Proposal for a Statewide California Real Time Network
Version 4.0
California Spatial Reference Center
Scripps Institution of Oceanography, La Jolla
September 21, 2008
Please send comments to ybock@ucsd.edu

LEGEND:
= ACTIVE CGPS
= FUTURE PB0 CGPS
= CURRENT NGS CORS

AVAILABLE REAL TIME SITES:

<table>
<thead>
<tr>
<th>AGENCY</th>
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CRTN IS BASED ON 239 EXISTING ACTIVE CGPS SITES AND 4 FUTURE PB0 SITES WITH A RELAXED SPACING OF 80 KM FOR A TOTAL NUMBER OF 243 CGPS-RT SITES.
Statement of the Problem

This proposal addresses two related problems:

1. The lack of an open, uniform and seamless statewide real-time network in California. Our State with its size, population, unique spatial referencing environment, and despite the tremendous resources at its disposal is far behind in providing a real-time solution for precise spatial referencing, a requirement for increased economic productivity and innovation in private and public sectors for a growing number of interrelated applications.

2. The crisis in Federal funding of the California Spatial Reference Center (CSRC), the absence of State support and funding, and a lack of a clear vision for the future. We are still guided by the CSRC’s Master Plan for a Spatial Reference Network in California (“Master Plan”) published in 2002, which needs to be updated to account for technological advances, infrastructure enhancements, and societal priorities.

The premise of this proposal is that a slightly modified version of the existing California Real Time Network (CRTN) and its expansion throughout the State will provide a needed public utility, realign CSRC priorities, enlarge our constituency, and enhance funding opportunities for the CSRC. Besides our traditional users, a successful effort could impact such areas as disaster preparedness and relief efforts, flood plain management, water transportation infrastructure, precision agriculture, international and offshore boundary mapping, aircraft landing and safety systems, intelligent transportation and telematics, fleet management, and coastal and harbor navigation.

The figure on the right (prepared by Art Andrew) shows a statewide network with 80 km spacing, based on existing stations from geophysical networks. Also shown are stations that are already providing real-time data streams.

CRTN is a multipurpose network. It serves as a test bed for developing early warning systems for geological hazards (earthquakes, tsunamis, volcanos, landslides), a contributor to earthquake early warning in California, and a prototype for a warning system for atmospheric hazards (e.g., flood control). This proposal is intended to address the use of CRTN as a statewide positioning service directly tied to the California Spatial Reference System (CSRS) and the National Spatial Reference System (NSRS).
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Elements of a Proposed Statewide CRTN

There are distinct advantages to adopting a slightly revised CRTN model for a statewide system. The salient points of this system are summarized below and discussed in more detail in later sections of the proposal.

- Builds upon existing (~80) CRTN stations in southern California, operated since 2003 by SOPAC, USGS, PBO, Orange County, San Diego County, and MWD (Figure 1)
- Requires a partnership with existing geophysical networks (SCIGN, PBO) to expand real-time connectivity throughout the State - discussions ongoing with the UNAVCO community
- Uses only CGPS stations that are part of the California Spatial Reference Network (CSRN), and built for high-accuracy, longevity, and geophysical stability
- Leverages existing metadata/archive infrastructure at SOPAC/CSRC
- Is directly tied to the California Spatial Reference System (CSRS) and National Spatial Reference System (NSRS) through SECTOR velocity model and HTDP crustal motion model, providing seamless epoch-date conversions
- Fulfills the requirements of the California public resource code for GPS-derived coordinates and orthometric heights, as provided by statutes that became effective on January 1, 2007
- Is able to recover from large seismic events by near-real-time monitoring of changing site positions, followed by rapid geophysical modeling and updates to SECTOR and HTDP models
- Contributes to and uses national real-time atmospheric propagation models (troposphere and ionosphere)
- Takes advantage of other satellite constellations such as GLONASS and the upcoming Galileo system, and new signals available from the GPS satellites
- Has a 20-80 km spacing, with 24/7 coverage and latency of 1 second
- Supports both kinematic and dynamic applications using server-side network positioning, rather than a rover-intensive approach
- Provides on-the-fly geodetic coordinates, and orthometric heights through national geoid models supplemented with local corrections
- Provides open access to CRTN network solution to all users through public protocol using standard GNSS formats (RTCM, NMEA)
- Provides access to raw data streams in receiver-native format to CRTN partners
- Requires no user fees for standard data services including server-based network positioning but is subsidized by CRTN partners
- Is operated by the CSRC operations center at SOPAC with management and governance provided by the CSRC Executive Committee and/or CRTN consortium operating through the existing UCSD Support Group
- Is funded by contracts between partners and the SOPAC recharge facility, overseen by the CSRC Executive Committee and/or CRTN consortium
Current Situation

CRTN is operational (~80 stations) and provides complete RT coverage with a latency of less than 1 second for the five southernmost California counties (Imperial, Los Angeles, Orange, Riverside and San Diego) (http://sopac.ucsd.edu/projects/realtime/) (Figure 1). Single-base RTK is fully supported through a variety of open protocols (RTCM, NTRIP). CRTN also provides two types of network solutions (client-side and server-side). Currently, access to the network solutions requires PDA-based commercial software, available from a single vendor. The proposed CRTN would open up the server-side network solution to all users using standard GNSS formats (RTCM, NMEA).

PBO has also started to provide real-time data streams in RTCM and BINEX formats. Figure 1 shows the current availability of real-time data streams.

Some development is still required at SOPAC to complete on-the-fly epoch-date conversions and to stream orthometric heights.

Description of Server-Side Network Positioning

In this section we describe server-side network positioning, why it is being proposed as the preferred CRTN network solution, and how it differs from traditional client-side solutions using server-provided “network corrections.” The components of CRTN are shown in Figure 2. We describe the salient points of each component.

Figure 2. Components of CRTN and Server-Side Network Positioning
The User
The proposed server-side network positioning can be viewed in several ways. For those familiar with positioning services such as OPUS and SCOUT, CRTN provides the same basic function but in real time. Simply put, the user streams GPS/GNSS data and associated metadata to an IP port, and receives back a stream of epoch-date geodetic coordinates and an orthometric height. Unlike standard RTK with “network corrections” provided by server software, CRTN network positioning is performed at the server, not in the field receiver or data controller. This approach allows a number of distinct advantages, which are described in the sub-sections below.

Typically, the user will have a field data recorder that communicates with the receiver through a Bluetooth connection. The field data recorder can be of a rugged design favored by surveyors, for example, or a lightweight PDA (such as a smart phone). The user (either on a static or dynamic platform) transmits GNSS receiver data in RTCM format and an epoch date to an IP port on the CRTN server. The CRTN server returns, in an open format, epoch-date geodetic coordinates (latitude, longitude, and ellipsoidal height) and an orthometric height. This two-way communications is performed once a second, with a latency of about 1 second, and with centimeter-level precision for the returned geodetic coordinates.

The Network
The reference network consists solely of stations that were built for highest-order geodetic accuracy, longevity, and geological stability. The basic station design consists of a geodetic-quality dual-frequency GPS/GNSS receivers, a GPS antenna (Dorne-Margolin antennas with chokerings are standard throughout the network), and a shallow- or deeply-anchored anchored GPS monuments (Figure 3). The network was built in southern California by SCIGN (and its predecessor the Permanent GPS Geodetic Array – PGGA), and later adopted by the PBO for the Western U.S. Thus, CRTN leverages well over $100M invested by the geophysics community since 1991 in GPS monitoring infrastructure in California, specifically existing SCIGN and PBO stations, and other stations built according to the same design. Access to real-time data streams from these stations requires the cooperation and support of the existing geophysical networks (i.e., SCIGN, PBO), and pertinent discussions are underway within the UNAVCO community.

Figure 3. Photos of 2 CRTN stations. Station RAAP was built by San Diego County Dept. of Public Works to SCIGN standards, including a shallow-anchored braced monument. PBO station P494 has a deeply-anchored braced monument.
This proposal builds upon (~80) existing CRTN stations in southern California (Figure 1), installed and operated beginning in 2003 by SOPAC, USGS (Pasadena office), PBO, Orange County, San Diego County, and Metropolitan Water District. The network includes several types of real-time communications links (spread spectrum radios, microwave, cellular modems). Currently, the GPS data are streamed at a 1 Hz rate (once per second) in a variety of formats with a latency of 1 second or less. These formats include (1) raw receiver formats, e.g., Ashtech MBEN, Trimble RT17, Leica LB2; (2) BINEX format (receiver-independent binary data developed by UNAVCO); and (3) RTCM (usually version 2.3). Our plan is to transition to the BINEX format since it receiver independent, is not expected to change, and contains the full data content produced by the GPS receiver (unlike RTCM formats which do not).

All existing and proposed CRTN stations are part of the California Spatial Reference Network (CSRN), which is integrally tied to the existing metadata/archive infrastructure at SOPAC/CSRC. Therefore, the stations are directly tied to the California Spatial Reference System (CSRS) and National Spatial Reference System (NSRS) through the SECTOR velocity model provided by SOPAC and the HTDP crustal motion model provided by NGS (see next subsection). CRTN is able to recover from large seismic events by near-real-time monitoring of changing site positions, followed by rapid geophysical modeling and updates to the SECTOR and HTDP models. This allows seamless, timely, and accurate epoch-date conversions. Furthermore, using these stations fulfills the requirements of the California public resource code for GPS-derived coordinates and orthometric heights, as provided by statutes that became effective on January 1, 2007.

The complexities of the reference network are transparent to the CRTN user. It is CRTN’s responsibility to ensure that the data flow reliably and with low latency from the stations or other data servers (e.g., at UNAVCO in Boulder, Colorado) to the CRTN server.

The Server

“The Server” consists of several integrated components: the SOPAC Oracle database and web services, the SOPAC/CSRC archive, and the Geodetics, Inc. RTD Pro server and CommLinkProxy utility. The RTD Server is the first point of contact with the CRTN data streams and performs multiple functions. These include:

1. Receiver control for stations that are maintained by SOPAC.
2. Recording of raw GNSS data streams and transfer to the SOPAC archive.
3. On-the-fly creation and recording of RINEX files and transfer to the SOPAC archive.
4. Computation, recording, and transfer to archive of 1 Hz instantaneous true-of-date positions and displacements, using ultra-rapid orbits computed by SOPAC and the NOAATrop real-time tropospheric delay model computed by NOAA. CRTN also serves as a test bed for developing early warning systems for geological hazards (earthquakes, tsunamis, volcanos, landslides), and as a component for earthquake early warning in California. Once an event is detected, it is followed by rapid geophysical modeling and updates to SECTOR (and HTDP) models. Instantaneous positioning also serves an effective indicator of reference station data availability and quality.
(5) Transfer of 30-minute RINEX files to NOAA for incorporation into its NOAATrop model for the continental U.S.

(6) Through CommLinkProxy, serving of raw and RTCM (currently RTCM 2.2 and 2.3) data streams from the reference stations to users.

(7) Server-side network positioning to provide real-time epoch-date geodetic coordinates and orthometric heights to users. This function is described in detail below.

(8) Recording and storing all real-time transactions with users.

The complexities of “The Server” are also largely transparent to the CRTN user, including the integration of the RTD Server, SOPAC database and web services and SOPAC on-line utilities. It is CRTN’s responsibility to ensure that the various data services (see below) are reliably available to users with low latency.

**The Models**

One of the primary advantages of server-side CRTN network positioning, is the ability to apply various models at the server, without having to bundle this information to the user. These include (1) models to improve the accuracy of GPS network processing, for example the NOAATrop real-time troposphere delay model available for the continental U.S., ultra-rapid precise orbits computed operationally by SOPAC for the IGS community, and ionosphere models (these may become more important as we move into the peak of ionospheric activity starting in 2012); (2) positioning models such as SECTOR coordinates and velocities to assign true-of-date coordinate constraints for the reference stations, and HTDP (currently 3.0) for converting true-of-date geodetic field coordinates to user-specified epoch dates (such as 2007.0); and (3) geoid models (such as Geoid 03 with the possible addition of local geoid corrections).

Server-side network positioning provides for a uniform client-light approach, rather than a field-equipment-specific, client-heavy approach.

CRTN network positioning is directly tied to the latest realizations of ITRF and NAD83, the California Spatial Reference System (CSRS) and National Spatial Reference System (NSRS) through the SECTOR velocity model and the HTDP crustal motion model, and provides seamless epoch-date coordinate conversions. It also fulfills the requirements of the California public resource code for GPS-derived coordinates and orthometric heights, as provided by statutes that became effective on January 1, 2007.

CRTN network positioning leverages existing metadata/archive infrastructure at SOPAC/CSRC, and is fully integrated with SOPAC web services and software applications. The complexities of “The Model” are also transparent to the CRTN user. It is the responsibility of CRTN to keep the models current.

**The Applications**

Server-side network positioning provides an additional advantage. The instantaneous rover positions (as well as RINEX files) are computed and stored at the CRTN server. There is an option at the server to pipe the instantaneous rover positions through an IP port to be received perhaps by another application running on some other computer. This feature could be used in support of various applications, such as machine control, GIS/resource mapping, fleet management, precision farming, and survey management.
Data Services and Availability
The CRTN server provides the following real-time data services:

1. Server-side network positioning through a single IP port (discussed above)
2. Raw receiver data through one IP port per station and NTRIP
3. RTCM version 2.2 through one IP port per station and NTRIP
4. RTCM version 2.3 through one IP port per station and NTRIP
5. Output field positions through a single IP port (discussed above)

Service 1 is the open server-side network positioning service discussed in detail earlier. Services 2-4 are freely available for single-baseline solutions. Service 5 is freely available and described in the sub-section (The Applications).

An enhanced service 2 is available for multiple stations for CRTN partners. Once the total annual maintenance costs for CRTN are covered by one or more partners, enhanced service 2 will also be freely available. The rationale for this policy is primarily to conserve bandwidth and maximize the efficiency and availability of data services for all users. The only practical use for enhanced service 2 is to provide an independent network solution from some subnetwork of CRTN, which requires 24/7 access to the CRTN infrastructure and a corresponding strain on the system. It is logical for these users to become CRTN partners so as to defray a portion of the total annual maintenance costs. Once all costs have been recovered, all data services including enhanced service 2 are freely available to all users.

Comments on “Single-Vendor” Issue
We have received many comments regarding the single-vendor issue. As detailed above the CRTN server is a combination of several integrated components: SOPAC web services and database, SOPAC on-line utilities, and the Geodetics, Inc. RTD Pro software. SOPAC licenses the software from Geodetics. It is used to support NASA- and NOAA-funded research into early warning systems for geological and atmospheric hazards as well as to provide CRTN data services. SOPAC is able to sole source to Geodetics because of the unique and multi-purpose capabilities of the RTD Pro software, which are not currently available from scientific or other commercial GPS network software packages, and the willingness of Geodetics to make software changes to support SOPAC. SOPAC is open to testing other solutions as they become available. In any case, it is transparent to CRTN users and/or partners as to what software runs the positioning service.

To neutralize the conflict of interest issue, CRTN funds will not be used to purchase the software licenses from Geodetics. Furthermore, all data services will be openly and freely available, so there is no advantage to any single vendor. Using the data services does not require the use of RTD Rover software, although RTD Rover users can still be able to access CRTN services.

There have been some reports that GPS manufacturers will not modify their field data controllers to use CRTN server-side network positioning. Since all GPS manufacturers make ample use of other SOPAC services in some of their proprietary software, it is not unreasonable that they would make simple modifications to accommodate customer requests for access to the CRTN positioning service. It is also reasonable to assume that they would be willing to become CRTN partners, rather than each one having to create their own reference station infrastructure. In any case, we have clarified the various data services so that the user (and manufacturer) has a “choice” as to what data they desire and
what open features they will support. Nobody is forced to use the network solution, but it’s an open and freely available option. Anyone has the option to become a partner which grants access to multiple raw data streams.

Management and Governance

The CRTN statewide expansion provides an important spatial referencing utility for California. Therefore, it is important to define an appropriate management and governance structure, with clear lines of authority, responsibility, and delegation. Our proposal is to take advantage of the existing CSRC governing structure and the SOPAC/CRTN and PBO infrastructure developed over the last decade, while the network expands to cover the state and as the existing system is transitioned to a fully open system with all the capabilities described in this proposal. It is anticipated that once the system is fully developed and operational the management and governance of CRTN will evolve to reflect changing circumstances, and may even shift to an appropriate entity outside of the University of California, once operations become routine.

In the meantime, our proposal is that the governance of CRTN will be provided by the CSRC, through its role as a UCSD Support Group. The Support Group umbrella currently includes CSRC Bylaws, the CSRC Coordinating Council (CC), and the CSRC Executive Committee (EC). CSRC could decide to form additional entities such as a CRTN Consortium with its own set of bylaws but accountable to the CSRC EC. Unlike the grant process in which the CSRC PI/Director has ultimate responsibility for the grant, the CSRC EC or the new CRTN consortium will assume the authority and responsibility to manage and govern, and delegate the development of the project to the SOPAC Director. In addition to serving as a Center at SIO, SOPAC serves as a mechanism for service contracts to be entered into by the University. CRTN will operate through service contracts to the SOPAC recharge facility. This mechanism is advantageous since it requires a lower university overhead rate (45% instead of 54.5%). The CSRC EC or members of the consortium will provide management of CRTN through these contracts and may withhold payment if services are not rendered and completed to their satisfaction. In the consortium model, each entity that enters into a contract with the University will be considered a CRTN Partner.

Cost Recovery

It is important that the costs of CRTN be evaluated properly, something that is complicated by the multiple ownership of some of the components. For example, the costs of maintenance of the PBO stations, in particular the real-time component, should be shared by CRTN and the budget should reflect this. Another example is the communications for the existing southern California network, which is currently being supported to a large extent by the NSF-funded HPWREN network at UCSD. Currently this capability is available for free; but HPWREN’s continued existence will depend on the renewal of NSF support, something that is never assured.
It is preferable that CRTN be funded as a public service, for example through a single state agency such as Caltrans or the Department of Water Resources. In this case, all services would become freely available to all users. It will take time to get public funding, and this is something that will be pursued vigorously by the CSRC. In the interim, we will also reach out to partners at local public agencies such as counties and semi-public entities such as water districts. There is a precedent for this. For example, the Riverside County Flood Control and Water Conservation District, the Riverside County Department of Transportation, and Caltrans have contracted in the past with SOPAC for services. Finally, we will make one data service available only to partners, such as GPS manufacturers and private RTN service providers who may require access to multiple raw data streams.

CSRC will develop an annual budget for CRTN, including an approved rate sheet and justification of costs. There may be various ways to determine the cost per consortium member/partner. One possible cost basis (favored by Scripps) could be a daily rate based on the annual budget (in this case partners would need to contribute enough funds to cover a total of 365 days of operation); another would be the number of ports (stations) a partner accesses. If the yearly budget increases or decreases, future consortium membership rates could be adjusted. A deficit or surplus from the previous year could also be incorporated into the consortium membership rates and would be readjusted from year to year. The budget and rates would be decided upon by the Consortium.

Each contract must conform to University requirements. To provide flexibility, it is recognized that contracts would vary according to the requirements of the contracting agency. It should be noted that warranties cannot be stipulated in University contracts.

Consortium funds administered through SOPAC could be used to subcontract services to others, such as UNAVCO, for use of real-time data from PBO stations.

Additional Information

Two Powerpoint presentations are available:


The appendices include comments that have been received in response to previous versions of this proposal.
Appendices

Appendix A: Comments by CSRC Executive Committee on CRTN White Paper

Appendix B: Comments by Mark Turner, Caltrans, on CRTN White Paper

Appendix C: Comments on CRTN Proposal Version 3.3

Appendix D: Responses to Caltrans RFI, Real-Time GPS/GNSS Data Sharing
Appendix A: Comments by CSRC Executive Committee on CRTN White Paper

CSRC-Executive Committee
Meeting Date: 05-07-2008

Executive Council discussion recognized that the draft proposal outlined an idea for transitioning CRTN to a statewide multi-user system, and that many of the details would necessarily be developed over time. To facilitate continued discussion, the following questions are presented for clarification.

Responses provided by Yehuda Bock on June 6, 2008.

1. What does “open” mean, please clarify the extent of what “open” is indicating?

Open means that CRTN will provide the protocol for anyone to freely use the server-generated network-solution through a single IP port. This will require fairly minor modifications to controller software provided by GPS vendors. I’ve already outlined the benefits of using the server-based RTK approach in that we will be able to provide instantaneous real-time access to epoch-date, geodetic coordinates and orthometric heights directly tied to the CSRS and NSRS, based on state-of-the-art reference stations built to survive earthquakes.

2. Will the raw receiver data from all stations be made available (continuously and simultaneously)?

Yes for partners. This capability provides a serious load on the system if it is used extensively. If various vendors or other groups would like this kind of access they should become partners by contributing funds to maintain CRTN. The benefit to the vendors is that they will not have to construct and build their own infrastructure, or that they can use CRTN to backup, densify, and/or extend their existing infrastructure.

3. Will all private agencies have 24/7 accesses and is it intended to be freely available to vendors to resell?

See answer above. They are free to resell if they are partners.

4. How is “Independent governance” to be defined?

This term is not used in my proposal, but see the section on “Management and Governance.”

5. Managed and operated by CSRC?

Yes, or by SOPAC if CSRC does not want to take on this responsibility. See the section on “Management and Governance.”
6. Who would own CRTN?

It will be operated by SOPAC/CSRC. See the section on “Management and Governance.” It wouldn’t be owned by one single group since no one group controls all the assets. It will require cooperation with several groups (UNAVCO/PBO and partners such as Caltrans, MWD, Counties) and understandings among them.

7. Are we open to all vendors s/w and capable of a fair competitive process in making this selection?

Y, Bock’s presentation at the CLSA/CSRC RTN seminars (see above ftp link to document) assumes that CRTN would continue to use the Geodetics RTD Pro software to gather and disseminate data and network solutions. This software is integral to research being performed at SOPAC into the development of earthquake early warning systems, but is also able to support field surveying in the most general sense using the server-side network RTK approach. The latter has been demonstrated successfully as part of the 2006 Southern California Height Modernization project using legacy Trimble GPS receivers with respect to CRTN. The RTD software has also been used in post-processing for the 2006 North San Joaquin Valley and the 2007 Central Coast projects. There is also some R&D required at SOPAC to provide the complete suite of models as part of the centralized server-based approach so there will need to be close cooperation between s/w vendor and CRTN. Some of this R&D is ongoing.

8. Who would own the software?

The software will be licensed by USCD/SIO as it is now.

9. Who owns the hardware that is/will be used by CRTN?

Hardware includes computer workstations and peripherals, radio communications equipment, GPS equipment and peripherals, GPS monuments, etc. Ownership will be mixed because CRTN is a cooperative project. Hardware at the central facility at SIO (workstations) will be owned by UCSD.

10. What arrangement does CSRC have with Scripps on the use of hardware?

No arrangement is required since CSRC is a Scripps project. See the section on “Management and Governance.” Of course, long-term commitment is based on adequate funding.

11. With funding issues being what they are (scarce) long-term reliability is an essential quality toward partnering. This begs the question, what is the foreseeable life-span of CRTN?
The primary intention of the proposal is to put CSRC and its projects (including CRTN) onto a more favorable funding environment that relies less on Federal funding and more on local and State funding. The intention is also to keep CSRC focused on staying at the cutting edge and being responsive to the needs of its constituency, which we hope to grow to include non-traditional users. So the foreseeable life-span of CRTN depends on whether we can implement and sustain this vision.

12. How would decisions be made with respect to the managing of the network?

Through the CSRC EC, or other group. See the section on “Management and Governance.”

13. Who would provide server software updates?

Since all network computations will be done at the CRTN server, updates will be seamless to the user and will not require modifications to field controller software.

14. CSRC's responsibility?

To run and manage the network and provide user support, and to provide oversight. The CRTN budget will have adequate funding to support these functions.

15. Who are the potential partners?

Some mentioned above: UNAVCO/PBO, Caltrans, MWD, Water Districts, Counties, Private Sector Survey Companies, GPS Vendors

16. We need a workable plan that includes identifying specifics on what partners might want. (A more detailed proposal is needed to approach partners.)

The CSRC needs to take the lead on this and solicit comments from the surveying community and professional organizations. The future users and partners need to provide insight and feedback on what they expect/need from a statewide network.
Appendix B: Comments by Mark Turner, Caltrans, on CRTN White Paper

Additional questions by Mark Turner (Caltrans) and responses by Yehuda Bock

Why have so many surveyors and engineers, including potential users in Caltrans, as well as the surveying service provider companies (Servco, CSDS, Haselbach, etc): 1) Not accepted the current CRTN model or fully utilize the existing CRTN subnetworks?, and 2) Compelled to actively build their own RTN infrastructure and provide/subscribe RTN network solutions for their users?

Currently CRTN has several limitations. First of all, it is limited to southern California (Imperial, Orange, Los Angeles, Riverside, and San Diego Counties). Most (if not all) of the service providers are outside of this region. Secondly, it is not an open system with respect to providing a network RTK solution or access to raw GPS data streams. Thirdly, it has had some technical problems in serving RTCM data to Trimble users. The first two limitations are addressed by this proposal; the third limitation appears to have been resolved.

Obviously, there is a profit motive driving the GPS vendors and service providers and they may continue with their efforts regardless of how CRTN develops. On the other hand, the benefit to the vendors is that they will not have to construct and build their own infrastructure, or that they can use CRTN to backup, densify, and/or extend their existing infrastructure. It is in CRTN’s interest to have vendors become CRTN partners. Although they are interested in promoting their individual network RTK solutions, they may decide that it is more economical to make use of the CRTN infrastructure and data products.

Will a new "open" CRTN model (and/or coupled with NGS/CSRC guidance) address the needs of this community and enable them to integrate, or disband any portion of, their efforts by leveraging the CRTN infrastructure and data? How?

Yes, I believe that this is adequately discussed in the present version (3) of the proposal.
Appendix C: Comments on CRTN Proposal Version 3.3
From: Duncan Agnew

Subject: CSRC CRTN proposal

I am very impressed with this proposal; it sets forth a very attractive vision of a statewide realtime GPS system that can provide uniform positioning throughout California. There is much to be gained by having such a system. However, it is more likely that this vision can be realized if possible difficulties with it are taken into account in advance; so I will take the positives as a given, and focus on my concerns.

Cost Issues

First, it is important that the costs of CRTN be evaluated properly, something that is complicated by the multiple ownership of some of the components. For example, in the short run the costs of maintenance of many of the stations will be covered by PBO; this is a great advantage in the short run, but CSRC should not overlook the possibility of CRTN having to eventually pay for some of this task. In the shorter run, there is the communications for the existing southern California network, which is currently being handled, very ably, by the NSF-supported HPWREN network. As another HPWREN user, I well appreciate the benefits of having this capability available for free; but it is important to realize that its continued existence will depend on the renewal of NSF support, something that is never assured.

Second, there is the problem of how to get money to pay for CRTN. I think it is useful to regard CRTN as a special type of radionavigation service; such services (GPS being an excellent example) are usually funded out of general revenues as a public service, basically because they are what economists call “public goods”: their costs are largely independent of the number of users, and anyone can use them. One challenge will be that it takes time to get public funding, no matter how good the idea being put forth. Another is that individual user of the service will naturally be faced with the appeal of staying uninvolved and instead being a free rider. The proposal does address this by planning to make certain types of data types available only to supporters. The specific plan proposed needs to be carefully considered to make sure that it both provides adequate incentives for users to provide support, without losing the political attractiveness of providing a truly public service. The balance proposed seems right to me—but I am no expert.

Third, there is the size of the user base: whether funding is public or private, it will be easier to get the greater the number of likely users is. Clearly there is a huge demand

---

1 Indeed, the classic example of a public good is lighthouses—which if you think about it, are the oldest form of radionavigation. There has been some dispute about the merits of government and private support of such facilities; see R. H. Coase (1974): “The lighthouse in economics”, J. Law Econ., 17, 357-376, and E. Bertrand, E. (2006): “The Coasean analysis of lighthouse financing: myths and realities”, Camb. J. Econ., 30, 389-402.
for positioning at the meter level, for personal navigation (afoot or while driving); this accuracy matches a natural human scale, namely a typical body length. For sub-meter positioning (e.g. for developing GIS data) the market is much smaller, but still large. At the extreme, the market for absolute positioning at (say) the 0.01 mm level is probably very small indeed: at best, the community of geophysicists who measure crustal motions.\footnote{Obviously, this level of accuracy, or much better, is widely needed for relative positions, as for example in manufacturing. But doing this with GPS is definitely trying to do things the hard way.} 

The question is, how does the user base scale with positioning accuracy from 0.1 m (already widely available through existing subscription services, or through post-processing) to the 1-10 mm available with the CRTN technology? Does it extend beyond the survey community? Plans for CRTN should include a realistic assessment of likely demand in the immediate future (the next few years). While someday precise GPS may be used for positioning intelligent vehicles, this will not happen soon.

**Governance**

The current document does not adequately describe how decisions will be made. As I understand it, the document says that rather than having a PI in charge, each user will have a service contract with the SOPAC recharge facility; and may, if not happy with the service, stop paying. This seems like a fairly crude way to guide what is done; it would seem advisable to allow the users some clearly-defined non-monetary role in the management of the CRTN operation at SOPAC, which should itself have clear lines of authority, responsibility, and delegation. It is not clear to me that CSRC’s current organizational setting (a University Support Group) is appropriate to something that will, if built, become a fairly important utility for California.

**Connection to UCSD**

I would also comment that the goals set forth in the document, while certainly important and beneficial, seem outside the University of California missions of research and education. The aims of CRTN do have some resemblance to the UC mission of public service, but such service more usually involves the transfer of research results to other organizations, which then make continued use of them; this is not what is being proposed here. My own feeling (and I expect others may disagree) is that while it may be best for this effort to be housed within the University for now, it is sufficiently apart from the University mission that significant University resources should not go into it.
Comments Received by the Caltrans Office of Land Surveys Concerning the CRTN Proposal

General

- The Department (Caltrans) should support this effort.
- Other functional areas within Caltrans (construction, maintenance, traffic management, etc.) should contribute funds to support this project, not just surveys.
- A single vendor solution for the software is unacceptable.
- PDA is not rugged enough for continuous field use.
- RTD does not work as a network correction provider in a RTN.
- Will CSRC be required to have a Land Surveyor on staff to meet the requirements of Section 8726(f) of the Business and Professions Code (Land Surveyors Act)?
- Develop an accounting system where the funds could be tracked and not diverted to another UCSD/SIO project.
- What are the thoughts of the state (California Geological Survey) and federal (USGS) agencies charged with earthquake research and preparedness concerning this proposal?
- The CRTN business model is flawed; providing value added products at no cost but charging for raw data.
- CSRC/SIO/UCSD must establish an administration unit that oversees the policy and direction for CRTN.

Infrastructure

- Caltrans should install and maintain an independent data communication network.
- The Department should invest in GNSS infrastructure. Do not expend resources on GPS only infrastructure.

Data

- Data from stations on Caltrans facilities should be routed to a Caltrans server before distribution to others.
- Caltrans identify sites that benefit transportation project delivery, install/upgrade telemetry equipment, and serve up a single base or network solution to Caltrans users. Make raw data available to CRTN and others.

Agreements/Permits

- Requesting other vendors (Leica, Topcon, Trimble, etc.) to modify their software to operate with CRTN/RTD is unreasonable. The other vendors have jointly
established interoperability standards. RTD could use these standards but chose not to.

**Benefits/Applications**

- Could be used to locate underground utilities and add a geospatial component to the underground utility database.
- CRTN could provide the geospatial component for the Pavement Management System.
- If the Department supports and/or funds some or all of CRTN, there must be guaranties that the Department will receive benefits. If not, what are the cost recovery options?
August 28, 2008

Maria Turingan  
California Spatial Reference Center (CSRC)  
Dept. IGPP, SIO, UCSD  
9500 Gilman Drive #0225  
La Jolla, CA 92039

Dear Maria:

The California Land Surveyors Association (CLSA) at their July 26, 2008 Board of Directors reviewed and voted to support the CSRC proposal for a statewide California Real Time Network (Version 3.3). CLSA appreciates the efforts of CSRC and Dr. Bock’s expertise in developing this proposal.

Should you require a resolution or additional letters of support, please feel free to contact us at (707) 578-6016.

Sincerely,

James M. Herrick, PLS  
President
From: Maria Turingan [mariaturingan@ucsd.edu]
Sent: Monday, July 07, 2008 2:46 PM
To: Yehuda Bock
Subject: Fwd: Statewide California Real Time Network

FYI

....................................................... 
Maria Turingan
E-mail <mariaturingan@ucsd.edu>
Phone (858) 822-2156
Fax (858) 534-9873

Begin forwarded message:

> From: "Dan Gilleland" <DGilleland@valleywater.org>
> Date: July 7, 2008 2:13:11 PM PDT
> To: "Maria Turingan" <mariaturingan@ucsd.edu>
> Subject: RE: Statewide California Real Time Network
>
> Hello Maria,
>
> I've read Yehuda's CRTN proposal and I appreciate and share his vision
> for establishing a CRTN however I have the following concerns.
>
> 1. Item 7, page 6, regarding CSRC ability to be "open to all vendors
> and s/w". I read this to say that the only software being considered
> for CRTN is Geodetics RTD. Is this a wise course of action? During
> the RTN meeting that Marti Ikehara hosted in Sacramento, many of the
> vendors (Trimble, Topcon, Sokkia and Leica) were present at this
> meeting and they expressed serious reservations on this subject. In
> part, they felt that there should be an unbiased evaluation of all
> software products capable of providing this type of service. Lacking
> an open evaluation of all software products, I do not believe that we
> will receive the vendor support that I feel that a endeavor of this
> magnitude requires.
>
> 2. Item 11, page 6, regarding funding of CRTN. I have concerns as to
> whether Caltrans or NGS is interested in funding CRTN or CSRC for that
> matter. During the last CC meeting in San Jose, both entities in so
> much stated that fact and the consensus of the Coordinating Council
> was that CSRC should update its work plan and look for other sources
> of financial support such as ESRI, PG&E and the like. Once again
> during Marti's meeting, I understood that Caltrans is looking to
> create its own state wide RTN. They did not seem to be willing to
> partner with anyone at this time.
>
> 3. Item 15, page 7, regarding potential partners. Public agencies
> tend to not be to be concerned with issues that are happening outside
> of their particular jurisdictions and in this day of scarce funding I
> doubt if they would be willing to fund something that doesn't
> primarily meet
> the needs of their constituents and focus on their core function.
> As I
> mentioned above, neither Caltrans or NGS seemed willing to provide
> addition funding and Caltrans seems reluctant to partner with CSRC in
> this venture.
> 
> > Any ways, that's my two-cents.
> > 
> Hope you had a great 4th of July holiday!
> 
> Dan
> 
> -----Original Message-----
> From: Maria Turingan [mailto:mariaturingan@ucsd.edu]
> Sent: Tuesday, July 01, 2008 1:40 PM
> To: Dan Gilleland
> Subject: Statewide California Real Time Network
> 
> Dear Dan,
> 
> I hope that this email finds you well and smiling. Thank you again
> for attending and for helping to organize the last CSRC Coordinating
> Council
> (CC) meeting in May in San Jose. We very much appreciate your time,
> participation, and support over the years.
>
> We are hopeful and excited about the expansion of a statewide
> California Real Time Network (CRTN), as discussed at the CC meeting.
> We are asking that you review the attached CRTN proposal (version
> 3.3).
> Your comments and feedback are important to us, as we move forward and
> seek partners to help us implement a statewide CRTN.
> Please respond with your comments by July 31st, 2008 and pass this
> proposal on to other interested individuals.
>
> Please also plan to join us at the next CSRC Coordinating Council
> meeting on October 16th (Thursday), 2008 from approximately 9:30 AM to
> 4:30 PM at the Scripps Institution of Oceanography, Revelle Conference
> Room/SIO Visualization Center (Revelle Lab Building 4000, 3rd Floor
> (the top floor); 8785 Biological Grade, La Jolla, CA 92037). As the
> date nears, requests for RSVPs and reminders will be emailed to you.
>
> Please let me know if you have any questions. Again, please email
> your comments about CRTN before July 31st.
>
> Thank you,
> Maria
>
> .............................................................
> Maria Turingan
> CSRC Project Coordinator
> E-mail  <mariaturingan@ucsd.edu>
> Phone  (858) 822-2156
> Fax  (858) 534-9873
> http://csrc.ucsd.edu/
Dear all CRSC members,

**General comment:**

I think the CRTN proposal presented in the actual form (version 3.3) is still potentially containing conflicts of interest and could generate conflicts between actors of the GPS in California. The CRTN as well as the CSRC should not be the institution of a potential conflict for the community but rather a place where everyone might be able to find help and support for its project or research in R&D domain. The money involved here is the California taxpayer contribution, we need to remind it at every moment and any waste of money or energy has to be tracked down.

**Detailed Comments:**

**Context of the May 16th meeting:**

My recollection of the May 16th meeting was the network operators were not ready to let access their sites to all end users. _Several questions arose at this meeting (liability, quietness of the site, ...) and showed there is still some work to do on pilot-mode before proposing to set up an extended version of the CRTN network._

Indeed, we still need to initiate/secure one-to-one collaboration between operator and a small group of surveyor that have authority to provide approved solutions (county surveyors, NGS, etc.). These studies might be able to provide coordinates (a Reference Frame including the existing networks is not published yet).
Also the conflict of interest ($) and the multiple general conflicts (access to the sites, etc.) that CRTN could generate were discussed. Indeed, if an operator is selling data (RAW/RTK) or a software to the end-user, is the public money can be used in order to support private interest? Also, Companies that are operating networks might find CRTN is disloyal because supported by State of California.

At last, several times the question of latency was discussed and it seems at least some PBO sites are not able to provide continuous reliable data through the PBO NTRIP server. This could be observed also on BARD/private network sites. What do we do about this?

Specific comments:

Several times in the proposal, the role of SOPAC keeps appearing. What is clearly the authority of SOPAC in the GPS community? California State is supporting other efforts (like NCEDC-Northern California Earthquake Data center, where data are freely available to the public). In other words, what mandate SOPAC owns to get control on all GPS sites in California?

There is also a potential conflict of interest between private and public money. Pocket GPS manager (PGM) software is sold to private users. This is a noble business. But can we request public money to improve the coverage of RTD in Northern California? Can SOPAC give full access to the source code of RTD? I understand the format of the data is open to everyone and everyone might be able to use the data flowing out of the port of the CRTN network. The truth is the surveyor community in California does not need more data but more education and to improve its expertise to achieve its goals and reduce its liability to its customers.

For all these reasons, I think the Caltrans RFI and CRTN project should be kept separated from the CRTN project.

Also CRSC should be able to lead the education effort and technical improvement of GPS network for private users in California. CRSC might support costs associated with the maintenance and telemetry costs without reducing the authority of operators on their own network.

At last, CRSC, as an entity of research and development designed primarily to support the infrastructure development and initiate economic activity, should be able to support R&D projects dedicated to address issues that the whole GPS community will have to face on (3G generation network, latency issues, strategies of processing, reference frames stability, troposphere, etc,) and that cannot be funded by NSF or other consortium such UNAVCO.

Additional questions for the Caltrans RFI

I provide here some additional questions to be added to the RFI questions.

1-Is the operator selling a software to process the data provided by your network?
1.1 -If so are you making this software freely available to CRSC members? Is this code open source?

3-Can you warranty the property of the data is your own? Please specify the funding source of your network.

4- Are you already funded to support high-rate telemetry?

5- Do you have full authority on the control of the sites and access to the site?

I hope the document will be helpful.

I thank you very much,

Nicolas Houlié
July 29, 2008

Re: CSRC Statewide CRTN Proposal, Version 3.3

Notes by Kari J. Launen, PLS, Psomas

I am submitting the following comments in support of a plan outlines within the subject text. These thoughts are not in any particular order and some ideas are included within the text.

1. It is desirable to establish a statewide system that addresses needs for present and future growth areas. Currently we have several vendors that provide fee based services for limited growth areas, and no similar support for statewide survey needs for maintenance and development of statewide infrastructure.

2. Emphasis will be needed to demonstrate benefit of state wide system to “non traditional” users. Recent disaster response to wide area forest is a clear demonstration of benefit.

3. CRTN will only succeed if it has a wide base of support from all sectors of surveying community. Smaller private firms provide services on limited local basis and have marginal need for statewide service. Larger private firms will see benefit of statewide network and realize savings. This support can only be realized by clear demonstration of cost benefits to the survey community.

4. Clarification will be needed to see how CSRC plays into NGS Ten Year Plan. My understanding is that NGS is will work with statewide CRTN providers, but the present plan includes “broad strokes” with no detail on how this will work and level of funding, if any. CSRC can’t depend on availability for federal funding on long term basis, and support CRTN.

5. “On-the-fly epoch-date conversion software” is sorely needed to overcome survey control ties to existing control networks.
Maria, in fact I have been reading several of the versions of the proposal that you have sent. I haven’t offered changes since I thought it was quite well written. I have a meeting tomorrow (Thursday) with Yehuda and I will re-read this version and offer any changes that might improve it. I’ve asked Rita Bauer to put the meeting on my calendar - I believe I will be here, but it's a very busy fall.

On Jul 1, 2008, at 1:54 PM, Maria Turingan wrote:

>>> Dear John,

>>> I hope that this email finds you well. We are hopeful and excited about the expansion of a statewide California Real Time Network (CRTN). We are asking that you review the attached CRTN proposal (version 3.3). Your comments and feedback are important to us, as we move forward and seek partners to help us implement a statewide CRTN. Please respond with your comments by July 31st, 2008 and pass this proposal on to other interested individuals.

>>> Please also plan to join us at the next CSRC Coordinating Council meeting on October 16th (Thursday), 2008 from approximately 9:30 AM to 4:30 PM at the Scripps Institution of Oceanography, Revelle Conference Room/SIO Visualization Center (Revelle Lab Building 4000, 3rd Floor (the top floor); 8785 Biological Grade, La Jolla, CA 92037). As the date nears, requests for RSVPs and reminders will be emailed to you.

>>> Thank you for your support of CSRC over the years. Please let me know if you have any questions. Again, please email your comments about CRTN before July 31st.

>>> Thank you,

>>> Maria

>>> .................................................................

>>> Maria Turingan
>>> CSRC Project Coordinator
>>> E-mail <mariaturingan@ucsd.edu>
>>> Phone (858) 822-2156
>>> Fax (858) 534-9073
>>> http://csrc.ucsd.edu/

>>> <CRTNProposal_version3.3.pdf>
Ms. Maria Turingan  
Scripps Institution of Oceanography’s  
California Spatial Reference Center  
9500 Gilman Drive  
La Jolla, Ca  92037-0225

Dear Ms. Turingan:

Re: Statewide California Real Time Network Version 3.3

It is very exciting to see CSRC take the initiative and propose such a huge project. As you are aware the District has supported CSRC throughout the years and will continue to do so. The District fully supports the concept of a "Free to User" State Wide Real Time Network and we look forward to working with CSRC to fine tune this concept, assist in the development and see to it that this vision may become a reality. At this time, the District will consider partnering with CSRC in this most important project and we offer our assistance for continued development and eventual success.

Very truly yours,

DAVID L. STONE  
Chief of Surveying and Mapping

BH:rlp
Appendix D: Responses to Caltrans RFI, Real-Time GPS/GNSS Data Sharing
Hello

As discussed in previous meetings, following is summary of the comments received in response to the Caltrans RFI for data sharing, an outline of the same information, and the "raw" comments from the respondents.

Regards,
Dick

----- Forwarded by Adrian Davis/HQ/Caltrans/CAGov on 09/17/2008 04:35 PM
-----

Caltrans Colleagues,

For the time being please consider this message as confidential and for your reading only. At some point we will come together as a group to discuss this and we can talk then about if and what data should be shared with others.

I had expected to send this out this morning but I got distracted. I have assembled the Data Sharing RFI responses and did my best to concisely summarize them both per each response and in our outline.

(See attached file: Response Summary.doc)(See attached file: Summary in outline.doc)
I was a little disappointed with the responses both in terms as the number of respondents and the responses themselves. Unfortunately, the CRTN white paper seemed to overshadow what we were hoping to accomplish with this RFI and most respondents framed their responses as if we were asking them to comment on it.

Greg Helmer from RBF was the first to respond. Basically they support the CRTN proposal and would like to see Caltrans take a leadership role in its development.

Ed Morrison of CSDS responded with what was almost an RFI of their own. They doubt that there is value in sharing data without significant issues being addressed. They believe Caltrans should simply be a client of a commercial system. They are very concerned that Caltrans will make data available to the public for free and undercut small business.

Adrian Borsa responded for UNAVCO with a very concise response indicating PBO’s willingness to work with partners if some issues like funding could be addressed AND it didn't detract from their core mission.

AZGPS (CalVRS) responded on the outline directly. They made some points about valuing different data products and eluded to wanting to work with Caltrans in an exchange of raw RTGPS data for correctors and other data. They also commented a little bit on wanting to see Caltrans take a statewide approach, but didn’t say that CRTN was preferred. They seemed to indicate an opinion that data shouldn't be give away for free.

James Yaccino responded for Leica, Servco and Haselbach with what was basically a business proposal, although they seemed to follow the outline very well. James followed up with a phone call and clarified some points. They are basically interested in including Caltrans stations in a Leica network. They are not interested in including CRTN stations unless we were to specifically request it to serve an area where their network didn't offer service. They seemed open to negotiation on many subjects.

Yehuda sent an e-mail clarifying where the responses from SOPAC and CSRC could be found. CSRC's response is the CRTN white paper. And SOPAC's response is that the RFI was an unneeded distraction and that we should support CRTN. He noted his opinion that Caltrans has a poor track record of data sharing and indicated that any other effort to build an RTN in California was superfluous and a waste of taxpayer monies.

Pierre Desjardins responded for Trimble. They responded as if the RFI was related directly to the CRTN white paper. Trimble is very concerned about the implications of CRTN to the user base and small business. They seem to believe that Caltrans should build its own network.

Here are all the summaries zipped up for you reading/records.
(See attached file: Responses.zip)

Dave Olander
Caltrans D-11 Field Surveys
dave_olander@dot.ca.gov
Office: 858-467-4305
Cell: 619-571-5556
Fax: 858-467-4301
Servco (James Yaccino) for Leica, Hasselbach and Servco:

- Would like to partner with Caltrans to build a network state wide.
- (By Phone) They would like to start with something like their current customer agreement, but would be willing to accommodate our needs.
- (By phone) They are not interested in paying for data through the CRTN proposal unless we were to request (and presumably pay for) it.
- Mention that as a subsidiary of Leica Geosystem’s parent company they are in a position to support the network well and have the capital to expand as needed.
- Say that not having to develop and maintain infrastructure would be a great benefit for Caltrans.
- They would provide a host of data products.
- Would require, at a minimum, consistent quality data streams from stations.
- Would see the partnership as done annually and executed 1 year in advance, but (by phone) say that other options are acceptable.
- Would work with us to put a plan together that meets our needs/concerns.
- Have already executed partnerships with other public and private sector entities.

RBF (Greg Helmer)

- Basically offered support for our involvement in the CRTN proposal.
- Private efforts towards RTN expansion should not be “squelched”.
- Suggests we should work towards RTN’s as being a tool to access the modern spatial reference system.
- RTN’s will enable quick realization of the spatial reference datum for many modern applications like machine control and imaging.
- Would like to see Caltrans should champion partnerships that promote a spatial referencing application like a statewide RTN.
- Favors a statewide system.
- Describe aspects of CRTN as a preferred alternative for RBF.
- Partner agreements must not create barriers for value added businesses.
- Public agencies and institutions should not be excluded from freely distributing data.
- Sees RTN’s as replacing local control networks.
- Will be an active participant in RTN’s no matter how the technology emerges.

CSDS (Ed Morrisson)

- Had a lot of concerns/questions. Makes me wonder which was the RFI, theirs or ours. Issues brought up:
  - Signal Latency
  - End user support
  - Infrastructure ownership
  - Suitability of stations in a solution
  - Natural disaster responsibilities
  - Data and reference station integrity
  - Liability
• Does not see what advantage there would be to partner with the state unless questions outlined were addressed
• Adding another network in CSDS sphere of influence will further saturate the market
• CSDS is concerned that Caltrans will make data freely available, undercutting small business
• CSDS is willing to make it affordable to the state to be a client
• Given their experience in this, they question Caltrans’ ability to operate a system
• Would be willing to support the educational and research communities
• Would be willing to share data for quality control purposes
• Given their experience, CSDS has concerns about the reliability, liability and serviceability of a shared network arrangement.
• Emphasized their concern about a publically accessible shared network affecting their business plan.

UNAVCO
• Real time data is not part of their mission
• They have been testing real time and are capable of doing it
• Are only interested in being a provider
• Does not currently have the resources to add many stations to the existing ones they host in real time.
• Provide BINEX and RTCM 2.3 data through NRTIP
• Will soon provide RTCM 3.0
• Users are free to re-broadcast data provided that they do not charge for services
• Must ensure that the expansion of real time data services does not impact its core mission
• Is supportive of state and other agencies efforts to simplify access to real time data

AZGPS
• California is uniquely benefited by the fact that much of the infrastructure is already in place
• Caltrans is in a position to guide the development of a statewide RTN
• Multiple partnerships seem to be the only way for expand statewide
• Believes that assigning value to different forms of data might be a way to create a fair exchange of data.
• Is interested in real time raw GNSS data 24/7 at some level of quality commitment
• Is interested in providing raw and GPS data and correctors
• Sees Caltrans starting out as a “moderator” between partners
• RTCM and NTRIP provide a good platform for data standards
• Interested in the area from Bakersfield to the south.
• Interested in immediately implementing a phased deployment
• Prefers an annual agreement open to the public
• A contract should be put in place formally outlining roles
- Consideration of the value of the exchange should be considered.
- There are several agreements in place and are currently held confidential between the parties (Caltrans D11 has a written agreement with AZGPS for data sharing)

**SOPAC**
- RFI implies that Caltrans has some central authority over ‘these matters’
- Caltrans has a history of not sharing data
- Does not believe that Caltrans should built its own stations as it is a waste of energy and funds
- Consider CRTN as a statewide RTN
- Use CRTN’s server side rtk solution
- Appears to believe that any effort outside of CRTN involvement is superfluous

**Trimble**
- Apparently answered as if the RFI were related to the CRTN proposal
- Was concerned about a negative impact of a statewide system to the user base
- CSRC proposal will
  - have a significant impact on the adoption and retention of RTK users in California (presumably referring to commercial RTN operators)
  - quality assurance concerns
  - no consideration for the future
  - VRS is the best solution available
  - Mixed hardware networks are problematic
  - Trimble hardware only networks work better
  - A unified service level agreement among the providers would be necessary to address many issues.
  - Private/public ownership model creates a conflict of interest
  - Concerned that we will put small businesses at risk.
  - Fully GNSS networks are the most desireable and the CRTN proposal will not address that.
  - 80km spacing in inadequate
  - Server side solution does not work
  - CRTN proposal puts the entire industry at risk
- California should develop its own statewide GNSS solution as has been done in other states and countries
I have done my best to fit comments into our outline. I didn’t include Trimble’s because they addressed the CRTN paper only and how we should accept it. -- Dave

1.) Partnership Justification

A. **Describe the benefits of developing a data sharing partnership between Caltrans and potential partners.**

RBF: Would like to see Caltrans champion partnerships that promote a spatial referencing application like a statewide RTN. Legitimizing effect.

CSDS: No benefit

AZGPS: Statewide Scope (AZGPS only interested in SoCal)

SOPAC/CSRC: Statewide Scope and hopes to secure reliable funding for CRTN and CSRC through partnership.

2.) Data sharing principles

A. Describe your thoughts regarding a mutual beneficial plan for real time CGPS data sharing. At a minimum the following should be addressed.

- **Who would be involved?**

RBF: Various partners public and private

Servco: Caltrans, Servco and its partners

AZGPS: Caltrans would have many partners

SOPAC/CSRC: Various partners public and private through consortium

- **Are you interested in a global partnership? (i.e. multiple partners or one on one partnership)**

RBF: Global

Servco: Global in as much as Caltrans would be one of Servco’s partners

AZGPS: Global in as much as Caltrans would be one of AZGPS’ partners

SOPAC/CSRC: Global

- **Are you a private enterprise?**

RBF: Private

Servco: Private

CSDS: Private

UNAVCO: Government funded

AZGPS: Private

SOPAC/CSRC: University

- **Are you a government agency?**

RBF: Yes

Servco: Yes

CSDS: None mentioned

AZGPS: Yes (including Caltrans Dist 11)

SOPAC/CSRC: Yes with PBO, universities, counties, utilities and etc.

B. **What would be exchanged?**

- **What are your needs? (real-time data, static data, 24 hours a day,**
7 days a week, what type of commitment?
Servco: raw data access 24/7
AZGPS: raw data access 24/7
SOPAC/CSRC: Funding for expansion

➢ What would you provide?
Servco: RTN data correction, IMAX, VRS, etc
UNAVCO: RTCM 2.3, Binex and RTCM3.0 is planned
Servco: RTN data correction, VRS, etc
SOPAC/CSRC: Raw data, RTCM correctors, expertise, server-side network correction

➢ What would you expect the State to provide?
RBF: Leadership
Servco: Negotiable but ideally total access to Leica 1200GXpro reference station
UNAVCO: Simplify access to the public
AZGPS: Leadership, raw real time data
SOPAC/CSRC: Leadership, funding, stations

➢ What data format would be used or needed?
Servco: Negotiable but ideally total access to Leica 1200GXpro reference station
AZGPS: RTCM standards

➢ What data format could be used?
Servco: Must be at least RTCM

➢ How would you prefer to receive the data (NTRIP, open port in your server, proxy)?
Servco: TCPIP (Vague)
AZGPS: NTRIP?

➢ How are you able to receive the data?
Servco: TCPIP
AZGPS: NTRIP?

➢ How would you prefer to provide data to Caltrans?
Servco: NTRIP
UNAVCO: NTRIP
AZGPS: NTRIP

➢ How would you be able to provide data to Caltrans?
Servco: NTRIP
UNAVCO: NTRIP
AZGPS: NTRIP

➢ What roles would partners assume?
CSDS: Concerned about this subject and basically ask the same thing
UNAVCO: Caltrans would provide free access to the public
AZGPS: Reliability guarantee
SOPAC/CSRC: Member of a consortium under CSRC jurisdiction. Partners would provide funding for the network.

➢ What legal issues should be addressed?

➢ What, if any, data standards should be addressed?
Servco: Standards would be addressed by contract

- Who would handle the various licensing costs?

Servco: Servco

C. Where would you be interested in developing this partnership?

Servco: Statewide
UNAVCO: Wherever stations are owned
AZGPS: Bakersfield and south
SOPAC/CSRC: Statewide

D. When would you be interested in implementation of your plan?
AZGPS: Immediately
SOPAC/CSRC: White paper is being circulated at this time for comments
  - Would this be a phased development?
AZGPS: Phased deployment seems to be the only practical way

- What do you anticipate the duration of the partnership to be?
Servco: Ready to begin negotiation immediately for an indefinite term
AZGPS: Indefinite
SOPAC/CSRC: Forever

E. How would you anticipate the partnership to be put in place?
RBF: Through the CSRC

- Contract
Servco: Contract
AZGPS: Contract
  - MOU
Servco: Possibly
AZGPS: Possibly

- Do you anticipate a financial exchange?
Servco: That will be dependant upon the number of stations/clients
AZGPS: Would like to consider the value of the data being exchanged
  - Will the formal agreement outline roles with periodic reviews?
RBF: In as much as RBF supports the CSRC initiative, then yes.
Servco: Yes, an annualized 1 year contract
AZGPS: Yes, with yearly contract

  - How will communication and administrative roles be identified?
Servco: Caltrans and Servco each will provide 1 point of contact and roles will be defined by contract
AZGPS: Spelled out in contract.
SOPAC/CSRC: in the CSRC directive?
Would the data sharing involve an end product to be sold? If yes, explain what product would be provided for your clients and what that product would be?

Servco: Servco GNSS corrections are sold
AZGPS: Yes
SOPAC/CSRC: That depends on consortium members

3.) Does Respondent currently have existing partnerships in place? If so, please provide examples of current data exchange agreements.

Servco: Many private surveying firms
AZGPS: Yes. Did not want to specify current partnerships. (Caltrans D11 is a partner and I have included our agreement with this summary)
SOPAC/CSRC: With many local agencies
AZGPS Response to RFI 070708 Data Sharing, 
Real-Time GPS/GNSS Data Sharing for The State of California

Point of Contact
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Outline Response

1) Partnership Justification

   a) Describe the benefits of developing a data sharing partnership between Caltrans and potential partners.

   California has a unique advantage when looking towards Real-Time GPS/GNSS, in that the majority of the infrastructure needed is already in place. Caltrans, having interest in the entire state, not just a specific geographic area, is uniquely qualified to develop a cooperative that allows and encourages the partnership of those who have invested and are maintaining that current infrastructure. One could say the only thing holding California back from having a Statewide Real-Time GPS/GNSS network is those that would benefit from such network. The benefits of a Statewide Real-Time GPS/GNSS network should be obvious to anyone reading or responding the this RFP, so I won’t venture down that path. The benefit of Caltrans developing a data sharing partnership, is their Statewide interest and their ability to encourage potential parties, some with vastly different project scopes, to partner together.

2) Data Sharing Principles

   a) Describe your thoughts regarding a mutual beneficial plan for real time data sharing. At a minimum the following should be addressed.

      i)    Who would be involved?
      ii)   Are you interested in a global partnership? (i.e. multiple partners or one on one partnership)
iii) Are you a private enterprise?
iv) Are you a government agency?
v) Do you currently have partnerships with other entities in place?

In my opinion a mutual beneficial plan for Real-Time data sharing would allow anyone with a vested interest in Real-Time GPS/GNSS data to join. While my interest at this time is focused on a Single partnership, in order to achieve the end Goal of Statewide Real-Time coverage a global partnership with multiple partners seems like the only logical option. AZGPS is a Limited Liability Company incorporated in Arizona on October, 28th of 2004. We are not a government agency although we do have partnerships with both government and private entities in place to share, host, and disseminate Real-Time GPS/GNSS data.

b) What would be exchanged?
   i) What are your needs? (real-time data, static data, 24 hours a day, 7 days a week, what type of commitment?)
   ii) What would you provide?
   iii) What would you expect the Caltrans to provide?
   iv) What data format would be used or needed?
   v) What data format could be used?
   vi) How would you prefer to receive the data (NTRIP, open port in your server, proxy)?
   vii) How are you able to receive the data?
   viii) How would you prefer to provide data to Caltrans?
   ix) How would you be able to provide data to Caltrans?
   x) What roles would partners assume?
   xi) What legal issues should be addressed?
   xii) What, if any, data standards should be addressed?
   xiii) Who would handle the various licensing costs?

It seems to me the best way to exchange data fairly would be to assign a value to the different forms of data, the latency of the data and to the quality of service or commitment of that data. For instance Real-Time data should have a higher value than static data, corrected data should have a higher value than Raw data, GNSS data should have a higher value than GPS Only data, etc. I know there are numerous agencies and companies out there that are insistent sometimes even mandated to provide data free of charge, however the only way I see a cooperative partnership, with vastly different goals, participating in a fair and open partnership is to assign values to the different information being exchanged. From AZGPS’s perspective we are interested in Real-Time Raw data delivered 24 hours a day 7 days a week, with some agreeable commitment level of availability and quality. In return we are prepared to offer Real-Time Raw data as well as Real-Time corrected data both network and single base, with some agreeable commitment level of availability and quality. There are REAL costs in setting up, maintaining, and sharing GPS/GNSS data. By assigning values to that data will allow AZGPS and other potential partners the opportunity to evaluate their level of participation, and while Caltrans may be a provider to this partnership. I see them at least to start as being the moderator and facilitator in establishing guidelines and organization for developing such a partnership. As far as data standards and formats are concerned the RTCM SC104 has established non-proprietary GPS/GNSS data format standards that would provide a good open platform for data sharing. NTRIP is also non-proprietary and a RTCM standard designed for disseminating or sharing data. This seems to me like the easiest and most cost effective way of authenticating and sharing data.

c) Where would you be interested in developing this partnership?
i) Do you anticipate a statewide partnership? ii) Are you interested in a particular geographical area only?

At this time AZGPS does not anticipate a statewide partnership, while I am not against hearing other options, our current interest is in Southern California. More specifically defined from Bakersfield South.

d) When would you be interested in implementation of your plan?

i) Would this be a phased development? ii) What do you anticipate the duration of the partnership to be?

While there are certainly a lot of details to be discussed, I think the implementation of a plan should take place as soon as possible. Due to the size and various levels of commitment I think a phased development would be appropriate. I think the terms of such partnership should be annual and the status of the partnerships made publicly available.

e) How would you anticipate the partnership to be put in place?

i) Contract
   ii) Memorandum of Understanding (MOU)
   iii) Do you anticipate a quid pro quo exchange?
   iv) Do you anticipate a financial exchange?
   v) Will the formal agreement outline roles with periodic reviews?
   vi) How will communication and administrative roles be identified?
   vii) Would the data sharing involve an end product to be sold? If yes, explain what product would be provided for your clients and what that product would be?

To ensure equality to all involved a contract with agreed upon terms and conditions should be put in place. If the value of services requested is equal to that of the services being offered, I see no problem with a quid pro quo exchange. If however there is a discrepancy in value between the value of services requested and that being offered there will have to be some level of financial exchange. It seems a formal agreement including an outline and administrative roles would be appropriate and necessary.

3) Does respondent currently have existing partnerships in place? If so, please provide examples of current data exchange agreements.

Yes, however our data sharing agreements are restricted to the parties outlined in each particular agreement. While arrangements could be made to facilitate this request, at this time it is not in our best interest to include them.
August 07, 2008

Dave Olander, PLS
Caltrans District 11 Surveys
4050 Taylor Street
San Diego, CA 92110

RE: Real-Time GPS/GNSS Data Sharing RFI
Response submitted via email dave_olander@dot.ca.gov

Dear Mr. Olander:

This document is in response to the State of California, Department of Transportation (Caltrans) Request for Information (RFI) to gather data for the purpose of identifying considerations in the development of public/private partnerships for real-time GPS/GNSS data sharing.

California Surveying and Drafting Supply (CSDS) is concerned about the viability of creating an amalgamated network. First and foremost, the technological challenges of such a configuration would be immense. A shared network would require a number of issues to be addressed, including but not limited to:

- Any such network configuration would require that it be available to all manufacturers equipment. How would this be guaranteed?

- Signal latency (i.e; There is latency of the signal from the GPS reference station to the Network servers). When there is an Internet Carrier (ATT, Sprint XO Communications, Level3 Communications, etc.) with an impacted network it will cause a delay in the timely delivery of the GPS signal to the servers. This will cause the reference station(s) to fall in and out of the network solution. The constant remodeling of the network area around the impacted reference station(s) will adversely affect the solutions of the network to the end user.
  1. Who are the responsible parties for resolving the signal latency?
  2. Signal latency is a particularly troublesome issue even when the Real-Time Network (RTN) provider is a sole responsible party. The reason for this is because of all the other parties it brings into the equation:
    - ISP for the reference station location
    - ISP for the RTN server location
    - All the Internet carriers that are in between the two end points the real-time signal has to travel through.
  3. How would you as the network operator resolve this issue?
• Identifying who will be responsible for fixing any issues with the reference stations, and establishing the required time frame, would be crucial to the reliability of the network.

• Who will provide end user support?
  1. If the “partners” are expected to be the supporting agents:
     • Will they have access to the RTN servers to facilitate that support?
     • If not, how will the partners be able to determine the cause of the end user’s issue?
     • What would be the path to resolution for any issues with the RTN servers?
  2. If Caltrans or another entity is to provide end user support:
     • How many staff will be dedicated to this?
     • Will they have access to the RTN servers to facilitate that support?
     • If not, how will the staff be able to determine the cause of the end user’s issue?
     • Will dedicated IT personnel be allocated to managing the network?

• How will you as the network operator know if the reference station that is streaming data from it is owned by the operator streaming the data?
  1. If the operator doesn’t own the station and adjustments need to be made to the station, but the owner doesn’t want those adjustments made, what happens?

• How will the suitability of the selected reference stations that are to be a part of the network be determined? (i.e.; Are the stations free from Multipath influences?)
  1. Will there be standards for the RTN reference stations?
  2. Who will determine the standards for allowable reference stations?
  3. How will this be enforced?
  4. Who will pay for the costs to meet these standards?
  5. Who will pay the costs of upgrading the stations if the standards change?
  6. What happens if you determine that none of a participant’s reference stations are suitable for the RTN?
     • How long would it take you to determine this was the issue?
     • How long would you be using bad reference station data input before you were able to resolve this issue?
     • How will you make that determination?
       1. Will you have staff go to every station and inspect the quality of the installation and equipment?
       2. To what extent and to what cost will you go to fix these stations?

• What happens if a natural disaster occurs such as floods, fires or earthquakes?
  1. Who will be responsible for the oversight and handling of any mass outages of reference stations?
  2. Who will pay the costs to fix them?
• Data Integrity
  1. Who will ensure the integrity of the data?
  2. How will this be accomplished?

• Reference station integrity
  1. What measures will be put into place to monitor the reference stations’
     positions for movement?
  2. Who will pay for the cost of the station monitoring?
  3. Who will be responsible for physically checking any movement of the
     stations?
  4. Who will pay the costs for repairing any issues with the stations?

• Liability
  1. What happens in the case of a lawsuit?
  2. Who would be liable?
  3. What would they be liable for?

Due in part to the aforementioned issues, CSDS currently does not see the advantage of
a data sharing plan – particularly with northern and southern California already having
RTN infrastructure in place. Another network in northern California would further saturate
a competitive market where three private RTN’s are already in head-to-head
competition. Further complicating this matter is whether this network will be accessible to
the public. Free public access will severely handicap the “fee-based” private vendors
giving the “no-cost” government network an inherent competitive advantage.

CSDS looks at RTN’s much like cell phone networks. Just as the cell carriers negotiate
low cost plans for the State of California, CSDS has made it very cost efficient for the
State of California to access and utilize RTN data with the favorable daily subscription
pricing already in place. Much like cell phone networks, having a for-profit organization
maintain the data feeds and technology would ensure the latest and best technologies
are made available to Caltrans with limited expenditures by the State. Utilizing an
existing network also eliminates the need for the State to worry about funding annual
infrastructure upgrades amid decreasing budgets.

Due to the longevity of CSDS’s involvement with building, operating and maintaining an
RTN across northern and central California, we understand the time, capital
expenditures, staff and dedication it takes to operate a network. This operation goes far
beyond receiving data feeds from reference stations and requires a significant monetary
investment, diligence and hard work, as can be noted from the issues listed above. Can
the State allocate that level of resources?

CSDS is in agreement with the State that it would be beneficial to support the
educational and scientific communities. We would be interested in providing these
groups with data at little to no cost, excluding any training or support. Additionally, we
would support providing data for quality control and network integrity reasons to
Caltrans, NGS or another agency that may be responsible for positioning accuracies.

In closing, we would like to point out that CSDS has been in the forefront of RTK
technology since its inception, and is one of very few true RTK GNSS networks in the
United States. After building and operating our own network for five years, we truly
understand the complexities, costs and arcane issues associated with establishing and
sustaining an RTK network. Our experience in this arena leads us to have concern about the reliability, liability and serviceability issues that could result in a shared network arrangement.

Additionally, the State’s desire for a publicly accessible or shared network would have a significant negative impact on small businesses in California that currently provide these services. In order for such a venture to be successful, the State would need to ensure that these businesses can remain viable and that the investment we have all made in establishing our own networks would not be jeopardized. Unless the issues outlined in this letter can be addressed, CSDS will be unable to consider participation in any sort of data sharing opportunity.

Sincerely,

Ed Morrison
Systems Administrator
California Surveying & Drafting Supply
916.344.0232 x126
Living Document

Proposal for a Statewide California Real Time Network
Version 3.3
California Spatial Reference Center
Scripps Institution of Oceanography, La Jolla, CA
June 27, 2008
Please send comments to ybock@ucsd.edu

Statement of the Problem

This proposal addresses two related problems:

1. The lack of an open, uniform and seamless statewide real-time network in California. Our State with its size, population, unique spatial referencing environment, and despite the tremendous resources at its disposal is far behind in providing a real-time solution for precise spatial referencing, a requirement for increased economic productivity and innovation in private and public sectors for a growing number of interrelated applications.

2. The crisis in Federal funding of the California Spatial Reference Center (CSRC), the absence of State support and funding, and a lack of a clear vision for the future. We are still guided by the CSRC’s Master Plan for a Spatial Reference Network in California (“Master Plan”) published in 2002, which needs to be updated to account for technological advances, infrastructure enhancements, and societal priorities.

The premise of this proposal is that a slightly modified version of the existing California Real Time Network (CRTN) and its expansion throughout the State will provide a needed public utility, realign CSRC priorities, enlarge our constituency, and enhance funding opportunities for the CSRC. Besides our traditional users, a successful effort could impact such areas as disaster preparedness and relief efforts, flood plain management, water transportation infrastructure, precision agriculture, International and offshore boundary mapping, aircraft landing and safety systems, intelligent transportation and telematics, fleet management, and coastal and harbor navigation.

The figure on the right (prepared by Art Andrew) shows a statewide network with 80 km spacing, based on existing stations from geophysical networks. Also shown are stations that are already providing real-time data streams.
Elements of a Proposed Statewide CRTN

There are distinct advantages to adopting a slightly revised CRTN model for a statewide system:

- Builds upon existing (~80) CRTN stations in southern California, operated since 2003 by SOPAC, USGS, PBO, Orange County, San Diego County, and MWD, and the CVSRN operated in the Central Valley by Caltrans (see figure)
- Requires a partnership with existing geophysical networks (SCIGN, PBO) to expand the network throughout the State - discussions initiated with UNAVCO management
- Uses only CGPS stations that are part of the California Spatial Reference Network (CSRN), and built for high-accuracy, longevity, and geophysical stability
- Leverages existing metadata/archive infrastructure at SOPAC/CSRC
- Is directly tied to the California Spatial Reference System (CSRS) and National Spatial Reference System (NSRS) through SECTOR velocity model and HTDP crustal motion model, providing seamless epoch-date conversions
- Fulfills the requirements of the California public resource code for GPS-derived coordinates and orthometric heights, as provided by statutes that became effective on January 1, 2007
- Is able to recover from large seismic events by instantaneous monitoring of changing site positions, followed by rapid geophysical modeling and updates to SECTOR and HTDP models
- Contributes to and uses national real-time atmospheric propagation models (troposphere and ionosphere)
- Has a 20-80 km spacing, with 24/7 coverage and latency of 1 second
- Supports both kinematic and dynamic applications using server-side network positioning, rather than a rover-intensive approach
- Provides on-the-fly geodetic coordinates, and orthometric heights through national geoid models supplemented with local corrections
- Requires no user fees but is subsidized by CRTN partners
- Provides open access to CRTN network solution through public protocol using standard GNSS formats (RTCM, NMEA)
- Provides access to raw data streams in receiver-native format to CRTN partners
- Is managed by a consortium, which may be under the CSRC Executive Committee through the UCSD Support Group
- Is operated by the CSRC facility at SOPAC under contracts with partners

Current Situation

CRTN is operational (~80 stations) and provides complete RT coverage with a latency of less than 1 second for the five southernmost California counties (Imperial, Los Angeles, Orange, Riverside and San Diego) (http://sopac.ucsd.edu/projects/realtime/). Single-base RTK is fully supported through a variety of open protocols (RTCM, NTRIP). CRTN also
provides two types of network solutions (client-side and server-side). Currently, access to the network solutions requires PDA-based commercial software, available from a single vendor. PBO has also started to provide real-time data streams in RTCM and BINEX formats. The Figure shows the current availability of real-time data streams.

Some development is still required at SOPAC to complete on-the-fly epoch-date conversions and to stream orthometric heights.


The Request for Information (RFI) for Real Time GPS/GNSS Data Sharing for the State of California, California Dept. of Transportation (Caltrans) dated June 2008 is complementary to this proposal. Information submitted in response to the Caltrans RFI will be shared with the CSRC in order to improve this proposal.

Management and Governance

The governance of CRTN would be provided through the CSRC Support Group at UCSD. The Support Group currently includes CSRC Bylaws, the CSRC Coordinating Council (CC), and the CSRC Executive Committee (EC). The Support Group could decide to form additional entities such as a CRTN Consortium with its own set of bylaws but accountable to the CSRC EC. The CRTN Consortium would include the CRTN Partners. Each consortium member (CRTN partner) would sign a contract with the University to agree to pay a pre-established rate for CRTN services. Unlike the grant process in which the CSRC PI/Director has ultimate responsibility for the grant, CRTN would be run through service contracts to the SOPAC recharge facility. In addition to serving as a Center at SIO, SOPAC serves as a mechanism for service contracts to be entered into by the University. This mechanism is advantageous since it requires a lower university overhead rate (45% instead of 54.5%). In addition, a portion of the overhead is returned to SOPAC. Members would provide governance and oversight of CRTN through these contracts and may withhold payment if services are not rendered and completed to their satisfaction.

Cost Recovery

The revenue for CRTN would come from SOPAC contracts with CRTN partners similar to the ones with the Riverside County Flood Control and Water Conservation District and the Riverside County Department of Transportation who have contracted with SOPAC for services (last one was in 2003).

CSRC/SOPAC would develop an annual budget for CRTN, including an approved rate sheet and justification of costs. There may be various ways to determine the cost per consortium member/partner. One possible cost basis (favored by Scripps) could be a
daily rate based on the annual budget (in this case partners would need to contribute enough funds to cover a total of 365 days of operation); another would be the number of ports (stations) a partner accesses. If the yearly budget increases or decreases, future consortium membership rates could be adjusted. A deficit or surplus from the previous year could also be incorporated into the consortium membership rates and would be readjusted from year to year. The budget and rates would be decided upon by the Consortium.

Each contract must conform to University requirements. To provide flexibility, it is recognized that contracts would vary according to the requirements of the contracting agency. It should be noted that warranties cannot be stipulated in University contracts.

Consortium funds administered through SOPAC could be used to subcontract services to others, such as UNAVCO, especially since many real-time sites are operated by them.
CSRC-Executive Committee
Meeting Date: 05-07-2008

Executive Council discussion recognized that the draft proposal outlined an idea for transitioning CRTN to a statewide multi-user system, and that many of the details would necessarily be developed over time. To facilitate continued discussion, the following questions are presented for clarification.

Responses provided by Yehuda Bock on June 6, 2008.

1. What does “open” mean, please clarify the extent of what “open” is indicating?

Open means that CRTN will provide the protocol for anyone to freely use the server-generated network-solution through a single IP port. This will require fairly minor modifications to controller software provided by GPS vendors. I’ve already outlined the benefits of using the server-based RTK approach in that we will be able to provide instantaneous real-time access to epoch-date, geodetic coordinates and orthometric heights directly tied to the CSRS and NSRS, based on state-of-the-art reference stations built to survive earthquakes.

2. Will the raw receiver data from all stations be made available (continuously and simultaneously)?

Yes for partners. This capability provides a serious load on the system if it is used extensively. If various vendors or other groups would like this kind of access they should become partners by contributing funds to maintain CRTN. The benefit to the vendors is that they will not have to construct and build their own infrastructure, or that they can use CRTN to backup, densify, and/or extend their existing infrastructure.

3. Will all private agencies have 24/7 accesses and is it intended to be freely available to vendors to resell?

See answer above. They are free to resell if they are partners.

4. How is “Independent governance” to be defined?

This term is not used in my proposal, but see the section on “Management and Governance.”

5. Managed and operated by CSRC?

Yes, or by SOPAC if CSRC does not want to take on this responsibility. See the section on “Management and Governance.”
6. Who would own CRTN?

It will be operated by SOPAC/CSRC. See the section on “Management and Governance.” It wouldn’t be owned by one single group since no one group controls all the assets. It will require cooperation with several groups (UNAVCO/PBO and partners such as Caltrans, MWD, Counties) and understandings among them.

7. Are we open to all vendors s/w and capable of a fair competitive process in making this selection?

Y, Bock’s presentation at the CLSA/CSRC RTN seminars (see above ftp link to document) assumes that CRTN would continue to use the Geodetics RTD Pro software to gather and disseminate data and network solutions. This software is integral to research being performed at SOPAC into the development of earthquake early warning systems, but is also able to support field surveying in the most general sense using the server-side network RTK approach. The latter has been demonstrated successfully as part of the 2006 Southern California Height Modernization project using legacy Trimble GPS receivers with respect to CRTN. The RTD software has also been used in post-processing for the 2006 North San Joaquin Valley and the 2007 Central Coast projects. There is also some R&D required at SOPAC to provide the complete suite of models as part of the centralized server-based approach so there will need to be close cooperation between s/w vendor and CRTN. Some of this R&D is ongoing.

8. Who would own the software?

The software will be licensed by USCD/SIO as it is now.

9. Who owns the hardware that is/will be used by CRTN?

Hardware includes computer workstations and peripherals, radio communications equipment, GPS equipment and peripherals, GPS monuments, etc. Ownership will be mixed because CRTN is a cooperative project. Hardware at the central facility at SIO (workstations) will be owned by UCSD.

10. What arrangement does CSRC have with Scripps on the use of hardware?

No arrangement is required since CSRC is a Scripps project. See the section on “Management and Governance.” Of course, long-term commitment is based on adequate funding.

11. With funding issues being what they are (scarce) long-term reliability is an essential quality toward partnering. This begs the question, what is the foreseeable life-span of CRTN?

The primary intention of the proposal is to put CSRC and its projects (including CRTN) onto a more favorable funding environment that relies less on Federal funding and more
on local and State funding. The intention is also to keep CSRC focused on staying at the cutting edge and being responsive to the needs of its constituency, which we hope to grow to include non-traditional users. So the foreseeable life-span of CRTN depends on whether we can implement and sustain this vision.

12. How would decisions be made with respect to the managing of the network?

Through the CSRC EC, or other group. See the section on “Management and Governance.”

13. Who would provide server software updates?

Since all network computations will be done at the CRTN server, updates will be seamless to the user and will not require modifications to field controller software.

14. CSRC's responsibility?

To run and manage the network and provide user support, and to provide oversight. The CRTN budget will have adequate funding to support these functions.

15. Who are the potential partners?

Some mentioned above: UNAVCO/PBO, Caltrans, MWD, Water Districts, Counties, Private Sector Survey Companies, GPS Vendors

16. We need a workable plan that includes identifying specifics on what partners might want. (A more detailed proposal is needed to approach partners.)

The CSRC needs to take the lead on this and solicit comments from the surveying community and professional organizations. The future users and partners need to provide insight and feedback on what they expect/need from a statewide network.

Additional questions by Mark Turner (Caltrans) and responses by Yehuda Bock

Why have so many surveyors and engineers, including potential users in Caltrans, as well as the surveying service provider companies (Servco, CSDS, Haselbach, etc): 1) Not accepted the current CRTN model or fully utilize the existing CRTN subnetworks?, and 2) Compelled to actively build their own RTN infrastructure and provide/subscribe RTN network solutions for their users?

Currently CRTN has several limitations. First of all, it is limited to southern California (Imperial, Orange, Los Angeles, Riverside, and San Diego Counties). Most (if not all) of the service providers are outside of this region. Secondly, it is not an open system with respect to providing a network RTK solution or access to raw GPS data streams. Thirdly, it has had some technical problems in serving RTCM data to Trimble users. The first two
limitations are addressed by this proposal; the third limitation appears to have been resolved.

Obviously, there is a profit motive driving the GPS vendors and service providers and they may continue with their efforts regardless of how CRTN develops. On the other hand, the benefit to the vendors is that they will not have to construct and build their own infrastructure, or that they can use CRTN to backup, densify, and/or extend their existing infrastructure. It is in CRTN’s interest to have vendors become CRTN partners. Although they are interested in promoting their individual network RTK solutions, they may decide that it is more economical to make use of the CRTN infrastructure and data products.

Will a new "open" CRTN model (and/or coupled with NGS/CSRC guidance) address the needs of this community and enable them to integrate, or disband any portion of, their efforts by leveraging the CRTN infrastructure and data? How?

Yes, I believe that this is adequately discussed in the present version (3) of the proposal.
August 6, 2008

Dave Olander, PLS
Caltrans District 11 Surveys
4050 Taylor Street
San Diego, California 92110

Subject: Real-Time GPS/GNSS Data Sharing for
The State of California Department of Transportation

Dear Mr. Olander:

RBF Consulting (RBF) is pleased to present the following response to the subject request for information dated July 7th. While the opinions and comments described herein are certainly shaped though my affiliation with the California Spatial Reference Center (CSRC), this response is on behalf of my firm and does not represent a consensus of CSRC or Scripps Institution of Oceanography.

I would like to express my appreciation to Caltrans and to your self for the continued efforts to promote geodesy and real-time GPS/GNSS in California. As you are well aware, the challenges have been significant and mostly from non-technical aspects of development and operation. It is very obvious that real-time networks (RTN) are soon to become the common place positioning application. That presents an opportunity to shape the character of this new tool, and hence the informational exchange being promoted with this RFI.

Thank you again for your personal efforts to promote RTN, and for this opportunity to present our opinions.

Gregory A. Helmer, P.L.S.
Sr. Vice President, Surveying Geomatics
1. Partnership Justification

Real-Time GPS/GNSS Networks (RTN) are emerging so quickly that the question is legitimate if there is any need, or any ability, to effect a change to the inevitable scope of the technology. Considering this question however; brings forth an interesting aspect to the emergence. Continuous GPS and real-time GPS in California have progressed gradually out of partnerships with the geophysical community. The sense of urgent growth of RTN now comes from private sector vendors going it alone to provide a better tool to their customers. That emergence will happen and should not be squelched, which leaves Caltrans, and land surveying professionals with the option of simply adopting better tools as they become available and are best applied to one’s responsibilities, or promoting RTN as grander application -- the tool to access to the modern spatial reference system. RBF Consulting favors the latter with partnerships that outreach to a broad spatial referencing audience. There is really not a lot of reason for Caltrans to expend the effort of this investigation if the intent is not similar. Just like vendors are able to provide softcopy workstations, laser scanning instruments, and digital levels, the private RTN will be capable of faster and more reliable surveying and mapping with or without our intervention.

Parallel with RTN, cadastral and imagery/DTM databases are emerging as a major resource for planning, design and construction. In similar fashion, machine control systems are providing the ability to feed the databases with near real-time information directly from the field. The point being that making better faster measurements is becoming less important and possessing the knowledge and ability to successfully integrate real-world data sources is becoming more important. Enabling the spatial reference system datum through RTN satisfies this demand.

Caltrans is in a unique position in California – a very unique state in terms of geodesy and geophysics – to champion partnerships that promote a spatial referencing application. It is the opinion of RBF Consulting that Caltrans should be that champion in California.

2. Data Sharing Principles

RBF Consulting is a privately held professional services firm with offices throughout California and the Southwest, and projects across the nation and abroad. We routinely invest in technologies that promote the interests of our clients and that of the professions that we work within. The coordinated effort of RBF and Caltrans regarding the nationally acclaimed storm water quality program is a great example of a successful technical and political partnership. As RTN becomes available and offers value to our clients, RBF is able to, and will, implement it. Some of our investments in RTN are discussed briefly under Existing Partnerships. With that willingness and flexibility, it hardly matters what data streams become available. If it provides value, RBF will embrace it. As noted above, RBF Consulting believes that the greatest value from RTN will come as the enabling resource of the spatial reference system.
RBF Consulting favors a statewide RTN as the California Spatial Reference System (CSRS) reference network. The network should support the broad audience of users including surveying geomatics, GIS professionals, and geophysical research. It should also support private sector, value-added, networks from interested manufactures and vendors. The unique position of Caltrans should be applied to this goal.

Some of the conceptual aspects to a statewide Real-time Spatial Reference Network (RSRN) could include:

- Founded upon the latest accepted version of ITRF
- Leverage existing high-quality stations (e.g. PBO) to the greatest extent possible
- Provide for the ability to transform on-the-fly to accepted datum and epoch dates
- Provide the ability to deliver orthometric heights through modern geoid models (and local correctors until improvements negate the need)
- Freely deliver near-real-time carrier-phase data for post-processing
- Communication systems based upon common protocol and open-source data formats
- Provide various real-time service levels to constituent partners ranging from a) control coordinates for post-processing, b) streaming RTCM (BINEX or other open-source format) carrier-phase observables, c) network correctors, d) streaming geodetic modeling (e.g. geoid, velocity, troposphere), e) server-based network solutions

Levels c) through e) might be reserved for value-added partnerships (i.e. private networks). Basic foundational CSRS data and models should be free. As noted in the cover letter herewith, the non-technical issues represent the greatest challenges to a statewide RSRN. Foremost among these would be establishing governance that would encourage participation. RBF Consulting would welcome any governmental agency or public/private partnership that would assume the necessary governance role, including Caltrans. In the interest of staying ahead of the changes, a separate entity with a focused mission seems most appropriate. While there are well-founded questions about the ability of CSRC to take on such a mission, the Center has the professional and legislative standing to assume such a role. In that scenario, funding and sufficient independence are the critical issues. Without Caltrans, or some other state government sponsor, there will never be the stability to funding and political will necessary to assure potential partners.

Implementation of a RSRN must allow for partners to contribute and receive on an equivalent basis, and must not create unnecessary barriers to the partners creating and charging for additional value. Similarly, public agencies and academic institutions must be able to freely distribute data as appropriate to fulfill their mission and should not be excluded by cost-cutting measures on monuments or data security. Sub-networks would contribute data, money, telemetry and/or expertise in exchange for access to service levels and the ability to provide coordinates in compliance with the CSRS and Public Resources Code. The governing body would be able to negotiate partnership agreements and contract for the necessary communications and processing infrastructure. Perhaps a majority of the user data will flow from sub-networks and data providers that will offer turnkey solutions or the in-house core competence to manage projects within their sphere of responsibility. County public works
departments, as have contributed to CRTN, would ultimately replace local control networks and benchmarks with sub-networks. Networks could be added or dropped as individual needs change in different geographic regions, and the program could then be implemented incrementally.

3. **Existing Partnerships**

As acknowledged previously, RBF Consulting has participated in and supported CSRC since its inception. That partnership will continue as long as the Center supports excellence in professional practices and regional geodesy. In regard to RTN projects, RBF participates with various private networks where these have been found to meet the demands of our clients. We have hosted stations and purchased software and subscriptions from providers such as AZGPS, Leica SpiderNet, and RTD Client through SOPAC. We have also worked with the Las Vegas Valley Water District, the Port of Long Beach, Shea Properties, and Allen Instruments on base stations and telemetry.

Regardless of how the technology emerges, RBF Consulting will be an active participant in the development and implementation of RTN, particularly in California where the majority of our projects are located. With Caltrans in the top 5 ranking of RBF clients for the past three years, we are certain to continue the successful partnerships we have enjoyed. Collectively promoting a statewide RSRN is our common best interest.
Friday, August 15, 2008

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It is our intention that this be a response to a Request for Information (RFI) distributed by Caltrans dated July 7, 2007. Our objective with this response is to make Caltrans aware of our desire to work with Caltrans, thus fulfilling our commitment to expanding and improving our existing GNSS partner network. Every effort was made to answer each outlined point clearly and concisely with the intent to make this document a basis for a more specific framework.

In the interest of establishing a GNSS network for the Southwestern United States, Surveyors Service Company and Haselbach Surveying Instrument, both Leica Geosystems Acquisitions Inc. companies, see many benefits in working with Caltrans as a potential partner and we welcome the opportunity. Caltrans is certainly a surveying center of excellence in the State of California, and a partnership with Caltrans would provide a constant confirmation of quality to other users in the GNSS community. With Caltrans’ many remote locations around the state, a partnership with Caltrans increases the potential GNSS network footprint. The economic benefit of partnering with Caltrans can be measured in many ways, but primarily the ability of Caltrans to utilize a statewide contiguous network without having to develop and maintain the infrastructure would be a tremendous value not only to Caltrans employees but the various firms associated and working with Caltrans on various contracts.

Surveyors Service Company would provide error corrections in the form of MAX and/or VRS using standard RTCM message streams to Caltrans from any reference stations Caltrans desires, provided Caltrans can provide Surveyors Service Company with a raw data stream of the desired station. Surveyors Service Company is a private enterprise. We have several existing partnerships with public and private entities to provide network corrections.

To provide Caltrans with corrections, Surveyors Service Company would need at minimum a constant, consistent, and quality data stream from the reference stations targeted by Caltrans for the network. From this stream, we would provide Caltrans with various types of correction, as defined by Caltrans. Caltrans would provide Surveyors Service Company with a responsible liaison to communicate future development and a commitment to continue expanding the network. At minimum, we would need a real-time stream of data from the
reference stations, but a raw data stream from the reference station would allow Caltrans a complete list of service from which to select. We prefer to receive the data in the most direct way possible, which could vary for each reference station. We are able to receive data through TCPIP connection. The corrections would be provided to Caltrans using a NTRIP protocol via TCPIP, with an ability to add other mediums as needed. Partners’ roles in this venture could vary from partner to partner, but the overwhelming majority of partners would be users of the final GNSS correction. We do not believe that there are any complex legal issues to address other than those derived between a surveying instrument manufacturer and an end user. Since this service would be defined by Caltrans, the standards would be set by Caltrans and Surveyors Service Company would adhere to said standards. Licensing costs would be handled by Surveyors Service Company.

This partnership is capable of being administered statewide, and in fact is already operating in California and Arizona. We intend to provide service to Caltrans for the entire state of California.

Caltrans and Surveyors Service Company would develop a plan together, utilizing existing infrastructure and expanding in phases based on defined geographic needs, based on the needs of Caltrans, and the implementation of the plan would depend greatly on the plan itself. This partnership should be developed with a plan that sustains the life of modern GNSS usage for land surveying.

The partnership should be based on an annualized contract between Caltrans and Surveyors Service Company, with the resigning of the agreement always one year ahead of the current year. Usage of this network can be based on the agreement between Caltrans and Surveyors Service Company, however that is defined. Surveyors Service Company’s role will be as a service provider and will be fee based determined on the level of cooperation. Communication will be primarily email based; however Surveyors Service Company will provide a Caltrans specific, dedicated administrator for daily communication regarding this and other issues. The GNSS corrections developed by the GNSS network would be for sale.

Surveyors Service Company and Haselbach Surveying Instruments have over a dozen partnerships currently in place, to include entities such as David Evans & Associates, Guida Surveying Inc., Provost & Pritchard, Ruggeri, Jesen Azar, and City of California City. These and other firms provide Surveyors Service Company with either a reference station or a raw data stream in return for a network corrected message, and we welcome the opportunity to add Caltrans to our list of network partners in a mutually beneficial working relationship.
There appears to be some confusion on whether SOPAC and CSRC responded to the Caltrans RTN RFI. The SOPAC response was sent to you in the e-mail exchanges below -- Yehuda

Y Bock, 6-7-08:

Caltrans Colleagues,

The RFI that you are planning to circulate about RTN partnerships implies that Caltrans has some central authority over these matters (it is Caltrans-centric) and that Caltrans is willing and able to facilitate RTN partnerships.

What concerns me in particular is that despite the tremendous effort that was expended on the Central Valley network by CSRC in collaboration with and under contract to Caltrans the real-time data are still not available to us to distribute through CRTN. Data were available to us throughout the construction process but since the network became operational (a year ago?) we no longer have access to the data. To be honest, I haven't really followed up on that as I have been busy with other matters. CSRC staff were contacted recently and asked if we were still interested in having CVSRN data streamed to CRTN, but that there were still legal problems in doing so. We responded that the question was moot since Caltrans wasn't in a position to stream data regardless of what CRTN wanted. Has the situation changed? As far as I know, only Caltrans surveyors have access to CVSRN data.

I'm also concerned about a similar effort that is being organized by Caltrans in the San Diego region in collaboration with Trimble to set up an RTN. What's different with this effort is that there already is an operational network in place, which along with the remainder of southern California is the model (with some modifications) on which I based the statewide expansion described in the CRTN whitepaper. Any effort with State funds to try to replace what is already in place here with another system appears to be a waste of energy and funds. I admit that Trimble users using the standard RTK option have had some problems using CRTN but that appears to have been resolved (I learned this from Bill Haaf from Orange County at the CLSA/CSRC seminar in Ontario).

Why should we worry about a new SDSRN? After all it will only be available to Caltrans users. It is a clear waste of public funds in times when the state has a huge budget deficit (what else is new?). Also, it is being done without consultation with interested parties in the area. Finally, it is an attempt to expand the CVSRN project beyond the Central Valley in a backdoor manner, and all that entails.

We all know about the restrictive IT environment at Caltrans, as well as the ongoing legal problems to support real-time access to your data. I encourage you to seriously consider the CRTN white paper as a starting point for a statewide RTN under the CSRC umbrella that would also fully serve Caltrans' interests, before your circulate the RFI. The advantages of using the inverse network-RTK approach proposed in the white paper is that CSRC will be able to provide instantaneous real-time access to epoch-date, geodetic
coordinates and orthometric heights directly tied to the CSRS and NSRS, based on state-of-the-art reference stations built to survive earthquakes.

We have been expanding on the CRTN white paper based on feedback from the CSRC Executive Committee, and have a teleconference on the 16th of this month, followed by a meeting with some of you on the 20th in San Diego. We plan to have a fairly detailed proposal prepared by these dates, which could be circulated to potential partners for their comments.

Thanks,
-- Yehuda

D. Olander 6-10-08:

It would help me put these comments in context if I knew whom you are you representing in this communication.

Dave Olander

Y Bock 6-10-08

Dave,

I'm not sure what you mean. My remarks are my own.

My main motivation is to promote the ideas outlined in the CRTN White Paper, i.e., a statewide RTN with at least 80 km nominal spacing under the CSRC umbrella using a modified (open) CRTN as the model, with widespread use of existing SCIGN and PBO stations. As you know, the CSRC EC is discussing details of the White Paper and we at Scripps/SOPAC are preparing a detailed plan including budget, cost recovery through partnerships, governance, etc.

I hope that Caltrans will become a major partner in this endeavor and not be distracted or distracting by superfluous efforts.

Thanks,
-- Yehuda

D. Olander 6-10-08

with responses from Y. Bock 6-10-08 in italics

Of course the statements are your own, but you did write 'we' and I didn't want to presume which groups that may be referring to. In regards to the paragraphs partially quoted below, there may be some different interpretation, and I take what you write very seriously, so I don't want to misunderstand where you are coming from.

"we no longer have access to the data"
We being SOPAC?
-- SOPAC who runs CRTN and CSRC (who partnered with Caltrans on CVSRN), and therefore the RTN community collectively (except Caltrans surveyors)

"Why should we worry about a new SDSRN?"
We being the RTN community collectively, SOPAC or CSRC?

-- all of the above since "we" will probably not have access to these superfluous data

"We have been expanding on the CRTN white paper based on feedback from the CSRC Executive Committee"
We being CSRC?

-- Scripps/SOPAC for presentation to CSRC EC and potential partners

The "We" appears to be referring to you individually and different groups at different times, I was hoping that I would be able to frame these comments from one perspective.

-- Sorry but I happen to be Director of SOPAC and CSRC.
Trimble Navigation’s Response to RFI 070708

Real-Time GPS/GNSS Data Sharing for the State of California

Contact:  Pierre Desjardins, Business Area Manager | GNSS Infrastructure

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Trimble Navigation is the leader in the development of RTK technology and is committed to the long term success of providing the most robust products and services available to meet our customers’ needs. Because of our extensive experience designing, building and operating commercial networks world wide, such as Trimble VRS Now™, our insight into the complex nature of the business of real time networks is extensive. Therefore, we have significant concerns about the long term stability and usefulness of this real time network proposal and the resulting negative impact to the industry as a whole if it is not implemented and managed in a way that best suits the needs of the user base.

The newly proposed CSRC structure for borrowing and using data sources from various locations raises many red flags. First, it will have a significant impact on the adoption and retention of RTK users in California. Second, with no clear management structure overseeing the quality and management of this data, the overall quality will be compromised and end users will not receive the results that they need to do their job efficiently. Third, it poses a conflict of interest for the use of tax payer dollars to be used in a commercial network. Finally, there is no consideration for the future or the potential issues that will occur in the next 3-5 years.
In our experience from operating networks world wide, we know that the quality of a VRS corrector is the highest quality solution available today. In a mixed network scenario, we have found that raw data cannot be shared easily due to the inherent differences in data structure that occurs from hardware created from different manufacturers. Data sources may be pre-processed, contain less content or data points, or may vary in overall quality, creating misleading, inaccurate results. In contrast, those networks that contain only Trimble receivers produce consistently better results than those with a mixed bag of outdated and less technically sound hardware and software. Not only is the data reliability and quality better, but the overall cost of running and maintaining a Trimble only system is much lower.

To successfully manage a network, there must be a defined and supported structure for operations and support. A unified Service Level Agreement among the providers would be required to address several issues including, but not limited to:

1. Who is responsible if a station goes down?
2. Who guarantees the accuracy and quality of the data?
3. Who administers the system?
4. Who hires and trains the staff?
5. Who insures that obsolete and older equipment is updated?
6. What data types/formats would be supported?
7. Who operates the system?
8. Who pays for what if it goes down?
9. How do we secure the data?
10. Who would oversee the whole process?

Without a defined plan to support and operate the network, the network would fail.

In addition, the suggested mixed use private/public ownership model creates a significant conflict of interest for those networks that were funded in the public sector with tax payer dollars. It also does not fit a business model found in similar applications such as telephone communications, electrical and gas utilities and will put small businesses at risk in the state of California. Ignoring the impact on existing commercial businesses, as well as the need for a network solution that provides a reliable, high-quality service, is a risky and irresponsible path to take.
Finally, the future must also be considered when undertaking an effort such as the one proposed by CSRC. Eventually, the users of the California network will require a GNSS corrector that contains both GPS and Glonass sources to improve geometry and redundancy in urban and natural canyon areas. With a mixed consortium of network components, that may or may not work with Glonass, the complications are obvious. In addition, CRTN proposal poses additional topics for concern. As we approach 2012, the increase in ionospheric activity will affect positioning results and reliability. Those skilled in this technology understand that spacing the stations 80 km apart in this environment will have a big impact on the overall quality of the data. It is very disturbing that this shortcut has been proposed yet no consideration has been taken to assess the impact this would have to the user base. The second issue involves the proposed “server side solution”. To date this approach has been tried unsuccessfully, providing unreliable results that do not meet international standards. This experimental approach would conflict with Trimble’s standards for providing the highest quality solution available on the market today.

Experience has shown us that the end-user’s expectations are high when it comes to adopting and using a real time network solution. If a real time network solution is to be accepted by the positioning industry, the service provider must be able to provide a state-of-the-art network service, with reliable, high quality data.

Looking throughout the world at GNSS real time network adoption, California may want to consider taking a leadership position in the U.S. and develop its own statewide GNSS RTK network like so many other countries have done. Emerging economies such as Malaysia, New Caledonia, and China, among others, have worked with Trimble to develop a custom solution to meet their specific needs. This has proven to be the most efficient and cost-effective approach to implementing a real time network solution and the one that poses the best opportunity for success.

In conclusion, without a high level of guaranteed service and quality data, the entire industry is at risk. The commercial interests of committed service providers will be jeopardized, resulting in a significant setback in the acceptance of modern real time networks in California. Trimble is committed to ensuring the long term success of RTK in this industry and is interested in developing a solution meet the needs of all interests involved.
UNAVCO/PBO Response to RFI

Real-Time GPS/GNSS Data Sharing
For
The State of California
Department of Transportation

August 7, 2008
UNAVCO’s Plate Boundary Observatory (PBO) runs a network of over 400 continuous GPS stations in California and could potentially be a major provider of real-time GPS data to both public and private users in the state. Although real-time GPS data streaming does not contribute directly to PBO’s scientific mission, PBO has been operating a pilot program to provide to the public real-time GPS streams from a small subset of stations. Our experience with this program indicates that we are technically capable of streaming real-time GPS data from our continuous stations using existing telemetry.

UNAVCO’s role with regard to any real-time data sharing partnership would be strictly as a provider of real-time GPS data streams. As part of its pilot program, PBO streams real-time GPS from over 50 stations in California, primarily in the Bay Area, the Los Angeles region, and just south of the Salton Sea (http://pboweb.unavco.org/?pageid=107). Additional stations could be added to this real-time network, although UNAVCO has neither a mandate nor resources to undertake such an effort at the present.

PBO’s publicly-available streaming data is provided exclusively via the NTrip protocol, from servers located at UNAVCO headquarters in Boulder, CO. The formats supported are BINEX and RTCM 2.3 at 1 second sampling, with RTCM 3.0 to be added in the near future. PBO has no plans to make available other formats. Access to PBO data streams is currently unrestricted and users are free to rebroadcast these streams provided they do not charge for these services.1

UNAVCO is a non-profit company whose position as a provider of publically-funded data and services to the geodetic science community requires it to maintain strict standards of neutrality and open access. UNAVCO must also ensure that any expansion of streaming data services does not impact its core mission of providing higher-latency data to the scientific community. UNAVCO’s participation in any real-time data sharing partnership is therefore contingent on 1.) open access of shared data to the public, 2.) its ability to share on identical terms the same data with entities or individuals outside the partnership and 3.) resources to fund the additional IT infrastructure and personnel required for taking PBO real-time operations beyond the pilot project stage.

We at UNAVCO are supportive of efforts by state and other agencies to expand and simplify access to real-time GPS data beyond the current patchwork system of networks and standards. We hope that the information we have provided here can help Caltrans to better plan its future activities in this area.

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1 The entire UNAVCO streaming GPS data policy can be found at: http://pboweb.unavco.org/dmsdocs/Root%20Folder/Data%20Management/Software/UStream/DataStreamingPolicy.pdf