gain for all of them. A systematic gain variation of just 0.1 dB per amplifier becomes 10 dB after 100 amplifiers. To achieve this, individual amplifiers contain compensating filters, and additional filters are usually in the line to maximize gain flatness.

ON THE BEACH

Because the seabed has no power sources, power must be fed to the amplifiers from the shore. DC current is fed along the metallic parts of the cable, passing through one repeater after the other. The long lengths of submarine cable systems require several kilovolts from each shore, and the equipment producing this must be extremely reliable, because a failure would lose the entire transmission capacity.

With several thousand volts on the cable, there are obviously safety issues. First, to protect people, attention is given to insulation, warning labels and automatic shutdown features. Second, the equipment in the line must be protected, as a powered cable has a lot of stored energy. If it's broken, the energy released can cause surges of 200 to 300 A. Consequently, repeaters need to contain very robust circuitry designed to handle this possibility.

On shore there is transmission and reception equipment – essentially WDM terminals adapted to long-span transmission. Submarine systems use forward error correction to get good transmission performance at signal – to – noise levels lower than normally possible. Although forward error correction at high speeds is not easy, the benefits are high. On long systems the number of repeaters is significantly reduced, which is important when each repeater may cost about $ 1 million.

Another way to improve the overall transmission is to incorporate a relatively complex modulation scheme, where the transmitted pulses are converted to return – to – zero and simultaneously phase modulated. This signal format usually

requires the use of a multistage Mach-Zehnder interferometer, with the different stages performing amplitude modulation, return – to – zero conversion and phase modulation.

Such complexity requires large numbers of complicated components, increasing the possibility of failure. Although the equipment is on land and therefore more accessible than the submarine components, reliability is still a factor.

WHAT NEXT?

The challenge now is to obtain even greater capacity, which might be achieved by any of the following:

- more fibers
- more wavelengths
- higher line rates
- better spectral efficiency

Increasing the number of fibers in the cable sounds easy except it also means additional amplifiers per repeater, which in turn means extra power consumed per repeater. This requires either reduced cable resistance or more voltage, which would necessitate increases in insulation. The repeater also must be kept to a practical size and weight.

The number of wavelengths can be increased both by reducing the spacing between them and by increasing the bandwidth of the amplifier. The International Telecommunications Union recommends spacing wavelengths 50 or 100 GHz apart (equivalent to 0.4 or 0.8 nm). The research shows that transmission is possible with spacing as low as 25 GHz (0.2 nm), but with significant penalties, suggesting that the practical limit is a bit larger. Likewise, a variety of techniques is stretching amplifier bandwidths. The use of the L-band in erbium amplifiers promises to roughly double their available bandwidth, although at present the amplifiers needed are more complicated.

The next line-rate step is 40 Gb/s, which presents major challenges. With a bit period of only 25 ps, components will need to be very fast, and the effects of dispersion will be four times more significant. Consequently, fiber polarization mode dispersion may become a serious limitation. It's also important to realize the transform-limited spectrum of a 40-Gb/s signal is four times that of a 10-Gb/s signal, thus requiring an increase in the wavelength spacing.

Current systems have a spectral efficiency of 0.2 bit per second per hertz, with closer wavelengths moving this toward 0.3 bits per hertz. Nonoptical systems have used more complex modulation formats than the simple binary ones currently used (for example, multilevel and phase or frequency modulation) to gain capacity in a limited bandwidth. But most of these techniques are difficult to apply at data rates of 10 Gb/s and above.

This might seem a somewhat pessimistic position. A combination of extra fibers, closer wavelengths and larger bandwidths is likely to increase capacity two to four times. It's more difficult to predict the next step.

Historically, line rates have increased even when it was believed that a limit was being approached, so suppliers of 40-Gb/s components and above should continue working toward new developments. New components have often been the key to new types of systems.

We have also seen the need from time to time to adopt a new technology. A number of possibilities are worth consideration. Some researchers suggest that new types of fiber and different dispersion maps will be critical to success. Others suggest that the key to 40 Gb/s may lie in systems that don't merely amplify the signals, but also regenerate them. They also speculate that nonlinear propagation may be important.

The history of this particular industry, however, bears out few predictions, so maybe you should be prepared for something different.

COMPREHENSIVE TESTING MAXIMIZES A SITE'S VALUE

A fabulous Web site is worthless if people can't access it quickly whenever desired. Testing is the one surefire way to ensure proper Web site performance, but failure to test everything, right down to the business logic hidden behind a link, can have disastrous results.

Take the costly (and real) example of a large office supply company that offered a rebate to those buying back – to – school supplies through its Web site. Splashy ads lured people there with the promise that, the more spent, the larger rebate. The rebates were calculated through a rebate button on the checkout page that should have been programmed for a single use per transaction.

Instead, the button did not disable, however often it was clicked. And many people clicked repeatedly, getting rebates that whittied the purchase price to pennies, paying only for shipping and tax on big items (computers, desks, chairs) and small items (staplers, paper, pens) alike. "That's bad business logic, something that should be tested for in a comprehensive Web site test program," emphasized Ken Lee, laboratory vice president of TestPros, "along with everything from the scripts running on a Web page, to the tags that enable its HTML coding and security measures for e-commerce transactions, to link between display screens."

The first thing to do is to gain an understanding of all the technical components that are supporting the Web site under test-Java or Jini, Cold Fusion (a Web portal development tool from Allaire Corp.,Newton, Mass.), the number and size of the servers, the operating system, and the bandwidth connection to the Internet.

Other important test considerations revolve around expected traffic and usage. Both factors determine which links are critical. Take a bank. The fact that most people interested in on-line banking will want to access account balances, check on deposits, and take care of automated teller transactions makes those the critical links. Current rates of interest paid on certificates of deposit are less likely to be used frequently, so a link to that information certainly should work, but need not be critical to the Web site's success.

Compare the expectations of the bank and a small engine repair shop. While the test methods are basically the same for both, what the test is looking for in terms of data is different in each case because each has different concerns and expectations of visitor numbers. The repair shop, whose site receives a hundred or so weekly visitors, is unlikely to be too concerned with the stress test. But it is of great concern to the bank, which is expecting thousands of concurrent users on its Web site.

Conversely, the repair shop lacks the clout to require use of the latest Web browser with 128-bit encryption, which the bank can demand of its users. Instead, the small business site is likely to be accessed by customers using several operating systems and browsers, old and new. So it must be tested against many more combinations of operating system and browser than the bank.

PUSH PAST THE BREAKING POINT

Most companies want their Web sites tested until they break – that is, to determine how many concurrent users it will take to crash the servers or even just produce a noticeable decline in server speed. The maximum number of users that can be simulated by a software script goes to infinity mathematically, but practically speaking, the number is a few thousand, maybe 15 000 at the top end.

A comprehensive test – until – it – breaks scenario looks at however many concurrent users are expected on the same traffic pattern in order to see just what is going to break in the application. It may be the database server, the bandwidth, the application server, the Web server, the load balancing algorithms, or the ability of the Web server to handle that many incoming Internet protocol addresses at once.

One performance measure is the time taken to display a requested Web page. By measuring the time form when a simulated user clicks on a link to request a page to when that page finishes loading, and doing this while adding simulated users across several connection speeds, a company can get an idea of just how much traffic its site can support comfortably.

For example, test results may show that the optimal number of concurrent users for a site is 1450-1500. Based on an 8-second industry – standard page response time, that may mean that a 28.8k modem will take too long to load a page. With that kind of information in hand, a company can look at its Web design and maybe eliminate a large graphic slowing things down, or post a warning to users of slower modems about long page – load times.

Benchmarking against speed trials of applications is one way to test a Web site. National Software Testing Labs are popular benchmark providers that do testing services.

But comparing a Web site's speed with a benchmark may not be enough of a test. Take the case of a $10 million ad campaign expounding on a corporate name change. The company may not want just to benchmark its Web site, but to know if the site can handle the expected traffic volume during the campaign's blitz period.

Knowing how changes in the site's systems will affect operation is essential for players in the volatile e-commerce market. Hardware scalability tests check to see what happens when more servers are added at the application, database, and/or Web site. In some cases, processing of requests slows significantly if the code is not written to expedite requests across multiple servers.

THE WIRELESS WEB MONKEY WRENCH

Personal digital assistants (PDA) and Web-surfing cell phones introduce yet another level of complexity since wireless adds different carriers and gateways to access the application. Wireless providers and devices work differently if they use different technologies. It's one more set of functions to test.

For instance, TestPros was hired to perform wireless application protocol (WAP) testing by a client that used specific service providers and a variety of WAP-enabled cellular phones. During the five days of functional testing, problems in content rendering and button-to-function areas appeared. Not so much logic

errors as display and device-button mapping errors, the primary problem was that they might cause e-mail to be sent to the wrong group or individual.

In the end, comprehensive testing will ensure that even wireless access to a Web site goes smoothly, once the kinks are worked out. Just remember that it's an evolutionary process. A Web site is only bulletproof until the next release of Windows or the next wireless Web PDA comes out.

THE REBIRTH OF RADIO

In the beginning, automobiles were known as horseless carriages, reflecting the feeling that horses were the natural way to propel vehicles. Similarly, radio was known as wireless. In the transportation arena, engines and motors have long since supplanted the horse, and the term horseless carriage has gone the way of the horse-drawn vehicle. But wiring of one kind or another is still regarded as the "natural" way to connect nodes in a communications network. To most of us, wireless is an inferior, niche technology appropriate only for mobile applications. Even television, which was originally popularized as a wireless service, is now broadcast largely over cable.

Today, that mindset is under attack. Scientists have predicted recently that very soon most people will be using wireless phones for both voice communications and Internet access.

They may be optimistic, but they are right about the direction in which things are moving. IEEE 802.II, the wireless local-area network standard, is one of the hottest product areas at the moment; Bluetooth threatens to become even hotter; Nokia recently unveiled its self-configuring rooftop RF system for Internet access; fixed-wireless links are gaining increasing attention as candidate solutions to the Internet's last-mile problem; and cell phones need hardly be mentioned.

Why the sudden interest in radio? It can't be compared with wired optical networks in capacity. It leaves users more vulnerable to eavesdropping than wired networks do. There is the problem of all those unguided waves interfering with one another. And cell phones with all their dropped calls and coverage gaps don't seem to be exactly a ringing endorsement of the technology.

The reason is not hard to find: advances in microelectronics have made it possible to build complex wireless systems at low enough cost to make them economically viable. These advances, and others on the way, are not only allowing us to realize the well-known advantages of wireless communication, they may also turn out to be the best way to access the Internet in many situations.

Besides, some of the cited drawbacks of wireless may not be as serious as they sound or they may be susceptible to treatment by further advances in semiconductor technology. Optical fiber indeed has much greater capacity than radio. But so what? Not every application needs immense transmission speed. Fiber makes sense at the core of a telecommunications network. Wireless is being touted for the periphery – or for small, self-contained networks – where blazing speed is less important than such factors as mobility, cost, and provisioning speed.

Today's cell phones certainly leave a lot to be desired. But is that because of any fundamental problem with the technology or is it because cellular service providers are signing up customers faster than they are building networks to serve them? If the latter, as appears to be the case, then time may well fix the problem.

As for eavesdropping and interference, advanced digital signal processors (DSPs) are already dealing with those problems and promise to do even more. DSPs, after all, are at the heart of every digital cell phone, compressing and encoding voice streams, and making them almost immune to eavesdropping in the process. They are only beginning to be used in smart antennas, which will mitigate the interference problem and boost system capacity.

CHIPS TO THE RESCUE

Take IEEE 802.IIa, the high – speed wireless local – area network standard. This 54-Mb/s improvement to 802.IIb uses an exotic orthogonal frequency – division multiplexing scheme and works in the new Unlicensed National Information Infrastructure band, where 300 MHz of bandwidth is available in two pieces: 200 MHz from 5.1 GHz to 5.3 GHz, and 100 MHz at about 5.7 GHz. With its 54-Mb/s data rate, 802.IIa is comfortably above the 22 Mb/s needed for a home network capable of simultaneously connecting two computers to the Internet or handling multiple audio and video streams such as might be generated by CDs, camcorders, and so on. So why hasn't this attractive technology been adopted until now?

Adoption of 802.IIa has been delayed by the high cost of implementing it – specifically, by the need to fabricate the radio-frequency portion of the circuitry in a compound semiconductor material like GaAs or SiGe. That is not only expensive, it also is incompatible with CMOS – the material of choice for the modem portion – with which the RF circuitry will one day be integrated. But no more.

Last September two unrelated companies announced all CMOS solutions to the 802.IIa problem. Radiata, an Australian company unveiled a pair of chips that between them almost constitute the physical layer of an 802.IIa transceiver. The R-M IIa modem chip, which includes 20-MHz analog-to-digital and digital-to-analog converters, is built with a 0.25-mm CMOS process. Its companion R-RF5 chip, fabricated with a 0.18-mm process, is a complete 5-GHz radio, including all necessary amplifiers, mixers, and filters. All that is needed to complete the transceiver is a media access controller (MAC) and possibly a power amplifier, if the R-RF5's 0-dBm transmitter output is insufficient. The chip set will sell for US $35 in large quantities.

Atheros Communications introduced an even more highly integrated chip set at N+I. Its two chips include both the MAC and a power amplifier. The company, which also has a tight academic connection with Stanford University, priced its

chip set at “below $35”. For both companies, the quoted price for the chips translates into an end-user price for the complete transceiver of about $150.

By contrast with 802.IIa, Bluetooth – the self – configuring short – range network pioneered by Sweden’s Ericsson – aims a lot lower down the performance scale – around a megabit per second – but also has a much more stringent budget. Companies contemplating the addition of Bluetooth to their products tend to regard $5 as the acceptable cost of adding that capability. What that $5 buys is connectivity – the capability to participate in an ad hoc network anytime two or more Bluetooth-enabled devices get within about 30 meters of each other.

Most Bluetooth visions involve portable equipment with limited display capability, so its fairly low data rate is consistent with its probable missions – e-mailing, wireless keyboards, wireless headsets, smart home appliances, and the like. Wireless headsets for cellular phones may be the killer app here; their very low power is likely to ease the anxieties of cell phone users worried about brain damage from excessive exposure to RF power.

Like several other RF technologies, Bluetooth operates in the 2.4- GHz ISM band using frequency-hopping spread-spectrum. If it gains anywhere near the popularity anticipated for it, problems may arise with other services operating in that band. Therefore, Bluetooth – or rather its avoidance – may turn out to be a factor contributing to the success of 802.IIa.

Yet another self-configuring network operating in the ISM band – at least for now – is the kind based on Nokia’s RoofTop Wireless Router. All that’s required to connect to a network based on this technology is to mount one of the wireless routers on a convenient rooftop; supply it with power; connect it to a computer’s Ethernet port; and, of course, make financial arrangements with an Internet service provider with RoofTop equipment. It’s not even necessary that the customer’s unit have a direct line-of- sight link to the service provider. Just as long as it can see one other node in the network, all will be well. The unit will “talk” to similar units in the neighborhood and together they will configure themselves into an ad hoc mesh network. RoofTop routers self – configure and self – heal as new customers

connect to the local system. New subscribers add redundancy to the network, and thereby strengthen the infrastructure.

Although the wireless routers run in the unlicensed 2.4-GHz band, there is no reason they cannot be moved to one or more other parts of the spectrum. The radio portion of the gear is separated from the router portion and can be independently re-engineered.

Nokia's system is illustrative of a new use of radio – wireless Internet access unrelated to mobility. The RoofTop Wireless Router makes possible data rates of up to 12 Mb/s, which compares favorably with cable TV and DSL access methods. Of course, since each user shares a cell with several others, the data rate achievable at any given time will vary with the number of users communicating in the cell.

More deterministic fixed – wireless systems are based on Local Multipoint Distribution Service technology, which uses directional antennas but has the corresponding drawback of requiring expert installation. These systems work in the 30-GHz region of the spectrum and provide data rates on the order of 10 Mb/s. As always, the name of the engineering game is tradeoff. Easy installation or high speed – you pay your money and you take your choice.

SPECIAL REPORT

Unintentional noise emission by unknown sources is often critical in submarine detection. Conversely, noise on board the searching vessel hampers the use of passive sonar. Noise can be classified as self noise and ambient noise. Self noise is associated with electronic circuitry of the sonar and the mechanical operation of the ships that are involved. Ambient noise encompasses all of the noises in the sea.

Self noise is produced by noisy tubes and components in the sonar circuitry, water turbulence around the housing of the transducer, loose structural parts of the hull, machinery, cavitation and hydrodynamic noises caused by the motion of the ship through the water. The dominant source of machinery noise in a ship is its power plant and the power distribution system that supplies power to the other

machinery on the vehicle, such as compressors, generators and propellers. Normally, machinery noise is always present and is kept to a minimum by acoustically isolating the various moving mechanical components.

Noise in the ultrasonic region is extremely important in sonar and acoustic torpedo performance. The noise produced by auxiliary units, such as pumps, generators, servos and even relays, is often more significant than the power plant noise. The large masses involved in the power plant usually keep noise frequencies relatively low. However, small, high speed servomotors may be serious sources of ultrasonic noise.

Flow noise results when there is relative motion between an object and the water around it. Under ideal conditions, the object is perfectly streamlined and smooth, and water movement will be undisturbed. This idealized condition is called laminar flow and produces no self noise. Irregular objects can achieve nearly laminar flow conditions only at very low speeds (one or two knots or below).

As the speed of the ship or object increases, the local pressure drops low enough at some points behind the object to allow the formation of low pressure steam. This decrease in pressure and the resulting bubbles of vapor represent the onset of cavitation. However, as the ship moves away from the bubbles, the pressure increases, causing the bubbles to collapse and produce a continuous, sharp, hissing noise signal that is very audible. Because the onset of cavitation is related to the speed of the object, it is logical that cavitation first appears at the tips of the propeller blades, since the speed of the blade tips is considerably greater than that of the propeller hub. This phenomenon is known as blade-tip cavitation.

Since all torpedo homing systems and many sonar systems operate in the ultrasonic region, cavitation noise is a serious problem. Torpedoes generally home on the cavitation noise produced by ships, and any cavitation noise produced by the torpedo interferes with the target noise it receives. Because the speed at which a vehicle can operate without cavitating increases as the ambient pressure is increased, some acoustic torpedoes are designed to search and attack from depths known to be below the cavitating depth.

It is important for an antisubmarine warfare vessel to operate with a very low noise level. Noise-reduction methods can be applied to other military vessels, as well as to commercial vessels. For protection against acoustic mines and to reduce the risk of being detected early by sonar listening devices, noise minimizing is necessary. A low level of noise also permits the ship to receive a lower level of signal from the enemy. Strict limits on the levels of structureborne noise and of airborne noise levels improve the habitability for the ship's crew. Ambient noise is background noise in the sea due to either natural or man-made causes, and may be divided into four general categories, including hydrodynamic, seismic, ocean traffic and biological.

TELEPHONE TRANSMISSIONS

The telephone whether cellular, wireless or hard wired, is so ubiquitous in today's technology that no report on UE would be complete without its consideration. Modern technology has elevated SIGINT effectiveness to a point where virtually all electromagnetic communications, including telephone and radio conversations, are highly vulnerable to hostile intelligence intercept. Telephone conversations are especially endangered because most are, at some point in transmission, relayed via microwave signals, which are monitored easily. Double talk, self-generated codes and other improvised security measures are readily defeated by hostile intelligence analysts. The wealth of information transmitted daily throughout the world via telephone and radio by military personnel is a highly valuable collection source for hostile intelligence agencies. Important factors include source sensitivity, timeliness of reporting and processing, and communications available to transmit information.

But even without a microwave link, a magnetic inductor, with no physical connection to a hard-wired circuit, can act as a passive sniffing device. By using a

current probe or transducer, a telephone link can be compromised with no disruption of network activities and with little likelihood of detection since there is no electrical connection to the network.

MILITARY COMPUTERS AND PERIPHERALS

A computer broadcasts electromagnetic information into the surroundings where it is physically located. Miniature receivers placed near the computer can eavesdrop electromagnetically upon the broadcast information. Describing the emission from VDUs, van Eck wrote: “It seems justified to estimate the maximum reception distance using only a normal TV receiver at around 1 km.”

But the computer, with its digital innards, is not the only source of UE. With current technology it is possible to reconstruct a computer’s VDU contents from up to a kilometer. Reconstructing the contents of a computer’s memory or mass storage devices is more complicated and must be performed from a closer distance.

The reconstruction of information via UE is not limited to computers and digital devices but is applicable to all devices that generate electromagnetic radiation. According to van ECK, the VDUs produce a very high level of UE. He says: “Cables may act as antennas to transmit the signals and reemit them farther away from the source equipment. It is possible that cables acting as an antenna in such a manner could transmit could transmit the signals much more efficiently than the equipment itself. A similar effect may occur with metal pipes such as those for domestic water supplies. If an earthing (grounding) system is not installed correctly such that there is a path in the circuit with a very high resistance (for example, where paint prevents conduction and is acting as an insulator), then the whole earthing system could well act in a similar fashion to an antenna.”

Emission security (for example, Tempest) is concerned with identifying and eliminating his type of unintentional radiation that conveys classified information. In the case of aircraft, Tempest surveys, required by OPNAVINST 5510.93E, must be conducted when classified information processing systems or transmitters are

added, relocated or modified, including both hardware and software modifications. The Tempest survey is conducted to ensure that the aircraft can conduct its emission with no compromise of security.

OTHER FORMS OF UE

UE takes many forms in addition to those already mentioned. Two common forms are electromagnetic interference (EMI) and infrared (IR). If unchecked, ENI can potentially cause the physical destruction of military platforms or at the very least cause them to malfunction. IR emission is so ubiquitous that perhaps it is not often considered a form of UE. But indeed, every animate object emits electromagnetic energy in the IR spectrum. In addition, inanimate objects at temperatures different from the ambient can be discerned using IR emissions.

THE COST OF THE OTHER SIGINT/ELINT

Simply stated, the end game of SIGINT/ELINT is to monitor everything, everywhere, all the time. With sophisticated receivers, unmanned aerial vehicles and satellites to gather and relay information, this goal may be achievable, but not without a cost. The cost is unprecedented processing power. Included in the arsenal of processor-intensive approaches used by contemporary military systems are data fusion, super-resolution procedures, simultaneous direction finding and signal enhancement.

An example of the demands placed upon technology is apparent in a recent request for proposals that appear in the Commerce Business Daily issue of January 16, 1996. In part, the requirements were for “Radar Warning Receiver Algorithm Development SOL PRDA NO.96-02-AAK. Introduction: Wright laboratory (WL/AAKD) is interested in receiving proposals (technical and cost) on the research effort described below. Description: The objective of this effort is to develop and test new EW concepts and algorithms based on the results from in-house and previous contractual programs and adapt/implement these

algorithms/concepts in a software simulation to develop specifications for developing future and modifying current EW threat warning systems and ELINT threat analysis tools. The simulation will be a mechanism for evaluating new concepts applicable to EW and ELINT processing systems. Current operational systems have highly integrated deinterleaving, identification (ID) and signal analysis software. This program will investigate new and innovative deinterleave techniques which utilize and exploit correlation, new independent signal type declaration software, probability analysis in ID generation, pattern recognition, unintentional modulation on pulse, frequency modulation on pulse, artificial intelligence and signal tracking algorithms."

Big Brother may be watching, but he had better be pretty digitally savvy to understand what he is seeing.

HEATING SILICA-CORE FIBERS REDUCES SCATTERING LOSS

In essence, the basic steps required to manufacture optical fiber are relatively few in number. Varying or adding postprocessing steps, however, can sometimes impact fiber-transmission efficiency dramatically. For example, although silica-core optical fiber routinely exhibits a Rayleigh scattering loss as low as 0.8 μm^4 dB/km, this value is somewhat high compared to typical values for silica glass, which can reach 0.6 μm^4 dB/km. According to Shigeki Sakaguchi and Shin-ichi Todoroki, researchers at NTT Opto-Electronics Laboratories (Tokai, Japan), one way to reduce the Rayleigh scattering of silica core fibers is to heat them – this also lowers transmission loss.

During recent experiments, the researchers studied the impact of heating a single-fiber with pure silica core and fluorine-doped silica cladding. They used several fibers cut from the same roll. Other than about 30 cm of striped coating, each fiber was bare. This section was suspended vertically in a furnace and heated to 1050°C – 1200°C in a dry flow of nitrogen for dwell times of 2 – 20 minutes.

This temperature range was chosen because it corresponds to the fictive temperature range of ordinary silica glass.

To study scattering losses, Sakaguchi and Todoroki launched 514.5 nm light from an argon laser into each fiber through a quarter-wave plate and measured the intensity of light scattering from the heated segment with a photomultiplier. These data were then compared with the subsequent intensity reading taken for the unheated part. Results indicate that, except for the data taken at 1050°C, the relative scattering intensity of a fiber dropped with heat treatment. The researchers also noted a strong correlation between the reduction in scattering intensity and the reduction in a fiber's fictive temperature. In addition, they found that the relative scattering intensity of the fiber segments varies with heating.

According to test data from this NTT experiment, it is possible to reduce the scatter loss of silica fiber by about 30% with heat treatment in the 1100°C to 1200°C range. Compared to a typical Rayleigh scattering loss of 0.8 μm^4 dB/km quoted for silica-core fiber (assume a fictive temperature of 1600°C), certain heated fibers in the test measured Rayleigh values of 0.51-0.62 μm^4 dB/km.

Although previous research in heat treatment of silica-core fibers also indicated that heat treatment reduces fictive temperatures, Sakaguchi notes that those experiments reported that a few hours of heat treatment were necessary to produce the temperature drop. The NTT experiments, however, indicate that the temperature reduction is possible in 20 minutes. Sakaguchi and Todoroki thus conclude that in-line fiber annealing during the drawing process offers a possible way to reduce the loss in silica-core fiber beyond what has been traditionally considered the norm.

NO PLACE TO HIDE

It's one of the classical movie plots: the bad guys –foiled in the attempt to grab piles or cash or some priceless artifact and makes getaway – have taken hostages. The police hatch a plan to covertly enter the building and capture the criminals,

and the hero almost always chooses just the right air duct that will let him spy on the captors before he springs into action. But in real life, where such heroic gambits are often deemed too risky, researchers have been working on radar that can “see” through walls, so police can know where hostages are congregated or soldiers can tell where the enemy is lying in wait. Two devices that meet demanding criteria are on the market, and one has been adapted for use by the US military in Iraq.

Some conventional radar can penetrate walls, but it cannot distinguish objects just ahead, it emits far too much power to be safe for operators, and it requires equipment about the size of a lab bench. Advances in digital signal processors and microwave integrated circuits have made it possible to fit a complete microwave system in a box the size of two encyclopedia volumes. Now, through-the wall radar devices that are lightweight, portable, and able to focus up to 20 or 30 meters ahead are available to municipalities and law enforcement agencies. Two such devices are RadarVision, built by Time Domain Corp., of England. Both rely on ultrawideband, a fairly new technology known mainly as a promising high-speed, low-power radio communications transmission technique.

A change in software can turn an ultrawideband radio, whose pulses of RF energy normally carry data, into an ultrawideband technology, they are quite similar. Both devices can detect the presence of inanimate objects through the wall, but only motion (in the form of a moving blob of color on their built-in color screens) is shown to the user. The devices are so sensitive that even if someone on the other side of the wall is sitting still, the machines can detect the rise and fall of the person’s chest with each breath.

The radars transmit millions of very short pulses. What they see through a wall is related to the timing of the return pulses. RadarVision generates 10 million 300 – to 500- picosecond-long pulses every second – each one at well below 100 microwatts. Its receiver knows to within a few picoseconds when anyone of the pulses will return and switch on only for a brief sampling window, after which it

shuts off again. This feature greatly improves the signal-to-noise ratio of the return signal and reduces the radar's power consumption.

Either device can run for a couple of hours on a single battery charge. Each also has the added benefit of making it difficult for the bad guys to know they are being monitored, because signal detection devices can't distinguish the devices' low-power transmissions from background noise.

On return, the pulses are picked up by a linear array of antennas. The time of arrival for each return pulse is measured at each antenna, providing an accurate determination of where the moving object is with respect to the machine's field of view. The radar systems look for changes in the range and angles at which successive pulses strike an object on the other side of the wall.

If, say, Pulse 1 comes back revealing that there is an object at range x and angle y, a difference in range or angle for Pulse 2 is registered as movement. An onscreen representation of that is shown to the user. Whenever there is no difference between the latest pulses return and the one preceding it, which is the case for pulses that bounce off inanimate objects, the system disregards those objects and omits them from the display.

What the user sees is a plain view of what lies on the other side of the wall, but seen onscreen from above. An optional mode shows the space on the other side of the wall the way it would appear from the side. This option allows an experienced operator to distinguish between tall and short objects, such as an adult and a small child or pet.

FUELING THE INTERNET

Amy Arnold of Menlo Park, Calif., spends much less time at her computer since she left Hewlett-Packard to stay home with her kids. Mostly she uses it for the half-dozen e-mail messages she gets a day. She used to turn it on every few days and spend an hour or so dealing with the accumulated e-mail. But late last year she signed up for digital subscriber line (DSL) service.

Now, Arnold turns her computer on when she wakes up and leaves it on until ready to go to sleep. Even though her computer is in so-called “sleep” mode for much of the day, Arnold’s computer usage will raise her household’s electric consumption by a percentage point or two. Add to that the increased power usage of all the other consumers signing up for DSL, cable modems, and other broadband Internet connections. Add corporate computer users, who are demanding more powerful machines, more kinds of, and more, peripherals (scanners, for example, once relegated to art departments, are becoming ubiquitous), and faster Internet connections. Then add in the air-conditioned server farms that distribute e-mail, host Web sites, and manage all these connections.

The total impact? It’s not clear. Some of the new, more powerful computers make more efficient use of energy than the obsolete models they replace, and the other numbers can vary, depending on how the calculation is done.

Among those who believe Internet use is driving power consumption much higher are Peter Huber and Mark Mills, co-authors of the Digital Power Report newsletter. They calculate that Internet use currently accounts for 8 percent of U.S. electric power demand, and they project it to rise to 30-50 percent in 20 years. Meanwhile, they expect overall demand for electric power to grow 33 percent over the next 20 years.

Huber and Mills, in their analysis, consider the assumption of power by PCs, by servers, and in computer manufacturing. For the last year or so, a lot of attention has been paid to their widely published conclusion that the digital economy is driving demand for power far beyond any projections made in past years by the power industry. They believe it will require the construction of a host of new power plants in the coming decades.

Living in Silicon Valley, this writer last summer became familiar with new terms such as “rolling outage block” and “stage 2 emergency.” The first is a system that shuts off power to consumers for short periods on a scheduled basis, and the “stage 2 emergency” means that more than 95 percent of the state’s available electricity supplies are in use, and reserves are dangerously low. Local papers

urged readers to turn off idle computers, printers, copiers, and other electronics and, whenever possible, use laptop computers and laser printers. So the Huber and Mills analysis seemed to ring true.

But is it? The bulk of the experts who have looked at it say no, that the California power problems have a host of causes, but Internet use is not one of them.

A VAST OVERESTIMATE

Jonathan Koomey, a staff scientist for Lawrence Berkley National Laboratory, Berkley, Calif., focuses on analyzing the consumption of electricity by computers and consumer electronic products. He told that he believes the Huber-Mills estimate of Internet power use is off by a factor of eight or more, meaning that Internet use currently amounts to little more than 1 percent of U.S. electric power demand. “In our independent technical peer review of Mills’s analysis, we compared measured data to Mill’s assumptions and concluded that he had vastly overestimated electricity use in every category of office equipment,” Koomey said.

Joseph Romm, executive director of the Center for Energy and Climate Solutions, a division of the Global Environment and Technology Foundation, Annandale, Va., takes issue with the Huber and Mills conclusions. He points out that in the four years prior to the big Internet boom (1992-1996), growth in the U.S. gross domestic product (GDP) averaged 3.2 percent a year, while electricity demand grew 3 percent a year, he said, GDP growth has averaged 4 percent a year, while energy demand is growing only 2.5 percent a year. “In addition,” he told, “the Internet era has also been the hottest period in U.S. history. So if anybody tells you that the Internet is an electricity hog,” he said, “the data refute that”.

Romm, a former U.S. assistant secretary of energy for energy efficiency and renewable energy, thinks there are several reasons why the GDP is increasing more quickly than energy demand. He lists gains in productivity, the replacement of old, energy-hogging computers with more efficient models, and the increasing ability

of people to work at home, which reduces both transportation and office energy costs.

“I believe the single most important thing the Internet does is allow better use of existing resources, and the single most unutilized resource is people’s homes – they are already constructed, and use a lot of energy whether you are there or not. One hundred square feet of office place uses 2 MWh per year; give me a laptop, let me work at home, and I save a huge amount of electricity.” Chris Lotspeich, a senior associate at the Rocky Mountain Institute, in Snowmass, Colo., said his organization agrees with Romm’s analysis. “Structural changes in the economy, facilitated by the Internet, are reducing overall energy use,” he told.

For Lotspeich, opportunities for energy savings abound. The devices could be made more efficient, components and systems be produced more efficiently, and the buildings that house them be made more efficient at cooling them.

“The biggest problem with computers right now is the air conditioning needed for them to operate,” agreed Joe Costello, an energy consultant with the Center for energy Efficiency and Renewable Technologies, Sacramento, Calif. “But there can be better ways to design buildings. And in the long run the Internet is going to greatly reduce our need for energy.

A QUESTION OF QUALITY

The long-term question may not be one of energy supply, but of energy quality.

“The issue is what I call digital-quality electricity,” said Karl Stahlkopf, vice president, power delivery, for the Electric Power Research Institute (EPRI), Palo Alto, Calif. “The silicon revolution has brought increases in productivity, but at a price.”

That price is an increased sensitivity to power outages. Transmission and distribution systems for electricity were designed for a world that could weather outages of a minute or so without major inconvenience.

“Today,” Stahlkopf said, “a one-cycle, one-sixtieth-of a-second outage can have very large consequences.

At Sun Microsystems Inc., for example, also in Palo Alto, outages are estimated to cost the company US $1 million per minute, because of the production lost when manufacturing lines are interrupted.

EPRI estimates that nowadays lost productivity due to power outages costs the United States $50 billion annually. And that number, Stahlkopf said, is rising as more and more industrial processes come under computer control.

“At a steel rolling mill, for example,” he said, “a power outage knocks the computer system off-line and interrupts production. Then everything that had been going through the plant at that time has to be recycled. An outage at a paper manufacturing plant takes one or two shifts to clean up and costs about $250000.”

Reducing power outages is not just a matter of generating more electricity, which could increase dependence on non-renewable fuels. It may mean that more local generation of power is needed, to reduce dependence on the grid. Additionally, it involves making the transmission and distribution grids more reliable. But, according to Stahlkopf, little investment is being made in these areas.

CELLPHONE ‘RADAR’ TRACKS TRAFFIC FLOW

Signals from cellphone masts can be used to track aircraft, monitor traffic congestion and spot speeding motorists without tipping them off that they are being watched.

The radar-like system, which is still being developed, has provoked media reports of the start of a huge extension of Big Brother-style surveillance – privacy campaigners have complained that it could be used to track individual people. But radar experts say such fears are unfounded.

Conventional radar works by transmitting a signal, listening for the reflection and using the time taken for the round trip to work out the object’s distance. More sophisticated systems can work out the object’s speed from characteristic changes

to the signal's frequency, known as Doppler shift. But such radar systems are expensive, and the signals they send out are easy to detect.

Position finder

An alternative technique, called passive radar, gets round these problems. Instead of broadcasting its own signal, a passive radar system listens in to the cacophony of radio signals in the environment and monitors the way moving objects change them.

The US defence company Lockheed Martin is developing a system called Silent Sentry which exploits the signals from radio and television masts to spot aircraft and ships.

Better accuracy

Now two British companies, Hampshire-based Roke Manor Research and aerospace giant BAe Systems, have done the same thing with signals from cellphone masts. They say their system, known as Celldar, short for cellphone radar, can achieve better accuracy because cellphone masts are far more widespread than television and radio transmitters.

Celldar works out the position of objects in the area by comparing the signals reflected from them with those it receives directly from a base station, whose positions are known. From the Doppler shift in the signal it can also calculate the target object's speed.

Celldar has a number of advantages over conventional radar. The expensive part in most radar systems is the transmitter, because of the high power requirements. Because Manor Research is currently testing a prototype system, and says it will be two to three years before a fully operational Celldar goes on sale.

Stealthy shadows

Because the system is passive, drivers will have no way of telling whether they are being monitored. It is this characteristic that makes passive systems so attractive to the military, says David Bebbington, a radar expert at the University of Essex in Colchester, UK.

Another advantage of passive systems is their ability to spot “stealthy” and ships, which are designed to fool conventional radar systems by absorbing signals or reflecting them away from the source. To passive radar, these objects show up as shadows that can be spotted.

Civil liberties groups are concerned that the system could be adapted or combined with other technologies to produce a device for tracking people. “I can see profoundly worrying aspects to the technology,” says Simon Davies, director of Privacy International in London.

A document on Roke Manor Research’s own website has fuelled speculation that technology could be used in this way, stating that it “can detect vehicles and even human beings at militarily useful ranges”.

But Bebbington points out Celldar will be virtually useless for following individuals because its resolution is simply not good enough. And Roke Manor Research now says the information on its website will be removed.

A PRECAUTIONARY RF REPORT

The issue of the effects of cellular telephones on health took on a new urgency late this spring. The British government had formed a group of experts to evaluate possible ill effects of mobile phones and make recommendations for public policy. In May of this year, the group, chaired by Sir William Stewart, presented its report.

The “balance of evidence,” the committee concluded, is that “exposures to RF energy below (present safety limits) do not cause health effects to the general population.” But “it is not possible at present to say that exposure to RF radiation is totally without potential adverse health effects.”

That last remark could surely be said about any technology.

The report presents a number of “precautionary” recommendations: companies should avoid siting base stations near schools such that their “beam of greatest intensity” falls on school property “without agreement from the school and parents,” phone companies should be discouraged from promoting the use of

cellular phones by children, and consumers should be provided with comparative information about specific rates (SARs) of mobile telephone handsets.

The Stewart report raises a number of difficult questions. One is how to make wise use of precautionary recommendations. Just advising against the marketing of cellular phones to children gives a strong impression that a real health problem exist – contrary to the conclusions of the Stewart committee.

And now can a member of the public make effective use of the data about specific absorption rate (SARs) from mobile phones? Users can quickly become enmeshed in technical details that have no demonstrable relation to risk. There are some general principles – the RF energy from digital handsets is usually lower than from analog units, and the RF energy from PCS handsets operating near 1900 MHz reaches more superficial layers of the head than that from older cellular handsets operating at 850 MHz.

Nevertheless, the output of the most modern handset is adaptively determined by the base station. Consequently, a user's exposure to RF energy from a high-SAR phone in a region of strong base-station signal might easily be lower than from a low-SAR phone in a weak signal area.

Then what aspects of the exposure should be reduced? The peak SAR in the head or the 1-gram or 10-gram averaged SAR? Should users prefer an analog unit (which emits continuous-wave energy) with an SAR near regulatory limits, or a digital unit (which emits energy in brief pulses) whose peak SAR might exceed the average SAR from the analog unit?

Even more problematic are devices on the market that purport to reduce the user's exposure to cell phone radiation by shielding the head so as to absorb RF energy from the antenna. The effectiveness of these devices in the real world has not been demonstrated, and there is no scientific basis to claim that these devices benefit health in any way. (However, contrary to some media reports, hands-free devices that move the handset away from the user's body do reduce exposure.) The market for such devices exists because of public health concerns, and the ethics of

exploiting such concerns for commercial purposes without any basis for anticipating real health benefits is troubling.

CAMERA-TELESCOPE SETUP ISOLATES GAS LEAKS

Detecting gas leaks is important at chemical factories and pipelines, at the scenes of gas-tanker accidents, and around air inlets and outlets in indoor work areas. Geologies also like to study emissions from volcanoes or mines, and other scientists need information about the greenhouse gases emitted by farms and swamps. Jonas Sandsten and his colleagues at the Lund Institute of Techonology (Lund, Sweden) have developed a method of imaging gas leaks in real time using ambient temperatures and an infrared (IR) camera. They say this passive method is better for real-time imaging of emissions than techniques using lidar, which they consider more limited in range and imaging capabilities.

Key to the technique is use of a gas-correlation cell, which acts as filter to the stronger absorption lines of the gas it is filled with. By comparing an image taken trough the correlation cell to the same image without the cell, the researchers can verify that the gas they're looking for is in fact the gas they're seeing.

Sandsten's team set up an experiment that used a burnt-out, rusty gas tank. The measurements were made in southern Sweden in September, with mostly sunny conditions and an ambient air temperature of 18°C to 21°C. The tanker provided a background with a surface temperature of 30°C to 40°C and an emissivity of 0.9. Researchers attached tubes to the tanker, which ran to bottles containing ammonia, ethylene, and methane, to estimate gas leaks.

The detector, placed 20 m away, consisted of a Cassegrain split-mirror telescope with a total receiving area of 2x10 cm^2, two primary spherical aluminum mirrors, and a secondary spherical aluminum mirror. The IR camera had a low noise-equivalent temperature difference of 80 mK and a maximum relative spectral response at 11 µm, chosen because the gases the team was looking for have unique spectral properties in the 3-to 13-µm region. For measuring gases with absorption

around 10 m, they used zinc selenide with an antireflection coating to make the windows for the gas-correlation cell. For gases with absorption around 8 m, they used calcium fluoride.

The telescope took in two simultaneous images, one passed trough the correlation cell and one without it. The images were passed to the IR camera, equipped with interference filters on a filter wheel, which then fed them to a PC. A frame grabber allowed the PC to record real-time images at 12 bits, 272x136 pixels, and 15 frames/s. A separate charge-coupled-device camera recorded the whole scene in visible light. The computer overlaid the images and processed them to create a movie showing the gas leak. With the setup, Sandsten's team was able to detect down to 220 parts per million of ammonia when the temperature difference between the background and the gas leak was 18°C.

The researchers say that it should be possible not only to detect leaks but to measure the amount of gas escaping, although that requires knowing the temperature difference between the gas and the background. They have recently developed a new telescope that improves the sensitivity and image quality and plan to test it under varying weather conditions. A camera sensitive in the 8-to 14-µm region would make it possible to monitor several gases. "We will explore the possibility of monitoring other gases, especially hydrocarbon emissions from petrochemical factories," Sandsten said.

They even picture a detector that could be carried aboard a helicopter to monitor pipelines. The fact that the two images are captured exactly simultaneously eliminates any problems from motion of the detector.

DOES ADDING MORE RAM TO YOUR COMPUTER MAKE IT FASTER?

Up to a point, adding RAM (random access memory) will normally cause your computer to feel faster on certain types of operations. RAM is important because of an operating system component called the **virtual memory manager** (VMM).

When you run a program such as a word processor or an Internet browser, the microprocessor in your computer pulls the **executable file** off the hard disk and loads it into RAM. In the case of a big program like Microsoft Word or Excel, the EXE consumes about 5 megabytes. The microprocessor also pulls in a number of shared DLLs (dynamic link libraries) -- shared pieces of code used by multiple applications. The DLLs might total 20 or 30 megabytes. Then the microprocessor loads in the data files you want to look at, which might total several megabytes if you are looking at several documents or browsing a page with a lot of graphics. So a normal application needs between 10 and 30 megabytes of RAM space to run. On my machine, at any given time I might have the following applications running:

- A word processor
- A spreadsheet
- A DOS prompt
- An e-mail program
- A drawing program
- Three or four browser windows
- A fax program
- A Telnet session

Besides all of those applications, the operating system itself is taking up a good bit of space. Those programs together might need 100 to 150 megabytes of RAM, but my computer only has 64 megabytes of RAM installed.

The extra space is created by the virtual memory manager. The VMM looks at RAM and finds sections of RAM that are not currently needed. It puts these sections of RAM in a place called the **swap file** on the hard disk. For example, even though I have my e-mail program open, I haven't looked at e-mail in the last 45 minutes. So the VMM moves all of the bytes making up the e-mail program's EXE, DLLs and data out to the hard disk. That is called **swapping out** the program. The next time I click on the e-mail program, the VMM will **swap in** all

of its bytes from the hard disk, and probably swap something else out in the process. Because the hard disk is slow relative to RAM, the act of swapping things in and out causes a noticeable delay.

If you have a very small amount of RAM (say, 16 megabytes), then the VMM is *always* swapping things in and out to get anything done. In that case, your computer feels like it is crawling. As you add more RAM, you get to a point where you only notice the swapping when you load a new program or change windows. If you were to put 256 megabytes of RAM in your computer, the VMM would have plenty of room and you would never see it swapping anything. That is as fast as things get. If you then added more RAM, it would have no effect.

Some applications (things like Photoshop, many compilers, most film editing and animation packages) need tons of RAM to do their job. If you run them on a machine with too little RAM, they swap constantly and run very slowly. You can get a huge speed boost by adding enough RAM to eliminate the swapping. Programs like these may run 10 to 50 times faster once they have enough RAM!

HOW FLASH MEMORY WORKS

Electronic memory comes in a variety of forms to serve a variety of purposes. Flash memory is used for easy and fast information storage in such devices as digital cameras and home video game consoles. It is used more as a hard drive than as RAM. In fact, Flash memory is considered a **solid state** storage device. Solid state means that there are no moving parts -- everything is electronic instead of mechanical.

Here are a few examples of Flash memory:

- Your computer's BIOS chip
- CompactFlash (most often found in digital cameras)
- SmartMedia (most often found in digital cameras)
- Memory Stick (most often found in digital cameras)
- PCMCIA Type I and Type II memory cards (used as solid-state disks in laptops)
- Memory cards for video game consoles

In this article, we'll find out how Flash memory works and look at some of the forms it takes and types of devices that use it.

Flash Memory Basics

We discussed the underlying technology of Flash memory in How ROM Works, but here's a quick review:

Flash memory is a type of **EEPROM** chip. It has a grid of columns and rows with a cell that has two transistors at each intersection.

The two transistors are separated from each other by a thin oxide layer. One of the transistors is known as a **floating gate**, and the other one is the **control gate**. The floating gate's only link to the row, or **wordline**, is through the control gate. As long as this link is in place, the cell has a value of 1. To change the value to a 0 requires a curious process called **Fowler-Nordheim tunneling**. Next, we'll talk about tunneling.

HOW DO THE SHOPLIFTING PREVENTION SYSTEMS IN STORES WORK?

There's a lot of methods retailers use for **loss prevention**. A very popular method is to use a system that attaches special **tags** onto everything so that an alarm goes off whenever a shoplifter tries to walk out with an item.

These tag-and-alarm systems, better known as **electronic article surveillance (EAS)** systems, identify articles as they pass through a gated area in a store. This identification is used to alert someone that unauthorized removal of items is being attempted. Using an EAS system enables the retailer to display popular items on the floor, where they can be seen, rather than putting them in locked cases or behind the counter.

The type of EAS system dictates how wide the exit/entrance aisle may be, and the physics of a particular EAS tag and technology determines which frequency range is used to create a surveillance area. EAS systems range from very low frequencies through the radio frequency range (see How Radio Scanners Work). These EAS systems operate on different principles, are not compatible and have specific benefits and disadvantages.

Three types of EAS systems dominate the retail industry:

- **Radio Frequency (RF) Systems** are the most widely used systems in the United States today and RF tags and labels are getting smaller all the time. A label that contains a miniature, disposable **electronic circuit** and **antenna** is attached to a product. The label responds to a specific frequency emitted by a transmitter antenna (usually one pedestal of the entry/exit gate). The response from the label is then picked up by an adjacent receiver antenna (the other pedestal). This processes the label response signal and will trigger an alarm when it matches specific criteria. The distance between the two gates, or pedestals, can be up to 80 inches wide. Operating frequencies for RF systems generally range from 2 to 10 MHz (millions of cycles per second); this has become standard in many countries. Most of the time, RF systems use a **frequency sweep** technique in order to deal with different label frequencies.
- The **Electromagnetic (EM) system**, which is dominant in Europe, is used by many retail chain stores, supermarkets and libraries around the world. In this technology, a magnetic, iron-containing strip with an adhesive

layer is attached to the merchandise. This strip is not removed at checkout -- it's simply deactivated by a scanner that uses a specific highly intense magnetic field. One of the advantages of the EM strip is that it can be reactivated and used at a low cost. What most people refer to as an electromagnetic tag is actually a metal wire or ribbon that has high **permeability**, making it easy for magnetic signals to flow through it. A magnetized piece of semi-hard magnetic material (basically, a weak magnet) is put up next to the active material to deactivate it. When you magnetize the semi-hard material, it saturates the tag and puts it in its inactive saturated state.

The EM system works by applying intensive low frequency magnetic fields generated by the transmitter antenna. When the strip passes through the gate, it will transmit a unique frequency pattern. This pattern is, in turn, being picked up by an adjacent receiver antenna. The small signal is processed and will trigger the alarm when the specific pattern is recognized. Because of the weak response of the strip, the low frequency (typically between 70 Hz and 1 kHz) and intensive field required by the EM system, EM antennas are larger than those used by most other EAS systems. The maximum distance between entry pedestals is 40 inches. Also, because of the low frequency here, the strips can be directly attached to metal surfaces. That's why EM systems are popular with hardware, book and record stores. (Check out the patent for more details!)

- Another magnetic technology is the **acousto-magnetic system**, which has the ability to protect wide exits and allows for high-speed label application. It uses a transmitter to create a surveillance area where tags and labels are detected. The transmitter sends a radio frequency signal (of about 58 kHz) in pulses, which energize a tag in the surveillance zone. When the pulse ends, the tag responds, emitting a single frequency signal like a tuning fork. While the transmitter is off between pulses, the tag

signal is detected by a receiver. A microcomputer checks the tag signal detected by the receiver to ensure it is at the right frequency, is time-synchronized to the transmitter, and that it is at the proper level and the correct repetition rate. If all these criteria are met, the alarm occurs.

In each case, an EAS tag or label is attached to an item. The tag is then **deactivated**, or taken from an active state where it will alarm an EAS system to an inactive state where it will not flag the alarm. The disposable tag is deactivated by swiping it over a pad or with a handheld scanner that "tells" the tag it's been authorized to leave the store. If the item has not been deactivated or detached by the clerk, when it is carried through the gates, an alarm will sound.

The use of EAS systems does not completely eliminate shoplifting. However, experts say, theft can be reduced by 60 percent or more when a reliable system is used. Be sure to read How Anti-Shoplifting Devices Work for more in-depth information on this subject.

SPEECH TO DATA

To convert speech to on-screen text or a computer command, a computer has to go through several complex steps. When you speak, you create vibrations in the air. The **analog-to-digital converter (ADC)** translates this analog wave into digital data that the computer can understand. To do this, it **samples**, or digitizes, the sound by taking precise measurements of the wave at frequent intervals. The system filters the digitized sound to remove unwanted noise, and sometimes to separate it into different bands of **frequency** (frequency is the wavelength of the sound waves, heard by humans as differences in pitch). It also normalizes the sound, or adjusts it to a constant volume level. It may also have to be temporally aligned. People don't always speak at the same speed, so the sound must be adjusted to match the speed of the template sound samples already stored in the system's memory.

Next the signal is divided into small segments as short as a few hundredths of a second, or even thousandths in the case of **plosive consonant sounds** -- consonant stops produced by obstructing airflow in the vocal tract -- like "p" or "t." The program then matches these segments to known **phonemes** in the appropriate language. A phoneme is the smallest element of a language -- a representation of the sounds we make and put together to form meaningful expressions. There are roughly 40 phonemes in the English language (different linguists have different opinions on the exact number), while other languages have more or fewer phonemes.

The next step seems simple, but it is actually the most difficult to accomplish and is the is focus of most speech recognition research. The program examines phonemes in the context of the other phonemes around them. It runs the contextual phoneme plot through a complex statistical model and compares them to a large library of known words, phrases and sentences. The program then determines what the user was probably saying and either outputs it as text or issues a computer command.

SPEECH RECOGNITION AND STATISTICAL MODELING

Early speech recognition systems tried to apply a set of grammatical and syntactical rules to speech. If the words spoken fit into a certain set of rules, the program could determine what the words were. However, human language has numerous exceptions to its own rules, even when it's spoken consistently. Accents, dialects and mannerisms can vastly change the way certain words or phrases are spoken. Imagine someone from Boston saying the word "barn." He wouldn't pronounce the "r" at all, and the word comes out rhyming with "John." Or consider the sentence, "I'm going to see the ocean." Most people don't enunciate their words very carefully. The result might come out as "I'm goin' da see tha ocean." They run several of the words together with no noticeable break, such as "I'm goin'" and "the

ocean." Rules-based systems were unsuccessful because they couldn't handle these variations. This also explains why earlier systems could not handle continuous speech -- you had to speak each word separately, with a brief pause in between them.

Today's speech recognition systems use powerful and complicated **statistical modeling systems**. These systems use probability and mathematical functions to determine the most likely outcome. According to John Garofolo, Speech Group Manager at the Information Technology Laboratory of the National Institute of Standards and Technology, the two models that dominate the field today are the Hidden Markov Model and neural networks. These methods involve complex mathematical functions, but essentially, they take the information known to the system to figure out the information hidden from it.

The Hidden Markov Model is the most common, so we'll take a closer look at that process. In this model, each phoneme is like a link in a chain, and the completed chain is a word. However, the chain branches off in different directions as the program attempts to match the digital sound with the phoneme that's most likely to come next. During this process, the program assigns a probability score to each phoneme, based on its built-in dictionary and user training.

This process is even more complicated for phrases and sentences -- the system has to figure out where each word stops and starts. The classic example is the phrase "recognize speech," which sounds a lot like "wreck a nice beach" when you say it very quickly. The program has to analyze the phonemes using the phrase that came before it in order to get it right. Why is this so complicated? If a program has a vocabulary of 60,000 words (common in today's programs), a sequence of three words could be any of 216 trillion possibilities. Obviously, even the most powerful computer can't search through all of them without some help.

That help comes in the form of program training. According to John Garofolo:

These statistical systems need lots of exemplary training data to reach their optimal performance -- sometimes on the order of thousands of hours of human-transcribed speech and hundreds of megabytes of text. These training data are used to create acoustic models of words, word lists, and [...] multi-word probability networks. There is some art into how one selects, compiles and prepares this training data for "digestion" by the system and how the system models are "tuned" to a particular application. These details can make the difference between a well-performing system and a poorly-performing system -- even when using the same basic algorithm.

While the software developers who set up the system's initial vocabulary perform much of this training, the end user must also spend some time training it. In a business setting, the primary users of the program must spend some time (sometimes as little as 10 minutes) speaking into the system to train it on their particular speech patterns. They must also train the system to recognize terms and acronyms particular to the company. Special editions of speech recognition programs for medical or legal offices have terms commonly used in those fields already trained into them.

THE FUTURE OF SPEECH RECOGNITION

The first developments in speech recognition predate the invention of the modern computer by more than 50 years. Alexander Graham Bell was inspired to experiment in transmitting speech by his wife, who was deaf. He initially hoped to create a device that would transform audible words into a visible picture that a deaf person could interpret. He did produce spectrographic images of sounds, but his wife was unable to decipher them. That line of research eventually led to his invention of the telephone.

For several decades, scientists developed experimental methods of computerized speech recognition, but the computing power available at the time

limited them. Only in the 1990s did computers powerful enough to handle speech recognition become available to the average consumer. Current research could lead to technologies that are currently more familiar in an episode of "Star Trek." The Defense Advanced Research Projects Agency (DARPA) has three teams of researchers working on Global Autonomous Language Exploitation (GALE), a program that will take in streams of information from foreign news broadcasts and newspapers and translate them. It hopes to create software that can instantly translate two languages with at least 90 percent accuracy. "DARPA is also funding an R&D effort called TRANSTAC to enable our soldiers to communicate more effectively with civilian populations in non-English-speaking countries," said Garofolo, adding that the technology will undoubtedly spin off into civilian applications, including a universal translator.

A universal translator is still far into the future, however -- it's very difficult to build a system that combines automatic translation with voice activation technology. According to a recent CNN article, the GALE project is "'DARPA hard' [meaning] difficult even by the extreme standards" of DARPA. Why? One problem is making a system that can flawlessly handle roadblocks like slang, dialects, accents and background noise. The different grammatical structures used by languages can also pose a problem. For example, Arabic sometimes uses single words to convey ideas that are entire sentences in English.

At some point in the future, speech recognition may become speech understanding. The statistical models that allow computers to decide what a person just said may someday allow them to grasp the meaning behind the words. Although it is a huge leap in terms of computational power and software sophistication, some researchers argue that speech recognition development offers the most direct line from the computers of today to true artificial intelligence. We can talk to our computers today. In 25 years, they may very well talk back.

WHY IS A CELL PHONE CALLED A “CELL” PHONE?

One of the most interesting things about a cell phone is that it is really a radio. Before cell phones, people who needed mobile communications ability installed **radio telephones** in their cars. In the radio telephone system, there was one central antenna tower per city, and perhaps 25 channels available on that tower. The cellular phone system divides the area of a city into small **cells**. This allows extensive **frequency reuse** across a city, so that millions of people can use cell phones simultaneously.

Here's how it works: The carrier chops up an area, such as a city, into cells. Each cell is typically sized at about 10 square miles (perhaps 3 miles x 3 miles). Cells are normally thought of as hexagons on a big hexagonal grid. Each cell has a **base station** that consists of a tower and a small building containing the radio equipment. Cell phones have low-power transmitters in them and the base station is also transmitting at low power. Low-power transmitters have two advantages:

- The power consumption of the cell phone, which is normally battery-operated, is relatively low. Low power means small batteries, and this is what has made handheld cellular phones possible.
- The transmissions of a base station and the phones within its cell do not make it very far outside that cell. Therefore, cells can use the same 56 frequencies. The same frequencies can be reused extensively across the city.

The cellular approach requires a large number of base stations in a city of any size. A typical large city can have hundreds of towers. But because so many people are using cell phones, costs remain fairly low per user. Each carrier in each city also runs one central office called the **Mobile Telephone Switching Office**

(MTSO). This office handles all of the phone connections to the normal land-based phone system, and controls all of the base stations in the region.

As you move toward the edge of your cell, your cell's base station will note that your signal strength is diminishing. Meanwhile, the base station in the cell you are moving toward (which is listening and measuring signal strength on all frequencies, not just its own one-seventh) will be able to see your phone's signal strength increasing. The two base stations coordinate themselves through the MTSO, and at some point, your phone gets a signal on a control channel telling it to change frequencies. This **hand off** switches your phone to the new cell.

Millions of people in the United States and around the world use **cellular phones**. They are such great gadgets -- with a cell phone, you can talk to anyone on the planet from just about anywhere!

These days, cell phones provide an incredible array of functions, and new ones are being added at a breakneck pace. Depending on the cell-phone model, you can:

- Store contact information
- Make task or to-do lists
- Keep track of appointments and set reminders
- Use the built-in calculator for simple math
- Send or receive e-mail
- Get information (news, entertainment, stock quotes) from the Internet
- Play games
- Watch TV
- Send text messages
- Integrate other devices such as PDAs, MP3 players and GPS receivers

Your Browser Does Not Support iFrames

But have you ever wondered how a cell phone works? What makes it different from a regular phone? What do all those terms like PCS, GSM, CDMA and TDMA mean? In this article, we will discuss the technology behind cell phones so

that you can see how amazing they really are. If you are thinking about buying a cell phone, be sure to check out **How Buying a Cell Phone Works** to learn what you should know before making a purchase.

To start with, one of the most interesting things about a cell phone is that it is actually a radio -- an extremely sophisticated radio, but a radio nonetheless. The telephone was invented by Alexander Graham Bell in 1876, and wireless communication can trace its roots to the invention of the radio by Nikolai Tesla in the 1880s (formally presented in 1894 by a young Italian named Guglielmo Marconi). It was only natural that these two great technologies would eventually be combined.

The first thing you probably think of when you see the words **night vision** is a spy or action movie you've seen, in which someone straps on a pair of night-vision goggles to find someone else in a dark building on a moonless night. And you may have wondered "Do those things really work? Can you actually see in the dark?"

The answer is most definitely yes. With the proper night-vision equipment, you can see a person standing over 200 yards (183 m) away on a moonless, cloudy night! Night vision can work in two very different ways, depending on the technology used.

- **Image enhancement** - This works by collecting the tiny amounts of light, including the lower portion of the infrared light spectrum, that are present but may be imperceptible to our eyes, and amplifying it to the point that we can easily observe the image.
- **Thermal imaging** - This technology operates by capturing the upper portion of the infrared light spectrum, which is emitted as heat by objects instead of simply reflected as light. Hotter objects, such as warm bodies, emit more of this light than cooler objects like trees or buildings.

In this article, you will learn about the two major night-vision technologies. We'll also discuss the various types of night-vision equipment and applications. But first, let's talk about infrared light.

Infrared Light

In order to understand night vision, it is important to understand something about light. The amount of energy in a light wave is related to its wavelength: Shorter wavelengths have higher energy. Of visible light, violet has the most energy, and red has the least. Just next to the visible light spectrum is the **infrared** spectrum.

Infrared light can be split into three categories:

- **Near-infrared** (near-IR) - Closest to visible light, near-IR has wavelengths that range from 0.7 to 1.3 **microns**, or 700 billionths to 1,300 billionths of a meter.
- **Mid-infrared** (mid-IR) - Mid-IR has wavelengths ranging from 1.3 to 3 microns. Both near-IR and mid-IR are used by a variety of electronic devices, including remote controls.
- **Thermal-infrared** (thermal-IR) - Occupying the largest part of the infrared spectrum, thermal-IR has wavelengths ranging from 3 microns to over 30 microns.

The key difference between thermal-IR and the other two is that thermal-IR is **emitted** by an object instead of reflected off it. Infrared light is emitted by an object because of what is happening at the **atomic** level.

Atoms

Atoms are constantly in motion. They continuously vibrate, move and rotate. Even the atoms that make up the chairs that we sit in are moving around. Solids are actually in motion! Atoms can be in different states of **excitation**. In other words, they can have different energies. If we apply a lot of energy to an atom, it can leave

what is called the **ground-state energy level** and move to an **excited level**. The level of excitation depends on the amount of energy applied to the atom via heat, light or electricity.

An atom consists of a **nucleus** (containing the **protons** and **neutrons**) and an **electron cloud**. Think of the electrons in this cloud as circling the nucleus in many different **orbits**. Although more modern views of the atom do not depict discrete orbits for the electrons, it can be useful to think of these orbits as the different energy levels of the atom. In other words, if we apply some heat to an atom, we might expect that some of the electrons in the lower energy orbitals would transition to higher energy orbitals, moving farther from the nucleus.

Once an electron moves to a higher-energy orbit, it eventually wants to return to the ground state. When it does, it releases its energy as a **photon** -- a particle of light. You see atoms releasing energy as photons all the time. For example, when the heating element in a toaster turns bright red, the red color is caused by atoms excited by heat, releasing red photons. An excited electron has more energy than a relaxed electron, and just as the electron absorbed some amount of energy to reach this excited level, it can release this energy to return to the ground state. This emitted energy is in the form of photons (light energy). The photon emitted has a very specific wavelength (color) that depends on the state of the electron's energy when the photon is released.

Anything that is alive uses energy, and so do many inanimate items such as engines and rockets. Energy consumption generates heat. In turn, heat causes the atoms in an object to fire off photons in the thermal-infrared spectrum. The hotter the object, the shorter the wavelength of the infrared photon it releases. An object that is very hot will even begin to emit photons in the visible spectrum, glowing red and then moving up through orange, yellow, blue and eventually white. Be sure to read How Light Bulbs Work, How Lasers Work and How Light Works for more detailed information on light and photon emission.

Thermal Imaging

Here's how thermal imaging works:

1. A special lens focuses the infrared light emitted by all of the objects in view.
2. The focused light is scanned by a phased array of infrared-detector elements. The detector elements create a very detailed temperature pattern called a **thermogram**. It only takes about one-thirtieth of a second for the detector array to obtain the temperature information to make the thermogram. This information is obtained from several thousand points in the field of view of the detector array.
3. The thermogram created by the detector elements is translated into electric impulses.
4. The impulses are sent to a signal-processing unit, a circuit board with a dedicated chip that translates the information from the elements into data for the display.
5. The signal-processing unit sends the information to the display, where it appears as various colors depending on the intensity of the infrared emission. The combination of all the impulses from all of the elements creates the image.

Types of Thermal Imaging Devices

Most thermal-imaging devices scan at a rate of 30 times per second. They can sense temperatures ranging from -4 degrees Fahrenheit (-20 degrees Celsius) to 3,600°F (2,000°C), and can normally detect changes in temperature of about 0.4°F (0.2°C).

There are two common types of thermal-imaging devices:

- **Un-cooled** - This is the most common type of thermal-imaging device. The infrared-detector elements are contained in a unit that operates at room temperature. This type of system is completely quiet, activates immediately and has the battery built right in.

- **Cryogenically cooled** - More expensive and more susceptible to damage from rugged use, these systems have the elements sealed inside a container that cools them to below 32°F (zero C). The advantage of such a system is the incredible resolution and sensitivity that result from cooling the elements. Cryogenically-cooled systems can "see" a difference as small as 0.2°F (0.1°C) from more than 1,000 ft (300 m) away, which is enough to tell if a person is holding a gun at that distance!

Image Enhancement

Image-enhancement technology is what most people think of when you talk about night vision. In fact, image-enhancement systems are normally called **night-vision devices** (NVDs). NVDs rely on a special tube, called an **image-intensifier tube**, to collect and amplify infrared and visible light.

Here's how image enhancement works:

1. A conventional lens, called the **objective lens**, captures ambient light and some near-infrared light.
2. The gathered light is sent to the image-intensifier tube. In most NVDs, the power supply for the image-intensifier tube receives power from two N-Cell or two "AA" batteries. The tube outputs a high voltage, about 5,000 volts, to the image-tube components.
3. The image-intensifier tube has a **photocathode**, which is used to convert the photons of light energy into electrons.
4. As the electrons pass through the tube, similar electrons are released from atoms in the tube, multiplying the original number of electrons by a factor of thousands through the use of a **microchannel plate** (MCP) in the tube. An MCP is a tiny glass disc that has millions of microscopic holes (microchannels) in it, made using fiber-optic technology. The MCP is contained in a vacuum and has metal electrodes on either side of the disc. Each channel is about 45 times longer than it is wide, and it works as an electron multiplier.

When the electrons from the photo cathode hit the first electrode of the MCP, they are accelerated into the glass microchannels by the 5,000-V bursts being sent between the electrode pair. As electrons pass through the microchannels, they cause thousands of other electrons to be released in each channel using a process called **cascaded secondary emission**. Basically, the original electrons collide with the side of the channel, exciting atoms and causing other electrons to be released. These new electrons also collide with other atoms, creating a chain reaction that results in thousands of electrons leaving the channel where only a few entered. An interesting fact is that the microchannels in the MCP are created at a slight angle (about a 5-degree to 8-degree bias) to encourage electron collisions and reduce both ion and direct-light feedback from the phosphors on the output side.

5. At the end of the image-intensifier tube, the electrons hit a screen coated with phosphors. These electrons maintain their position in relation to the channel they passed through, which provides a perfect image since the electrons stay in the same alignment as the original photons. The energy of the electrons causes the phosphors to reach an excited state and release photons. These phosphors create the green image on the screen that has come to characterize night vision.
6. The green phosphor image is viewed through another lens, called the **ocular lens**, which allows you to magnify and focus the image. The NVD may be connected to an electronic display, such as a monitor, or the image may be viewed directly through the ocular lens.

Generations

NVDs have been around for more than 40 years. They are categorized by **generation**. Each substantial change in NVD technology establishes a new generation.

- **Generation 0** - The original night-vision system created by the United States Army and used in World War II and the Korean War, these NVDs use **active infrared**. This means that a projection unit, called an **IR Illuminator**, is attached to the NVD. The unit projects a beam of near-infrared light, similar to the beam of a normal flashlight. Invisible to the naked eye, this beam reflects off objects and bounces back to the lens of the NVD. These systems use an anode in conjunction with the cathode to accelerate the electrons. The problem with that approach is that the acceleration of the electrons distorts the image and greatly decreases the life of the tube. Another major problem with this technology in its original military use was that it was quickly duplicated by hostile nations, which allowed enemy soldiers to use their own NVDs to see the infrared beam projected by the device.
- **Generation 1** - The next generation of NVDs moved away from active infrared, using **passive infrared** instead. Once dubbed **Starlight** by the U.S. Army, these NVDs use ambient light provided by the moon and stars to augment the normal amounts of reflected infrared in the environment. This means that they did not require a source of projected infrared light. This also means that they do not work very well on cloudy or moonless nights. Generation-1 NVDs use the same image-intensifier tube technology as Generation 0, with both cathode and anode, so image distortion and short tube life are still a problem.
- **Generation 2** - Major improvements in image-intensifier tubes resulted in Generation-2 NVDs. They offer improved resolution and performance over Generation-1 devices, and are considerably more reliable. The biggest gain in Generation 2 is the ability to see in extremely low light conditions, such as a moonless night. This increased sensitivity is due to the addition of the microchannel plate to the image-intensifier tube. Since the MCP actually increases the number of electrons instead of just

accelerating the original ones, the images are significantly less distorted and brighter than earlier-generation NVDs.

- **Generation 3** - Generation 3 is currently used by the U.S. military. While there are no substantial changes in the underlying technology from Generation 2, these NVDs have even better resolution and sensitivity. This is because the photo cathode is made using **gallium arsenide**, which is very efficient at converting photons to electrons. Additionally, the MCP is coated with an ion barrier, which dramatically increases the life of the tube.
- **Generation 4** - What is generally known as Generation 4 or "filmless and gated" technology shows significant overall improvement in both low- and high-level light environments.

  The removal of the ion barrier from the MCP that was added in Generation 3 technology reduces the background noise and thereby enhances the signal to noise ratio. Removing the ion film actually allows more electrons to reach the amplification stage so that the images are significantly less distorted and brighter.

  The addition of an automatic gated power supply system allows the photocathode voltage to switch on and off rapidly, thereby enabling the NVD to respond to a fluctuation in lighting conditions in an instant. This capability is a critical advance in NVD systems, in that it allows the NVD user to quickly move from high-light to low-light (or from low-light to high-light) environments without any halting effects. For example, consider the ubiquitous movie scene where an agent using night vision goggles is “sightless” when someone turns on a light nearby. With the new, gated power feature, the change in lighting wouldn’t have the same impact; the improved NVD would respond immediately to the lighting change.

Many of the so-called "bargain" night-vision scopes use Generation-0 or Generation-1 technology, and may be disappointing if you expect the sensitivity of the devices used by professionals. Generation-2, Generation-3 and Generation 4 NVDs are typically expensive to purchase, but they will last if properly cared for. Also, any NVD can benefit from the use of an IR Illuminator in very dark areas where there is almost no ambient light to collect.

A cool thing to note is that every single image-intensifier tube is put through rigorous tests to see if it meets the requirements set forth by the military. Tubes that do are classified as **MILSPEC**. Tubes that fail to meet military requirements in even a single category are classified as **COMSPEC**.

Night Vision Equipment and Applications

Night-vision equipment can be split into three broad categories:

- **Scopes** - Normally handheld or mounted on a weapon, scopes are **monocular** (one eye-piece). Since scopes are handheld, not worn like goggles, they are good for when you want to get a better look at a specific object and then return to normal viewing conditions.
- **Goggles** - While goggles can be handheld, they are most often worn on the head. Goggles are **binocular** (two eye-pieces) and may have a single lens or stereo lens, depending on the model. Goggles are excellent for constant viewing, such as moving around in a dark building.
- **Cameras** - Cameras with night-vision technology can send the image to a monitor for display or to a VCR for recording. When night-vision capability is desired in a permanent location, such as on a building or as part of the equipment in a helicopter, cameras are used. Many of the newer camcorders have night vision built right in.

Applications

Common applications for night vision include:

- Military

- Law enforcement
- Hunting
- Wildlife observation
- Surveillance
- Security
- Navigation
- Hidden-object detection
- Entertainment

The original purpose of night vision was to locate enemy targets at night. It is still used extensively by the military for that purpose, as well as for navigation, surveillance and targeting. Police and security often use both thermal-imaging and image-enhancement technology, particularly for surveillance. Hunters and nature enthusiasts use NVDs to maneuver through the woods at night.

Detectives and private investigators use night vision to watch people they are assigned to track. Many businesses have permanently-mounted cameras equipped with night vision to monitor the surroundings.

A really amazing ability of thermal imaging is that it reveals whether an area has been disturbed -- it can show that the ground has been dug up to bury something, even if there is no obvious sign to the naked eye. Law enforcement has used this to discover items that have been hidden by criminals, including money, drugs and bodies. Also, recent changes to areas such as walls can be seen using thermal imaging, which has provided important clues in several cases.

Many people are beginning to discover the unique world that can be found after darkness falls. If you're out camping or hunting a lot, chances are that night-vision devices can be useful to you -- just be sure to get the right type for your needs.

If you have been using the Internet for any length of time, and especially if you work at a larger company and browse the Web while you are at work, you have probably heard the term **firewall** used. For example, you often hear people in

companies say things like, "I can't use that site because they won't let it through the firewall."

If you have a fast Internet connection into your home (either a DSL connection or a cable modem), you may have found yourself hearing about firewalls for your home network as well. It turns out that a small home network has many of the same security issues that a large corporate network does. You can use a firewall to protect your home network and family from offensive Web sites and potential hackers.

Basically, a firewall is a barrier to keep destructive forces away from your property. In fact, that's why its called a firewall. Its job is similar to a physical firewall that keeps a fire from spreading from one area to the next. As you read through this article, you will learn more about firewalls, how they work and what kinds of threats they can protect you from.

What is the Year 2038 problem?

The Year 2000 problem is understood by most people these days because of the large amount of media attention it received.

Most programs written in the C programming language are relatively immune to the Y2K problem, but suffer instead from the **Year 2038 problem**. This problem arises because most C programs use a library of routines called the **standard time library** . This library establishes a standard 4-byte format for the storage of time values, and also provides a number of functions for converting, displaying and calculating time values.

The **standard 4-byte format** assumes that the beginning of time is January 1, 1970, at 12:00:00 a.m. This value is 0. Any time/date value is expressed as the number of seconds following that zero value. So the value 919642718 is 919,642,718 seconds past 12:00:00 a.m. on January 1, 1970, which is Sunday, February 21, 1999, at 16:18:38 Pacific time (U.S.). This is a convenient format because if you subtract any two values, what you get is a number of seconds that is

the time difference between them. Then you can use other functions in the library to determine how many minutes/hours/days/months/years have passed between the two times.

If you have read How Bits and Bytes Work, you know that a signed 4-byte integer has a maximum value of 2,147,483,647, and this is where the Year 2038 problem comes from. The **maximum value of time** before it rolls over to a negative (and invalid) value is 2,147,483,647, which translates into January 19, 2038. On this date, any C programs that use the standard time library will start to have problems with date calculations.

This problem is somewhat easier to fix than the Y2K problem on mainframes, fortunately. Well-written programs can simply be recompiled with a new version of the library that uses, for example, 8-byte values for the storage format. This is possible because the library encapsulates the whole time activity with its own time types and functions (unlike most mainframe programs, which did not standardize their date formats or calculations). So the Year 2038 problem should not be nearly as hard to fix as the Y2K problem was.

What's the problem with Microsoft Word?

January 27, 2007

In the last two months alone, at least four major security flaws involving Microsoft Word have come to light. All are **"zero day" flaws**, meaning Microsoft and security organizations became aware of them at the same time that destructive hackers became aware of them. In many "zero day" cases, it's the exploitation of the flaw that brings it to the attention of the software companies; in other cases, the software companies announce the flaw and hackers immediately take advantage of it before a patch can be released. The strange thing about the latest Word problems is that almost eight weeks after the first one hit the news because it was exploited by attackers, Microsoft still hasn't released a patch to fix it.

The first in this string of security holes popped up in early December. This flaw affects computers running Word 2000, 2002 and 2003; Word 2004 for Mac and Word 2004 version X for Mac; Word Viewer 2003; and Microsoft Works 2004, 2005 and 2006. An attacker hides a piece of code in a Word document and puts it on a Web site for download or sends it out as an e-mail attachment. When a user downloads or opens the document, the attacker can remotely control the user's computer and execute a wide array of codes under the user's own login. This flaw came to Microsoft's attention on December 5, 2006, when people started reporting attacks.

A second, previously unknown flaw started to draw attention just a week later, this one also allowing a remote attacker to take control of a user's PC. According to Microsoft, though, this flaw exploits a entirely different security hole -- one that opens when Word undergoes a specific error. Apparently, this attack doesn't require a user to download a malicious file; it only requires the Word program on the person's computer to experience this error, at which point an attacker can enter the system and run malicious code. It affects Word 2000, 2002 and 2003 and Word Viewer 2003.

Security experts have attributed these two security holes to **memory-corruption flaws** in the Word programs. Days later, a third flaw was revealed. This one also allows for remote access and control of a user's machine and has been tied to a **buffer-overflow** problem in Word. It came to public attention when a software expert called "Disco Johnny" published a proof-of-concept code on the Web that showed how a malicious hacker could exploit it, essentially providing instructions for running an attack in addition to showing Microsoft it has yet another problem. And about five weeks later, on January 25, a fourth security hole became the subject of a malicious attack that begins when a user opens a rigged Word file sent as an e-mail attachment and has similar results to the previous attacks: Remote access and control of an entire system if it's running Word 2000. If

the computer is running Word 2003 or Word XP, it only crashes the computer, as opposed to opening it up to remote control.

These four issues are only the latest in a series of attacks exploiting previously undiscovered flaws in a wide array of Microsoft Office applications. In September 2006, hackers started exploiting another zero-day Word flaw, this one only affecting Word 2000. A user had to open an infected Word 2000 document using the Word 2000 program in order for the virus, MDropper.Q, to drop a piece of code in the user's PC. This allowed a remote attacker to take control of the infected PC. Security sources report that this flaw still has not been patched, almost five months later. Microsoft has, however, patched several of the flaws involving other Office programs, including security holes in versions of PowerPoint and Excel.

Since no security patches have been released for the Word flaws, Microsoft recommends installing multiple layers of security software and updating the versions vigilantly. Beyond that, we can only use the wariness we've become accustomed to when opening attachments or downloading files, with an extension into a traditionally safer area: Now, if it ends with .doc, don't touch it unless you know and trust the source.

Feature Articles

Why Software Fails

We waste billions of dollars each year on entirely preventable mistakes

Have you heard the one about the disappearing warehouse? One day, it vanished—not from physical view, but from the watchful eyes of a well-known retailer's automated distribution system. A software glitch had somehow erased the warehouse's existence, so that goods destined for the warehouse were rerouted elsewhere, while goods at the warehouse languished. Because the company was in financial trouble and had been shuttering other warehouses to save money, the employees at the "missing" warehouse kept quiet. For three years, nothing arrived or left. Employees were still getting their paychecks, however, because a different computer system handled the payroll. When the software glitch finally came to

light, the merchandise in the warehouse was sold off, and upper management told employees to say nothing about the episode.

This story has been floating around the information technology industry for 20-some years. It's probably apocryphal, but for those of us in the business, it's entirely plausible. Why? Because episodes like this happen all the time. Last October, for instance, the giant British food retailer J Sainsbury PLC had to write off its US $526 million investment in an automated supply-chain management system. It seems that merchandise was stuck in the company's depots and warehouses and was not getting through to many of its stores. Sainsbury was forced to hire about 3000 additional clerks to stock its shelves manually [see photo, "Market Crash"] This is only one of the latest in a long, dismal history of IT projects gone awry [see table, "Software Hall of Shame" for other notable fiascoes]. Most IT experts agree that such failures occur far more often than they should. What's more, the failures are universally unprejudiced: they happen in every country; to large companies and small; in commercial, nonprofit, and governmental organizations; and without regard to status or reputation. The business and societal costs of these failures—in terms of wasted taxpayer and shareholder dollars as well as investments that can't be made—are now well into the billions of dollars a year.

The problem only gets worse as IT grows ubiquitous. This year, organizations and governments will spend an estimated $1 trillion on IT hardware, software, and services worldwide. Of the IT projects that are initiated, from 5 to 15 percent will be abandoned before or shortly after delivery as hopelessly inadequate. Many others will arrive late and over budget or require massive reworking. Few IT projects, in other words, truly succeed. The biggest tragedy is that software failure is for the most part predictable and avoidable. Unfortunately, most organizations don't see preventing failure as an urgent matter, even though that view risks harming the organization and maybe even destroying it. Understanding why this attitude persists is not just an academic exercise; it has tremendous implications for business and society.

SOFTWARE IS EVERYWHERE. It's what lets us get cash from an ATM, make a phone call, and drive our cars. A typical cellphone now contains 2 million lines of software code; by 2010 it will likely have 10 times as many. General Motors Corp. estimates that by then its cars will each have 100 million lines of code.

The average company spends about 4 to 5 percent of revenue on information technology, with those that are highly IT dependent—such as financial and telecommunications companies—spending more than 10 percent on it. In other words, IT is now one of the largest corporate expenses outside employee costs. Much of that money goes into hardware and software upgrades, software license fees, and so forth, but a big chunk is for new software projects meant to create a better future for the organization and its customers. Governments, too, are big consumers of software. In 2003, the United Kingdom had more than 100 major government IT projects under way that totaled $20.3 billion. In 2004, the U.S. government cataloged 1200 civilian IT projects costing more than $60 billion, plus another $16 billion for military software. Any one of these projects can cost over $1 billion. To take two current examples, the computer modernization effort at the U.S. Department of Veterans Affairs is projected to run $3.5 billion, while automating the health records of the UK's National Health Service is likely to cost more than $14.3 billion for development and another $50.8 billion for deployment. Such megasoftware projects, once rare, are now much more common, as smaller IT operations are joined into "systems of systems." Air traffic control is a prime example, because it relies on connections among dozens of networks that provide communications, weather, navigation, and other data. But the trick of integration has stymied many an IT developer, to the point where academic researchers increasingly believe that computer science itself may need to be rethought in light of these massively complex systems. When a project fails, it jeopardizes an organization's prospects. If the failure is large enough, it can steal the company's entire future. In one stellar meltdown, a poorly implemented resource planning

system led FoxMeyer Drug Co., a $5 billion wholesale drug distribution company in Carrollton, Texas, to plummet into bankruptcy in 1996.

IT failure in government can imperil national security, as the FBI's Virtual Case File debacle has shown. The $170 million VCF system, a searchable database intended to allow agents to "connect the dots" and follow up on disparate pieces of intelligence, instead ended five months ago without any system's being deployed [see "Who Killed the Virtual Case File?" in this issue].

IT failures can also stunt economic growth and quality of life. Back in 1981, the U.S. Federal Aviation Administration began looking into upgrading its antiquated air-traffic-control system, but the effort to build a replacement soon became riddled with problems [see photo, "Air Jam"]. By 1994, when the agency finally gave up on the project, the predicted cost had tripled, more than $2.6 billion had been spent, and the expected delivery date had slipped by several years. Every airplane passenger who is delayed because of gridlocked skyways still feels this cancellation; the cumulative economic impact of all those delays on just the U.S. airlines (never mind the passengers) approaches $50 billion.

Worldwide, it's hard to say how many software projects fail or how much money is wasted as a result. If you define failure as the total abandonment of a project before or shortly after it is delivered, and if you accept a conservative failure rate of 5 percent, then billions of dollars are wasted each year on bad software.

For example, in 2004, the U.S. government spent $60 billion on software (not counting the embedded software in weapons systems); a 5 percent failure rate means $3 billion was probably wasted. However, after several decades as an IT consultant, I am convinced that the failure rate is 15 to 20 percent for projects that have budgets of $10 million or more. Looking at the total investment in new software projects—both government and corporate—over the last five years, I estimate that project failures have likely cost the U.S. economy at least $25 billion and maybe as much as $75 billion.

Of course, that $75 billion doesn't reflect projects that exceed their budgets—which most projects do. Nor does it reflect projects delivered late—which the majority are. It also fails to account for the opportunity costs of having to start over once a project is abandoned or the costs of bug-ridden systems that have to be repeatedly reworked.

Then, too, there's the cost of litigation from irate customers suing suppliers for poorly implemented systems.

When you add up all these extra costs, the yearly tab for failed and troubled software conservatively runs somewhere from $60 billion to $70 billion in the United States alone. For that money, you could launch the space shuttle 100 times, build and deploy the entire 24-satellite Global Positioning System, and develop the Boeing 777 from scratch—and still have a few billion left over.

Why do projects fail so often?

Among the most common factors:

? Unrealistic or unarticulated project goals
? Inaccurate estimates of needed resources
? Badly defined system requirements
? Poor reporting of the project's status
? Unmanaged risks
? Poor communication among customers, developers, and users
? Use of immature technology
? Inability to handle the project's complexity
? Sloppy development practices
? Poor project management
? Stakeholder politics
? Commercial pressures

Of course, IT projects rarely fail for just one or two reasons. The FBI's VCF project suffered from many of the problems listed above. Most failures, in fact, can be traced to a combination of technical, project management, and business

decisions. Each dimension interacts with the others in complicated ways that exacerbate project risks and problems and increase the likelihood of failure.

Consider a simple software chore: a purchasing system that automates the ordering, billing, and shipping of parts, so that a salesperson can input a customer's order, have it automatically checked against pricing and contract requirements, and arrange to have the parts and invoice sent to the customer from the warehouse.

The requirements for the system specify four basic steps. First, there's the sales process, which creates a bill of sale. That bill is then sent through a legal process, which reviews the contractual terms and conditions of the potential sale and approves them. Third in line is the provision process, which sends out the parts contracted for, followed by the finance process, which sends out an invoice.

Let's say that as the first process, for sales, is being written, the programmers treat every order as if it were placed in the company's main location, even though the company has branches in several states and countries.

That mistake, in turn, affects how tax is calculated, what kind of contract is issued, and so on.

The sooner the omission is detected and corrected, the better. It's kind of like knitting a sweater. If you spot a missed stitch right after you make it, you can simply unravel a bit of yarn and move on. But if you don't catch the mistake until the end, you may need to unravel the whole sweater just to redo that one stitch.

If the software coders don't catch their omission until final system testing—or worse, until after the system has been rolled out—the costs incurred to correct the error will likely be many times greater than if they'd caught the mistake while they were still working on the initial sales process.

And unlike a missed stitch in a sweater, this problem is much harder to pinpoint; the programmers will see only that errors are appearing, and these might have several causes. Even after the original error is corrected, they'll need to change other calculations and documentation and then retest every step.

In fact, studies have shown that software specialists spend about 40 to 50 percent of their time on avoidable rework rather than on what they call value-added work, which is basically work that's done right the first time.

Once a piece of software makes it into the field, the cost of fixing an error can be 100 times as high as it would have been during the development stage.

If errors abound, then rework can start to swamp a project, like a dinghy in a storm. What's worse, attempts to fix an error often introduce new ones. It's like you're bailing out that dinghy, but you're also creating leaks. If too many errors are produced, the cost and time needed to complete the system become so great that going on doesn't make sense.

In the simplest terms, an IT project usually fails when the rework exceeds the value-added work that's been budgeted for. This is what happened to Sydney Water Corp., the largest water provider in Australia, when it attempted to introduce an automated customer information and billing system in 2002 [see box, "Case Study #2"]. According to an investigation by the Australian Auditor General, among the factors that doomed the project were inadequate planning and specifications, which in turn led to numerous change requests and significant added costs and delays. Sydney Water aborted the project midway, after spending AU $61 million (US $33.2 million).

All of which leads us to the obvious question: why do so many errors occur?

Software project failures have a lot in common with airplane crashes. Just as pilots never intend to crash, software developers don't aim to fail. When a commercial plane crashes, investigators look at many factors, such as the weather, maintenance records, the pilot's disposition and training, and cultural factors within the airline. Similarly, we need to look at the business environment, technical management, project management, and organizational culture to get to the roots of software failures.

Chief among the business factors are competition and the need to cut costs. Increasingly, senior managers expect IT departments to do more with less and do it

faster than before; they view software projects not as investments but as pure costs that must be controlled.

Political exigencies can also wreak havoc on an IT project's schedule, cost, and quality. When Denver International Airport attempted to roll out its automated baggage-handling system, state and local political leaders held the project to one unrealistic schedule after another. The failure to deliver the system on time delayed the 1995 opening of the airport (then the largest in the United States), which compounded the financial impact manyfold.

Even after the system was completed, it never worked reliably: it chewed up baggage, and the carts used to shuttle luggage around frequently derailed. Eventually, United Airlines, the airport's main tenant, sued the system contractor, and the episode became a testament to the dangers of political expediency.

A lack of upper-management support can also damn an IT undertaking. This runs the gamut from failing to allocate enough money and manpower to not clearly establishing the IT project's relationship to the organization's business. In 2000, retailer Kmart Corp., in Troy, Mich., launched a $1.4 billion IT modernization effort aimed at linking its sales, marketing, supply, and logistics systems, to better compete with rival Wal-Mart Corp., in Bentonville, Ark. Wal-Mart proved too formidable, though, and 18 months later, cash-strapped Kmart cut back on modernization, writing off the $130 million it had already invested in IT. Four months later, it declared bankruptcy; the company continues to struggle today.

Frequently, IT project managers eager to get funded resort to a form of liar's poker, overpromising what their project will do, how much it will cost, and when it will be completed. Many, if not most, software projects start off with budgets that are too small. When that happens, the developers have to make up for the shortfall somehow, typically by trying to increase productivity, reducing the scope of the effort, or taking risky shortcuts in the review and testing phases. These all increase the likelihood of error and, ultimately, failure.

A state-of-the-art travel reservation system spearheaded by a consortium of Budget Rent-A-Car, Hilton Hotels, Marriott, and AMR, the parent of American

Airlines, is a case in point. In 1992, three and a half years and $165 million into the project, the group abandoned it, citing two main reasons: an overly optimistic development schedule and an underestimation of the technical difficulties involved. This was the same group that had earlier built the hugely successful Sabre reservation system, proving that past performance is no guarantee of future results.

TRANSLATE THE SENTENCES

1. A science is more than a large amount of information on some subject.
2. These amount to refusal from a deeper understanding of the phenomenon.
3. For this purpose no direct method has been devised, nor is it likely than such a method is possible.
4. Hardly had this result been ignored.
5. The maintenance of a temperature within a prescribed range under conditions of varying loads can be termed temperature regulation.
6. The close agreement of the six observations is unlikely to be a coincidence.
7. A number of derived and related compounds were prepared and tested with few results of any promise.
8. One cannot start applying probability theory before one has an adequate method for the numerical representation of the data.
9. If one diagrams it one finds about twenty layers.
10. The square root of any number can be extracted from any number to any degree of accuracy provided the number is positive.
11. It is, of course, impossible to prove anything about points and lines unless we agree in advance about some properties that they are to have.
12. This demonstration is the more convincing the greater the variety of adsorbate vapors.

13. The more accurately the forecast of the future demand is made the less the requirement for safety stock.

PASSIVE VOICE

1. From the equations all but one of the unknown functions can be eliminated by successive substitutions.
2. It is of no practical importance whether this pathway exists in physical or logical space.
3. No matter how many observations are performed, there will always be alternative hypotheses which can account for them.
4. In the presence of this compound there was formed a mixture of two products.
5. During the period embraced by the preceding chapters there had arisen in the world two new and mighty political forces.
6. With the discovery of laser and the development of coherent optics there appeared a new way of concentrating energy in a plasma.
7. There did not remain any more controversial phenomena to describe.
8. The only thing that matters is purity of the starting material.
9. This hypothesis lacked confirmation.
10. For the estimations use will be made of a hypothetical reference model.
11. The question of the laws of resistances in circuits may now be turned to.
12. The book was terribly bad, it was just a chance that it got published.
13. When exposed to a beam of light this movement becomes oriented in the directions of the beam, and on a vertical surface it becomes directed by gravity.
14. The speed with which arithmetic operations are performed is affected by a number of factors.
15. In gaseous reactions the equilibrium position is largely influenced by pressure.

16. The qualitative examination of an organic compound is followed by a quantitative analysis.
17. Questions can be asked and answered, but unfortunately the questions asked and those answered are frequently not the same.
18. Does everyone understand which part of the organization has control over and responsibility for documentation?
19. The static nature of the structure has limited effectiveness due to two implicit assumptions.
20. He had been prevented from acting sooner by civil war in Poland.
21. Statements may be added, listed, deleted and changed at will while other activated programs are being executed.
22. After a careful study we came to the conclusion that the formula appeared much more complicated than the one we had been using before.
23. However useful it may be, it can not be employed to advantage unless it can be obtained in adequate quantities and at reasonable price.
24. It is for this reason that many reports on scientific research include discussion of how the research ought to have been done in the light of the experience gained in having done it the first time.

VERBALS

1. A gram of water is proved to change exactly to a gram of ice when freezing and to a gram of water vapor when evaporating.
2. Strictly speaking, this somewhat arbitrary division may be justified taking into account an imperfect technique.
3. Several treatments of this problem have been presented, with theories resulting from this investigation falling into one of the two categories.
4. Other theories having so far proved inadequate, dynamo theories of the origin of solar fields are regarded as the most promising.
5. This value is subject to systematic errors, the most important one reflecting our lack of knowledge of the energy spectrum.

6. It was early recognized that all the rocks were surprisingly similar in chemical composition, the fact having been confirmed by the subsequent examination of rocks from different parts of the world.
7. The chemist is usually inclined to regard the appearance of this product as signifying that the reaction is over.
8. They planned from the first the project as being primarily a communication experiment.
9. The experiment that is being conducted is of great interest and is thought of as being highly promising.
10. It is worthwhile reconsidering this case as well as adding another even more impressive example.
11. Up to the present time, several writers have succeeded in finding exact solution of the fundamental differential equation in certain particular cases.
12. Today we cannot help witnessing a tendency in science to direct the collective efforts of a research team at the achievement of a common goal.
13. The opening words of this curious treaty are worthy of being recorded.
14. The possibility of radio waves being reflected from the Moon to the Earth has been frequently speculated upon by workers in the radio field.
15. He was afraid of the results not proving conclusive.
16. It is of importance to know the basic principle to be observed in the design and use of optical equipment.
17. To specify the model in this field will require advances both in mathematics and physics.
18. The theory to be developed only aims at verifying the above discussions but is not sufficiently detailed to give a complete description.
19. We know physical changes to be caused by heat.
20. Furthermore, one need not even know how to make the reaction in question occur.
21. It is to scientifically educated manager that this book is primarily addressed, for he is a man to seize cybernetics and make it work for him.

22. Therefore, it should be possible to launch light from three sources into the fiber and to have them separate in space at the output.
23. Hot springs are believed often to be due to the presence of magma near the surface.
24. The present era, which is distinguished by the utilization of metals in enormous quantities, may be said to have begun in the 1860.
25. The atmosphere has been proved to extend several hundred kilometers above earth.
26. In any case, current theories, either empirical or electronic, do not appear to account for this result.
27. It must be remembered, however, that in these specimens a second phase exists whose concentration might be expected to vary with temperature.
28. They succeeded in obtaining good results working with quicksilver, it being known to be a very dangerous metal.
29. A rough idea of what is thought to be taking place is given by the formula below.
30. If all the melt, considered to be homogeneous, is kept at the same temperature, solidification will begin at certain positions in the body of the melt, called “nuclei.
31. For an automatic system to be successful it must tune a transmitter at least as accurately as it can be done manually.
32. The suggestion is both attractive and interesting but the work is not sufficiently advanced for any definite opinion of its validity to be formed.
33. These experiments prove that it is physically possible for the ground ice of Alaska to have been formed by a process of segregation.
34. Carrying this test successfully was helped by the careful investigation of outstanding scientists.
35. The explanation lies in the cyclotron being regarded as a modification of the linear accelerator.

36. The inductance of a coil depends on several factors, the chief among them being the number of turns and the cross-sectional area of the coil.
37. In spite of the gases having been compressed they returned to their original volume as soon as the applied force stopped acting.
38. Breaking a magnet does not separate the north and south poles, for each part is now a complete magnet.
39. Rutherford began a series of investigations of radioactive elements which were known to disintegrate, and showed that the radiations emitted were of three kinds.
40. The radiation spectra have been shown by previous studies to be quite complex.
41. One of the cache controller's main jobs is to look after "cache coherency" which means ensuring that any changes written to main memory are reflected within the cache and vice versa.
42. There are several techniques for achieving this, the most obvious being for the processor to write directly to both the cache and main memory at the same time.
43. Cache entries that have changed are flagged as "dirty", telling the cache controller to write their contents back to main memory before using the space to cache new data.
44. This tends to improve the chance of a cache hit as most programs spend their time stepping through instructions stored sequentially in memory, rather than jumping about from one area to another.
45. Depending on the algorithm that is being applied, this may be the information that has been in the cache the longest, or the information that is the least recently used.
46. The CPU's request can then be met, and the cache already has the adjacent data loaded in anticipation of that information being requested next.
47. Not only is computing equipment getting smaller, it is getting more sophisticated.

48. Using mailmerge a standard letter is then printed off addressed to the vehicle owner.
49. Once the data to be mined is identified, it should be cleansed.
50. But after analyzing patterns within clusters, the mining software can start to figure out the rules that point to which claims are likely to be false.
51. Furthermore, all input and output operations, although invoked by an application program, are actually carried out by the operating system.
52. When you combine computer vision with speech understanding, it liberates the user from having to sit in front of a keyboard and screen.
53. Doctors can also access a drugs database on CD-ROM which provides prescribing information on thousands of drugs including their suitability for different categories of patients.
54. Not having to worry about upgrading to the latest version of your office suite or about battling with the complexities of managing an e-mail system, leaves business with more time.
55. To use applications remotely requires a lot of bandwidth, which is only really available from a broadband connection or a leased line to the ASP itself.
56. Providing applications and storage space for vast number of users requires some powerful technology on the part of the ASP.
57. This is particularly beneficial to small businesses which are likely to grow quickly and don't want to deal with the problems caused by outgrowing their existing system and having to move to a high-end package.
58. It's very rare for an e-commerce business to handle all these elements by itself.
59. Being able to respond rapidly to changes in the size of your customer base and the type of product that they want to order from your business, demands more flexibility than traditional software can provide.
60. By stripping out sounds most people can't hear, MP3 significantly reduces the information stored.

61. Each MP3 file has a tag permitting extra information to be stored on the performer and other track details.
62. Special isolation adapters can be fitted to allow existing mains lines to be used instead of twisted-pair cabling.
63. Most future home networks, however, are likely to be wireless network systems, using tuned transmitter and receiver devices.
64. Before you start work, call up the hi-fi control program and have the music of your choice pumped through the living room speakers.
65. Once a message has been delivered, it can't be recalled.

COMPLEX SENTENCES

1. It should be stated that we are assuming throughout this chapter that the primary condition that the system be stable is already satisfied.
2. It is important that the satellite not be dependent upon orientation relative to the sun or the earth.
3. Air cooling instead of water cooling would also reduce the weight of the engine, but a larger fan would be required to keep the engine cool.
4. Whether this is a good thing or a bad thing is irrelevant from the point of view with which we are concerned in this chapter.
5. What we mean by questions and what we mean acceptable answers is becoming a topic of interest to more and more researches.
6. It is not claimed that this is really what happens in the practical case.
7. The question remains whether the mathematical interpretation of the physical event is adequate in a strict sense, or whether it gives only an inadequate image of physical reality.
8. The fact of instability of heavy nuclei throws light on the question as to why there are only ninety two elements in nature.

9. This process of refinement continues until a level is reached that can be understood by a computer.
10. No matter what variable is treated there is a corresponding possibility of physical manipulation.
11. Automatic equipment cannot be produced unless and until sufficient number of people qualified to design and build it becomes available. And even if its production becomes technically possible, it is not likely to be installed by any firm until the necessary specialized workers who are to operate it and serve it also become available.
12. Data analysis also consists of asking questions until the problem is understood, then developing alternative solutions until the best is obvious.
13. Had there been no earth's gravitation, the satellites would have moved through airless space in a straight line at a uniform speed.
14. Unless a very high pressure is used, electrons produce only a small number of ions.
15. We observe that had our study been presented one month earlier, its results might have been lost in the many competing issues, and, if presented one week later, action of existing bills would have been completed and this study would have had no impact whatsoever.
16. No matter what is the number of the event, the frequency of recombination is 0.5, provided the exchanges occur at random.
17. Unless other conditions are stated specifically, we shall use the term "state" to represent an equilibrium state.
18. One has to find whether there were any traces of water left.
19. The authors were able to prove that no serious error had affected the measurements.
20. Today it seems certain that a given ion does have a definite mobility, one that does not change with time.
21. The reference channel monitors a constant, but adjustable, proportion of the primary tungsten radiation.

22. Kinematics, or the study of motion differs from geometry in having to consider the element of time
23. Associations will organize numerous meetings devoted to the part our state has played in the progress of modern society.
24. The applications the radioactive isotopes are finding in different fields of life are of great importance.
25. If, as is much more likely, an electron is forced into the conduction band in the crystal lattice, a delay depending upon the mobility of the electronic carrier and the percentage impurity present will ensue.
26. Experiments in chemistry, though extremely valuable, yield information about the interactions between atoms rather than knowledge of the inner electrical nature of the atom.
27. It was recognized that light could be amplified in the same way as microwaves, provided that the energy difference between two energy levels corresponds to a frequency in the light region of the spectrum.
28. Thus, by the careful selection of the impurity to be added, we can determine whether the germanium is of n or p-type.
29. Whether it is satisfactory for a given case depends upon the importance of the error resulting from neglecting the thickness of the lens.

ATTRIBUTIVE GROUP

1. Balanced microphone amplifier is intended as a cheaper alternative to the conventional method of amplification using an impedance transformer.
2. The power in a plane sound wave is given by the product of the square of the RMS particle velocity and the specific acoustic impedance of the medium, air in our case.
3. To show the fine detail of the spectra only a narrow range of frequencies can be displayed, using a slow sweep rate and narrow bandwidth.

4. The camera calculates which zone the subject is in and adjusts the lens accordingly.
5. In the early years of radio transmission and reception almost all the broadcast signals intended for domestic news and entertainment were transmitted on either the long wave (150-285 kHz) or the medium wave (525-1605 kHz) bands, because the available technology and hardware was really only suitable for use at relatively low radio frequencies.
6. Although each transmitted signal might occupy some 30 kHz of bandwidth and the total available space in these two bands is only 1215 kHz, the poor sensitivity of the average receiver and the relatively small number and low effective radiated power of the transmitters meant that there was very little likelihood of interference from broadcast transmissions on adjacent frequencies.
7. This leads to the possibility that, if the input voltage is applied to the centre tap of a tuned circuit, which is arranged to feed a pair of diode rectifiers, the input signal will either add to or subtract from the output rectified voltage from each diode, depending on whether the input signal frequency is above or below the resonant frequency of the tuned circuit.
8. In optical communications systems digital information is carried as a train of light pulses through the fiber.
9. When powered from light sources such as laser diodes, either directly or via fiber optic cable, the new converter is said to produce 1mW to 1W with voltages of about 12V.
10. Based on the assumption that the molecules are sensitive to specific frequencies and that the cell has a mechanism to enable the signals to generate a cumulative effect over time, the scientists provide models to show that thresholds for electric field effects can be reduced by a factor of 100 below the thermal noise level.
11. The input current only differs from the load current by the current flowing into the op-amp, which is extremely small due to the high open-loop voltage

gain and input impedance of the op-amp, so the current gain of the circuit is very close to unity.

12. An alternative way of viewing the circuit from a stability stand-point is to look at the two feedback factors.
13. It is seen that the bandwidth of each voltage-follower section is close to the gain-band width product of the op-amp.
14. The high probability of correct reception using 1200b/s standard means that such systems do not need error-correction software, except where more than 64Kbyte of data is being sent or in the presence of extremely bad noise.
15. As for the modems, increased speed not only increases the cost but also the likelihood that the received data will contain errors.
16. When he studied the electron emission from tungsten filaments he found that at temperatures close to the melting point of tungsten the emission was orders of magnitude less than predicted by theory.
17. A modulator can be made by using a piezoelectric device to stretch the fiber in response to an applied voltage, increasing the phase length of that portion of the fiber and hence the time for light to travel through it.
18. Any ripple fed back is due to multiplier non-linearities, integrator component mismatch, offsets and op-amp open-loop gain limitations.
19. Connecting a balanced amplifier at the output removes the need for a symmetrical carrier to reduce aliasing and it makes highly symmetrical switching in the mixer unnecessary.
20. Elements of the design are a high-gain narrow-band amplifier to capture the incoming signal, a counter to measure phase, a transputer to perform a signal processing and trigonometric calculation, a keyboard and a display.
21. It was shown that cold cathode guns of simple structure could be designed to produce shaped beams focusing over the whole length of the junction of metals to be welded.
22. In general assessment of the dynamic performance of electronic systems, such as amplifiers and filters, usually demands that a suitable test signal be

injected at the input and the resulting output waveform examined. In this way frequency response and distortion can be quantified.

23. Although the system to be described does not offer a new performance-assessment strategy, it does provide the engineer with the possibility of developing and using unique wave forms for specific measurement tasks.
24. However, as previously indicated, the system was designed to provide test signals for radio telephony speech band up to 3 kHz.
25. The wave form consists of the sum of two audio tones, 800Hz and 1200Hz, and is used as a test signal for assessing the non-linearity of baseband speech-signal processing systems.
26. Any non-linearity in such systems leads to the generation of spurious frequency components in the output signal which take the form of harmonics and intermodulation products related to the input signal tones.
27. This circuit is based on a high-gain operational amplifier that provides the sensitivity required for the single-sideband operation.
28. To fully exploit the potential of free-space laser communications, you need to understand how light propagates from a source to a receiver.
29. Light, whether from a laser or the sun, travels faster through less dense hot air than denser cool air. In much the same way that the refractive differences in optical fiber effectively constrain light to travel within the fiber core, temperature differences in the atmosphere can cause light to travel in curved paths
30. It is important to note that these microwave distribution system transmitters are not multichannel, and are effectively low-power television transmitters which operate in the microwave bands.
31. The normal technique for the high-power systems is to use an individual solid-state transmitter for each program channel, and then to combine the 2,5GHz outputs before feeding the combined signal to one or two broadband transmitting antennas.

32. Medium-power C-band satellite reception equipment is readily available in some parts of the world at reasonable cost.
33. The flicker noise corner frequency of bipolar operational amplifiers ranges between 1 Hz and 100 Hz compared to 100 to 1 kHz for fet op-amps.
34. The rectifier unit is normally supplied with a constant amplitude voltage either directly from the mains or via a transformer.
35. Exploration of the surface acoustic wave devices was paid great attention.
36. They were to study the performance of single sideband radio receivers.
37. The two frequencies are compared and, as the frequency of the signal generator drifts, a correction voltage is applied to the voltage-controlled oscillator in the signal generator.
38. A State Research Coordination Committee was offered to improve their method of guidance of the scientific work.
39. State weightlessness effects and those of acceleration have to be studied to make a space travel possible.
40. Low energy radio waves are reflected and absorbed by the electrons and ions of atmosphere.
41. A nuclear reactor is a device in which a fission chain reaction takes place.
42. Our great hydraulic engineering projects solve the power, irrigation and power-transport problem.
43. During the flight two-way radio-communication is being maintained with a spaceship.
44. Only one quarter of the world synoptic surface weather observation posts are below the Equator.
45. The spaceships and sputniks are helping to study radio-wave propagation.
46. The important radiation characteristic is that it can occur in the vacuum.

ПЕРЕВЕДИТЕ ПРЕДЛОЖЕНИЯ

1. Analysis is naturally followed by synthesis.

2. The question now arises as to how the behaviour of metals is affected by the changes in temperature.
3. The charge of an atom is not affected by the number of neutrons present but depends on the balance between electrons and protons.
4. Chemical methods of purifying water are given much attention to by our scientists.
5. In practice the solidification of pure metals is influenced to a great extent by what may be generally described as external conditions.
6. Conditions which affect the plastic behavior of material will also influence its fracture behavior since fracturing is normally preceded by plastic deformation.
7. By now the phenomena of life are beginning to be seen more and more as problems which can be dealt with as scientifically as those of physics and chemistry.
8. In the chapter on experimental techniques, we are given a good insight into many of the special problems that have to be solved.
9. In order to determine whether a given compound is organic it is frequently sufficient merely to heat it.
10. Some elements possess so few metallic qualities that it is uncertain whether they should be called metals or nonmetals.
11. We shall now examine gases in the light of kinetic theory and see if any explanation of the exceptions to the gas laws can be found.
12. Gases are such good insulators that, in the early days of science, argument arose as to whether they conduct electricity at all.
13. The question arises whether there is any fundamental difference in the kinetics of reactions occurring in condensed media compared to the gaseous state.
14. The causes of the fluctuations which have been described are not known, nor is it known whether these fluctuations are periodic in character.
15. If a single drop of water were magnified to the size of the earth, each molecule contained in it would be no larger than a football.

16. Were there no loss of energy by friction, the motion would continue once it had been started.
17. Should the temperature of the filament increase, the magnitude of the electron flow will increase.
18. Should a rubber ball be immersed in liquid air and then taken out and thrown on the floor, it would fly to pieces like a ball of glass.
19. There are many considerations to be taken into account in determining space velocity.
20. The general problem to be solved is to find the current density distribution across the radius as a function of time.
21. The value of the resistance to be used will depend on the amount of plate current that passes through the rectifier.
22. The atmosphere has been proved to extend several hundred kilometers above the earth.
23. There are crystals in which there appears to be two types of interatomic attraction acting at the same time.
24. The only velocity known in physics to possess the desired degree of generality is the velocity of light spreading through empty space.
25. At the time the phenomenon of radioactivity was discovered the chemical elements were regarded as unalterable; they were thought to retain their identities throughout all chemical and physical processes.
26. It is reasonable to expect and it has been found in practice, that an automatic computer is much less likely to make mistakes than a human being doing the same work.
27. Comparatively few of the elements prove to occur as uncombined substances in nature, most of them being found in the form of chemical compounds.
28. Cosmic rays have been shown to be a form of radiation similar in nature to those of radio and light and differing from them only in wavelength and penetrating property.

29. Many proposals for changing the traditional methods of storing and searching for information have been made in the last decade, and some of these have already proved to be of considerable practical value.
30. There seems to be almost universal agreement that the traditional methods of storing and searching for information are not efficient enough at the present time and will become less so in the future.
31. No way of producing cosmic rays artificially has yet been discovered; indeed, as they represent an energy pressure of thousands of millions volts, they are not as yet likely to be generated electrically upon the earth.
32. It is possible for elements to combine in different proportions, but when they do so different substances are produced.
33. Whenever motion exists friction is always acting in a sense opposed to the motion, although in many cases its very presence is essential for the motion to take place.
34. The radio frequency has to be chosen such that its period equals the time it takes for the ions to make one revolution.
35. A number of conditions must be fulfilled simultaneously for electron transfer to take place, and, for different systems, different factors dominate in controlling the rates.
36. When a high velocity missile strikes a target, it is usual for both the missile and the target to deform plastically as a result of the impact.
37. For any reaction to occur it means that the final state of the system must have a lower free energy than the initial state, and if this condition is satisfied there must be some tendency for the change to take place.
38. To prevent the metal parts of ships from being covered with rust under water, various kinds of paint are being used.
39. Without being subjected to a special treatment, raw rubber can not be used for manufacturing such things as tyres, wire insulation, etc.
40. The exact operation of some devices can not be much relied upon due to their being influenced by the changes in the ambient temperature.

41. Only in the middle of the XIX century the fact of the quantity of heat produced being proportional to the work done was definitely stated.
42. As radio waves travel away from their point of origin, they become attenuated as a result of spreading out due to energy being lost in travel.
43. The accumulation of a vast amount of information on chemical and other properties has been condensed into a fairly simple and concise table, which has not only enabled the chemist to inter-relate his elements but has resulted in his being able to predict the physical structure of the atoms of which those elements consist.
44. The first problem we shall investigate is that of calculating the chance the electron passing over a distance *x* parallel to the electric force without becoming attached to a molecule.
45. Lebedev's having worked out an efficient method of making artificial rubber made our industry independent of imported rubber.
46. Different forms of magnetic circuits can be employed, depending on the material used, results desired, cost and other factors.
47. The type of complex reaction having been the object of numerous investigations will be discussed in more than usual detail as it illustrates a number of methods of handling complex reactions that may be applied to other cases.
48. The theoretical treatment given is based entirely upon the methods of statistical mechanics, since this seems to be the only rational procedure.
49. Two objects being at the same temperature, the average energy of motion of their molecules is the same.
50. X-rays are usually produced by bombarding a metal target with a beam of high voltage electrons. This is done inside a vacuum tube, the X-rays passing out through the glass wall of the tube in a well-defined beam.
51. The name electronics is known to be derived from the word electron, the electron itself being the basic unit of negative electricity and all electric currents consisting of electrons in motion.

52. Some types of machine tool equipment may be used to the best advantage in several of the industries, such industries not necessarily being similar in nature.
53. Cosmic rays have been observed to end their paths from outer space in violent nuclear collisions, the latter being known to take place high above the earth.
54. It was early recognized that all the rocks were surprisingly similar in chemical composition, this fact having been confirmed by the subsequent examination of rocks from different parts of the worlds.
55. It was not until the industrial revolution that metals began to assume the importance they now possess.
56. In phenomena such as oxidation and corrosion it is the surface rather than the body of the metal that is affected.
57. It was the study of intermediate-sized particles, small enough to be influenced by molecular motion but still large enough to be seen through a strong microscope, which gave scientists their first proof of the kinetic theory of heat.
58. Never before has there been any device so versatile and efficient in handling electricity as the electron tube.
59. Essential and valuable as the physical picture of stability is, mathematical definition provides more useful and exact means of describing system performance.
60. Were there no loss of energy by friction, the motion would continue indefinitely once it had been started.
61. Had there been no earth's gravitation, the satellites would have moved through airless space in a straight line at a uniform speed. It is the gravitation that makes them move round the earth.
62. One can hardly proceed in any exploration without some definite objective and some idea of what one is likely to get.
63. Combining the information concerning the central temperature of the sun, with the known facts concerning the reaction rates of various nuclear

transformations one can find out which particular reaction is responsible for the energy production in the sun.

64. In the chapter on current economic problems, we are given a good insight into many of the special problems that have to be involved.

65. It is still uncertain whether the variation in energy of the electrons can be wholly accounted for by energy losses during their passage through the material, or whether their initial energies differ. The former would seem more probable on theoretical grounds.

66. It is apparent from the previous discussion that only a few of the thermometers mentioned would be suitable for field tests.

67. In order that the inductance be independent of the current, it is necessary that no magnetic materials be used in the coil construction.

68. As might be expected, there are intermediate reactions in which two ionic mechanisms appear to be taking place simultaneously.

69. The reader should not expect to be given a complete account of measuring techniques such as he would find in an inclusive textbook on the subject.

70. With a pure liquid the only way concentration could increase at the interface would be by a compression of the molecules: an increase in the number of molecules per unit volume of the liquid, and this does not seem to occur.

71. We could go on indefinitely discussing the physical foundation of the gene theory, in particular the important evidence supplied by the study of mutations produced by X-rays and other radiation, but what has already been said appears to be sufficient to convince the reader of the fact that science is at present crossing the threshold of the purely physical explanation of the “mysterious” phenomenon of life.

72. Thus it would be quite impossible to walk were it not for the friction between one’s feet and the earth, a train could not run were there no friction between the wheels and rails. Friction, therefore, acts as a resistance to motion and yet without it many motions would be impossible.

73. The case we have considered is the one which gives the greatest chance for the mobility of the ion to be independent of its nature; we have seen, however, that even in this case there would be much greater variations in the mobility than are consistent with the experiments.
74. Whatever the nature of the metal may be, the slower the rate of cooling the larger will be the size of the crystals after solidification.
75. Taking photographs of such small objects as atoms and molecules, one has to take into account the fact that nothing will come out at all unless the wave length of illuminating light is smaller than the size of the object to be photographed.
76. He insisted on my being present at the conference.
77. I objected to being criticized so stupidly.
78. His being a foreigner prevented him from getting a good job.
79. Most governments pay for their budget deficits by selling government bonds.
80. Sliding scale is a system of pay, taxes, etc., calculated by rates which may vary according to changing conditions.
81. The heart of capitalism is private ownership. And a limited liability company allows people to own almost anything – from skyscrapers to television stations – without risking their personal assets should the company go bankrupt.
82. Coordinating the country's monetary policy is one of the important functions of the central bank.
83. Once a customer deposits money in a local bank, it becomes available for further lending.
84. The bank can lend out the remainder of the deposit, further increasing the money supply – without any new currency being printed.
85. By buying large amounts of securities the central bank pumps money into the economy.

ПРЕДЛОЖЕНИЯ ДЛЯ ПЕРЕВОДА С РУССКОГО НА АНГЛИЙСКИЙ

1. Опыты показывают, что в металлах имеются свободные электроны.
2. Ведутся разработки по применению лазера в вычислительной технике.
3. Электронные приборы применяются в промышленности для автоматизации, управления и контроля.
4. В результате быстрого развития квантовой электроники появилось большое количество разнообразных лазеров.
5. Полупроводники играют огромную роль при создании, запуске и контроле за работой спутников и автоматических станций.
6. Звук – это колебание среды, в которой он распространяется.
7. Радар используется для обнаружения и определения местоположения различных предметов и целей.
8. Требования к этому оборудованию очень высокие.
9. Работа приемного оборудования была значительно улучшена этой группой ученых.
10. Основная цель нашей статьи более точно определить расстояние между двумя оптическими системами обработки данных.
11. Сопротивление прибора регулируется током, проходящим через интегральный диод.
12. Способность конденсатора запасать энергию и быстро разряжаться делает его незаменимым в разных электронных схемах.
13. Новые конденсаторы будут иметь большую емкость и смогут работать при более высоких температурах.
14. С помощью этого метода электромагнитные волны можно получить разрядом конденсатора.
15. Изменяющийся ток поступает в антенну, от которой радиоволны распространяются в атмосферу.
16. Преимущество цифрового метода заключается в улучшении качества изображения.

17. Оптические электронные приборы для записи, хранения и обработки информации используют лазерный луч.
18. Ученые используют компьютеры для проверки чувствительных лабораторных инструментов и анализа экспериментальных данных.
19. Ученые пытались найти возможность превращать изображение, получаемое на ТВ или рентгеновском экране, в информацию, которую можно было бы кодировать и вводить в ЭВМ.
20. Волоконная оптика имеет много преимуществ: более широкая полоса частот, меньшие потери и невосприимчивость к электромагнитным помехам.
21. Оптические волокна почти не дают искажений. Они дают большую экономию при передаче информации на большие расстояния.
22. Самые современные лазеры – лазеры, которые преобразуют электрические сигналы в световые импульсы для передачи по оптическому волокну, могут давать четко очерченные световые импульсы длительностью менее 1 нс.
23. В современных сетях связи сигналы в виде световой волны возбуждаются в оптическом волокне полупроводниковыми лазерами, которые непосредственно модулируются сигнальным током.
24. Другая проблема с этим типом лазеров состоит в спектральной чистоте, которая определяет дальность передачи сигнала световой волны по оптическому волокну.
25. Чтобы охарактеризовать работу волоконно-оптических устройств или систем для приложений, связанных с передачей данных, необходимо использовать лазер непрерывного излучения, позволяющий получить длины волн в инфракрасной области электромагнитного спектра около 1,3 мкм.
26. Экспериментальная установка содержит твердотельный материал, дающий лазерную генерацию и называемый усилительной средой, две линзы для фокусирования лазерного излучения, два зеркала для

отражения излучения, проходящего через эту среду, и призму для того, чтобы можно было настроить лазер на определенную длину волны.

27. Британская фирма разработала и создала серию цифровых видеоприборов, которые работают на кодированной информации.
28. На промышленных предприятиях устанавливались камеры, следящие за ходом производственного процесса, а полученная ими информация преобразовывалась цифровым анализатором-преобразователем в цифры, т.е. в язык, понятный для ЭВМ, которая в свою очередь выдавала печатную информацию и параметры различных операций.
29. LCD экран покрыт листом стекла с прозрачным проводящим покрытием.
30. Горизонтальные и вертикальные линии образуют тонкую сеткую
31. Пользователи могут писать на экране все что они хотят с помощью электронных чернил.
32. Весь прцесс занимает долю секунды.
33. В зависимости от мощности компьютера и сложности программного обеспечения, системы Clipboard могут быть запрограммированы распознавать различные особенности почерка конкретного пользователя.
34. Стоимость покупки аппаратного обеспечения значительно снизилась.
35. Широкая доступность компьютеров изменила мир навсегда.
36. Иконки представляют функцию, которая должна быть выполнена.
37. В отличии от системных программ пакеты программного обеспечения распространяются различными продавцами а не производителями.
38. Компьютерная операционная система это именно системная программа, которая управляет ЦПУ, входом, выходом и устройствами памяти.
39. Именно язык С нужно использовать, если вам нужно написать компактные, быстрые в исполнении программы.

40. В то же время, распределенные компьютерные сети должны улучшать технические возможности.

ТЕКСТЫ ДЛЯ ПЕРЕВОДА С РУССКОГО НА АНГЛИЙСКИЙ

ЛЕТАЮЩИЙ АВТОМОБИЛЬ

Американский профессор Кроу планирует в течение ближайших четырех лет создать летающий автомобиль «Старкар», который по утверждению разработчика, «будет летать практически самостоятельно». Управление новым аппаратом будет сведено к нескольким рукояткам благодаря использованию бортового компьютера и спутниковой радионавигационной системы. Маршрут полета будет отображаться на ветровом стекле, причем компьютер автоматически вернет автомобиль на выбранный маршрут полета в случае отклонения от него.

ЗДЕСЬ ПЛЕСКАЛИСЬ ОКЕАНЫ?

Марсоход «Спирит» обследовал на днях камень, лежащий недалеко от места посадки. И удивил ученых. С помощью микроскопа, которым оснащена механическая рука аппарата, удалось разглядеть в породе неожиданные подробности – маленькие полые шарики и трубочки. По мнению геологов, они вполне могли образоваться в результате испарения соленой воды. Затем посредством спектрометра марсоходу удалось определить, что в камне есть сера, кремний, цинк, хлор, кальций и даже следы кристаллической соли. Похоже, на Марсе и в самом деле когда-то были океаны.

РЕКЛАМА

Одна британская фирма, по словам её руководителей, готова затратить 45 тысяч фунтов стерлингов, чтобы с помощью звуковых волн выманить на поверхность знаменитую «Несси». Первые опыты с проигрыванием Пятой симфонии Бетховена привлекли только мелких рыбешек, но фирма не отчаивается. Вся эта затея выглядела бы очень странной, если бы действительной целью фирмы не была реклама её магнитофонов.

ВИДЕО КАНЕТ В ЛЕТУ

Сейчас стоит серьёзно задуматься, стоит ли покупать видеокассеты. По прогнозам специалистов, к 2007 году они могут полностью исчезнуть, а вместе с ними и видеомагнитофоны (как это в своё время произошло с ленточными магнитофонами). Их место уже сейчас всё настойчивее занимают DVD. И это справедливо: DVD-диски и качеством лучше, и места на полке меньше занимают. Более того, позволяют устраивать домашние кинотеатры, чем ставят под угрозу существование кинотеатров традиционных, которые смогут выжить лишь за счет изобретения каких-то особенных спецэффектов.

МЕЛОМАНЫ ПОД ВОДОЙ

Любители музыки и плавания смогли не так давно совместить эти два увлечения, насладившись уникальным подводным концертом. В олимпийском бассейне Тулузы директор Международного центра музыкальных исследований представил свою последнюю постановку, часовое зрелище, явно пришедшее к нам из 21 века. Присутствовавшие на премьере – истинные меломаны и хорошие пловцы – получили возможность насладиться чистейшим звуком, который распространялся в воде

электронными устройствами со скоростью 1450 м/сек, то есть в четыре раза быстрее, чем в воздухе.

Более того, специальные шлемы с передатчиками, соединенные с музыкальными компьютерами, позволяли слушателям самим участвовать в создании мелодии. Грациозные подводные танцовщицы завораживали глаза участников феерии, а водорастворимые духи, добавленные в воду бассейна, приятно щекотали обоняние. Неудивительно, что восхищенные меломаны горят теперь желанием повторить необыкновенный спектакль.

ГОРОД НА ОРБИТЕ?

Есть такая точка в космосе, где силы притяжения Земли и Луны находятся в полном равновесии. Ученые называют её Либрейшн-5, или, более фамильярно, Л-5. Под этим же сокращением известно международное научное общество, которое занимается разработкой проектов космических станций.

Американские учёные полагают, что уже через 15-20 лет человечество будет в состоянии построить станцию на 10 000 человек. 98 процентов необходимых материалов – алюминий, титан и прочее – могла бы, считают они, дать Луна. Характерной чертой проекта является создание на станциях земных условий жизни – городов и посёлков с магазинами, кинотеатрами, просторными и живописными зонами отдыха, с привычными для человека силой притяжения и сменой дня и ночи.

Один из проектов представляет собой два цилиндра, обращающиеся вокруг общей оси. Длина каждого цилиндра – километр, радиус – сто метров, период обращения – 21 секунда.

ЯПОНЦЫ СПАСУТ Е-БИЗНЕС?

Исследователи японской корпорации Toshiba заявили о разработке новой технологии, которая может оказать неоценимую услугу в борьбе против хакеров.

Учёным удалось получить новый тип излучающих светодиодов, испускающих по одному фотону в заданный промежуток времени. По словам авторов изобретения, новые светодиоды позволят сделать оптоволоконную связь практически неуязвимой для перехвата. Ведь полученный результат приводит исследование в область квантовой криптографии, особого вида оптической связи, недоступной для хакеров. Фотоны, несущие зашифрованные данные, полностью исключают возможность перехвата злоумышленниками. Технология к тому же позволяет каждый раз изменять ключи шифрования. Это открытие должно сыграть важнейшую роль в распространении широкополосных Интернет-сервисов, в том числе и за счёт повышения пошатнувшегося доверия пользователей к безопасности электронной коммерции.

ТЕЛЕВИЗОР СТАНЕТ КОМПЬЮТЕРОМ

Телевидение перестанет исполнять свою святую миссию: согласно телепрограмме показывать передачи, перемежаемые рекламой. По прогнозу одного из главных специалистов по новым технологиям в мире, основателя Microsoft Билла Гейтса, «голубой экран» превратится в большой компьютер, который сможет связываться через Интернет с серверами, где хранятся все произведенные передачи и фильмы. И по запросу телезрителя находить и показывать на экране его любимый сериал или новости в любое удобное для него время. Рекламе в её нынешней ипостаси гипнотизёра «а-ля Кашпировский», конечно, придет конец: её будут заказывать лишь заинтересованные лица, которым надо будет купить-продать-снять.

ТАКСОФОНЫ ИЗГОНЯТ ИЗ БУДОК

Мобильники нанесли мощный удар по обычным таксофонам, которые постепенно исчезают с наших улиц. В Японии телефонных будок уже практически нет. А в Нью-Йорке и в Москве их решили спасти с помощью компьютеризации. С января 2004 года в обеих столицах установили web-таксофоны, с которых можно выходить в Интернет, отсылать электронную почту, SMS-сообщения, а также сфотографироваться и отослать фото по e-mail. Но пока таксофоны остаются самым надёжным средством связи, особенно при чрезвычайных ситуациях. Например, в Нью-Йорке во время терактов 11 сентября 2001 года сотовая связь была перегружена, а уличные телефоны продолжали работать.

УЧЁНЫЕ СМОГУТ ВЫЯВЛЯТЬ ГЕНЕТИЧЕСКИ МОДИФИЦИРОВАННЫЕ ПРОДУКТЫ

Выявлять генетических мутантов в продуктах питания научились российские учёные. В скором времени будет утвержден стандарт, благодаря которому информация на упаковках некоторых товаров сможет открыть покупателям подробности их сложного состава.

Новый метод позаимствован отечественными специалистами у западных коллег. Он позволяет выявить у растения вживлённый ген, кодирующий новые свойства, со стопроцентной точностью. Лишь в тех случаях, когда содержание модифицированного источника очень мало (0,1%), чувствительность метода составляет 83-91%.

Как известно, модифицированные микроорганизмы ещё с 1982 года используют для производства йогуртов и сыров. На сегодняшний день список продуктов значительно увеличился. Среди самых распространённых растений, подвергнутых многоразовой мутации, - рапс, соя и кукуруза. Одна соя используется при производстве более чем 30 тысяч видов пищевых продуктов.

После внедрения нового метода специалисты не оставят эту тему. Они намереваются создать метод, который поможет определять ещё и количественное содержание модифицированных источников.

НЕ ОТДАДИМ ИНТЕРНЕТ НА СЪЕДЕНИЕ

Ошеломляющее заявление недавно сделал профессор Технологического университета Хельсинки Хану Карри: Интернет перестанет существовать в 2007 году. Учёный считает, что Сеть будет уничтожена вирусами и спамом. Действительно, бороться с вирусами, которые создают хакеры, с каждым годом становится всё сложнее. По данным ФБР США, ущерб от компьютерных взломщиков составляет триллионы долларов ежегодно. Спам – бесплатные рекламные письма – ежедневно на 80 % забивают электронную почту каждого пользователя Сети. Борьба при помощи «чёрных списков», ключевых слов и отслеживания ложных адресов отправителя результата не дала. В этом году попробуют уничтожать назойливые рекламные письма с помощью новых программ, которые будут требовать от отправителя подтверждать свою личность ещё до того, как письмо уйдёт с почтового сервера. В общем, программисты пока делают всё, чтобы спасти Всемирную паутину.

«СУМАСШЕДШАЯ» РУССКАЯ РАКЕТА

Один из самых засекреченных российских военных суперпроектов имеет кодовое название «Стрела». Наши конструкторы создают принципиально новое оружие – гиперзвуковую ракетную систему. Эта ракета способна маневрировать по высоте и курсу и поражать цели в любой точке земли. Поведение «Стрелы» в полёте не способен просчитать даже самый мощный компьютер противника – алгоритм известен только тем, кто вводит полётное

задание в «мозг» ракеты. Курс выглядит совершенно «нелогичным», нарушающим все законы баллистики.

Даже самые авторитетные западные учёные признают, что эффективные средства борьбы с такой ракетой будут разработаны в лучшем случае лет через 50-70. «Стрела» выводится в космос с помощью мощного двигателя межконтинентальной баллистической ракеты, на заданной высоте отделяется от нее и летит автономно со скоростью, которая от 6 до 14 раз превышает скорость звука.

Объективности ради стоит сказать, что первые испытания этого супероружия хотя и прошли в целом успешно, но выявили и некоторые технические проблемы, связанные прежде всего с двигателями ракеты, которые при маневрах по высоте и курсу испытывают запредельные нагрузки. Однако нашим инженерам уже удалось «перехитрить» и эту проблему за счет использования секретного ноу-хау, которое позволяет двигателям устойчиво работать при любых температурных режимах.

ЧТО ТАКОЕ WI-FI И WI-MAX?

Wi-Fi (Wireless Fidelity) – беспроводная компьютерная сеть, придуманная Виком Хейзом. Изначально Wi-Fi предназначалась для обслуживания кассовых систем, но потом ушла в массы. Как заявляют компьютерные гиганты типа Intel, в скором времени мы полностью перейдём на беспроводные технологии Wi-Fi или Wi-Max. И это не голословные заявления – в 2003 году в Париже начали создавать национальную беспроводную сеть, которая накроет не только всю французскую столицу, но и ближайшие пригороды. Представьте себе: локальная беспроводная сеть размером с мегаполис! Это ли не фантастика? А в округе Колумбия (США) местный Интернет-провайдер собирается создать беспроводную сеть, покрывающую территорию 9500 км.

На данный момент нам предлагают использовать Wi-Fi практически везде. Карманные игровые приставки при использовании Wi-Fi дают нам возможность коллективной игры. В модемы DSL или Dial-UP встраиваются передатчики Wi-Fi, подобные устройства могут не только обеспечить Интернетом всю квартиру и соседей, но и наладить маленькую домашнюю беспроводную сеть.

В Москве же сейчас около 1000 зарегистрированных точек доступа и примерно 5000 неофициальных беспроводных сетей. Масса поводов говорить о том, что Wi-Fi – это будущее и, кстати, довольно неплохое будущее, так как в ближайшее время ожидается продолжение семейства Wi-Fi. Уже родилось сильное дитя с именем Wi-Max. В принципе это логическое продолжение Wi-Fi, но только гораздо мощнее и быстрее.

НОВЫЙ СТАНДАРТ, БОЛЬШЕ ВОЗМОЖНОСТЕЙ

Wi-Max (Worldwide Interoperability for Microwave Access) – коммерческое имя стандарта беспроводной связи. Сегодня Wi-Max - это уже не просто небольшие передатчики с маленькими возможностями – это технология, позволяющая передавать данные на 7-8 км со скоростью 2 мегабита в секунду. А перспективы ещё более солидные: 50 км и скорость до 70 мегабит. Причем если раньше форматы стандарта GSM «затачивались» сначала для передачи голоса, а потом для передачи данных, то формат Wi-Max «заточен» сразу для передачи данных – видео-аудио и любых файлов. Это полноценный цифровой формат.

Получается, Wi-Max может составить серьёзную конкуренцию не только на рынке беспроводных сетей, но и на рынке мобильной связи. Уже сейчас планируют выпускать телефоны с поддержкой Wi-Max,значит, будущее видеотелефонии не просто не за горами, а уже на горизонте.

БУМАЖНЫЕ ГАЗЕТЫ ОСТАНУТСЯ В БИБЛИОТЕКАХ

Представьте себе, что вы читаете газету. Но в руках держите не обычный газетный лист, а гибкую пластиковую плёнку: каждые пять-десять минут информация на ней обновляется прямо у вас на глазах вместе с картинками. Именно так, по прогнозам экспертов IBM и Массачусетского технологического института, будут выглядеть газеты будущего уже лет через семь. Революция в мире носителей информации совершится благодаря электронной бумаге, которая сможет работать, как дисплей, и принимать тексты и фотографии с помощью новой беспроводной технологии. При этом «газета» почти ничем не будет отличаться от старой бумажной: изображение видно под большим углом зрения, её можно свернуть в трубку диаметром в два сантиметра или сложить, как носовой платок. Информация на электронной бумаге может быть «перерисована» более 1000 раз – три раза в день в течение года. Жалко будет выбросить не до конца использованный газетный лист. Кроме того, у электронной газеты будет ещё и устройство, которое позволит скачивать из Интернета новости по желанию владельца.

Из такой бумаги изготовят и электронные книги, которые можно будет «менять» на новые после прочтения. Уже есть опытные образцы, на которых, помимо текста, легко отображаются видеоматериалы и графика. Подобная технология со временем позволит читателям буквально вживаться в динамику виртуального повествования. И даже становиться участниками сюжета.

ДЛЯ МОЩНЫХ ЛАЗЕРОВ

Явление электрического разряда в газах лежит в основе многих приборов и устройств, сделанных человеком, начиная от ламп дневного света и кончая газовыми лазерами.

Разряд может быть вызван приложением к электродам как постоянного напряжения, так и электрического импульса. При небольших значениях величины импульса и низком давлении процесс протекает медленно. В

результате этого ионизированный газ (плазма) заполняет большой объём, как в той же лампе дневного света, где он занимает всю трубку. Стоит увеличить величину импульса и давление, как разряд принимает форму искрового шнура, протянутого между электродами.

Авторы открытия показали, что и при атмосферном давлении и больших значениях импульса можно получить объёмный, а не шнуровой разряд. Для этого достаточно подвергнуть газ предварительной ионизации с помощью облучения.

Открытие дало возможность создать технологию получения плазмы в больших объёмах, что в свою очередь стало основой для новых мощных газовых лазеров на разряде высокого давления.

УКАЗУЮЩИЙ ПЕРСТ

Надев этот перстень на указательный палец можно управлять компьютерным курсором, как угодно перемещая лазерный луч абсолютно по любой поверхности. Это идеальное устройство для проведения презентаций с использованием мультимедийных проекторов. Под большим пальцем удобно разместились колесо скролинга и две клавиши.

ОДНОАТОМНЫЙ ТРАНЗИСТОР

Специалисты Манчестерского университета в Англии под руководством профессора Андре Гейма и доктора Константина Новоселова создали самый маленький в мире транзистор. Он представляет собой структуру из графена - материала, состоящего из одного слоя атомов углерода. Таким образом, транзистор при ширине 50 атомов имеет толщину всего в один атом. Чем меньше размеры, тем выше быстродействие, однако обычный полупроводниковый материал – кремний – в таких масштабах теряет свои свойства, в то время как графен остается стабильным даже в том случае,

когда речь идет об элементах атомных размеров. Достижение исследователей делает возможным создание сверхбыстрых микропроцессоров с невысоким энергопотреблением, однако прежде придется решить множество технологических проблем: в настоящее время не существует эффективных методик для формирования элементов размером в несколько нанометров, подобных традиционной литографии. Так что появления микрочипов на основе графеновых транзисторов вряд ли стоит ожидать ранее 2025 года.

ЦИФРОВАЯ ФОТОПЛЕНКА

Компания SANDISK, известная как крупнейший производитель устроиств на основе эноргонезависимой памяти, разрабатыавает принципиально навый вид цифровых носителей для фотокамер. Особенность их будет заключатся в том, что информацию пользователь сможет записать только один раз, как на традиционную фотопленку. В SANDISK подчеркивают, что применение такой «цифровой фотопленки» избавит владельцев фотоаппаратов от необходимости хранит свои коллекции изображений на винчестерах компьютеров или оптических дисках. Гарантированный срок хранения данных на носителях, построенных на основе трехмерных структур полупроводниковой памяти, составит 100 лет.

КУРТКА С МЫШЦАМИ

Жилет POWER JACKET заменяет неработающие мышцы. Протез состоит из восьми групп искусственных мускулов – аналогов трапециевидной, дельтовидной мышц, бицепса, трицепса, мышц предплечья. Сенсоры, установленные на локтях и запястьях здоровой руки, передают информацию о движении в блок управления. После обработки процессором сигнал посылается уже на соответствующие пневматические механизмы, которые управляют искуственными мышцами больной руки. В результате пациент

может выполнять простейшие действия: поднимать и опускать руки, сгибать их в локтях и лучезапястных суставах. К сожалению, POWER JACKET не может помочь полностью парализованным людям.

MSI MEGA BOOK S270

Компания MSI представила нашему вниманию новый ноутбук. Модель S270 можно считать логическим развитием этой линейки. Обладая ярким двенадцатидюймовым TFT – дисплеем, система предназначена в первую очередь для деловых людей, которым важна не столько скорость в приложениях, сколько качество работы. И правда, функционирование системы, основанной на новом процессоре AMD Turion 64, заслуживает всяких похвал. Несмотря на то, что частота процессора лишь 1.6 ГГц, все операции выполняются довольно шустро, а загрузка емких приложений осуществляется быстро, благодаря 512 Мб оперативной памяти. Взаимодействие с внешним миром ведется практически всеми возможными способами. Владельцу ноутбука предоставляется широкий выбор способов выйти в сеть или соеденить свой ПК с другими устройствами: Gigabit LAN, модем, Wi – Fi или Bluetooth. Но для нормального функционирования всех устройств может понадобится установка драйверов, которые идут в комплекте на дисках. В нашем случае потребовалось устанавливатьдаже драйвера для звуковой платы. В комплект поставки включены три диска с драйверами и ПО. Возможности обмена данными представлены устройствами работы с дисками: DVD – RW – драйвом и флеш – ридером на три типа карт: SD, MMC, MS. Расширять возможности ноутбука можно и внешними устройствами, способными подключатся к PCMCIA, USB или FireWire. В коробке также найдется USB – мышь, которая существенно облегчит работу. Основное значение данного устройства – быть помощником деловому человеку, который не прочь порой посмотреть видео или послушать музыку. Встроенные спикеры не смогут обеспечить отличного

звучания, но возможность подключения наушников исправит этот недостаток. Ноут оснащен Li – Ion – аккаумуляторм емкостью 4400 мА. К сожалению, время работы в автономном режиме лишь немногим больше двух часов, если нагрузка системы сравнима с офисными задачами. Активная игра, просмотр DVD – фильмов и другие подобные задачи могут сократить время функционирования. Подводя итог, стоит сказать, что данная система представляет собой хорошую машину, обладающую всеми необходимыми функциями, необходимыми деловому человеку, не стремящемуся превратить мобильный компьютер в игровую станцию.

USB WIRELESS ID – LOCK

для того чтобы ограничить доступ к компьтеру в целях безопасности существует нескольку простых способов: установка пароля на BIOS, например, или на профиль пользователя в Windows. С появлением устройства iD – Lock этот список можно расширить. Оно состоит из двух частей: датчикапередающего сигнал и устройства принимающего этот сигнал. При первом рассмотрении приемник покажется тебе обычной флешкой небольших размеров. На нем написано название устройства и находится светодиод, индицирующий работу устройства. Передатчик сделан в виде круглого брелка, с одной стороны которго находится кнопка и индикатор включения, с другой отсек для установки батарейки. Как же все это работает? Приемник устанавливается в USB – порт компьтера, а передатчик используется как своеобразный блокиратор. При его отдалении от принимающего устройства более чем на 2 – 5 м компьтер закрывается от посторонних. Если опять внести передатчик в радиус действия, то происходит разблокировка. Кнопка на брелке (передатчике сигнала) служит для его включения/выключения. При выключении принимающее устройство перестает принимать сигнал передатчика и блокирует доступ, на экране возникает диалоговое окно, в котором нужно ввести пароль (задается при

установке ПО) для снятия защиты. Все донельзя просто. Устройство поставляется с диском, который содержит программное обеспечение для работы с iD – Lock и руководство пользователя, в котором очень понятно расписаны все шаги по установке и работе с устройством. Мануал можно почитать как в PDF так и в DOC – формате. В коробке есть USB – удлинитель, что повысит удобство работы. Для перемещения брелка – передатчика в комплекте поставки предусмотрен шнурок для его ношения на шее. При использовании беспроводного устройства ограничения доступа к компьтеру iD – Lock были выявлены некоторые недостатки. Крышка, закрывающая отсек для батарейки на передатчике, делает это очень плохо, того и гляди сломаешь защелку. На принимающем устройстве есть колпачок, защищающий разъем USB от повреждений, но он так туго снимается и одевается, что начинаешь волноватся за судьбу устройства. В заключении можно сказать, что iD – Lock сможет остановить недоброжелателей, возжелавших овладеть твоим компьтером.

ПРИЛОЖЕНИЕ 1

according to- согласно
account for- объяснять
after a while- через некоторое время
after the manner- по способу
a great deal of- много
ahead of time- заблаговременно
allow for- компенсировать
along with- одновременно
and the like- и тому подобное
any longer- уже; больше не
apart from- помимо, кроме
as- как, когда, так как
as a matter of fact- фактически
as close as possible- как можно точнее
as a whole- в целом
as early as- уже; ещё
as for- что касается, относительно
as if- как будто
as in the case- как в случае с
as long as- до тех пор, пока
as regards- что касается
as soon as- как только
as well as- также как
at a glance- сразу, с первого взгляда
at all- вообще, совсем
at all events- при всех условиях
at least- по крайней мере
at a time- одновременно
at issue- рассматриваемый
at random- наугад; произвольно
at the cost- за счет
at will- по желанию
be alike- быть похожим
bear in mind- иметь в виду
because of- из-за, вследствие
be due to- обуславливать(ся)
before long- вскоре
be likely- вероятно
be of use- быть полезным
be of value- иметь значение

beyond doubt- несомненно
beyond question- вне сомнения
bring about- осуществлять, быть причиной
bring into contact- соединять
but for- если бы не
by all means- обязательно
by far- непосредственно
by means of- при помощи
by no means- никоим образом
by then- к тому времени
by turns- по очереди
by virtue of- благодаря, посредством
compatible with- совместимый
deal with- иметь дело
depending on- в зависимости от
despite- несмотря на
do without- обходиться без
due- должный, надлежащий
due to- вследствие, из-за
either…or- или…или
end to end- непрерывный
even- даже, ровный, четный
ever since- с того времени
far less- гораздо меньше
far more- значительно больше
figure of merit- критерий
first rate- первоклассный
for- для, в течение, так как
for ever- навсегда
for lack of- из-за отсутствия
former- первый
for the rest- в остальном
for the sake of- ради
for the time being- на время, пока
get rid of- освобождаться от
give rise to- вызывать
go into operation- вступать в действие
greatly- очень, в значительной степени
have nothing to do with- не иметь никакого отношения
half as much- в два раза меньше
hence- следовательно
highly- весьма
if any- если таковые вообще имеются
if at all- если это вообще будет

if ever- если когда-л. это бывает
in accordance with- согласно
in addition to- в дополнение к
in advance- заранее
in behalf of- для, ради
in common with- совместно
in comparison to- по сравнению с
in consequence of- в результате
in contrast to- в противоположность
in due time- в своё время
in effect- в действительности, в сущности
in evidence- заметный
in excess of- больше, чем
in favour of- в пользу
in fine with- в соответствии
in honour of- в честь кого-л.
in its turn- в свою очередь
in many respects- во многих отношениях
in mind- помнить, иметь в виду
in no case- ни в коем случае
in no time- моментально
in order to- для того, чтобы
in outline- в общих чертах
in part- частично
in particular- в особенности
in point- рассматриваемый
in question- о котором идет речь
in relation to- относительно
in respect of- что касается
in spite of- несмотря на
instead of- вместо того, чтобы
in step- синхронно
in succession- последовательно
in such a way- таким способом
in terms of- в виде, на основе
in the course of- в процессе
in the long run- в конце концов
in virtue of- посредством, благодаря
irrespective of- безотносительно
it goes without saying- само собой разумеется
it is high time- давно пора
it is of interest- интересно
it is safe to say- можно с уверенностью сказать
it is unlikely- маловероятно

last but one- предпоследний
liable- подверженный
like- похожий, подобный
likely- вероятно
make use of- использовать
means- средство, способ
meet demands- отвечать требованиям
minute- мельчайший
needless to say- нечего и говорить
neither …nor- ни…ни
no longer- больше не, уже не
no matter- независимо от
none the less- нисколько не меньше
no sooner…than- как только
notably- исключительно, особенно
off the point- не по существу
of value- ценный
on account of- из-за, вследствие
on a par- в среднем
on behalf of- от имени, во имя
once- как только, после того как
once and again- неоднократно
on no account- ни в коем случае
on record- зарегистрированный
on the contrary- наоборот
on the one hand- с одной стороны
on the other hand- с другой стороны
on the whole- в целом
other than- кроме, помимо
otherwise- иначе
out-of-date- устаревший
out of place- не на месте
owing to- из-за, вследствие
partially- частично
particular- особый, определенный
partly- частично
pay attention- обращать внимание
provided- при условии
quite a few- много
rather than- а не
regarding- относительно
regardless- независимо
relative to- относительно
result from- получаться в результате

result in- приводить к
roughly- приблизительно
rule of a thumb- эмпирический метод
scarcely- едва
similar to- подобный
since- с, с тех пор, как, так как
so far- до сих пор, пока
so long as- поскольку, пока
somewhat- в некоторой степени
step by step- постепенно
such is the case- так обстоит дело
take account of- учитывать
take advantage of- воспользоваться
take into account- учитывать
take part- принимать участие
take place- происходить
take steps- принимать меры
thanks to- благодаря
that is- то есть
that is why- поэтому, вот почему
the former- первый из упомянутых
the latter- последний
the only- единственный
the…the- чем…тем
the very- тот самый
thus- таким образом
to advantage- с успехом
to a great extent- в значительной степени
to be a success- иметь успех
together with- наряду с, вместе с
to some extent- до некоторой степени
to this end- с этой целью
turn out- оказываться
twice as high- в два раза выше
under consideration- рассматриваемый
under way- в процессе осуществления
unless- если … не
unlikely- маловероятно
until recently- до недавнего времени
until then- до того времени
up to- вплоть до
vice versa- наоборот
whatever- какой бы ни
whenever- когда бы ни

whereby- тем самым
wherein- в чем
whether…or- или … или
with a glance to- с учетом
with a view to- с целью
without question- бесспорно
with reference to- ссылаясь на
with regard to- с намерением
with respect to- по отношению к
with the exception of- за исключением
worth-while- заслуживающий внимания