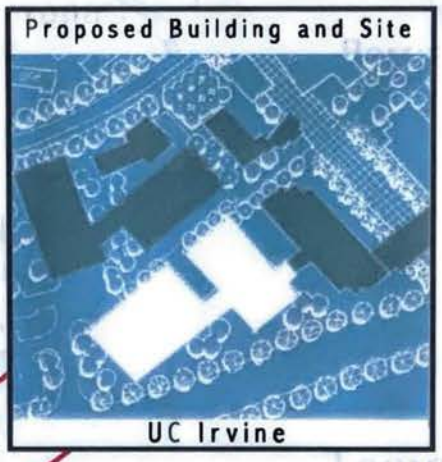
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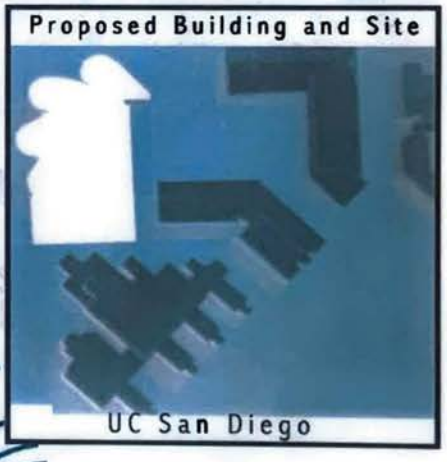
UC San Diego & UC Irvine

A CALIFORNIA INSTITUTE FOR SCIENCE AND INNOVATION

California Institute for Telecommunications & Information Technology



High Tech Coast





University of California

California Institutes for Science and Innovation

Cover Sheet

Must Accompany All Applications

Send To:

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University of California, Berkeley
Berkeley, California 94720-3340

Project Title:

California Institute for Telecommunications and Information Technology [Cal-$(IT)^2$]

Requested Budget Amount:

$100M

Matching Contributions Amount:

$200M (but we project $257M total in matching contributions)

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B. Abstracts

(These descriptions are meant to serve as succinct, accurate descriptions of the proposed work when separated from the application.)

TECHNICAL ABSTRACT: (1/2 page or less)

The California Institute for Telecommunications and Information Technology [Cal-(IT)^2] will conduct an integrated study of the "new Internet" infrastructure: Digital wireless, broadband to the home, an all-optical backbone, and novel information technologies it will require. We have assembled strong, interdisciplinary teams from UCSD and UCI faculty, research professionals, and students, working with industrial partners organized vertically in five interacting "layers": 1) Materials and Devices: novel materials and devices critical for the new infrastructure--molecular materials; optical, wireless, and storage components; and micro-electro-mechanical system (MEMS) devices; 2) Networked Infrastructure: digital wireless, broadband, network architecture; protocols and management; photonics; sensors; and storage; 3) Interfaces and Software Systems: secure and scalable distributed system software, mobile agents, knowledge management and data mining, and human-computer interfaces, 4) Strategic Applications: environment and civil infrastructure; energy; intelligent transportation; telemedicine, bioinformatics, and digitally enabled genomic medicine; and the new media arts, and 5) Policy, Management, and Socioeconomic Evolution: Spectrum allocation, privacy, intellectual property, and networked enterprises. These teams will conduct frontier research and develop novel educational environments using real-world "living laboratories," enabling evaluation of new Internet technologies using a systems approach. We have constructed our program to accelerate the transfer of our prototypes to the marketplace.

NON-CONFIDENTIAL, NON-TECHNICAL ABSTRACT FOR PUBLIC INFORMATION OR PROGRAM PROMOTION: (1/2 page or less)

Major changes in the structure and scale of Internet telecommunications will occur over the next decade as large numbers of mobile end points—information appliances, sensor arrays, and embedded processors—are added to digital wireless extensions of the current Internet. At the same time, tens of millions of households and businesses will move from modems to broadband connections. This combination implies huge increases in the Internet's backbone capacity, leading to an all-optical core architecture. The California Institute for Telecommunications and Information Technology [Cal-(IT)^2] will team UCSD and UCI faculty, students, and research professionals with leading California telecommunications, computer, and software companies to research the scientific and technological components required to bring this "new Internet" into being. We will focus on extending the current wired Internet into the physical world, efficiently gathering critical data and making it easily available for interpretation. Institute applications researchers will "live in the future" on leading-edge testbeds to investigate how this new Internet will accelerate advances in environmental science and energy, transportation, medicine, entertainment, policy, industrial management, and education. The organization of our institute is farsighted: It is not a loose collection of faculty research projects, but a well considered strategic plan to conduct an interdisciplinary, integrated study of the impact of the new Internet telecommunications infrastructure on California.

PROJECT OBJECTIVE: Provide a one to two sentence, non-technical description of the project's overall objectives and key milestones. (one or two sentences)

The California Institute for Telecommunications and Information Technology will research and develop prototype technologies to extend the reach and capacity of the new Internet, that, in turn, will enable revolutionary advances in applications important to California's economy: environmental and civil infrastructure assessment, transportation, health care, artistic expression, e-commerce, and education.

D. Research Plan

D1. Research Plan

The Internet information infrastructure is poised to undergo several fundamental transitions during the next decade. Explosive growth of digital wireless Internet channels will connect vast numbers of *mobile* end points (information appliances, sensor arrays, and embedded processors) to the fixed Internet components, at the same time tens of millions of households and businesses will move from modems to broadband connections. This confluence of trends will require the Internet's fiber backbone to carry highly parallel wavelengths of light. As David Nagel, President of AT&T Labs, says in his supporting letter, "Here at AT&T, we believe the next-generation information infrastructure will change our lives in ways we can't imagine today."

California's companies justly enjoy a leadership position in today's Internet technologies and wireless mobile voice communications. However, as the "technological discontinuities" inherent in the creation of the new Internet come to pass, leadership may shift among existing companies or to companies that don't exist today, based on products and services derived from innovative science and technology. To help ensure that California maintains its leadership in the telecommunications and information technology marketplace, UCSD and UCI have teamed, in response to the Governor's initiative, to propose the California Institute for Telecommunications and Information Technology [Cal-$(IT)^2$].

Our institute's mission is simple—*extend* the reach of the current information infrastructure throughout the *physical* world. As simple as this statement is, the research required to bring it to pass is formidable. For instance, sensing the environment and civil infrastructure continuously and efficiently requires research on materials, devices, circuits, and systems-on-chip to create a new generation of low-cost, low-maintenance, low-power nodes that can sense, store, process, and communicate data. New research on devices, circuits, and communication systems is needed to develop a common untethered communication fabric. Organizing the large-scale sensor networks demands software research on self-organization, scalability, and security.



Figure 1: Conceptual Framework for Cal-$(IT)^2$

The "new Internet" will be *an integrated system.* However, one of the innovative aspects of our institute is how we decompose that system into five vertically interlocking set of "layers," each teaming academic and industrial researchers on interdisciplinary problems: Materials and Devices, Networked Infrastructure, Interfaces and Software Systems, Strategic Applications, and Policy, Management, and Socioeconomic Evolution (Fig. 1). In Strategic Applications, we assembled four drivers—Environment and Civil Infrastructure, Intelligent Transportation, Digitally Enabled Genomic Medicine, and the New Media Arts—to foresee the long-term potential of the infrastructure's capabilities and provide feedback to technology developers. These applications target core concerns addressing California's quality of life and represent large market segments of California's economy poised to be transformed by the new Internet.

We can understand the intricate interactions between applications and new Internet technologies only by deploying prototype instrumented "smart environment" testbeds, enabling

institute participants to "work in the future" in a continually improving, mobile digital environment with flexible information management resources, tied together with a high-bandwidth fiber backbone. These testbeds will allow researchers to "plug in" new algorithms and experimental systems, receiving immediate feedback. Industrial partners will gain first-hand experience with product prototypes and identify, early on, new services and products that the infrastructure will require. Students will learn in this powerful, dynamic environment and, upon graduation, become the leaders of the next generation of research and development in academia, industry, and government. Policy makers and business management experts will have the opportunity to study emergent issues in this "living laboratory."

No single investigator could hope to study this emerging system in its entirety, nor does any single company have sufficient resources to dominate the corresponding market. Our institute, by contrast, because of our organization and vision, expects to make a significant impact. We will work at the frontiers of the new Internet telecommunications infrastructure at least 3-5 years ahead of commercial practice, yet tightly coupled to long-term basic research that will lay the foundation for products 5-10 years into the future.

In short, the whole of our institute is more than the sum of its parts. As the CEO of the pre-IPO startup Silicon Wave says in his supporting letter: "We are excited about the innovative approach being taken in assembling a team of researchers spanning from device physics to applications to policy. In fact, we see this aspect of your institute as bringing a unique new capability to California."

As our proposal cover shows, our institute spans the "High Tech Coast," home to a concentration of telecommunications and information technology companies that most agree will be the site of *the* major economic growth in California over the next 10-20 years. We have partnered with many companies in this area and with leading companies in Silicon Valley and elsewhere in California and the U.S. to ensure our institute will have a continuing impact on the State's economy. Industrial partners strongly support this plan as shown by their commitments already in excess of $139 million. In addition, we have firm pledges of $32 million in foundation and individual gifts and $30 million in Garamendi cost sharing, and expect $56 million in federal grants over the next four years based on our demonstrated track record in recruiting federal research grants (Sec. C). This totals $201M committed and $257M in projected matching funds.

Organization by Science and Technology "Layers"

Over the last nine months, starting from our central theme of the new Internet, we have deconstructed the theme into its subcomponent layers, searched out and engaged some 200 UCSD/UCI faculty and research professionals (identified by team in App. A), and developed partnerships with 28 key companies identified in Sec. F. Each team has, from the bottom up, chosen its "layer leaders" (App. A) and engaged in many group meetings, which, over time, has resulted in the research plan described below. Each layer is integrated between campuses and with our industrial partners, but, in each case, leadership is clear. The result is a new "critical mass" of collaborating researchers in each logical layer, built from excellent individual researchers, most of whom were not collaborating with each other prior to our team building process. We have carefully designed many "vertical" links between layers so as to make a "supercritical" interacting whole. Significantly, many of the faculty members have commented that this process has started "changing the culture" of the campuses toward a more cross-disciplinary approach. Without the Governor's initiative, it would have been essentially impossible for a systems-integrated approach on this scale focused on serious California problems to have come into being.

1. Materials and Devices

Materials and device technologies developed over the past few decades have provided the foundation for the current explosion in computing systems, wireless communications, and optical networks. For example, fiber-optic capacity has increased over the past decade from 10 to 3000 Gbps because of doped fiber amplifiers, semiconductor lasers, high-speed optical modulators, wavelength filters and routers, and high-speed devices for associated electronic circuits. Similarly, breakthroughs in materials and device technology have the potential to enable dramatic advances in the new Internet telecommunications systems (Fig. 1).

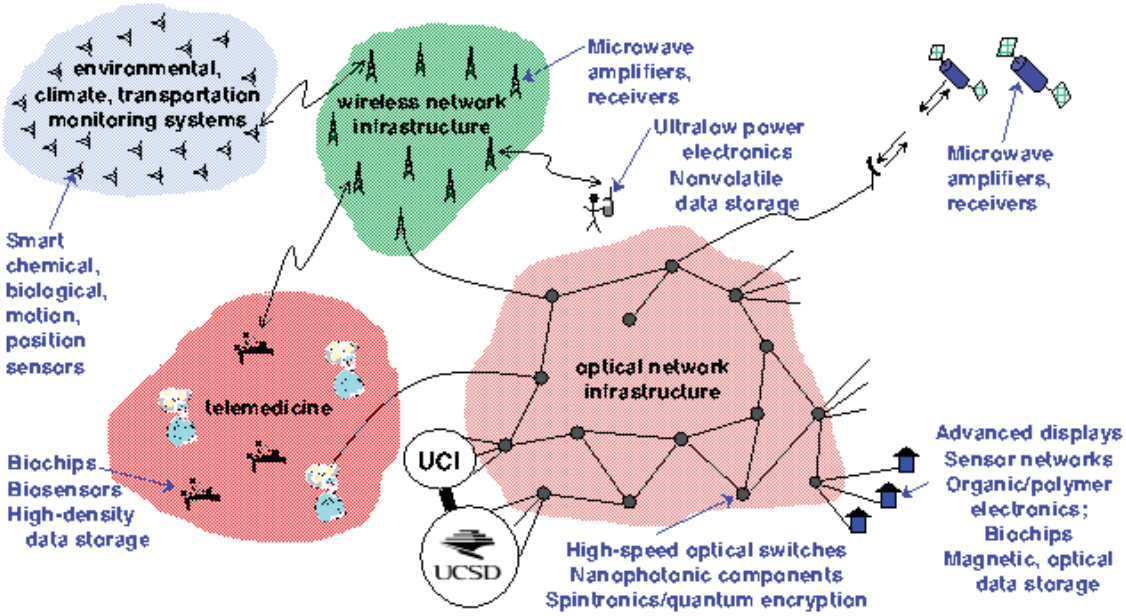


Figure 2: Advanced materials and devices play an essential role in all parts of the new Internet.

Further increases in optical network capacity will depend on new materials and device concepts, based on nanoscale design and engineering of photonic materials, ultra-small device structures such as thresholdless lasers, and micro-electro-mechanical systems (MEMS) for compact optical components. Wireless, high-speed, handheld access to the Internet will require new ultra-low-power, high-speed transistors and advanced materials and processing. Industrial partners AMCC, Broadcom, Conexant, Ericsson, IBM, and Intersil will be involved closely in our projects.

Cal-$(IT)^2$ will create experimental facilities (Sec. D4) to enable research in four critical areas:

- **Materials and devices for wireless communications:** This effort will focus on (1) ultra-low-power devices operating at frequencies of several GHz to >100GHz based on advanced semiconductor heterostructures, devices scaling to nanoscale dimensions, and novel materials for gate insulators, contacts, and packaging; (2) high-power microwave transistors for wireless network infrastructure based on wide-bandgap semiconductors such as GaN; (3) novel integrated materials based on wafer bonding, hetero-epitaxial growth, and self-assembly for advanced electronic device, passive components such as inductors, capacitors, and resonators, and efficient systems integration; and (4) spintronics for nonvolatile, high-density memory and very-high-frequency microwave filters. This work will be led by UCSD and work with Networked Infrastructure (next section).
- **Materials and devices for photonic networks:** We will develop highly tunable, multi-spectral light sources, advanced receivers, wavelength converters, optical amplifiers, dense

wavelength division filters, and high-speed optical switches and routers based on advanced semiconductor heterostructures, micro-electro-mechanical systems (MEMS)-based components, and nanoscale engineering of optical properties of materials and devices. These components will enable transmission of information at speeds an order of magnitude or more higher than current technology in land-based optical communication systems, with scalability from long-haul to chip-to-chip optical links enabled by nanoscale design and fabrication (Fig. 3). This work will be led by UCSD in conjunction with Networked Infrastructure.

- **Molecular materials:** We will develop sensors and switches with ultra-high sensitivity, chemical and/or biological specificity, fast response, and ultra-low-power consumption from molecular and hybrid polymer materials easily fabricated to any shape and at very low cost. This effort will be led by UCI, with the development of biochip sensors led jointly by UCI and UCSD. We will work with the applications teams to develop implantable biochips for *in vivo* monitoring of blood chemistry, combined with wireless telemetry for data collection and offline analysis, implantable systems for feedback-controlled drug delivery, and wireless, self-powered environmental (chemical/biological) sensors to monitor California pollution.
- **Micro-Electro-Mechanical Systems:** Communication system-on-a-chip and medical diagnosis lab-on-a-chip are essential for future wireless medical devices. Here we will focus on integrated (amplifier and filter/switch) devices and bio-compatible polymers, and bio-MEMS fabrication processes to create disposable bio-chips for the Environment and Civil Infrastructure and Telemedicine applications. This work will be led by UCI. We will work with the applications to develop disposable biochips for mobile (wireless) health monitoring and drug screening and three-dimensional DNA array detectors.

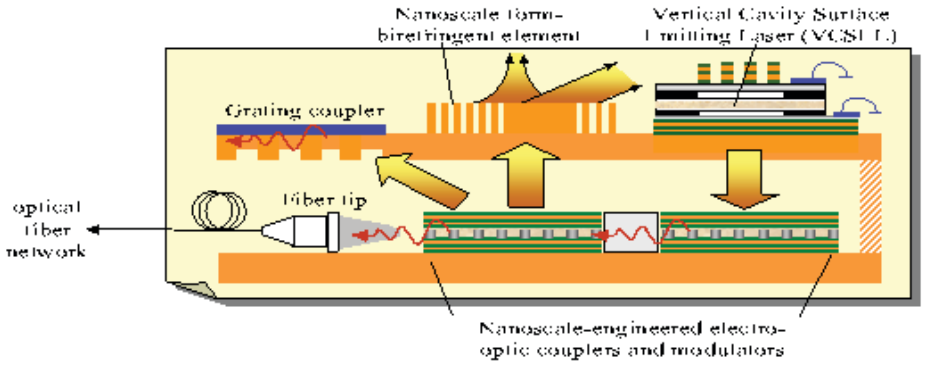


Figure 3: Nanoscale design and fabrication techniques will develop ultra-compact, integrated photonic chips for optical communication and data network systems.

2. Networked Infrastructure

Cal-(IT)^2 has assembled a team from UCSD's Center for Wireless Communications (CWC), Center for Magnetic Recording Research (CMRR), San Diego Supercomputer Center (SDSC), and UCI's Center for Pervasive Communications and Embedded Systems Research Center with expertise in all components of the new Internet's networked infrastructure: digital wireless, broadband, fiber links, network architecture, protocols, management, computing, and storage. We will research and construct several large-scale prototype testbeds described (Sec. D4).

The seminal work of Claude Shannon, published some 50 years ago, established limits on reliable communication and compression, and launched the systematic study of coding, signaling, detection, classification, and compression. Cal-(IT)^2 researchers will study these topics in the context of ultra-high-density communication and storage of multimedia information over wireless, copper, photonic, and read-write channels. In particular, Networked Infrastructure will

research advanced signal coding and decoding techniques, including "Turbo Codes," low-density parity check codes, and newly emergent iterative decoding. We will investigate space-time codes and processing to generate order-of-magnitude increases in spectral efficiency. Future broadband wireless systems, when called upon to support high data rates over limited frequency bands, may have to operate with low processing gains and rely on spatial diversity techniques. The need to provide quality-of-service guarantees to voice, data, and other sensor traffic streams will require us to study adaptivity at every level of the protocol stack to design the communications receiver. We will also focus on novel data compression and bandwidth efficient modulation techniques. Cal-$(IT)^2$ industrial partners here will include Ericsson and Qualcomm.

Cal-$(IT)^2$ will establish a Telecommunications Circuit Laboratory, a powerful national resource to design and implement the most advanced integrated circuits for wireless and optical communications networked applications. As silicon technology drops to the sub-0.1-μm level, mobile wireless devices will require single-chip advanced radio circuits that can tune over multiple standards and self-calibrating data converters that digitize data increasingly closer to the antenna. We will investigate baseband digital processor architectures to accommodate advanced wireless multimedia applications in an energy-efficient manner. We will also investigate new circuit architectures and interface approaches that enable implementation of the optical interconnection protocols at the >40GB/s rates. Here we will work closely with AMCC, Broadcom, Conexant, Copper Mountain, Ericsson, IBM, Intersil, Qualcomm, and STMicrosystems.

Extraordinary advances are occurring in microelectronic design and integration of portable networked embedded system devices. We will focus on improving RF transceivers, radio modems, wireless link controls, cellular and Internet protocols, audio and video processing, and security mechanisms. Finally, we will improve algorithms, methods, tools, and software libraries to conceptualize and implement complex microelectronics-based systems on a chip targeted for network-embedded applications.

Ubiquitous access to the Internet from handheld wireless terminals and sensors will require research on algorithms for media access, congestion control, signaling strategies, security, resource allocation, service composition, and pricing for wireless access to the Internet using sensor-based and power-aware hardware/software. For example, UCI's Center for Embedded Computer Systems research on "smart environments" is investigating the use of thousands of small, disposable, wireless sensor packages to "blanket" an area of interest (such as a remote environmental area). In such scenarios, power budgets/package will be so small that each sensor cannot afford the power to connect to the Internet using a cellular telephone. Instead, the sensors themselves must form autonomous, self-organizing systems in which data will be forwarded and routed through the sensor network until they "find" devices with more powerful transmission capabilities. Such self-organizing *ad hoc* networks will enable rapid deployment of sensing arrays in emergencies without pre-planning.

Our work building reliable networks from unreliable links will address smart media access protocols and link adaptation algorithms. We will also consider network and transport layer protocols, including TCP over wireless links and IP multicasting for wireless networks with mobile terminals. The recent emergence of competing technologies that target the unlicensed RF band could lead to large-scale, uncoordinated systems sharing a common resource. We will use our campus-wide, wireless testbeds (Sec. D4) to investigate control algorithms to mitigate interference between large-scale distributed networking systems. Researchers from UCSD's

Dynamical Systems and Control group will study the stability of free and controlled systems together with quantification and realization of improvements achievable via feedback.

While higher microwave frequencies are expected to cater to the growing demand for wireless services, optical-fiber links in the backbone of the global telecommunication network must also scale to address future needs. We are building a strong fiber-optics group based on work in UCSD's Ultrafast and Nanoscale Optics Laboratory and industrial partners AMCC, Broadcom, Cox Cable, Global Photon Systems, IBM, OMM, and TeraBurst Networks. We will focus on three critical scales for photonic coupling: nanoscale devices to enable highly parallel wavelength division multiplexing (WDM), short-range optical links inside and between computers and peripherals, and global WDM testbeds (Sec. D4).

Just as important are developments in widespread distributed storage.UCSD's CMRR studies the science and engineering of magnetic materials, design and fabrication of disks and read-write transducers, and performance of mechanically engineered servo control at very small physical scales. In Cal-$(IT)^2$, CMRR will work with CWC to develop signal processing and coding methods for very low signal-to-noise ratio channels. CMRR will explore novel recording technologies based on patterned recording media, holographic recording materials, nano-scale mechanical structures (permitting storage at atomic scales), and storage architectures for mobile communications and computing networks.

With respect to computing and data analysis, Cal-$(IT)^2$ is strengthened by its partnership with UCSD's SDSC. This, in addition to partnerships with the Los Alamos (LANL) and Lawrence Livermore National Laboratories (LLNL) guarantees our institute will have access to the world's most advanced computational resources. Cal-$(IT)^2$ will enhance this infrastructure, focusing on data mining, visualization, distributed computing, and storage. Leveraging these resources with additional funding from Ericsson and Qualcomm, we propose to create a holistic, software-based communication testbed to simulate complete commercial communication systems. We will use it to study propagation, modulation, coding, spreading, power control, scheduling, and link and transport layer protocols.

Currently, two million homes have cable modem or DSL, and that number will jump to 30 million in the next three years. UCI's Interoperability Lab and UCSD's CWC are developing a strong program on next-generation broadband with industrial partners Broadcom, Conexant, Copper Mountain Networks, and Intersil. Broadband access encompasses both wireless (e.g., LMDS) and wireline services. We will pioneer the development of new applications using "peer-to-peer" distributed computing built out of broadband connections to individual PCs at homes and businesses, such as that of Entropia, one of our pre-IPO partners.

Finally, we will have a long-range basic research program on breakout technologies in telecommunications and information technology. With support from Qualcomm, IBM, and STMicroelectronics, we will investigate devices, circuits, air interfaces, and protocols for new ultra-wideband communication systems. UCSD's Institute for Nonlinear Science will develop wireless communications devices and optical devices based on optoelectronic feedback semiconductor laser systems, which produce chaotic waveforms.

With information technology shrinking to nanometer scales over the next two decades, Cal-$(IT)^2$ has assembled a multidisciplinary group of UCSD and UCI physicists, chemists, mathematicians, computer scientists, and electrical engineers who will conduct research on quantum information processing and telecommunications. Close collaboration is underway with experts in the field at LANL, and discussions are continuing for closer ties with the Caltech group. This research will create components of a "quantum Internet." UCSD will study the

design and function of a quantum computer using techniques such as optical control of excitons in semiconducting quantum dots or control of spins in magnetic quantum dots. The design will be implemented using the institute's Materials and Devices nanolithography facilities to prepare systems in which quantum effects are important. UCI will use its optical and chemical laboratories to study quantum computing using nonlinear optical methods and develop 3-D optical read/write memory, the first step toward full optical quantum computers. In the long term, quantum computers may well run algorithms that simplify a wide range of computational tasks, including those required for effective and secure telecommunications.

3. Interfaces and Software Systems

Major advances in software technologies will be required to enable the "new Internet." Areas of investigation will include large-scale *ad hoc* wireless networks, a secure metacomputing infrastructure, mobile agent technologies, sensor simulation, sensor network integration, and development of new middleware and human-computer interfaces. The need for innovation in algorithms to match the vast size and complexity of this new Internet, in turn, indicates that mathematical research will also play a critically important role in our institute. UCSD will take the lead in this layer with strong collaboration from UCI's Information and Computer Science Department, Center for Networks and Middleware Information Systems, and Center of Integrated Information Technologies for Infrastructure Systems. Underlying all Cal-$(IT)^2$ software infrastructure development will be the need for security and scalability.

Security spans authentication of people and devices to integrity of data from sensor networks to methods of encryption. Wireless platforms will form the smart communications end points for users, providing interactivity and acting as secure input/display terminals. For applications in which interactivity and availability in the face of network interruptions are important, such as providing access to medical records for emergency medical physicians, secure mobile agents will act as mobile service providers for the users' wireless devices. One of Cal-$(IT)^2$'s first security projects will be to complete and extend the UCSD Sanctuary secure mobile agent system as a wireless application security platform.

We will also examine design and implementation of a public key infrastructure to support host-security attribute certificates for security-aware migration and attribute certificates to implement role-based access control. In the real world, availability and function must be maintained in the presence of inevitable security breaches, but in large-scale environments a single global entity cannot monitor all attacks centrally. Distributed intrusion detection is needed to detect and defend against distributed attacks. Cal-$(IT)^2$ security research will team UCSD Computer Science and Engineering faculty, SDSC's Pacific Institute for Computer Security, and industrial partners Ericsson, IBM, Orincon, and Qualcomm.

Scalability of software at all levels is critical because Cal-$(IT)^2$ systems will need to accommodate growth to thousands, even millions of devices when production systems are introduced. Software integration alone will not meet these challenges. Many current software solutions for distributed and parallel computing do not scale and cannot be used in the dynamic application environment we envision, requiring us identify new software concepts.

Our "living laboratories" will face a major challenge to enable rapid, secure deployment of experimental software and hardware *and* rapid recovery from unwanted effects. We will address these challenges by using a software engineering methodology that supports careful design, prototyping, and simulation before deployment. For example, we will use UCSD's SensorNetSim, a simulator for large-scale sensor arrays, such as used in several application layers. SensorNetSim will provide a framework to implement prototypes of the various software

components and a platform to perform "virtual" experiments with sensor arrays prior to deployment of Cal-(IT)^2 's sensor infrastructure. In addition, in UCSD's MicroGrid, we will develop simulations of large-scale computational environments to represent element behavior, interactions, and the impact of load and external factors. Simulation and modeling must occur before deployment to evaluate software/hardware deployment alternatives and continuously afterwards to understand the behavior and drive the management of Cal-(IT)^2's large-scale, complex, dynamic systems.

The "Grid" is a term that refers to an integrated networked world of computing, sensors, storage, and software. To be effective, it must address a large number of software issues: security; messaging; resiliency to failure and partitioning; authentication of users, code, and data; and utilization. To achieve these goals, we will build on mature research at UCSD and UCI to develop innovative middleware to support scalable programming paradigms and adaptive Grid applications. This work will use distributed "metacomputing" techniques to adapt to dynamic environments. Our research on mobile Grids will benefit by our industrial partnership with Sun Microsystems (collaborating on our extensive use of Java, Jini, Jiro, and Solaris) and IBM.

To integrate wireless "appliances" and other devices with the Internet and support quality of service for multimedia applications, we will focus on mobile agent technology, such as UCSD's MobiMedia, which enables transmission of appliance-specific "mobile" code to information servers to tailor information at its source to meet a client's needs *before* transfer. For instance, a medical image might be filtered for optimal viewing on a portable digital assistant and reduced in size for more efficient wireless transfer. In collaboration with USC's Information Sciences Institute (ISI), we will add features to the Globus Toolkit to support mobile Grids. Finally, the Cal-(IT)^2 Grid Portal Toolkit (built on SDSC's GridPort) will provide an Internet portal testbed to facilitate experiments with wireless, Grid, and metacomputing services.

The imminence of "third-generation" wireless Internet devices will cause a major increase in demand for Grid computing. Users will demand seamless performance as they move from desktop PCs to mobile information appliances. Such performance can only be maintained if computing power *and* data resources become highly distributed "inside the Internet," enabling effective distributed data preprocessing, filtering, and data mining. We will work with industrial partners Akamai, Entropia, IBM, Leap Wireless, MedExpert, NCR, SBC, and Sun Microsystems to apply these new techniques to important types of information: scientific databases, commercial databases, and very large text databases. For instance, Webclopedia, a research project at partner USC/ISI, is one example of extending Internet-accessible information to include billions of Web pages available now only as disjoint fragments of natural language. Webclopedia functions by converting the existing "Web of pages" into a "Web of knowledge" that functions as a multilingual encyclopedia to answer simple questions.

Finally, Cal-(IT)^2 will conduct research on the human-computer interface. We will create large screen "control rooms" for analysis of very large datasets, beginning with California oil and gas companies using immersive visualization. Because of their dense data sets, they are using stereoscopic three-dimensional seismic imaging on 28' x 8' screens; this work has clear applicability to our research on telemedicine, disaster response, entertainment, and distributed learning. This work will team our New Media Arts layer, SDSC visualization experts, a research geologist at San Diego State University working with Chevron, and our industrial partner Panoram Technologies.

We will link multiple control rooms so that groups can engage in "virtual huddles," sharing cyber/physical resources to make sense of complex events, such as earthquake emergencies,

fires, floods, and oil spills. The underlying research will be relevant to practical applications, including "smart offices" that will facilitate interaction among Cal-$(IT)^2$ participants before the proposed buildings are built. Such an environment will enable users to capture meeting information, summarize it, annotate it, edit it, and re-create it. Ultimately, users will be able to recover the "state" of a situation, in effect like retrieving a saved file from a hard drive, so that subsequent meetings literally can pick up where they left off.

This shared workspace will enable a number of paradigmatic shifts: *Time shift,* where people will be able to join a meeting that has already taken place, provide their input, and affect the outcome *after* the fact; *space shift* where people will be able simultaneously to occupy the same virtual space with relevant ambience and resources (paper, communication devices, etc.); and *environment shift* where people will be able to share, swap, or invent an ambience supportive of a discussion they want to have. Shared virtual spaces are an example of adaptive (context-aware) computing, in which the physical and virtual worlds become merged. Once all objects in our workspace know the identity and location of all other objects, it will become possible to use any physical object, gesture, or voice as input devices to the Internet. We will also develop new interface paradigms to target adaptive and context-aware programs to small info appliances.

4. Strategic Applications

Here, we describe Cal-$(IT)^2$'s four strategically chosen applications—Environment and Civil Infrastructure; Intelligent Transportation; Digitally Enabled Genomic Medicine; and the New Media Arts—that will work with the technology layers and the Policy and Socioeeconomic Evolution layer (described below). Technology cannot be developed and evaluated in a vacuum. Rather, optimal development choices must be made in a "real world" testbed context. Furthermore, the use of new Internet technologies in the four applications will enable innovative basic scientific and artistic research not possible before. Finally, these applications are all critical to California's economy and its quality of life.

Environment and Civil Infrastructure. Our ability to conduct detailed studies of our environment and civil infrastructure will be transformed radically by developing and deploying sensor networks supported by a wireless infrastructure, producing--for the first time--a continuously updated set of "state variables" from the field. This, in turn, will enable us to better detect and forecast climate variability, manage natural resources, preserve and restore ecosystems, and carry out crisis management. The challenge is that we must place sensors in remote locations not convenient for landline or commercial wireless access.

As a pilot project, led by the UCSD's Scripps Institution of Oceanography (SIO), we will define and deploy, over the next four years, what we term the Southern California Wireless Environmental Sensor Network and Information System [WESNIS], extending from the Sierra mountain range on the east to the outer limits of the southern California continental shelf on the west. With the recent offer to SIO from industrial partner Chevron to use three retired offshore oil platforms in central California, we will be able to extend the line-of-sight communications offshore considerably. The data streams from these widely distributed sensors will be integrated in real time with historical data archives and sophisticated computational models of environmental processes in prototype distributed computing, visualization, and information systems ("control rooms"). We have laid a foundation for these rooms with two Keck Foundation-funded "satellite" sites of SDSC and are working with the UCSD Telemedicine satellite, SIO, SDSC, SDSU, and industrial partners Chevron and Panoram Technologies to develop unprecedented capabilities in California to analyze and enable decision making for basic research, crisis management, and industrial exploration of enormous data sets.

We will build WESNIS on previous SIO/SDSC infrastructure using point-to-point wireless Internet links and on a recent NSF award to develop a prototype wireless research/education network in southern California (App. D). In collaboration with these pioneering efforts, we will develop a testbed to provide Internet access to collect and process data from remote field sites across a variety of disciplinary areas. This project will produce a prototype architecture that can be replicated in other regions, across a variety of scales. We will use this information infrastructure to enable two environmental application projects in southern California, described next.

California's infrastructure of constructed facilities (pipelines, bridges, ports/harbors, offshore structures) is aging. Pipeline failures have already occurred in the Mojave Desert resulting in dangerous explosions and large craters that must be repaired. The same water pipeline system extends through heavily populated urban areas, often in close proximity to schools, increasing the danger. Similarly, more than 40% of existing bridge structures are functionally deficient or obsolete and in need of replacement. Therefore, monitoring the health of this infrastructure and enabling its strategic renewal (by retrofitting or replacement) is critical not only to extending the infrastructure's life span by 10-20 years, but by saving California's citizens the corresponding multi-billion dollar *annualized* taxpayer investment. Because of the importance of renewal engineering to the state, UCSD has started a research and degree program in renewal engineering.

The civil infrastructure can be damaged greatly by earthquakes. The California Division of Mines and Geology has estimated the seismic risk in California costs more than $4 billion annually. Following an earthquake, it is vital to assess the integrity of the civil infrastructure immediately. Currently, such assessment is done via on-site inspection--both time-consuming and insufficient to quantify the stresses experienced by structures. In this context, UCSD's Powell Structural Research Laboratories, the largest lab in the world conducting full-scale controlled testing of buildings, wood-frame houses, and piers, proposes to prototype with Cal-$(IT)^2$ smart infrastructure management to monitor infrastructural health and integrity and enable remote monitoring and assessment.

Preparing for earthquake-related emergencies requires continuous acquisition and telemetry of seismic and geodetic information from ground sensors, synthetic aperture radar and GPS data from space, and data from sensors monitoring the integrity of the civil infrastructure. Southern California's network of broadband seismographs and precision GPS receivers, capable of mm-level accuracy, will be integrated into WESNIS to provide reliable real-time access to their data. Together with interferometric synthetic aperture radar data, these sensors will provide a revolutionary synoptic view of ground displacement in southern California useful for quick response to large earthquakes and improved earthquake forecasting. Furthermore, adaptive actuators are beginning to be developed that, for example, can counteract--in real time--the stresses on civil infrastructure, in effect negating the forces of an earthquake. Such sensors and actuators, as they become available, will be deployed in WESNIS. Cal-$(IT)^2$ will collaborate with USC's Information Sciences Institute and Civil Engineering Department to leverage and build on the collaborative infrastructure for earthquake experimentation, simulation and analysis being designed and deployed under the NSF-funded National Earthquake Engineering and Simulation project.

Our second major focus area, the management of the California coastal ocean hydrological system requires improved technologies to monitor, understand, and predict water resource characteristics, and water hazards. The California Applications Program at SIO is partnering with the California Department of Water Resources and the U.S. Geological Survey, which have developed quantitative, model-based approaches to decision making. We will team to deploy

additional low-cost meteorological and hydrological sensors and link them to WESNIS to collect watershed data to provide a real-time view of California's watersheds.

The coastal ecosystem is subject to ever-increasing demands by fishing, commercial shipping, recreation, and human habitat. Beach closings caused by contaminated runoff is a growing economic and quality-of-life concern in California. To manage this important California resource, we will add *in situ* coastal ocean sensors including biosensors to WESNIS. The real-time data thus captured will be coupled with sophisticated computational models of associated physical, chemical, and biological processes. Initially, coastal data incorporated into the wireless backbone will come from an offshore network of wave-monitoring sensors maintained by the Coastal Data Information Program at SIO. In addition, we will assimilate real-time coastal ocean data into computational models and make available estimates of regional coastal currents to applications including emergency response to oil and sewage spills, understanding pollution disbursement from point sources, and predicting sediment transport along the coast.

Cal-$(IT)^2$ and SIO will actively collaborate with the privately funded Monterey Bay Aquarium Research Institute (MBARI) to extend SoCal WESNIS from the San Diego Bay to the Monterey Bay and from the near-shore coastal waters to the mid and deep ocean. MBARI's active ocean observatory development program provides a natural complement to the Cal-$(IT)^2$ effort, extending the reach of the wireless communication system to both fixed instruments deployed on the seafloor, and autonomous underwater vehicles roaming the coastal ocean. DNA probe-based sensors created at MBARI are allowing the in situ detection of toxic algae for the first time, providing the base technology which will be applied to a range of biological detection problems, including those important in beach pollution. As ocean sensor networks will necessarily operate beyond line-of-sight of land, MBARI will work with our Institute on architecting the wireless sensornet to include "over-the-horizon" sensors that may require satellite links.

Intelligent Transportation. In California each year, 24 million vehicles travel 155 billion vehicle miles over 166,000 miles of streets and highways. Even with this intense demand, urban freeways and arteries are managed based on only the coarsest of information (sparsely distributed inductance loop detectors buried in traffic lanes transmit bits of data indicating the presence of a vehicle over wireline to a traffic control center). As a result, traffic congestion is fast becoming one of the principle blocks to California's economic development. However, the emergence of digital, broadband, wireless communication systems, and advanced information technologies, promises to lay the foundation for a wireless information "central nervous system" for urban transportation that can improve, qualitatively, the worsening transportation crises.

Imagine California in the year 2010. Roadside data stations will broadcast traffic data to passing vehicles while simultaneously collecting detailed traffic flow data. Navigation devices will also have access to commercial navigation and route guidance services that provide augmented traffic data based on advanced traffic prediction algorithms. Vehicle-to-vehicle communication will provide drivers with enhanced local navigation assistance and enable *sharing* of traffic and other data, fusing dynamic context-aware data with on-board static datasets. We call this concept AUTONET. An autonomous, self-organizing information/control system to manage interactions among "intelligent" vehicles, roadways, and stations.

This vision is realizable. Wireless technology enables a traffic probe vehicle equipped with a Global Positioning Systems (GPS) antenna and a wireless data modem to collect traffic flow data. Private firms, including our industry partners, are deploying in-vehicle devices that will couple map displays with GPS data. As wireless bandwidth increases, so will the ability for private industry to augment the dashboard maps with routing advice. Cal-$(IT)^2$, led by the UCI

Institute of Transportation Studies and collaborating with UCSD's Computer Vision and Robotics Laboratory, will create testbeds (Sec. D3) in which public data will be augmented in-vehicle devices equipped with inexpensive, local-area communicators, namely, a second-generation Bluetooth technology. Such communicators will "talk" with the probe vehicle infrastructure, gathering traffic data and sending back flow information. By coupling the vehicles' processors, each vehicle will contribute local information and a small amount of computing power. In aggregate, the vehicles will form a real-time, distributed database "traffic computer" aware of unpredictable movements of its own individual nodes.

The technical challenges cut across virtually every layer of Cal-$(IT)^2$. Bluetooth and existing cellular infrastructure are two extreme architectures, both with deficiencies for transportation-related communication needs. As a result, we need to develop a new kind of distributed architecture with unique protocols, and wireless and wireline infrastructure. For near-term trials, this infrastructure will be based on wireline, high-bandwidth networks running along the sides of roadways, linked to communication and navigation being developed by our industrial partner Qualcomm in collaboration with Ford. We will augment this system with enhanced Bluetooth-like, inter-vehicular wireless protocols.

Specific devices for traffic applications include self-powered, wireless sensors with short-range telemetry; robust sensors with compact, non-volatile memory; and vastly improved position-sensitive devices. For example, current differential GPS allows positioning of vehicles only within a few meters—insufficient to trace detailed movements of vehicles across lanes of traffic—monitor their acceleration profiles to estimate emissions or reconstruct conditions leading to accidents. Through Cal-$(IT)^2$ discussions, this application discovered researchers studying earth motion at SIO's Orbit and Permanent Array Center and the California Spatial Reference Center that have developed GPS positioning algorithms achieving two-centimeter accuracy multiple times a second. We are excited about the potential for transferring these GPS algorithms from seismic activity to AUTONET to obtain accurate real-time positions of vehicles *without* expensive base reference stations required every 15-20 kilometers.

This application team will work with other layers on data structures and distributed computing in a self-organizing traffic system to develop protocols for a constantly evolving network of moving, in-vehicle processors and develop alternative architectures for the system. We are particularly interested in two-way interaction of passive, multi-modal sensor clusters embedded in the transportation infrastructure with in-vehicle, mobile sensors populating the AUTONET database. We will also develop a distributed, intelligent management and control environment with intelligent consoles and stations for on-demand, semantics-driven, multi-resolution, and multi-perspective viewing of the traffic state, grounded in visualization tools to visualize, navigate through, and interact with the traffic network in real time.

Digitally Enabled Genomic Medicine. Over the past decade, technology created in academia and its transfer to industry sustained strong industrial growth related to drug discovery and telecommunications in the San Diego-Irvine corridor. Through partnerships with industry, Cal-$(IT)^2$, in turn, will serve as the nucleus for next-generation companies, helping the state assume a leadership role in revolutionizing health care. Recent extraordinary accomplishments in the biomedical sciences, including completing sequencing of human DNA, highlight the complexity of living systems and the challenges for delivering on the promise of genome science to improve health. The combination of personalized (genomic) medicine and the application of wireless technology to health care delivery (digitally enabled medicine) will provide enormous benefit to the citizens of California, the state's economy, and our society in general.

Our vision is one in which health care professionals and biomedical scientists should be able to gain access to every known fact instantly, regardless of where the information resides or the seeker is located. Clinical practice will require time-urgent, secure delivery of large amounts of patient information. High-speed, high-bandwidth wireless communication devices linked to powerful, interoperable clinical and biomedical databases will empower physicians, extend delivery of genomic medicine to remote clinical settings, increase certainty in diagnosis, and improve effectiveness in clinical practice while reducing costs.

Decisions crucial for urgent medical care (e.g., cardiac monitoring) will be made with information updated on demand, including physiological data from noninvasive biosensors linked to wireless transceivers. Such sensors will lead to digitally monitored smart home care, which will reduce medical costs, minimize hospital stays, reduce the risks and costs of noncompliance, and increase patient awareness to monitoring their own health care. UCI is building an instrumented "smart house" in which some of these concepts can be tested out.

We will build on advances in telecommunications and information technology from the technology layers strengthened by UCSD and UCI leadership in the biomedical sciences. Doing so will require cutting-edge research testbeds on two complementary fronts: telescience and bioinformatics. Telescience, pioneered at UCSD, enables scientists to manipulate remote instruments located even continents away, compute models, and steer data collection. This project helped demonstrate (trans-Pacific) IPv6 technology. Working with medical imaging groups at UCSD, LANL, and the New Mexico Brain Imaging Institute, UCSD is now implementing wireless technology to provide the interactive (information on demand) environment for interdisciplinary teams to establish noninvasive imaging technology, including medically relevant imaging modalities (fMRI and MEG). Building, for example, on the recently announced Israeli "video pill" for continuous monitoring, telescience will permit remote clinical monitoring of patients who then will have the opportunity, perhaps for the first time, to lead normal lives. We will expand the types of clinical instruments enabled by telemedicine technologies through collaboration with our industrial partners Merck and R.W.Johnson Pharmaceutical Research Institute.

New strategies in informatics are needed to discover the meaning and implications of genomic complexity, ranging from uncovering the information implicit in the sequence of the human genome to characterizing the processes involved in human health and disease. This science, *bioinformatics*, is the backbone of the biotechnology and pharmaceutical industries, a strength of UCSD and UCI, and a research area benefiting from collaborations with local pharmaceutical firms, our information technology industrial partners (IBM, Sun Microsystems, and SAIC), SDSC, the Keck Graduate Institute, and the Institute for Quantitative Systems Analysis in Biology. Research also will also be carried out by our academic team in medical, neural, chemical, and pharmaceutical informatics, in collaboration with our industrial partners Merck, R.W.Johnson Pharmaceutical Research Institute, and Silicon Valley startup MedExpert.

Establishing the connection between the genome and human physiology will entail a quantitative, whole-systems approach to model the integrated activity of tens of thousands of genes. Our biologists will work with the Cal-$(IT)^2$ data-mining team on these challenges, as well as demanding an unprecedented amounts of computing. For example, a recent UCSD/SDSC study concluded that a rigorous (Smith-Waterman) comparison of whole eukaryotic genomes requires a distributed computing approach (similar to SETI@home). Cal-$(IT)^2$ will evaluate industrial partner Entropia's software for this task.

Our biomedical researchers must work with the Cal-$(IT)^2$ technology layers to gain access to the components critical for digitally enabled genomic medicine. For instance, we need research on non-volatile memory; ultra-high-density storage devices for reliable, sustained repositories; ubiquitous access to high-bandwidth, high-throughput distribution and storage networks; biomedical sensors with telemetry for monitoring and diagnosis by noninvasive imaging methods; miniaturized, microfluidic clinical devices; computational infrastructure to support informatics; data compression and encryption methods; handheld "smart systems" for high-speed retrieval from large volumes of molecules-to-physiology multi-scale data; infrastructure to organize such complex data; and on-demand access for data-intensive computation.

By teaming pioneering researchers across computer science, biology, and materials, we plan to create innovative "living laboratories" for such technology in clinical settings at the UCSD School of Medicine, in public health settings with San Diego County Health and Human Services Agency, and in collaboration with our industrial partners Merck, R.W. Johnson Pharmaceutical Research Institute, MedExpert, and SAIC.

New Media Arts. This team will focus on computer games and novel visualization environments to provide creative research challenges likely to have impact on distance learning, collaborative work environments, and understanding large complex data sets. We have chosen computer games because they combine many key elements of the digital media arts--its temporal structures are driven interactively; it has a social dimension; and it has varying degrees of sensory immersion and integration with the physical environment. Computer games are also one of our fastest growing export industries: More than $6.1 billion in U.S. entertainment software sales in 1999 was attributed to games—its fourth consecutive year of double-digit growth. One year previous, more than one in four American youngsters reported playing games 7-30 hours a week. Games also represent a useful paradigm to address design challenges to prototype a new pedagogic form, particularly as it scales up to very large numbers of users engaging multiple information streams. As a result, we need to evaluate how to adapt its metaphors, design principles, and technologies to other forms of content and delivery. In this context, we will work with the technology layers to

- Develop wireless input/output devices to coordinate monitoring of virtual presence in mediated realms using micro-/nano-sensors and infrared imaging technology.
- Design interactive media installations and events that demonstrate the capabilities of a hybrid wireless/optical, ubiquitous computing environment. Create innovative audio/visual interfaces to mixed-mode, online educational gaming environments delivered via high-resolution and sensory-immersed displays linked to lower-bandwidth, wireless devices.
- Program mobile agents to explore agency and personification relative to information discovery, delivery, visualization, and navigation and produce non-linear interactive narrative forms including the interpretation and expression of motion and emotion.

Hardware and software development in digital imaging and sound, and their impact on gaming, promise to have a profound effect on the future of cinematic production and delivery--a critical component of California's entertainment industry. This layer will team with visualization experts from SDSC, UCI, industrial partner Panoram Technologies, and UCSD's Center for Research in Computing and the Arts (CRCA) to conduct visualization research on how best to express the complexity of wireless data inputs with multiple participants. Panoram Technologies, a Sun Valley California company that has installed 60 facilities worldwide in energy companies, will work with the Cal-$(IT)^2$ building architects to design cutting-edge visualization facilities,

"unique in California" [see letter from Panoram's CEO, Appendix B]. We will build scalable data visualization environments that include:

- Room-sized visualizations using multiple visual planes and spatialized audio for audiences ranging from dozens to hundreds of people as well as stereoscopic 3-D images to create the effect as if one were viewing the real performance or event in person.
- Wall-sized visualizations that involve multiple users incorporating spatially directed imaging, surround sound, and robust haptic interactivity.
- Portable visualization for networked individual users, including handheld, head-mounted, and biologically embedded devices.

To accomplish this, we will continue developing the underlying specifications for key media components (expressive 3-D graphics, spatialized audio, and semantic media compression) and image storage, presentation, distribution, and manipulation from non-volatile magnetic RAM and 3-D optical storage devices.

Broadening the impact of the proposed activities will be the UC Digital Arts Research Network (UC DARNet), a Multi-campus Research Unit representing six UC campuses; the UC Institute for Research in the Arts (UC IRA); the IDEA Institute (Interdisciplinary Digital Exploration of the Arts); the UCI Interdisciplinary Gaming Studies Program; UCSD's Sixth College (E, Education), and UCSD's Interdisciplinary Computing in the Arts Major (ICAM).

5. Policy, Management, and Socioeconomic Evolution

A key part of the institute's research agenda will be to study how policy and management drive the Internet's evolution and how the new Internet will evolve society's institutions. UCI's Graduate School of Management (GSM), in collaboration with UCI's NSF Center for Research in Information, Technology, and Organizations (CRITO) and UCSD's International Relations and Pacific Studies (IR/PS) graduate school will explore how the new Internet alters the management of networked enterprise: Emergence of new organizational forms and transactional systems based on new technologies, implications of these technologies for improving the way business can be conducted, and, the value-creation process by which these technologies are brought to society. This research will focus in three areas: 1) We will examine the economic, managerial, and strategic impacts of information technology for management, including evolution of the network-based economy, analysis of the impact on organization and market structures, productivity in the new economy, the nature of competition in a global digital economy, and e-business strategy and practice; 2) we will research the changes induced by broadband access to the home and ubiquitous mobile wireless access on the economic and social fabric (households, consumers, and citizens); 3) we will study the challenges facing policy makers in charge of macro-institutional environments and infrastructures in balancing privacy and access, as well as greatly increased interaction with a net-active set of constituents.

Finally, we will build on UCSD's and UCI's complementary strengths in policy research to establish strong program in international telecommunications policies on questions related to the evolution and use of wireless networks:

Technical standards and intellectual property: Patent pools and standards setting pose critical commercial challenges to competition policy. Standards setting, especially in Asia, is tied to national industrial policies more concerned with obtaining favorable terms for intellectual property rights on information technology than promoting competition and lower prices. UCSD, together with UC Irvine's GSM, will study how the process differs across countries with regard to representation, transparency, voting rules, and obligations for licensing intellectual property; and what reforms to suggest.

Promoting universal service: We will analyze technology options to determine how governments could redefine universal service and the most efficient funding mechanism for universal service. An initial study on how wireless infrastructure in rural Mexico could reverse migration from mega-cities will include participation from three UCSD institutions: the Center for U.S.-Mexico Studies, the Center for Comparative Immigration Policy, and the Institute of the Americas, which already has a telecommunications infrastructure project for South America.

Privacy and information security: The battle between the European Union and the U.S. is avoiding many deep issues related to privacy and technological/network development. We will study prevailing privacy principles by collaborating with the Transportation and Environment Assessment application teams. We are already investigating international security and privacy as part of the "E-conomy project," a joint effort of the Berkeley Roundtable on the International Economy (BRIE) at UC Berkeley, UC Davis, and IGCC.

Spectrum and competition policies: Plans for allocating spectrum diverge around the world, and many countries (including the U.S.) are not releasing enough new spectrum for advanced wireless networks. UCSD, known for its work on political institutional design, bargaining theory, and auction theory, will work with the technology layers to generate examples of imaginative spectrum planning, suggesting ways to redesign the global system for spectrum allocation and assignment. Initially, the Institute for Global Conflict and Cooperation (IGCC), a multi-campus research unit headquartered at UCSD, will design new tools to support spectrum allocation decisions, and we will assess the feasibility of dynamic allocation of spectrum.

Summary

The intricate interactions between applications and new Internet technologies can only be understood by deploying prototype instrumented "smart environment" testbeds, which will enable institute participants to "live in the future." The Cal-$(IT)^2$ approach will fill a critical gap in technology transfer because researchers who focus on a particular subcomponent often make unrealistic, simplifying assumptions about the nature of other subsystems, which, in turn, makes it difficult to assess the relative value of individual innovations in a complete end-to-end system. No university or company alone could build such an integrated environment. It is only through the opportunity of the Governor's initiative that we can pull the unprecedented resources together from multiple campuses (including Caltech, Stanford, and USC), industries, and government laboratories to undertake such an ambitious and visionary project and yet have such confidence in the success of the undertaking.

UCSD and UCI have taken the Governor's challenge seriously. We have recruited experienced senior management to create our vision, catalyze our academic teams, develop relationships with committed industrial partners, and write this proposal. We have already raised the needed 2:1 match and anticipate exceeding it considerably. And we have selected the architectural firms, determined our buildings' technical requirements, and selected conceptual designs (see cover). Our proposal is visionary and time-urgent for the California economy, and we stand ready to turn our vision into reality.

D2. Timeline and Milestones

The foundation of proposed Cal-$(IT)^2$ research is underway, and we will build on it aggressively if selected. We have prioritized proposed projects and will also use UC, industrial, federal, foundation, and individual donor matching funds to support the growth of the research staff and capital. The excitement our initiative has generated, with more than 200 faculty members supporting this effort, gives us confidence that we will be even more successful than we appreciate now. Here, we give examples of our plans for the first few years.

To jump start activities across the institute, in Year 1 we will deploy initial infrastructure testbeds building on the foundation of ongoing research activities, recently awarded relevant grants (Appendix D), the two SDSC Keck "satellites," and continuing UCSD/UCI campus wireless deployment. We will add more sensors to the recently NSF-funded wireless infrastructure supporting seismic and astronomical observations, expand the sites coupled by wireless into the campus testbeds, begin detailed planning of the Sixth College wireless infrastructure (Sec.E), build a data analysis and visualization "control room" at SIO, extend the bioinformatics data-mining infrastructure through the "Alliance for Cell Signaling" and "Joint Center for Structural Genomics" grants (which includes the Stanford Synchrotron Radiation Laboratory), and, to ensure effective ongoing communication, implement multi-site videoteleconferencing among SDSC, SIO, the Jacobs School of Engineering, and UCI.

Given the limitations of space in the RFP, we illustrate our approach by considering plans for two layers and one applications area, each of which is representative of our plans overall for the institute. For Materials and Devices, in Year 1, we will develop prototypes of self-powered wireless sensors for nanophotonic optical filters and stress/motion position sensors, and establish device and system requirements for efficient optical networking. In Year 2, we will make new devices for high-speed networks, including practical GaAs MOSFET for "Fourth Generation (G4) handsets, all-optical wavelength converters, molecular ultra-fast optical switches, and high-performance G4 GaN telecom devices. In Year 3, we will produce prototype devices: LED/LD on silicon, implantable biosensors, silicon magnetoresistive nanowires, near-field optical switch devices, and cuprate superconducting filters. In Year 4, we will complete development of devices for several institute applications: polymer interconnects; 10-micron blood-born pressure sensors; wireless *E. coli* water pollution sensors; and 3-D DNA array detectors.

The Interfaces and Software Systems layer will design and implement software to integrate information and knowledge management systems with wireless access protocols, visualize large, sensor-gathered data sets, and support data subsetting for handheld devices; integrate software developed in various projects (e.g., SensorSim, MobiMedia, and Grid Portal Toolkit) to create a more capable, easier-to-use infrastructure overall; work with computational scientists to develop new applications which utilize tens of thousands of Entropia processors..

Similarly, the Environment and Civil Infrastructure team will build on an existing wireless network in San Diego, Riverside, and Imperial counties to deploy broader coverage nodes in Orange County, the coast region, and from offshore platforms, integrate access to real-time data and distributed archives, visualize large-scale multidimensional, heterogeneous data, and prototype a first-generation digital "field tool." Then we will build out wireless coverage to include Santa Barbara Channel and the lower Sierra Nevadas, integrate access to archives, computations, and collaborative decision making among multiple "control rooms," and roll out more general information portals for educators and policymakers.

D3. Relevance

Cal-(IT)^2 will extend the power of the Internet in applications critical to the vitality of California's economy and new users, applications, and industries will emerge as a result of the infrastructure we create. To illustrate our plans we describe below specific plans for innovation in the areas of Environment and Civil Infrastructure, Intelligent Transportation, Networking and Computing in partnership with Qualcomm, Ericsson, Leap Wireless, GlobalPhoton, TeraBurst, IBM, SiliconWave, Sun, Entropia, Lucent, CALTRANS, USC/ISI, LLNL, and SDSC. Our approach to fostering this is via the deployment of testbeds, that use the core technologies described in section D1.

Environment and Civil Infrastructure Cal-(IT)^2 will partner with the UCSD Powell Structural Research Laboratories, which is the largest lab in the world conducting full-scale controlled testing of buildings, wood-frame houses, and piers. Testing of large models demonstrates the need for wireless sensors: A recent test of a wood-frame house with more than 300 instruments required three miles of cable! The experiments' data transmission and teleparticipation requirements also call for state-of-the-art networking, data management, and visualization technologies, which Cal-(IT)^2 will supply. These efforts will enhance and accelerate structural integrity and safety of California's public and private structures. Going the next step, routine, real-time monitoring to assess the structural integrity of civil infrastructure will involve instrumenting hundreds of CalTrans bridges over the next 10 years. UCSD and CalTrans are developing a comprehensive bridge health-monitoring program starting with several bridges across California; UCI has instrumented two bridges in Orange County. Cal-(IT)^2 will collaborate on instrumenting these bridges as prototype "smart civil infrastructures." Two bridges under construction near the Salton Sea will be equipped with sensors as a wireless extension of WESNIS. This is a precursor to the high-visibility, cable-stayed, composite bridge planned across Interstate 5 linking the east and west sections of UCSD's campus. The point here is that civil infrastructure management will depend on sensor data on a large scale, with the best decisions based on overall system performance rather than localized data in isolation. Through these testbeds, Cal-(IT)^2 will create the proven system that must predate any large scale commercialization or full scale deployment on California's 24,000 bridges.

Intelligent Transportation will upgrade the UCI Institute of Transportation Studies' testbed of high-speed fiber communications links to the local Caltrans District in Orange County. The university laboratories associated with the testbed have access to network-wide traffic surveillance and control information in a real-time environment, which provides the ability to issue a closed-loop response to the traffic conditions through remote control access to field elements such as ramp meters and traffic signals. UCSD's Computer Vision and Robotics Laboratory will use real-time machine vision systems, remotely controllable platforms and devices, and mobile systems to collect sensory information to support the proposed experimental, systems-oriented research. Our efforts in this regard will provide proof of concept for new commercial transportation applications.

Networking. The UCSD Cal-(IT)^2 building, one of the tallest structures on campus, will include a roof top wireless networks laboratory with provisions for mounting radio frequency antenna arrays and free space laser transceivers. This hub will be the launch pad for a network testbed. Leap Wireless has committed to providing access to cellular spectrum in California (fully supported access to one 1.25 MHz cellular channel at 10 cell sites for 10,000 hrs./year involving up to 5,000 subscribers) for studies in remote delivery of content. Global Photon Systems, a pre-IPO company, will provide four-year access to their 800 mile long, environment

friendly, undersea, OC-3 (155 Mbits/s), fiber-optic, wide-area network that links seven high tech clusters along the California coast from San Diego to San Francisco. TeraBurst, another pre-IPO partner, will provide early access to state of the art, high speed, optical cross connect systems.

In partnership with Ericsson, Lucent, Qualcomm, and Silicon Wave, UCSD and UCI will expand their existing campus wireless telecommunication infrastructure to cover all departments affiliated with the institute and selected areas of students' living and work space, creating our first "living laboratory". We will focus on the interoperability of equipment from different vendors, access architectures, multimedia services (video distribution), and interfacing to *ad hoc* networks that use Bluetooth, IEEE 802.11, and other RF solutions. Instrumented testbeds will allow us to test and deploy new algorithms, protocols, and designs, such as HDR and Bluetooth, in a real world environment.

An all optical testbed backbone among SDSU, UCSD and UCI will evolve over the lifetime of CALIT2. We envision several wavelengths of an all-DWDM network (Providing multiple 10+ gigabit pipes) to be dynamically provisioned through technology developed by TeraBurst, Inc, a Cal(IT) Partner. A continually evolving optical core is an essential complement to the wireless network.In collaboration with SDSC and the Lawrence Livermore National Laboratory (LLNL), we are engaged with the National Transparent Optical Network, into which we would couple our local optical testbed. We also plan on coupling NTON to the University of Illinois at Chicago, Star Light, the next-generation optical STARTAP, the NSF funded "port of entry" for international research networks.

Computing. In collaboration with Sun Microsystems, we will build an integrated, multi-campus, multiplatform Solaris "metacomputer" testbed which will provide the institute's primary UNIX compute capacity. Working with SDSC, IBM, Entropia, and other industrial partners, we will build Linux and Windows PC clusters surrounded by a vast Internet PC-based distributed computing service to support highly scalable applications as telecommunication system emulation, bioinformatics, computer graphics rendering, and environmental modeling. In collaboration with SDSC and LLNL, we will explore the commercial feasibility of the experimental IBM Blue Light, a unique extreme computing architecture, involving multiprocessor nodes tightly coupled by a high-speed network. We will develop and deploy very large (10s of terabytes) data warehouses implemented on parallel hardware to support sophisticated data-mining. USC/ISI working with SDSC will install the widely deployed Globus Toolkit on all institute machines, enabling Grid middleware and extend our compute capability to our wireless testbeds. SDSC will provide support personnel to deploy and maintain a distributed software, hardware, and telecomm infrastructure.

Other testbeds will include UCSD's planned Sixth College and related underserved- and minority-oriented and testbeds (Sec. E) to extend the power of the technology we develop to new communities, evaluate their effectiveness in those contexts, and enable feedback from them to the technology developers.

D4. Facilities and Resources

Cal-$(IT)^2$ will create leading-edge research laboratories and supporting facilities in two new buildings (Sec. C), with major capital investment in clean room facilities and specialized laboratories. At UCSD, Materials and Devices faculty will establish a facility for epitaxial growth, nanofabrication, and advanced characterization. The facility will include dry etchers to form micro- and nano-structures; material deposition chambers; optical lithography and, for nanoscale patterning, electron-beam lithography; scanning-probe and near field optical microscopes; a molecular beam epitaxy system integrated under ultra-high-vacuum with a scanning tunneling microscope for atomic-scale investigation of epitaxial growth of quantum

semiconductor structures; X-ray photoelectron and Auger electron spectroscopies to determine material composition; a scanning electron microscope with better than 4-nm resolution to study quantum structures; and deep UV microscopes to observe ultra-fine features beyond the limit of conventional optical microscopes.

The corresponding UCI Materials and Devices faculty will house a new molecular/polymer lab for developing molecular sensors embedded in polymer matrices and hybrid bio-polymers for broadband sensors, wave-guides, and high-frequency devices for wireless communications, environmental sensing, proteomics, and bio-chip applications. An expanded Integrated Nanosystems Research Facility (INRF) will enable frontier work on micro-electro-mechanical system (MEMS) devices, high-speed, low-power electronic materials and devices, superconductors, and spintronic structures for the Intelligent Transportation, New Media Arts, and wireless communication applications.

Networked Infrastructure will establish specialized laboratories at UCSD focusing on circuits, systems-on-a-chip, wireless and photonic networks, and magnetic recording. These labs will support research in advanced switching ICs, network processors, gigabit routers, dynamic re-configurable processors, mixed-signal ASICs, and radio-frequency integrated circuits; propagation studies; algorithms and architectures for coding, modulation, and signal processing; and network access protocols in real and hardware-simulated photonic and mobile, wireless communication, and magnetic recording systems. The facility will include microwave probe stations for optical and microwave characterization of opto-electronic components; femtosecond tunable lasers to generate ultra-short optical pulses, a wideband spectrum analyzer, and 10-Gbit-error-rate tester for characterization and performance testing; and phase noise test set and low-phase microwave sources for characterizing phase noise cross-talk levels in close-by communication channels and the Guzik head and media tester machine.

New Media Arts will implement a lab for research related to interfaces and environments for telepresence and experimental interface technologies; a fabrication and scanning lab to develop 3-D environments, research tools, device prototypes, and large-scale equipment and props for digital cinema and computer game environments; an audio spatialization lab for research in multi-channel, real-time audio systems for advanced virtual-reality environments; and a public event performance space. Together with the SDSC Visualization Lab and industrial partner Panoram, New Media Arts will implement a virtual-reality visualization lab, multi-megapixel walls, HDTV, and digital video editing suites and audio recording studios to support complex visualizations and analysis of large data sets. Finally, this team will create, initially in the UCSD Jacobs School of Engineering, a digital gallery to present results of the institute in ways compelling to the public.

To support the research projects, we will put in place a strong in-house professional technical team to develop and maintain institute software infrastructure and the persistent, functional testbeds required for Cal-$(IT)^2$ software and applications research. The technical staff will partner with computer scientists; networking, materials, and applications researchers; and educators and students to deploy Cal-$(IT)^2$ software on a large scale and provide a critical and functional prototype on which Cal-$(IT)^2$ researchers can build.

Industrial Facilities. IBM will provide access to its most advanced semiconductor processes, such as 100-GHz Silicon-Germanium for RF and new Internet circuits, as well as advanced 0.13-um CMOS circuits, which will provide a one-of-a-kind resource for California academics to develop state-of-the-art integrated circuits. STMicroelectronics will provide access to advanced technology including their design kits and mask processing.

E. Education

E1. Education

Wireless Internet capabilities will have a profound impact on the delivery and accessibility of education. Educators must leverage this capability to prepare today's students who will become tomorrow's workforce in an environment *founded* on this technology. Moreover, this revolution in technological capability will allow us to re-invent delivery of education to *all* California students, regardless of location or income. UCSD and UCI together are slated to accommodate nearly 40% of Tidal Wave II growth anticipated by UC. Since our two campuses are leaders in telecommunications and information technology research and have strong relationships with industry in these areas, we have a unique opportunity to marry the research, commercial, and education thrusts of this proposal *and* have an impact on an unusually large student population by comparison with other UC campuses.

Technology Development. Cal-$(IT)^2$ will create the Center for Excellence in Educational Technology (CEET) to design and develop information technology specific to the online educator and facilitate adoption of this technology though faculty workshops. CEET will employ a professional interdisciplinary staff of educators, software engineers, graphic designers, and education researchers to design and develop the "Learning Platform," an easy-to-use, flexible tool that will allow educators to create and publish online courses. These courses will be incorporated into UCSD and UCI degree programs and advertised to our industrial partners.

Research on Technology Efficacy. We must ensure our tools meet the needs of educators and contribute to, rather than hinder, students' education. Cal-$(IT)^2$ will team with faculty in UCSD's Communication Department to conduct research studies on the efficacy of teaching and learning using the most advanced telecomunications and information technology, disseminate findings to the community through workshops and seminars, and provide research opportunities for undergraduates, graduates, and industrial fellows. UCI's Center for Education, partnering with Microsoft, will contribute expertise/software for learning experiments with children and adults. We will also partner with USC/ISI's Center for Advanced Research in Technology for Education, which develops and evaluates new technologies that promote problem-solving skills.

Technology Assessment Testbeds. The efficacy, scalability, and socio-cultural implications of a new technology, such as the Learning Platform, can be assessed only by testing in the field. Here, Cal-$(IT)^2$ has a unique opportunity: A new college—Sixth College at UCSD with its theme "Art, Culture and Technology"—provides an innovative and exciting opportunity to develop an undergraduate educational institution *founded* on ubiquitous telecommunications and information technology. Sixth College will pioneer radically new teaching, communication, community, and life-long learning paradigms, and blur the distinction between "in the classroom" and "in the field" to provide a more comprehensive learning environment. Students will *learn* about technology, *use* it in-/outside the classroom, and *provide feedback* to the technology layers about areas requiring additional research/development. Wireless infrastructure will be incorporated into the very design of this college's infrastructure and curricular planning.

Additional testbeds will address the needs of inner city and rural high schools, the Native American community, and industry. Research demonstrates that the failure of California's inner city and rural high schools to offer advanced placement courses is a major obstacle to students advancing to the UC system. We will team with UCSD's Center for Research on Educational Equity and Teaching Excellence (CREATE) to compare the consequences and benefits of distance learning to traditional approaches and with UCSD's Native American Outreach

Program that provides campus resources to prepare K-12 Native American students to become UC-eligible. Furthermore, our industrial partners will provide an excellent additional testbed to evaluate the efficacy of the Learning Platform and other CEET tools.

Teacher Education. Research indicates that teachers who use technology *while learning to become teachers* are more likely to infuse technology effectively in their teaching practice. Therefore, CEET will work with teacher education programs at both campuses and SDSU to integrate Cal-$(IT)^2$-developed technologies into their curricula and proselytize their adoption.

Fellowships. Cal-$(IT)^2$ has raised more than $12 million for graduate student fellowships. We will use these funds to attract a pool of talented graduate students and support them for their first two years of study. During these early course-work years, graduate students are typically not ready to conduct research, making it difficult to support them on focused research projects. Cal-$(IT)^2$ principal investigators will support them in subsequent years on relevant research grants.

Professional Development. The ability to stay abreast of new knowledge is becoming an increasingly serious problem for professional workers, especially those in industries related to emerging technologies. Numerous telecommunications companies have asked UCSD and UCI to provide employee development. But companies cannot afford to send employees to our campuses, nor do faculty have time to go to them. The solution is time- and location-independent delivery of education, i.e., Internet-based courses. According to Nokia (Appendix B), "One of the most fruitful aspects of our collaboration with UCSD has been in education. The university has been open and responsive to the needs of industry, and has initiated new curricula at the suggestion of [our] Board. Programs initiated through Cal-$(IT)^2$ will help UCSD educate students in the skill sets our companies need."

A senior-level design capstone course is a part of UCSD's Electrical and Computer Engineering curriculum. Cal-$(IT)^2$'s Corporate Partners' Program (CPP, Sec. F) will enhance this program by matching Cal-$(IT)^2$ sponsors with groups of students. Sponsors will serve as technical contacts whom students can interview and request advice to develop design specifications and complete other projects. Cal-$(IT)^2$ will underwrite the costs of the materials for projects in telecommunication and information technologies, and support other UCSD and UCI campus units to incorporate a design requirement or option in their curricula.

Industrial Participation in Education. Industry scientists will work in residence at Cal-$(IT)^2$. They will participate in the institute's day-to-day research activities and mentor graduate and undergraduate students with respect to how theory finds its way into practice. CPP will oversee an internship program to help partners identify and place undergraduate students at company sites for summer employment and in academic internships during the school year.

E2. Timeline and Milestones

In Year 1, we will establish the Center for Excellence in Educational Technology, begin developing the Learning Platform, launch the internship program, identify courses most receptive to integration of Cal-$(IT)^2$ technology tools, and design the Sixth College ubiquitous computing infrastructure. In Year 2, we will distribute and support the initial release of the Learning Platform, team with the teacher education programs to integrate Cal-$(IT)^2$ technology tools into their curricula, and begin research studies to evaluate the efficacy of technology use vs. traditional learning approaches in the classroom (leveraging the various testbeds). In Year 3, we will roll out completed courses, admit the entering class at Sixth College, and host class sessions of the teacher education programs in this novel learning environment to they can experience its power in person. In all years, we will recruit and support talented graduate students with fellowship funding.

F. Industry Participation

F1. Industry Participation Plan

From the beginning, our design of Cal-(IT)^2 included a very close tie to industry. As our faculty formulated plans for research based on the abstraction of the integrated layer structure of the new Internet, they worked with campus administrators and the corporate partners developed by UCSD's Jacobs School of Engineering, SDSC, and UCI's Samueli School of Engineering to attract key companies in each subcomponent. What has attracted so much enthusiasm from our industrial partners has been our holistic systems approach to the new Internet. As the President of AT&T Labs says in his supporting letter, "Cal-(IT)^2 provides a platform for components manufacturers, software innovators, device makers, and telecommunications providers to work together creatively on issues such as availability, quality of service, seamless operations between wired and wireless devices, and policy issues such as privacy."

We have been flexible in negotiating agreements with industrial partners, recognizing the unique needs and assets of each company. In total, UCSD and UCI have raised more than $139 million in firm industrial commitments (Section C), from 28 industrial partners. Private Donors have contributed another $32M. We also have strong letters of support from another sixteen companies with whom we are still engaged in discussions. Therefore, we expect the industrial cost sharing number to rise considerably over the next six months.

We believe that the very strong response from industry as shown in the size of their financial commitments, verify that our vision, while arguably ambitious, can be achieved. We have completed agreements with a broad set of California "leadership companies," (Appendix B), such as Akamai, AMCC, Boeing, Broadcom, Conexant, Copper Mountain Networks, Emulex, Ericsson, IBM, Intersil, Irvine Sensors, Johnson & Johnson, Leap Wireless, Merck, Microsoft, NCR, Orincon, Qualcomm, SAIC, SBC, Sun Microsystems, Texas Instruments, and WebEx; but we have also focused on including key small privately held companies such as Caimus, Entropia, Global Photon, MedExpert, Panoram Technologies, Silicon Wave, and TeraBurst Networks.

Besides proposed useful in-kind donations ($56M), the firm cost-sharing contributions from our industrial and foundation partners will support academic professionals ($15M), visiting researchers, student fellowships ($12M), endow 12 new faculty chairs ($14M), provide support for young faculty ($5.6M), establish "named" laboratories, and provide research personnel. This might usefully be compared to the NCSA Industrial Program that the Director previously ran. In the fifteen years of that very successful program, only about $60M were raised, roughly half of what Cal-(IT)^2 has raised in nine months.

Every Cal-(IT)^2 industry partner will be asked to nominate a senior executive to serve on the Cal-(IT)^2 Industry Council. In partnership with Cal-(IT)^2 and campus academic leaders, the Cal-(IT)^2 Industry Council will help guide our broad strategic vision for the institute. Industry engineers and scientists will be in residence at Cal-(IT)^2; they will participate in the day-to-day research activities of the institute and offer graduate and undergraduate students valuable insights by serving as mentors to summer interns. A Senior-level design capstone course is already a part of the ECE curriculum at UCSD. We will enhance this program by matching Cal-(IT)^2 sponsors with groups of students. The industrial partners responding to the Governor's initiative have also provided an increase in support to ongoing University-Industry programs. For example, three of the Cal-(IT)^2 partner companies (Ericsson, AMCC, IdeaEdge) will be simultaneously joining the Center for Wireless Communications at UCSD, including the CWC annual dues in their pledge to Cal-(IT)^2. Conversely, three of the 16 current CWC members (Qualcomm, Intersil and Conexant) partnered with Cal-(IT)^2.

An innovative feature of the technology transfer approach of Cal-(IT)^2 has been to include venture capital firms in our industrial partners. VC firms ideaEDGE Ventures (focused on creating and launching global companies in the emerging mobile Internet markets), Enterprise Partners, and Mission Ventures will provide counsel on prospects for commercialization of innovations created by Cal-(IT)^2, as well as future investments in technologies developed by Cal-(IT)^2 if appropriate. As ideaEDGE Managing Partner Rick LeFaivre says in his letter of support: "A key reason for ideaEDGE Ventures locating in San Diego is the flow of ideas and students from UCSD, which has been instrumental in establishing San Diego as the leading wireless technology center in the United States."

UCSD has a long tradition of working with industry through its CONNECT program, JSOE, and SDSC that will serve as the foundation for industrial relationships in Cal-(IT)^2. UCSD will place a full-time member of its Technology Transfer & Intellecutal Property Services Office in the Cal-(IT)^2 building to work with faculty on opportunities regarding licensing, patents, and other intellectual property. UCI's GSM will leverage the Irvine Innovation Initiative (I^3), a pre-incubator to provide students with space and encouragement to turn ideas into businesses.

We are also pleased to be supported by many southern California industrial associations (Appendix C) including BIOCOM (340 member companies), the San Diego Chamber of Commerce, the San Diego Defense & Space Technology Consortium, the San Diego Mayor's Council for Science & Technology, the San Diego Regional Economic Development Corp., the San Diego Regional Technology Alliance, the San Diego Software and Internet Council (435 members), the San Diego Telecom Council (160 members), the Orange County Business Council, the Building Industry Association of Southern California, UC Irvine's Chief Executive Roundtable, and the Irvine Company.

Finally, we believe there is a potential for great synergy between Cal-(IT)^2 and the UC Industry-University Co-operative Research Programs (CoRe), administered through the UC office of the President. The Cal-(IT)^2 research focus overlaps with elements of MICRO, CoRe, DiMi and SMART. The need to raise additional funds for focused research projects from private industry will greatly benefit from the leveraging of these funds through the IUCRPs.

F2. Timeline and Milestones

We have been fortunate that industry has found our vision so compelling that we have adequate funds committed to implement our research plan as laid out in Section D2. Because we have built our program on existing faculty strength, we can work as a virtual institute while our building is being built. We will form the Industry Council in Dec. 2000 if we are selected with the first meeting scheduled for 1st Quarter, 2001. In May, 2001 we will hold our first Science and Technology review, inviting interested members from our industrial partners and our VC partners to scan the presentations for potential ideas for technology transfer. We will fund some students in the Winter quarter, 2001, gradually expanding the numbers in Spring quarter with a summer intern program starting in Summer, 2001. We will aggressively recruit Endowed and junior faculty, funded by industrial funds, starting in Dec. 2000 with the goal of filling a number of the postions in Fall 2001 and all by Fall 2003.

The Director developed a complete evaluation process for success of industrial partners during the previous 15 years at NCSA. This includes quarterly tracking of funded projects, mutual review by faculty and industry of progress toward goals, annual S&T "Fairs" with interactive exhibits of projects, and institute staff to work full time on the management of the industrial program. We expect to blend this approach with the local UC experiences, such as with the industrial programs of UCSD's CWC and UCI's INRF.

G. Leadership and Management Plan
G1. Leadership and Management Plan

The institute will be directed by Dr. Larry Smarr, the founder and 15-year director of the National Center for Supercomputing Applications (SDSC's sister NSF-supported supercomputer center) and the National Computational Science Alliance (NPACI's sister partnership). The Alliance links 100 researchers at 50 universities with some 400 faculty, students, and staff at NCSA. Smarr created the Strategic Industrial Partners program at NCSA (which brought in more than $50 million in industrial funding over 15 years) and also was one of the founding scientists in the UIUC Beckman Institute, the largest interdisciplinary center under one roof in the U.S. While Cal-$(IT)^2$ shares Beckman's interdisciplinary vision, it adds an explicit emphasis on core technologies and applications enabled by telecommunication and information technology.

Smarr will report to UCSD Chancellor Robert C. Dynes and be assisted by Chief Scientist Ronald Graham, the UCSD Irwin and Joan Jacobs Professor of Computer Science and Engineering. Previously, Professor Graham was Chief Scientist at AT&T Labs. Dean Robert Conn of the UCSD Jacobs School of Engineering, has had primary institutional responsibility for the development of this proposal. During his tenure, UCSD's JSOE has risen faster in the *U.S. News and World Report* rankings than any school of engineering in UC history, now standing 7th among public universities. Thus, our institute leaders have experience working on activities of a larger scale than Cal-$(IT)^2$, and all with strong industrial partnerships.

Two associate directors, Dr. Ramesh Rao at UCSD and Dr. Peter Rentzepis at UCI, will oversee operations at their respective campuses. Rao is Director of UCSD's Center for Wireless Communications (CWC), which has 17 industrial sponsors and supports 45 Ph.D. students under the direction of 17 faculty members on communications circuits, signal processing, communications theory and systems, and wireless networks. CWC has attracted $12 million in industrial funding since its founding six years ago. Rentzepis is Presidential Chair and Professor of Chemistry and Electrical and Computer Engineering at UCI. Previously, he was head of chemistry at Bell Labs, has been awarded numerous national and international prizes, and is a member of several U.S. and foreign academies of sciences.

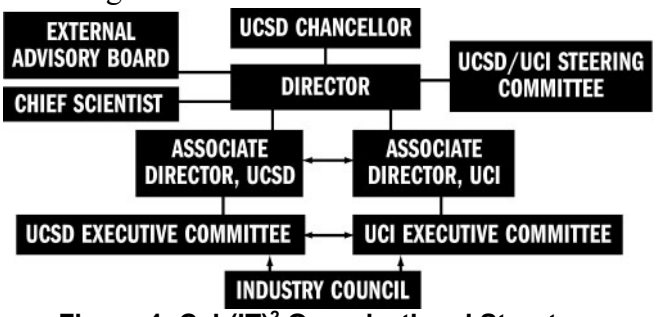


Figure 4: Cal-$(IT)^2$ Organizational Structure

It is noteworthy that Professors Dynes, Graham, and Rentzepis all held senior management positions at Bell Labs, considered by many the most successful industrial laboratory in history. The Presidents of both AT&T Labs and Lucent Bell Labs, have also written strong letters of endorsement and SAIC, the parent company of Bellcore, is a full industrial partner of ours. Thus, Cal-$(IT)^2$'s leadership is well positioned to create an institute capturing the spirit of Bell Labs, with a focus on the telecommunication and information technologies of the 21st century. Smarr, Rao, and Rentzepis will have technical oversight responsibilities for selected layers and applications. Smarr will oversee the Policy, Applications, and Interfaces and Software Systems layer. Rao will oversee the Networked Infrastructure layer. And Rentzepis will oversee the

Materials and Devices layer. In each layer, the overseer will have intellectual responsibility for activities at both campuses. At any given interface in Cal-$(IT)^2$'s layer "cake," the two responsible for either side of the interface will interact to reach decisions. Graham will oversee integration of industry with the academic research and educational activities in all layers. The three directors and Graham will constitute the Office of the Director.

Under Cal-$(IT)^2$, UCSD will have lead responsibility overall. UCI will provide leadership in Intelligent Transportation and in Management in a Networked Economy. All technology layers and the four applications thrusts will include complementary science and technology groups at both campuses. Each institute layer and application will be led by two faculty researchers, one from each campus, who will coordinate projects in their respective areas and ensure that integration is achieved intellectually across the campuses. Those from each campus will comprise their campus' Executive Committee (Table 1), which, together with the Industry Council, will define and guide the institute's long-term research agenda. Each Executive Committee, chaired by the respective associate director, will review the research plans and advise the director on how to optimize the institute. Members will serve staggered two-year terms to keep the brain trust fresh while preserving intellectual continuity.

Layer or Applications Area	UCSD Executive Committee	UCI Executive Committee
Materials & Devices	Ivan Schuller	G.P. Li
Networked Infrastructure	Paul Siegel	Magda El Zarki
Interfaces & Software Systems	Francine Berman	Dan Gajski
Environment & Civil Infrastructure	William Hodgkiss	Maria Feng
Intelligent Transportation	Mohan Trivedi	Wilfred Recker
Digitally Enabled Genomic Medicine	John Wooley	Pierre Baldi
New Media Arts	Sheldon Brown	Alan Terricciano
Policy, Management, & Socioeconomic Evolution	Peter Cowhey	Vijay Gurbaxani
Education	Gabriele Wienhausen	Robert Beck

Table 1: Initial Members of the UCSD and UCI Executive Committees

The two Executive Committees will meet together monthly via video teleconference and quarterly face-to-face, alternating between UCSD and UCI. It is clear that the greatest failure mode for such an enterprise is the possibility that the faculty will fail to cohere in the systematic manner envisioned in the research plan. The Directors together have many decades of experience at the success and failure modes of large research teams, both academic and industrial. We have decentralized the leadership as much as possible, with local autonomy on each campus, and yet by the organization structure ensured a high level of coherence to the vision and its implementation.

To enhance communication across this distributed enterprise, we will use the very high-speed telecommunications infrastructure we will be studying to experiment with videoteleconferencing and collaboration technologies: the Access Grid from Argonne National Laboratory; the Digital Amphitheater and Webclopedia, research projects from partner UCS/ISI; and WebEx, Inc. software. The Access Grid and WebEx are already operational at SDSC.

UCSD has had a Steering Committee, led by Dean Robert Conn, composed of the UCSD principal Deans and Directors, plus the Vice Chancellor for Research, which has ensured that all academic concerns are brought to the senior management of the Institute. This Steering

Committee will be will be joined with a parallel UCI Steering Committee chaired by William Parker, Vice Chancellor of Research and composed of the UCI associate director and the principal deans. The Directors of SIO and SDSC will join this committee.

In addition, we have formed an External Advisory Board (EAB) to guarantee that institute research is of the highest caliber seen from a national and California perspective. The EAB will therefore be co-chaired by senior experts from California and Washington, DC. We have recruited Forest Baskett, a venture partner in New Enterprise Associates, a Bay Area venture capital (VC) firm that just raised the largest VC fund in history. Baskett was a distinguished computer scientist at Stanford University when Sun Microsystems, MIPS, and SGI spun off, and he served for more than 10 years as CTO for SGI. We recruited Phil Smith to serve as co-chair. Smith is one of the most senior science and technology policy experts in the nation, having been Executive Director of the National Research Council for 13 years and having served in every presidential administration since Eisenhower's.

In addition, the following prominent national figures in institute focus areas have agreed to serve on this board: Karl Hess, Swanlund Chair of Electrical Engineering, UIUC [co-founder of the Beckman Institute for Advanced Science and Technology, and Co-director of the NSF funded Distributed Center for Advanced Electronics Simulations]; Deborah Estrin, UCLA Professor of Computer Science and [Director of the Laboratory for Embedded Collaborative Systems]; Andrew Vitterbi, President, The Vitterbi Group [Member, President's Information Technology Advisory Committee]. The co-chairs are currently in discussion with three other nationally prominent researchers to join the Board if the institute is funded.

Evaluation. Successful strategies related to accountability and periodic review of progress developed through the two NSF PACI partnerships to manage large, distributed, interdisciplinary teams will be adapted. Institute progress and plans will also be reviewed periodically by the EAB. Industry sponsors will monitor progress via periodic reports and on-site research reviews. In addition, a variety of human resource metrics will be monitored to evaluate success, including the two campuses' competitiveness for relevant research grants, the ability to achieve greater than 2:1 cost matching, the number of spin-off businesses or amount of technology transfer to industry, the number of students graduated who participated in the institute, the number of participant undergraduate students who continued to graduate school, and the number of publications produced by participating researchers.

G2. Timeline and Milestones

At the start of the project, we will prioritize research activities to target initial hiring of academic professionals. We will also hire administrators to support operations (Sec. C). With respect to communication both within the institute and with interested parties outside, in Year 1 we will establish a Web site and tour program; install Access Grid nodes at SIO, UCSD's Jacobs School of Engineering (JSOE), the Visual Arts department, and at UCI H. Samueli School of Engineering (HSSOE); begin experimenting with VTC tools to integrate activities in the absence of a centralized location; and, in years 2-4, conduct annual institute meetings for all participants. In year 2, we will design and build an exhibit gallery temporarily housed in JSOE. We also expect to report annually to UCOP and additionally as needed on institute progress, new technology trends, and research plans for the future. The executive committees will meet monthly for at least the first year, then move to quarterly meetings, with some members being rotated off and new members rotated on at the start of Year 3. The steering committees will meet quarterly. The EAB will start meeting annually in Year 1, with some rotation of membership in Year 3.

Appendix A: Personnel Biographies

This appendix includes biographies of Larry Smarr (director), Ronald Graham (chief scientist), Ramesh Rao (associate director, UCSD), and Peter Rentzepis (associate director, UCI), followed, in alphabetical order, by biographies for the leaders in all layer and applications areas. At the top of each of the latter, please find the team members in that layer or application from that campus, their departments, and areas of expertise. The number of faculty participating is approximately 210 people.

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EDUCATION

Ph.D., Physics, University of Texas at Austin, 1975 (Ph.D. advisor: Bryce S. DeWitt [The Structure of General Relativity with a Numerical Illustration: The Collision of Two Black Holes])
M.S., Physics, Stanford University, 1972
M.S. and B.A., Physics, University of Missouri, August 1970 and June 1970, respectively

PROFESSIONAL EXPERIENCE

Professor, Computer Science and Engineering, University of California, San Diego, 2000 - present
Strategic Advisor, National Computational Science Alliance, 2000 - present
Director, National Computational Science Alliance, October 1997 - 2000
Director, National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign, February 1985 - 2000
Professor, Astronomy and Physics departments, University of Illinois at Urbana-Champaign, August 1985 - 2000
Associate Professor, Astronomy and Physics departments, University of Illinois at Urbana-Champaign, August 1981 - August 1985
Assistant Professor, Astronomy and Physics departments, University of Illinois at Urbana-Champaign, August 1979 - August 1981 and August 1980 - August 1981, respectively
Junior Fellow, Harvard Society of Fellows; in departments of Physics and Astronomy, Harvard University, August 1976 - July 1979
Research Affiliate, Department of Physics, Yale University, September 1978 - July 1979
Research Associate, Princeton University Observatory, July 1975 - July 1976

HONORS AND AWARDS

Member, National Academy of Engineering, Section 5 (Computer Science and Engineering)
Fellow, American Academy of Arts and Sciences
Fellow, American Physical Society
Champaign County Most Valuable Citizen Award, Champaign County Chamber of Commerce, 1998
Franklin Institute's Delmer S. Fahrney Gold Medal for Leadership in Science or Technology, 1990
Member, Editorial Board, *Science*, American Association for the Advancement of Science, 1986 - 1990

Distinguished Alumnus Award, College of Arts and Science, University of Missouri at Columbia, 1985
Max-Planck Institute for Physics and Astrophysics Fellowship, 1982 - 1983
Alfred P. Sloan Research Fellow, 1980 - 1984
Junior Fellow, Harvard University, 1976 - 1979
National Science Foundation Fellow, 1970 - 1973
Woodrow Wilson Independent Study Award for Top 10% of W.W. Fellows, 1970

PUBLICATIONS

On Information Technology and National Policy

"Infrastructure for Science Portals," *IEEE Internet Computing*, January/February 2000, "A Millennium Internet Mosaic" [http://computer.org/internet/v4n1/index.htm].

Information Technology Research: Investing in Our Future, a Report to the President of the United States by the Members of the President's Information Technology Advisory Committee, February 24, 1999.

"Grids in Context," Larry Smarr, Chapter 1 in The Grid: A Blueprint for the New Computing Infrastructure, edited by Ian Foster and Carl Kesselman, MKP, 1998.

"Supercomputers: Directions in Technology, Architecture, and Applications," Larry Smarr, *Proceedings of Supercomputing '98*, Mannheim, Germany, 1998.

"Computational Infrastructure: Toward the 21st Century," Larry Smarr, *Comm. of the ACM*, 40(11) pp. 28-32, 1997.

"A Nationwide Parallel Computing Environment," Ken Kennedy, Charles F. Bender, John W.D. Connolly, John L. Hennessy, Mary K. Vernon, and Larry Smarr, *Comm. of the ACM,* 40(11), pp. 62-72, 1997.

Uses of Information Technologies in Science

The Biomedical Information Science and Technology Initiative, prepared by the Working Group on Biomedical Computing, Advisory Committee to the Director, National Institutes of Health, June 3, 1999 [www.nih.gov/welcome/director/060399.htm].

INDUSTRIAL ACTIVITIES

Member, Vanguard Advisory Board, CSC, 1993 - 1997; TTI 1998 - 1999 (created quarterly IT frontier programs for industrial CIOs)
Member, Fisher Scientific Biotechnology Council, 1993 - 1998
Creator with John Stevenson of NCSA's Strategic Industrial Partner Program (since 1986, 17 partners have added more than $70,000,000 to NCSA's programs)

RONALD L. GRAHAM
Chief Scientist Designate,
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Irwin and Joan Jacobs Endowed Chair,
Computer Science and Engineering Department
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EDUCATION

Ph.D., Mathematics, University of California, Berkeley (NSF Fellow and Woodrow Wilson Fellow), 1962
M.A., Mathematics, University of California, Berkeley, 1961
B.S., Physics, University of Alaska, Fairbanks, 1958
Ford Foundation Scholar, University of Chicago, 1951-1954

PROFESSIONAL EXPERIENCE

Jacobs Endowed Chair of Computer and Information Science, University of California, San Diego, 1999-present
Chief Scientist, AT&T Labs, 1996-1999
University Professor of Mathematical Sciences, Rutgers University, 1986-1999
Visiting Professor of Computer Science, Princeton University, 1989
Visiting Professor of Computer Science, Princeton University, 1987
Fairchild Distinguished Scholar, California Institute of Technology, 1983
Visiting Professor of Computer Science, Stanford University, 1981
Visiting Professor of Computer Science, Stanford University, 1979
Distinguished Visiting Letters and Sciences Professor, University of California, Davis, 1979
Regents Professor of Mathematics, University of California, Los Angeles, 1975
Director, Information Sciences, AT&T Bell Laboratories, Murray Hill, New Jersey, 1962-1965
U.S. Air Force, 1955-1959

COMMITTEE MEMBERSHIPS

Treasurer, Chair, Class I, National Academy of Sciences, 1994-1996
President, Board of Trustees, Council, Executive Committee, American Mathematical Society, 1993-1995
Board of Governors, President's Council and Mathematics Advisory Board, New York Academy of Sciences
Chair and Secretary, American Association for the Advancement of Science, Scientific Program Committee, Mathematics Section
First Vice President, Executive Committee, Mathematical Association of America
Mathematical Sciences Education Board, National Research Council
Committee on the Undergraduate Program in Mathematics
Executive Committee, Council, Conference Board of Mathematical Sciences, Joint Policy Board on Mathematics

U.S. National Committee on Mathematics
Chairman, Polya Prize Committee, SIAM
Chairman, Fulkerson Prize Committee, Mathematical Programming Society
National Research Council, Computer Science and Telecommunications Board
Computer Science Advisory Committee, University of California, Berkeley
Office of Naval Research, Advisory Panel on Mathematics
Advisory Committee, VISUMAP PBS Television Series
Square One Television Series Advisory Committee, Children's Television Workshop
Chairman, Scientific Advisory Board, Development Committee, Mathematical Sciences Research Institute, Berkeley
Program Committee, International Congress of Mathematicians, Kyoto, Japan, 1990
Scientific Advisory Board, Institute of Pure and Applied Mathematics, UCLA, 1999-2002

HONORS AND AWARDS
Member, National Academy of Science
Fellow, American Academy of Arts & Science
Fellow, New York Academy of Sciences
Fellow, American Association for the Advancement of Science
Polya Prize Combinatorics, 1972
Carl Allendorfer Award of Math. Assoc. of Amer., 1990
Lestor Ford Award of Math. Assoc. of Amer., 1991
Euler Medal, Institute of Combinatorics, 1994

SELECTED CURRENT EDITORIAL BOARDS
Combinatorics: Journal of Combinatorial Theory (A), Combinatorica, European Journal of Combinatorics, Discrete Mathematics, Discrete Applied Mathematics, SIAM Journal on Discrete Mathematics, Wiley Series in Discrete Mathematics and Optimization, Random Structure & Algorithms, Annals of Discrete Mathematics, Combinatorics, Probability and Computing, Geombinatorics, Electronic Journal of Combinatorics, Annals of Combinatorics, Journal of Combinatorial Optimization, SIAM Monographs on Discrete Mathematics and Applications
Graph Theory: Journal of Graph Theory, Graphs and Combinatorics, Networks
Computer Science: Journal of Algorithms, SIAM Journal on Computing, Mathematics of Operations Research, Information and Computation, International Journal of Computers and Mathematics, Discrete and Computational Geometry, Springer Series on Algorithms and Combinatorics, International Journal on Foundations of Computer Science, International Journal on Computational Geometry, Computational Geometry and Applications, Springer Series on Discrete Mathematics and Theo. Comp. Sci.
General: Journal of Number Theory, Applied Mathematics Letters, Naval Research Logistics, Advances in Applied Mathematics, Journal of Classification, Caribbean Journal of Mathematics, Springer Series on Computational Mathematics, Journal of Experimental Mathematics, International Journal of Algebra and Computation, Journal of Difference Equations, Collectania Mathematica, Integer: The Electronic Journal of Combinatorial Number Theory

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RESEARCH INTERESTS
Architectures, protocols, and performance analysis of wireless, wireline, and photonic networks for integrated multimedia services.

EDUCATION
Ph.D., Electrical Engineering, University of Maryland, College Park, 1984
M.S., Electrical Engineering, University of Maryland, College Park, 1982
B.E. (Honors), Electrical and Communication Engineering, University of Madras, India, 1980

PROFESSIONAL EXPERIENCE
Director, Center for Wireless Communications, 2000 - present
Professor, UCSD, 1998 - present
Associate Professor, UCSD, 1991 - 1998
Assistant Professor, UCSD, 1984 - 1991

PROFESSIONAL ACTIVITIES
Member of the Board of Governors, IEEE Information Theory Society (2000 - 2002, 1997 - 1999)
Secretary, IEEE Communications Society, Technical Activities Council and Technical Committees Board, 1990 - 1991
Publications Editor, IEEE Information Theory Society, 1999 - present
Editor for Packet Multiple Access, *IEEE Transactions on Communications*, 1997 - present
Member of the Editorial Board, *IEEE Network*, 1997 - present
Member of the Editorial Board, *ACM/Baltzer Wireless Networks Journal*, 1997 - present
Founding Web Editor, Information Theory Society Web site (http://itsoc.org), 1995 - 1999
Guest Editor, *IEEE Journal of Selected Areas in Communications*, Special Issue on "Multi-media Network Radios," 1998
Editor, *Information Theory Society Newsletter*, 1993 - 1995

Chair, Technical Program Committee, 1997 IEEE International Conference on Universal Personal Communications
Proceedings Chair, 1995 International Conference on High Performance Computing
Proceedings Chair, 1994 International Parallel Processing Symposium

REVIEWER

IEEE Transactions on Communications, ACM/IEEE Transactions on Networking, IEEE Transactions on Information Theory, IEEE Transactions on Automatic Control, IEEE JSAC, IEEE Transactions on Computers, IEEE Transactions on Parallel and Distributed Systems, IEEE Conferences, NSF Grant Proposals, UC Micro Program, Natural Sciences and Engineering, Council of Canada, Morgan Kauffman Publishers

SELECTED PUBLICATIONS

"Stochastic Battery Discharge in Portable Communication Devices," *Proc. of Battery Conference*, Long Beach, CA, January 2000 (with C. F. Chiasserini).

"Energy Efficient Battery Management", *Proc. of Infocom 2000*, March 2000, Tel Aviv, Israel (with C. F. Chiasserini).

"Performance Analysis of TCP on Channels with Memory" *IEEE Journal on Selected Areas in Communications*, July 2000 (with M. Zorzi and A. Chokalingam).

"On the Impact of Burst Errors on Wireless ATM," *IEEE Personal Communications*, Vol. 6, No. 4, pp. 65-76, August 1999 (with M. Zorzi).

"Perspectives on the Impact of Error Statistics on Protocols for Wireless Networks," *IEEE Personal Communications*, Vol. 6, October 1999 (with M. Zorzi).

"Lateness Probability of a Retransmission Scheme for Error Control on a Two-state Markov Channel," *IEEE Trans. Comm*., Vol. 47, No. 10, pp. 1537-1548, October 1999 (with M. Zorzi).

"Wireless Channel Models—Coping with Complexity," in *Wireless Multimedia Network Technologies*, Kluwer Academic Publishers, 1999, pp. 271-288 (with A.M. Chen).

"Pulsed Battery Discharge in Communication Devices," *Proc. of Mobicom '99*, Seattle, WA, August 1999 (with C. F. Chiasserini).

"Wireless Data Access," *Proc. of the IEEE Region 10 Conference*, Cheju Island, Korea, pp. 41-44, September 1999.

"A Traffic Control Scheme to Optimize Battery Pulsed Discharge," *Proc. of Milcom '99*, Atlantic City, NJ, November 1999 (with C. F. Chiasserini).

"A Model for Battery Pulsed Discharge with Recovery Effect," *Proc. of WCNC '99*, New Orleans, LA, October 1999 (with C. F. Chiasserini).

"Is TCP Energy Efficient?" *Proceedings of the Sixth IEEE International Workshop on Mobile Multimedia Communications*, San Diego, CA, November 1999 (with M. Zorzi).

"Performance of Closed-loop Power Control in DS-CDMA Cellular Systems," *Transactions on Vehicular Technology*, 1998 (with A. Chockalingam, P. Dietrich, and L.B. Milstein).

"Multi-channel Packet Resource Allocation for Multimedia Support," *Proceedings VTC '98*, Ottawa, Ontario, Canada, May 18-21, 1998, pp. 1770-1774, Vol. 3 (with A. M. Chen).

"Performance of TCP on Wireless Fading Links with Memory," *Proceedings ICC98* (with A. Chockalingam and Michele Zorzi).

"Error Statistics in Data Transmission over Fading Channels," *IEEE Trans. Comm*., Vol. 46, pp. 1468-1477, November 1998 (with M. Zorzi and L. B. Milstein).

"Exploiting Overlapping Coverage in Pico-cellular Networks for Web Support," appears as "Multi-channel packet resource allocation for multimedia support," *Proceedings VTC'98*, Ottawa, Ontario, Canada, May 18-21, 1998, pp. 1770-1774 (with A. M. Chen).

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Presidential Chair and Professor,
Department of Chemistry
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EDUCATION
Ph.D., Cambridge University, Britain, 1963
M.S., Syracuse University, Britain, 1962
B.S., Dennison University, Britain, 1958

EMPLOYMENT
Member of Technical Staff, Research Laboratories, General Electric Co., Schenectady, NY
Member of Technical Staff, AT&T Bell Laboratories, Murray Hill, NJ
Head, Physical and Inorganic Chemistry Research, AT&T Bell Laboratories, Murray Hill, NJ

PROFESSORSHIPS (PARTIAL LIST)
Visiting Professor, Rockefeller University, NY
Visiting Professor of Chemistry, Massachusetts Institute of Technology
Visiting Professor of Chemistry, University of Tel-Aviv, Tel-Aviv, Israel
Adjunct Professor of Chemistry, University of Pennsylvania
Center for Biological Studies, State University of New York, Albany
Adjunct Professor of Chemistry and Biophysics, Yale University

AWARDS
Irving Langmuir Award in Chemical Physics, awarded by the American Physical Society
Scientist of the Year Award, R&D
Member, National Academy of Sciences
The A. Cressy Morrison Award in Natural Sciences, New York Academy of Sciences
ISCO Award
AHEPA Award for Leadership in Science and Education
Honorary Doctor of Philosophy, Syracuse University
Honorary Doctor of Science, Denison University
The Peter Debye Award in Physical Chemistry, American Chemical Society
Fellow, New York Academy of Sciences
Fellow, American Physical Society
Regents' Professor, University of California at Los Angeles
Camille and Henry Dreyfus Distinguished Scholar
Distinguished Alumni, SUNY
Honorary Doctor of Science, Carnegie-Mellon University

The H.S. Ganning Award, University of Alberta, Canada
AAAS Fellow
Int. Quantum. and Laser Soc. Award
Sigma Xi
Honorary Doctor of Science, National Technical University of Greece

NAMED LECTURESHIPS (PARTIAL LIST)
Robert A. Welch Foundation Lecturer
Faculty Lecturer, Rensselaer Polytechnic Institute
Alumni Scholar, Denison University
IBM Lecturer, Williams College
Distinguished Lecture Series, University of Utah
Regents Lecturer, University of California at Irvine
Xerox Lecturer, North Carolina State University
Frank C. Whitmore Lectures in Chemistry, Pennsylvania State University
Dreyfus Distinguished Scholar Lectures
Regents' Lecturer, University of California, Irvine
The Harry S. Gannig Distinguished Lectures, University of Alberta, Canada
Distinguished Lecturer, University of Crete, Greece
Distinguished Lecturer, York University, Canada

PUBLICATIONS
330 technical papers plus 58 patents and four books

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Pierre Baldi will lead the **UCI Digitally Enabled Genomic Medicine** team with expertise in machine learning, probabilistic modeling, protein structure and function, gene regulation, and DNA microarray gene expression data analysis. His team will include the following:

Nancy Albritton, Physiology and Biophysics, pathways, biochips
John Gennari, Information and Computer Science, medical informatics
G. Wesley Hatfield, Microbiology and Molecular Genetics, gene regulation, DNA microarrays
Dennis Kibler, Information and Computer Science, bioinformatics, gene regulation, clustering
Richard Lathrop, Information and Computer Science, bioinformatics protein structure, pathways
Anthony Long, Environmental and Evolutionary Biology, gene regulation, DNA arrays, complex traits, complex diseases
James Nowick, Chemistry, organic chemistry, artificial beta-sheets, drug design
Wand Pratt, Information and Computer Science, medical informatics
Suzanne Sandmeyer, Biological Chemistry, gene regulation, pathways, oxidative stress, DNA microarrays

EDUCATION

Ph.D., Mathematics, California Institute of Technology, 1986
M.S., Computer Science and Engineering, ENSTA, Paris, France, 1983
D.E.A., Mathematics, University of Paris VII, France, 1981
M.S., Mathematics, University of Paris VII, France, 1980
M.S., Psychology, University of Paris X, France, 1980

PROFESSIONAL EXPERIENCE

Associate Professor, Department of Information and Computer Science, University of California, Irvine, and Department of Biological Chemistry, College of Medicine, and Department of Developmental and Cell Biology, School of Biological Sciences. Director, Institute for Genomics and Bioinformatics, 1999 - present
Chairman and CEO, Net-ID, Inc., 1991 - 1999
Visiting Professor, Department of Computer Science, University of Florence, January 1999
Member, Professional Staff, Division of Biology, California Institute of Technology, 1995 - 1996
Member, Technical Staff, Nonlinear Science and Information Processing Group, Jet Propulsion Laboratory, and Visiting Research Associate, Division of Biology, California Institute of Technology, 1988 - 1995

Visiting Research Mathematician, Department of Mathematics, University of California, San Diego, summer 1988
Visiting Lecturer, Department of Mathematics, University of California, San Diego, 1986 - 1988

PROFESSIONAL ASSOCIATIONS
Member, American Association for the Advancement of Science
Member, International Society for Computational Biology
Member, International Society for Bayesian Analysis
Member, American Statistical Association

BOOKS
P. Baldi and S. Brunak. Bioinformatics: The Machine Learning Approach, MIT Press, 1998 (second edition in press).
P. Baldi and G. Wesley. Hatfield DNA Microarrays and Gene Expression, Cambridge University Press (in press).
P. Baldi. The Shattered Self—The End of Evolution, MIT Press (in press).

PUBLICATIONS
P. Baldi, and P. Baisnée. Sequence Analysis by Additive Scales: DNA Structure for Sequences and Repeats of All Lengths. *Bioinformatic*s, 2000 (in press).
P. Baldi, G. Pollastri, C.A.F. Andersen, and S. Brunak. Matching Protein-sheet Partners by Feedforward and Recurrent Neural Networks. *Proceedings of the 2000 Conference on Intelligent Systems for Molecular Biology (ISMB00)*, La Jolla, CA, 25-36, 2000, AAAI Press.
S. Hampson, P. Baldi, D. Kibler, and S. Sandmeyer. Analysis of Yeast's ORFs Upstream Regions by Parallel Processing, Microarrays, and Computational Methods. *Proceedings of the 2000 Conference on Intelligent Systems for Molecular Biology (ISMB00)*, La Jolla, CA, pp. 190-201, AAAI Press.
P. Baldi, S. Brunak, Y. Chauvin, and A. Gorm Pedersen. Structural Basis for Triplet Repeat Disorders: A Computational Analysis. *Bioinformatics*, Vol. 15, No. 11, pp. 918-929, 1999.
P. Baldi, S. Brunak, P. Frasconi, G. Soda, and G. Pollastri. Exploiting the Past and the Future in Protein Secondary Structure Prediction. *Bioinformatics*, Vol. 15, No. 11, pp. 937-946, 1999.
A. Gorm Pedersen, P. Baldi, S. Brunak, and Y. Chauvin. The Biology of Eukaryotic Promoter Prediction—a Review. *Computers and Chemistry, Special Issue on Genome and Informatics*, 23, pp. 191-207, 1999.
A. Gorm Pedersen, P. Baldi, Y. Chauvin, and S. Brunak. DNA Structure in Human RNA Polymerase II Promoters. *Journal of Molecular Biology*, 281, pp. 663-673, 1998.
P. Baldi, M.C. Vanier, and J.M. Bower. On the Use of Bayesian Methods for Evaluating Compartmental Neural Models. *Journal of Computational Neuroscience*, 5, pp. 285-314, 1998.

ROBERT J. BECK
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Robert Beck will lead the **UCI Education** team with expertise in pre-K learning and teacher education through technology. His team will include the following:

Hank Becker, Education, research on teachers' attitudes toward technology as it relates to pedagogic philosophy and technical competency

Jean-Claude Falmagne, Cognitive Sciences, research and development related to computer-based tutorials in mathematics (intelligent tutors)

Maria Pentelia, Classics, director of Thesaurus Linguae Graecae (computerized ancient classics), computer classics

EDUCATION

Ph.D., Personality, Values, and the Career Line, University of Chicago, 1965
Postdoctoral Program, Psychotherapy and Psychoanalysis, New York University, 1965-1968
M.A., Spatial Meaning and the Properties of the Environment, University of Chicago, 1964
B.A., Psychology of Legal Competency and Examination, University of Chicago, 1958

PROFESSIONAL EXPERIENCE

Acting Chair, Department of Education, University of California, Irvine, 2000-present
Director, Center for Collaborative Research in Education, Department of Education, University of California, Irvine, 1999-present
Assistant Professor, Department of Education, University of California, Irvine, 1998-present
Research Specialist, School of Social Ecology, Department of Psychology and Social Behavior, University of California, Irvine, 1995-1998
Senior Fellow in Art Education, Meadows Museum, Southern Methodist University, 1993-1995

HONORS AWARDS

Phi Beta Kappa
Sigma Xi (Graduate Science Honorary Society)
ViRA Award, *Video Dictionary of Classical Ballet*, Best Special Set, 1984

PROFESSIONAL ASSOCIATIONS

Association for Supervision and Curriculum Development (ASCD)
American Educational Research Association (AERA)
International Society for Technology in Education
Environmental Design Research Association
Division of Educational Psychology (American Psychological Association)

PUBLICATIONS

Beck, R.J., Cesario, T.C., Yousefi, A., & Enamoto, H. (2000). Choral singing, performance perception, and immune system changes in salivary Immunoglobulin A and Cortisol. Music Perception (in press).

Beck, R.J., Kotkin, R.A., Swanson, J.M., & Miller, F. (1999). Stability of situational non-compliance in ADHD children in two school settings. Journal of Attention Disorders, **3**(1), pp. 5-12.

Clarke-Stewart, K.A., & Beck, R.J. (1999). Maternal scaffolding and children's narrative retelling of a movie story. Early Childhood Research Quarterly, **14**(3), pp. 409-434.

Beck, R.J., Martinez, M., & Lires, V. (1999). The application of an expert model of interpretive skill to a multicultural-multimedia system on ethnic dance. Studies in Art Education, **40**(2), pp. 162-179.

Clarke-Stewart, K.A., & Beck, R.J. (1998). Improving five-year-old children's narrative recall and comprehension. Journal of Applied Developmental Psychology, **19**(4), pp. 543-569.

FUNDED GRANTS

Principal Investigator, "Implementation of an E-Education Program." U.S. Department of Education. Preparing Tomorrow's Teachers to Use Technology, 2000-2003.

Principal Investigator, "The Irvine Experiment in Restructuring Credential Program Preparation and Support for the Development of Student Teachers' Technological Proficiencies." U.S. Department of Education. Preparing Tomorrow's Teachers to Use Technology, 1999-2000.

Principal Investigator, "T.A.L.E.N.T. Technology & Literacy—Educators Networked & Teamed."

Evaluator of the impacts of computer networking of teachers on students' literacy. Orange County Department of Education/State of California, 1999-2002.

Co-Investigator, "An integrated arts/social studies curriculum for Orange County schools." U.S. Department of Education, Fund for the Improvement of Post-Secondary Education (FIPSE), 1998.

Member, Task Force on Head Start/University Partnerships, Head Start Bureau, Administration for Children, Youth & Families, U.S. Department of Health and Human Services, 1995-1997.

FRANCINE BERMAN
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Francine Berman will lead the **UCSD Interfaces and Software Systems** team with expertise in middleware, programming environments and tools, scheduling, performance prediction, mega-computing, and scientific computing. Her team will include the following:

- Scott Baden, Computer Science and Engineering, parallel programming models, algorithms, and data structures, high-performance applications
- Chaitanya Baru, SDSC, database systems, digital libraries, data mining
- Rik Belew, Computer Science and Engineering, adaptive representations (neural networks and genetic algorithms, computational biology and information retrieval applications)
- Mihir Bellare, Computer Science and Engineering, cryptography (design and analysis of cryptographic protocols), computer and network security
- Larry Carter, Computer Science and Engineering, performance programming, hierarchical tiling, computational science
- Garrison W. Cottrell, Computer Science and Engineering, pattern recognition with neural networks, cognitive modeling, face and expression recognition
- Jeanne Ferrante, Computer Science and Engineering, high-performance compilation, hierarchical tiling, parallel programming environments and tools
- Fan Chung Graham, Mathematics, Computer Science and Engineering, algorithms and combinatorial analysis in computing/telecommunications, active compilers for the Grid
- William E. Howden, Computer Science and Engineering, software testing methods (data-oriented systems, communication systems, wireless communication) and software risk analysis (error modeling, error prevention)
- Andrew B. Kahng, Computer Science and Engineering/Electrical and Computer Engineering, VLSI CAD physical design and performance analysis, VLSI design-manufacturing interface, circuits and design tools for VLSI system design fabrics
- Daniele Micciancio, Computer Science and Engineering, foundation of cryptography, computational complexity
- Alex Orailoglu, Computer Science and Engineering, VLSI CAD, embedded processors and systems, VLSI testing, fault tolerance
- Philip M. Papadopoulos, SDSC, distributed, cluster, and metacomputing infrastructure software and hardware
- Joseph Pasquale, Computer Science and Engineering, mobile code-based middleware, wireless/wired Internet, operating systems
- Ramamohan Paturi, Computer Science and Engineering, algorithms, complexity, digital libraries
- George Varghese, Computer Science and Engineering, high-speed router design, algorithms for routers to aggregate information from sensors

Goeffrey M. Voelker, Computer Science and Engineering, operating systems, distributed systems, Internet systems

Bennet Yee, Computer Science and Engineering, computer security, electronic commerce, mobile agents, operating systems

BIOGRAPHICAL SKETCH

Francine Berman is Professor of Computer Science and Engineering at UCSD, a Fellow of the San Diego Supercomputer Center, an ACM Fellow, and director of the Grid Computing Laboratory at UCSD. Her research interests focus on parallel and distributed computation, in particular, programming environments, tools, and performance models that support high-performance computing. Berman's research focuses on design and development of adaptive programs and software for distributed heterogeneous resources, also known as the *Computational Grid.* More specifically, she conducts research on the design and development of user-level middleware that can leverage dynamically changing capacities of distributed environments to achieve high performance. She leads the AppLeS (Application-Level Scheduler) project to develop adaptive and dynamic application scheduling methods and performance technology for multi-user distributed environments. The AppLeS group is developing leading-edge, user-level middleware for programming common classes of distributed applications in large-scale Grid environments. Berman has served on numerous editorial boards, and program and conference committees related to parallel and Grid computing. She also is a member of the Metasystems thrust of the National Partnership for Advanced Computational Infrastructure (NPACI) where she provides leadership in application scheduling issues.

EDUCATION

Ph.D., University of Washington, 1979 (dissertation advisors: R. Ritchie and M. Fischer)**;** M.A., University of Washington, 1976; B.A., UCLA, 1973

PROFESSIONAL EXPERIENCE

Professor, UCSD, July 1993 - present; Associate Professor, July 1987 - June 1993; and Assistant Professor, UCSD, July 1984 - June 1987, UCSD

Assistant Professor, Purdue University, August 1979 - July 1984

PUBLICATIONS [available at http://apples.ucsd.edu]

H. Casanova, G. Obertelli, R. Wolski, and F. Berman, "The AppLeS Parameter Sweep Template: User-level Middleware for the Grid," to appear in SC00, Best Paper Finalist.

S. Smallen, Walfredo Cirne, Jaime Frey, Francine Berman, Rich Wolski, Mei-Hui Su, Carl Kesselman, Steve Young, and Mark Ellisman, "Combining Workstations and Supercomputers to Support Grid Applications: The Parallel Tomography Experience," Proceedings of the 2000 Heterogeneous Computing Workshop.

Berman, F., Wolski, R., and D. Zagorodnov, "Application Scheduling on the Information Power Grid" (invited paper), *International Journal of High Performance Computing,* Vol. 14, No. 3, Fall 2000.

M. Faerman, A. Su, R. Wolski, and F. Berman, "Adaptive Performance Prediction for Distributed Data-intensive Applications," Proceedings of SC99.

Berman, F., "High-Performance Schedulers," a book chapter for The Grid: Blueprint for a New Computing Infrastructure, edited by Ian Foster and Carl Kesselman.

SHELDON BROWN
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Sheldon Brown will lead the **UCSD New Media Arts** team. Brown examines relationships between information and space, which manifests as public artworks and installations combining architectural settings with mediated and computer controlled elements. His team will include

Thomas Allen Harris, Visual Arts, a multimedia installation and performance artist whose work uses real-time streaming technologies for Internet-based performance.

Louis Hock, Visual Arts, a media producer pursuing new media technologies for installation, video production, and Web distribution. He uses the Internet to bring together diverse cultures and locations in support of dialogue, collaboration, and presentation of works.

Adriene Jenik, Visual Arts, a researcher focused on interactive and online environments. She has been developing theatrical interventions into Internet visual chat rooms to engage deeper public debate about the rapid adoption of life-shaping technologies.

George Lewis, Music, a composer, performer, and computer-installation artist who performs improvisatory duets with his own interactive computer program.

Lev Manovich, Visual Arts, an internationally acclaimed theorist of new media. His upcoming book The Language of New Media (MIT Press) takes a savvy look at the meaning of new media cultural forms.

F. Richard Moore, Music, a researcher studying music technology, acoustics, computer music, and digital audio signal processing.

János Négyesy, Music, developer of an electronic violin performance system.

Peter Otto, Music, a researcher studying digital multi-channel sound spatialization and developing tools applicable to the arts, entertainment, and communications.

Miller Puckette, CRCA and Music, developer of Max, released in 1990, the lingua franca of real-time computer music composition and research.

Roger Reynolds, Music, creator of music concerned with myth, text, and computer spatialization ranging from the purely instrumental to involvement with video, voice, dance, and theater.

Mohan Trivedi, Electrical and Computer Engineering, Computer Vision and Robotics Research Laboratory, a researcher who studies active perception, machine vision, integrated intelligent systems, and multimodal interfaces.

PROJECTS, EXHIBITIONS , AND GROUP SHOWS (SELECTED)

4/98-7/99 *Mi Casa Es Tu Casa/My House Is Your House*: Networked virtual reality environment at the Centro Nacional de las Artes in Mexico City, Children's Museum of San Diego.

12/95 Permanent *In the Event* Commissioned public artwork at the Seattle Key Arena.

11/94-3/95 *The Video Wind Chimes* public artwork, Center for the Arts, San Francisco, CA.

9/94 *Apparitions* virtual reality installation and *The Video Wind Chimes* public art video installation, InSite '94, San Diego, CA.
5/93 *The Vorkapitchulator,* computer-controlled installation, Machine Culture, Anaheim, CA.
11/99 *CYBERART: Bienal do Mercosal,* Caxias do Sul, Brazil.
10/99 *Telesculpture*, Institute for Studies in the Arts, Arizona State University.
12/97 and 12/98 *image/architettura in movimento*, University of Florence, Italy.

COMMISSIONS, GRANTS, AND AWARDS (SELECTED)
Digital Media Innovations Award 2000; Artist in Residence, Department of Art, University of Colorado, 1999; Artist in Residence, Institute for Studies in the Arts, Arizona State University, 1999-2000; Asian Cultural Council Fellowship, 1996; Hellman Fellowship, 1996; Seattle Center Coliseum Public Art Commission, 1994-1995; National Endowment for the Arts Public Art Project Grant, 1994-1995; 3Com Corporation, 1998-1999; Intel Corporation, 1997-2000; AT&T Foundation, 1998; Mandel Weiss Foundation, 1997; Mexican Cultural Institute, 1998; InSITE 97, 1996; Sony Corporation, 1996; Schoepflin Foundation, 1997.

REVIEWS AND PUBLICATIONS (SELECTED)
"Mi Casa Es Tu Casa," Proceedings of the 4th International Conference on Virtual Systems and Multimedia, Gifu, Japan, November 1998.
"*Real Art and Virtual Reality"* by Sheldon Brown, ACM SIGGRAPH Computer Graphics, Vol. 31, No. 4, November 1997.
"The Video Wind Chimes," The 4th International Conference on Artificial Reality and Tele-Existence Proceeding, pg. 227, Tokyo, Japan, 1994.

PANELS AND LECTURES (SELECTED)
Technology Is Not the Point, International Sculpture Conference 5/2000
*Telesculpture Colloquium***,** Institute for Studies in the Arts, ASU 10/99
*Out of the Box: The Future of the Interface***,** Banff Center for the Arts, 9/98
Technotopia, University of New Mexico, Albuquerque, 11/97
Real Art/Virtual Reality, First International Conference on Cyberspace, Valencia, Spain, 11/96
Public Artist Talk: "In the Event," Key Arena, Seattle, WA, 10/28/95
Post-Photography, San Diego Supercomputer Center, 9/93

APPOINTMENTS (SELECTED)
Director, Center for Research in Computing and the Arts, 7/99 - present; and Associate Professor III, Department of Visual Arts, 1998 - present, UCSD.
New Media Arts Consultant, Los Angeles County Museum of Art, 9/98 - present.
Visiting Faculty, Department of Art and Technology, School of the Art Institute of Chicago, 1991 - 1992.
Faculty Fellow, Photo-Video Department, Kansas City Art Institute, 1990-9991.

EDUCATION
M.F.A., Conceptual Design, San Francisco State University, 1990; Graduate Studies in Environmental Design, University of California, Berkeley, 1989; B.F.A. in Film, San Francisco Art Institute, 1986.

PETER F. COWHEY
Director, Institute on Global Conflict and Cooperation (IGCC)
Professor, Political Science
International Relations/Pacific Studies (IR/PS) Graduate School
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Peter Cowhey will lead the **UCSD Policy, Management, and Socioeconomic Evolution** team with expertise in international communications and information technology industries—competition and regulation, international trade policy. His team will include the following:

- Roger Bohn, IR/PS, Co-director, Sloan Foundation Project on the Disk Drive Industry, technology management and competition in networked industries
- Stephan Haggard, IR/PS, comparative political economy of the Pacific Rim, international trade
- Mikhail Klimenko, IR/PS, international economics, communications markets and policy
- Arthur Lupia, Political Science, American political institutions and political economy
- Mathew McCubbins, Political Science, American political institutions, law and economics, comparative public policy in the Pacific Rim
- Colleen Morton, Deputy Director, Institute of the Americas, Latin American politics and public policy

EDUCATION

Ph.D., Political Science, University of California, Berkeley, 1977
M.A., University of California, Berkeley, 1971
B.S.F.S., Foreign Service, Georgetown University, 1970

PROFESSIONAL EXPERIENCE

Professor, Graduate School of International Relations and Pacific Studies (IR/PS) and Department of Political Science, University of California, San Diego, 1989-present
Director, Institute on Global Conflict and Cooperation, University of California (while serving as professor at IR/PS and adjunct professor of Political Science), 1999
Chief, International Bureau, FCC, 1997
Senior Counselor for International Economic and Competition, Federal Communications Commission, 1994-1997
Assistant Professor of Political Science, University of California, San Diego, 1976-1983
Senior Consultant, International Market Planning, AT&T International, 1985-1986
Associate Professor of Political Science, University of California, San Diego, 1983-1988

COMMITTEE MEMBERSHIPS

Member, Study Group on Trade Policy, 1999-present
Member, China-Japan-U.S. Trilateral Forum, 1996-1999
Member, Secretary General of International Telecommunications Union Expert Group on

International Settlement Rates, 1997-1998
Member, Council on Foreign Relations: Co-director of Study Groups in 1985-1986 (foreign investment) and 1995-1996 (information and communications policy)
Member, Computer and Information Policy Project Committee on Convergence, National Research Council, 1993-1994
Member, Committee on the Consequences of Communications, Computers, and the Entertainment Industries, National Research Council, 1992-1993
Member, International Advisory Board, The International Center for Telecommunications Management, 1988-1993
Member, International Advisory Board, Project Promothee (French research institute on international economic policy), 1985-1994

PUBLICATIONS

"Keeping the Internet Open: When Doing Nothing is Doing Harm," *Telecommunications Policy*, Fall 2000 (with F. Bar, S. Cohen, B. de Long, M. Kleeman, and J. Zysman).
"Dialing for Dollars: The Revolution in Communications Markets," in Jeffrey Hart and Akheem Prasash (eds.) Coping with Globalization (New York: Routledge, 2000) (with J. Richards).
"Telecommunications Reform in Developing Countries after the WTO Agreement on Basic Telecommunications Services," *Journal of International Development*, 12, pp. 265-281, 2000 (with M. Klimenko).
"FCC Benchmarks and the Reform of the International Telecommunications Market," *Telecommunications Policy,* January 1999.

COLLABORATORS WITHIN THE LAST 48 MONTHS

Jonathan Aronson, Annenberg School, University of Southern California
Mikhail Klimenko, Graduate School of International Relations and Pacific Studies, University of California, San Diego
John Richards, Stanford University School of Business and McKinsey Consulting
Francois Bar, Department of Communications, Stanford University
Stephen Cohen, School of City and Regional Planning, University of California, Berkeley
Brad de Long, Department of Economics, University of California, Berkeley
John Zysman, Department of Political Science, University of California, Berkeley
Michael Kleeman, Berkeley Roundtable on the International Economy, University of California, Berkeley

LIST OF ADVISEES

Hendrik Spruyt, University of Arizona
John Richards, Stanford University and McKinsey
David Auerswald, George Washington University
Deborah Avant, George Washington University
Kal Raustiala, UCLA

GRADUATE AND POSTGRADUATE ADVISOR

Prof. Ernst Haas, Department of Political Science, University of California, Berkeley

MADGA EL ZARKI
Professor, Department of Information and Computer Science
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http://www.ics.uci.edu/~magda

Magda El Zarki will lead the **UCI Networked Infrastructure** team with expertise in all aspects of networking from data link layer to applications, wireless networking, and real-time services (video and voice over IP). Her team will include the following:

- Nader Bagherzadeh, Electrical and Computer Engineering (chair), signal processing and communications.
- Rui Defigueiredo, Electrical and Computer Engineering, communications and signal processing, new artificial neural network techniques for nonlinear adaptive time series prediction, interference cancellation, and channel equalization, and V-BLAST-oriented methods for exploitation of space/time diversity in wireless communications
- Rajesh Gupta, Information and Computer Science, embedded systems, low-level networking design (chip design), wireless communications
- Scott Jordan, Electrical and Computer Engineering, network performance analysis, wireline and wireless, resource allocation, quality of service, pricing and network control
- Kane Kim, Electrical and Computer Engineering, middleware with emphasis on enabling high-level, distributed, object-based, real-time programming; dynamically adaptable fault tolerance and QoS; distributed real-time simulation
- Sharad Mehrotra, Information and Computer Science, data representation, management and organization, visualization
- Doug Schmidt, Electrical and Computer Engineering, middleware with emphasis on hands-on research and implementation of systems
- Tatsuya Suda, Information and Computer Science, Internet-related research, video multicast, Web applications, quality of service, performance analysis, routing and congestion control, wireless/mobile networking and distributed systems
- Kevin Tsai, Electrical and Computer Engineering, optimization with emphasis on network performance analysis and flow/congestion control
- Gene Tsudik, Information and Computer Science, security and cryptography related to wireless, group communications security, database privacy and Internet anonymity
- Nalini Venkatasubramanian, Information and Computer Science, quality of service (QoS) and multimedia systems, building a reflective middleware system to support QoS

EDUCATION

Ph.D., Electrical Engineering, Columbia University, 1988
M.S.E.E., Electrical Engineering, Columbia University, 1981
B.S.E.E., Electrical Engineering, Cairo University, Cairo, Egypt, 1979

PROFESSIONAL EXPERIENCE

Professor, Department of Information and Computer Science, University of California, Irvine, 1999 - present

Assistant Professor, Department of Electrical Engineering, University of Pennsylvania, 1988 - 1999; Secondary Appointment: Department of Computer & Information Science, 1989 - 1999, Department of Systems Engineering, 1997 - 1999

Lecturer and Research Scientist, Fulbright Scholar, Cairo, Egypt, affiliated with Cairo University, Ain Shams University, and the Electronics Research Institute, 1996 - 1997

Professor, Telecommunication Networks, Delft University of Technology, Delft, The Netherlands, 1993 - 1995

Manager of Network Planning, Division of International Telecommunications, Citibank N.A., New York, NY, 1981 - 1983

PROFESSIONAL ACTIVITIES

Editorial Board, *Wireless Personal Comm*., Kluwer Acad. Publ., 1993 - 1996; *Wireless Networks*, J.C. Baltzer AG, Science Publ., 1993 - present; *Computer Networks and ISDN*, Elsevier Publ., 1993 - 1999; *Transactions on Networking*, IEEE/ACM, 1995 - 1999

Board of Governors, IEEE Communications Society, January 1995 - December 1997

IEEE Technical Computer Communications Committee (TCCC) - Conference Coordinator for IEEE TCCC, 1991 - 1993; Secretary of IEEE TCCC, 1993 - 1995; Vice Chair of IEEE TCCC, 1995 - 1997

Technical Program Chair, IEEE INFOCOM 94

Technical Program Co-chair, ACM Mobicom 98

Vice Technical Program Chair, IEEE INFOCOM 93

Tutorial Chair, IEEE INFOCOM 91, ACM SIGCOMM 90

Technical Program Committee, IEEE INFOCOM 89 - 98, 01; ACM SIGCOMM 90 - 92, 96; IC3N 93; IEEE PIMRC 94; 3rd ORSA Telecommunications Conf. 95; 4th ORSA Telecommunications Conf. 98; 5th Int'l IEEE Conf. on Network Protocols 97; SPIE International Symposium on Voice, Video and Data Comm. 97; IEEE ICC 90

Session Organizer, ICC, INFOCOM, GLOBECOM, Computer Comm. Workshop

PUBLICATIONS

"Delay and Synchronization Control Middleware to Support Real-time Multimedia Services over Wireless PCS Networks," Hang Liu and M. El Zarki, *IEEE Journal on Selected Areas in Communications*, Vol. 17, No. 9, pp. 1660-1672, September 1999.

"Adaptive Source Rate Control for Real-time Video Transmission over Wireless Networks Using Hybrid ARQ Error Control," Hang Liu and M. El Zarki, *ACM/Baltzer Journal for Mobile Networks and Applications (MONET),* Vol. 3, No. 1, pp. 49-60, 1998.

"Error Control for Networks: An Overview," Hang Liu, Hairuo Ma, M. El Zarki, and Sanjay Gupta*, ACM/Baltzer Journal for Mobile Networks and Applications (MONET)*, Vol. 2, pp. 167-182, 1997.

MARIA Q. FENG
Associate Professor, Department of Civil and Environmental Engineering
E 4139, Engineering Gateway
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949-824-2117 (fax)
mfeng@uci.edu

Maria Feng will lead the **UCI Environment and Civil Infrastructure** team with expertise in optical fiber sensors and wireless communication for monitoring structures/lifelines; health monitoring of bridges; fusion of GPS, GIS, and remote sensing for rapid seismic damage assessment; and SCADA for damage detection of lifelines. Her team will consist of the following:

Thorsten Benter, Chemistry, microsensors for environmental gasses
Franco De Flaviis, Electrical and Computer Engineering, electromagnetic imaging technology for damage detection of structures/lifelines
Barbara Finlayson-Pitts, Chemistry, detection of ultra-low impurities in water and sea
Medhat Haroun, Civil and Environmental Engineering, monitoring and damage assessment of lifelines
Louis Joffre, Electrical and Computer Engineering, electromagnetic topography for damage detection of structures/lifelines
Doo-Kie Kim, Civil and Environmental Engineering, signal processing, system identification, advanced computing
Shunji Moromugi, Civil and Environmental Engineering, image processing and recognition, fusion of GPS, GIS, and remote sensing for rapid seismic damage assessment
Gerard Pardoen, Civil and Environmental Engineering, experimental modal analysis, bridge monitoring
Roberto Villaverde, Civil and Environmental Engineering, experimental modal analysis, advanced computing
J.N. Yang, Civil and Environmental Engineering, structural control, advanced computing

EDUCATION

Ph.D., Mechanical Engineering, University of Tokyo, Tokyo, Japan, 1992
M.S., Mechanical Control Engineering, University of Electro-Communications, Tokyo, Japan, 1987
B.S., Mechanical Engineering, Nanjing Institute of Technology, Nanjing, China, 1984

PROFESSIONAL EXPERIENCE

Associate Professor, Department of Civil and Environmental Engineering, University of California, Irvine, 1997 - present
Associate Professor, Department of Civil and Environmental Engineering, University of California, Irvine, 1992 - 1997
Research Assistant II, Department of Civil Engineering, Princeton University, 1990 - 1992

COMMITTEE MEMBERSHIPS

Secretary and member of Technical Committee on Performance-based Design and Evaluation, ASCE, 2000 - present

Member of Technical Committee on Health Monitoring and Structural Identification of Constructed Facilities, Institute of Structural Engineering, ASCE, 1998 - present

Member of Technical Committee on Search and Rescue Robots, Japan Society of Mechanical Engineering, 1997 - present

Member of HITEC National Evaluation Panel for Seismic Isolation and Energy Dissipation Devices, sponsored by Federal Highway Administration, 1994 - present

Member of Technical Committee on Field Sensing and Robotics in Civil Engineering, Aerospace Division, ASCE, 1993 - present

PROFESSIONAL ASSOCIATIONS

Member, ASCE

PUBLICATIONS

Feng, M.Q., De Flaviis, F., and Kim, Y.J. "Application of Electromagnetic Waves in Damage Detection of Concrete Structures," *Proceedings of the International Symposium on Smart Structures and Materials*, SPIE, Newport Beach, CA, March 1-2, 2000.

Feng, M.Q., Liu, C., He, X., and Shinozuka, M. "Electromagnetic Image Reconstruction for Damage Detection," *Journal of Engineering Mechanics*, ASCE, **126**(7), pp. 725-729, 2000.

Feng, M.Q., and Bahng, E.Y. "Damage Assessment of Jacketed RC Columns Using Vibration Tests," *Journal of Structural Engineering*, ASCE, Vol. 125, No. 3, pp. 265-271, 1999.

Feng, M.Q., and Kim, J.M. "Identification of a Dynamic System Using Ambient Vibration Measurements," *Journal of Applied Mechanics*, ASME, Vol. 65, No. 2, pp. 1010-1023, 1998.

Feng, M.Q. "An Electro-optical Accelerometer and Its Field Testing," *Journal of Engineering Mechanics*, ASCE, Vol. 124, No. 5, pp. 513-519, 1998.

COLLABORATORS WITHIN THE LAST 48 MONTHS

Professor Richard Liu, Department of Electrical Engineering, University of Houston

ADVISEES

Professor Takafumi Fujita, University of Tokyo, Tokyo, Japan

Professor Kazuo Yamafuji, University of Electro-Communications, Tokyo, Japan

GRADUATE AND POSTGRADUATE ADVISOR

Professor Jae Min Kim, Department of Civil and Environmental Engineering, Yosu National University, Yosu, Korea

Dr. Winston Chai, EQE International, Los Angeles, CA

Dr. Don Chu, Cisco Systems, San Jose, CA

DANIEL D. GAJSKI
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Daniel Gajski will lead the **UCI Interfaces and Software Systems** team with expertise in computer and information systems, software hardware codesign, algorithms and methodologies for embedded systems, CAD environments, and science of design. His team will include

- Lubomir Bic, Information and Computer Science, parallel and distributed computing, biomedical simulation and data and knowledge base systems
- Nikil Dutt, Information and Computer Science, embedded systems and computer systems design
- Michael Franz, Information and Computer Science, mobile code technologies, dynamic code generation and optimization
- Alfred Kobsa, Information and Computer Science, user-adaptive information environments, human-computer interaction, user modeling, information visualization, expert finders, multimedia educational software, user interfaces for handicapped and elderly people
- Gloria Mark, Information and Computer Science, computer-supported collaborative work, design and usability of collaborative technologies, virtually co-located team environments
- Michael McCarthy, Mechanical Engineering, geometric design of spatial linkages
- Alexandru Nicolau, Information and Computer Science, architecture parallel computations, programming languages and compilers
- David F. Redmiles, Information and Computer Science, design environments, human-computer interaction, usability engineering, knowledge-based software engineering
- Debra J. Richardson, Information and Computer Science (chair), software quality engineering, life-cycle verification and validation, specification-, architecture-, and component-based testing and analysis, multi-platform automated software testing
- David Rosenblum, Information and Computer Science, software engineering, software architecture, distributed component-based software validation, Internet-scale event observation and notification
- Walt Schacchi, Information and Computer Science, organizational and software process engineering, electronic commerce, computer-supported collaborative work environments
- Padhraic Smyth, Information and Computer Science, statistical pattern recognition, automated analysis of large data sets, applications of probability and statistics to artificial intelligence
- Tatsuya Suda, Information and Computer Science, computer communication networks, distributed computing systems
- Richard Taylor, Information and Computer Science, director of the Institute for Software Research, software engineering, hyperware/Web technologies, configurable software architecture, and workflow/process technology
- Bruce Tromberg, Physiology and Biophysics, development and application of novel optical techniques

André van der Hoek, Information and Computer Science, software engineering, configuration management, software architecture, configurable distributed systems

Alex Veidenbaum, Information and Computer Science, computer architecture, compilers and embedded systems design

BIOGRAPHICAL SKETCH

After 10 years of industrial experience in digital circuits, switching systems, supercomputer design, and VLSI structures, Gajski spent 10 years in academia with the Department of Computer Science at the University of Illinois, Urbana-Champaign. Gajski is interested in requirements and specifications of embedded systems and the design process that leads from an executable specification to the final manufacturable blueprint. To study the design process, his group is developing new specification languages, modeling guidelines, and simulation and synthesis tools. To obtain efficient specifications and design models, they are "taxonomizing" models of computations, computer architectures, and design styles. To develop efficient CAD tools, they are studying synthesis algorithms for systems, architectures, processors, controllers, data paths, and other intellectual properties. Their goal is to build proof-of-concept tools and prove their methodology and tools on extensive industrial-strength examples. He is editor of the book Silicon Complication (Reading, MA: Addison-Wesley, 1988), a co-author of High-level Synthesis: An Introduction to Chip and System Design (New York: Kluwer-Academic, 1992) and Specification and Design of Embedded Systems (Englewood Cliffs, NJ: Prentice Hall, 1994).

EDUCATION

Ph.D., Computer and Information Sciences, University of Pennsylvania

Dipl. Ing. and M.S., Electrical Engineering, University of Zagreb, Croatia

PUBLICATIONS

D.D. Gajski, J. Zhu, R. Dömer, A. Gerstlauer, S. Zhao, SpecC: Specification Language and Methodology, Kluwer Academic Publishers, Boston, MA, ISBN 0-7923-7822-9, March 2000, 336 pages.

D.D. Gajski, Principles of Digital Design, Prentice Hall: Upper Saddle River, NJ, 1997, 450 pages.

Daniel D. Gajski, Rainer Dömer, Jianwen Zhu, "IP-centric Methodology and Specification Language," in Distributed and Parallel Embedded Systems, edited by Franz J. Rammig, Kluwer Academic Publishers, Boston, MA, ISBN 0-7923-8614-0, September 1999.

Daniel D. Gajski, Rainer Dömer, Jianwen Zhu, "IP-centric Methodology and Design with the SpecC Language," Chapter 10 in System-Level Synthesis, *Proceedings of the NATO ASI on System Level Synthesis for Electronic Design*, Il Ciocco, Lucca, Italy, August 1998, edited by Ahmed A. Jerraya and Jean P. Mermet, Kluwer Academic Publishers, Dordrecht, ISBN 0-7923-5749-3, May 1999.

Daniel D. Gajski, Jianwen Zhu, Rainer Dömer, "Essential Issues in Codesign," Chapter 1 in Hardware/Software Co-Design: Principles and Practice, edited by Jørgen Staunstrup and Wayne Wolf, Kluwer Academic Publishers, Boston, MA, ISBN 0-7923-8013-4, October 1997.

VIJAY GURBAXANI
Professor, Graduate School of Management
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Vijay Gurbaxani will lead the **UCI Policy, Management, and Socioeconomic Evolution** team with expertise in e-commerce strategy, the impact of information systems on organizations and markets, management of information technology, and economics of information technologies. His team will include the following:

- David H. Blake, Graduate School of Management (dean), global business strategy, leadership development, strategy of leadership and power in a networked economy
- Paul Chwelos, Graduate School of Management, economics of information systems, microcomputer price and quality change, revealed preferences in electronic auctions, intellectual property rights and technological change, electronic data interchange, channel competition in e-commerce
- Claudia Bird Schoonhoven, Graduate School of Management, evolutionary dynamics of technology-based firms, innovation, and entrepreneurship
- Kevin Zhu, Graduate School of Management, e-commerce and its impacts on firms and industries, economics of information technology, network effects and competitive strategies in the emerging electronic economy

EDUCATION

Ph.D., Computers and Information Systems, William E. Simon Graduate School of Business Administration, University of Rochester, 1987
M.S., Computers and Information Systems, William E. Simon Graduate School of Business Administration, University of Rochester, 1983
M.S., Computer Science and Mathematics, Indian Institute of Technology, Bombay, India, 1980

PROFESSIONAL EXPERIENCE

Area Coordinator, Information Systems, Graduate School of Management, University of California, Irvine, 1991 - 1993, 2000 - present
Faculty Chairman, Graduate School of Management, University of California, Irvine, 1993 - 1994, 2000 - present
Professor of Management, Graduate School of Management, University of California, Irvine, 1997 - present
Visiting Scholar, Graduate School of Business, Stanford University, 1999 - 2000
Associate Dean of Academic Degree Programs, Graduate School of Management, University of California, Irvine, 1995 - 1999
Research Fellow, CSC/Index Research and Advisory Services, Computer Sciences Corporation, Cambridge, MA, 1994 - 1995
Associate Dean of Research, Graduate School of Management, University of California, Irvine, 1993 - 1994

Associate Director, Center for Research on Information Technology and Organizations, University of California, Irvine, 1992 - 1994
Associate Professor of Management, Graduate School of Management, University of California, Irvine, 1991 - 1997
Visiting Scientist, Sloan School of Management, Massachusetts Institute of Technology, 1987 - 1987
Assistant Professor of Management, Graduate School of Management, University of California, Irvine, 1985 - 1991
Instructor, William E. Simon Graduate School of Business Administration, University of Rochester, 1981 - 1985

COURSES TAUGHT
Information technology, coordination and control in organizations
Information systems and business strategy
Economics of information systems
Measuring business value of information systems
Database management systems
Management information systems

Courses offered in Master's, Ph.D., and Executive programs.

PUBLICATIONS
"The Production of Information Services: A Firm-level Analysis of Information Systems Budgets" (with N. Melville and K. Kraemer), *Information Systems Research*, June 2000.
"Executives' Perceptions of the Business Value of Information Technology: A Process-oriented Approach," *Journal of MIS,* 2000.
"A New Strategic Framework for IT Outsourcing" (with A. DiRomualdo), *Sloan Management Review,* 1998.
"Disaggregating the Return on Investment to IT Capital" (with N. Melville and K. Kraemer), *Proceedings of the International Conference on Information Systems*, 1998.

RECENT PROFESSIONAL PRESENTATIONS
"The Production of Information Services: A Firm-level Analysis of Information Systems Budgets," Carlson School of Business, University of Minnesota, May 2000.
"Disaggregating the Return on Investment to IT Capital," *International Conference on Information Systems*, Helsinki, Finland, December 1998.
"A Strategic Perspective on Information Systems Outsourcing," National University of Singapore, Singapore, January 1998.
"Information Systems Outsourcing Contracts—Theory and Evidence," Anderson Graduate School of Management, UCLA, January 1997.

PROFESSIONAL ASSOCIATIONS
INFORMS

WILLIAM S. HODGKISS
Deputy Director, Scientific Affairs; Associate Vice Chancellor, Marine Sciences
Scripps Institution of Oceanography (SIO)
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William Hodgkiss will lead the **UCSD Environment and Civil Infrastructure** team with expertise in data telemetry, sensor array signal processing, and environmental parameter estimation. His team will include the following:

- Jonathan Berger, SIO/Institute for Geophysics and Planetary Physics (IGPP), seismic and geodetic monitoring
- Yehuda Bock, SIO/IGPP, crustal deformation/earthquake hazards, short-term weather forecasting, collection of GPS space geodetic data
- Dan Cayan, SIO/Climate Research Division, regional climate modeling, hydrology
- Michael Dettinger, SIO/Climate Research Division, hydrology, land-air interactions
- Ahmed Elgamal, Structural Engineering, earthquake engineering, dynamics of structures and soil-structure interactions, monitoring
- Charles Elkan, Computer Science and Engineering, learning algorithms, data mining, search and reasoning algorithms, Web applications of artificial intelligence
- Robert T. Guza, SIO/Center for Coastal Studies, surface gravity waves, near-shore/surf-zone processes
- Myrl C. Hendershott, SIO/Center for Coastal Studies, coastal circulation and internal waves
- Francesco Lanza di Scalea, Structural Engineering, nondestructive testing, sensor technology for monitoring of advanced composite structures
- Bernard Minster, SIO/IGPP, laser altimetry and lidar imaging related to geomorphology, land use/cover
- John Orcutt, SIO/IGPP, global telemetry of geophysical and geodetic data
- Frieder Seible, Structural Engineering, assessment/testing of constructed facilities infrastructure to determine structural integrity, expected service life, and emergency response
- Richard Seymour, SIO/Center for Coastal Studies, ocean engineering, wave mechanics and climatology, near-shore processes
- Detlef Stammer, SIO/Physical Oceanography Research Division, numerical ocean modeling and ocean state estimation (data assimilation), cluster computing
- Bradley M. Tebo, SIO/Marine Biology Research Division, biogeochemical cycling of manganese, iron, and trace metals in marine environments, bioremediation and marine biotechnology
- Frank Vernon, SIO/IGPP, regional network and transportable broadband seismic arrays
- Clinton D. Winant, SIO/Center for Coastal Studies, wind- and buoyancy-forced coastal circulation
- Aristides A. Yayanos, SIO/Marine Biology Research Division, molecular biophysics, marine genomics

EDUCATION
Ph.D., Electrical Engineering, Duke University, 1975
M.S., Electrical Engineering, Duke University, 1973
B.S., Electrical Engineering, Bucknell University, 1972

PROFESSIONAL EXPERIENCE
Deputy Director, Scientific Affairs, Scripps Institution of Oceanography; Associate Vice Chancellor, Marine Sciences, University of California, San Diego, 1998-present
Adjunct Professor, Department of Electrical and Computer Engineering, University of California, San Diego, 1998-present
Professor, Graduate Department of SIO, 1993-1998
Deputy Director, Marine Physical Laboratory, 1991-present
Applied Ocean Science Curricular Group Coordinator, SIO, 1980-1998
Associate Director, Marine Physical Laboratory, 1990-1993
Associate Professor, SIO, 1984-1991
Assistant Professor, SIO, 1989-1990
Assistant Director, Marine Physical Laboratory, 1978-1984
Assistant Director, Department of Electrical Engineering, Bucknell University, 1977-1978
Engineer, Naval Ocean Systems Center, San Diego, CA, 1975-1977

COMMITTEE MEMBERSHIPS
Technical Committee on Underwater Acoustics, Acoustical Society of America, 1994-1997

PROFESSIONAL ASSOCIATIONS
Fellow, Acoustical Society of America; Member, IEEE

PUBLICATIONS
D'Spain, G.L., Murray, J.J., Hodgkiss, W.S., Booth, N.O., Schey, P.W., Mirages in shallow water matched field processing, *J. Acoust. Soc. Am*., v. 105(6), pp. 3245-3265, 1999.
Carbone, N.M., and Hodgkiss, W.S., Effects of tidally driven temperature fluctuations on shallow-water acoustic communications at 18 kHz, *IEEE J. Oceanic Eng*., v. 25(1), pp. 84-94, 2000.
Gerstoft, P., Gingras, D.F., Rogers, L.T., and Hodgkiss, W.S., Estimation of radio refractivity structure using matched-field array processing, *IEEE Trans. Antennas Propagat*., v. 48(3), pp. 345-356, 2000.
Hodgkiss, W.S., Song, H.C., Kuperman, W.A., Akal, T., Ferla, C., and Jackson, D.R., A long range and variable focus phase conjugation experiment in shallow water, *J. Acoust. Soc. Am*., v. 105(3), pp. 1597-1604, 1999.
Song, H.C., Kuperman, W.A., Hodgkiss, W.S., Akal, T., and Ferla, C., Iterative time reversal in the ocean, *J. Acoust. Soc. Am*., v. 105(6), pp. 3176-3184, 1999.
Unpingco, J., Kuperman, W.A., Hodgkiss, W.S., and Hecht-Nielsen, R., Single sensor source tracking and environmental inversion, *J. Acoust. Soc. Am*., v. 106(3), pp. 1316-1329, 1999.
Kuperman, W.A., Hodgkiss, W.S., Song, H. C., Akal, T., Ferla, C., and Jackson, D., Phase conjugation in the ocean: Experimental demonstration of an acoustic time reversal mirror, *J. Acoust. Soc. Am*., v. 103(1), pp. 25-40, 1998.

GUANN-PYNG LI
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G.P. Li will lead the **UCI Materials and Devices** team, with expertise on high-speed electronic devices and circuits, and polymer MEMS for integrated system on a chip. His team will include the following:

Nancy Allbritton, College of Medicine/Bioengineering, single cell analysis of RNA, protein for bioinformatic appliances

Mark Bachman, Electrical and Computer Engineering, polymer MEMS for communication, computing, and biomedical systems

Michael W. Berns, Electrical and Computer Engineering /Bioengineering, microscope and chip-based photonics detectors

Ying Chang, Chemical and Biochemical Engineering and Materials Science, polymer surface modification for biomedical applications

Zhongping Chen, Beckman Laser Institute and Medical Clinic, bio-photonics, *in situ* and *in vivo* monitoring

F. De Flaviis, Electrical and Computer Engineering, RF and microwave circuits and systems

John C. Hemminger, Chemistry, chemistry/physics of surfaces, ultra-thin films and nanostructures

John LaRue, Mechanical and Aerospace Engineering, flat-panel, high-resolution field emission display and MEMS

Henry P. Lee, Electrical and Computer Engineering, intelligent systems for III-V epitaxy, fiber-based modulating devices

Chin C. Lee, Electrical and Computer Engineering, electronic packaging and integrated photonic devices

D. L. Mills, Physics, theory of magnetic nanostructures and spintronic materials

Rick Nelson, Electrical and Computer Engineering, MEMS and flat-panel, high-resolution field emission displays

Reg. Penner, Chemistry, nanoscale structures, quantum dots, and molecular electronics

Suzanne Sandmeyer, SOBS, DNA array technology

Frank G. Shi, Materials, packaging and interconnect simulation and nanocomposite materials

A. Shkel, Mechanical and Aerospace Engineering, telecommunication MEMS

Bruce Tromberg, College of Medicine/Electrical and Computer Engineering, bio-photonics, non-invasive or minimally invasive optical probing

Chen Tsai, Electrical and Computer Engineering, optoelectronic and magneto-optics materials and devices

Vasan Venugopalan, Chemical and Biochemical Engineering and Materials Science, bio-photonics, laser-induced thermal/mechanical transport phenomena

EDUCATION

Ph.D., Electrical Engineering, University of California, Los Angeles, 1983
M.S., Electrical Engineering, University of California, Los Angeles, 1982
B.S., Electrical Engineering, National Cheng Kung University, Taiwan, 1978

BIOGRAPHICAL SKETCH

Guann-Pyng Li has published more than 130 research papers involving semiconductor materials, devices, technologies, and circuit systems. He worked on developing a silicon silicide molecular beam epitaxy (MBE) system while at UCLA, and then in the area of silicon bipolar VLSI technology and process-related device physics while at IBM. During his tenure at IBM, he coordinated and conducted research efforts in technology development of high-performance and scaled-dimension (0.5 um and 0.25 um) bipolar devices and ICs, as well as on optical switches and optoelectronics for ultra-high-speed IC measurements. In 1987, he also chaired the committee for defining IBM semiconductor technology for beyond the year 2000.

He joined UCI in 1988 and is a professor in Electrical and Computer Engineering. His research interests include novel materials and processes for high-speed electronic/optoelectronic device fabrication for network and wireless communication applications, novel electro-optical probing of semiconductor materials, devices and circuits for *in situ* wafer quality evaluation and ultra-high-speed chip-level testing, design and fabrication of novel electronic/optoelectronic devices for low-power technology, and novel micro-electro-mechanical system (MEMS) device design and fabrication for biomedical and sensing applications.

PUBLICATIONS

Yandong Chen, Zhongping Chen, Yonghua Zhao, J. Stuart Nelson, Mark Bachman, Yuh-Min Chiang, Charles Chu, G.P. Li, "Test channels for flow characterization of processed plastic microchannels," presented at the 1999 Fall Materials Research Society conference, Boston, MA, December 1999.

Yuh-Min Chiang, Mark Bachman, Hung-Pin Chang, Charles Chu, G.P. Li, "SU-8 processing on a variety of substrates," presented at the 1999 Fall Materials Research Society conference, Boston, MA, December 1999.

Charles Chu, Mark Bachman, Yuh-Min Chiang, Fernando Gonzales, G.P. Li, "Characterizations of metallized plastic MEMS," presented at the 1999 Fall Materials Research Society conference, Boston, MA, December 1999.

G.P. Li, M. Young, M. Bachman, Y.M. Chiang, C. Chu, "A wafer-level micro-cap package," UC patent disclosure, UC Case No. 2000-038-1, August 1999.

M. Bachman, Y.M. Chiang, C. Chu, G.P. Li, "Laminated microfluidic structures using a micromolding technique," Microfluidic Devices and Systems II, *Proceedings of SPIE*, 3877, C. Ahn and A. Frazier, Eds., SPIE 1999, pp. 139-146.

Y.M. Chiang, M. Bachman, C. Chu, G.P. Li, "Characterizing the cast molding process of micromolded microfluidic systems," Microfluidic Devices and Systems II, *Proceedings of SPIE*, 3877, C. Ahn and A. Frazier, Eds., SPIE 1999, pp. 303–311.

WILL RECKER
Professor, Civil Engineering
Director, Institute of Transportation Studies
University of California, Irvine
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949-824-8385 (fax)
wwrecker@uci.edu

Wrecker is the leader of the **UCI Intelligent Transportation** team with expertise in transportation information and control systems. His team will include the following:

Nicolaos G. Alexopoulos, Electrical and Computer Engineering, wireless communication
Nader Bagerzadeh, Electrical and Computer Engineering, parallel processing
Sandra Irani, Information and Computer Science, online algorithms
R. Jayakrishnan, Civil and Environmental Engineering, transportation network analysis
K. H. Kim, Electrical and Computer Engineering, ultra-reliable, real-time distributed and parallel computing
Michael G. McNally, Civil and Environmental Engineering, travel behavior and transportation systems analysis
Amelia C. Regan, Civil and Environmental Engineering, logistics and real-time optimization
Stephen G. Ritchie, Civil and Environmental Engineering, development of emerging technologies for transportation and intelligent transportation systems
Douglas C. Schmidt, Electrical and Computer Engineering, distributed object computing
Phillip Sheu, Electrical and Computer Engineering, database systems
Allen R. Stubberud, Electrical and Computer Engineering, control systems, optimization, and digital signal processing
Wei Kang Tsai, Electrical and Computer Engineering, data communication networks

EDUCATION

Ph.D., Civil Engineering, Carnegie-Mellon University, 1968
M.S., Civil Engineering, Carnegie Institute of Technology, 1966
B.S., Civil Engineering, Carnegie Institute of Technology, 1964

BIOGRAPHICAL SKETCH

Will Recker is Professor of Civil Engineering and Director of the Institute of Transportation Studies, University of California, Irvine. Dr. Recker is active as a university educator, researcher, and administrator. He has authored more than 100 research articles and served as principal investigator on many research projects in travel demand forecasting and transportation engineering. Since assuming his position at the University of California, he has served as principal investigator on more than 25 extramural research grants and contracts in transportation totaling more than $20 million.

His research has focused on travel demand models, disaggregate modeling methodologies, and transportation systems analysis. He is responsible for development of several models of transportation choice based on hierarchical, non-compensatory structures. He has been instrumental in the development of activity-based travel behavior approaches.

He heads the California Advanced Transportation Management Systems Testbed Research Program, an effort centered around a basic university research program in advanced transportation management and information systems coupled to a research implementation program involving aerospace industrial partners and city and state government agencies. During the past five years, research conducted within this testbed has led to more than 100 refereed publications and almost 20 Ph.D.s.

ACADEMIC APPOINTMENTS

Professor, Civil Engineering, University of California, Irvine, 1979 - present
Director, Institute of Transportation Studies, University of California, Irvine, 1983 - present
Professor, Engineering and Applied Sciences, SUNY at Buffalo, 1978 - 1979
Associate Professor, Engineering and Applied Sciences, SUNY at Buffalo, 1971 - 1978
Assistant Professor, Engineering and Applied Sciences, SUNY at Buffalo, 1967 - 1971

PUBLICATIONS

Recker, W.W. (2000). A Bridge between Travel Demand Modeling and Activity-based Travel Analysis. *Transportation Research, Part B: Methodological* (forthcoming).

Chang, A., J.-S. Oh, B. Park, and W. Recker (2000). Solving the Bi-criteria Traffic Equilibrium Problem with Variable Demand and Nonlinear Path Costs. *Transportation Research Record* (forthcoming).

Recker, W.W., C. Chen, and M.G. McNally (2000). Measuring the Impact of Efficient Household Travel Decisions on Potential Travel Time Savings and Accessibility Gains. *Transportation Research, Part A: Policy and Practice (forthcoming).*

Conroy, P., S. Shladover, J. Dahlgren, W. Recker, S. Ritchie, and P. Varaiya. (2000). Intelligent Transportation Systems: Research Products for Public Works Professionals. *Public Works Management & Policy*, 5, 1, pp. 3-13.

Recker, W.W. and A. Parimi (1999). Development of a Microscopic Activity-based Framework for Analyzing the Potential Impact of TCMs on Vehicle Emissions. *Transportation Research, Part D: Transport and Environment*, 4, pp. 357-378.

Zhang, H.M., and W.W. Recker (1999). On Optimal Freeway Ramp Control Policies for Traffic Corridors. *Transportation Research, Part B: Methodological*, 33, 6, pp. 417-436.

Sun, C., W. Recker, S. Ritchie, B. Gallagher, and J. Thai (1997). OAK-TREE: One-of-a-kind Traffic Research and Education Experiment. *Transportation Research Record*, 1603, pp. 106-111.

Leonard, J.D., and W.W. Recker (1997). A Streamlined Methodology for Application of TRANSYT-7F. *ITE Journal*, 67, 2, pp. 26-35.

Zhang, H., S. Ritchie, and W. Recker (1997). Some General Results on the Optimal Ramp Control Problem. *Transportation Research Part C: Emerging Technologies*, 4, 2, pp. 51-69.

RELEVANT GRANTS (AS PRINCIPAL INVESTIGATOR)

PATH Center for Advanced Transportation Management Systems Research, California Department of Transportation, July 1, 1996 - June 30, 2001, $669,498

California Advanced Transportation Management Systems Testbed–Operational Phase, California Department of Transportation, July 1, 1997 - June 30, 2001, $4,319,360

IVAN K. SCHULLER
Professor, Physics Department
University of California, San Diego
9500 Gilman Drive
La Jolla, CA 92093-0319
858-534-2540
858-534-0173 (fax)
ischuller@ucsd.edu

Ivan Schuller will lead the **UCSD Materials and Devices** team, with expertise in nanostructures, thin films, and novel devices. His team will include the following:

Peter Asbeck, Electrical and Computer Engineering, III-IV HBTs for wireless
John E. Crowell, Chemistry and Biochemistry, group IV materials for HBTs
Robert C. Dynes, Physics, electrical transport in reduced dimensional solids
Sadik Esener, Electrical and Computer Engineering, photonic sensors and photonic switch chips
Shaya Fainman, Electrical and Computer Engineering, nano- and micro-optic devices
John M. Goodkind, Physics, electron on He
Ronald Graham, Computer Science and Engineering, computer science
Francis Hellman, Physics, thermodynamic characterization of nanoscale materials
Cliff Kubiak, Chemistry and Biochemistry, self-assembled functional electronics
Andrew C. Kummel, Chemistry and Biochemistry, materials for GaAs CMOS devices
S.S. Lau, Electrical and Computer Engineering, 3-D integration of homogenous and heterogeneous systems
Yu-Hwa Lo, Electrical and Computer Engineering, optoelectronic devices, and photonic integrated circuits
M. Brian Maple, Physics, physics of heavy fermion and non-Fermi liquid states
D. Mayer, Mathematics, quantum computing
Michael J. Sailor, Chemistry and Biochemistry, electrochemical synthesis of optical and sensor materials
Lu Sham, Physics, modeling opto-electronic processes in nanostructures
Jan B. Talbot, Chemical Engineering, display materials
Peter Taylor, Chemistry and Biochemistry/SDSC, theory of defects in ionic lattices
Charles W. Tu, Electrical and Computer Engineering, deep infrared devices for optical communications
Edward T. Yu, Electrical and Computer Engineering, nanoscale properties of electronic materials and devices
Paul K.-L. Yu, Electrical and Computer Engineering, MOCVD and liquid phase expitaxial growth of optoelectronic materials

EDUCATION

Ph.D., Physics, Northwestern University, 1976
M.S., Physics, Northwestern University, 1972
Licenciado en Ciencias, University of Chile, 1970
Bachelor in Mathematics, University of Chile, 1965

PROFESSIONAL EXPERIENCE

Professor of Physics, University of California, San Diego, 1987-present
Special Term Appointee, Argonne National Laboratory, 1987-1996
Group Leader and Senior Physicist, Argonne National Laboratory, 1976-1987
Adjunct Assistant Professor, UCLA, 1976-1978

COMMITTEE MEMBERSHIPS

Organizing International Conferences: 2nd International Symposium on Metallic Multilayers, September 11-14, 1995, Cambridge, United Kingdom. European Physical Society-Condensed Matter Division Meeting, Leuven, Belgium, August 25-28, 1997. 3rd International Symposium on Metallic Multilayers (MML'98), June 14-19, 1998, Vancouver, BC, Canada. Second International Conference on "Stripes and High Tc Superconductivity," Rome, Italy, June 2-6, 1998. International Conference on Magnetism, ICM 2000, Recife, Brazil, August 6-11, 2000. International Symposium on Metallic Multilayers (MML '01), Aachen, Germany, June 24-29, 2001. **American Physical Society Committees:** Wheatley Award, American Physical Society (1994 and 1996). Vice-Chair and Chair, International Scientific Affairs (CISA), American Physical Society, 1997-1998. James C. McGroddy Prize, American Physical Society, 1998-1999. Executive Committee Member, American Physical Society, Topical Group on Magnetism and Its Applications, 1999.

HONORS AND INTERNATIONAL PRIZES

DOE Outstanding Scientific Accomplishments, 1987; Chilean Academy of Sciences, 1992; APS Centennial Speaker, 1998-1999; APS Wheatley Award, 1999; Dozor Fellow, Israel, 1993; Distinguished Speaker, Japan, 1998; Corresponding Fellow, Belgian Academy of Sciences, 1998; Alexander von Humboldt Award, 2000

PUBLICATIONS

"Tailoring Exchange Bias with Magnetic Nanostructures," Kai Liu, S.M. Baker, T.P. Russell, and Ivan K. Schuller, *Phys. Rev. B* (submitted).

"Magnetic Domain and Domain Wall Imaging of Submicron Co Dots by Probing the Magnetorestrictive Response Using Atomic Force Microscopy," J. Wittborn, K.V. Rao, J. Nogues, and Ivan K. Schuller, *Appl. Phys. Lett*. 76, 2931, 2000.

"Magnetic Superlattices and Multilayers," Ivan K. Schuller, S. Kim, and C. Leighton, *J. Mag. Mag. Mat,* 200, 571, 1999.

"Research Frontiers in Magnetic Materials at Soft-X-ray Synchrotron Radiation Facilities," J.B. Kortright, D.D. Awschalom, J. Stohr, S.D. Bader, Y.U. Idzerda, S.S.P. Parkin, Ivan K. Schuller, and H.-C. Siegmann, *J. Mag. Mag. Mat.* 207, 7, 1999.

"Fabrication of Submicrometric Magnetic Structures by Electron Beam Lithography," J.I. Martin, Y. Jaccard, A. Hoffmann, J. Nogues, J.M. George, J.L. Vicent, and Ivan K. Schuller, *Jour. Appl. Phys.* 84, 411, 1998.

"Exchange Bias," Joseph Nogues and Ivan K. Schuller, *J. Mag. Mag. Mat.* 192, 203, 1999.

"Persistent Photoinduced Effects in High T_c Superconductors," Axel Hoffmann, Dmitry Reznik, and Ivan K. Schuller, *Adv. Mat.* 9, 271, 1997.

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Paul Siegel with lead the **UCSD Networked Infrastructure** team with expertise in coding techniques for error control, bandwidth-efficient communications, and input-constrained channels, and applications to digital data storage and transmission. His team will include the following:

Anthony S. Acampora, Electrical and Computer Engineering (ECE), wireless networks, cellular/PCS, broadband wireless
Peter M. Asbeck, ECE, microwave and RF devices/circuits (Materials and Devices)
William Coles, ECE, wave propagation, antenna design, RF electronics, real-time computing, digital signal processing
Pamela C. Cosman, ECE, image and video compression/processing
Rene L. Cruz, ECE, scheduling, routing, and performance
Sujit Dey, ECE, hardware/software-embedded systems, ultra-deep sub-micron system chips
Ian Galton, ECE, mixed-mode integrated circuits and systems
Lawrence E. Larson, ECE, high-frequency micro-electronic devices/circuits
Bill Lin, ECE, integrated circuits/systems, communication applications
Elias Masry, ECE, time series analysis, adaptive filtering, wavelets
Laurence B. Milstein, ECE, wireless, digital, spread spectrum communications
Alon Orlitsky, ECE, interactive communications, speech recognition, and low-power circuits)
Joseph C. Pasquale, Computer Science and Engineering (CSE), operating systems: kernel structure, multimedia agents, fast I/O, IPC
George C. Polyzos, CSE, communication networks and multimedia applications
Baskar D. Rao, ECE, speech coding and recognition (Interfaces and Software Systems)
Ramesh R. Rao, ECE, protocols for wireless/wireline networks and energy-efficient communications
Bang-sup Song, ECE, analog/digital CMOS integrated circuits for communications
Alexander Vardy, ECE, coding and information theory for communications
Ken Yun, ECE, synthesis, verification, and analysis of mixed-timed digital VLSI circuits and systems for high-speed networking
Kenneth A. Zeger, ECE, source and channel coding, and image/speech compression
James Zeidler, ECE, adaptive signal and array processing for wireless networks, antenna arrays

EDUCATION AND HONORS

Ph.D., Mathematics, Massachusetts Institute of Technology, 1979
S.B., Mathematics, Massachusetts Institute of Technology, 1975
IEEE Fellow, 1997

IBM Fifth Plateau Invention Achievement Award, September 1994
IBM Master Inventor, Almaden Research Center, June 1994
IEEE Communication Theory Society, Leonard G. Abraham Paper Prize, 1993
IEEE Information Theory Society Best Paper Award, 1992
IBM Outstanding Innovation Award, June 1990
IBM Outstanding Technical Achievement Award, February 1983
Chaim Weizmann Postdoctoral Fellowship, 1979-1980
Phi Beta Kappa, MIT Chapter, 1974

PROFESSIONAL EXPERIENCE

Director, Center for Magnetic Recording Research, UCSD, September 2000 - present
Professor, Department of Electrical and Computer Engineering, UCSD, July 95 - present
Department Manager, Mathematics and Related Computer Science, IBM Almaden Research Center, January 1994 - July 1995
Project Manager, Signal Processing and Coding, IBM Almaden Research Center, July 1984 - December 1993
Research Staff Member, Recording Channels, IBM Almaden Research Center, August 1980 - June 1984

PROFESSIONAL ACTIVITIES

Member, Board of Governors: IEEE Information Theory Society, 1991 - 1996
Editor-in-chief Designate, *IEEE Transactions on Information Theory*, July 2001 - June 2004
Guest Editor-in-chief, The Turbo Principle: From Theory to Practice*, IEEE Journal on Selected Areas in Communications*, Spring 2001 (to appear)
Associate Editor: Coding Techniques, *IEEE Transactions on Information Theory*, 1992 - 1995
Co-guest Associate Editor, Special Issue on Coding for Storage Devices, *IEEE Transactions on Information Theory*, May 1991
Conference Co-chair, 1998 IEEE Information Theory Workshop, San Diego, CA; 1995 IEEE Information Theory Workshop, Rydzyna, Poland

PUBLICATIONS

M. Oberg and P. Siegel, "Performance Analysis of Turbo-equalized Partial-response Channels," *IEEE Trans. Commun.* (to appear).
B. Moision, A. Orlitsky, and P.H. Siegel, "On Codes that Avoid Specified Differences," *IEEE Trans. Info. Th.*, Vol. 46, No. 1, January 2001 (to appear).
T. Souvignier, M. Oberg, P.H. Siegel, R.E. Swanson, and J.K. Wolf, "Turbo Decoding for Partial Response Channels," *IEEE Trans. Commun.*, Vol. 48, No. 8, pp. 1297-1308, August 2000.
R. Karabed, P.H. Siegel, and E. Soljanin, "Constrained Coding for Binary Channels with High Intersymbol Interference," *IEEE Trans. Info. Th.*, Vol. 45, No. 6, pp. 1777-1797, September 1999.
S.A. Altekar, M. Berggren, B.E. Moision, P.H. Siegel, and J.K. Wolf, "Error-event Characterization on Partial-response Channels," *IEEE Trans. Info. Th.*, Vol. 45, No. 1, pp. 241-247, January 1999.
B. Marcus, R. Roth, and P. Siegel, "Constrained Systems and Coding for Recording Channels," Handbook of Coding Theory, Elsevier Scientific Publishers, 1998.
K.A.S. Immink, P.H. Siegel, and J.K. Wolf, "Codes for Digital Recorders," *IEEE Trans. Info. Th.*, Special Commemorative Issue, Vol. 44, No. 6, pp. 2260-2299, October 1998.

ALAN TERRICCIANO
Associate Professor of Dance
Associate Dean for Technology
School of the Arts
University of California, Irvine
300 Mesa Arts Building
Irvine, CA 92697-2780
949-824-5744
949-824-4563 (fax)
aterricc@uci.edu

Alan Terricciano will lead the **UCI New Media Arts** team with expertise in musical resources including telecomunications and digital arts, music for dancers, design of dance accompaniment, composition, and multimedia arts. His team will include the following:

Jill Beck, School of Arts (dean) and professor of dance, dance notation, reconstruction, telearts

Deidre Sklar, Philosophy, aesthetics/criticism, research methods, dance ethnology

EDUCATION

M.A., Music Theory, Eastman School of Music, University of Rochester, 1986 (Chief Marshall, ESM Graduation ceremony)

B.A., Music, Yale University, 1983

PROFESSIONAL EXPERIENCE

Associate Dean for Technology, School of the Arts, University of California, Irvine, 1999 - present

Associate Professor, Dance Department, University of California, Irvine, 1999 - present

Assistant Professor, Dance Department, University of California, Irvine, 1994 - 1999

COMMITTEE MEMBERSHIPS

Member, Academic Senate Council on Research, Computing, and Library Resources, University of California, Irvine, 2000 - present

Member, Triple-E Advisory Committee, University of California, Irvine, 1999 - 2000

Co-chair, School of the Arts Faculty Technology Advisory Board, University of California, Irvine, 1998 - present

Member, Academic Computing Support Review Committee, University of California, Irvine, 1997 - 1998

Chair, Gassmann Electronic Music Studio Committee, Academic Year, 1994 - 1995

PROFESSIONAL ASSOCIATIONS

International Guild of Musicians in Dance, Society for Music Theory, Computer Music Association

INTERACTIVE ELECTRONIC MUSIC COMPOSITION FOR CHOREOGRAPHY

Virtual Therapy (Electronic Media) - Choreographed by Lisa Naugle, videography by John Crawford, and commissioned by the X Company, Vancouver, British Columbia, Canada. Premiered February 2000 in Vancouver.

Close to the Bone (Electronic Media) - Choreographed by Colin Connor and commissioned by the Dance Department, University of Nevada, Las Vegas, NV. Premiered, March 28, 1998 in Las Vegas, NV.

Spelunking the Center (Electronic Media and Piano) - Commissioned by Liz Lerman and The Dance Exchange. Premiered December 10, 1993 at the Kennedy Center, Washington, DC.

PUBLICATIONS

Dancing History Collection, Volume 1 (Electronic Media) - Music direction for the book. A series of lab-annotated world dances with extensive documentation including music and video.

JURIED PRIZES AND ORIGINAL COMPOSITIONS (SELECTED LISTING)

Blue Motions (String Quartet) - 1st Prize. Festival des Arts de Saint-Sauveur, Music for Dance Competition, Saint-Sauveur, Quebec, Canada. Festival dates: July 27-August 5, 2000.

Triptych Humpty-Dumpty (Piano and Synthesizer) - Choreographed by David Grenke and commissioned by the Doris Duke Foundation and American Dance Festival (ADF). Premiered June 30, 1998 at the ADF in Durham, NC.

Gatherings (Viola and Piano) - Choreographed by Jeff Slayton and commissioned by the Dance Department, California State University, Long Beach, CA. Premiered April 29, 1998 in Long Beach, CA.

Now...Then (Electronic Media) - Choreographed by Julia Gleich for the concert "To the Point." Premiered March 19, 1998 at the Dance at Holy Trinity Series, New York, NY.

Days of Sorrow (Prepared Piano) - Choreographed by Yueh-Ping Feng. Professional premiere September 9, 1997 in Taiwan (origination-UCI).

Off the Hook/We're Sorry (Electronic Media) - Choreographed by Colin Connor and commissioned by the company Dancefusion, Movement Theater. Premiered May 2, 1997 at the Soho Dance Festival, New York, NY.

Periphery (Electronic Media) for the concert "The Men's Project, Solos Performed by Li Chiao-Ping." Choreography by Gus Solomons, Jr. Premiered December 6, 1996 at the Kanopy Performing Arts Center, Madison, WI.

Incidents in the Life of an Ohio Youth… (String Quartet and Snare Drum) - Commissioned by BalletMet of Columbus, OH, and choreographed by Liz Lerman. Premiered April 1, 1993 at the ADF.

PIANO PERFORMANCES

Performance Pianist (Guest Artist) - Alvin Ailey Dance Company. "Danger Run" (music by Frederic Rzewski, four North American ballads) choreographed by Donald Mckayle. Premiered December 8, 1999 at City Center, New York, NY. *Performance Pianist (Guest Artist)* - Ballet Pacifica. "Episode" (music by Franz Liszt, "Reminiscences de Norma") choreographed by David Allan. Premiered June 12, 1998 in Irvine, CA.

MOHAN M. TRIVEDI
Professor, Electrical and Computer Engineering
University of California, San Diego
9500 Gilman Drive
La Jolla, CA 92093-0407
858-822-0075; 858-534-1004 (fax)
mtrivedi@ucsd.edu

Mohan Trivedi will lead the **UCSD Intelligent Transportation** application team with expertise in robotics and intelligent environments. His team will include the following:

Bhaskar Rao, Electrical and Computer Engineering, signal and speech processing
Ramesh Rao, Electrical and Computer Engineering, wireless communication
Charles Elkan, Computer Science and Engineering, programming languages, artificial intelligence
Amarnath Gupta, SDSC, spatial databases, data mining
Shailendra Bhonsle, Electrical and Computer Engineering, semantic event/activity databases, data mining
Pamela Cosman, Electrical and Computer Engineering, image and video processing
Dave Sworder, Electrical and Computer Engineering, non-linear stochastic systems
Ken Kreutz-Delgado, Electrical and Computer Engineering, non-linear decision processes

EDUCATION

Ph.D., Electrical Engineering, Utah State University, 1979
M.E., Utah State University, 1976
Bachelor of Engineering in Electronics (Honors), BITS, India, 1974

PROFESSIONAL EXPERIENCE

Professor, Electrical and Computer Engineering, University of California, San Diego; and Director, UCSD Computer Vision and Robotics Research Laboratory, 1995-present
Professor, Electrical and Computer Engineering, University of Tennessee, 1986-1995
Associate/Assistant Professor, Electrical and Computer Engineering, Louisiana State University. 1979-1986

RESEARCH INTERESTS

Mohan Trivedi's research areas of interest include active perception, machine vision, integrated intelligent systems, and multimodal interfaces. His group's recent research and accomplishments include a novel simulation and interactive control environment for sensor-based virtual and real robots; efficient means for extraction and integration of multiple depth cues; development of mobile sensor probes; computational models for texture analysis and synthesis; real-time flow imaging and object detection system; omni-directional camera networks for surveillance; and integrated robotic systems for applications in hazardous environments and for maintenance of high-speed railway tracks.

COMMITTEE MEMBERSHIPS

Editor-in-Chief, *Machine Vision and Applications Journal*

Program Committee Member, Applications of Neural Networks and Evolutionary Computing Conference, Denver, CO, September 1999; Digital Image Processing Conference, Denver, CO, September 1999; IEEE Human Motion Modality Workshop (panel member), Hilton Head, SC

Plenary Talk, NATO "Evaluation of Computer Algorithms," June 1999

Panel member, IEEE International Conference CVRR, Santa Barbara, CA

Panel member, NATO Workshop

Executive Committee member, UC DiMI, Hilton Head, SC

PROFESSIONAL ASSOCIATIONS

Editor-in-Chief, *Machine Vision and Applications*, journal of the International Association of Pattern Recognition

Charter Member, Executive Committee, *Digital Media Innovation Initiative*, University of California System

Member, Advisory Committee, Center for Research in Computing and the Arts, UCSD

PUBLICATIONS

M.M. Trivedi, *Digital Image Processing*, Encyclopedia of Computer Science (4th ed.), Macmillan, 2000.

K.C. Ng, H. Ishiguro, and M.M. Trivedi, "Multiple Omni-Directional Vision Sensors (ODVS) based Visual Modeling Approach," IEEE Visualization '99, San Francisco, CA, October 1999.

K.C. Ng, H. Ishiguro, M.M. Trivedi, and T. Sogo, "Monitoring Dynamically Changing Environments by Ubiquitous Vision System," IEEE International Workshop on Visual Surveillance, June 1999.

H. Ishiguroa and M.M. Trivedi, "Integrating a Perceptual Information Infrastructure with Robotic Avatars: A Framework for Tele-Existence," IEEE/RSJ Intelligent Robotic Systems Conference, Korea, October 1999.K.C. Ng, M.M. Trivedi, and H. Ishiguro, "3D Ranging and Virtual View Generation Using Omni-view Cameras," *Proc. Multimedia Systems and Applications*, SPIE, Vol. 3528, Boston, MA, November 1998.

S. Iwamoto, M.M. Trivedi, and D. Checkley, "Real-time Flow Imaging and Classification System for Marine Biological Studies," SPIE Machine Vision and Inspection Conference, Boston, MA, November 1998.

M.M. Trivedi, S. Roche, and R. Capella, "Navigation and Control of Blind Robots in Sensorized Environments," *Proc. Sensor Fusion and Decentralized Control in Robotic Systems*, SPIE, Vol. 3523, pp. 13-17, 1998.

K.C. Ng and M.M. Trivedi, "A Fuzzy-neural Controller for Mobile Robot Navigation and Multirobot Convoying," *IEEE Transactions on System, Man, and Cybernetics*, December 1998.

M.M. Trivedi, K. C. Ng, N. Lassiter, and R. Capella, "New Generation of Multirobot Systems," *IEEE International Conference on Systems, Man, and Cybernetics*, San Diego, CA, October 1998.

GABRIELE K. WIENHAUSEN
Provost, Sixth College, Division of Biology
University of California, San Diego
9500 Gilman Drive
La Jolla, CA 92093-0355
858-534-3018
858-534-1835 (fax)
gwienhausen@ucsd.edu

Gabriele Wienhausen will lead the **UCSD Education** team with expertise in online learning, instructional technology in science, and science outreach. Her team will consist of the following:

- Geoffrey Bowker, Communication, interplay of infrastructural technologies with organizational memory, communication of scientists with each other and with policymakers, how data structures and practices in use affect communication
- Ross Frank, Ethnic Studies, Native American history/culture, outreach to American Indian reservation communities in San Diego county to test new telecommunications technology
- Hugh Mehan, Sociology/Center for Research on Educational Equity and Teaching Excellence, educational inequality and equality
- Pat Neill, Biology/Chemistry and Biochemistry, design and development of online educational software and tools
- Ann Redelfs, SDSC, K-12 outreach, mentoring programs for women and minorities, national education, outreach, and training programs related to NPACI
- Barbara A. Sawrey, Chemistry and Biochemistry, interactive, computer-based learning in science
- Randall Souviney, Director, Teacher Education Program, teacher preservice education and professional development, mathematics and technology education
- Susan Leigh Star, Communication, sociology of science and technology, especially new information technologies and life sciences/analysis of work practices and knowledge production in museums, laboratories, hospitals, libraries, and high-tech research and development sites

EDUCATION

Dr. rer. nat, Westfaelische Wilhelms-Universitaet, Muenster, Germany, 1979
Diploma, Westfaelische Wilhelms-Universitaet, Muenster, Germany, 1976

PROFESSIONAL EXPERIENCE

Provost, Sixth College; Vice Chair for Education, Division of Biology, 1998-June 2000
Assistant Vice Chair for Education, Department of Biology and Biochemistry, 1993-June 2000
Co-director, Doctoral Program in Mathematics and Science Education, 1993-present
Principal Investigator, Howard Hughes Undergraduate Science Enrichment Program, 1991-present
Academic Coordinator and Lecturer, Department of Biology, UCSD, 1987-1993
Visiting Lecturer, Department of Biology and Biochemistry, UCSD, 1985-1987
Visiting Scholar, Dr. M DeLuca's laboratory, Department of Chemistry, UCSD, 1981-1985
Wissenschaftlicher Assistant, Westfaelische Wilhelms-Universitaet, Muenster, Germany, 1978-1981

PROFESSIONAL ASSOCIATIONS

American Association for the Advancement of Science
Association for the Advancement of Computing and Education
Association for Biology Laboratory Education
National Science Teachers' Association
Society for College Science Teachers

PUBLICATIONS

Wienhausen, G., and Sawrey, B., Spectrophotometry CD-ROM, Science Media Inc., 1998.
Wienhausen, G., and Sawrey, B., "Improving Laboratory Instruction with Multimedia," National ACS Meeting, Anaheim, CA, April 1995.
Wienhausen, G., and Sawrey, B., "Understanding Science: Visualizing the Molecular World and Simulating the Equipment," International Symposium on Mathematics/Science Education and Technology, 1994.
Wienhausen, G., and Sawrey, B., "Interactive Multimedia Courseware for Bio 103," Syllabus 22, 20, 1992.

COLLABORATORS WITHIN THE LAST 48 MONTHS

Sawrey, B.A., Development of online course material (Chem6B)

ADVISEES

Dr. Valerie Otero, Assistant Professor, Department of Education, University of Boulder, Colorado
Dr. Andy Johnson, Associate Director, Center for the Advancement of Math and Science Education, Black Hills State University

GRADUATE ADVISOR

Prof. Dr. Ernst Zebe, Physiologishes Institut, Universitaet, Muenster, Germany

JOHN C. WOOLEY
Associate Vice Chancellor, Research
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jwooley@ucsd.edu

John Wooley will lead the **UCSD Digitally Enabled Genomic Medicine** team with expertise in molecular biochemistry and establishing research funding programs at the federal level. His team will consist of the following:

Phil Bourne, School of Medicine/Pharmacology/SDSC, biological databases, bioinformatics with emphasis on structural bioinformatics, computational methods, integration of the Protein Data Bank with Cal-$(IT)^2$ technologies

Rick Buxton, School of Medicine/Radiology, fMRI and quantitative assessment of blood flow, will integrate instruments and data from UCSD's new functional imaging center

Mike Colvin, Lawrence Livermore National Lab, computational biochemistry, quantum chemistry, protein structure prediction

Mark H. Ellisman, School of Medicine/Neurosciences/Bioengineering/SDSC, integration of telescience and multi-scale imaging of biological structure/function with Cal-$(IT)^2$'s core technologies into Cal-$(IT)^2$'s emerging wireless information fabric

David J. Galas, Keck Graduate Institute, molecular biology, human genetics, application of new technologies to the life sciences

Michael Gribskov, Biology/SDSC, databases/tools for functional genomics, systems of knowledge across multiple electronic resources, macromolecular sequences and structure and function of molecules

Daniel Masys, School of Medicine, Director of Biomedical Informatics, will connect emerging technologies to clinical decision-making practices using wireless information access devices with analytical utilities capable of correlating clinical findings and measurements with gene expression patterns and functional imaging (e.g., FMRI)

Reagan Moore, Computer Science and Engineering/SDSC, information-based data-intensive computing including massive data analysis systems, scientific data publication systems, and persistent archives

K.C. Nicolaou, Chemistry and Biochemistry, chemical synthesis and chemical biology, total synthesis of natural products, molecular design, combinatorial chemistry, biologically active molecules

Pavel Pevzner, Computer Science and Engineering, combinatorial methods in computational molecular biology

Shankar Subramaniam, Bioengineering/SDSC; Director, Graduate Program in Bioinformatics; bioinformatics and new high throughput technologies for understanding the function of genes on a genome-wide scale (functional genomics)

Lynn Ten Eyck, School of Medicine/Pharmacology/SDSC, protein interactions and applications of computation to problems of biological structure

Chris Wood, Brain Imaging Foundation (interim director), University of New Mexico, Los Alamos

EDUCATION

Postdoctoral, Molecular Biochemistry, Harvard University, 1977-1978
Ph. D., Physics and Biophysics, University of Chicago, 1975
B.S., Physics, Chemistry, and Biochemistry, Michigan State University, The Honor's College, 1967

PROFESSIONAL EXPERIENCE

Adjunct Professor, Pharmacology, and Chemistry and Biochemistry, University of California, San Diego, 1999-present
Associate Vice Chancellor, Research, University of California, San Diego, 1999-present
Chief of Staff, OER, ER-4, Department of Energy, 1996-1998 (concurrent position)
Associate Director, OER, ER-1, Department of Energy, 1995-1998
Danforth Teaching Scholar, Biological Sciences Division Director, Medical Applications and Biophysical Research, OER, Department of Energy, 1993-1996
Research Associate Professor of Biophysics, Johns Hopkins Medical School, 1992-present
Division Director, Instrumentation and Resources Division (DIR), BBS, National Science Foundation, 1988-1992
Program Director, Special Projects, DIR, BBS, National Science Foundation, 1988
Program Director, Biological Centers Program, BBS, National Science Foundation, 1986-1988 (concurrent position)
Program Director, Biological Instrumentation Program, Division of Molecular Biosciences (DMB), Biological, Behavioral and Social Sciences (BBS) Directorate, National Science Foundation, 1984-1988
Visiting Scientist, Biology Department, Brookhaven National Labs, 1979-present
Assistant Professor, Affiliated Appointment, Biology Department, Princeton University, 1979-1983
Assistant Professor, Department of Biochemical Sciences, Princeton University, 1978-1983
Instructor, Physiology Course, Marine Biological Labs, 1978
Tutor in Biochemical Sciences, Department of Biochemistry and Molecular Biology, Harvard University, 1976-1978
Research Fellow in Biochemistry, The Biological Laboratories, Harvard University, 1976-1978
Searle Visiting Scientist, Biophysics Department, Molecular Biology Research Laboratories of G.D. Searle and Co., 1975-1976

CURRENT COMMITTEE MEMBERSHIPS

Bioinformatics Center (BIC) Advisory Committee; National University of Singapore; National Biomedical Computing Resource, San Diego Supercomputer Center, UCSD; NIH Resource for Macromolecular Modeling and Bioinformatics, University of Illinois; Deep Computing Institute, IBM

PUBLICATIONS

Theresa Head-Gordon and John Wooley (2000). Computational Structural Biology, *IBM Journal* (in press).
Wooley, J. (1999). "Trends in Computational Biology," *J. Comput. Biol.* 1999 Fall-Winter, 6 (3-4), pp. 459-74.
Su-Yun Chung and John C. Wooley (1997). "The Likely Impact of Developments in Computer-based Information, Networking and Research: A Perspective from the Biological Sciences," in Equipping Science for the 21st Century, ed. John Irvine, Ben Martin, Dorothy Griffiths, and Roel Gathier, Edward Elgar Press, Cheltenham, United Kingdom.

Appendix B: Budget Plan Documentation

This appendix includes letters from industrial and service companies, venture capital and management firms, foundations, and individuals that have committed to partnerships in Cal-$(IT)^2$. These commitments are more than just financial. The named organizations and individuals plan to engage actively in the institute's research and education programs as a key ingredient for Cal-$(IT)^2$'s success. We have sought partnerships with companies and individuals that complement our institute's focus, that can make strong technical contributions, and that are likely to commercialize the resulting prototypes we create. Letters in this appendix are from the following companies:

Akamai
AMCC
Anonymous donor ($10M)
Boeing Company
Donald L. Bren (Chairman of the Board, The Irvine Company)
Broadcom Corporation
CAIMUS, Inc.
Conexant
Copper Mountain
Emulex Network Systems
Enterprise Partners
Entropia
Ericsson
Global Photon Systems, Inc.
IBM
IdeaEdge Ventures
Intersil Corporation
Irvine Sensors Corporation
Leap Wireless International
William J. Link
Merck
Microsoft Corporation
NCR
Newport Corporation
Orincon Industries
Panoram Technologies
Qualcomm
R.W. Johnson Pharmaceutical Research Institute
SAIC
Henry Samueli
Seagate
Silicon Wave
Sony
STMicroelectronics, Inc.
Sun Microsystems
TeraBurst Networks

Texas Instruments
UCSD Health Care
WebEx

Appendix C: Letters of Endorsement

This appendix includes endorsement letters from industrial companies, trade organizations, civic groups, and scientists with Cal-(IT)^2 research affiliations. Many are from companies who are potential partners, but time did not permit us to finalize partnering arrangements to obtain formal commitments. (As indicated in relevant letters, we will be interacting with these companies to establish partnerships over the coming months.) We view the endorsing companies and the trade/professional organizations as resources we can draw on for assistance and support during the institute's implementation and ongoing operation. We have relationships with the leadership and key personnel in these firms, and they will help us because they are committed to the success of Cal-(IT)^2. The letters are from the following:

3COM
AT&T
Donald Beall, Retired Chairman/CEO, Rockwell International Corporation
BIOCOM
Building Industry Association of Southern California/Orange County Chapter
County of San Diego Health and Human Services Agency
Cox Communications
FileNET
Hewlett-Packard Company
Jacobs School of Engineering Corporate Affiliates Program (UCSD)
Irvine Company
Knobbe, Martens, Olson & Bear
Lucent Technologies
Mayor's Science & Technology Commission (San Diego)
MedExpert International, Inc.
Mission Ventures
Motorola
Nokia
Omm, Inc.
Orange County Business Council
Printronix
San Diego Association of Governments (SANDAG)
San Diego Defense & Space Technology Consortium
San Diego Regional Economic Development Corporation
San Diego Regional Technology Alliance
San Diego Software and Internet Council
San Diego State University
San Diego Telecom Council
SciFrame, Inc.
Sony
Stanford Linear Accelerator Center/Stanford Synchrotron Radiation Laboratory
Texas Instruments
TRW
UCI Chief Executive Roundtable

California Legislature: Assemblywoman Marilyn C. Brewer
California Legislature: Assemblyman Lou Correa, Assemblyman
California State Senate: Senator Joseph L. Dunn
California State Senate: Senator Ross Johnson