IRIS NEWSLETTER

INCORPORATED RESEARCH INSTITUTIONS FOR SEISMOLOGY

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SAMPLE ISSUE
April, 1989

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April, 1989

Memo to: Interested Seismologists
Subject: Mailing List
From: Stewart W. Smith

As many of you know, IRIS is a 61-member consortium of U. S. universities funded by the National Science Foundation to develop global and portable seismographic networks for the research community. We publish an annual report and newsletters, and would like to insure that this information is widely available. This is a sample issue of IRIS Newsletter based on the regular issue from December, 1988. If you are interested in receiving this type of information on a continuing basis, at no charge, please return the enclosed postcard, giving your preferred mailing address. I'll use the rest of this memo to give you a brief update on other IRIS activities.

Global Seismographic Network (GSN): The new digital station processor developed for IRIS has been completed and is undergoing final tests at the USGS Albuquerque laboratory. It features a 24-bit digital encoder, disk buffer, telephone dial-up capability, and generally all the features that were planned in 1985 with the publication of the report entitled "Design Goals for the Global Seismographic Network." Ten of these systems will be purchased this year for installation in early 1990. Prototype versions that provide dial-up capability are operating at Harvard (HRV), Caltech (PAS), and Hawaii (KIP), and have already been used remotely by a variety of researchers to access data from recent earthquakes.

While awaiting the new instrumentation, several WWSSN stations which have been upgraded with Streckeisen seismometers are now operating at COL, KEV, AFI, TOL, and CTAO. As part of the IRIS program, new digital broad-band stations have been installed at IDA Network sites PFO, RPN, ESK, and NNA. In a cooperative program with the USSR Academy of Sciences, five broad-band digital seismographs have been installed in the USSR at Obninsk, Garm, Arti, Kislovodsk, and Irkutsk. This project was carried out by the University of California at San Diego. Data from these stations, as well as all the other stations in the IRIS program, will be available through the IRIS Data Management Center. This data will also appear on the USGS network day volumes, and selected events will be distributed by the USGS on CD-ROMS.

Data Management Center (DMC): The prototype data management system is being developed at the University of Texas Institute of Geophysics and Center for High Performance Computing. The interim system that will enable access to blocks of data by means of a user interface developed at Lamont-Doherty will be operational in the very near future, and information on its use is now available on request. The next phase is the incorporation of a flexible database management system. This system will initially provide access to data by station time-windows. Access to the database through events and event-station midpoints will be made available at a later date.

We expect that users will request information by sending electronic mail messages to the DMC using NSFnet. Most requests will generate data sets sets too large for electronic transmission, so most data will be sent by physical medium such as 1/2" tape or digital audio tape. An electronic bulletin board will soon be available at the DMC, and current information about data holdings and DMC projects will be available on it. Seismologists interested in receiving information about this bulletin board should send a note to Tim Ahern at IRIS (tim@iris.css.gov).

Program for Array Studies (PASSCAL): Field tests involving 10 prototype PASSCAL instruments as well as a number of other portable systems have been carried out at Parkfield, California, in the Nevada Basin and Range experiment, and in New Mexico. The next 35 PASSCAL instruments, which incorporate changes and improvements resulting from these field tests, have been ordered from REFTEK for late Spring delivery. Several experiments utilizing these new instruments are planned for Summer and Fall, including teleseismic recording in the Canadian Shield, air-gun recording in Greenland, and wide-angle reflection work in Alaska. More details on these experiments will be available in the next edition of the Newsletter.

PROGRESS ON THE EDGE PROJECT

by Manik Talwani
Houston Area Research Center
and Rice University

A two-year EDGE proposal, a modest version of the original five-year plan, was resubmitted to NSF in 1987, and has recently been funded jointly by NSF's Ocean Science and Earth Science Divisions. Additional support for acquisition operations off the East Coast, and possibly also in the Gulf of Alaska, has been promised by an oil company. More industry support may be forthcoming. Nonetheless, funds in hand permit acquisition of only two of four previously planned transects.

One of the transects will be in the Gulf of Alaska and will run from the magmatic arc (in the vicinity of St. Augustine volcano) to the Aleutian Trench. The transect will examine the accreted sedimentary complex landward of the trench, which has defied penetration during earlier surveys utilizing low-power sound sources, and may also shed light on the "plumbing" complex feeding recent eruptions of St. Augustine. The second transect will be off the Middle Atlantic portion of the East Coast and will examine offshore extensions of Paleozoic (i.e., Appalachian) and Mesozoic structure related to the collision and separation of Africa and North America, and the early evolution of the North Atlantic. Each transect, which will consist of at least one dip line and possibly one or more strike lines, will be approximately 300-500 mi in length.

The EDGE transects offer short term as well as long term scientific opportunities for ancillary work with ocean bottom seismometers along the transects and seismic group recorders on land. In the short term, the presently planned EDGE transects could be supplemented by such experiments. In the longer term, more comprehensive plans could be developed for OBS's and land seismic group recorders to complement a more comprehensive EDGE proposal that we plan to submit in 1990 for work in 1991 and later years.

EXPERIMENT NEWS FROM CALIFORNIA

by David Okaya

Upcoming CALCRUST Field Acquisition

The CALCRUST crustal studies group will return to the field this spring in order to collect seismic reflection profiles in the Colorado River region of the Mojave-Sonoran deserts. Four sites for seismic profiles have been selected near the Whipple Mountains metamorphic core complex, of which each addresses a specific geologic problem. The new profiles will complement CALCRUST and industry profiles which exist within the region.

The planned seismic profiles were selected to address the following topics: (1) the possible tie of mid-crustal reflections to nearby outcrops within the core of the Whipple Mountains; (2) extend Whipple Mountains exposures to the northeast in order to tie with an existing industry profile in the direction of the Colorado Plateau; (3) examine regional extent of mid-crustal reflectivity by tying into four industry profiles located three valleys west of the Whipple Mountains; and (4) to image the structural relationship between the Whipple and Chemehuevi Mountains detachment faults.

These seismic profiles will be collected with high temporal and spatial resolution in mind. Also to be collected are research field tests in order to understand field acquisiton problems and piggyback recordings using the profile sources. A possible piggyback experiment is to record intermediate- to critical-angle reflections in order to image a Moho root under the Whipple Mts as postulated by the USGS PACE program.

CALCRUST welcomes interaction and will try to accomodate those wishing to conduct piggyback or other experiments during the same period of field work. For information regarding profile locations or experiment design, contact David Okaya at LBL (okaya@ccs.lbl.gov) or at USC (okaya%sei@kylara.usc.edu).

Continuation of Cajon Pass VSP

NSF has provided funds to complete to total depth the Cajon Pass scientific drillhole VSP survey by Tom Henyey-Peter Leary (USC) and Tom McEvilly (UCB/LBL). P- and S-wave sources will be used in a multi-offset, multi-polarization survey designed to investigate structure, rock properties, fractures and S-wave anisotropy (stress/fracture-induced). Results of the preliminary VSP survey are given by Daley et al. in the recent GRL supplement focused on the Cajon Pass drilling project (GRL, v. 15, 1001-1004). The VSP experiment will be conducted within the next nine months, depending on the availability of tools.

SEISMIC PROCESSING PACKAGE PURCHASE

by T. Ahern & J. Fowler

IRIS has purchased a commercial seismic processing package from Sierra Geophysics for its field computer systems. As part of this purchase agreement, IRIS will be able to make the system available to IRIS members at substantially reduced costs. IRIS will cost share 50% of the cost for the SierraSEIS Basic package and pay the yearly maintenance fee for systems which run on the hardware outlined below.

The IRIS package is subject to the following constraints:

1. SierraSEIS can be run on SUN 3 or SUN 4 workstations running UNIX or a Microvax II workstation running VMS.
2. The minimum hardware configuration is:

   - 4 megabytes of memory
   - 500 megabytes of disk
   - Monochrome monitor
   - Versatec V80 compatible hardcopy plotters.

   SierraSEIS is capable of supporting the following peripherals:

   - EXABYTE 8mm helical scan data cartridge
   - Floating point accelerator boards
   - SKY Warrior array processor or comparable AP
   - Versatec 22" or wider hardcopy plotters or compatibles
   - Color Monitors
   - 1600/6250 BPI tape drives.
3. All software distribution and maintenance will be handled through a central IRIS facility. All communications between Sierra and IRIS will be via the designated IRIS central site.

IRIS members with different hardware configurations may still want to purchase systems through IRIS in order to take advantage of the cost savings associated with the central maintenance agreement. Each of these agreements will have to be negotiated with Sierra separately.

IRIS SIERRASEIS PACKAGE

The BASIC package includes routines for

- -Job Control
- -Demultiplexing of all SEG standard tape formats
- -Data input from either tape or disk
- -Plotting on either Versatec hardcopy devices or CRTs
- -Data output to either tape or disk
- -Geometry specification
- -Vibroseis correlation
- -Predictive deconvolution
- -Pulse shaping deconvolution
- -Field statics corrections
- -Semblance velocity analysis
- -Velocity panels
- -Space variant normal moveout correction
- -Trace editing (kills, reversals, muting, spike removal)
- -Sorting of data
- -Scaling of data
- -Stacking of data
- -Space and time varying frequency filtering
- -Residual statics corrections

-Synthetic data generation
-Utility routines to aid in processing

SierraSEIS EXTENSIONS

Wavelet Processing
Special Deconvolution
Migration
Amplitude vs. Offset
FK Filtering
Field QC
Pseudoacoustic Impedance
Seismic Attribute
Coherency Filter
Velocity Analysis
Median Stack

Additionally Sierra will make a product called SierraSET available to IRIS members. SierraSET is a collection of of software engineering tools that support:

- a user interface system (menus, pointing devices, etc)
- generic I/O interface (tapes and disks)
- graphics capabilities
- standard database and file interface

SierraSET allows true portability of applications between any Sierra supported computer systems. A programmer developing an application on a Microvax for instance can easily port the code to a SUN workstation. These tools can assist in the exchange of software between IRIS institutions.

IRIS members that are interested in purchasing SierraSEIS BASIC, SierraSEIS EXTENSIONS and/or SierraSET should notify Tim Ahern (tim@iris.css.gov) or (206) 543-9024. Clearly indicate which products you have interest in and clearly state what hardware configuration you have. Please feel free to contact IRIS if you have any other questions related to this matter. We anticipate placing as many SierraSEIS packages in as many IRIS institutions as express interest.

UC BERKELEY/LBL SEISMIC COMPUTING UPGRADE

by David Okaya

UCB/LBL has completed installation of the SierraSEIS and Geowell seismic processing packages on a new CONVEX C1-XP computer at their Center for Computational Seismology (CCS). SierraSeis is geared to process seismic reflection data; Geowell handles VSP data. The CCS serves researchers at Berkeley in a broad variety of seismological studies, in addition to providing seismic data processing capability to members of the CALCRUST consortium.

CCS is the first academic site for installation of the SierraSEIS software package. In this role, CCS researchers have worked closely with Sierra Geophysics in order to obtain a smoothly operational processing package. CCS is adding functionality to allow SierraSeis to handle other types of seismological data and will work with Sierra to properly install the added features. For more info regarding SierraSeis, contact David Okaya or Tom McEvilly at LBL (okaya or mcevilly @ccs.lbl.gov).

Technical Report on Optical Disk Technology
and the Archiving of Times Series

by William Menke, LDGO, Palisades, NY 10964

This report describes LDGO's experience with archiving geophysical data (including earthquake time series) on a write-once optical disk.

1. Hardware configuration.

The LDGO system consists of an ethernet-based local area network of about 75 UNIX-based computer workstations that use the Sun Microsystem's Network File System for sharing files. The Write-Once, Read Many times (WORM) disk is a Sony Corp. model WDD-2000 disk drive and model WDC-2000 disk controler attached to a SCSI interface on a Sun 3/180 computer. The WORM drive uses 12 inch cartridges that can store 1.6 Gbyte per side. The Sun 3/180 is equiped with magnetic disk storage as well. We are using Advanced Technology System's (ATS, Vienna, Virginia) UNIX driver software, which provides a standard UNIX file system for the WORM disk. The total cost of WORM system (including driver and SCSI interface) is about $23,000. A two-sided disk cartridge costs $360.

2. Description of the ATS driver.

The ATS driver (called LCACHE) provides UNIX file system emulation for a WORM drive by maintaining a updatable mapping between UNIX block numbers and physical WORM block numbers. An attempt by UNIX to overwrite an existing block results in the allocation of a new block and the updating of the mapping table. All UNIX commands including user commands such as LS (list directory), RM (delete file), OPEN (open a file), READ (read from a file), WRITE (write to a file), and system utilities such as MKFS (make file system) and FSCK (file system check) function normally, although certain operations waste disk capacity.

The disk drive is operated in the following way: A new cartridge is initialized by a OLABEL command. The OSTART command creates write-cache and block mapping files (the "lcache flush structure") on magnetic disk and in memory. MKFS (make file system) is then used to build a UNIX file system on the disk, and the file system is mounted on the host computer with the MOUNT command. The disk can then be written and read as if it were a magnetic disk. We typically copy files to it using CP (copy) and achieve NFS transfer rates of about 1 Mbyte per minute. All writes are cached to a 4 Mbyte magnetic-disk cache, with the driver automatically handling occasional transfers to the optical disk. Reads are uncached. After dismounting the file system with UMOUNT, the cartridge can be removed form the drive in two ways: by using the OFLUSH command, which writes a copy of the block-mapping table onto the optical cartridge, and by using OSTOP command, which leaves the block mapping table on magnetic disk.

3. Databases.

We have experimented with storing and retrieving a variety of data on the WORM drive including:

A. Earthquake hypocenter databases consisting of several hundred thousand earthquake records, each consisting of about 100 bytes of information. The data are indexed by geographical location. Typical retrieval rates are about 1000 records per minute, as compared to 2000 records per minute for magnetic media. This performance is deemed acceptable for most applications.

B. Images of about 1 Mbyte in size. Access rates seemed to be controlled by NFS speeds and not the speed of the WORM.

C. UNIFY relational databases. UNIFY and the ERIC routines function normally (for read-only operations) on the WORM drive, with a reduction of speed by about a factor of 3 compared to magnetic media.

D. Earthquake times series. We have prepared a disk containing about 3 years of Global Digital Seismic Network (GDSN) earthquake event tapes, converted to LDGO's standard time series format (AH format, consisting of concatenated single-channel time series, each with a 1 Kbyte header followed by floating point data). We first tried a directory structure of the format:

```
/optical_disk/tape/event/station.component
```

Thus each file consisted of a single AH time series of one component of one station, with about 15,000 files per year of data. This disk performed very poorly during writing, being both slow and wasting about 50% of the disk capacity, presumably because the directory and inode tables on the optical disk were being extensively modified during the copy of so many files. We then tried a directory structure of the format:

```
/optical_disk/tape/event
/optical_disk/tape/event.list
```

where the event file was a concatenation of all AH time series for that event and where the event.list file indexed the contents of the event file (to speed access during read). This method performed very well, with less than 10% of the disk capacity being wasted. Reading was accomplished by building an auxillary relational database, containing parametric data from each time series and the time series pathname, and then passing the results of a query to the parametric database to a program that would extract the times series from the optical and concentrate them into a temporary magnetic disk file. This method performs well, with 100 time series recovered in less than 2 minutes.

4. Problems.

A. The UNIX file system is not really set up for removable media like optical disk cartridges. One needs superuser authority to mount and dismount volumes, which is a bit inconvenient. Furthermore, one mounts the device, not the cartridge, so that there is no built-in way to keep track of which cartridge is in the drive at any given time. One would really like a system similar to that is used on Apple Macintosh for diskettes: Once a diskette has been mounted, the system keeps track of its name, which is an attribute of the diskette not the drive. The system maintains a table of what volumes are currently mounted in the several available diskette drives. If an unmounted diskette is needed, then the system prompts for the user to insert the diskette into whatever drive is convenient, possibly ejecting a mounted cartridge if no empty drives are available.

B. We occasionally find file system errors on our optical disks. These are usually of the type identified by FSCK as "Missing Cylinder Group N", and can be fixed relatively easily. We have not been able to determine their source.

C. The ATS driver has some minor problems:

a. Part of the driver exists as a separate process running in user space, which leads to some problems: 1) If this process dies for any reason, then the operation of the optical disk hangs. 2) If the network fails due to a power interruption, and all the workstations reboot simultaneously, then they usually mount the optical disk incorrectly, since the shell script that does an "lcache&; onstart; mount..." on the worm-drive host computer may not have executed prior to the "mount -nsf ..." on the remote workstation. The remote workstation therefore mounts an empty mount point.

b. Since part of the block-mapping table (the "lcache flush structure") is in memory, a system crash can lead to corruption of the optical disk file system. We therfore normally write to the disk only at well-controlled times (that is, times of low usage), keeping it mounted as a read-only volume at other times. The disk cartridge also has a write-protect switch, which normally keep set.

c. No provision has been made for a write-protected optical cartridge. If you try to OFLUSH a write protected optical cartridge, LCACHE generates an endless set of error messages (which cannot easily be stopped). If, on the other hand, you OSTOP an optical cartridge, then you must manually delete the cache files before OSTARTing a new cartridge, or LCACHE gets confused. But LCACHE then takes several minutes to build a new cache file.

d. Other workstation processes are severely slowed down during the automatic transfer of the cache to optical disk (which can take 3-4 minutes)

e. The automatic cartridge eject after an OSTOP/OFLUSH is not correctly implemented, and one must use the emergency-eject button on the drive instead. This can lead to major disasters in a multi-user environment.

f. The OSTAT command is improperly implemented, and gives the wrong number of blocks remaining on the disk. OSTAT does not work when executed by someone without superuser privilege.

g. Most lcache command (OSTART, OFLUSH, etc) write messages on the system console but not on the console on which the command was executed. This behavior is very inconvenient in a network environment, since one often accesses the worm-drive host by a remote network login (via rlogin).

h. No provision is made for the possibility of unexpectantly running out of free blocks on the disk. One possible fix is for lcache to reserve enough space at the end of the disk for a final lcache flush structure that is written only when the operator explicitly oflushes the volume. If the operator then had a means for ostarting with the n^{th} flush-structure on the disk (possibly a command line argument in the ostart command, "ostart -f n"), it would be at least possible to recover some of the data on the disk.

PASSCAL INSTRUMENTATION

by Jim Fowler

INSTRUMENT TESTING

The first five prototype PASSCAL Instruments were delivered to the University of California Santa Barbara in April 1988. These instruments were constructed by Refraction Technology under an IRIS development contract. Peter Malin at the Institute for Crustal Studies of the University of California Santa Barbara acted as Principal Investigator in a project to use the instruments in a field test at the Parkfield site. In addition to the REF TEK instruments there were 12 other instruments from four other manufacturers to be tested. These instruments included 5 EDA PRS-4's, 5 Sprengnether DR-2000's, 1 Kinemetrics SSR-1, and 1 Teledyne/Geotech PDAS-100. The objective is testing additional instruments was twofold. First we wanted to look at the instruments which could possible fulfill our needs for a "simple" instrument, that is, a three channel system with fewer capabilities than the PASSCAL instrument, but at roughly half the cost per channel. The Kinemetrics, EDA, and Sprengnether instruments were purchased with this goal in mind. Second, although Refraction Technology was the successful bidder on development of the PASSCAL prototype, and we have an option to purchase 100 production units when they have passed acceptance tests, it seemed prudent to keep track of other competing developments for instruments that meet the PASSCAL design objectives. With this in mind, we purchased the Teledyne instrument for testing and comparison.

The Parkfield program ran from May through the middle of August. All of the instruments in this program were either prototypes or from the first production run. Therefore, in addition to the problems associated with trying to operate five different types of instruments, there were problems associated with the fact that the instruments were "new" instruments. Despite these problems, many things relating to operating instruments in a PASSCAL type experiment were learned. A complete evaluation of the instruments will be available after the completion of the test program. However, as a result of the initial tests, the following observations can be made:

- For closely spaced stations accurate timing between instruments is an absolute necessity. The preferable way to achieve this is to have each of the instruments synchronized to some sort of timing signal. If this is not possible, then it is necessary to have a quick and easy way to accurately set the time in the instrument.
- It is difficult for a small crew to operate many different kinds of instruments in the field at the same time.
- For instruments with large memories(1MByte or greater) it is imperative to have a high speed data transfer capability.
- Having a quick-look capability in the field is extremely useful.

Table I shows a comparison of the instruments as they were tested by the University of California Santa Barbara. Since this testing was completed we have received a new instrument (IDS-3602) manufactured by Terra Technology. Information on its capabilities will be included in the final testing report.

The instruments test program includes a series of laboratory tests to be conducted by the University of California Los Angeles, and further field tests to be conducted by Texas A&M University and New Mexico Institute of Mining and Technology.

PASSCAL INSTRUMENT

The PASSCAL Instrument as constructed by Refraction Technology Inc. represents a significant change in portable seismic instrument technology. This instrument was designed to record everything from conventional seismic reflection profiles to long-term broadband deployments in support of the Global Seismic Network. The instrument, the auxiliary recording system and the field computer were designed to enable a small group of researchers to support a large number of instruments in the field at one time.

The PASSCAL System consists of four major subsystems. Figure 1 shows a diagram of the PASSCAL System Components.

TABLE I					
Specifications of Instruments Tested by UCSB					
	REF TEK	Teledyne	Kinemetrics	Sprengnether	EDA
	DAS 72-02	PDAS-100	SSR-1	DR2000	PRS-4
Input sampling rate/ch	1000	1000	same as out	same as out	200
Max sample rate/ch @3ch	1000	1000	200	250	200
RAM storage cap and type	5.1MB static	4.5MB static	1MB static	1MB static	1MB dynamic
Mass Storage	2GB tape	Laptop PC	Laptop PC	laptop PC	PC
Channels	6	6	3	3	3
Aux channels	0	1	1	0	1
State of Health infor	yes	yes	no	no	no
External clocks as tested	GOES	none	none	none	none
Internal clock	DCXO	DCXO	TCX)	TCXO	TCXO
A/D resolution (bits)	16	16	16	12	12
Trigger modes:					
Threshold level	yes	yes	yes	yes	yes
STA/LTA	yes	yes	yes	yes	yes
Continuous	yes	yes	yes	yes	yes
External	yes	yes	yes	yes	yes
Murdoch-Hutt	no	yes	no	no	no
Timed windows	yes	yes	yes	yes	yes
Gain Ranging	no	yes	no	yes	yes
Fixed gain	yes	yes	yes	yes	yes
Dynamic range (Gain ranging)		138dB		120dB	126dB
Dynamic range (fixed)	96dB	96dB	96dB	72	
Preamp gains (dB)	0-72	0-60	0-60	0-60	
Multiple Data Streams	8 any comb	1 trg + 1 cont	1 trg + 1 cont	1	1
Max input signal	7.5 v PP	2 v PP	2.5 v PP	10 v PP	10 v PP
Power	1.85 watts	2.5 watts	1.5 watts	1.6 watts	2 watts
Data Xfer speed	2 MB/min	.5 MB/min	.125 MB/min	.06 MB/min	<1.8 MB/min
Weight	45 lbs	40 lbs	36lbs	22 lbs	12 lbs
Approx price	$15,000	$15,000	$11,000	$7,000	$4,000

The Data Acquisition Subsystem (DAS) is the basic recording subsystem. It takes the signals from up to six sensors and digitizes the signal, performs event detection when necessary and stores the data in an internal 4 Mbyte memory.

The Time Keeping Subsystem mounts on top of the DAS unit and provides an external clock signal which synchronizes data samples to a common time base. The specifications for the timing system call for an array of recorders to be synchronized relative to one another to within 1 ms. The absolute time accuracy is to be within 10 ms of Universal Time. A GOES receiver and two types of Omega receivers are being tested.

The Auxiliary Recording Subsystem (ARS) is currently a portable tape unit which is carried to the field to collect data from multiple DAS units, thus permitting them to remain installed in the field. The ARS utilizes a helical scan tape unit which can store 2000 Mbytes of data on a tape. By utilizing the SCSI port available in the ARS, it is possible to change to new mass storage units as technology improves.

The final part of the system is the Field Set-Up Terminal. This is a small hand-held terminal which will be carried to the field and used by the operator to communicate with both the DAS and the ARS. The operator can down-load all of the set-up parameters, run self-checks and calibrations, and modify instrument performance through this unit. It can be used to display data, check geophone installation, and check general system performance. Two different types of terminals are supported. The first is the Epson Terminal which is a small light weight unit which can easily be used in rugged terrain. The second is laptop PC.

The DAS has six input channels. If channels 4-6 are not being used the supply voltage to the analog section of these channels is turned off to save power. Each of the six channels is sampled with 16 bit resolution at a rate of 1000 samples per second. The signals are then passed to the Digital Signal Processor where they are filtered and decimated to the final output sample rates for the various data streams. The Digital Signal Processor operates with 32 bits of resolution, thus through the process of filtering and decimating it is possible to have more than 16 bits of resolution at the lower sample rates.

The concept of the Data Stream is unique to this instrument. The instrument can handle up to eight data streams. Each data stream consists of from one to six input channels sampled at a given sample rate and activated by a specified trigger. As an example Data Stream 1 could consist of channels 1-3 sampled at 200 samples per second with an event trigger designed to local events. Data Stream 2 could consist of channels 1-3 sampled at 20 samples per second with an event trigger designed for teleseismic events. Data Stream 3 could be channel 1 recorded continuously at one sample per second. There is no restriction on which input channels can be connected to a given data stream. All channels in the stream will have a common sample rate in that data stream. There are several different triggers which can be used to activate a data stream. These are:

- Event trigger,
- Radio or External trigger,
- Timmed trigger,
- Continuous trigger, and
- Cross trigger.

The cross trigger allows one data stream to be triggered by the activation of a trigger on another stream. With this concept, each data stream is like having a separate instruments in the field. It is possible to conduct multiple experiments within a single instrument.

Another different feature of this unit is in the fact that the sampling is synchronized to an external clock if one is present. In the past, when an external clock was present it was recorded on an auxiliary data channel, and any timing corrections were made during post-processing. Because this correction is a labor intensive task, it was not always done. The PASSCAL instrument is synchronized to the clock. Each sample is time tagged with the correct time as it is taken. Thus all of the data have the correct time as they are read into the field computer. This type of system is a necessity if many instruments are to be deployed at a single time.

The PASSCAL Instrument is designed with a Small Computer System Interface (SCSI) port as standard feature. This port gives the instrument the capability to be used in many different types of environments. The port acts as the standard upload port for data to be transferred from memory to the ARS. The speed of this transfer is extremely fast and a typical upload of 4.5 Mbytes to the tape recorder takes about 2 minutes. The port also allows SCSI devices to be installed in the box for long-term deployments. Five of the prototype units have 200 Mbyte disks installed in the battery compartment of the unit. In deployments where external power such as solar cells is being used, the disk gives the unit about 200 Mbytes of storage. This allows service intervals to be extended to once every two to four weeks. The disk is powered only when it is being written to, so that the overall increase in power necessary to operate is minimal. The data can be uploaded to the tape unit by execution of a SCSI copy command. This can take place quickly without the need of CPU intervention of the recording system.

The SCSI port allows the PASSCAL instrument to utilize any mass storage system that has a SCSI port. Currently this includes magnetic and optical disks as well as several different tape units. The major market for this technology is PC industry so that developments are rapid and we can take advantage of the cheaper pricing of this market. The PASSCAL instrument is not tied to any one kind of mass storage medium. Currently none of the mass storage units are specified to operate below freezing, therefore, if the units are to be deployed in freezing conditions it is best to plan on using the solid state memory as the recording medium.

Two additional features of the system are first all non-data related happenings including operator communications are logged in a State of Health channel with the data. This State of Health channel is uploaded with the data and it provides a record of what went on in the instrument. Secondly, all communications between the Hand Held Terminal including uploading of the data can be accomplished without stopping data acquisition. This allows the operator to check instruments a look at event directories without interfering with the data gathering activities of the instrument.

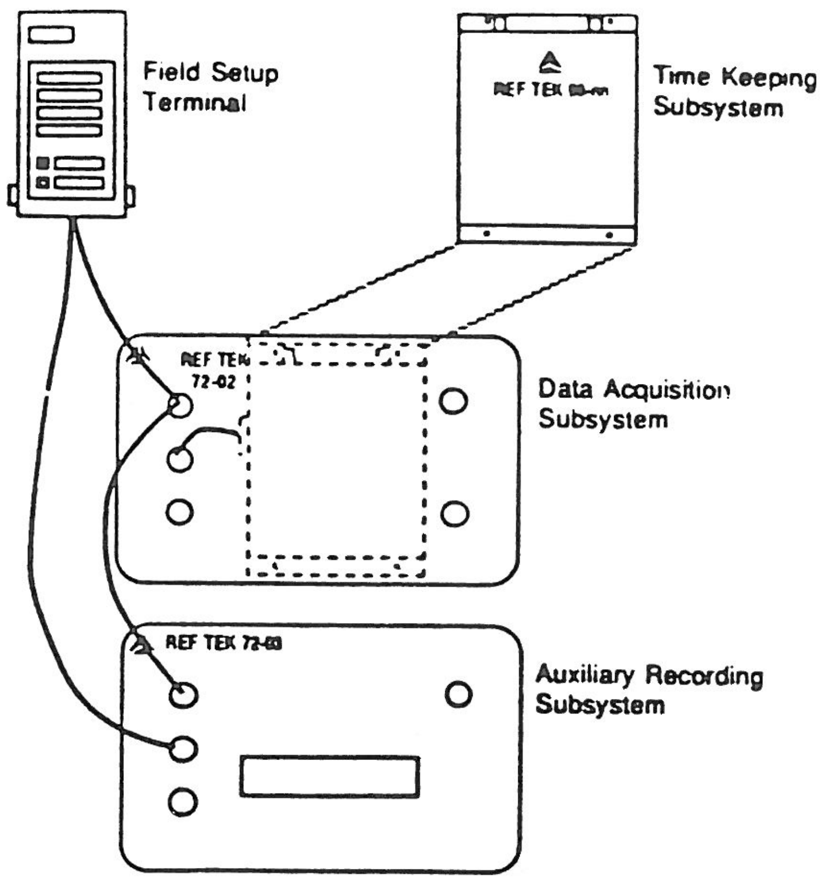

Figure 1 System Components

FIELD COMPUTER

by T. Ahern & J. Fowler

The PASSCAL field computer was developed to make it possible to get the data from the field instrument into a format which can be examined and processed as quickly as possible. The system has been designed around Sun Microsystem workstations because of their performance and popularity in the IRIS community.

The first deployment of a prototype field system took place during the first week of June, 1988. The system was installed at the University of California Santa Barbara where the field testing of the various PASSCAL field instruments was being performed. The instruments tested included the

-EDA PRS-4,
-Sprengnether DR2000,
-Teledyne Geotech PDAS-100,
-Kinemetrics SSR-1, and the
-REFTEK Model 72 (the IRIS/PASSCAL instrument)

recording systems. Software that translates the data formats recorded by the five supported instruments into a SEGY format has been written for the PASSCAL field computer. The SEGY format has been modified to store non-reflection trace header values in the unassigned header entries of the SEGY header. For instance SEGY format used by industry does not allow for storage of the time to the nearest millisecond for the first sample in the trace, one of the PASSCAL modifications allows for storage of this time index. Effort was made to insure compatibility of the PASSCAL/SEGY format with standard industry processing packages.

Since PASSCAL field computers will be used by a wide variety of university users, effort was made to provide interfaces with tools presently in use in the university community. Programs have been written that provide conversion of the SEGY formatted traces into both SAC and AH data formats. This allows users wishing to further analyze trace data to use the tool they are presently familiar with rather than being forced to learn another tool. Although only SAC and AH are supported at the present time, we feel that this provides support for the vast majority of IRIS users.

At the present time, hardcopy is provided by doing screendumps to either a BENSON B-90 plotter or a GULTON Wellogger ST-250 plotter. Both of these plotters are Versatec V-80 compatible plotters and produce hardcopy by a thermal process. All future PASSCAL field computers will be equipped with the Gulton ST-250 plotters since they are less expensive, faster and easier to load with paper than the B-90. It is worth noting that the field computers can drive other Versatec plotters including the V-80 and 24" Versatecs with no modifications to the software. Screendump software provides for image enlargement and automatically produces multiple strips of hardcopy output when the image size exceeds the physical width of the plotter. An extensive plotting routine developed at Princeton University (SEISPLOT) has been installed on the PASSCAL field computer and will soon be ready for use when plotting SEGY traces directly on the plotter.

At the present time the first prototype system is deployed in Reno, Nevada where it is supporting the PASSCAL field project in Nevada. This project is using PASSCAL instruments exclusively and can be considered a typical PASSCAL field experiment.

PASSCAL FIELD COMPUTERS - HARDWARE CONFIGURATION

During the development of the PASSCAL field computer, specific processing requirements have been more clearly identified and three separate hardware configurations have been determined. The first system is designed to support up to 100 PASSCAL instruments and is designed around a SUN 3/180, a second system will support up to 25 PASSCAL instruments and is designed around a SUN 3/60, and a third system could be used to support about 12 instruments and is designed around a SUN 3/50. At the present time components for two of the large systems have been acquired, one system being fully operational. Additionally a SUN 3/50 system exists to cover the low end of the field computer requirements but does not yet have appropriate disk and hardcopy support.

The field computer provides adequate field processing power to allow field personnel to quality control the data being recorded. Additionally, processing capabilities exist that allow researchers to completely analyze the data at remote field locations. The field computer is also responsible f or reformatting the data into a format consistent with the Data Management Center (DMC).

Tables I, II, and III show various configurations for the PASSCAL Field Computer. Please note that the costs are to be used as a guideline only.

TABLE I			
SMALL PASSCAL FIELD COMPUTER SYSTEMS (1-12 Instruments)			
ITEM	PART NUMBER	SUPPLIER	APPROX PRICE
SUN Workstation	3/50ME	Sun Microsystems	$3,776
EXABYTE/DISK	ss-600D2000T	Delta Microsystems	~8,700
Plotter	Wellogger ST-250	Gulton	4,095
Shipping Case-CPU	CASE-1	Artecon	525
Shipping Case-Sidecar	CASE-2	Artecon	525
Ruggedized Case-plot	CASE-3	Artecon	~525
TOTAL	-	-	$18,146

TABLE II			
MEDIUM PASSCAL FIELD COMPUTER SYSTEMS (12-25 Instruments)			
ITEM	PART NUMBER	SUPPLIER	APPROX PRICE
SUN Workstation	3/60HM	Sun Microsystems	$6,930
4Mbyte memory	X104C	Sun Microsystems	1,400
EXABYTE/DISK	ss-600D2000T	Delta Microsystems	~8,700
Plotter	Wellogger ST-250	Gulton	4,095
Shipping Case-CPU	CASE-1	Artecon	525
Shipping Case-Sidecar	CASE-2	Artecon	525
Ruggedized Case-plot	CASE-3	Artecon	~525
TOTAL	-	-	$22,700

TABLE III			
LARGE PASSCAL FIELD COMPUTER SYSTEMS (>25 Instruments)			
ITEM	**PART NUMBER**	**SUPPLIER**	**APPROX PRICE**
SUN 3/180 CPU card	501-1164	APEX	$5,500
4Mbyte memory	112B	Sun Microsystems	2,800
monitor	251A	Sun Microsystems	2,100
card cage	VMECC3	Dawn VME	3,121
SCSI port	501-1138	Sun Microsystems	938
Exabyte DAT & driver	EXB 8200	Delta Microsystems	3,700
SMD controller	V/SMD 4200	Interphase	3015
SMD cables	-	Almac 10 ft.	80
690 Mbyte disk	M2344K	Unison	7,850
Form factor adapter	9U 400/6U 160-3	Dawn VME Products	157
Versatek Controller	10088-CV	IKON Corporation	1250
Versatek Cables	-	Almac	51
Plotter	Wellogger ST-250	Gulton	4685
IKON/Versatek Driver	-	Geoimage	200
Form factor adapter	9U 400/6U 160-2	Dawn VME Products	360
Ruggedized Case-CPU	6712	ECS	1,943
Ruggedized Case-I/O	6712	ECS	2,163
Ruggedized Case-mon	CASE-1	Artecon	525
Processing Software	SierraSeis	Sierra Geophysics	8,000
Field QC Option*	-	Sierra Geophysics	875
FPA*	150A	Sun Microsystems	3,430
1/4" cartridge*	60T	Delta Microsystems	1,975
SKY Warrior AP*	4472	Sky Computer	12,720
SKY Memory 4M*	4184	Sky Computer	2,500
TOTAL	-	all options	$69,938
-	-	no options	$48,438

* Denotes optional equipment.

IRIS E-mail Directory
by Rick Williams

Last modified 1 April 1989

To get the most recent version of this list, use the command "finger gphysics@utkvx1.utk.edu" or send a mail message either to "gphysics@utkvx1.utk.edu" or to "gphysics@utkvx.bitnet"

Exclamation points (!), where they occur in the following addresses, have been replaced by vertical bars (|). Reverse this substitution before using any address so altered. An astrisk (*) preceeding a name means that I was unable to send mail to the address given. Others may be able to use the address successfully. A carat (^) preceeding a name means that individual is a member of the anisotropy interest group assembled by Joe Dellinger. Contact Joe for details. The letter (j) before a name indicates a Japanese seismologist from the list compiled by Kioyshi Suyehiro.

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