Healy Cruise UHDAS installation

Dr. Julia M Hummon

University of Hawaii

hummon@hawaii.edu

Revision History

mid-June, 2010	original, very crude document. submitted on board Healy
July 1, 2010	broken out into part 2 of 3 (“UHDAS Installation”)
July 9, 2010	added references to fiber and interleaved pings
July 20, 2010	remove “draft” designation

Table of Contents

1 Introduction

USCGC Healy has two Doppler current profilers made by Teledyne RDI. These instruments are used to calculate ocean currents beneath the ship. Historically, data acquisition was

performed by the manufacturer's software, “VmDAS”. On the 2010 Healy transit HLY10TC from Honolulu to Dutch Harbor, a new system , “UHDAS”, was installed for ADCP data acquisition and processing. This document describes UHDAS and the installation of the system on the Healy.

2 Overview of UHDAS + CODAS at sea

2.1 Introduction

UHDAS refers to a suite of programs and processes developed at the University of Hawaii that perform data acquisition, data processing, and monitoring, at sea. In addition, access to documentation and code are provided on the ship's network. We have tried to make a system that is useful and reliable, easy to operate, and which provides as close to a final dataset as is reasonably automatable while maintaining the fundamentals necessary to reprocess the data from scratch if necessary.

Documentation for UHDAS and CODAS (the processing component) are housed

- at sea (http://currents)
- on land (http://currents.soest.hawaii.edu/docs/adcp_doc/index.html)

3 UHDAS Overview

This section is available in the CODAS documentation, referenced above.

UHDAS has four components at sea:

- Acquisition
- Processing
- Monitoring
- Access (to data and figures)

3.1 Data Acquisition component

Data acquisition programs are written in C, and the gui and supporting code are written in C and Python.

Data acquisition includes

- a dialog with each of the RDI ADCPs to set parameters and start pinging
- acquisition and timestamping of passive serial inputs
- data collected are
  - binary records (from ADCP ensemble)
  - NMEA strings (from serial inputs)
- NMEA data recorded usually comprise
  - GGA messages (gps) from two sources if possible
  - gyro heading
  - accurate heading (POSMV, Ashtech, Seapath, Mahrs, Phins,... if available)
- files roll over every two hours
- timestamps are zero-based decimal day (Jan 1, 12:00 UTC is 0.5, not 1.5)
- all but the most recent two ascii files may be compressed to save space
- a parsed version of each NMEA string is added to a set of intermediate files to stage information for the processing component ("rbin" files)

3.2 Processing component

Processing code is written in C, Python, and Matlab. Final processed output are written as Matlab files on a regular basis. Processing is done using a CODAS database (Common Ocean Data Access System) as storage and retrieval system. The suite of programs designed to extract from, manipulate, and write to the database is known as "CODAS ADCP Processing" and has been free, maintained, and in use since the late 1980's.

In a batch mode, CODAS processing can be applied to single-ping data gathered by UHDAS (or the commercial RDI software "VmDAS"), or averaged data collected by VmDAS or the original DAS2.48 (used with Narrowband ADCPs in the late 1980's and through the 1990's).

At sea, a UHDAS installation acquires data and uses CODAS processing to calculate ocean velocities from ADCP measured velocities, position, and heading (gyro, corrected to accurate heading if one is available). The following three levels of processing combined are called CODAS Processing:

(1) CODAS steps performed on single-ping data
- make sure every ADCP ping has a position and a heading
- gather the next T seconds of data (eg. 300 seconds)
- screen the ADCP data to eliminate bad values (eg. acoustic interference)
- average in earth coordinates
- write to the disk

(2) CODAS steps performed on averaged data
- load measured velocities into the database
- add navigation to the database

The following are steps automated on a ship with UHDAS, but can be done afterwards with human intervention

(3) CODAS Post-processing (on averaged data)

- correct the gyro heading to the accurate heading device (if there is one)
- apply scale factor if specified (eg. NB150, BB150, WH300)
- apply additional fixed rotation if specified
- edit out bad bins or profiles (eg. data below the bottom)

It should be noted that Phased Array ADCPs ("Ocean Surveyor" series) are capable of pinging in either narrowband or broadband mode. They are also capable of pinging in interleaved mode, where narrowband and broadband pings alternate. This mode of operation is possible with both UHDAS or VmDAS, but with VmDAS it is much more difficult to access the second ping type. If interleaved mode is chosen with UHDAS acquisition, CODAS processing treats each pingtype as a virtual instrument, processing the data from each ping type in a separate directory.

3.2.1 UHDAS Enhancements to CODAS Processing

UHDAS adds steps to the basic processing at sea by extracting (on a regular basis) processed, corrected, edited data for scientists to use during the cruise. These data and figures that are generated from them, are available on the ship's web.

- every 5 minutes
  - get the last 5 minutes of new data
  - rotate to earth coordinates
    - in general, this is done using a gyro as the primary heading device and correcting to the "accurate heading device" (if one exists)
    - on Healy, the POSMV is (at present) the sole attitude device
  - edit single-ping data (for this 5-minute chunk)
  - average, write to disk (staging for addition to the codas database)
  - save the 5-minute chunk of data, specifically for plotting
- every 30 minutes
  - the CODAS database is updated with the staged averages
  - scale factor and fixed rotation are applied if specified
  - the averages in the database are also edited (to look for bad bins or bad averaged profiles, and the bottom)
- after the codas database is updated
  - the data are extracted and averaged (for plotting)
  - the data are extracted with "every bin, every profile"
  - data are stored as Matlab files, accessible via ship's web site or via windows shares [samba] or nfs.

- vector and contour plots of the last 3 days of data are updated, available via ship's web

3.3 Monitoring component

Monitoring programs are written in Python and make use of Linux system calls.

Monitoring includes

- daily email sent to land with information about
  - processes running, disk space, error messages
  - data processing status
  - daily email includes a message about heading correction
  - the last 3 days of heavily averaged (vector plot)
- **on land**, when the email is received, crude vector and contour plots are made of the data snippet that was sent
- **at sea**, the following are available on the ship's web:
  - most recent 5-minute profiles of all instruments that are pinging
  - the last 3 days of data shown as contour and vector plots
  - the last half-day of gyro and "accurate heading"

3.4 Access to data and figures

Two fundamental access mechanisms exist

(1) ship's web (usually http://currents)

- figures
  - most recent ocean velocity profile for each instrument
  - 3-day tail with surface velocity vectors
  - 3-day tail contour plot (vs time, longitude, or latitude)
- data
  - all data so far, (thick layers, eg 50m) over 1-hour, for vector plots
  - all data so far, (thinner layers, eg 10m) over 15 minutes, for contour plots

(2) network shares

- in the adcp home directory, `www/figures/png_archive` contains copies of the most recent 3-day figures made every day so far in the cruise (also available via `http://currents`)
- in the data directory, `current_cruise/proc` contains processing directories for all instruments logging data.
  - the same data files that are available on the web (15-minute and 1-hour) are available in the vector and contour subdirectories.
  - a collection of files prefixed with `allbins_` contains many useful variables, stored at the highest resolution of the averaged data. The bin size matches the bin size of the instrument, and the data are averaged every 120sec

(wh300) or 300sec (all other instruments). (also in `contour` directory)

- in the data directory, `current_cruise/raw` contains all the data logged by UHDAS, including the single-ping ADCP data.

4 Healy UHDAS installation

4.1 ADCPs

The Healy was delivered with two Broadband ADCPs, a 300kHz and 150kHz. The 300kHz instrument never really worked, and in 2002, it was replaced with 75kHz phased array "Ocean Surveyor" ADCP. During the winter inport period of 2010, the 150kHz Broadband ADCP was replaced with a 150kHz phased array "Ocean Surveyor" (loaned by Univ Alaska, Fairbanks). These are referred to as OS75 and OS150, respectively.

Also during the 2010 inport period, a new cableway was built from the transducer void to the Potable water room. The OS150 cable was routed through that new cableway in an attempt to reduce electrical noise. See Appendix for partial ADCP well drawings and photos of a portion of the new cable route. The new cable route is part of a plan to carry transducer cables well away from collections of electrically active cables.

During the cruise, serial transmission errors between the UHDAS computer and the ADCP deck units prompted two actions: (1) rewriting the binary serial acquisition routine to be more robust against gaps in transmission (2) replacing the RS232 serial run with fiberoptic cable. No serial errors were seen in the ADCP data after this improvement.

4.2 Computer

Historically, ADCP acquisition and processing have used the software provided by the manufacturer ("VmDAS"). This software acquires data from the ADCP and other serial feeds (GPS and attitude), timestamps the serial data and it saves to disk. It also adds UTC time and GPS positions to each ADCP ensemble, and transforms the ADCP beam velocities into horizontal velocities referenced to earth. The software includes averaging and display of various variables. Each ADCP requires one Windows machine running VmDAS. In addition to the ADCP, each computer needs its own serial feeds of position and attitude.

Although we anticipate UHDAS being the primary acquisition and processing package used on the Healy, VmDAS capability must be maintained for the annual RDI Groom of the ADCPs. During this interaction, RDI evaluates the system and makes recommendations about settings and the installation.

For the UHDAS installation, LDEO supplied a Dell R210 server, Digi Neo 8-port PCI serial card (with octocable dongle), and R14.3 Matlab license. These were shipped to Hawaii prior to the ship's arrival. The basic Ubuntu 8.04 (Hardy Heron) installation was the starting point; other software components were added at U. Hawaii. The computer contained two 160Gb disks with two bootable Windows partitions and a requirement that 30Gb be reserved for dire emergency (in case this machine needs to be pressed into service to replace some other failed

machine, at sea). The two Windows partitions were reserved with the plan that they (a combination of 2 Windows installations and a virtual machine) will replace the two VmDAS computers, thus consolidating all ADCP operations in one computer.

The computer and Digi card were brought to Healy and installed in the forward-port computer lab rack (located above the two VmDAS computers). After the computer was configured, the permanent display, mouse, and keyboard were set up in the watchstanders' area, using one of the displays that had previously been used for one of the VmDAS computers. The other VmDAS display may be retasked during the field season.

4.3 Serial Ports

UHDAS uses one process per serial port for data acquisition. The input streams are filtered by message, timestamped, and written to a directory named after the instrument being logged. More than one NMEA string can be acquired from a given serial stream. If the rate of repetition is too high, messages may be subsampled prior to recording. The file "`sensor_cfg.py`" contains settings for serial acquisition, including ports, baud rates, and message strings. (NOTE that indentation must be respected when editing sensor_cfg.py, as it is written in Python). CODAS processing requires position and heading. We try to log all required input types from multiple sources, to allow for reprocessing (in case of gaps or failure in the primary serial feed).

Serial messages logged as of June, 2010, are:

Serial directory	**instrument**	**suffix**	**messages**
ashpaq5	Ashtech adu5	paq	$GPGGA,$GPPAT
gpsnav	Pcode gps	gps	$GPGGA
gyro	Sperry mk39	hdg	$INHDT
gyro2	Sperry mk27	hdg	$HEHDT
os150	RDI adcp (150kHz)	raw, log, log.bin	(binary adcp data + log files)
os75	RDI adcp (75kHz)	raw, log, log.bin	(binary adcp data + log files)
posmv	POSMV	pmv	$PASHR,$INGGA

Serial acquisition layout is diagrammed in the Appendix.

To return acquisition to the VmDAS computers:

1. Return the VmDAS keyspans (from their secured location) to the top of the computer rack
2. Move the db9 cables from the Digi ports labeled 1,2,3,4 to the OS150 keyspan (keeping the same numbering scheme)
3. Move the OS75 port from Digi labeled "8" back to the OS75 keyspan (see labels!)
4. Plug the two keyspan USB cables into the appropriate computers

As of this writing, the keyboard, mouse, and monitor for “currents” are in the watchstander area. The monitor used to be labeled “OS150”. The “OS75” monitor now has no label. The two VmDAS computers presently have no monitors. Once keyboard/mouse/monitor is addressed, boot the VmDAS computers and they “should work” just like early June, 2010.

4.4 UHDAS and CODAS settings

4.4.1 UHDAS settings for ADCPs

The UHDAS gui starts with defaults for ADCP data acquisition. These are:

ADCP	broadband mode	narrowband mode	bottom track
os150	biased: do not use	bin size = 4m 70 bins blank = 5m	use sparingly; not necessary with CODAS processing
os75	biased: do not use	bin size = 8m 50 bins blank = 10m	use sparingly; not necessary with CODAS processing

4.4.2 CODAS processing settings

Settings for heading and position source, and transducer angle are:

heading (reliable)	best position	heading correction (accurate)	transducer angle os75	transducer angle os150
posmv $PASHR	posmv $GPPGA	(none)	43.4	28.4

If necessary, processing of UHDAS data can be redone at a later date using different supporting serial strings. Reprocessing of UHDAS data on the Healy should be able to use appropriate settings chosen from:

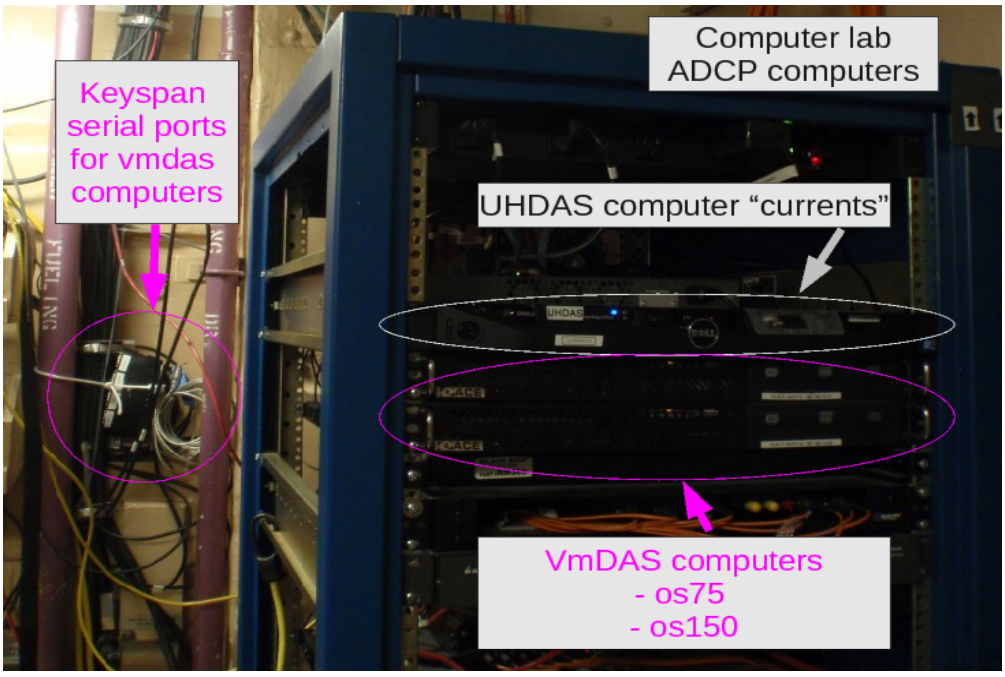
position/time	reliable heading	accurate heading
Ashtech $GPGGA		Ashtech $GPPAT
Pcode $GPGGA		
POSMV $INGGA	POSMV $PASHR	POSMV $PASHR
	mk39 $INHDT	

position/time	reliable heading	accurate heading
	mk27 $HEHDT	

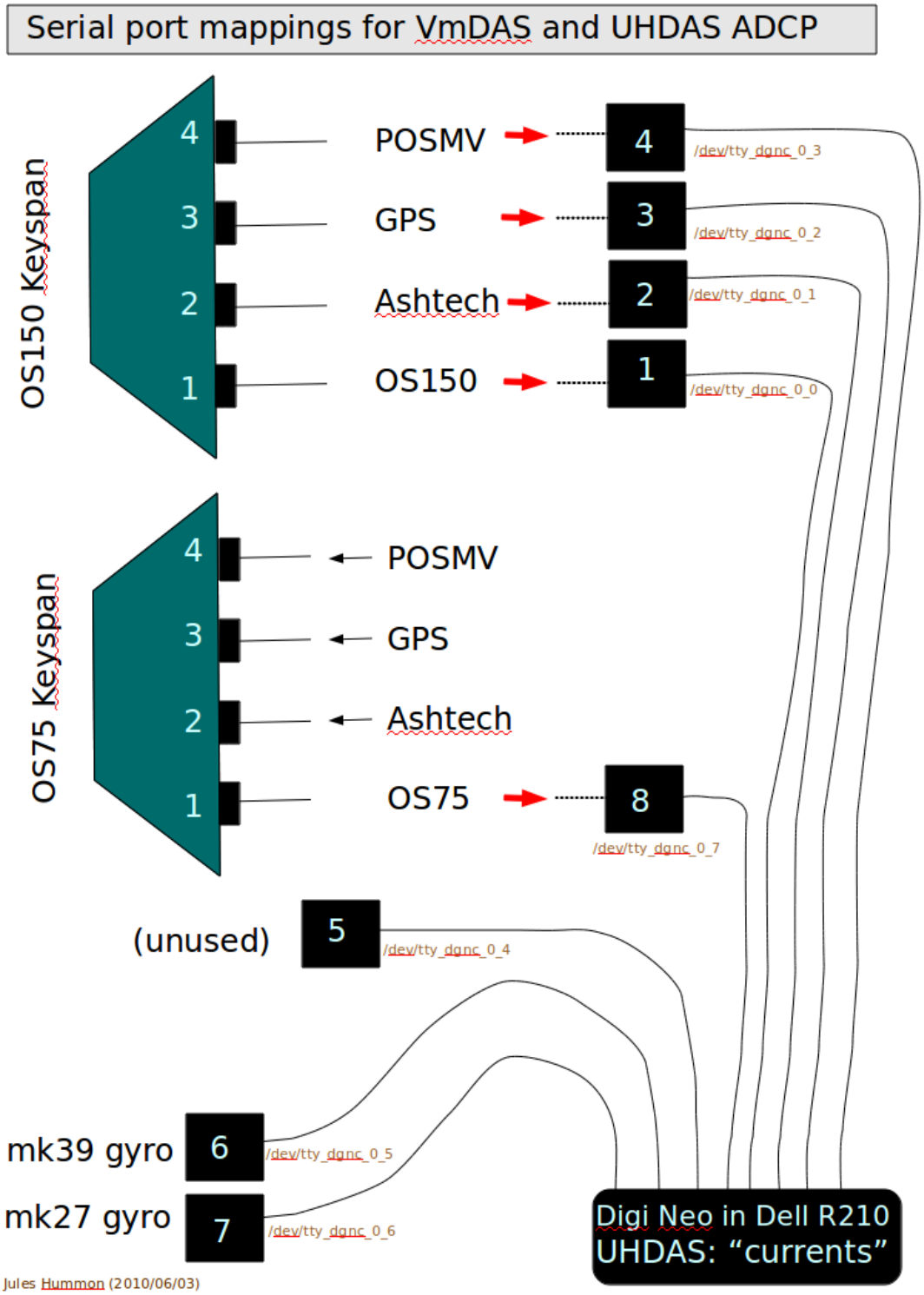
5 Appendices

5.1 UHDAS and VmDAS Computers

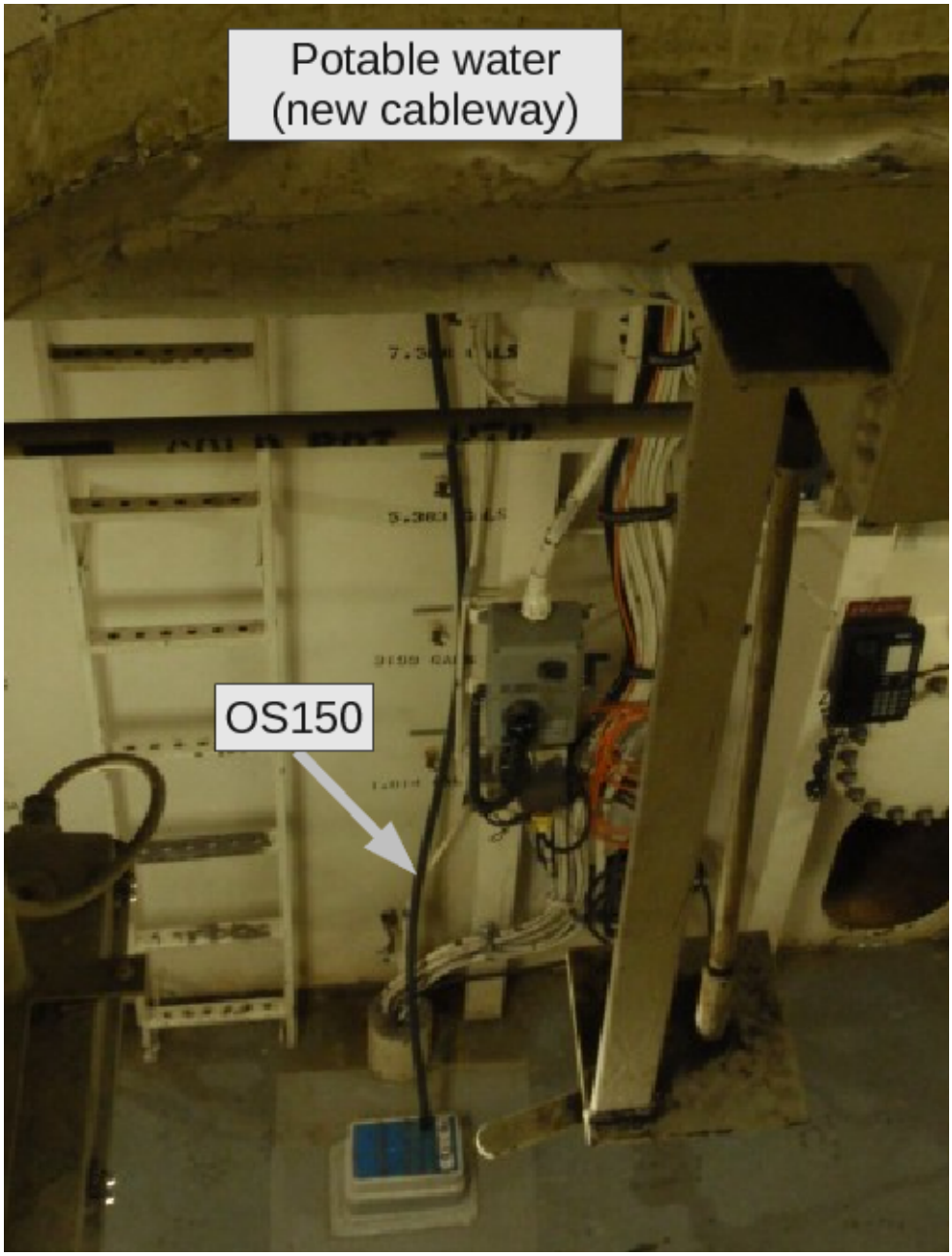
Figure 2: UHDAS and VmDAS computers, and (secured) VmDAS keyspan serial adapters



5.2 ADCP Transducer drawings



5.3 Potable Water Room, OS150 cable



5.4 OS150 cable entering Mica room from potable water room