

III B.2 INTRA-CAMPUS INFRASTRUCTURE

This section summarizes the recommendations of the Intra-Campus Infrastructure Team¹, which was established by the Systemwide Internal Partnership.

SCOPE & GOALS

The Intra-Campus Infrastructure goal of the ITS-TII is to provide the technology pathways, spaces and media and terminal resources that will support anytime, anywhere access to information resources for all faculty, students and staff on all 23 campuses.

The CSU's ITS-TII addresses the entirety of its communications and information transport infrastructure within and across its 23 campuses. The intra-campus facilities support the telecommunications needs of over 344,000 students and 38,000 full and part-time faculty and staff in every geographic area of the state. The following outlines the broadest scope of the project currently envisioned to serve the 23 campuses.

The scope of the ITS-TII includes telecommunications functions primarily used for providing intra-campus communications service. These fall into the categories of facilities, network, hardware and applications and include:

- Inside and outside plant facilities;
- The design, construction, installation and all activities associated with “building-out” the infrastructure;
- Media, pathways, spaces and terminal resources required for provision of intra-campus communications;
 - Wireline, fiber, wireless distribution facilities, riser cable and inside wire;
 - Terminal resources, wire frames, bridges, hubs, routers, amplifiers, line extenders; LANs, WANs and video facilities; and,
- Required network hardware and equipment necessary for the ongoing support of the intra-campus infrastructure.

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CURRENT ENVIRONMENT

Throughout the CSU there are locations where the telecommunications environment is currently adequate. There are also sites where the media (twisted pair copper wire, fiber optics and coaxial cable), pathways (duct banks and conduit), spaces (main and intermediary telecommunications rooms) and terminal resources (equipment and hardware) do not even exist. It is often cumbersome if not impossible to support baseline IT requirements at these sites.

In 1995, CSU campuses spent almost \$4 million to assess their intra-campus telecommunications environment. Each campus selected a pre-qualified consultant to perform a detailed study. The results were incorporated into campus Telecommunications Infrastructure Master Plans (TIMPs). The TIMPs confirm the inadequacy of the intra-campus technology infrastructure. The TIMPs delineate the media, pathways, spaces and terminal resource capabilities that are below industry benchmarks as defined in the *CSU Telecommunications Infrastructure Planning Guidelines* or TIP and other telecommunications practices.

The current state of the CSU campus intra-building infrastructure varies widely from campus to campus. No campus has a fully adequate infrastructure. To a greater or lesser degree, there is a shortfall in meeting baseline needs in some or all of the following areas:

- Classrooms, laboratories and preparation environments;
- Instructional technology areas such as libraries, self-instructional computer labs, lecture halls multimedia centers, studio classrooms, electronic conference rooms and video production centers;
- Faculty and staff offices and student assistant work areas; and,
- Public areas, e.g., interior and exterior campus emergency telephones, pay telephones, telemetry, and security systems.

While CSU has made great strides in developing and building to technology standards, the sheer number of buildings and their age have precluded bringing the infrastructure up to baseline level in all CSU locations, given current funding levels. Environments which may have been totally adequate a few years ago are fast becoming obsolescent for the following reasons: the pace of change in digital technology; the need to transport ever greater amounts of information at higher and higher speeds; the inability of CSU to acquire funds to keep the infrastructure technically current; and, greater reliance on information technology to support the academic and administrative functions of the university.

DESIGN CONSIDERATIONS

The deployment of an expanded Intra-Campus Network at CSU campuses will provide an opportunity for CSU and campus network planners and analysts to take a systemic look at networking. The uniqueness of each campus will generally require an extensive review of its network backbone, voice, data and video transports, and their relationship with the Inter-Campus Network.

Media can be connected in a number of topographies, or physical configurations. Another term used to describe the way networks logically connect is topology. The distinction between the two terms is that topography refers to physical connections and topology refers to the way the networking software views the network. The particular topography that is best suited to an individual installation is a function of both the geographic make-up of the installation and the anticipated traffic requirements.

Design Topology and Architecture

In the context of networks, topology refers to the way that end points, or stations, are connected. Topology is determined by the layout of the communications links, switching elements and path between any pair of stations. Network designers use constrained topologies, which have to meet several requirements. They must:

- Ensure proper receipt of all message traffic;
- Route traffic across the network's least-cost path;
- Minimize the length of the channel;
- Support the least expensive transmission medium;
- Provide the best possible end-user response time and throughput; and,
- Provide ability to apply security filters on traffic to and from selected portions of the network.

In achieving these outcomes, CSU campuses have been inclined to use bus, star, ring and hierarchical topologies, in one or more fashions or in various combinations, in meeting their networking goals. Certainly each methodology brings its own list of assorted advantages and disadvantages with respect to a particular technology. As is to be expected, the actual drivers for establishing the topology or architectural design can vary dramatically. Factors may include:

- ◆ Existing hardware or software;
- ◆ Personal preferences imposed by the network analyst/designer;
- ◆ Applications;
- ◆ Existing nature of the intra-building wiring;
- ◆ Management or control requirements;
- ◆ Security considerations; and,

- ◆ The nature of the technology itself (i.e. voice, data or video).

Strategies for Wiring Buildings

Much work has been done by the CSU, CSU campuses, and others on strategies for building an inter/intra-campus infrastructure that minimizes life cycle costs. This energy and effort must continue to go forth by all parties to insure that every campus builds out its inter/intra-campus infrastructure under the framework of the Telecommunications Infrastructure Planning (TIP) guidelines, and in accordance with the CSU Minimum Baseline requirements. Given that the costs associated with installing a highly robust inter/intra-campus that saturates information outlets everywhere renders that option impossible, it is essential that alternative methodologies be applied in meeting various data networking applications and services. Although in any network it is the physical medium that performs the task of transporting signals from one location to another, it should be understood that this type of connectivity may occur through assorted media (i.e., twisted pair, fiber optics, coaxial cable, wireless) applying several architectural layout designs and structures.

As with any engineering problem, every data network situation must be examined and tradeoffs made to arrive at an installation solution that meets the needs of the network users and administrators.

TARGET ENVIRONMENT

The target environment for the CSU campuses must be one which supports the scope and goals stated above. In *Leveraging the Future*, the 1994 plan for telecommunications in the CSU, the target environment was described as follows:

It must provide adequate pathways, spaces and media to support connectivity of all classrooms, laboratories, faculty and staff to all campus information resources (voice, data and video). The ability to make use of computing tools, library resources, Internet access, enhanced voice communications or access to video and imaging applications must not be dependent upon the building in which an individual's office or classroom happens to be located.

The goal of the ITS-TII for intra-campus infrastructure is to ensure that the telecommunications pathways, spaces and media and terminal resources support anytime, anywhere access to information resources by all students, faculty and staff. Specifically, this means every faculty and staff in his or her office, as well as every student in labs and academic and instructional spaces, can accomplish the following:

- Make and receive phone calls;
- Receive voice mail messages;

- Access databases;
- Link to the Internet and Web sites;
- Transmit and receive electronic mail (e-mail messages);
- Open and read an e-mail attachment with its original formatting intact;
- Collaborate or share documents, library and other information resources;
- Produce and distribute courseware internally and externally; and,
- Display or present computer video/sound instructional materials.

In 1995, the Commission on Telecommunications Infrastructure (CTI) charged a task force with determining what encompasses the minimum baseline environment for an intra-campus infrastructure. The document that defines these standards, *CTI Minimum Baseline for an Intra-Campus Infrastructure, April, 1996*, is the basis for the target environment of the ITS-TII. The full text of the document on which this summary is based may be found at the website <http://tii.calstate.edu/>.

The ITS-TII target environment is described in terms of the spaces and facilities that must be equipped, and in terms of the functional specifications which must be met. The *Infrastructure Build-out Framework* document outlines five major topics to be considered in defining the scope of the campus' build-out of its physical infrastructure. The *Taxonomy* section of the document describes campus spaces in terms of four classifications: instructional; information technology; academic and administrative; and, public. See that document for further definition of the classifications, technological provisioning, service and installation expectations. The full text may be found at the website <http://tii.calstate.edu/>.

FUNCTIONAL TARGET ENVIRONMENT

While analog services are, and will continue to be, an important part of CSU's environment, the digitization of all forms of information is blurring the distinction between transport mechanisms for voice, data and video services. The baseline target environment envisions having the appropriate physical infrastructure to support digital information transport for all applications; nevertheless, the Intra-Campus Infrastructure Team found it useful to articulate specific target environments.

Data Services: The Intra-Campus Network may be built as either a star or ring network. In special instances, a combination of the two topographies may be used.

Fast (100Mb) or gigabit ethernet switches, routers, LAN concentrators or ATM² switches will be used to provide the connectivity. Backbone equipment using fast

² Asynchronous Transfer Mode

ethernet as the network topography should support expansion of the backbone using 'striped' (or shared) 100Mb connections. ATM switching is another method of providing for high bandwidths between buildings where quality of service (QoS) is a requirement.

In a star topography, all campus buildings would connect to a central switch and/or router. If a campus building does not have any QoS, or higher bandwidth needs, this connection could be a 100Mb ethernet drop connected directly to a high-end ethernet switch or router. For QoS, or higher bandwidth needs, an OC-3 ATM connection from a central ATM switch to a building ATM switch could be used.

For a ring topography, point-to-point connections from building to building, at either OC-3 or OC-12, would be used. Where ATM capable equipment is used or required, an OC-3c drop is the minimum necessary to meet the baseline requirement of 100-155 Mb/s access to a particular building. In some cases, it may be difficult or cost-prohibitive to build a full ring throughout the campus; in this event the majority of buildings may be served by home runs back to a smaller higher speed ring in order to preserve the minimum baseline requirement of 100-155Mb/s access to the building.

Voice Services: PBX switches (new, existing or upgraded) will be an integral part of the inter- and intra-campus network. The target voice environment includes uniform dialing based on the public switched network numbering plan currently used by each campus. Automatic Route Selection and Automatic Alternative Routing will be used to route calls on private, software defined (SDN) and public (PSTN³) networks.

Although wireline services represent the core of a campus, wireless service will grow in importance with respect to their portability and functionality. Future micro cell telephone networks connected to the campus PBX must allow subscribers to forward campus extensions to the wireless network. In addition, the campus PBX must route calls through an external wireless service provider when the subscriber is off campus.

Video Services: Video infrastructure facilities will permit buildings to receive television programming, and to allow for the transmission and reception of "broadcast quality" services from designated inter- and intra-campus sites.

Connectivity between buildings will provide for the broadband distribution of multiple uncompressed television channels from one or more cable head ends to locations throughout the campus.

The typical campus cable head end may include analog and digital satellite reception equipment (compatible with the CSUSat system and others), program recording and

³ Public Switched Telephone Network

origination equipment, message channels, cable modems, decoders, television modulators, processors and amplifiers and other equipment sufficient to support the cable television infrastructure.

Desktop and conference room systems requiring video capabilities will be accommodated via the intra-campus infrastructure. Similar facilities may also be used to support classrooms, laboratories and other spaces.

STANDARDS

CSU has always adhered to national and international standards in the deployment of technology throughout the campuses. CSU personnel have often provided leadership in the development of those standards. With regard to the intra-campus infrastructure, there has been a thirteen year continuous effort to develop and constantly update the technology standards which would enable intra-building and inter-building communications.

In the development of standards for the TII intra-campus infrastructure build-out, CSU will adhere to the "TIP Guidelines" <http://tii.calstate.edu/> and the *Minimum Baseline Taxonomy*.

SPACE & FACILITY STANDARDS

The TIP Guidelines define the types of technology and information system-related distribution services that are in use or must be planned for in the construction of new or remodeled telecommunications physical plant projects. The Guidelines identify specific design and construction requirements that must be followed as the **minimum acceptable quality level** of building infrastructure support. TIP outlines specific "media" (i.e., twisted pair, fiber and coaxial) configurations and systems required to support the technology needs of the university.

IMPLEMENTATION

The ITS-TII implementation plan will ensure that each campus meets the *Minimum Baseline Taxonomy* requirement.

Appropriate coordination will occur with CSU entities, such as Physical Planning & Development, Information Resources Management Program Designees and Executive Deans. All construction and construction-related activities which affect a campus' physical plant and/or its information resources infrastructure will be coordinated in advance with appropriate representatives of the facilities management, facilities planning and information resources departments of the local institution. All required building code and environmental clearances must be

obtained prior to project implementation. The campus will be responsible for any necessary interaction with the Physical Planning and Development section of the Chancellor's Office.

PHASE I - September 1997 to June, 1998

In Phase I, the CSU worked with the potential industry partners to develop a public/private partnership to fund and manage the development of the infrastructure build-out. Teams of CSU and industry personnel formed into work groups (see Part 1 -under ITS-TII Partnership Development & Consultation). That intra-campus infrastructure task group:

- Used the campuses' preliminary engineering designs submitted in January 1997, as the foundation for planning the infrastructure rollout;
- Conducted half-day interviews at WestEd with representatives from every campus to discuss the in depth infrastructure needs within the context of the TIMPs and *Minimum Baseline Taxonomy* document;
- Spent several days at two campuses (Pomona and San Diego) to validate results of the aforementioned interviews;
- Prepared draft scopes of work which describe the planned infrastructure build-out for each campus. These were published on the web for review in December 1997;
- Accepted input from campuses on draft scopes of work and finalized them. The task group resolved systemwide issues raised during the review and published *CSU Policy: CETI and the Physical Telecommunications* (now called the *Infrastructure Build-out Framework*) and the *Campus Intra-Building Infrastructure Taxonomy* (now part of the *Minimum Baseline Taxonomy*). These documents can be found on the web at <http://tii.calstate.edu/>;
- Planned and implemented a pilot field survey at Pomona. This survey required a large team of engineering personnel to spend several weeks at the campus with members of the task group. The result was a "Statement of Work," a far more refined version of the scope of work. The Statement of Work is a building-by-building, floor-by-floor definition of the infrastructure build-out and could serve as the final design for the build-out;
- Used the "scope of work" to create a high level cost estimate; a statement of work can lead to a more refined and accurate cost;
- Established the *CSU Quality Standards* that will specify construction standards for build-out. These can be found on the web at <http://tii.calstate.edu/>;
- Assisted in the revision of the TIP Guidelines; and,
- Determined the implementation schedule.

The team determined success depended upon all participants recognizing the importance of meeting project deadlines and campuses dedicating the necessary personnel to meet milestones. It is crucial that any issues be resolved quickly and expeditiously. A CSU Project Management Team would ensure an efficient and effective implementation, control costs and adhere to the schedule.

The three-year implementation schedule for the intra-campus build-out was determined by the following campus criteria that included: campus need; readiness/receptivity; executive input and support; unique campus/programmatic requirements; and, revenue potential. The methodology, and the resulting schedule was approved by SIP at their January 15-16, 1998 meeting. A unique facet of the implementation was a SWAT component to address academic and administrative planning agendas that could be quickly resolved with a limited infusion of energy and resources.

YEAR ONE	YEAR TWO	YEAR THREE
Channel Islands	Chico	Bakersfield
Dominguez Hills	Hayward	Fresno
Long Beach ⁴	Humboldt	Fullerton
Los Angeles	Maritime Academy	Monterey
Northridge	Sacramento	San Marcos
Pomona	San Luis Obispo	San Diego
San Bernardino	Sonoma	San Francisco
	Stanislaus	San Jose

The magnitude of this intra-campus build-out and the compressed time schedule was viewed as a challenge to implementation.

PHASE II - July, 1998 to June, 2003

The work in Phase I was predicated on the CETI partnership’s securing the capital funding and absorbing risk. With the abandonment of the CETI partnership, CSU must seek alternative funding sources and project management approaches.

CSU executive leadership has reaffirmed the high priority for the installation of telecommunications infrastructure at all campuses in accordance with campus plans and to adopted CSU standards. Since the required infrastructure is the essential physical foundation for the achievement of all ITS initiatives, it is critical that the build-out be accomplished within three to five years. In addition to ITS requirements, a number of other factors also support the case for swift action:

- California’s economic picture is more positive than at any other time this decade. This offers an increased possibility of significant public funding;

⁴ Includes the Chancellor’s Office facilities in Long Beach and Los Alamitos

- Campus interest in approaching the infrastructure build-out on a systemic basis remains high;
- There is a high level of campus concurrence on standards for build-out; and,
- Existing Preliminary Plans for the infrastructure still have high asset value, and further delays will mean increasingly costly revisions.

CSU constituencies involved in the planning, including the Systemwide Internal Partnership, view the build-out as a comprehensive systemwide project, since it involves the accomplishment of very similar work at a multitude of sites across the state and, therefore, lends itself to integrated and cost-effective management. The economies inherent in centralized procurement of many miles of fiber optic and copper cabling and thousands of network electronic components are clear. In addition, the State of California must be assured that the ultimate product achieves the level of quality established as essential by system representatives.

The network product must be as nearly uniform as possible across the CSU, reflecting adherence to technical standards and component standardization. This will be a key factor in facilitating the network's electronic refreshment and in promoting economical operations and maintenance.

While the project's development and implementation as a single, large-scale activity makes the best sense for the CSU, campus interests will be reflected at the system level by SIP or the Commission on Technology Infrastructure oversight and at the local level by the close involvement of site personnel in the design and build-out processes.

PHASE II IMPLEMENTATION PLAN

The immediate primary target for the funding will be a combination of CSU Capital Outlay Program and General Fund Support Budget, based on an expected new four-year bond authorization by the California voters this fall. Therefore, the infrastructure build-out will be done under the auspices of the capital program. Consequently, the build-out will be managed like any other CSU construction project with the appropriate engineering, contractor management and professional oversight.

Project management will recognize, and incorporate, as much as possible, the original CETI industry-partnership plan to implement the project over a three year period with approximately 1/3 of the campuses being involved each year. It also accommodates essentially all important programmatic considerations. However, because the funding will be from public sources, some of the anticipated flexibility in the original rollout plan will be abridged. This change should not have significant detrimental impact on the project, but the nature of its management will change somewhat. For example, the heavy reliance on the design/build format visualized

in the original approach will be much less of a feature, while there probably will be greater reliance on local campus facilities professionals.

The following chart displays the implementation schedule envisioned for the build-out:

TII - Development Plan

Activity/ Function	FY 98/99	FY 99/00	FY 00/01	FY 02/03	New bond period 02/03
Preparation	Prelim. Drawings Secure Capital & Support Budget Commitments				
Build-Out First 7 Campuses		Working Drawings	Construction & Install of Network Electronics		
Build-Out Next 8 Campuses			Working Drawings	Construction & Install of Network Electronics	
Build-Out Final 8 Campuses				Working Drawings	Construction & Install of Network Electronics

Using capital outlay funds, working drawings for approximately one-third of the CSU campuses can be included in the 1999/00 capital outlay program, with construction funding for that group to follow in 2000/01. Another one-third of the campuses will also be funded for working drawings in 2000/01. This pattern would repeat in the following year, so that the final one-third of the campuses would receive construction funding in 2002/03.

To provide the necessary large-scale, unified engineering resource appropriate to the systemwide project, it is proposed that the P2S and RMI firms would collaborate to become the design engineers for all of the campus infrastructures. In addition, these firms would provide expanded contract administration and observation services during construction. Since, as separate organizations, the two firms developed the preliminary plans for more than half of the twenty campus projects pursued in

1996/97, IRT and PP&D feel that the composite size and extensive CSU experience that the firms have acquired, constitute a valuable resource for the build-out program.

The engineers were asked to review the existing preliminary plans that they had not designed, and also to evaluate the Channel Island and Monterey Bay campus requirements. Then they were asked to provide PP&D with a proposal for engineering services to bring all campuses up to completed preliminary plans at the Minimum Baseline level. This proposal was submitted during the first week in August 1998.

During the construction phases of the build-out, CSU will contract for field inspection services with a firm or firms having extensive experience and expertise in this area. Individuals responsible for day-to-day inspection services will be required to be telecommunication specialists. This insures that problem solving during construction can be handled with sensitivity to telecommunication services installation quality.

The public works infrastructure portion of the overall project will be handled in the traditional manner, with the campuses managing the local construction project unless some compelling justification for an alternate approach should arise. The typical scope of the public works infrastructure project includes both the basic backbone of duct banks, pull-boxes, manholes and conduit for the inter-building underground distribution systems, and also building connections, telecommunications space development and interior pathways.

Campus telecommunications personnel and campus facilities planning staff will mutually approve decisions affecting design and changes required during construction.

Starting with FY 2000/01 or FY 2001/02, and in parallel with the public works infrastructure installation, the cabling and equipment, including network electronics, will be purchased and installed at the first group of campuses. In the subsequent two fiscal years, the remaining two groups will be similarly served. It is planned that this portion of the infrastructure project use a systemwide procurement contract awarded to a single firm, and be funded from an alternate source. The assigned design engineers and project inspectors will function in the same manner as with the public works infrastructure portion of the project.

While this major activity is being pursued, in FY 1998/99 the CSU will proceed to secure PBX systems for the Chico, Hayward, Northridge and San Marcos campuses. This continues the long-term strategy of providing all campuses with cost-effective, state-of-the art, voice telephone services. The four campuses have agreed to mount a collaborative effort to obtain these systems.

COSTS

CSU currently estimates that \$243.6 million is required to bring the pathways, spaces, media and terminal resources on every campus to minimum baseline.

The following table is an example of the mix of funds required and the sequencing of build-out and expenditures.

The California State University
Campus Telecommunications Infrastructures
Projected Funding Sources

Campus	Costs Not Escalated for Inflation				(5) COP (2) Escalated for Inflation
	(1) Total	(2) Capital Outlay Program	(3) Support Budget	(4) Special Repairs	
Phase 1: (W 1999/00; C 2000/01)					
Channel Islands	\$4,000	\$ -	\$4,000	\$ -	\$ -
Dominguez Hills	9,096,000	7,095,600	1,740,400	260,000	7,750,000
Long Beach	17,980,000	12,381,000	5,149,000	450,000	13,515,000
Los Angeles	12,592,000	10,244,670	2,040,330	307,000	11,165,000
Northridge	9,643,000	5,358,723	3,976,277	308,000	5,854,000
Pomona	8,560,000	6,175,000	2,009,000	376,000	6,731,000
San Bernardino	9,959,000	6,564,000	2,795,000	600,000	7,172,000
Subtotals:	\$67,834,000	\$47,818,993	\$17,714,007	\$2,301,000	\$52,187,000
Phase 2: (W 2000/01; C 2001/02)					
Chico	12,102,000	7,513,000	3,831,000	758,000	8,207,000
Hayward	10,088,000	7,245,000	2,163,000	680,000	7,909,000
Humboldt	12,832,000	9,609,000	2,873,000	350,000	10,630,000
Maritime Academy	4,016,000	2,385,000	1,504,000	127,000	2,591,000
Sacramento	17,661,000	12,387,000	4,516,000	758,000	13,518,000
San Luis Obispo	19,297,000	14,931,000	3,336,000	1,030,000	16,239,000
Sonoma	6,718,000	4,046,000	2,372,000	300,000	4,347,000
Stanislaus	10,625,000	6,136,000	3,883,000	606,000	6,594,000
Subtotals:	\$93,339,000	\$64,252,000	\$24,478,000	\$4,609,000	\$70,035,000
Phase 3: (W 2001/02; C 2002/03)					
Bakersfield	4,920,000	3,195,000	1,623,000	102,000	3,482,000
Fresno	19,667,000	11,352,000	7,426,000	889,000	12,202,000
Fullerton	4,975,000	3,058,000	1,492,000	425,000	3,375,000
Monterey Bay	13,747,000	11,147,500	2,499,500	100,000	12,259,000
San Diego	16,760,000	10,327,000	6,133,000	300,000	11,284,000
San Francisco	13,479,000	10,455,000	2,717,000	307,000	11,428,000
San Jose	6,710,000	4,987,000	923,000	800,000	5,411,000
San Marcos	2,179,000	1,011,060	1,167,940	-	1,085,000
Subtotals:	\$82,437,000	\$55,532,560	\$23,981,440	\$2,923,000	\$60,526,000
Project Totals:	\$243,610,000	\$167,603,553	\$66,173,447	\$9,833,000	\$182,748,000

- Notes:
1. W = Working Drawings; C = Construction, including installation of electronics
 2. Capital outlay funding to be used for pathways, spaces, and intra-building media
 3. Support Budget to be used for inter-building media and network electronics
 4. Special Repairs funding to be used for asbestos treatment
 5. Unescalated costs contain no adjustment for inflation (ENR Index adjustment)