



QUALCOMM INSTITUTE



CSRO GUIDE TO QUALCOMM INSTITUTE FACILITIES, SERVICES AND RESOURCES AT UC SAN DIEGO

The Qualcomm Institute is the UC San Diego division of the California Institute for Telecommunications and Information Technology (Calit2). It is a multidisciplinary research and development institute that creates and supports collaborations with more than two-dozen academic departments. Faculty members and labs can benefit from access to unique technology or resources that would otherwise be too expensive or impractical to acquire independently. This includes facilities to build prototypes and test existing designs.

The facilities, services and resources made available to campus partners on a recharge basis or as a percentage of personnel and materials costs (%FTE), and to awardees of **Calit2 Strategic Research Opportunities (CSRO)** grants on an in-kind basis generally fall into five categories:

- Hardware design, fabrication and testing;
- Software and information technology;
- Communications and multimedia production;
- Conference and event support services; and
- Facilities management.

Armed with extensive experience in industry, top-tier technical specialists on the Calit2 staff are available to design and build systems within funded projects. These exceptional researchers provide the bridge between traditional academic research and the path to commercialization, by building prototypes and solutions for real-world applications – a rarity on university campuses. QI also provides administrative and other services to support research collaborations via resources and specially-trained personnel. Our staff members offer expertise in:

- Project management
- Event coordination
- Communications and audio-visual services
- IT infrastructure and support, and much more.

The Qualcomm Institute (QI) offers state-of-the-art facilities and equipment to campus collaborators, primarily on a recharge basis or as a percentage of personnel and materials costs (%FTE).

Note to CSRO Applicants:

Access to QI's facilities, services and resources may also be secured in connection with the Calit2 Strategic Research Opportunities (CSRO) mini-grant program, a peer-reviewed program that awards 12-month grants in the form of cash and in-kind support to the most competitive of the PI-led proposals after a peer-reviewed selection process. CSRO applicants (faculty or research scientists must be PI-eligible on federal or other extramural funding agency calls) are encouraged to familiarize themselves with the *guide to QI facilities, services and resources* available as in-kind support, and to *contact the Functional Manager in charge of the relevant group* to discuss needs and availability prior to submitting a CSRO proposal (to ensure that group personnel will be available to work on a specified project if the proposal is funded under the CSRO program).

Need help accessing the resources described here? Have a general question about engaging with QI? For detailed information, visit the links in this document, or for general questions, address them to info@calit2.net.

HARDWARE DESIGN, FABRICATION AND TESTING

NANO3 FACILITY

<http://nano3.calit2.net>

Contact: Bernd Fruhberger, bfruhberger@ucsd.edu, (858) 534-4518

Calit2's Nano3 nano-fabrication cleanroom facility enables R&D in nanoscience, nanoengineering and nanomedicine. Directed by Electrical and Computer Engineering professor Yuhwa Lo and managed by Dr. Bernd Fruhberger, the facility is available for use by academic and industry researchers on a fee-for-service basis. The facility has served many hundreds of individual users from over 100 academic groups and over 50 companies, with nano/micro-fabrication needs ranging from research on electronic and optoelectronic materials and devices to emerging, interdisciplinary, and rapidly growing fields, including biomedical and biochemical devices, heterogeneous integrated devices and circuits, and sensor technology.

Nano3 consists of 7,000 square feet (sf) of Class-100 and Class-1000 clean rooms, surrounded by 3,000sf of analytical and design labs for materials characterization. Funding from an NSF Major Research Instrumentation grant and the Qualcomm Institute enabled the purchase of a state-of-the-art electron-beam lithography system with guaranteed <8nm linewidth resolution. Housed in Nano3, the Vistec EBPG5200 system enhances the facility's currently available electron-beam lithography capabilities, enabling major new research areas (nanomagnetism for data storage, nanophotonics for intra-chip communications, and tissue engineering for biomedical applications).

The facility contains equipment for material deposition, lithography, etching, and other processing, including thermal and electron-beam metal deposition, sputtering systems, optical lithography systems, rapid thermal annealing systems, plasma-enhanced chemical vapor deposition, reactive ion etching, inductively coupled plasma etching, reactive ion beam etching, plasma etching, and wet chemistry. Routine in-process characterization tools such as optical microscopes, probe stations, semiconductor parameter analyzers, curve tracers, stylus and optical profilometers, stress measurement tools, etc. are available in the facility. Specialized facilities for nanoscale fabrication and characterization include an electron-beam lithography system, a nanoimprinting system, an atomic layer deposition system, two field-emission electron microscopes, a scanning probe microscope, and more.

In addition to enabling ready access to a broad range of experimental capabilities, as a shared experimental facility Nano3 also provides a natural venue for interaction among campus and external researchers pursuing solid-state materials and device technology for applications ranging from high-performance electronics to photonics to biology and medicine. Shared office space for dedicated use by students and researchers working in the facility is present in the vicinity of the laboratories, further enhancing opportunities for unique and inventive interdisciplinary interactions.

For more details on the equipment available in Nano3 cleanrooms and analytical laboratories, see partial list in the Appendix 1 of this document.

Recharge rates: Cleanroom use (\$25/hr); analytical lab use (\$15/hr); Raith50 (30kV) E-beam Lithography Machine Time (\$50/hr); Vistec (100kV) E-beam Lithography Machine Time (\$150/hr); SEM without staff assistance (\$25/hr); SEM with staff assistance (\$65/hr); general staff assistance (\$59/hr); training courses (\$300/user)

PHOTONIC SYSTEMS LABORATORY

Contact: Nikola Alic, nalic@ece.ucsd.edu, (858) 534-722

This 2,000-square-foot facility is a telecom-class space supporting a one-of-a-kind, high-capacity testbed with unique capabilities that are presently not matched by any comparable facility in the U.S. or elsewhere:

- Nanometer-scale fiber mapping, capable of measuring molecular-scale radial fluctuations;
- Mixer construction capable of 20 THz-wide operation; and
- Real-time Tbps signal generation, transmission and distribution.

The lab was seeded by a Bell Labs equipment donation in 2004 and subsequent industry gifts from Cisco Systems, Sumitomo, Sun Microsystems and IBM. The Laboratory was the first to establish true, all-optical Terabit-scale signal processing capabilities, and it has unique set of technologies that “do not have an equivalent in industry or academia,” says Adel Saleh, a Program Manager in DARPA’s Strategic Technology Office. “Chief among these is the ability to measure and alter fiber geometry with molecular-scale precision. This technology, developed under DARPA’s aegis, has allowed for synthesis of ultra-wideband photonics mixer devices exceeding 10s of THz for the first time.”

The Laboratory core is formed by five independent BERT clusters, two re-circulating loops, 2000 km of fiber plant and accompanied by EDFA/Raman amplification nodes. The Laboratory possesses the only set of C/L terahertz oscilloscopes in a university setting and a 50 Gbps BERT cluster. A true MHz-scale optical spectrum analyzer is complemented by five high-speed oscilloscope systems with up to 80GHz bandwidth. The laboratory’s specialty is ultrafast signal processing that includes a genuine 640 GHz capability to generate, diagnose and process at that rate. It operates the most advanced parametric testbeds, capable of ultra-fast signal processing, band conversion and quantum-limited amplification. The work currently supports microlidar research in SWIR and inaccessible bands by leveraging telecom-band equipment for sensing, imaging and signal processing.

Recharge rate: Lab usage is available on an hourly basis at \$199/hr.

CHIP-SCALE PHOTONIC TESTING FACILITY

Contact: Shaya Fainman, ECE Professor and CIAN Deputy Director, fainman@ece.ucsd.edu

One of the first supporters of the facility was Agilent Technologies, which helped enhance the existing tools by adding the Agilent 81600B-201 Tunable Laser (operating from 1455-1640nm with a 0.8fm-100fm resolution), the Agilent 83453B High-Resolution Spectrometer (8fm resolution), and the N4373C Lightwave Component Analyzer, which allows the measurement of the electrical/optical spectral response of photonic devices up to 67GHz. In addition to the equipment listed above, the Laboratory offers two isolated optical tables and an overhead rack for optical/optoelectronic measurement setups.

Through a dedicated fiber-optic link, the facility (on the fourth floor of Atkinson Hall) is connected to the experimental datacenter facility on the first floor and also has the capability to connect to the Photonic Systems Laboratory on the sixth floor. For testing photonic devices, a custom fiber coupling setup with piezo-electric position control has been assembled. In addition, it is possible to package and pigtail the chips using UV epoxy bonding. The lab’s capability is augmented with state-of-the-art software tools, such as COMSOL and RSoft, running on a server donated by Oracle with 8 cores and 128GB of memory. The facility has been used to test nanophotonic devices such as nanolasers and low-loss silicon photonic waveguide devices designed in the Fainman group and fabricated in the Nano3 facility. Our ultimate goal is the seamless integration of electronics with photonic circuits via CMOS-compatible process for numerous applications, including energy-efficient and scalable high-performance computers and datacenters as well as ultra-compact and cost-effective medical devices, implants and systems.

Recharge rate: Lab usage is available on an hourly basis at \$149/hr.

PROTOTYPING FACILITY & DESIGN STUDIO

<http://research.calit2.net/prototyping/>

Contact: Curt Schurgers, cschurgers@ucsd.edu, (858) 246-1442

QI offers two specialized resources in electrical and mechanical systems prototyping and design to support researchers, as well as students and student groups. These resources include access to professional electrical and mechanical engineers, as well trained student interns. In addition, we make available work benches, tools, machining and measurement equipment, and a shared lab environment that encourages system building, experimentation and tinkering. The various labs and spaces target users from novices to experts, offering a resource that is both a “maker space” and a dedicated consulting/training service in electrical and mechanical systems.

The **Prototyping Facility** is a set of labs that were created to make embedded systems prototyping available to researchers within the UCSD community as well as outside clients, such as industry collaborators or startup companies. Its resources include:

- **Mechanical/electrical design and prototyping services:** staff engineers provide specialized electrical and mechanical design services as a recharge.
- **Student interns trained in mechanical and electrical prototyping**
- **Access to machining and prototyping equipment:** design software for electrical and mechanical systems (PCB design, 3D-CAD, etc.), soldering stations, hand tools, and 3D printers, as well as a dedicated machine shop with a CNC mill, gantry router, laser cutter, and saws.
- **Prototyping space:** workbench space is available for users to work on their own projects.

The **Design Studio** offers a creative space open to educators, student groups, and people within the UCSD community who want to engage others in design and the exploration of embedded systems. It is available to formal or informal groups who seek an environment that encourages creativity, tinkering and exploring the world of embedded systems. It offers:

- **Shared work environment:** workbenches, audio/visual
- **Basic tools:** soldering, electrical components, arts/crafts, PC workstations, and test kits (such as Arduino)

Recharge rates: Staff support at \$85/hr, student support at \$29/hr, 3D printing \$18/hr, 3D printing ABS material \$7/hr, CNC Gantry machine \$30/hr, CNC prototyping machine \$15/hr, CNC production machine \$35, 2D laser \$25, basic lab access \$30/month/person, shop access \$3/hr.

CIRCUITS LABS

<http://research.calit2.net/circuitlab/>

Contact: Curt Schurgers, cschurgers@ucsd.edu, (858) 246-1442

The Qualcomm Institute’s Circuits Labs enable the design, assembly and testing of new wireless devices, techniques and systems. It features state-of-the-art equipment rarely found in a university environment, suitable for testing and design in RF, analog, wireless, and telecommunications electronics. The Circuits Labs offer resources for design, prototyping, testing and deployment of electronic devices, as well as for undergraduate and graduate student projects in these areas. Previous work included record-setting power-efficient cellular & WLAN power amplifiers, ultra-low-power/noise no-delay radios, as well as portable software-defined radios, wireless medical response devices, MIMO devices, personal mobile pollution sensors, wireless health monitors, etc. The labs offer access to specialized equipment and tools, including:

- **mm-Wave Lab**, focusing on frequencies of 20MHz – 170GHz, including micro-probe stations, a low-noise shield room and miscellaneous equipment, e.g., microamps and micro-volt sources, noise-figure meters and low-phase noise test sets;
- **Power Amplifier Lab** (200mW – 2000W), with state-of-the-art amplifier testbeds and notable expertise in battery management;
- **Base-Station Lab:** a roof-top on-the-air cellular service under experimental licenses for research use; and

- **Antenna-Garden Lab** consists of a rapid-antenna-deployment testbed with RF and gigabit Ethernet connections to various other labs.

Recharge rates: Staff support at \$85/hr; student support at \$29/hr

SOFTWARE AND INFORMATION TECHNOLOGY

WIRELESS SYSTEMS AND ENGINEERING GROUP

<http://wise.calit2.net>

Contact: Curt Schurgers, cschurgers@ucsd.edu, (858) 246-1442

The Wireless Systems and Engineering (WISE) Group offers design and prototyping services focusing on software and communications systems—from concept to reality. The group employs programmers with extensive expertise in building wireless application code, networking protocols, algorithms and data processing solutions for a mix of platforms, including modern mobile communication devices such as phones and tablets, embedded (Linux) platforms, and software-defined radio (SDR) platforms such as FPGA/DSP/GPP.

In past projects, the group developed mobile Android-based systems, Bluetooth/Zigbee/Wifi sensor networks, as well as custom-built rapidly deployable mesh networks for emergency response. In addition, the team has extensive experience with Joint Tactical Radio System (JTRS) open-waveform and FPGA-based SDR testbeds, as well as interfacing with data acquisition cards and kernel programming.

WISE Areas of Expertise:

- Application-level software development
- Advanced SW design for embedded Linux-based platforms
- Software development for embedded systems (including Xilinx FPGA and Power PC)
- Software for Android clients
- Software and firmware design for target platforms, for detailed evaluation and testing
- Designing and implementing RESTful API's for Web applications
- Interfacing and controlling RF front-end systems
- Wireless mesh (ad-hoc) network routing protocol design and prototyping
- All aspects of the physical, MAC and networking layers of communication protocol stacks
- Standards and underlying communications technologies, for LTE, WiMax, WLAN, WCDMA, TD-SCDMA, Bluetooth, and more
- SCA (JTRS) waveform system-level design and simulations
- Design of demonstration devices for field-testing of system prototypes.
Large-scale wireless network simulations (QualNet)
- Architecture of algorithms and protocols within FPGA/DSP/GPP prototyping platforms
- FPGA design with Xilinx's System Generator
- FPGA design verification using HDL, Matlab and System Generator design flow
- Software development for TI DSP

Recharge rates: Senior programming \$125/hr; staff programming \$85/hr; student programmer \$29/hr

MOBILE APPLICATIONS GROUP

<http://telematics.calit2.net>

Contact: Ganz Chockalingam, ganz@ucsd.edu, (858) 822-3844 or for telemedicine applications contact Phil Rios, prios@ucsd.edu, (858) 525-5983

The mobile applications group is primarily focused on the research and development of next-generation mobile applications for iOS and Android platforms. A portfolio of our projects can be found at <http://bit.ly/1ivjghp>. We develop both client and server components. Traditional mobile applications typically push content to the phone. We have been working on leveraging the phones as sensors and relay information that would typically require deploying an infrastructure. Some of the domains we have worked on include:

- Telematics and transportation
- Health care
- Social networks
- Crowdsourcing
- Mobile surveys / data collection

The group has expertise in:

- Mobile application development for the Android and iOS Platforms
- Location-based services
- Server-side development in Java/.Net/PHP
- Cloud-based application development

The Mobile Applications Group also creates wireless and Internet-based technologies for the advancement of medical research and treatment. The group has developed enabling telemedicine technologies in the areas of patient-monitoring, physician/patient communication and remote physician presence, with particular emphasis on embedded systems development, medical-device integration, server-management systems, interactive web portals for patient interaction, and mobile clients for handsets and wearable computers. Technical capabilities include medical device integration with data collection, as well as monitoring and information-management systems.

Recharge rates: Staff programmer \$85/hr; student programmer \$29/hr; senior programmer \$125/hr

INFORMATION TECHNOLOGY RESOURCES

<http://itr.calit2.net>

Contact: Tad Reynales, treynales@ucsd.edu, (858) 699-6271

The ITR team manages the QI/Calit2 server rooms and supports research projects with advanced networking, computer and storage system administration, software configuration, database management and data processing. We also work closely with the Media Technology Resources team and the Visualization Research groups on projects such as CineGrid Exchange, 4K digital content processing and telepresence (Cisco Telepresence and other non-production VTC systems for research and teaching). We are interested in supporting all QI/Calit2-affiliated research. Resources available include:

- Atkinson Hall data center space – full racks or partial racks
- System administration – Windows/Linux/Solaris/OS X
- Virtual servers – Windows/Linux, using VMware hypervisor
- Compute/storage -- design/build or specify/purchase
- Network – connection to private, Calit2 or OptIPuter/Prism

- Data acquisition – integration of instruments with workflows; for example, gene sequencers, imaging systems, sensors
- Wireless networks – assistance with non-ACT wireless systems

We can also help with integration of third-party services:

- UCSD RCI – campus research cyberinfrastructure
- SDSC – local supercomputer and XSEDE resources
- UC Irvine division of Calit2 – network connections
- R&E networks – CENIC CalREN, Internet2, ESnet, etc.
- Cloud services – Amazon, Google, Microsoft, others

Recharge rates: Desktop support is available at \$70/hr, server room \$5/rack unit/month, IT consulting \$125/hr, network and system administration \$85/hr

EXERCISE AND PHYSICAL ACTIVITY RESOURCE CENTER

<http://www.ucsdparc.org>

Contact: David Wing, dwing@ucsd.edu, (858) 534-9315

The Exercise and Physical Activity Resource Center (EPARC), part of Calit2's Center for Wireless and Population Health Systems (CWPHS), is a campus recharge designed to offer state-of-the-science tools, resources, and services to assist physical activity and exercise-related research. We have a fully equipped laboratory to support the research community. At our facility we train students and medical residents, and conduct comprehensive health-related fitness and performance assessments. EPARC also offers equipment loan of accelerometers, pedometers, heart rate monitors, GPS devices and smartphones, as well as study consultation on how to use these devices in health-related research including processing and analyzing device data.

EPARC serves as an independent testing laboratory for the university research community and the commercial health and fitness sector. In addition to providing traditional physiological assessments, we are skilled and experienced in assessing and validating new technologies under non-disclosure agreements, and working with R&D departments to improve wireless devices designed to monitor, track, and/or improve health and athletic performance.

EPARC offers five core services:

- Graded exercise tests of metabolic and cardiorespiratory function
- Bone densitometry and body composition analysis
- Balance assessment
- Equipment loan
- Study consultation, data collection, and data interpretation

Recharge rates: Diagnostic assessment of bone density using dual X-ray absorptiometry (DXA) starting at \$50; body composition analysis using DXA \$50; graded exercise test (GXT) on treadmill or cycle ergometer starting at \$85, resting energy expenditure (REE) using indirect calorimetry \$75; Quantified Balance Testing using Computerized Dynamic Posturography (CDP) starting at \$75; device rental with configuration and calibration \$55/unit/month, consultation – starting at \$36/hour. \$36/hour (excluding travel if necessary), travel costs \$80/day. For full list of services and rates, see Appendix 2.

COMMUNICATIONS AND MULTIMEDIA PRODUCTION

COMMUNICATIONS GROUP

Contact: Doug Ramsey, dramsey@ucsd.edu, (858) 822-5825

The Communications Group at Calit2 provides professional services on a recharge basis for internal and external users. They include:

- *Editorial Services:* The group employs three full-time, professional writers and editors with experience in technical/scientific writing as well as writing for lay audiences. They write news releases, brochures, pamphlets, conference programs, etc., and edit documents such as grant proposals and academic publications.
- *Web Development:* Our Web team offers a full range of development and management services for new and existing websites, including navigation, front-end design and back-end database and content management system support.
- *Graphic Design:* A full-time in-house graphic designer develops logos, posters, layouts for printed collateral materials, and custom designs as required, in addition to liaising with printers and other contractors.
- *Video Production:* Together with the A/V group, the Communications team provides editorial script-writing, editing and produces broadcast-quality, short- and long-form programming.

Recharge rates: Senior writer, web or graphic designer \$67/hr; senior communications director \$130/hr

HD VIDEO PRODUCTION FACILITY

<http://mtr.calit2.net>

Contact: Hector Bracho, hbracho@ucsd.edu, (858) 534-2594

Calit2's advanced video production facility supplies visual content for scientific, artistic and communications purposes. The facility consists of five spaces available on recharge to internal and external users for video editing, audio recording, full-scale live and/or recorded studio shoots, etc.:

- **HD Studio:** For one-on-one interviews, discussion-format programs and limited performance capture, using a multi-cam system of high-definition cameras. Remote-controlled cameras allow for operation with minimal staff. The studio features a full 20x20 lighting grid, large plasma displays and green-screen capabilities.
- **HD Control Room:** The control room features a video switcher, a digital audio mixer, live graphics generator, light control board and production intercom system for recording live-switching or pre-recorded programs.
- **HD Server Room:** Servers and editing systems are located in the machine room for noise reduction temperature control. Equipment includes digital video recorders/servers, quality control monitoring station, video assets storage servers, signal/format converters, digital and analog video/audio patch bays, video and audio editing systems.
- **HD Editing Suite:** Consists of 3 multi-functional editing stations. For video editing, there are two PCs with Adobe Creative Suite Master Collection (Premiere Pro) and one Mac with Apple Final Cut Studio. For audio editing, a Pro Tools LE system is also available. All stations are all displayable on a built-in 8-foot projection screen routable to an 8.1 surround-system.
- **Audio recording booth:** The booth features high-quality microphones for live recording and a ProTools HD audio editing setup for full-function, multi-track editing on audio timelines.
- **Video production professionals:** Calit2's full-time video production staff can consult and work on an hourly basis. Services range from nonlinear video editing to full-scale studio productions.

Recharge rates: Staff time \$85/hr; student time \$15/hr; HD Studio space only \$10/hr

VISUALIZATION

VISUALIZATION GROUP

<http://ivl.calit2.net/wiki/index.php>

Contact: Tom DeFanti, tdefanti@ucsd.edu

The Visualization Group works on research projects that translate data onto screens, typically in advanced ways (4K/UHD, large multi-panel displays, 3D and virtual reality, mobile devices). High-resolution camera input and various other sensor data (LiDAR, structure from motion photography, environmental monitors) are all of interest. Collaborating with others (Phil Papadopoulos of SDSC, Peter Otto of Music, Joe Keefe of Tad Reynales' QI group), the team builds advanced PCs, designs displays, and uses high-speed networks, programs the systems, and then we work data and models into interactive display sessions for large-scale projects. We hold workshops to train internal and external groups.

The Visualization Group can benefit any project that needs expert programming for research-level video/photography, development of sensors of all types including high-resolution video and audio, interactive/immersive computer graphics/virtual reality, simulation, and data visualization. Big data projects with their focus on fast storage, networking, and interactive display, are a current focus of the Visualization Group. Projects are underway in health care, automobile CFD visualization, geospatial applications with advanced terrain rendering, designing hardware, software, and applications of large-scale displays for a variety of internal and external customers.

The Group would like to increase usage and expand access to QI's large-scale display environments by creating new applications in partnership with faculty and researchers. Design of clonable lab-scale displays with PCs that have significant local processing/storage and advanced networking is a focus of the FIONA (Flash I/O Network Appliance) project with SDSC. Novel interaction devices and interfaces are available for exploration and adoption as well. Graphical display of social media findings through custom programming of Google tools is a fast-developing area of the Group's expertise. Advanced CAD design of parts and their realization through 3D printing has developed into a specialized offering over the past year. Significant parallel processing (CPU and GPU) is available on several well-networked clusters off hours when the displays are not in use.

The Visualization Group was substantially involved in seven projects in the second CSRO round. CSRO projects enable the Visualization Group to work with new collaborators and assess the need and desire to continue to work together to attract future funding. In addition, the methods and software/hardware tools developed by CSROs become part of the offerings to new CSROs and faculty research funding proposals.

Recharge rates: Visualization services are available to CSRO and other collaborating groups on a %FTE basis for the six current staff.

STARCAVE

Contact: Trish Stone, tstone@ucsd.edu, (858) 336-6456

The StarCAVE virtual-reality environment is popular among researchers as well as with visitors to the Qualcomm Institute. The StarCAVE consists of five walls with three screens each, plus floor projection. Two JVC HD2K projectors generate a stereo image for each screen, plus four projectors for the floor, totalling 34 projectors. Every projector pair is driven by a Dell XPS computer running under CentOS Linux version 6, with dual Nvidia GeForce GTX 285 graphics cards and a 10 Gigabit NIC. We use an additional XPS machine as the head node to control the rendering cluster, for a total of 18 nodes. For user tracking and interaction we use a wireless, optical tracking system by ART Tracking. It consists of four infrared cameras

and a Flystick2 3D joystick. We currently support two software environments to drive the StarCAVE: Calit2's own CalVR and COVISE. But any Linux-compatible OpenGL-based application can be ported to the StarCAVE. The StarCAVE is located on the first floor of Atkinson Hall in room 1608a. StarCAVE is available to researchers and visitors..

Recharge rates: Daytime usage \$210/hr; night time users \$140/hr; staff time \$67/hr; staff software and hardware setup \$99

CONFERENCE AND EVENT SUPPORT SERVICES

CONFERENCE AND MEETING FACILITIES

<http://mtr.calit2.net>

In addition to its research infrastructure, Atkinson Hall is an excellent venue to hold conferences, workshops, symposia, performances, dinner or lunch meetings, and VIP tours of our facilities. To this end we provide access to the space, facilities, equipment and support staff necessary for these events on a recharge basis (see below). Information can be obtained, reservations made, and current rental fees and other prices viewed at: <http://events.calit2.net>. To reserve these facilities for events appropriate to Calit2's mission, check the online policy.

- **Calit2 Auditorium:** The Calit2 digital-cinema auditorium is a state-of-the-art theater/conference facility with 200 comfortable seats and the latest in communications technologies. Each seat has AC power and 1 Gb/s Ethernet jacks. This dual production-and-research facility allows it to be used for anything from standard PowerPoint presentations from the podium and HD video screenings, to innovative visual and performance art, or ultra-high-resolution (4K) digital cinema and video-conferencing. The hall has a 12.1 Mayer multichannel surround-sound system, an 18x32-foot screen, and a Sony SXRD-S110 projector for 4K video. The 4K projector provides 4,096 x 2160 pixels, or 8 megapixels per frame – four times the resolution of HDTV. All events in the auditorium can be webcasted live and recorded on a built-in, multi-cam HD video system.
- **Calit2 Theater:** The Theater is a multipurpose room and 'black box' space available for research, exhibitions or events. It is a 2-story, reconfigurable space with removable seating up to 80 people. Equipment includes a multi-channel surround-sound system, fully digitally controlled lighting, and the impressive Vroom display wall consisting of 32x 50" LCD displays of HD resolution.
- **Meeting Rooms:** Meeting and teleconferencing rooms, equipped with LifeSize HD videoconferencing systems and a Cisco TelePresence system, are provided **free of charge to UCSD researchers** (not including any required A/V staff time, see below), but are subject to availability. Qualcomm Institute-affiliated researchers are given priority.

Recharge rates: Calit2 Auditorium (max out at 8 hrs for 1-day charge) \$62.50/hr; Calit2 Theater and conference rooms (max out at 8hrs for 1-day charge) \$12.50/hr

AUDIO-VISUAL SUPPORT

<http://mtr.calit2.net>

Contact: Hector Bracho, hbracho@ucsd.edu, (858) 534-2594

The Media Technology Resources (MTR) group in the Qualcomm Institute provides professional services on a recharge basis for internal and external users. They include:

- **Event Tech Support:** The team provides Audio-Visual support for the activities taking place in Atkinson Hall's public spaces, such as conferences in the Calit2 Auditorium, performances in the

Calit2 Theater or seminars in one of the small conference rooms. Any event in our spaces can be also be video recorded/edited for on-demand viewing, and some events can be webcasted live.

- *Videoconferencing support:* QI's AV team can handle your videoconferencing needs on any scale, whether it is a small meeting in one of the VTC-equipped conference rooms, or a remote presenter for your conference in the auditorium.
- *HD Video Production:* With our talented videographers and video editors, the MTR team can document performances and events, record and package online courses or produce video profiles of researchers. Either by using the HD studio or portable video equipment, the team can deliver high-quality professional video content to meet your needs. Please visit the institute's YouTube channel at <http://www.youtube.com/user/Calit2ube> for past work.
- *Photography:* QI employs several photographers for editorial portraits, event photography, headshots and other photographic services. The institute maintains a Flickr Photostream at www.flickr.com/photos/calit2/, which is updated daily.

Recharge rates: General AV support staff time \$50/hr; student time \$15/hr; Video production/editing \$85/hr; Sr. Photographer \$60/hr; Jr. Photographer \$30/hr

EVENT SUPPORT

<http://events.calit2.net>

Contacts: Johnny Nguyen / Amira Noeuv, events@ucsd.edu

Qualcomm Institute's Event Support Coordinators provide the support services to produce highly successful events in its Atkinson Hall public facilities—and elsewhere on/off-campus as well. With the experience of having organized and staged hundreds of previous events, event coordinators are very familiar with Atkinson Hall facilities, UCSD policies and event production options, guaranteeing that all details for a first-rate event will be covered. Support is provided on an hourly basis,

The Events group provides comprehensive planning, coordination and staffing of events that range from intimate VIP meetings to large (200+) international conferences. The Events group has well-established contacts with caterers, vendors and service providers on and off campus, including UCSD's Parking Office. An Events team member is always on hand both before (to negotiate and manage critical interactions among organizers and vendors) and during each event to ensure that all operations run smoothly.

Recharge rates: Staff time \$50/hr; student time \$15/hr

TOURS AND DEMONSTRATIONS

<http://tours.calit2.net>

Contact: Trish Stone, tstone@ucsd.edu, (858) 336-6456

QI's partners can request tours and research demonstrations. There is a cost to the institute for providing this service and the facilities are used primarily for research, so tours and demos are subject to a fee (see below) and to the availability of QI personnel and equipment.

Tour Options

Overview of Qualcomm Institute facilities that may be included on guided tours:

- 4K video projection in the Calit2 Auditorium

- Calit2 Theater and VROOM large-scale display system
- StarCAVE virtual-reality environment (see bottom of page 9)
- NexCAVE; TourCAVE; and WAVE advanced tiled display systems (the latter located in the Structural and Materials Engineering building)
- OptIPortals
- Cisco Telepresence system
- Nano3 Cleanroom Facility and Analytical Labs
- Server Room
- Sun Modular Data Centers
- gallery@calit2
- Circuit Assembly and Sub-system Integration Labs
- Photonic Systems Lab
- Wireless Platforms and System Integration Labs
- Others, by prior arrangement.

Recharge rates: Tours not including 4K, VROOM or StarCAVE \$280/hr; Tour 4K supplement \$105.25/tour; Tour VROOM supplement \$18.75/hr; staff for walk-through tour (no demos) \$50/hr; student for walk-through tour (no demos) \$15/hr

FACILITIES MANAGEMENT

FACILITIES MANAGEMENT

Contact: Tim Beach, tbeach@ucsd.edu, (858) 822-4538

Planning, designing, construction and maintenance of facilities; liaison with campus Facilities Management work units; development of appropriate safety and/or service plans to alleviate risk, provide protection, etc.; oversight of building maintenance, including HVAC and lighting control systems.

Recharge rates: Facilities management staff/consultant \$75/hr

Note: All rates in this document, as of March 1, 2014, are subject to changes pending campus approval; for more recent information, consult the group websites referenced at the beginning of each group listing, or speak with the contact person listed. The rates above apply only to users from the UCSD community; recharge rates are typically 40% higher for non-UCSD external users.

Appendix 1: Nano3 Facilities & Equipment

Class 100 Cleanroom Facilities

• E-beam Lithography

Vistec EBP5200 (see inset)
Raith50 E-beam writer

• Photolithography

HTG mask aligner
Karl Suss MA6 mask aligner
Karl Suss MJB3 mask aligner
Quintel mask aligner

Class 1000 Cleanroom Facilities

• Back-end Processing

West Bond wedge wire-bonder
West Bond ball wire-bonder
Disco DAD3220 semi-automatic wafer saw
Aremco Accu-Cut 5200 dicing saw
New Wave Research QuikLaze 50ST2 IR/green/UV laser micromachining system

• Dry Etching

Oxford Plasmalab 100 RIE/ICP w/cryoprocessing (deep-etcher)
Oxford Plasmalab 80 RIE
Technics PEIIB planar etch
PVA Tepla Plasma System 100
Trion RIE/ICP Dry-etch

• Electrical Characterization

HP 4155 parametric analyzer/probe station
Agilent B1500 semiconductor device analyzer with PIV option
Cascade M150 probe station

• Microscopy

Phillips XL30 ESEM w/ backscattered electron-detector
Horiba XRF microscope
Veeco scanning-probe microscope
Zeiss Axio-Imager optical/fluorescence microscope

• Metallization / Thin-Film Deposition

Denton 502A E-beam evaporator
Denton Desk IV sputter-coater
Denton Discovery 18 sputter system
AJA International Orion3 DC sputter system
AJA International Orion8 RF/ DC
Emitech K575X sputter-coater
Oxford Plasmalab PECVD
Temescal BJD 1800 E-beam evaporator (2 each)

• Metrology

Dektak 150
Dektak 3030
Filmetrics F20 (2 each)
Rudoph Auto EL ellipsometer
Toho Technology FLX 2320 thin film stress measurement
Veeco NT1100 optical profiling system
Zeiss Axio-Imager optical microscopes (3 each)
4-point resistivity probe

• Materials Processing

AG Associates rapid thermal annealers (2 each)
Ulvac MILA-3000 mini-lamp annealer
Tousimis Autosamdri 815B super-critical-point dryer (2 each)
Tempress 4-Stack diffusion/annealing furnace system

• Atomic-layer Deposition

Beneq TFS200 system

Analytical Facilities

These facilities and equipment are located outside of, but adjacent to, the Nano3 clean rooms.

• Veeco Scanning-Probe Multimode Microscope with Nanoscope IV controller, performing a full range of SPM techniques for surface characterization using:

Tapping Mode
Contact-mode Atomic Force Microscopy
Phase Imaging
Magnetic-force Microscopy
Scanning-tunneling Microscopy
Electric-force Microscopy
Surface-potential Microscopy
10 μm x 10 μm non-magnetic scanner with 2.5 μm vertical range
125 μm x 125 μm non-magnetic scanner with 5 μm vertical range

• Hewlett Packard 4155 Parametric Analyzer and Probe Station for characterization of semiconductors:

Employs 4 source/monitor units, 2 voltage-source units and 2 voltage-measurement units for measuring and analyzing semiconductor device characteristics.

Appendix 2: EPARC Services and Rates

The Exercise and Physical Activity Resource Center (EPARC) offers five core services:

Graded exercise tests of metabolic and cardiorespiratory function.

Our cardiac stress testing system (Quinton Q-Stress) is a medical grade treadmill with integrated 12 lead ECG for conducting graded exercise tests. For participants with orthopedic, peripheral vascular or neurological limitations that restrict weight bearing exercise, we also offer bicycle and arm ergometry as an alternative to treadmill testing. We use a COSMED Quark system for laboratory-based indirect calorimetry to assess maximal or submaximal oxygen consumption and fuel utilization during steady-state exercise. We can provide measurements of metabolic equivalents (METs), energy expenditure (kcal/min), VO_2 max, minute ventilation, breath by breath ventilatory equivalents (VE/VO_2 $VE/VC0_2$), and respiratory exchange ratio (RER). For field-based metabolic assessments we use a COSMED K4 b² device. This wireless portable system enables oxygen consumption and caloric expenditure to be conducted during field-based assessments (e.g., during occupational and free living activity). Our portable system can transmit data wirelessly up to 800m and includes an integrated GPS system to add geolocation information.

Bone densitometry and body composition analysis

We use Dual Energy x-Ray Absorptiometry (DXA) for measuring bone mineral density and body composition. DXA is considered a gold standard for the assessment of bone health, body fat, and lean tissue mass. Our GE Lunar Prodigy Advance densitometer uses a direct-digital array detector and narrow-angle fan-beam to enhance dose efficiency and precision in spine, hip and total body measurements. Densitometry also enables visualization of regional, e.g., android vs. gynoid fat mass, and also calcification in the abdominal aorta--an indicator of coronary disease and stroke risk. Clinical tests also include vertebral assessments associated with osteoporotic fracture risk.

Balance assessment

We use Computerized Dynamic Posturography (CDP) to quantify balance and mobility disorders associated with falls risk. Populations of interest might include older adults, stroke, head trauma and Parkinson's patients, as well as individuals with other neurological pathologies. Our SMART EquiTest system enables the isolation and assessment of visual, vestibular and somatosensory inputs to static and dynamic balance. A dynamic force plate with rotation and translation capabilities quantifies the vertical forces exerted through the patient's feet to measure center of gravity position and postural control, as well as a dynamic visual surround to measure the use of visual information to maintain balance. We provide assessment and retraining capabilities with visual biofeedback on either a stable or unstable support surface and in a stable or dynamic visual environment. Example assessments include the Sensory Organization Test; the Motor Control Test; the Adaptation Test; Limits of Stability; Rhythmic Weight Shift; Weight Bearing Squat; and Unilateral Stance Test.

Equipment loan

EPARC offers physical activity measurement instruments that can be rented for laboratory or field-based data collection. Renting equipment is often much more cost effective than purchasing new equipment for one time use. Equipment and services for loan include:

- Accelerometers, pedometers, and heart rate monitors. We also offer wearable multi-sensor devices that integrate data streams to provide more accurate estimates of physical activity intensity and energy expenditure under free living conditions.
- GPS devices. Objective geolocation data can be used to help contextualize physical activity, measure travel behavior, as well as exposure to the built and natural environment.
- Smart phones. Mobile applications are becoming increasingly important for in-situ assessments of behavior and psychological states, as well as behavior change interventions. We offer a loan program (includes contract) of iPhone and android phones as a platform for behavioral assessment and intervention. We also offer a stand-alone text messaging system (SMS) system that can be

customized to meet individual study needs (e.g. for sending SMS prompts or using SMS to support ecological momentary assessment).

- Specialized software to help process, clean, and analyze physical activity and GPS data.

Study consultation, data collection, and data interpretation

Our team includes international experts in clinical exercise physiology and the behavioral assessment of physical activity and sedentary behavior. We offer comprehensive study consultations across the research spectrum from hypothesis generation to data analysis, as well as turn-key solutions for grant proposals that include measurement of physical activity and exercise, body composition, and balance. Furthermore, EPARC staff members are trained in all aspects of the data collection process, including participant scheduling, participant follow-up, data collection, and data entry. By using trained EPARC staff to collect your physical activity data, you maintain the integrity of your data while reducing the cost and burden of hiring and training additional members of your research team.

Item Number	Assessment or Service	UCSD recharge
1	Diagnostic Assessment of Bone Density using Dual X-Ray Absorptiometry (DXA)- 2 sites	\$50
1.1*	Lateral Vertebral Assessment using DXA*	+ \$35
2	Body Composition Analysis using DXA	\$50
3	Graded Exercise Test on Treadmill or Lode Cycle Ergometer	\$85
3.1*	VO2 max and/or submaximal caloric expenditure using Indirect Calorimetry*	+ \$30
3.2*	Calculation of Performance Thresholds and Exercise Zones using Indirect Calorimetry*	+ \$30
3.3*	Direct Measurement of Blood Lactate and Calculation of Lactate Threshold*	+ \$50
3.4*	Inclusion of Electrocardiogram with physician supervision and interpretation*	+ \$50
4	Resting Energy Expenditure using Indirect Calorimetry	\$75
5	Limites of Stabity using NeuroCom Balance Manager	\$75
6	Sensory Organization Test (SOT) using NeuroCom Balance Manager	\$75
5.1 or 6.1*	Other Tests of Balance and/or Gait using NeuroCom Balance Manager *	+ \$10 per test
7	Device rental with configuration and calibration	\$55 per unit/month
8	Consultation - Junior: Quality Assurance, Data Collection/Cleaning and Validation	\$36/hour
9	Consultation - Junior: Research Design, Data Interpretation, Direct Participant Feedback and/or Customized Report Writing by Junior (MS/GSR) Associate	\$36/hour
10	Training: Initial training of project staff on use of devices and participant interaction. (Travel to off-site location additional)	\$36/hour
11	Consultation - Senior: Research Design, Data Interpretation, Direct Participant Feedback and/or Customized Report Writing by Senior (PhD, or MD) Associate	\$62.25/hour
12	Travel Costs	\$80/day

Rates listed here are current as of February 2014. All rates subject to change based on yearly review of cost or personnel, and renewable supplies. There rates are for internal UC San Diego clients.

For more information about EPARC, including external rates applicable to non-UCSD and industry customers, contact David Wing at dwing@ucsd.edu or (858) 534-9315 or visit the [EPARC website](#).

*indicates that the associated (sub)test can only be conducted as part of the larger (main) test. For example, test 3.1 can only be conducted in addition to test 3.