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RC2610/11 TECHNICAL SUMMARY
14 October 1985 Dale Chayes

INTRODUCTION

This summary will cover the technical aspects of both legs of the ATT Pacific cable survey (RC2610 and RC2611) which departed Honolulu on 27 August and ended in Hong Kong on 16 October with a brief stop in Guam (27 - 29 September.)

During the week long maintenance period in Honolulu, a new radar and three new radios were installed in the wheel house and the chart room. An IBM PX/XT was installed in the 'radio room' for communications and ship's business. A microcomputer network for real-time navigation was installed in the MCS\NAV lab. During the transit leg from Tahiti, virtualy everything in the labs was shut down, including the air conditioning. Upon arrival in Honolulu, the 7.5 ton unit in the MCS/NAV lab did not work. Shore-side contractors repaired this unit three times before departure. Lack of adequate A/C interfered to some extent with with the planned upgrades to the Data Logger software, and the SeaBeam computers as well as installation of the new navigation computers.

There were three major failures during the cruise. SeaBeam failed shortly after startup and was down for about 41 hours. On day 258 we found that the Data Logger had not been advancing tape on one drive, it has since been determined that 23 hours of navigation data were not recorded. This data gap is in two places: day 255 (1058 - 2359) and day 258 (0000 - 0955). Prior to our arrival in Guam, the A/C failed resulting in lab temperatures in the vicinity of 100 degrees Farinheit. During this time, the SeaBeam real time Vax crashed and it took 21 hours to get back on-line. Each of these problems as well as a collection of not so serious ones are detailed in this report. In addition, I have included some recommendations which might help in the future.

DATA LOGGER

Software:

Peter Buhl came to Honolulu to modify the software for the Data Logger to accomodate the Magnavox Tset GPS data format and to reconstruct the software to log Internav Loran data. These modifications were finished just before the ship left the fuel pier, and there have been no major problems detected.

There may be a minor problem with the handling of Internav data. When the Internav is realy confused, it sends a large quantity of operator messages. It appears that the Data Logger may not wrap its operator message buffer properly, thus putting messages in the data area.

Tape Drives:

In normal operation, the NOVA-4 Data Logger uses two Kennedy 9300-003 nine-track 1600 bpi tape drives which are both set to respond to the same drive number. To change tapes, the watch-stander loads a new tape, puts the drive with the full tape off-line, and puts the drive with the fresh tape on-line. This proceedure is simple, requires no operator interaction with the application software, and can be implemented with relatively simple software.

The data reduction proceedures for this project required that "yesterday's data be processed today" and that the Data Logger tapes be the basis for navigation. Because of this requirement, data tapes were changed every day at mid-night GMT. On day 258 we confirmed that data from the tape of day 255 was incomplete ending at about 1058Z. The board were familiar with the innards of SeaBeam, and a significant learning curve had to be surmounted.

Fortunately, there was a multiplexer among the spares. When SeaBeam was powered up following the repair, the Power Amp failure lights lit up in what looked like a major failure, but re-starting from scratch was sucessful.

Crashes:

There were several short failures of SeaBeam data acquisition computer early in the first leg while problems related to the new verison of VMS were worked out. Most of these data losses were noticed quickly. It appears that most of the problems were caused by VMS system routines which are no longer recommended for use with Version 4 but which had worked under the previous version.

Near the end of RC2610 (day 267) the 7.5 ton air conditioner in the MCS/NAV Lab failed, and it took two days to get it repaired. The initial failure of the A/C unit appeared to be a short in the compressor motor. A temporary repair was attempted which failed immediately. A spare compressor was found aboard and installed. In the mean time, the air temperature in the lab rose to about 97oF. At about the time that the AC unit was put back on-line after the second repair, the real time SeaBeam Vax crashed.

The crash dump indicated that the power had been cut to the computer several times in rapid sucession. The computer did not re-boot sucesssfuly by itself, and attempts to boot it manualy also failed. After several attempts at to get the Vax up, SeaBeam logging was switched to the backup Vax. It took another day to get the dead Vax to boot. The failure was probably caused by loose connectors or integrated circuits working out of their sockets. After logging was started on the backup Vax, the AC quit again, and SeaBeam and the Vaxes were shut off rather than risk running them at high temperature again.

Vertical Reference:

Vertical reference to the SeaBeam synchros was lost twice. The first (on day 259) was caused by failure of the BGM-3 gravity system. While the BGM-3 was beign repaired, vertical reference from the Aeroflex table was used. SeaBeam was without vertical reference for about 12 minutes while the switch was made. The second failure lasted less than ten minutes and was caused by inadvertent power loss to the BGM-3 while moving the gravity printer to the main lab.

Swath Plotter:

During RC2610 one of the slide wire sheaves in the SeaBeam Swath Plotter began to fail. The backup plotter was used for several hours while the bearing and sheave were replaced.

Subbottom Cutout:

If the ship's 3.5kHz profiler transmits when SeaBeam is digitizing it's bottom return, the resulting contours will be bogus. Last summer, a circuit was installed to minimize this problem by disabling the subbottom transmit key during the SeaBeam receive window. The addition has been proven to work in smooth to moderate terrain.

During the first leg, the cutout began to behave erraticly. During the second leg, Steve LaBrecque replaced a bad counter, and added bypass capacitors which had been omitted in the original design. Following these repairs, the cutout worked as well as ever, but was not able to cope with the rough terrain. Subsequently, Steve added an option to use a wider time gate which is symetrical about the NBES center beam. This helped somewhat, but was not sufficient.

The primary problem seems to be that the source of the depth from which the cut out derives its gate is not allways correct. Secondly, the distribution of beam depths is not allways symetrical about the center beam. In addition, the depth is incorrect when the NBES does its self-test every half hour.

A re-designed cutout could substatialy improve the situation by decoding the beam depths (either as parallel data as output by the Eclipse, or after it has been converted to serial data) and calculating a gate width based upon the actual depths. It would also have to sense the 'test' signal from the NBES, and accomodate the loss of beam data input.

Backup/Post Processing Vax

LA-120 Printing terminal:

There were no major problems with the Vax itself, but the DEC LA-120 which is used as a line printer for this computer was not working when we left Hawaii, and efforts to repair it were unsucessful. The lack of this printing terminal was barely noticed, but is also functions as the backup system console for SeaBeam and for the other Vax.

Huston Instruments CPS-19 Plotter:

The sporadic failure of the Houston plotter slightly reduced the amount of post processing of SeaBeam data accomplished onboard. The initial symptoms were very intermittent and not suggestive of any particular failure, so we continuted to use it until it failed completely. There were two initial failure modes: 1) offsets in the X-axis; and 2) total failure of the plotter to respond the the computer.

The eventual failure mode was complete loss of control on the X-axis. This was finaly determined to be caused by broken solder joints on chip resistors on the position encoder of the X-axis drive motor. Several attempts were made to resolder these joints and some lasted longer than others. The spare motor was found to have the same problem, and none of the attempts to repair the spair were sucessful.

Bell Gravimeter (BGM-3)

The BGM-3 failed on day 259 of the first leg. The problem was found to be an opamp in one of the servo preamps. There is no spare board, but Joe was able to replace the opamp. While the BGM-3 was down, the Aeroflex table was used as the vertical reference for SeaBeam. The system was down for about 12 hours.

Prior to the seamount surverys, the printer from the gravity system was moved to the main lab so that it could be more closlely monitored by the watch. During this move, the main power to the BGM-# was accidentaly turned off fro a couple of minutes.

Magnavox GPS Receivers (Tsets)

The two Lamont owned Tsets were upgraded to two channel receivers in Honolulu with receiver boards which I picked up during my vist to Magnavox on the way to the ship. I also brought out the repaired antenna and version 2.4 software. An attempt was made to keep both recievers up throughout the cruise. This attempt was partialy successful.

With the two channel receiver boards and the new software the Tsets have been significantly improved. The receivers will now navigate during two satellite coverage if they have previously established a frequency bias (fudge factor) for the external atomic clock.

In order to allow experimentation with the receivers, Joe Stennet built a buffered line driver which takes serial data and video signals from both receivers and allows the watch stander to select which one is sent to the various computers and video monitors.

The Tsets are standard DEC VT-103 microcomputers packaged in a VT-100 terminal chasis to which Magnavox has added their GPS receiver, an internal oscillator, and application software. These computers use a PDP 11/23 cpu and boot from a TU-58 cartridge tape.

In assessing the performance of these units it should be remembered that both the Navstar Satellite system and these receivers are experimental. Magnavox has been moderately responsive to the input from the user community in the past, and particularly responsive this during this cruise. Furthermore, the version 2.4 software and the two channel receviers installed in Honolulu were the first release. Interaction with Magnavox was particularly good during this cruise and I am planning to stop at Magnavox on my way home to discuss the results of this leg.

I think that short of building our own hardware (as in the Transit Sat development days) the only way the marine geophysics community (and Lamont in particular) will be able to stay near the state of the art in hardware is to develop a working relationships with manufacturers such as Magnavox.

Tape Controller:

It became apparent early in the first leg, that one of the Tsets (#101) had a tendency to lock up at random times. At first, I thought that this was related to changes in constellations. Eventualy, I began to suspect that it was related to the DEC hardware in the VT-103. Toward the end of RC2610 I requested that Magnavox send a set of boards so that I could experiment with board swapping without shutting down both recievers. After swapping out all of the boards which they sent to Guam, the problem still remained, so I swapped tape controllers between the two receivers as there was no spare in the set which Magnavox sent. Immediately, the problem switched to the other receiver, confirming that the problem was related to the tape controller. I have requested that Magnavox send a tape controller to Hong Kong for exchange.

Tape Drive:

Reciever #108 has not been able to boot from its left-hand tape drive since we left Honolulu. So far, this has not been a problem, but if this drive fails, the receiver will only be useful for spare parts. Before we repair this drive, we should make a decision about upgrading the two Tsets to use micro-floppy disks instead of tapes. I have not seen a quote from Magnavox, but they have told me verbaly, that the price will be in the range of $4,000 each.

There are two advantages to using floppies. First, the cold start time is reduced from about 15 minutes to 3 minutes, and secondly, the reciever will store an Almanac on the disk so that receiver does not have to acquire an Almanac every time it boots.

Antennas:

Prior to the start of RC2610, one of our GPS antennas was at Magnavox for repair, and the other was on the ship. The repaired antenna was installed on the aft mast in Honolulu, and we left port with two working antennas.

On day 252 I noticed that Tset #108 had not tracked satellites for several days. By switching antennas between the sets, I was able to isolate the problem to one antenna. On inspection, we found that the bulkhead connector on the antenna was damaged. Since we did not have the correct replacement connector, we substituted a BNC bulkhead connector and used an adapter on the cable. Following this fix, the Tset worked properly. There was only a slight difference in signal to noise ratio between the two receivers. As a result of this test and repair proceedure, we ended up witht the antennas exchanged.

Shortly after leaving Guam I noticed that the Tset #108 did not pick up any satellites during a constellation when the other reciever worked fine, I measured the DC current to the antenna preamp, and found only about 40 milliamps at 12 VDC. The correct current is in the range of 70 to 120 mills. Frank brought the antenna down and I found a significant amount of moisture condensed inside. I also noted that there was an excessive amount of silicon grease on the O-ring, and that two traces were burnt off of the printed circuit board. I was able bypass the burnt traces with wire. I flushed the internal components of the antenna with alcohol, dried it carefully, and put it back together. After Frank installed it, it worked adequately, but with slightly lower signal to noise than the other.

Currently, both of our GPS antennas are operating correctly, but with out being purged with Nitrogen, and with some modifications. I suggest that both of the antennas be sent back to Magnavox for overhaul while the ship is in they yard in January.

Firmware:

The Tset receivers are implemented on one surface mount printed circuit board which is controlled by three microprocessors and interfaces to the VT-103 host computer via serial interfaces. During RC2610, I noticed a number of behavioral traits which I communicated to Magnavox. One of these is the tendency of the Tset to rocket off to another hemisphere during changes in constellations.

At their direction, I made a new eprom which was supposed to solve this problem, but this did not seem to work properly. They sent a full set of new eproms (Version 1.11) to Guam. With the new firmware, the problem of ending a satellite constellation in the wrong hemisphere has stopped, but the recievers do not always stop navigating with an appropriate frequency bias. Without a correct bias, two satellite navigation will not produce an accurate solution.

Frequency Standards:

Because both Range-Range Loran-C navigation and two satellite GPS navigation depend upon an external reference frequency, we leased a spare Hewlett Packard HP-5065A Rubidium frequency standard in case the Lamont owned one failed. As it turned out, the Lamont Rb standard worked, but with a drift rate greater than expected. Calibrations against Transit Satellite fixes, against GPS positions, and during the port periods in Guam and Honolulu produced drift rates on the order of 3 to 4 microseconds per day which is about twice the specification. It appears that the drift rate changed during RC2610. A change in drift rate is particularly disquieting, and we are trying to understand what happened. There is some suspiicion that execssive lab temperature may have been responsible.

Chronolog Clock

Toward the end of RC2611 (day 284) the Nav_net computer which decodes data output from the Data Logger detected bad data from the Chronolog Clock. Steve LaBrecque determined that the data being output from the Chronolog was good up to the the input to the Data Logger, so we speculate that the TTL input board may be bad, but did not want to stop the Data Logger to try to isolate the problem. This will be persued in Hong Kong if time permits.

Internav LC-408 Loran C Receiver:

Prior to the begining of RC2610, we installed two firmware upgrades in the LC-408. One upgrade was to enable the receiver to acquire and track slaves of a chain without having to first acquire the master. This enables a new "master independent" mo de of range-range operation. The second upgrade enables the LC-408 to calculate position from range data. These new capabilities significantly expanded the areal coverage in which Loran C is a useful aid to navigation.

The LC-408 exhibited three types of undesireable behavior. First, it was not possible to call up a display of range and signal strength for the first slave of chain one. Second, when thye most significant digit of a range changes, then the positi on calculation routine will not recognize the requested range as an allowable input. The third source of difficulty is the receiver's erratic operation when signal to noise ratios are low. Under duress, the reciever may exhibit one or more of these symptoms:

1) loss of lock on slave, but tracks something, often the master
2) failure to transmit complete data message
3) undocumented characters in the message strings.

In addition, watchstanders found that the user interface was awkward and often obscure.

Magnavox MX-211 Marisat and BusiShip

BusiShip:

During the inport in Honolulu, an IBM PC/XT was installed with a software package called BusiShip which was purchased from Navcom. This system is intended to improve communication between the Lamont and the ship as well as reduce the costs. There was some confusion about what bits and pieces were needed and as a result, the correct hardware was not available when the ship left Honolulu. The required circuit board was forwarded to Guam where it was installed.

After several abortive attempts, the package works after a fashion. However, it is still not possible to use the automatic dialing capability which is supposed to be supported. I have explored this as fully as possible on the ship, and repeatedly asked for answers from Navcom via Lamont, but have gotten none.

There is significant potential for use of BusiShip which will be useful in supporting hardware and software on the ship. It is possible to call out from the ship into shore-side data bases and computers with relative ease. Although it is relatively expensive, in many cases, it will prove cheaper than sending someone to meet the ship in port, and may allow software and hardware upgrades during cruises which have not been feasable in the past.

MX-211:

On day 279, the MX-211 Satcom terminal failed to restart after a power failure. The primary symptom was a diagnostic message which indicated that down-link data from the antenna was not correct. Eventualy we found that the AC input to the power supply for the antenna electronics had arced over and shorted out. I bypassed the input feed-thru and the power supply seemed to work, so I re-installed it and the MX-211 came up normaly.

NAV_NET Microcomputer Navigation Network

A network of Compaq-286 microcomputers were installed in Honolulu for the purpose of improving the real time navigaiton capablily on the Conrad for the ATT survey. Of the four computers installed, two are used for real time tasks and the other two are used for software development. These computers are interconnected via and Ethernet Loca Area Network (LAN) which allows the sharing of data files among cooperating programs.

Two of these computers and their peripherals will be left on the ship with the understanding that they will be supported by the Marine Science Coordinator and used to improve the real time navigaiton capabilites on the Conrad. The other two will be returned to Lamont and used for continued development of the LAN interaction with real time software. During both legs, there has been a continuous process of software development which will be continued on board by Kurt Fiegl and by myself at Lamont.

We have generated an outline of the directions which this system should be expanded and assigned priorities to these items. This plan is primarily a document which can be used for planning purposes and is expected to change but be kept current.

Current Capablity:

The present system takes condensed navigation sensor data from the Data Logger and produces the following outputs:

1) Display of sensor input for the Lab and the Bridge
2) Sends position from the sensor of choice to SeaBeam
3) Displays detailed output from the Internav Loran C
4) Plots ships position from GPS, Loran-C, and Transit sat
5) Plots Loran-C signal Strength and ranges
6) Prints sensor input

This system provides operator interaction for changing paper in the plotters, and other simple housekeeping tasks such as changing the message to the bridge display. It has proven to be moderately robust and is rapidly imporving its capability to withstand bogus inputs from operators and from the Data Logger. The operator interaction has been substantialy improved over the last few weeks.

RECOMMENDATIONS

Technical Support:

Because of the increasing number of micro-computer based systems on the Conrad consideration should be given to the inclusion of a micro-computer system hardware/software specialist should be included in the permanent technical staff on the ship.

There should be a technical support person at Lamont whose principal function is to support the staff on the ship. Presently, the response from Lamont to technical questions is not supported as well as it should be. This person could also oversee the technical purchasing.

Air Conditioning:

The lack of adequate air conditioning has been a significant problem during this cruise. This seems to be caused by lack of insulation, lack of maintanence, and excess heat load in the labs. Thermal insulation can be added to the inside of the lab. A program of preventive maintainence could be instituted, and some of the major heat sources such as power transformers could be moved out air conditioned spaces.

Acoustic Noise:
The sound pressure level in the MCS/NAV lab is probably above safe limits for long term exposure when the core winch is running. It is certainly too loud to work or think without ear protection. The same situation is true in the Wet lab when the hydraulic pack for the crane is running.

Frequency Standard Calibrations:
Now that our GPS receivers are using the Rubidium clock regularly, and we have the capability of Range-Range Loran-C navigation, it will become increasingly important to keep the frequency standard in calibration, and to be prepared for the day when it fails. The best option would be to acquire a new or used atomic clock sot that we have a backup.

Calibration techniques should be worked out so that we are not dependent upon being able to acquire Loran-C stations while in port as has been done in the past. Our experience during this leg has shown that even in ports which should have good Loran coverage, such as Honolulu, the local interference can be so bad that it is impossible to acquire stations. I suspect that the Tsets will turn out to be the most usefule method of calibration, but it will require some effort to work out a technique.

Depth Digitization:
Since a bathymetric profile is one fo the fundamental products of nearly every Conrad cruise, some effort should be made to make the creation of an accurate profile wuicker and cheaper. During legs when SeaBeam is supported, it would be quite easy to pass the center beam depth to the data logger once a minute so that it would be on the data tape along with the navigation. Currently, the depths are read from the SeaBeam data files at the end of a cruise.

On cruises where SeaBeam is not supported, a manually operated digitizers such as the MPL Deep Tow T-Square could be fitted to any fax recorder sot that the watch could enter depths directly into the data logger.

Second Frequency Standard:
We are now using our Rubidium standard for the GPS receivers, the Loran-C reciever, and as the timebase for all of our real time clocks when we are out of range of the GOES satellite. There are four reasons to have a second standard:

1) To cover failure and repair of the primary
2) To allow adjustment for drift rate
3) So that we will be capable of translocation
4) So that we can navigate two ships for some experiments.

I suggest that we first decide if we can make a good case for a Cesium standard, and on the basis of that we should propose to purchase a second standard.

Tset upgrades:

I think that we should find the money to upgrade both of our GPS receivers from tape cartridges to microfloppies for the following reasons:

1) We would have to repair one of the tape drives
2) Significantly faster boot to navigate time
3) Keep us current for software upgrades.

I believe that there is enough money left in the GPS account to pay for this upgrade.

Loran-C:

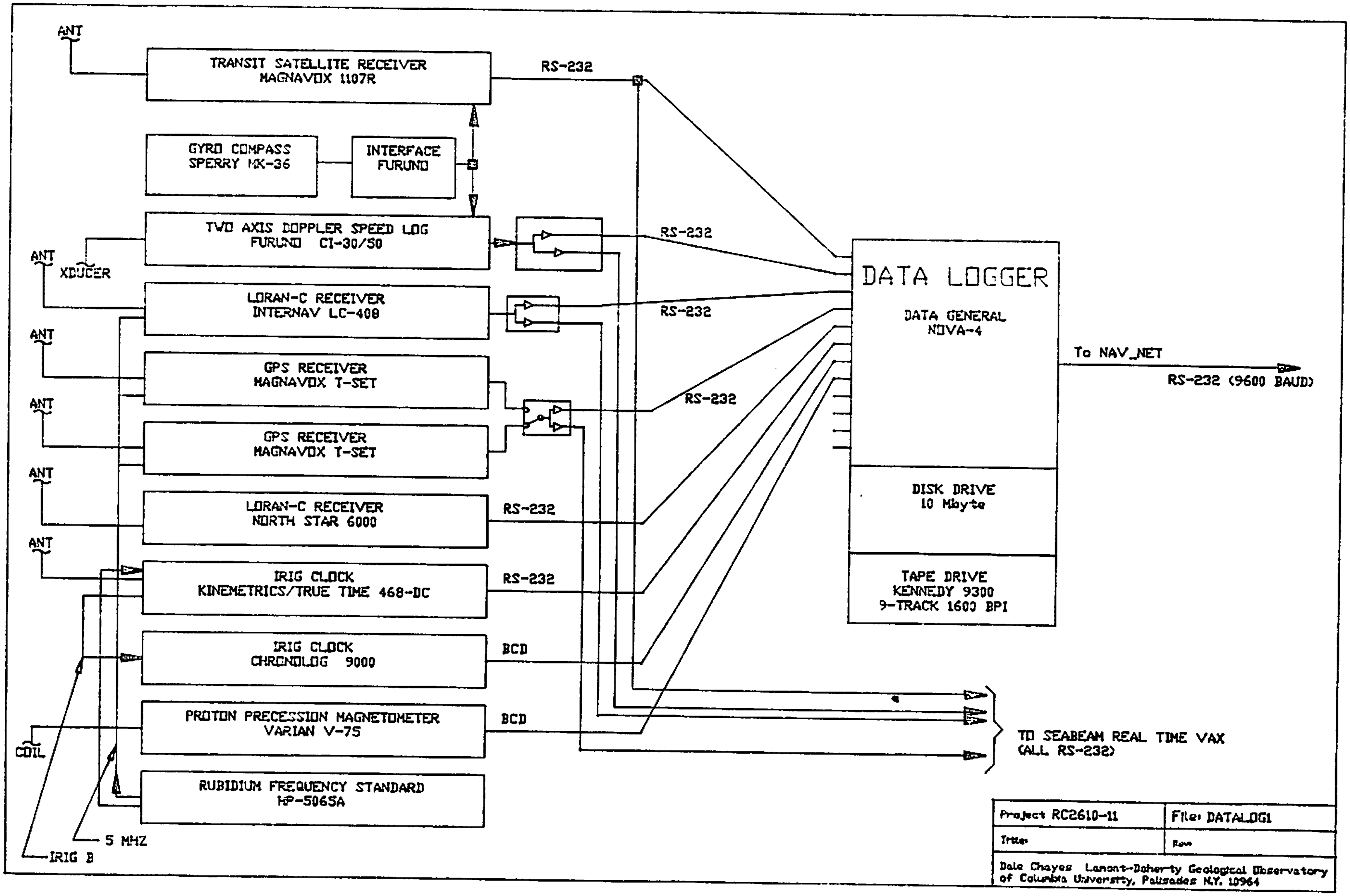
We should discuss the known bugs with Internav and work with them to improve the LC-408. Shortly, the Conrad will be out of Loran-C coverage for an extended period, and we should consider bringing the receiver to Lamont for test and evaluation.

Data Reduction:

In order to facilitate data reduction during SeaBeam legs, and to make it possible on non-SeaBeam legs, we should acquire a minicomputer specificaly for shipboard reduction of MG&G data. Prior to this purchase, we ought to consider the sanity of having all of our software tied to a specific family of hardware and software. I think that the reduction system on the ship ought to be functionaly equivalent to what exists at Lamont, but if the computing capability at Lamont is going to change in the near future, this decision should be made in that light.

MX-211 Satcom:

It should be made clear who is responsible for the operation, maintenance, and upgrades to the Marisat system. Presently, the second mate is generaly responsible for operation, but is not qualified in its repair and decisions on its upgrade have been made which lack technical expertise.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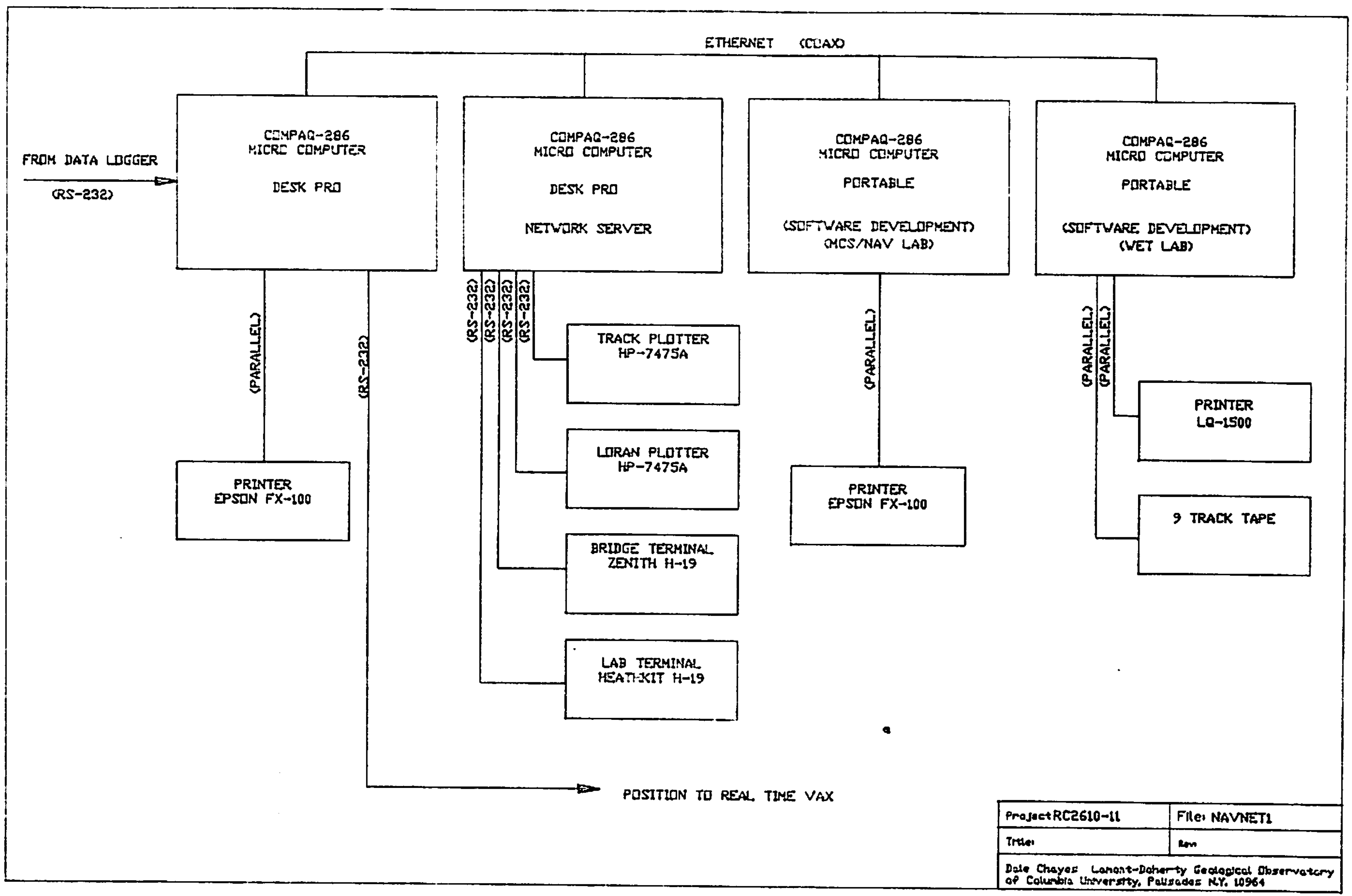
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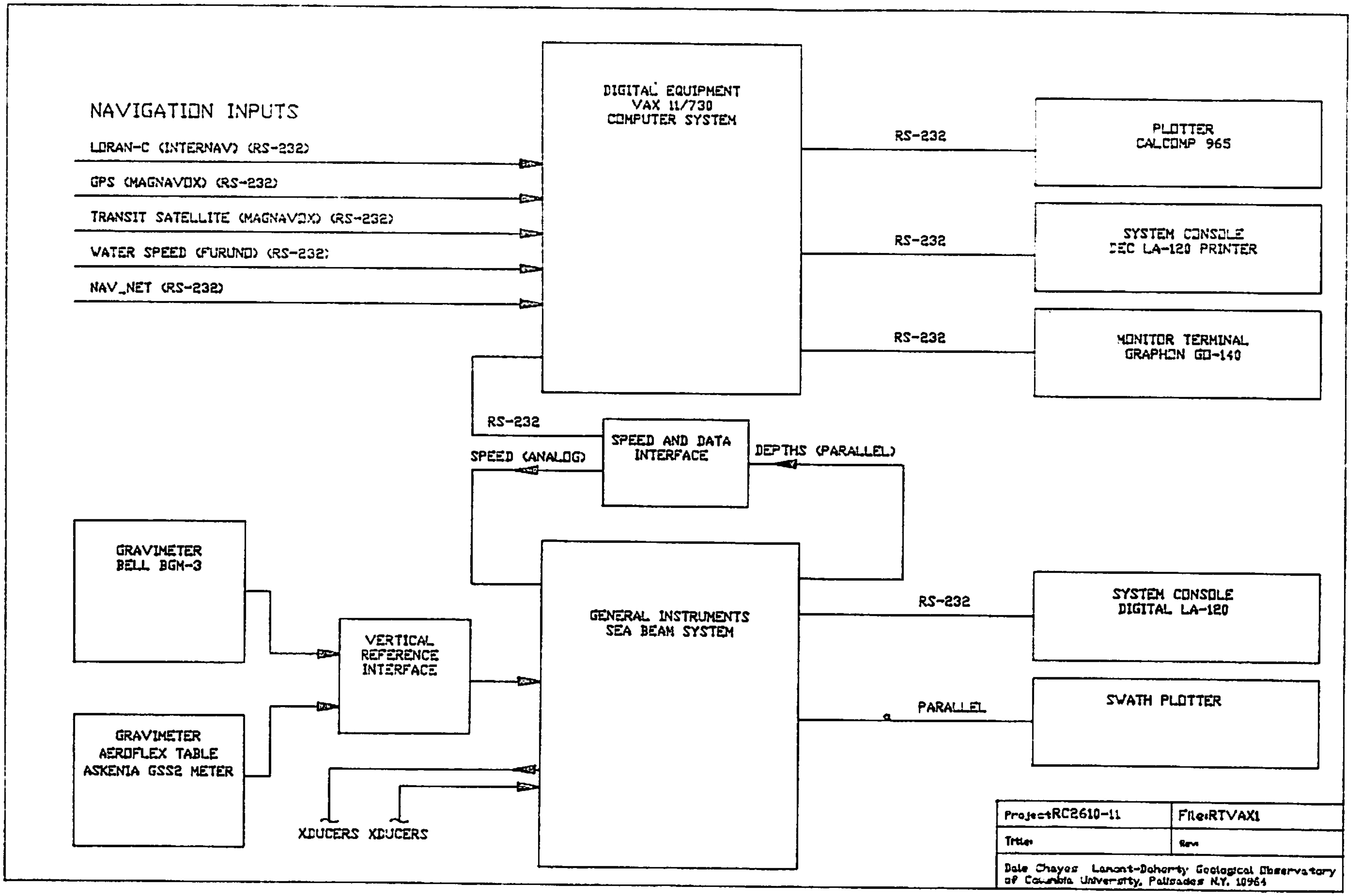
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