Shipboard Data Systems
RVTEC 2005

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Instrument Lab
Lamont-Doherty Earth Observatory
of Columbia University

And Many Others

Outline

- Overview (what's the problem)
- From bits to data
- An example shipboard data system (USCGC Healy)
  - Acquisition - displays - archive
- What does yours look like?
- Intro to Show and Tell
  - Steve Roberts: Real-time shipboard GIS
  - Kevin Fall: Delay/disturbance tolerant networking
  - Jules Hummon: ADCP xxxxx
  - Ilya Nikanorov: QC System for Marine Technician Operations

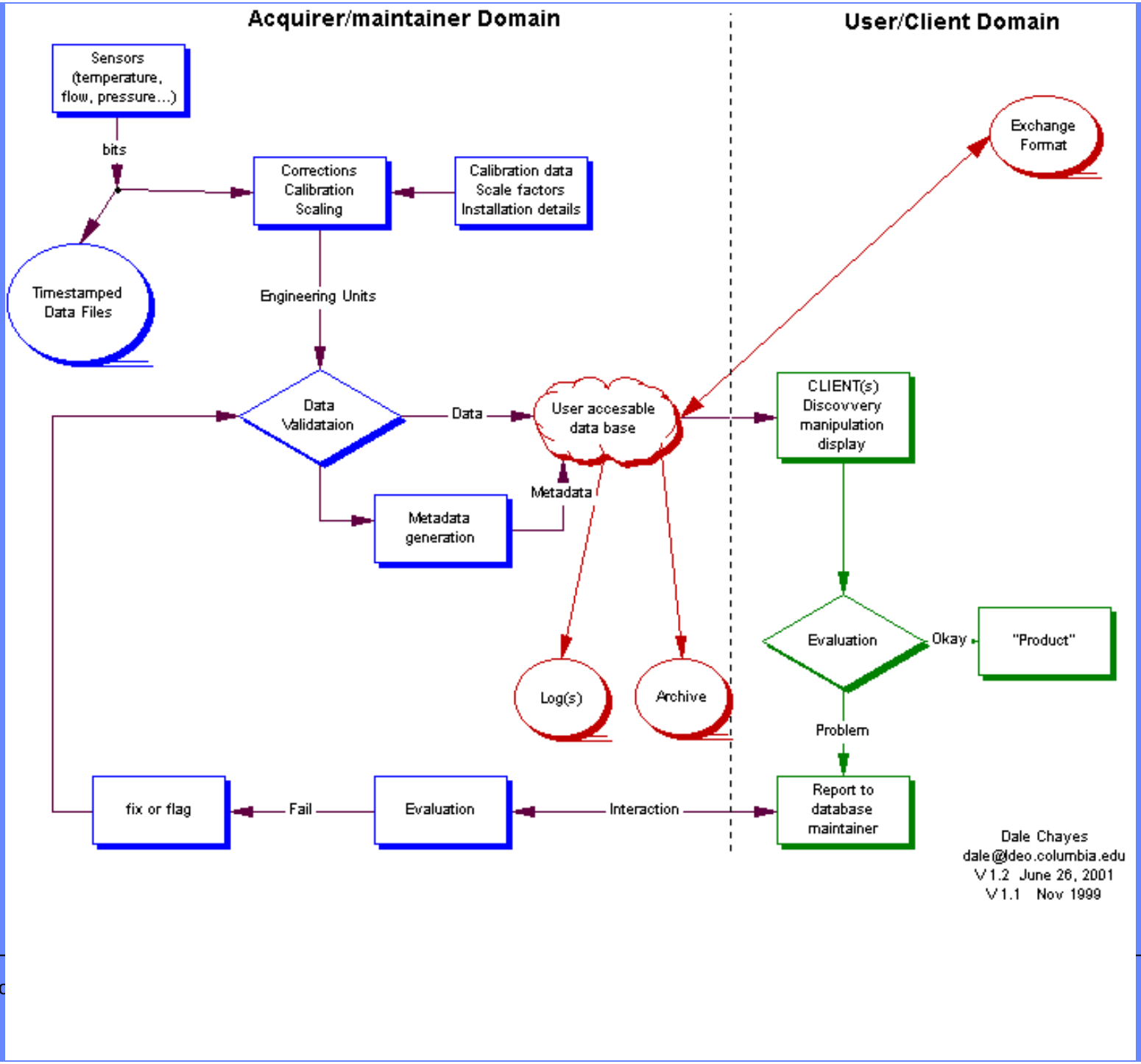
What problem(s) are we trying to solve?

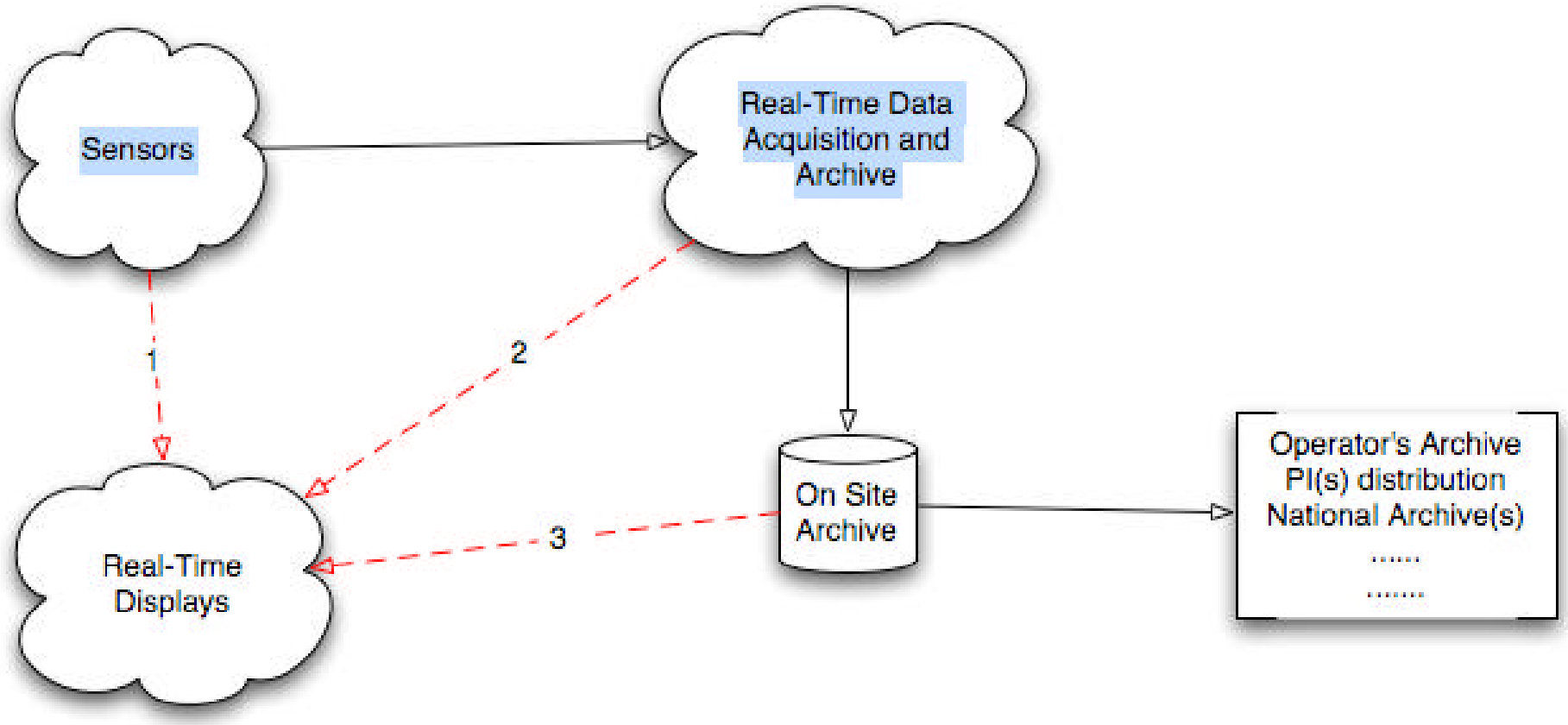
- Satisfy the needs/desires of the current science party, so they can do good science (and get funded to come back again)
- Insure that the data can be used to do good science 10 or 20 or 50 years in the future.
- ?

Some interesting issues to consider

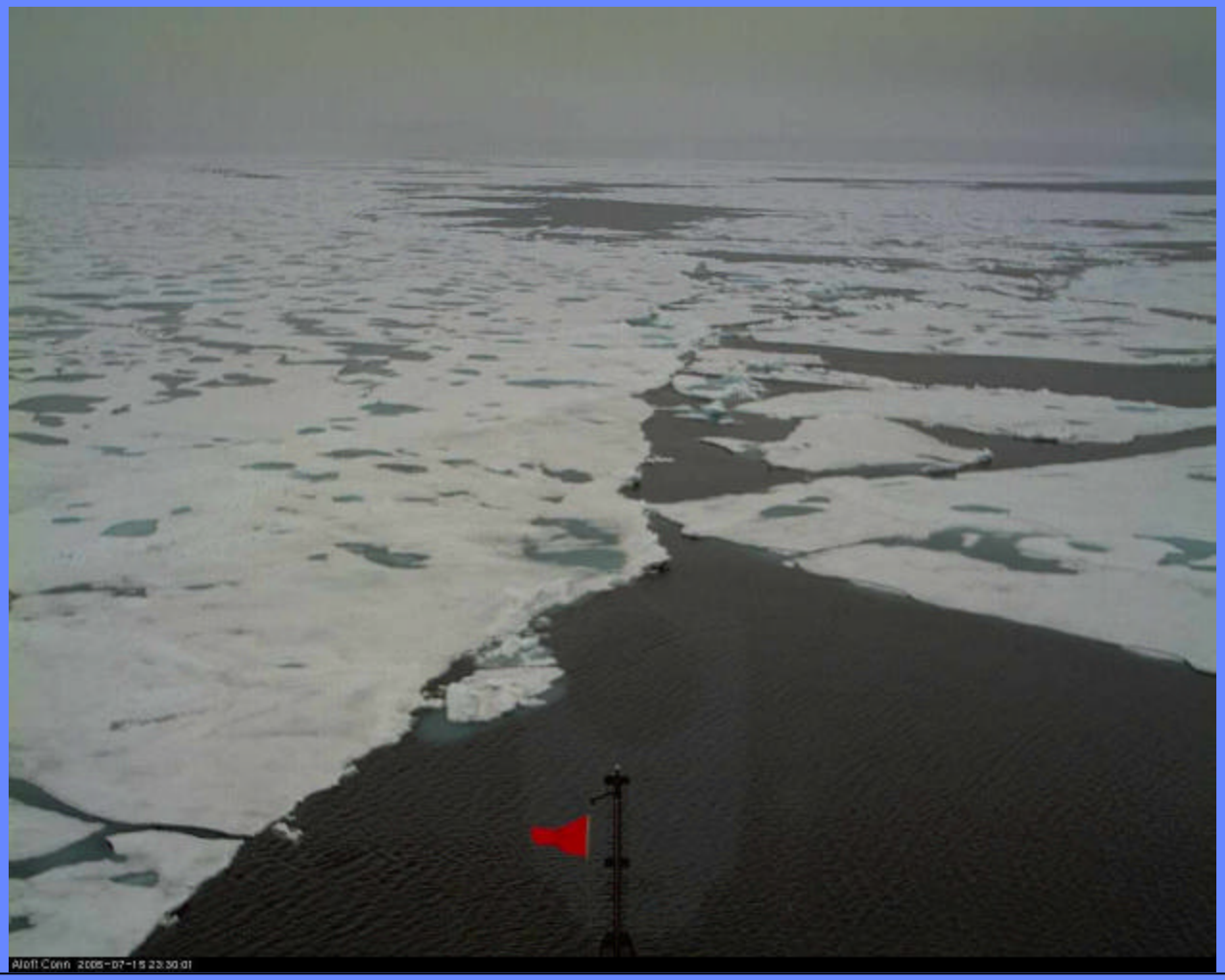
- Longevity
- Maintainability
- Transparency
- Evolvability
- Scalability

from Danny Hillis,The Clock of the Long Now
http://www.longnow.org/projects/clock/


Acquirer/maintainer Domain
User/Client Domain
Sensors (temperature, flow, pressure...)
bits
Corrections Calibration Scaling
Calibration data Scale factors Installation details
Timestamped Data Files
Engineering Units
Exchange Format
Data Validataion
Data
User accesable data base
CLIENT(s) Discovvery manipulation display
Metadata
Metadata generation
Log(s)
Archive
Evaluation
Okay
"Product"
Problem
fix or flag
Fail
Evaluation
Interaction
Report to database maintainer
Dale Chayes
dale@ldeo.columbia.edu
V1.2 June 26, 2001
V1.1 Nov 1999


Sensors
Real-Time Data Acquisition and Archive
1
2
3
Real-Time Displays
On Site Archive
Operator's Archive
PI(s) distribution
National Archive(s)
.....
.....

Healy Science Data System



Categories of data by “type”

- Time of day
- Navigation, Attitude, & Heading
- Sonars (multibeam, sub-bottom, ADCP)
- Physical properties (weather, TSG)

Time of day

the key that ties all
of the data sets together

Healy uses a GPS station clock to provide time of day synchronization across the science network.

All data is time stamped.

All time stamps are not created equal

Navigation Sources

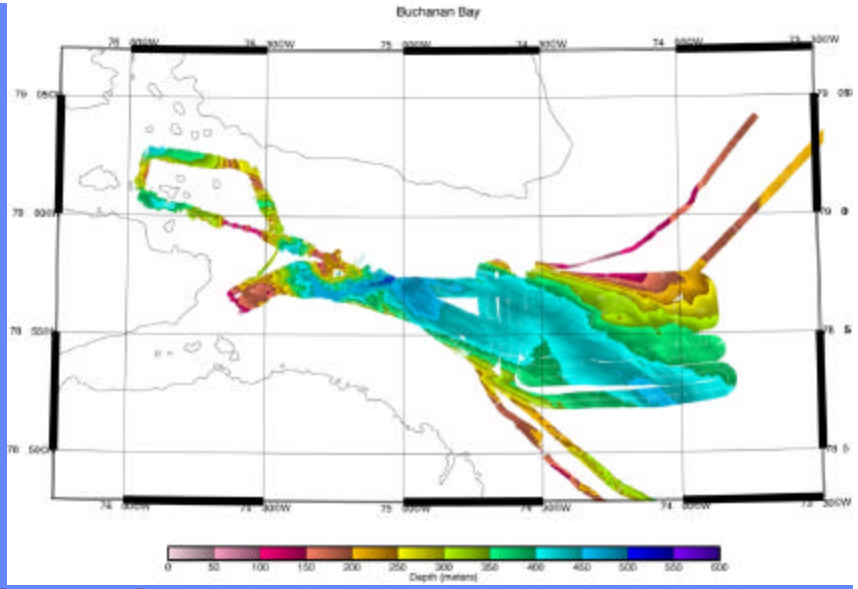
- Rockwell Collins P-Code
- Trimble Centurion P-Code GPS
- Ashtech ADU-5 GPS
- Furuno WAAS GPS
- Ashtech Glonass/GPS
- Applanix POS/MV-320

Text
Text

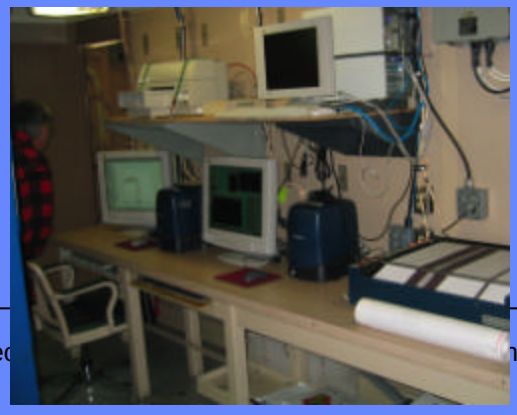
Attitude & Heading

- Sperry MK-37 gyro compasses (2)
- TSS-335 Marine Motion Sensor
- Seatex MRU-6
- Applanix POS/MV-320
- Ashtech ADU5

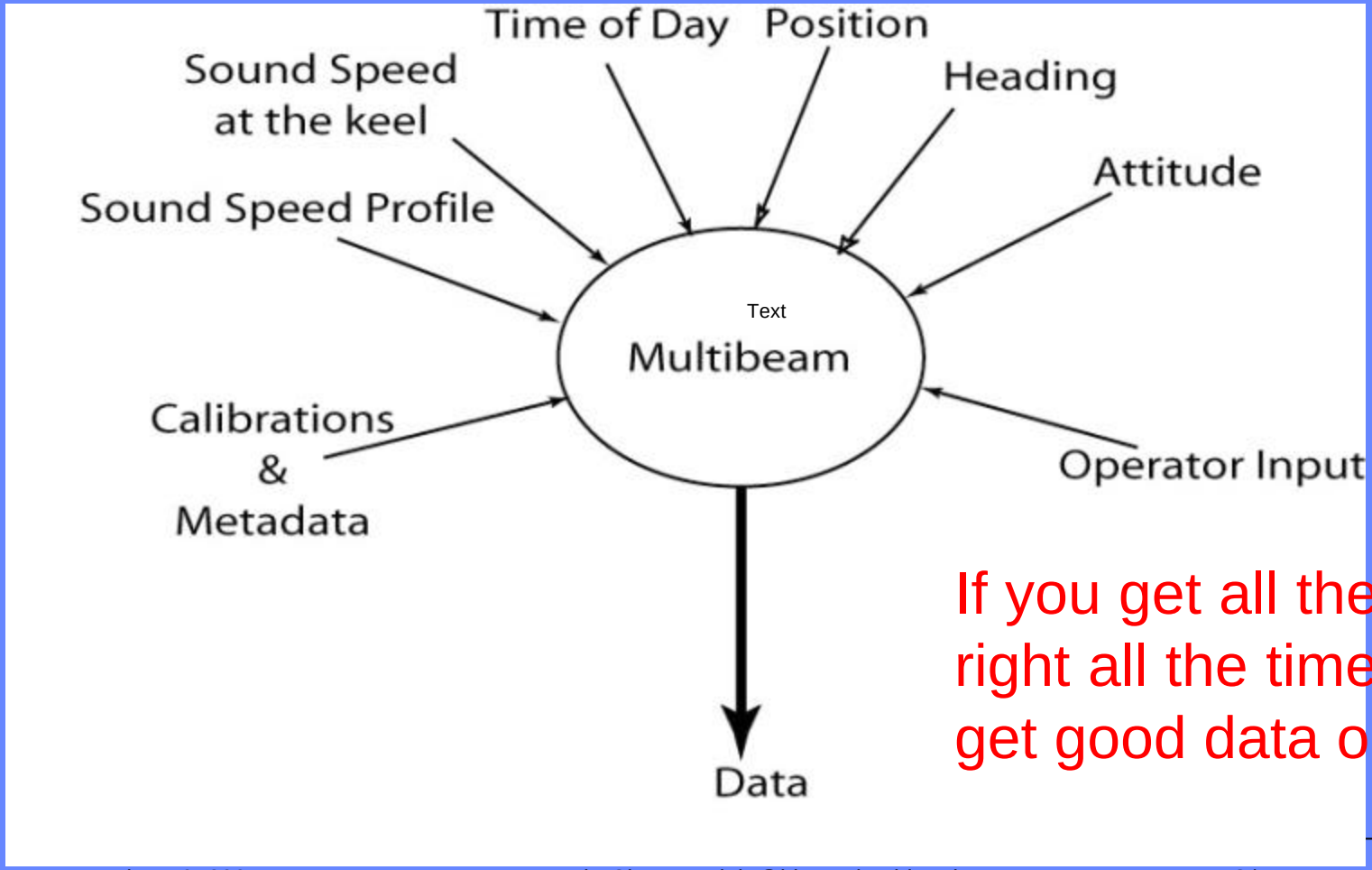
Multiple formed beam sonar: (multibeam) SeaBeam 2112



- 150m - 10,000m water depth
- 12 kiloHertz (cw, short pulse)
- 115º full swath (on a good day)
- seafloor bathymetry
- image (sidescan-like)
- amplitude

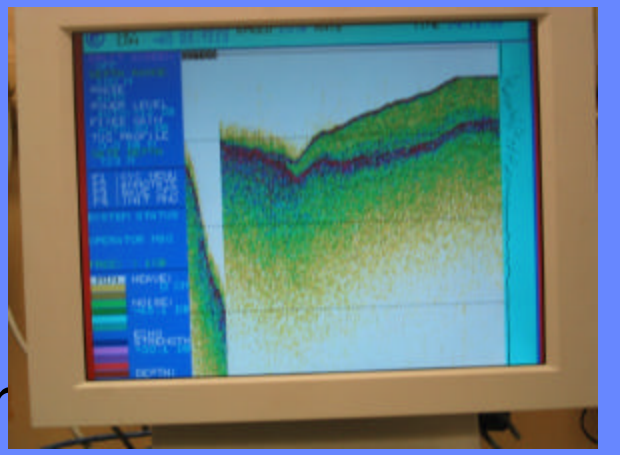


Multibeam data flow



If you get all the inputs right all the time, you get good data out!

Sub-bottom Profilers (2)



- ODEC Bathy 2000 & Knudsen 320
  - CW and FM modulated transmission
  - 2.75 to 6.75 KHz subbottom
  - 12 KHz echo sounder
  - Only one set of transducer arrays for each frequency

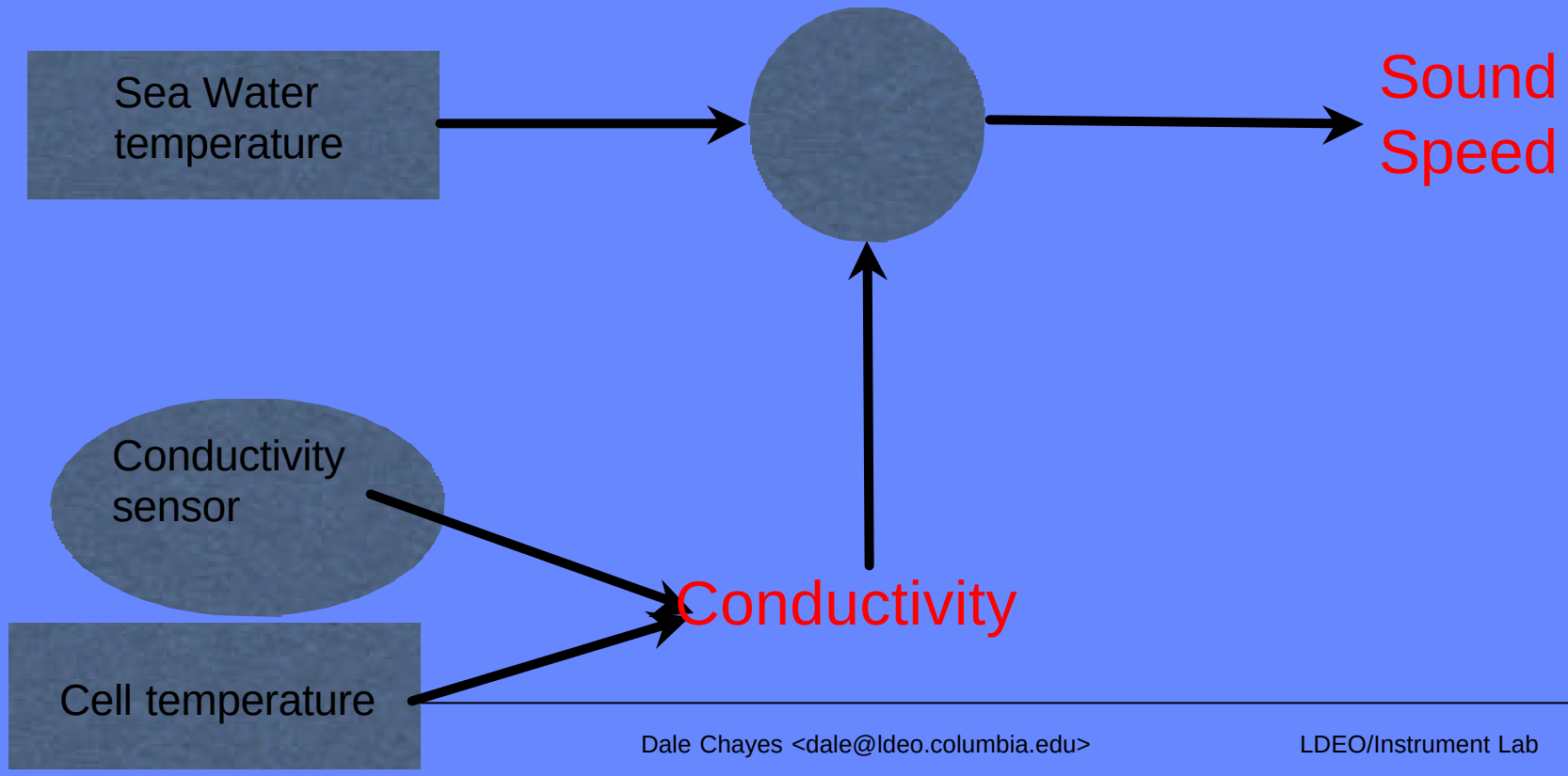
Acoustic Doppler Current Profilers (ADCP)

- RDI ADCP-75 Ocea Surveyor (76.8 KHz
- RDI ACP-150 Broac Band (153.6 KHz)
  - Has an SVP-2000 sound speed probe in the well with it.

Thermosalinographs

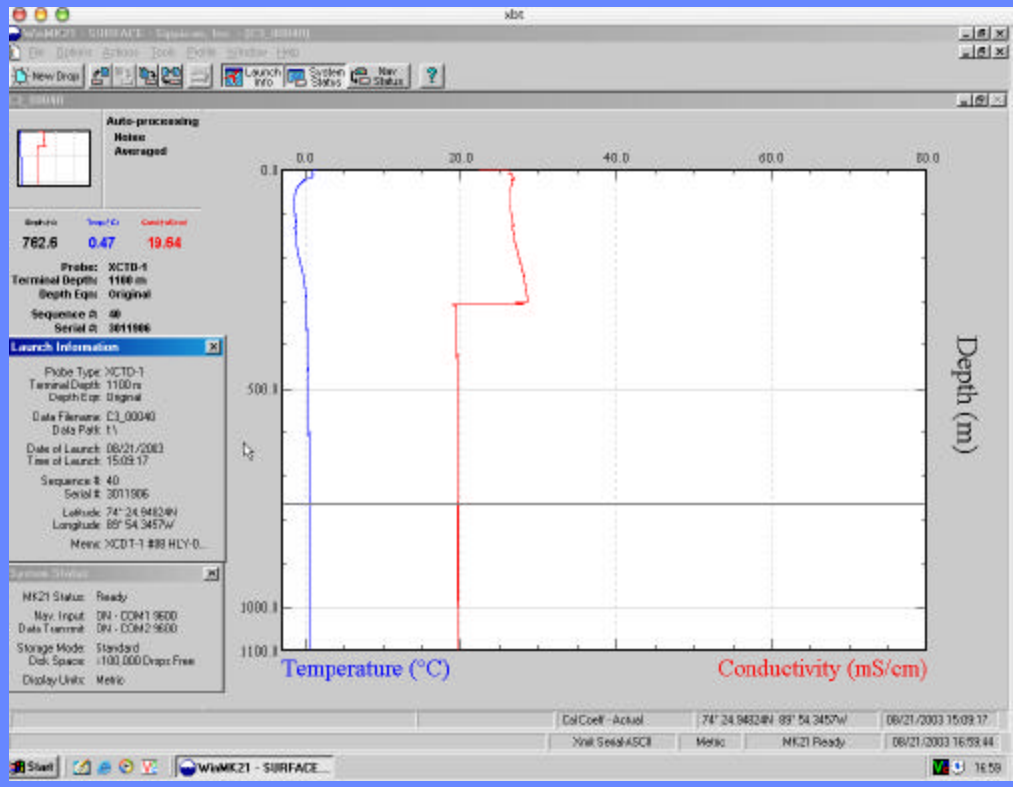
- Sea-Bird Electronics SBE
  - Forward (Biochem Lab)
    - Two remote temperature probes, one for each water intake (old and new)
  - Aft (Aft Hose Reel Room)
    - no remote temperature probe
  - New on this winter in main deck passageway

Calculating sound speed



XBT, XCTD, XSV Probes

- Expendable probes
- XBT provided with multibeam for sound speed profile



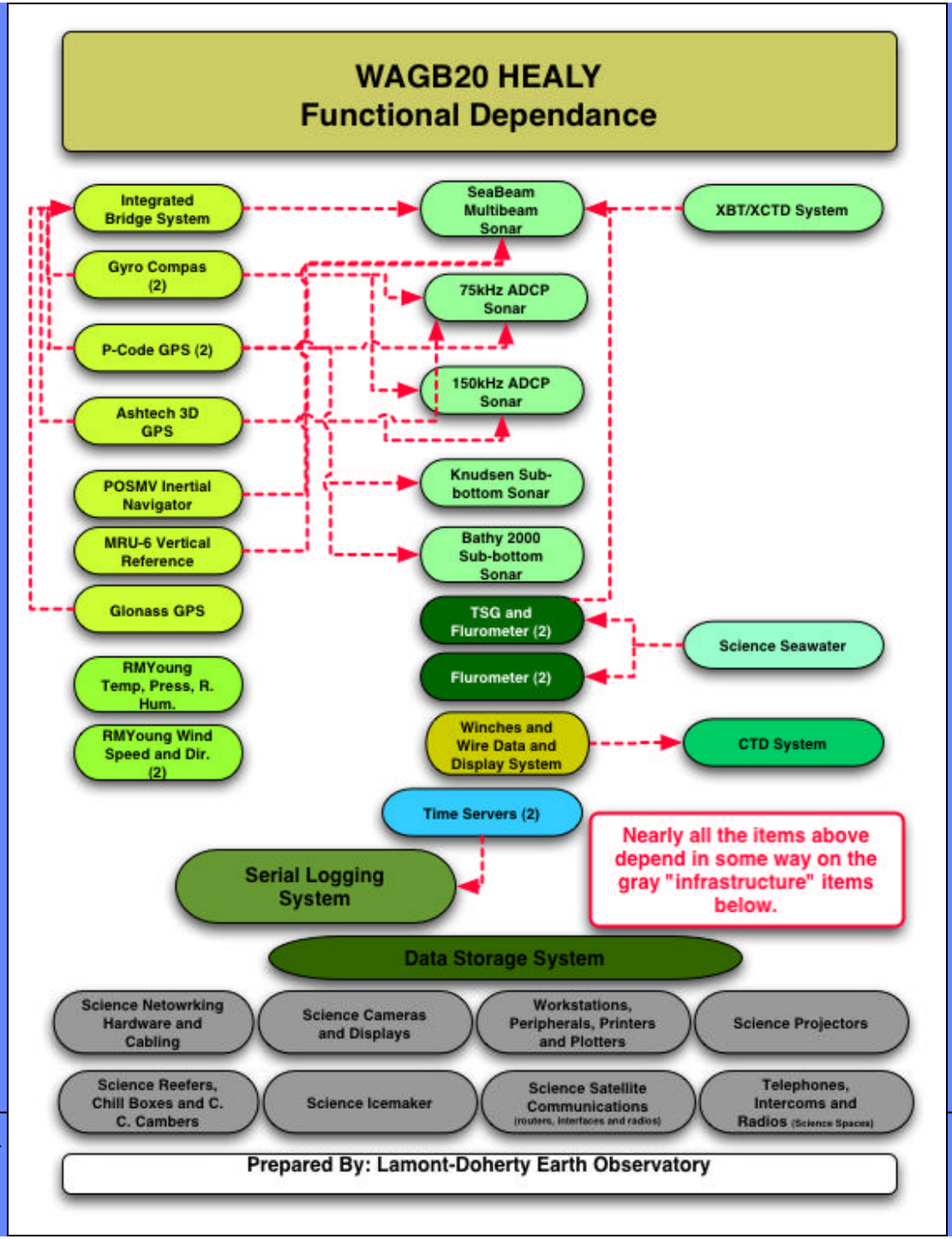
Gravity Meter (temporary*)

- Bell BGM-3 on loan to Dr. Coakley (UAF) from the Navy (NAVIGATION AND GEODESY APPLICATIONS BRANCH of the NAVAL OCEANOGRAPHIC OFFICE)

* for two years now.....

Weather+

- R M Young (and manual)
  - Wind speed & Direction
  - Temperature
  - Humidity
  - PAR (not yet)
  - Atmospheric Pressure
- Terascan

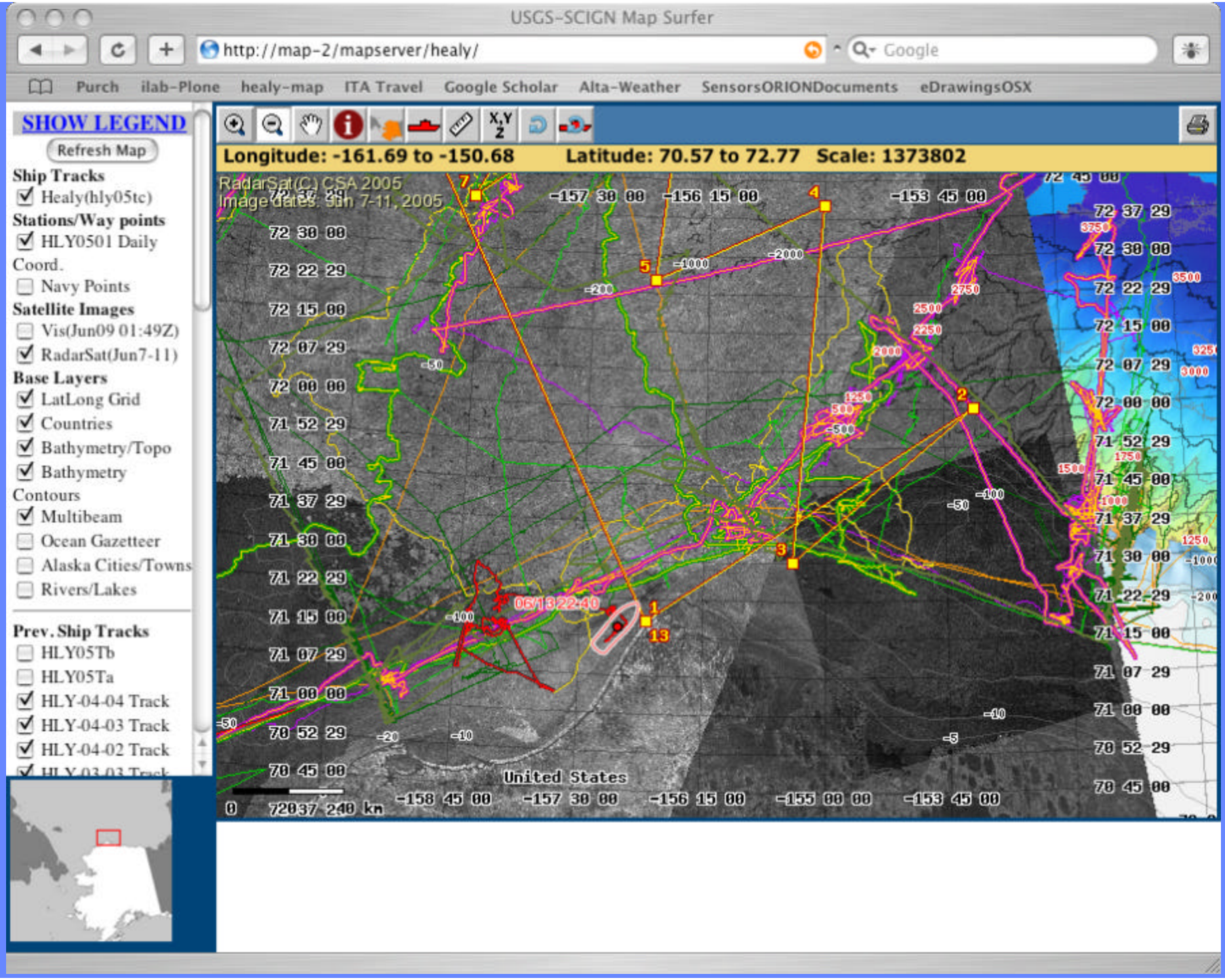

WAGB20 HEALY
Functional Dependance
Integrated Bridge System
Gyro Compas (2)
P-Code GPS (2)
Ashtech 3D GPS
POSMV Inertial Navigator
MRU-6 Vertical Reference
Glonass GPS
RMYoung Temp, Press, R. Hum.
RMYoung Wind Speed and Dir. (2)
SeaBeam Multibeam Sonar
75kHz ADCP Sonar
150kHz ADCP Sonar
Knudsen Sub-bottom Sonar
Bathy 2000 Sub-bottom Sonar
TSG and Flurometer (2)
Flurometer (2)
Winches and Wire Data and Display System
Time Servers (2)
XBT/XCTD System
Science Seawater
CTD System
Serial Logging System
Nearly all the items above depend in some way on the gray "infrastructure" items below.
Data Storage System
Science Netowrking Hardware and Cabling
Science Cameras and Displays
Workstations, Peripherals, Printers and Plotters
Science Projectors
Science Reefers, Chill Boxes and C. C. Cambers
Science Icemaker
Science Satellite Communications (routers, interfaces and radios)
Telephones, Intercoms and Radios (Science Spaces)
Prepared By: Lamont-Doherty Earth Observatory

“Real-time” access to data

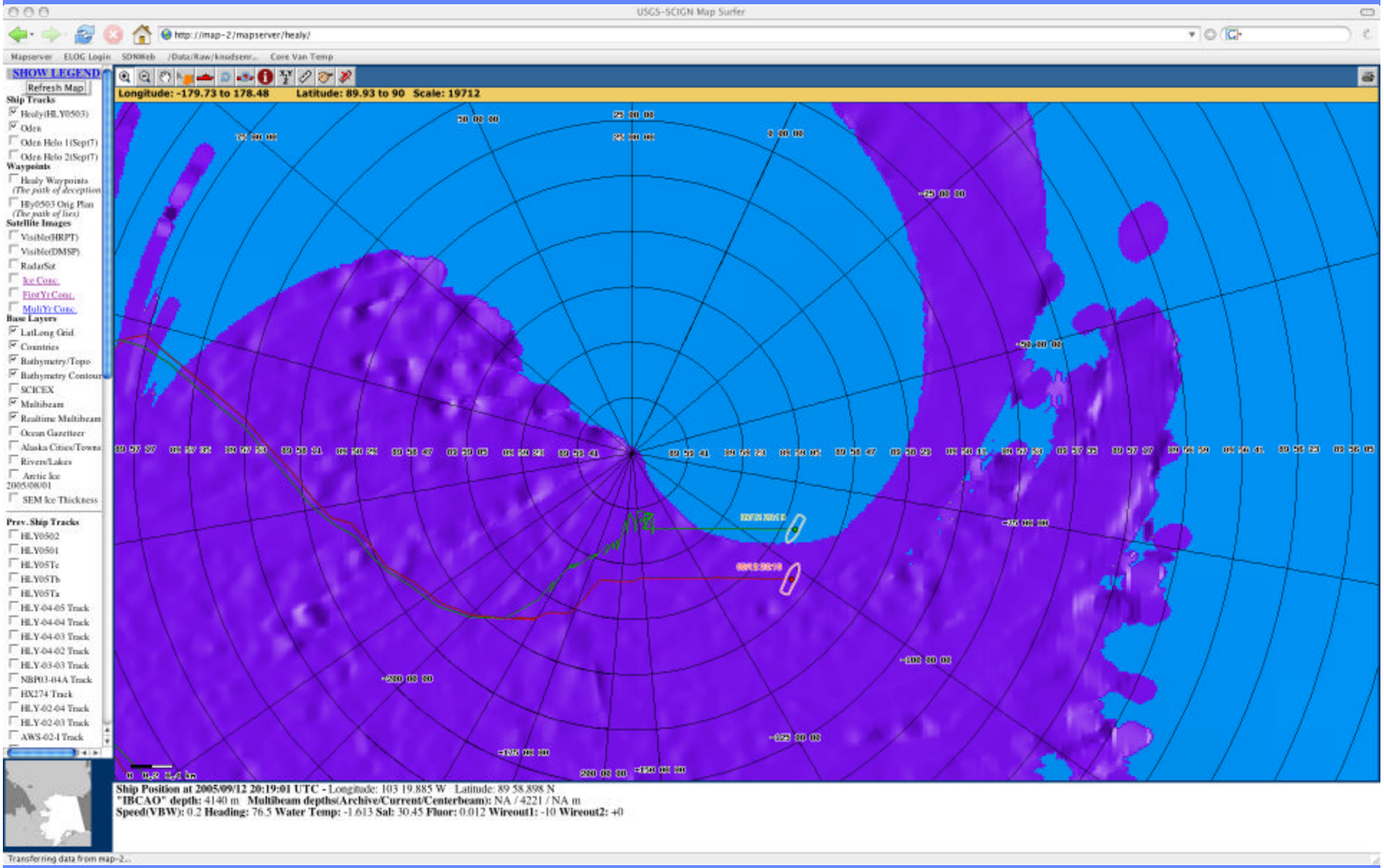
- Read-only file systems
- UDP (broadcast) datagrams (currently)
  - Considering moving to multicast datagrams

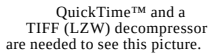
Real-Time Displays

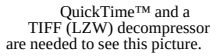
- NOAA SCS
- Mapserver (open source web GIS)
- Labview
- Custom applications


USGS-SCIGN Map Surfer
http://map-2/mapserver/healy/
Google
Purch
ilab-Plone
healy-map
ITA Travel
Google Scholar
Alta-Weather
SensorsORIONDocuments
eDrawingsOSX
SHOW LEGEND
Refresh Map
Ship Tracks
Healy(hly05tc)
Stations/Way points
HLY0501 Daily Coord.
Navy Points
Satellite Images
Vis(Jun09 01:49Z)
RadarSat(Jun7-11)
Base Layers
LatLong Grid
Countries
Bathymetry/Topo
Bathymetry
Contours
Multibeam
Ocean Gazetteer
Alaska Cities/Towns
Rivers/Lakes
Prev. Ship Tracks
HLY05Tb
HLY05Ta
HLY-04-04 Track
HLY-04-03 Track
HLY-04-02 Track
Longitude: -161.69 to -150.68
Latitude: 70.57 to 72.77
Scale: 1373802
RadarSat(C) CSA 2005
Image dates: Sun 7-11, 2005
06/13 22:40
United States
0 72037 240 km


200 00 00
-150 00 00
sia
06/11 02:57
Canada
-175 00 00
-125 00 00
-125 00 00
-175 00 00
66 15 00
-170 30 00
-169 30 00
66 07 29
66 00 00
65 52 29
Russia
65 45 00
65 37 29
65 30 00
65 22 29
65 15 00
65 07 29
65 00 00
64 52 29
64 45 00
64 37 29
-170 00 00
-169 00 00
-168 00 00
-167 00 00
-166 00 00
65 07 29
66 45 00
66 37 29
66 30 00
66 22 29
66 15 00
66 07 29
66 00 00
United States
65 52 29
65 45 00
65 37 29
65 30 00
65 22 29
65 15 00


USGS-SCIGN Map Surfer
http://map-2/mapserver/healy/
SHOW LEGEND
Refresh Map
Ship Tracks
Healy(HLY0503)
Oden
Oden Helo 1(Sept7)
Oden Helo 2(Sept7)
Waypoints
Healy Waypoints
(The path of deception)
Hly0503 Orig Plan
(The path of lies)
Satellite Images
Visible(HRPT)
Visible(DMSP)
RadarSat
Ice Conc.
First Yr Conc.
MultiYr Conc.
Base Layers
LatLong Grid
Countries
Bathymetry/Topo
Bathymetry Contour
SCICEX
Multibeam
Realtime Multibeam
Ocean Gazetteer
Alaska Cities/Towns
Rivers/Lakes
Arctic Ice
2005/08/01
SEM Ice Thickness
Prev. Ship Tracks
HLY0502
HLY0501
HLY05Tc
HLY05Tb
HLY05Ta
HLY-04-05 Track
HLY-04-04 Track
HLY-04-03 Track
HLY-04-02 Track
HLY-03-03 Track
NBP03-04A Track
HX274 Track
HLY-02-04 Track
HLY-02-03 Track
AWS-02-1 Track
Longitude: -179.73 to 178.48
Latitude: 89.93 to 90
Scale: 19712
Ship Position at 2005/09/12 20:19:01 UTC - Longitude: 103 19.885 W Latitude: 89 58.898 N
"IBCAO" depth: 4140 m Multibeam depths(Archive/Current/Centerbeam): NA / 4221 / NA m
Speed(VBW): 0.2 Heading: 76.5 Water Temp: -1.613 Sal: 30.45 Fluor: 0.012 Wireout1: -10 Wireout2: +0
Transferring data from map-2...


QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.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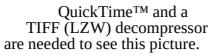
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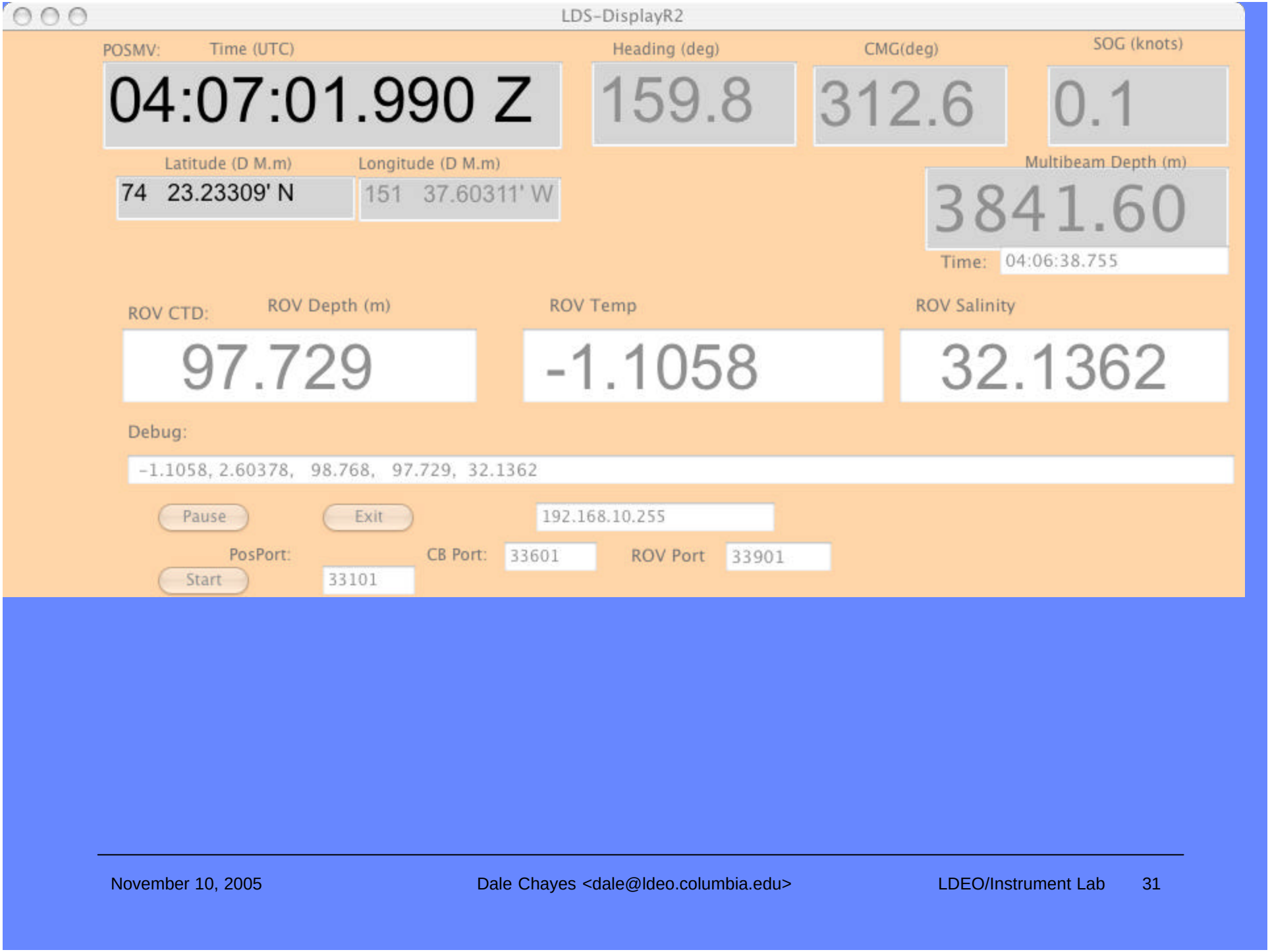
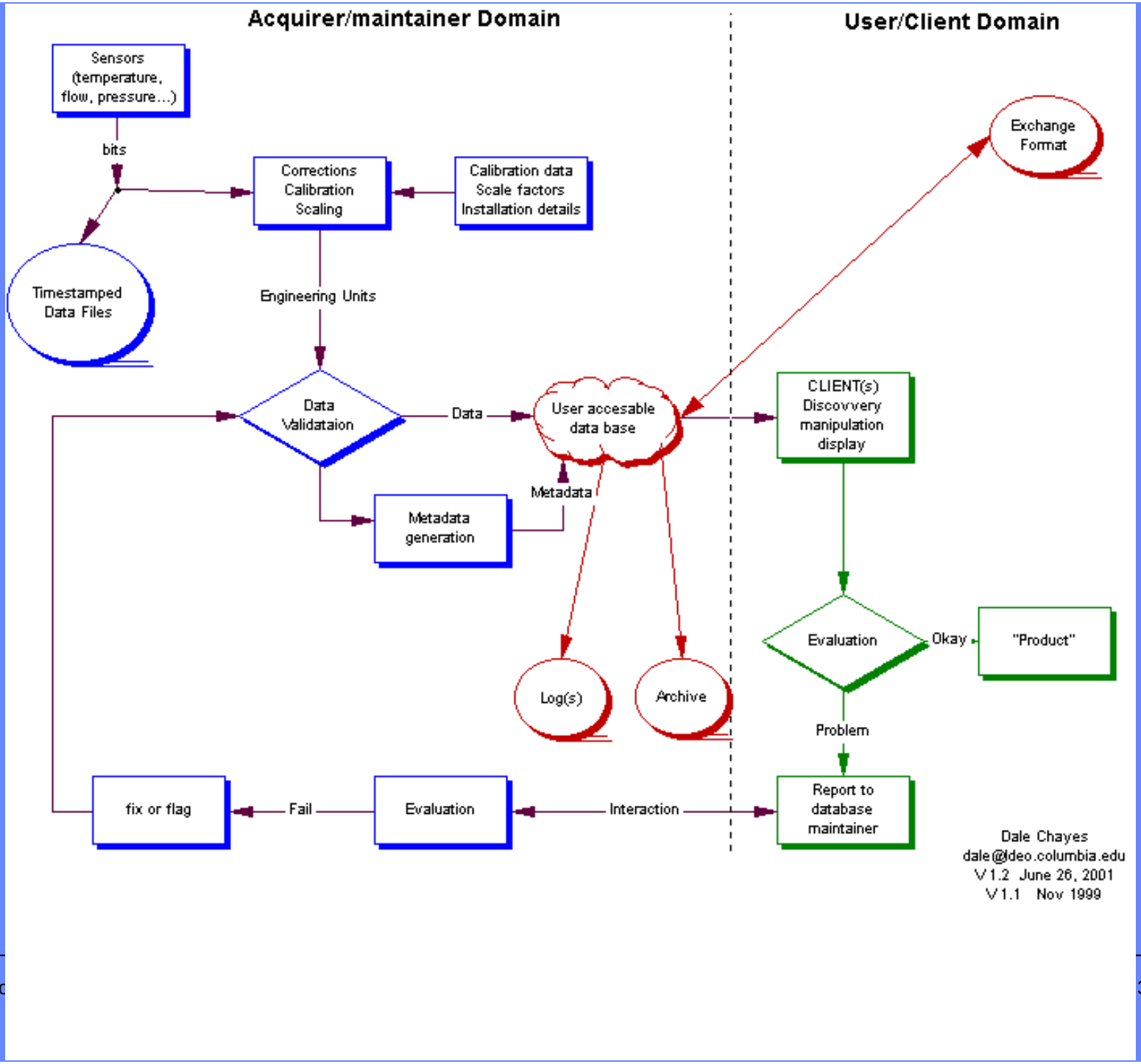

LDS-DisplayR2
POSMV:
Time (UTC)
04:07:01.990 Z
Heading (deg)
159.8
CMG(deg)
312.6
SOG (knots)
0.1
Latitude (D M.m)
74 23.23309' N
Longitude (D M.m)
151 37.60311' W
Multibeam Depth (m)
3841.60
Time:
04:06:38.755
ROV CTD:
ROV Depth (m)
97.729
ROV Temp
-1.1058
ROV Salinity
32.1362
Debug:
-1.1058, 2.60378, 98.768, 97.729, 32.1362
Pause
Exit
192.168.10.255
PosPort:
33101
Start
CB Port:
33601
ROV Port
33901


Acquirer/maintainer Domain
User/Client Domain
Sensors (temperature, flow, pressure...)
bits
Corrections Calibration Scaling
Calibration data Scale factors Installation details
Timestamped Data Files
Engineering Units
Exchange Format
Data Validataion
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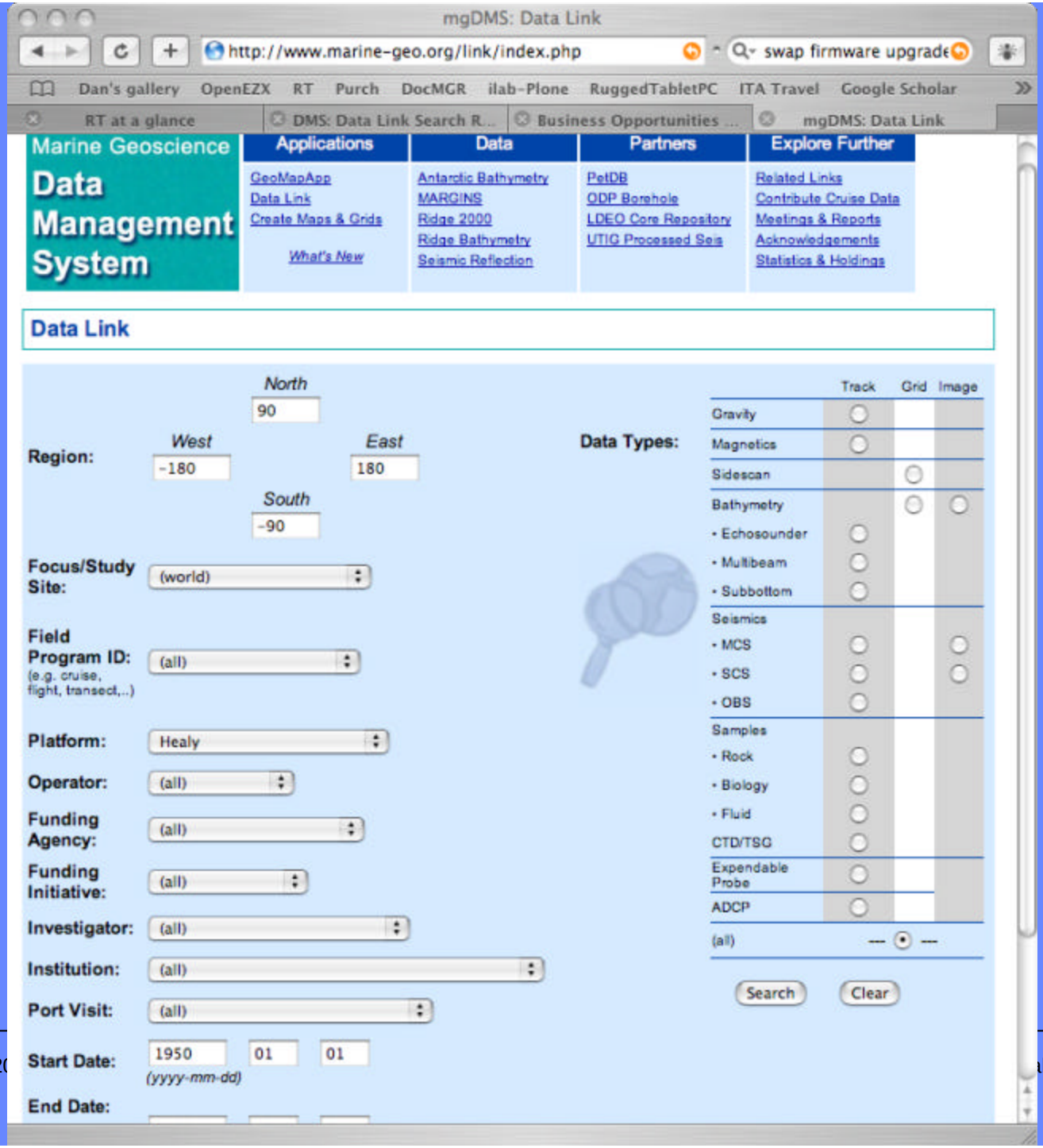
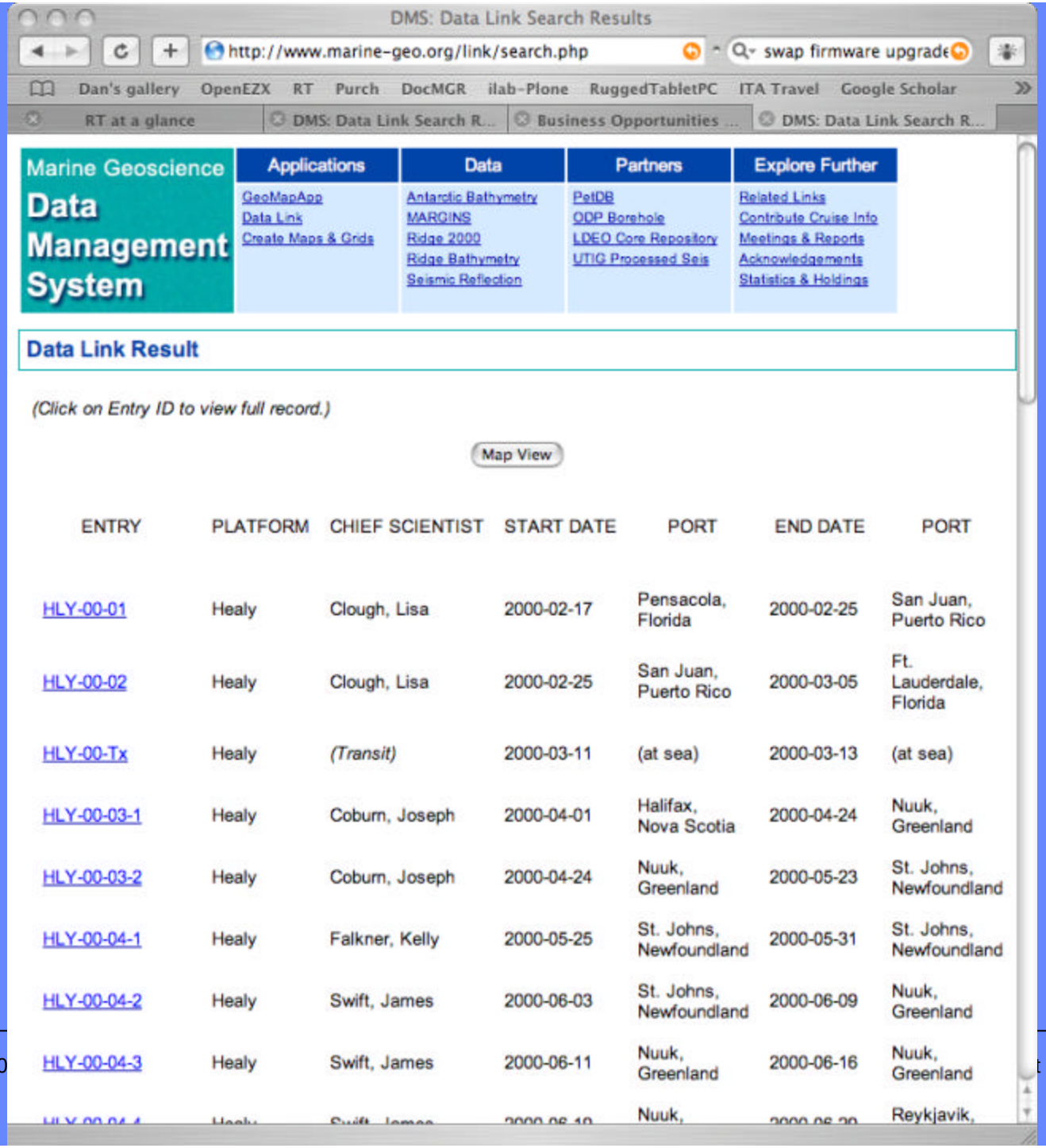

mgDMS: Data Link
http://www.marine-geo.org/link/index.php
swap firmware upgrade
Dan's gallery
OpenEZX
RT
Purch
DocMGR
ilab-Plone
RuggedTabletPC
ITA Travel
Google Scholar
RT at a glance
DMS: Data Link Search R...
Business Opportunities ...
mgDMS: Data Link
Marine Geoscience
Data Management System
Applications
GeoMapApp
Data Link
Create Maps & Grids
What's New
Data
Antarctic Bathymetry
MARGINS
Ridge 2000
Ridge Bathymetry
Seismic Reflection
Partners
PetDB
ODP Borehole
LDEO Core Repository
UTIG Processed Seis
Explore Further
Related Links
Contribute Cruise Data
Meetings & Reports
Acknowledgements
Statistics & Holdings
Data Link
Region:
North
90
West
-180
East
180
South
-90
Focus/Study Site:
(world)
Field Program ID:
(e.g. cruise, flight, transect,..)
(all)
Platform:
Healy
Operator:
(all)
Funding Agency:
(all)
Funding Initiative:
(all)
Investigator:
(all)
Institution:
(all)
Port Visit:
(all)
Start Date:
1950
01
01
(yyyy-mm-dd)
End Date:
Data Types:
Track
Grid
Image
Gravity
Magnetics
Sidescan
Bathymetry
• Echosounder
• Multibeam
• Subbottom
Seismics
• MCS
• SCS
• OBS
Samples
• Rock
• Biology
• Fluid
CTD/TSG
Expendable Probe
ADCP
(all)
Search
Clear


DMS: Data Link Search Results
http://www.marine-geo.org/link/search.php
swap firmware upgrade
Dan's gallery
OpenEZX
RT
Purch
DocMGR
ilab-Plone
RuggedTabletPC
ITA Travel
Google Scholar
RT at a glance
DMS: Data Link Search R...
Business Opportunities ...
DMS: Data Link Search R...
Marine Geoscience
Data Management System
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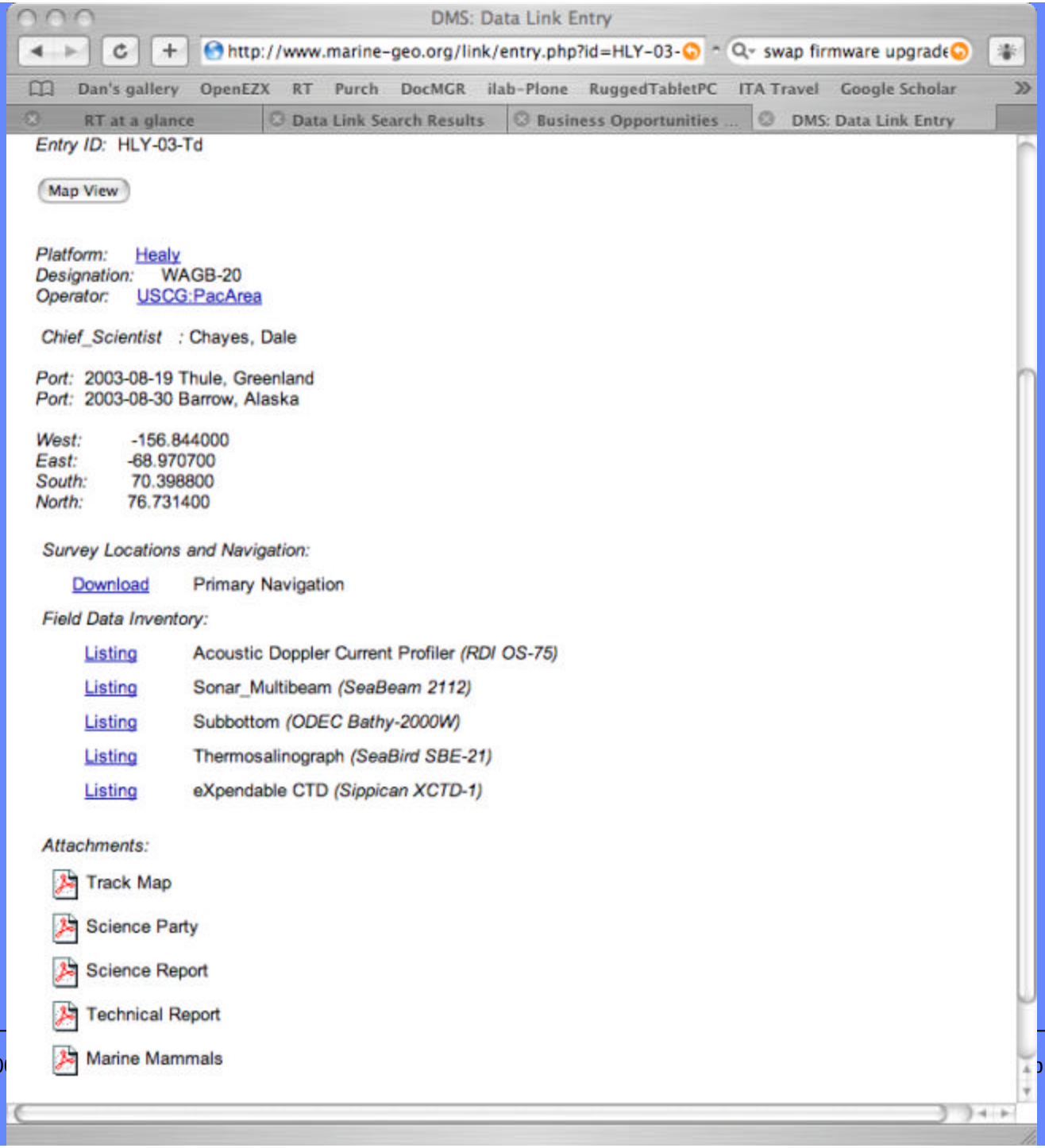
Partners
PetDB
ODP Borehole
LDEO Core Repository
UTIG Processed Seis
Explore Further
Related Links
Contribute Cruise Info
Meetings & Reports
Acknowledgements
Statistics & Holdings
Data Link Result
(Click on Entry ID to view full record.)
Map View
ENTRY
PLATFORM
CHIEF SCIENTIST
START DATE
PORT
END DATE
PORT
HLY-00-01
Healy
Clough, Lisa
2000-02-17
Pensacola, Florida
2000-02-25
San Juan, Puerto Rico
HLY-00-02
Healy
Clough, Lisa
2000-02-25
San Juan, Puerto Rico
2000-03-05
Ft. Lauderdale, Florida
HLY-00-Tx
Healy
(Transit)
2000-03-11
(at sea)
2000-03-13
(at sea)
HLY-00-03-1
Healy
Coburn, Joseph
2000-04-01
Halifax, Nova Scotia
2000-04-24
Nuuk, Greenland
HLY-00-03-2
Healy
Coburn, Joseph
2000-04-24
Nuuk, Greenland
2000-05-23
St. Johns, Newfoundland
HLY-00-04-1
Healy
Falkner, Kelly
2000-05-25
St. Johns, Newfoundland
2000-05-31
St. Johns, Newfoundland
HLY-00-04-2
Healy
Swift, James
2000-06-03
St. Johns, Newfoundland
2000-06-09
Nuuk, Greenland
HLY-00-04-3
Healy
Swift, James
2000-06-11
Nuuk, Greenland
2000-06-16
Nuuk, Greenland
Nuuk,
Reykjavik,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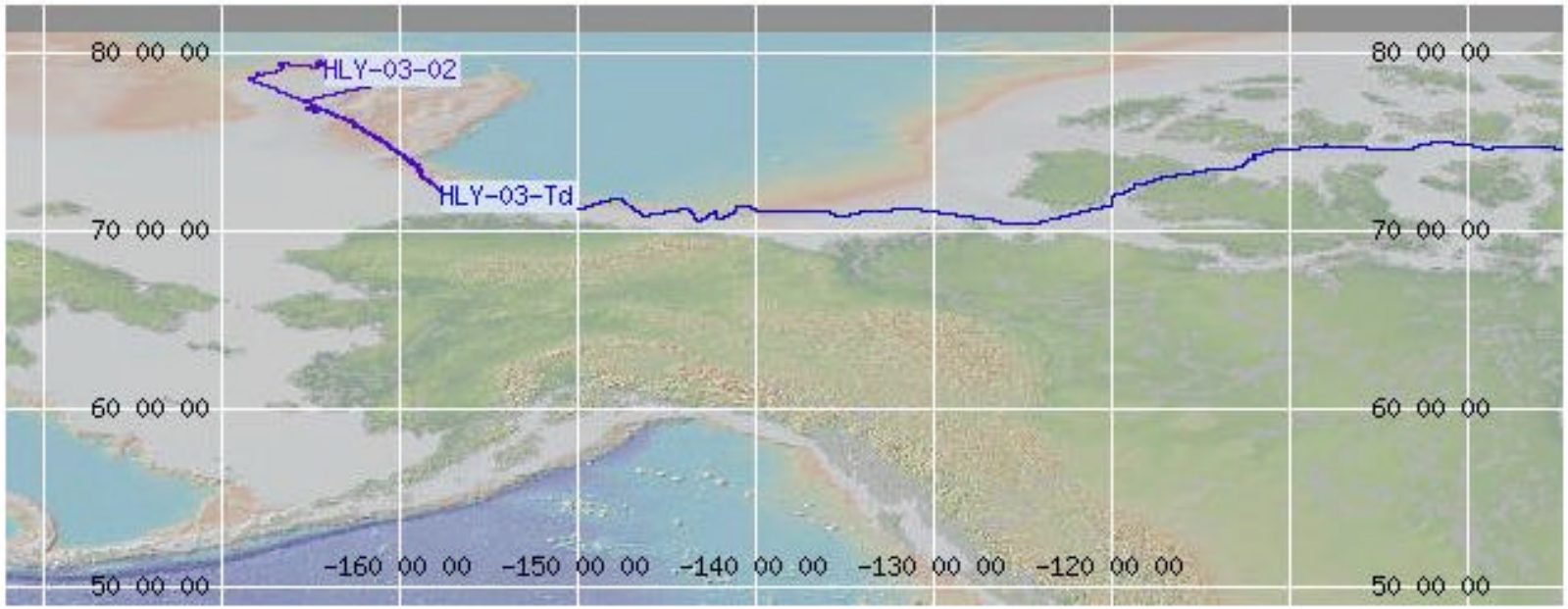
OpenEZX
RT
Purch
DocMGR
ilab-Plone
RuggedTabletPC
ITA Travel
Google Scholar
RT at a glance
Data Link Search Results
Business Opportunities ...
DMS: Data Link Entry
Entry ID: HLY-03-Td
Map View
Platform: Healy
Designation: WAGB-20
Operator: USCG:PacArea
Chief_Scientist : Chayes, Dale
Port: 2003-08-19 Thule, Greenland
Port: 2003-08-30 Barrow, Alaska
West: -156.844000
East: -68.970700
South: 70.398800
North: 76.731400
Survey Locations and Navigation:
Download Primary Navigation
Field Data Inventory:
Listing Acoustic Doppler Current Profiler (RDI OS-75)
Listing Sonar_Multibeam (SeaBeam 2112)
Listing Subbottom (ODEC Bathy-2000W)
Listing Thermosalinograph (SeaBird SBE-21)
Listing eXpendable CTD (Sippican XCTD-1)
Attachments:
Track Map
Science Party
Science Report
Technical Report
Marine Mammals

mgDMS: Data Link: Map View

Data Link: Map View



Click Map:
- ○ Re-Center
- ◉ Zoom In
- ○ Zoom Out

Factor: 2

Display Layers:
- ☑ Navigation
- ☑ Stations
- ☑ Global DEM *
- ☑ Lat/Lon Grid
- ☑ Coastlines

(under development)

Scale:

0 — 570 mi

Mode: Browse

Powered by MapServer and PostGIS

Healy Summary

- Mix of:
  - NOAA/SCS (Win)
  - LDS (Linux)
  - Vendor's apps, eg.g (ADCP, Multibeam, Subbottoms, Terascan, TSG
- Common network RAID array(s)
- Win, OS X, and Linux "seats" via wired and wireless

Credits

- Healy crew (MSTs) El McFadden
- David Hasseliv
- Val Schmidt
- Ethan Gold
- Anthony Johnson
- Will Handley
- Steve Roberts
- Richard Perry
- Bob Arko
- William J Robinson
- Jay Ardai
- Kevin Fall
- Many from the Conrad, Ewing, Palmer and SCAMP data systems
- The open source community including Minnesota Mapserver, Perl, MB-System, GMT, and many others

Healy Real-time mapserver

Steve Roberts

(Demo in Show & Tell)

Delay Tolerant Networking

Kevin Fall

Intel Research Berkley

(Talk here and Poster in the Show & Tell)

ADCP Acquisition and Processing

Jules Hummon

(Demo in Show & Tell)

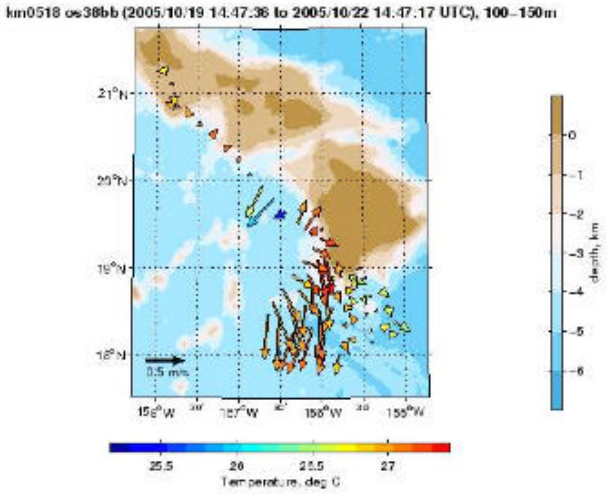
University of Hawaii

ADCP data acquisition and processing

"UHDAS"

- linux computer
- using C, Matlab, Python
- simple gui
- flexible data acquisition system
- builds on CODAS processing
  - open source
  - suitable for NODC submission
- works with all common RDI models
- works with 1-2 (or more) ADCPs
- serial data shared between instruments
- sends daily email with status and data

Daily email contains status and data



Uses:

- Education
- Public Relations
- Outreach
- Ocean Observing
- Monitoring (of the instrument and the acquisition system)

http://currents.soest.hawaii.edu/uhdas_fromships.html

AT SEA

Access to raw and processed data

- Windows shares (Samba)
- NFS export
- shipboard web (Thursday show-n-tell)
  - data and figures
  - documentation for processing
  - processing programs
  - calibrations

Single-ping data:

- signal return (bioacoustics)
- data quality (bubbles, ice, bottom depth)
- instrument comparisons

Processed data:

- dynamic sampling schemes
- following drifting instrumentation
- interpreting science during the cruise

Next UHDAS goals:

- better documentation for installation and post-processing of at-sea data
- better packaging for installation
- additional single-ping editing options

Longer-term goals

- Completely "open source" (no license fees: no Matlab)

Problems and challenges:

- permission to release processed data
- gps-derived heading devices
  - what is an acceptable heading source?
  - eg. Furuno gps gyro: no comparison yet

Quality Control System for Marine Technician Operations

Ilya Nikanorov

(Demo in Show & Tell)