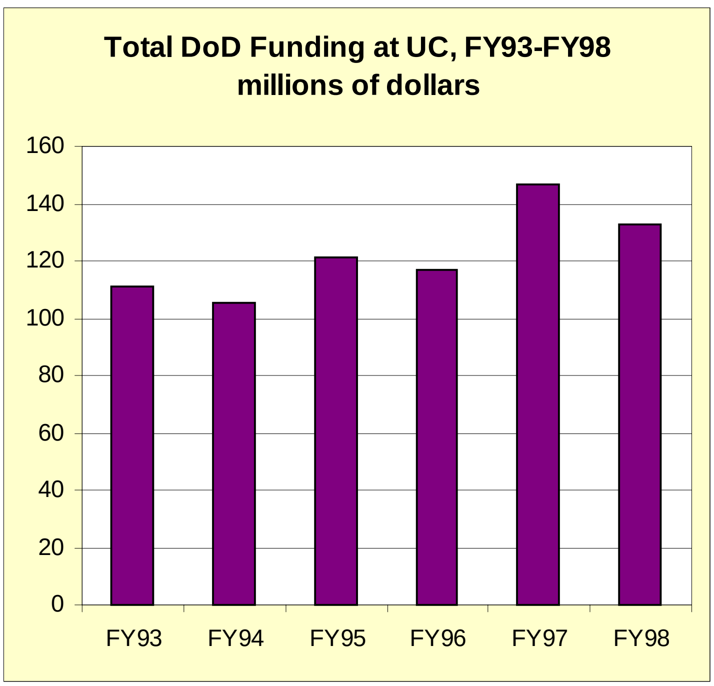
DoD at UC

OFFICE OF RESEARCH, UC OFFICE OF THE PRESIDENT SPRING 1999

The Department of Defense at the University of California

In fiscal year 1998 (July 1, 1997–June 30, 1998) the Department of Defense awarded the University of California $133 million, about 10 percent of the total awarded by the federal government to UC.

The amounts awarded have risen since the early 1990s. In inflation-adjusted dollars, DoD expenditures at UC peaked in the 1960s, declined in the 1970s, and have risen gradually since then back to their 1960s levels.



The Department of Defense has been a generous patron of research, especially in the early post-war period. The Office of Naval Research (ONR) took the lead in federal government support for scientific research until the formation of the National Science Foundation. The Defense Advanced Research Project Agency (DARPA) has also played a pivotal role in the foundation of many new technologies. DARPA is

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DoD funding facts in brief

- In FY98, DoD awarded $133 million to UC.
- DoD awards 10 percent of all federal research dollars to UC.
- UCSB gets one-third of its federal research funding through DoD.
- DoD's breast cancer research program is highly regarded for incorporating advocates and survivors (page 6).
- DoD continues its historic role in developing Internet technologies (page 7).
- With the help of DARPA, UCSB is helping to bring the fiber optic revolution closer to the home (pages 4-5).
- The Office of Naval Research is funding innovative environmental clean-up techniques at the Alameda Naval Air Station (page 6).
- UCI and DARPA are exploring ways to increase the speed of memory-intensive computing by a factor of 100 (page 2).

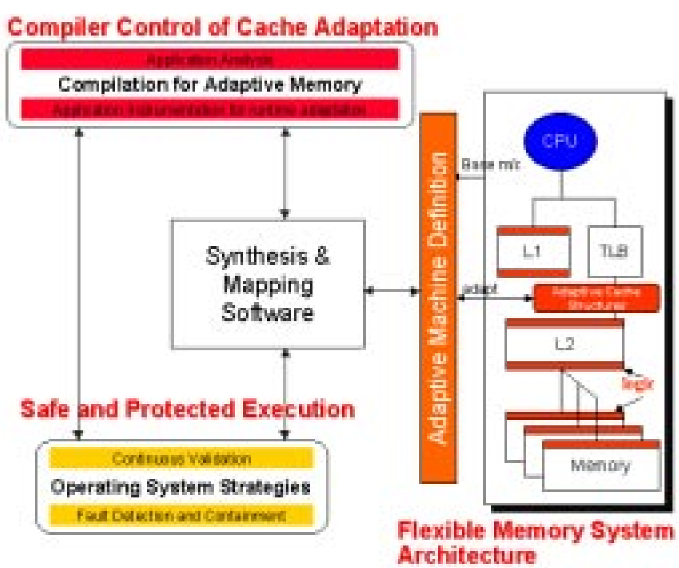
Mighty Morphing Computers

Gordon Moore, a founder of Intel, coined what is known as "Moore's Law"–the power of computer chips doubles every 18 months. Even though hailed as a wonder of modern technology, this rapid advance in computing power has left many problems in its wake. Computer processors are dependent upon a whole group of other devices–hard drives, memory chips, modems–to function. Moore's law begs the question of what happens when all the other devices can't keep up.

The problem is particularly acute for dynamic random access memory (DRAM) chips. Although microprocessor speeds double every 18 months, DRAM speed increases only at a rate of about seven percent annually. Increasingly, microprocessors are becoming data-starved as they wait for the slower DRAM chips to feed them information.

Military computer applications like high definition imaging and large databases are data intensive. For these applications, microprocessor speed is no longer the problem. Memory is now the bottleneck.

DARPA is funding research at UC Irvine to overcome the memory bottleneck. The MORPH Adaptive Memory Reconfiguration and Management (AMRM) project will attempt to create a memory architecture that demonstrates an improvement of two orders of magnitude (100x) in memory system performance. The project is lead by researchers at UC Irvine, Professors Rajesh Gupta and Alex Nicolau, with help from Professor Andrew Chien of UC San Diego.



The MORPH AMRM project is designing a flexible memory system architecture that will allow for 100x increase in data-intensive computing speeds. The flexible memory will also require changes in compilers and operating system strategies.

The basic idea is to design a memory system that is flexible and can adapt itself optimally for different computing needs. Huge spreadsheets, relational databases, and graphics applications all might use data in very different ways. For optimal performance, each type of program requires a very different memory architecture to keep feeding the data-hungry microprocessor.

Creating hardware with application-specific memory configurations is very costly. Another solution is to design memory that is flexible and can be reconfigured to suit the particular software that needs to be run.

Gupta likens the problem to a hotel conference center with rooms of a fixed size. A conference with a few very large meetings would find some rooms overcrowded, and others empty. A conference with many small meetings would find all rooms underutilized and some meetings with no rooms at all. The solution is movable partitions that can adapt the room size to the size of the meetings.

This is precisely what memory reconfigura-tion does. It allows the configuration of the memory to be changed by the program itself to optimize its own performance.

DARPA's emphasis on dual-use technologies means that the improvements fostered by MORPH AMRM will eventually find their way to the commercial sector, which in turn will allow the DoD to purchase the hardware it needs without having to resort to custom products and prices.

Defending Against Breast Cancer

What is an Agency better known for funding new missile systems and advances in electronics doing waging battle against breast cancer?

In 1992, Congress appropriated $25 million to study breast cancer among military women and families. Breast cancer research advocates lobbied for more money, and in 1993, Congress raised the appropriation to $210 million, and created a peer-reviewed competitive grant program.

Dr. Laura Esserman

The DoD program is second in size only to that of the National Cancer Institute (NCI), part of the National Institutes of Health (NIH). Unlike the research sponsored by the NCI, the DoD grants are not limited to basic research. A broader approach incorporates advocates and cancer survivors as members of panels that review grant proposals and program goals.

UC San Francisco's Dr. Laura Esserman has used a $3.2 million DoD grant to help maintain a unique patient-centered breast care center. Located at UCSF's Mt. Zion Hospital and run in conjunction with the California Pacific Medical Center, the breast care center brings together radiologists, surgeons, pathologists and other cancer specialists in teams that focus on patient care.

DoD's grant is funding a study of the effectiveness of a "one-stop" patient-focused breast care center. If the grant's hypothesis proves correct–that a single-site integrated program offers advantages to the patient over a decentralized system–then the center could serve as a national model to other institutions.

Trained at Stanford University, Dr. Esserman returned to her alma mater and earned an MBA degree in 1993. Dr. Esserman takes a holistic, people-centered approach to her work, but she also brings to the breast care center her training in operations management. Her goal is to deliver health care services as efficiently as possible.

"We want to find the simplest, easiest and most patient-friendly way to evaluate people who have breast abnormalities and cancer," Esserman said. "We also want to make sure that innovations from the laboratory reach the patients as quickly as possible."

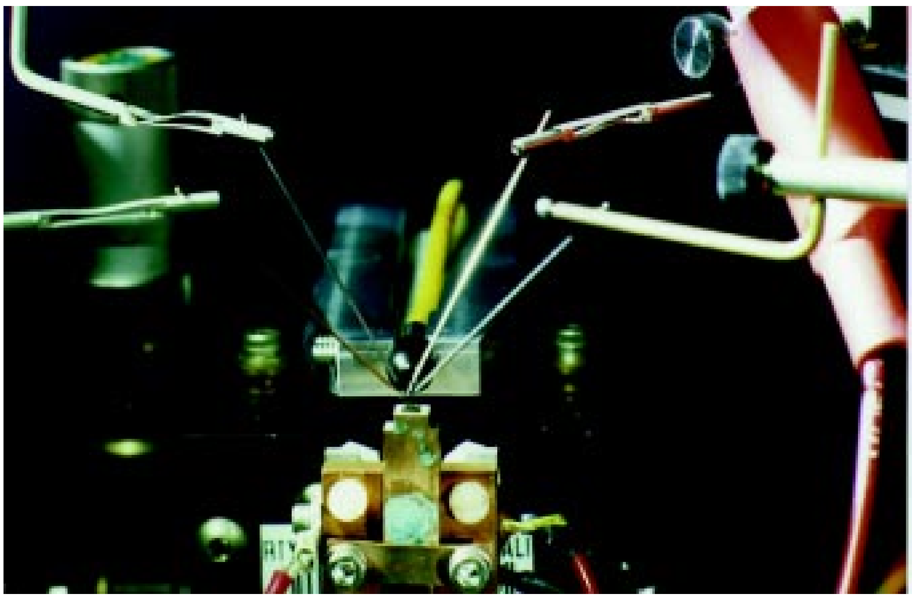
The breast cancer center features a drop-in chemotherapy center, and a gift store for wigs and other cosmetic needs. Many of the staff members are themselves breast cancer survivors. It shares a cafe, garden and a small patient-centered research library with the other cancer centers at Mt. Zion.

As the roles for women in the military expand, their unique health care needs will become a larger part of the military's health care planning. With the help of DoD, Dr. Esserman is helping to streamline breast cancer health care delivery,

A patient in the waiting area of UCSF's patient-oriented Breast Care Center. With the help of DoD, UCSF is has created and is evaluating the benefits of a model program that integrates many services into a comprehensive "one-stop" center.

Speaking Electrons, Hearing Photons:

At the end of the 19th century, a new mode of sending information revolutionized communication. Dubbed the "Victorian Internet," the telegraph used a binary digital code of dots and dashes. This Morse code was crude but effective. On board the sinking Titanic, the ship's two telegraph operators kept sending S-O-S signals even as the water rose around them. Only one of them lived to see the results–the arrival several hours later of the steamer *Carpathia*.



This prototype optical switch is capable of switching light signals without first having to convert them into electronic form.

Using Morse code, the communication rate was limited by the speed of the human hand and ear to no more than a few dozen bits per second. Compare that to the speed of a modern personal computer modem, which can talk at speeds of up to 56,000 bits per second–more than 2,000 times as fast as the telegraph operator on the Titanic.

The increase in speed between the telegraph and a PC modem pales in comparison to the speed difference between modems and fiber optics. A single fiber optic strand, thinner than a human hair, can carry hundreds of billions of bits per second. That's over a million times faster than the best PC modem. A small transoceanic fiber optic cable is sufficient to carry all the long distance phone communications for a small country simultaneously.

The fiber optic revolution is very young. Using light to transmit information was first proposed in the 1960s. The critical techniques for creating the glass wires were patented in 1972, the first fiber optics were used commercially in 1979, and the first transoceanic cable was laid in 1987. The cost of long distance telephone calls has plummeted as a result.

A single fiber optic strand is like a data
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operating a transoceanic cable, it's not
can be–bank after bank of lasers and el
this technology to control a fighter jet,
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electrons and photons–the way electro
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With the help of a $6 million grant fro
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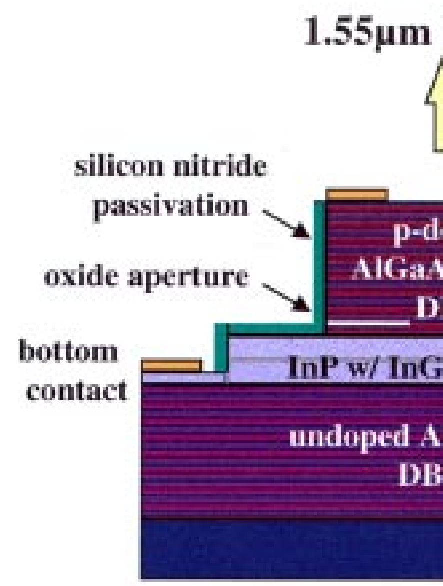

The VCSEL (vertical cavity surface emitting la
millimeter wide. Consisting of alternating lay
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Optoelectronics at UC Santa Barbara

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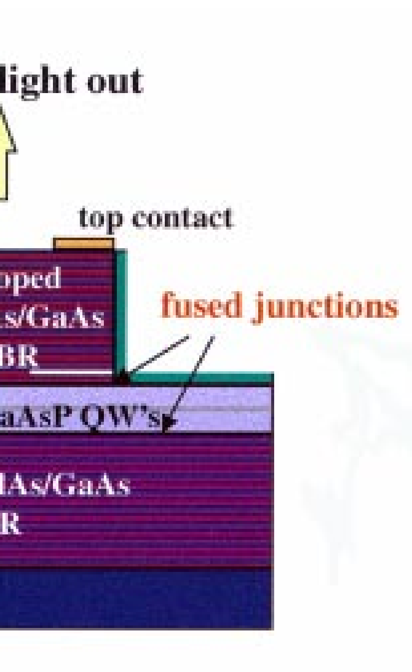

ser) is only ten microns, or 1/100 of a
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By building an array of several different lasers, each tuned to a slightly different frequency, several different messages can be sent down the same fiber simultaneously. This wave division multiplexing (WDM) has allowed for the rapid increase in fiber optic transmission rates, which are now about 1,000 times faster than their predecessors two decades ago.

Increasing efficiency in fiber optic communications demands that the conversion back and forth between photons and electrons be kept to a minimum.

The communication system being tested here can transmit at the 30 gigabit level–30 billion bits per second.

The problem of amplifying the light signals (without converting them back to electronic form) has already been solved. The next hurdle is optical switching. For now most of the signals must be converted back to electronic form to be routed from city to city or house to house. Household fiber optic hook-ups to the Internet won't become a reality until switching can be done optically.

The is the domain of another DARPA-funded project at UC Santa Barbara, the Center for Multidisciplinary Optical Switching Technology (MOST). Along with funding from the National Science Foundation, MOST is exploring techniques to sort out dozens of signals of different wavelengths, and to route them to several different locations without having to convert to signals to electronic form. The work at MOST is directed by Professor John Bowers, with the collaboration of many OTC researchers.

DARPA and UCSB's optoelectronics centers are leading the way to safer and more reliable "fly by light" military and commercial airplanes, the end of the "world wide wait," and ever cheaper long distance phone and video communications.

To Turn a Brown Site Green

The idea first came to Professor Kent Udell from watching oil extracted from old wells using pressurized steam. Why not use the same techniques to remove toxic chemicals from contaminated soil?

Professor Kent Udell

With the help of a grant from the Office of Naval Research, Udell, a mechanical and civil engineer at UC Berkeley, is demonstrating the technique at the site of the Alameda Naval Air Station.

Located on prime San Francisco Bay Area real estate, the Alameda NAS is scheduled to be closed. The land cannot be commercially developed until contaminated sites are cleaned-up. The major environmental problems at the 2,800 acre base are an aviation fuel spill, and two landfills totaling more than 100 acres contaminated with trichloroethylene (TCE).

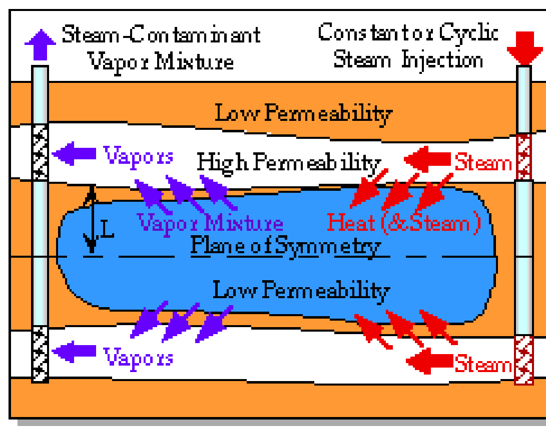
The technique pioneered by Prof. Udell has been featured in recent articles in the *L.A. Times* and *Scientific American*. High pressure steam is injected into perforated steel pipe sunk around the region of contamination. A vacuum pump sucks the steam from the outer ring to a central well. The steam scours out many of the most common liquid contaminants, including gasoline, diesel fuel and industrial solvents. Condensers at the surface capture the fluids and vapors for recycling.

Located on prime Bay Area real estate, the former Alameda NAS cannot be developed until contaminated sites are cleaned up.

The effort will be coordinated through the new Berkeley Environmental Restoration Center (BERC), with assistance from the Lawrence Livermore and Lawrence Berkeley National Laboratories. BERC will bring in both students and other faculty to take advantage of this unique opportunity to study a large-scale clean-up of a military base.

At the Lemoore Naval Air Station, located mid-way between San Francisco and Los Angeles, Udell and his crew were able to clean up a major jet fuel spill caused by a leaking pipeline. In a demonstration project, they recovered 80,000 gallons of jet fuel, which was then sold to a recycler.

At a Consolidated Edison yard in Visalia, California, this steam technique removed 902,000 pounds of contaminants. It would have taken more than 1,000 years to achieve the same results using conventional pump-and-treat methods.



In Udell's technique, high pressure steam is injected into perforated steel pipe sunk around the region of contamination. The steam vaporizes many of the most common liquid contaminants.

According to Udell, "We are trying to tap into the expertise at the University and the national laboratories to make a contribution to the Navy and the taxpayers. I hope that the front-end studies will lead to more cost-effective ways to do the total clean-up. If we can shave 10 percent off the total clean-up bill that will have been a great investment."

Pure Web–no Wires, No ISPs

Professor J.J. García-Luna Holds a Prototype Wireless Internet Gateway (WING)

Professor J. J. García-Luna considers himself an Internet plumber. If everything he designs works well, no one ever notices. The *transparency* of his devices makes it difficult to explain exactly what they do.

Put one way, García-Luna is trying to do is to extend the concept of the wireless modem. The wireless modem is basically a small data cell phone that attaches to a laptop computer. So equipped, a user can browse the Web or answer e-mail while from anywhere–a library, a beach–within range of a receiver.

García-Luna is taking this concept one step further. Even a wireless modem has to connect to the Internet via an Internet service provider (ISP). With a wireless internet gateway (WING) a laptop computer could become an integral part of the Internet itself.

Think of it another way. The Internet traces its roots to the DoD-funded ARPAnet. Much of the early work centered around designing protocols and algorithms for sending information in discrete packets over constantly shifting electronic routes, and having the packets reassembled at the destination.

This packet-switching technology gives the Internet its robustness. With the help from several DARPA grants, García-Luna is taking this whole concept into the wireless realm.

Imagine WINGs small and durable enough to be standard equipment for soldiers or fire fighters. Each fighter could be wired with medical sensors and a global position satellite (GPS) monitor. Via WINGs, even an unconscious soldier could transmit vital signs and an exact location to nearby comrades or to a rescue vehicle.

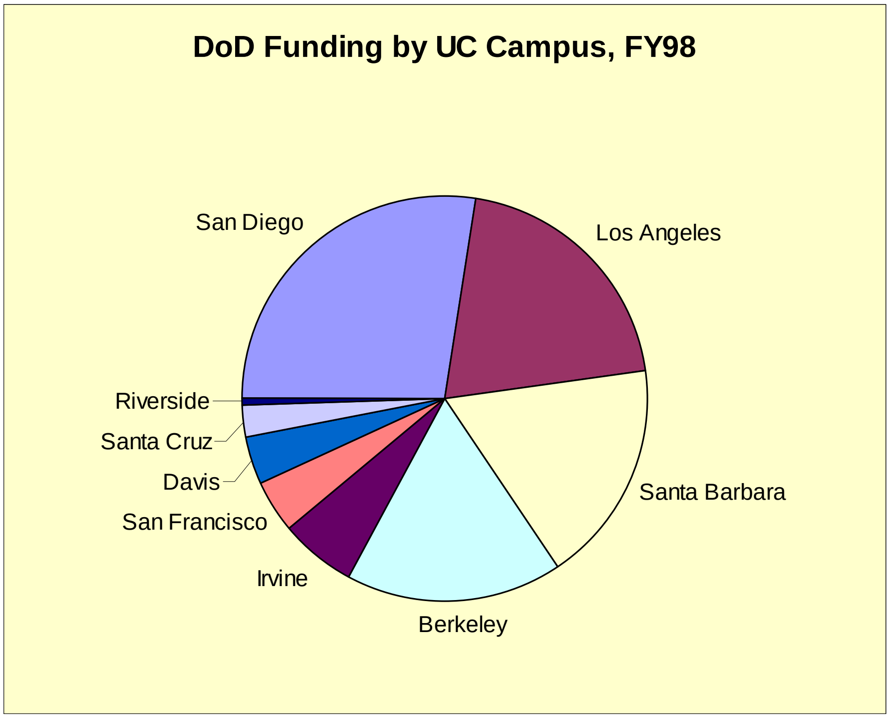
For the rest of us, WINGs could democratize the Web and bring it into a nomadic environment. You could carry your Web home page files with you on your vacation, and update them as you travel. Or you could attach a Web camera to your laptop and take it with you to a remote job site.

According to García-Luna, "People need to move more and more often, away from walls and workstations. We're trying to make networking pervasive and transparent. It will be everywhere, but you won't know it's there."

(continued from page 1)

probably best known for funding the development of the ARPAnet, the precursor to today's Internet.

At UC, the San Diego campus took the largest share of DoD spending at 28 percent. The three campuses at Los Angeles, Santa Barbara and Berkeley each took roughly 20 percent. Although not as large as the Los Angeles, Berkeley, or San Diego campuses, the Santa Barbara campus did relatively well–approximately 33 percent of total federal government support to Santa Barbara comes from DoD alone. This is due to the strength of the engineering programs at Santa Barbara. The other five campuses at Irvine, San Francisco, Davis, Santa Cruz and Riverside share the remaining 17 percent of DoD funds.



Although federal support for research has held up better than many observers predicted at the end of the Cold War, the success has been mixed. The National Institutes of Health have done well in recent years, and the health sciences in general are predicted to continue to fare well. The results have been more mixed for DoD and NSF research funding. The chances for substantial increases in DoD research funding are not considered good.

For more information about DoD awards at UC, please contact:

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