Call For Partners
(CFP)

for

Corporation for Education Network Initiatives in California (CENIC)

Optical Network Infrastructure (ONI) Initiative

March 12, 2001

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1 BACKGROUND INFORMATION

1.1 Objective Of The Call for Partners

The Corporation for Education Network Initiatives in California (CENIC) is planning the next generation advanced services network to support education and research needs statewide. CENIC is seeking partners that can provide an Optical Network Infrastructure (ONI) to support this network. Based on the Inventory of Possible Facilities Report, Phase 1A of the ONI, your firm has been selected to be considered as a potential partner.

We are now ready to begin Phase 1B which involves selecting one or more firms with whom to develop and implement a strategy to achieve the next generation advanced services network to serve the research and education community throughout California. *Since CENIC needs are for aggregate bandwidth only, and the requirements are relatively straightforward, CENIC is using this "Call for Partners" approach rather than the typical "Request for Proposal."*

Specifically, CENIC desires partners that can:

- Provide network connectivity amongst the 43 primary research and higher education locations, and potentially to all K-20 educational institutions across the 58 counties.
- Define a relationship with CENIC that capitalizes on the strengths of all partners and which may differ from the traditional vendor/customer arrangement.
- Provide a solution that is cost-effective for CENIC and its Charter Associate Universities and provides added value to the partner

CENIC believes that it may be necessary to have more than one partner to cover the entire state. Therefore, it is engaging firms that may be only addressing certain geographic areas. It will also welcome an invited firm to bring other firms with whom they already have a strategic relationship into this process. Potential partners should enter this process with the above criteria in focus, and should be prepared to address these criteria in their proposals. Potential partners should also be prepared to support their proposals and negotiations with individuals empowered to make decisions.

Although services such as IP-based services will be supported over the requested infrastructure, equipment for those applications is outside the scope of this Call. However, the proposals will require general information on expected fiber types deployed on all proposed routes, the points of access on these fiber routes, and the capabilities of potential partners equipment (e.g., DWDM capacities, optical amplifiers spacing and characteristics, regenerator spacing and characteristics) as appropriate to the bandwidth mode proposed. Also, CENIC will provide and manage the network needed to provide service to the end users. Thus, the CENIC ONI focuses primarily on the fiber/bandwidth infrastructure that potential partners can offer.

1.2 Introduction to the CENIC ONI

California, as a leader in education and research, has developed, or is developing a number of high-speed networks. These include:

- **CalREN-2** - an advanced services network, owned and operated by CENIC, and supporting the UC campuses, CSU campuses, Caltech, Stanford, USC, USC/ISI, and JPL. This is built around OC-48 SONET rings in LA and SF areas, and offers an OC-12 for POS and an OC-12 for ATM. It also provides I2 connectivity and commodity ISP services.
- **4CNet** - owned and operated by Cal. State University, this network connects California State University Campuses (23) and Community Colleges (~125). 4CNet links to CalREN-2 in Sunnyvale and Anaheim, and shares some circuits with CalREN-2.
- **Los Nettos** - a consortium in the LA area operated by USC/ISI, this network provides connectivity between its members and ISP aggregation for its members. The same group operates the LA exchange (no cost peering), and also assists with Supernet, NTON, and CAIRN. The network shares circuits with CalREN-2 in some places.
- **DCP** - a State funded project for CENIC to extend the CalREN-2/4CNet advanced services infrastructure into each of the 58 counties to facilitate connectivity for all the K-12 schools. The design for this network has been completed and implementation is to be launched in mid-April 2001.

These various IP networks have served their users well, and have established California as a leader in network development. However, there is a desire to develop a shared infrastructure for the future. The CENIC ONI is the platform for achieving this goal.

The key objectives of the ONI are to:

- Meet the evolving needs of the institutions served, particularly the need for higher speeds
- Foster integration of the infrastructures for these networks
- Establish the most cost-effective multi-layered advanced services network.

To accomplish these objectives CENIC is looking for relationships with firms that will result in wins for all participants.

The specific services to be supported on the ONI fall into three general classes:

- Production Network: transport of intranet applications vital to education and research needs, and access to ISP services.
- Internet2 Research Network: pre-production quality services, but with greater "reserved bandwidth" to support high-performance applications, and with more features (at IP level)
- Experimental Network: a network that can be used as test bed for early software and hardware that may move into production. This may also include "raw glass" needed by some network researchers. (Note: Providing raw glass is not a formal requirement of the ONI network, but a potential partner's ability to provide this capability would be a plus.)

1.3 Site Locations

The CENIC ONI locations are listed in Appendix A. There are a total of 43 sites, comprised of 25 California State University locations, 11 University of California (UC) locations, 6 locations related to the University of Southern California (USC), CalTech, and their Los Nettos affiliates, and Stanford University. In addition, the network is expected to have a number of hub sites. Ten such sites at Qwest POPs are used in current networking. Of these, Sunnyvale and Anaheim are critical sites in the current network infrastructure, and are expected to be present in the new network. Hub sites in carrier hotels, as appropriate, may replace others.

1.4 Implementation Schedule

The ONI is expected to have many similarities to the current (and projected) topology of the CalREN-2 network, as shown in Figure 1-1. In particular, the CENIC ONI is expected to have seven infrastructure components. These are the campus clusters in the SF Bay area, and in the LA Basin, the communities in and around San Diego and Sacramento, central and coastal corridors as key parts of the backbone, and, finally, the outlying sites, Humboldt and Chico. Within the main SF Bay and LA Basin clusters, as well as at other points in the network, hub sites will be provided, both to serve the campus end points, and to connect as appropriate to other hub sites for end-to-end connectivity.

The desired schedule for the CENIC ONI is to start implementation in 4Q2001, and to complete the full network by the end of 2002. The specifics of the phasing for the seven infrastructure components are open to suggestion by the potential partner.

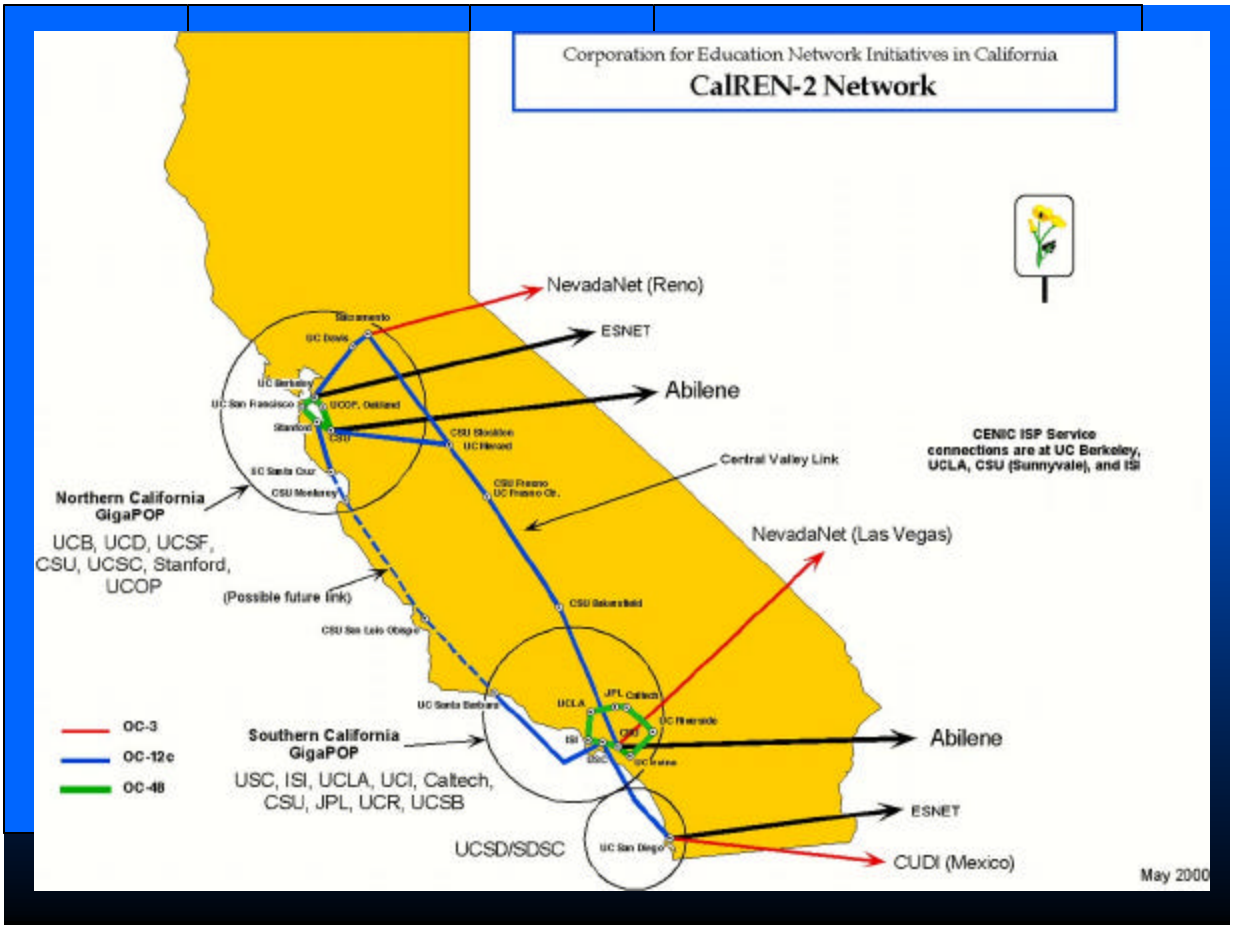

Figure 1-1 CalREN-2 Network Overview

2 CFP RESPONSE AND EVALUATION PROCESS

2.1 Schedule and Format

The overall time line for this CFP process is as follows:

- Potential Partners notified of pending CFP on February 27, 2001.
- Final CFP sent to potential partners by March 14, 2001.
- An electronic copy of the Potential Partner's proposal and presentation material should be provided to the CENIC contacts no later than March 29, 2001.
- 90 minutes will be set aside for meeting with each potential partner between April 2 and April 4, 2001 at LA Airport Crowne Plaza Hotel. Please allow 30 minutes for a question and answer session.
- CENIC will notify potential partners which ones have been selected for follow-up discussions/negotiations on or about April 6, 2001.
- Follow-up meetings will be held between April 6-30, 2001

- The CENIC Architecture Team expects to make its recommendation to the CENIC Technical Advisory Council (TAC) on May 9, 2001.
- TAC will make its recommendations and action will be taken by the CENIC Board at its June 6, 2001 meeting.

CENIC reserves the right to change this schedule for any reason it deems appropriate.

Potential Partners are encouraged to come up with creative network solutions that meet all the CENIC needs (defined in Sections 3 and 4). As outlined subsequently, these include bandwidth needs, collocation in carrier hotels, and a topology that will allow restoration. The potential partner should briefly summarize their proposal in a cover letter serving as an executive overview. The Potential Partner is encouraged to focus on conciseness and clarity of information, rather than providing voluminous material. The response should consist of Microsoft® PowerPoint slides supported by a short Microsoft® Word 97/2000 document (10 – 15 pages) and supporting information such as maps. ***An electronic copy of these materials should be provided to the contacts listed below no later than March 29, 2001.***

When the verbal presentations are given, the potential partner should include an empowered representative able to engage in discussion and decision-making with regards to the proposal.

The specific proposal and presentation should generally address:

A. Technical solution

- Proposed bandwidth mode (e.g., dark fibers, wavelengths)
- Proposed hub-sites and collocation services
- Proposed connectivity, including route maps and distances, link details
- Optical characteristics of proposed links and link availability
- Proposed fiber types
- Other value added features (e.g., dynamic bandwidth provisioning)
- Optional services, such as fiber maintenance

B. Organizational relationship

- Proposed partner arrangement
- Proposed centralized relations
- Proposed length of term, and options to terminate

C. Costs

- Range of costs
- Cost sharing among the partners

Electronic copies of materials, and any questions should be addressed via email to **ghamilto@telcordia.com** and **jostrand@telcordia.com**. You may confirm receipt of any questions via phone or request confirmation via email. Answers will be returned with the questions to all participants via (vendor anonymous) email.

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2.2 CENIC Evaluation

CENIC's assessment of the proposal and suitability of the firm as a strategic partner will reflect, but not necessarily be restricted to, the following considerations:

A. Technical solution

- Overall strategic value, addressing the extent to which the potential partners solution can help CENIC exploit technology trends to best serve their users.
- Bandwidth attributes, including speeds, flexibility, quality.
- Network attributes, robustness of topology.
- Degree that network routes can be provided seamlessly from one partner (either alone or under their auspices), or integrated seamlessly by CENIC.
- Schedule, including potential of potential partner to meet schedule guidelines in this CFP, or to propose ways to improve upon this schedule.

B. Organizational relationship

- Cultural fit
- Complimentary skills and resources
- Partnership opportunities

C. Costs

- Overall cost
- Cost-sharing

CENIC also assumes that the selected partner will have opportunity for shared publicity based on the network, and will have access to CENIC experience based on leading edge uses of the ONI.

As suggested above, CENIC is open to partner ideas on the opportunities presented by the partnership.

3 NETWORK ASSUMPTIONS

The CENIC ONI is predicated on a small set of high-level principles. While not every principle is directly reflected in the more detailed requirements for potential partners, it is important that potential partners understand these principles.

3.1 The Network is an IP Network

The ONI infrastructure at the optical level will support IP services, with the possible exception of direct use of fibers for research purposes.

3.2 Restoration will be Primarily at Level 3

CENIC assumes that network restoration will be done through IP equipment. However, layer 1 or 2 recovery mechanisms, e.g., restoration at the DWDM level may be possible.

3.3 SONET Framing is Not Assumed

The ONI will support IP links, and may use framing techniques such as Ethernet on these links. As a result, dependence on even a "thin layer" of SONET for monitoring the network cannot be assumed.

3.4 Dark Fiber is the Generally Preferred Mode of Bandwidth

At this time, CENIC believes that acquiring bandwidth through dark fibers may provide the most cost-effective and scalable solution for their needs. However, CENIC is open to proposals from the potential partners, and will also consider options such as wavelength services. If wavelength services are proposed, the highest degree of transparency is desirable. Conventional SONET services will be considered last.

3.5 Hubs are Required in Carrier Hotels

CENIC expects to place carrier-grade equipment, e.g., very high-speed routers and/or DWDM optical transport systems, in hubs that will be located in carrier-neutral carrier hotels. Such hotels are necessary for network interconnections critical to the network, e.g., to support peering relationships. In general, campus sites will not be hubs, although there may be some exceptions to this. In this case, such sites are also referred to as transit sites.

3.6 The Network Demarcation Point is Assumed to be at the Campus Sites

For purposes of monitoring and managing the network, the CENIC network demarcation point between the user and the network is considered to be at the campus sites. Specifically, in the event that DWDM equipment is placed on site, the network must monitor this equipment. For transit sites, this consideration does not apply; the network demarcation point in this case will be on the user side of carrier-grade network equipment.

3.7 Standards-based Solutions

Although CENIC is generally committed to standards-based solutions (e.g., for IP), the partnership opportunity and the ONI focus mitigate that position somewhat. Therefore, CENIC will consider any potential partner ideas on possible proprietary solutions at layer 1 or layer 2, if this contributes to the value of the network.

4 NETWORK REQUIREMENTS

The following requirements directly impact the proposed solutions to be developed by potential partners.

4.1 Fiber Requirements

Potential partners are being requested to propose the topology for the network, and to provide their view of fiber connectivity. The following are estimates of the required minimum dark fibers required at different points in the network, to facilitate a common view.

	Production	Internet2	Research	Spare	Total
Campus link to hub node	2	2	2	2	8
Hub to hub connection in a cluster (e.g., Bay Area), *if directly connected*	2	2	2	2	8
Central corridor or coastal corridor	2	2	2	2	8

Although the needs for hub-to-hub bandwidth in or between clusters may be greater than for access, due to number of nodes concentrated to a hub, CENIC assumes that any needed added capacity can be derived through application of DWDM.

4.2 Wavelength Requirements (as an alternative/supplement to fiber)

If a potential partner proposes a wavelength solution (including bi-directional wavelengths over a single fiber), the following are the minimum number of bi-directional wavelengths required.

	Production	Internet2	Research	Spare	Total
Campus link to hub node	1	1	1	1	4
Hub to hub connection in a cluster (e.g., Bay Area), *if directly connected*	2	2	2	2	8
Central corridor or coastal corridor	4	4	4	4	16

In this pure wavelength case, the above numbers represent very rough estimates on needs for increased capacity on the backbone, since CENIC cannot independently augment capacity. Actual numbers depend not only on the overall demand, but also on the degree of connectivity in the network.

4.3 SONET Requirements

No SONET requirements exist for this network. Should SONET be proposed, CENIC assumes requirements similar to the existing network, though increased in speed. However, it is assumed that SONET may only be proposed for remote locations.

4.4 Carrier Hotels as Hub Sites

Vendor-neutral carrier hotels are the preferred location for hubs, due to the carrier-grade equipment to be installed, and the need to connect to a number of networks. These may include peering relationships with: Internet2, ESNET, CUDI, NASA (potentially), Nevada, Asia-Pacific, PAIX, LA Exchange. Although CENIC recognizes that LATA boundaries are not necessarily a hard constraint, for planning purposes CENIC would prefer to have a hub in each LATA where sites are located.

4.5 Adequate Hub Diversity

The backbone architecture must facilitate dual homing, and in general eliminate single points of failure. As a result, CENIC requires at least two hubs in the major metro areas. Two hubs are preferred for other areas. In addition, the mesh backbone connecting the hubs should be sufficiently rich to allow robust restoration of traffic. However, a fully-connected mesh topology is not assumed.

4.6 Dual-homing Options

It is desirable to have physically diverse paths from each campus to two hubs. This is a requirement for transit campuses, and campus-selectable option for non-transit campuses.

4.7 Collocation Space

Hub sites, and in particular carrier hotels, will need to provide space sufficient for 3 – 5 standard CO bays, with power requirements to match.

4.8 Minimal Carriers per Link

CENIC prefers that each fiber link in the network should be provided by no more than one carrier. In the event that a potential partner proposes a solution that uses multiple carriers to create a link, this information must be made available to CENIC.

5 TECHNICAL RESPONSE

5.1 Network Proposal

THE POTENTIAL PARTNER SHALL RESPOND TO THE FOLLOWING

Consistent with the above network principles and network requirements, a potential partner shall submit a detailed network proposal for the CENIC ONI. The potential partner should address any required detail on the interconnection links proposed, and on the hub sites, such as distance, type and number of fibers, optical characteristics of the fiber plant, collocation space, etc. The potential partner shall elaborate on how their bandwidth can support network services. Any proposed DWDM network plan should be integrated with the proposed fiber network, to allow for a single operations platform to manage the entire network

5.2 Specific Technical Questions

For hub sites in carrier hotels, please answer the following:

Q 5.2-1. What are the provisions for access to the hubs, and what physical or other protections are provided to ensure others do not compromise equipment?

Q 5.2-2. What are the standard provisions for power, including protection?

For dark fiber solutions, as applicable, please answer the following questions:

Q 5.2-3. Please provide the standard delivery times for bringing up a fiber link for the CENIC ONI.

Q 5.2-4. CENIC has identified a spare pair of fibers on each route for the dark fiber solution. Please describe any options to provide this fiber out of a shared pool (e.g., on backbone links), and the procedures and timing involved in connecting the fibers to a CENIC hub.

For dark fiber solutions, or for fiber plants used with wavelength services, please answer the following questions:

Q 5.2-5. What types of fiber are assumed in your solution? (Please identify from the following list, and add others as needed.)

SMF-28™ fiber
Lucent TrueWave® fiber
Lucent TrueWave® RS fiber
SMF-LS™ fiber
Corning LEAF® fiber
Alcatel TeraWave fiber
Other fiber?

For *each* of the fiber types (as identified above) that you are proposing, please answer the following questions:

Q 5.2-6. Please provide the detailed measured optical characteristics of the proposed fiber links in the O and C wavelength bands (e.g., fiber length, fiber loss, chromatic dispersion, PMD, reflectance, return loss, splice locations, splice loss, splice reflectance, etc).

Q 5.2-7. What are your standard technologies used on the fibers for optical amplification, and for regeneration? What spacings are assumed for each?

Q 5.2-8. If the fiber plant is used with a DWDM system (assuming 10Gb/s on each channel and a BER of 10-12), please provide the maximum - internode spacing, amplifier spacing, regenerator spacing and span budget (dB) range, together with specific assumptions on the number of channels.

For wavelength solutions, as applicable, please answer the following questions:

Q 5.2-9. What are the standard delivery times for bring up a wavelength for the CENIC ONI (if proposed)?

Q 5.2-10. What type of DWDM equipment is used to support your wavelength services? What is the architecture?

Q 5.2-11. Please provide the system capacity (i.e., total number of wavelengths) for the proposed DWDM system, and the maximum bit-rate per channel.

Q 5.2-12. What are the requirements on the CENIC wavelengths connecting to the carrier wavelength solution?

Q 5.2-13. What are the interface constraints (e.g., transparency) and options for connecting to the carrier wavelength solution?

Q 5.2-14. If CENIC uses wavelengths, but without SONET framing (e.g., Ethernet), would this have any impact on the proposed wavelength solution?

Q 5.2-15. Please indicate whether the optical network element (ONE) interface cards are bit-rate specific or do they operate over a range of bit-rates.

Q 5.2-16. Please indicate the multiplexing/combining capability of the client interface cards (e.g., 4 x 2.5 Gb/s to 10 Gb/s) for efficient fill of optical wavelengths.

Q 5.2-17. Please provide the maximum and minimum span budget (dB) for the optical system assuming OC-192 (or equivalent rate) on each channel and a BER of $1x10^{-12}$.

Q 5.2-18. Please indicate whether the optical system complies with the 50 GHz ITU-T grid specified in ITU-T Rec. G.959.1. What are the specific frequencies used in the DWDM system?

Q 5.2-19. Please indicate whether the proposed optical solution supports tunable lasers.

Q 5.2-20. Please indicate whether Automatic Gain Control (AGC) for Optical Amplifiers (OAs) can be provisioned in the proposed optical solution. In case AGC is not supported by the system, indicate the alternative OA provisioning for gain control when an additional wavelength is added to the system.

Q 5.2-21. Please indicate the physical characteristics of the proposed DWDM equipment. For example, the potential partner may specify the shelf size, bay size, bay weight, etc.

Q 5.2-22. Please indicate the power consumption requirements for all proposed optical equipment that may be required in campus or hub sites.

Please answer the following questions only if ring protection or mesh restoration is assumed for wavelength services:

Q 5.2-23. Please specify the type of protection mechanism (e.g., 1+1 dedicated protection or 1:n shared protection) supported in optical ring or mesh wavelength networks.

Q 5.2-24. Please provide the benefits and tradeoffs of the proposed ring protection or mesh restoration mechanism.

Q 5.2-25. If an an optical ring solution is proposed, please provide the maximum – internode spacing, amplifier spacing, regenerator spacing, circumference and number of nodes supportable.

6 OPTIONAL SERVICES

6.1 Fiber Maintenance

Please describe you ability to provide fiber maintenance services, including the response time to repair fibers and the costs for these services.

6.2 Other Services

Please describe other services that you believe may be of interest to CENIC, including pricing.

7 FINANCING ARRANGEMENTS

The potential partner response should identify costing considerations for at least three different areas:

- Construction costs, if required, to establish initial fiber connectivity (by site)
- Collocation costs, including space and power, access, etc.
- Long term fiber/wavelength lease costs, both in aggregate and normalized form (e.g., price/fiber mile/term)
  - Ten year term
  - Ten year term with five year termination clause

The potential partner should discuss any cost-sharing proposals, and any cost trade-offs with reference to the following elements associated with the development and implementation of the network.

- Bandwidth acquisition mode (dark fiber, wavelength, SONET service)
- Volume discounts based on units of bandwidth acquired
- Forward pricing (committed decreases)
- Market adjustments (extraordinary adjustments)
- Length of the contract
- Early termination
- Other trade-offs that will reduce cost estimates

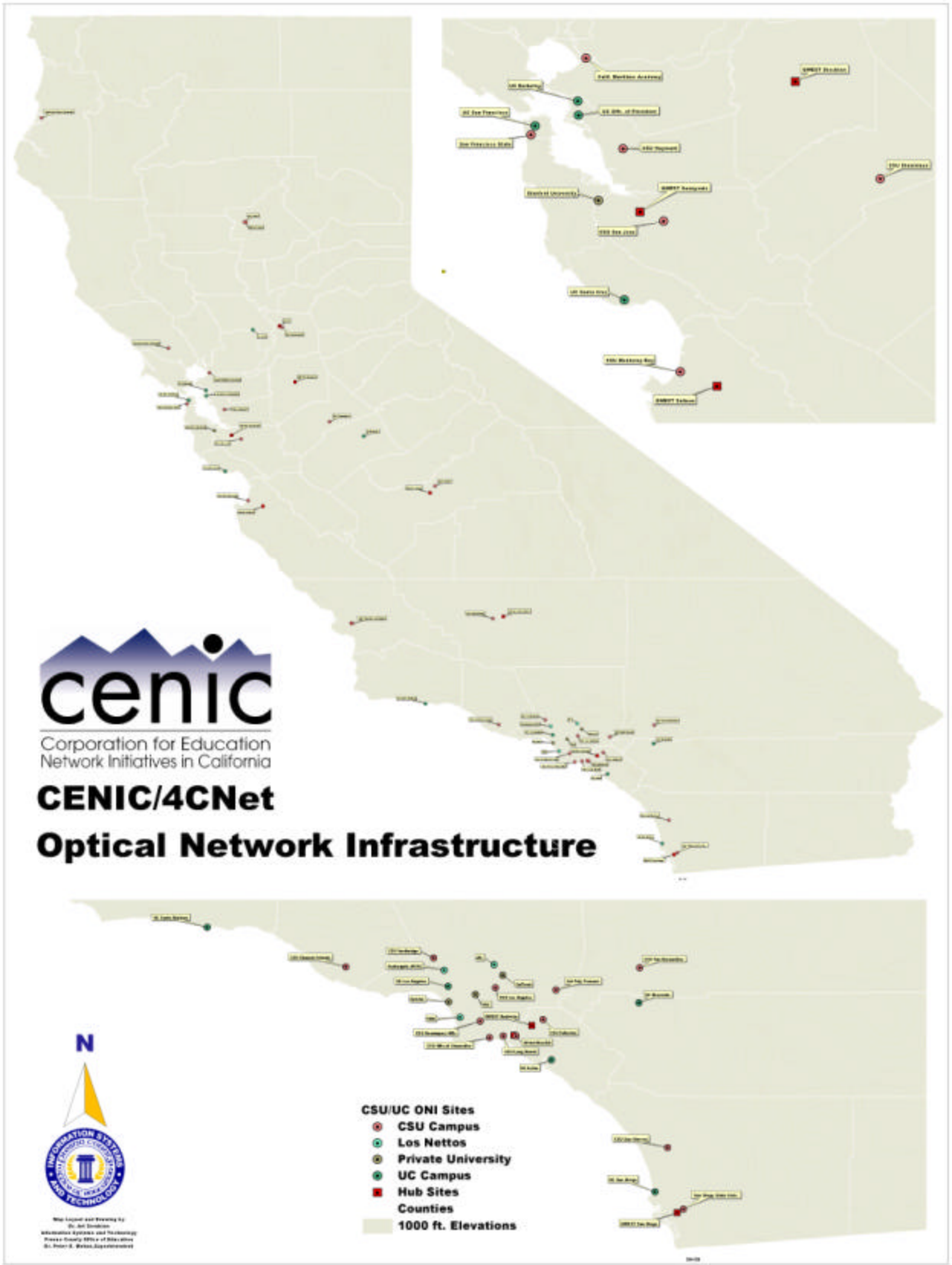
For example, the potential partner might discuss the cost ramifications under a 5-year contract and a 10-year contract. Respondents may add any other trade-off that they can provide to bring down costs. Please include a discussion of any new technologies being considered in both the near term and long term, if these are factors in pricing.

8 CONFIDENTIALITY

Each potential partner is requested to identify specifically any information contained in its proposal, which it considers confidential and/or proprietary and which it would not want disclosed to a third party. Potential partners are required to treat all information provided to them by CENIC as highly confidential.

APPENDIX A – SITE LIST AND MAP

Bay Area:	**Central Corridor:**
CSU San Francisco	CSU Stanislaus
UC San Francisco	UC Merced
CSU Hayward	CSU Fresno
UC Office of the President (Oakland)	CSU Bakersfield
Stanford	
CSU San Jose	
UC Berkeley	**San Diego:**
Maritime Academy	
Sonoma State	UCSD/SDSC
	CSU San Diego
	CSU San Marcos
Coastal Corridor:	
UC Santa Cruz	**Sacramento:**
CSU Monterey Bay	
Cal Poly SLO	CSU Sacramento
UC Santa Barbara	UC Davis
CSU Channel Is.	CSU Chico
	CSU Humboldt
LA Basin:	
USC	
USC – Information Sciences Institute	
UCLA	
CSU LA	
Caltech	
Jet Propulsion Laboratory	
UC Riverside	
Cal Poly Pomona	
CSU San Bernardino	
CSU Fullerton	
UC Irvine	
CSU Long Beach	
CSU Dominguez Hills	
WestEd	
CSU Chancellors Office	
TRW Redondo Beach	
Centergate Sherman Oaks	
CSU Northridge	


cenic
Corporation for Education
Network Initiatives in California
CENIC/4CNet
Optical Network Infrastructure
N
CSU/UC ONI Sites
CSU Campus
Los Nettos
Private University
UC Campus
Hub Sites
Counties
1000 ft. Elevations

APPENDIX B – ACRONYMS

AGC	Automatic Gain Control
ATM	Asynchronous Transfer Mode
CAIRN	Collaborative Advanced Inter-Agency Research Network
CALREN	California Research & Education Network
CENIC	Corporation for Education Network Initiatives in California
CO	Central Office
CUDI	Corporation for University Development of the Internet (Mexico)
DCP	Digital California Project
DWDM	Dense Wave Division Multiplexing
ESNET	Energy Services Network
I2	Internet 2
IP	Internet Protocol
ISI	Information Sciences Institute
ISP	Internet Service Provider
LAN	Local Area Network
LATA	Local Access and Transport Area
NASA	National Aeronautics and Space Administration
NE	Network Element
NTON	National Transparent Optical Network
OA	Optical Amplifier
PAIX	Palo Alto Exchange
POP	Point of Presence
POS	Packet over SONET
QoS	Quality of Service
SONET	Synchronous Optical Network
TAC	Technical Advisory Committee (for CENIC)
USC	University of Southern California
WDM	Wavelength Division Multiplexing