Delay Tolerant Networking in Maritime Networks

Summer 2006--DTN and Oceanography at WHOI

Kevin Fall

Andrew Maffei

Woods Hole Oceanographic Institution & Intel Research

Sep 15, 2006 – SIGCOMM CHANTS Workshop – Pisa, Italy

Goals

- Increase comms robustness/reliability
  - above & under-water challenged environment
  - wi-fi, satellite, uam's
  - AUV's buoys, ships
- Common infrastructure
  - develop applications once
  - do not burden oceanographer with details

Oceanography Application DTN Needs (Hopes?)

- Works in challenging comms environment (acoustic,etc)
  - Multi-path, low BW, power conservation, etc.
- Reduce application development time by providing consistent/easy API for comms
- Work *seamlessly* over a variety/multitude of platforms (AUVs, buoys, ships) including both laptops (on ships) and low power and small packaging (on moorings).
- Initial features of interest to oceanography:
  - UDP-DTN tunnel to support existing data delivery apps
  - Transparent multi-hop file transfer to/from platforms
  - Data tree mirroring where different parts of tree have different characteristics (comm-link, priority, BW-limits)

Initial Features of Interest

- Support for unmodified applications
  - UDP-DTN tunnel to support existing data delivery apps [instruments and loggers]
  - Transparent multi-hop file transfer to/from sometimes-connected platforms
  - Data tree mirroring where different parts of tree have different characteristics (comm-link, priority, BW-limits)

RVTEC's SWAP

swap The Ship to Ship Ship to Shore Wireless Access Protocol

- WIFI comms btwn ships, shore, and buoys
- 60 current installations {UNOLS}
- Works well w 2 or 3 node, major routing problems with more than this.

http://sssg1.whoi.edu/swap

Inside SWAP

- x86-based SBC's with 802.11b WiFi
  - (ships/shore have 1 or 2 omni's)
- HostAP with WDS
- Auto IP address assignment (Aladin)
- Routing using OSPF
- Observations
  - works for 2-node case
  - cycle during intermittency:
    - WDS links -> IP assignment -> reroute
    - WDS links are p2p: $O(n^2)$ adjacencies

Toward SWAP2

- Kevin's 2nd/3rd shift job for July
- Same hardware as original SWAP H/W
- Other changes
  - Operates WiFi in Ad-hoc mode
  - Includes AODV routing [w/Gateways]
  - Includes dtn daemon + storage

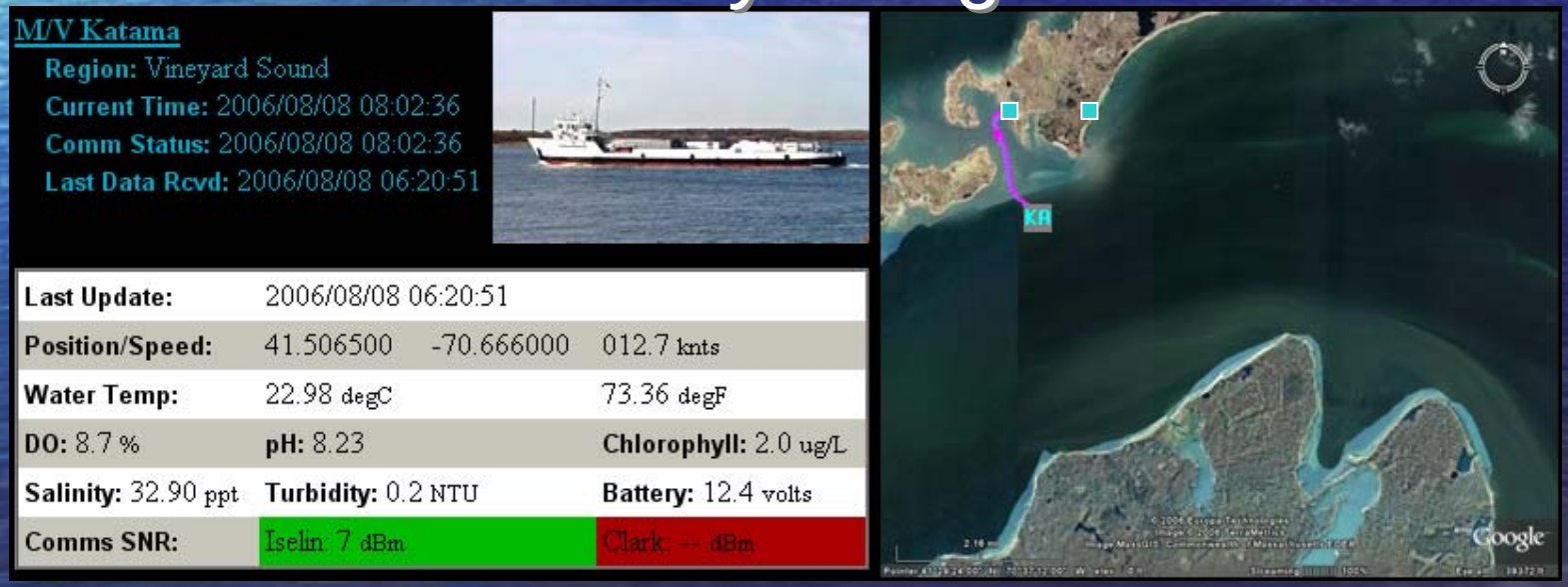
- Added ntpd, dtntunnel, dtnd, dnsmasq, pptpd as standard part of the SWAP2 package

Comment on MANET

- Ship connectivity
  - all (can) have SWAP Wi-Fi
  - only a few have Internet {HighSeasNet}
- Want ad-hoc net among ships
  - should be easy
  - but need multi-homing and gw discovery
- Started with Uppsala's aodv
  - "supports" gateways
  - a few unresolved issues remain
    - [e.g. IP-IP MIP encapsulation issue]
  - (your good idea here; MIT's roofnet?)

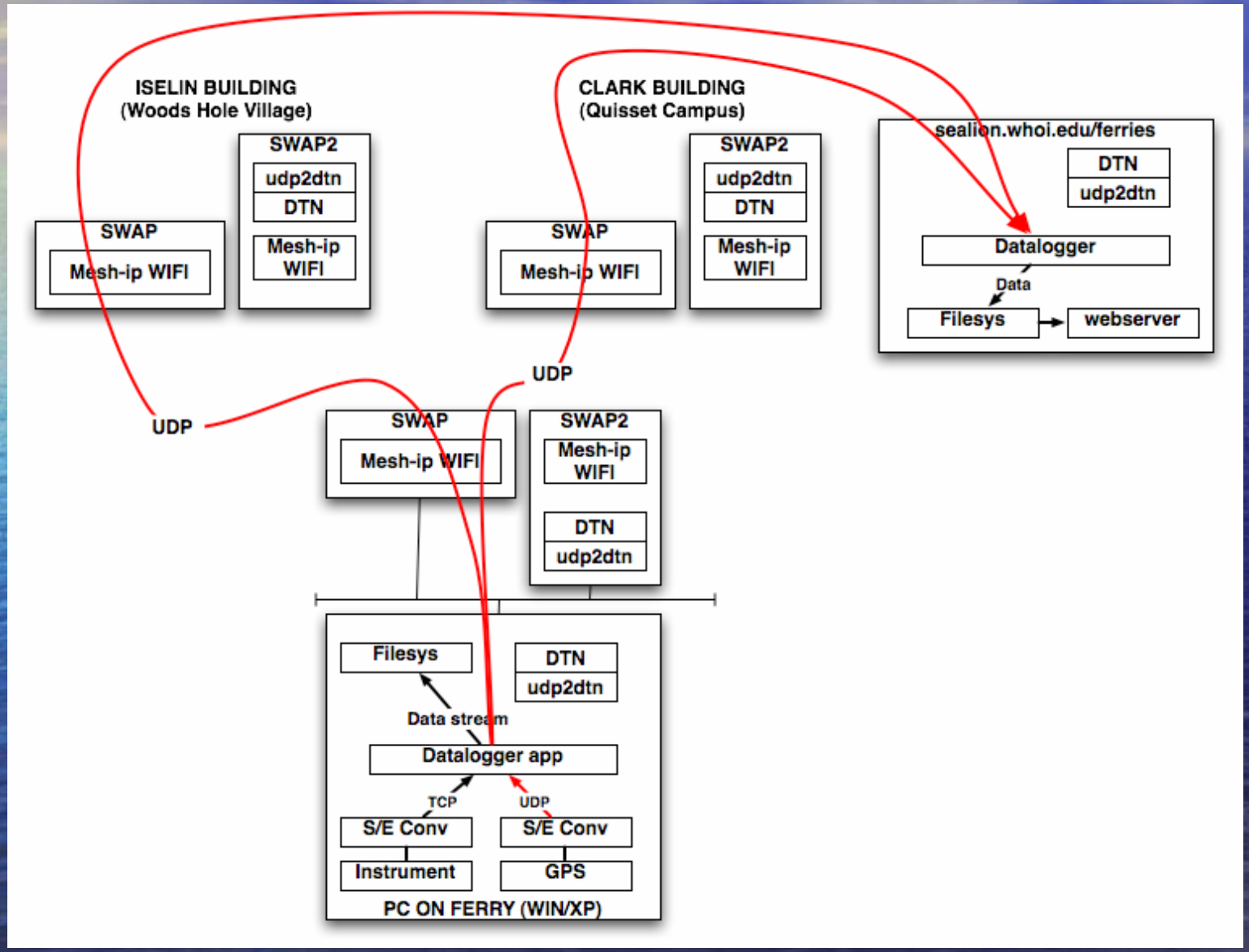
MV Ferry Experiment Status

- Reliable data delivery from a MV ferry
- SWAP & SWAP2 installed in 3 locations
- Science instruments up and running w SWAP, website is live.
- SWAP2 is currently being tested



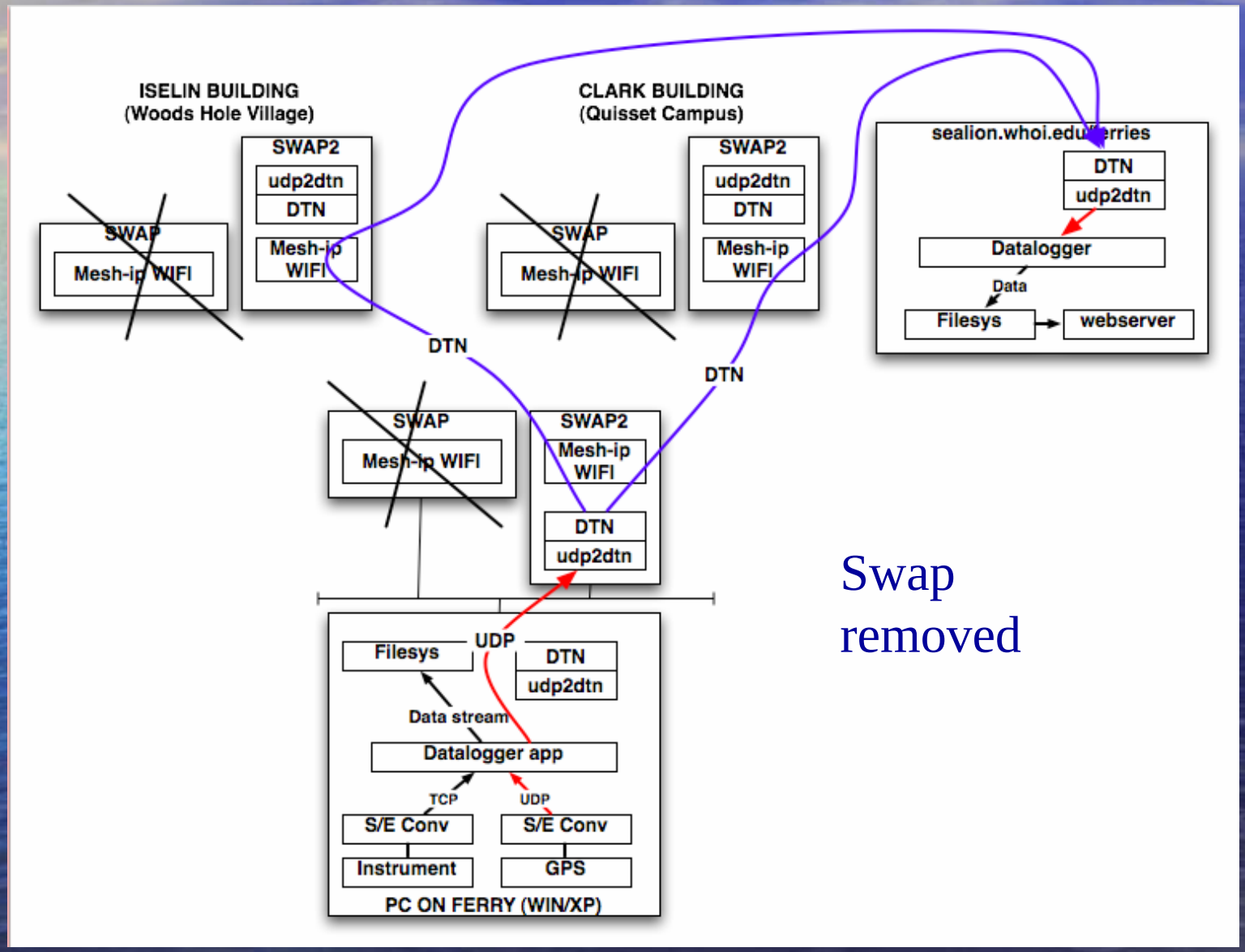
http://sealion.whoi.edu/ferries

MV Ferry Experiment - Now



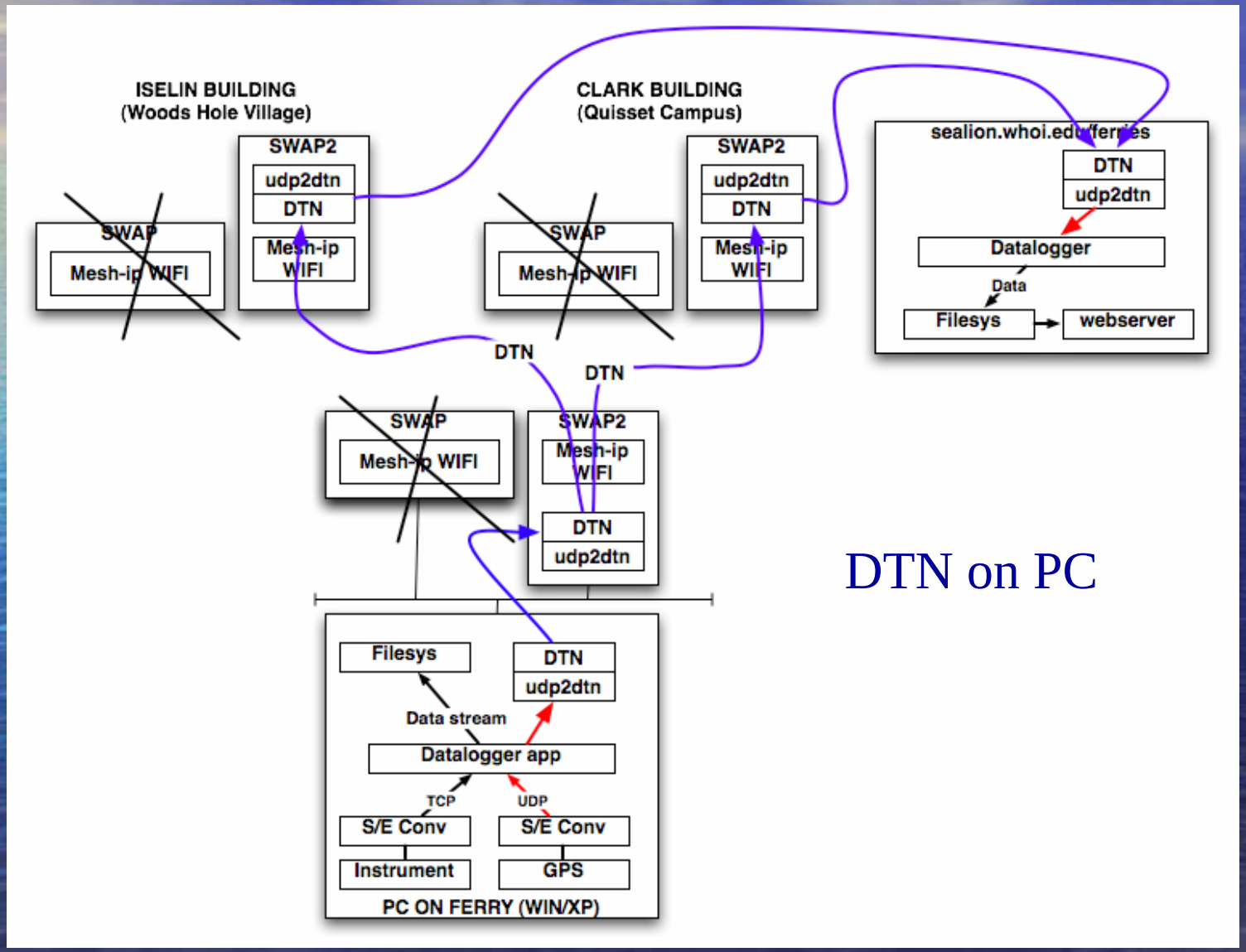
MV Ferry Experiment Status

MV Ferry Experiment - Soon



Swap removed

MV Ferry Experiment - Later



DTN on PC

Desired Enhancements to DTN

- Bandwidth limits for dtntunnel (so links are not overwhelmed after down for some time)
- More convergence layers (Cellphone, IRIDIUM, Acoustic Modem)
- Alternative to TCP for transport
  - UDP with erasure coding?
- Routing based on $$$
- Bandwidth, priority, and link control at application (dtntunnel) layer.
- More intuitive ‘dtnping’ operation
- UDP multicast for dtntunnel

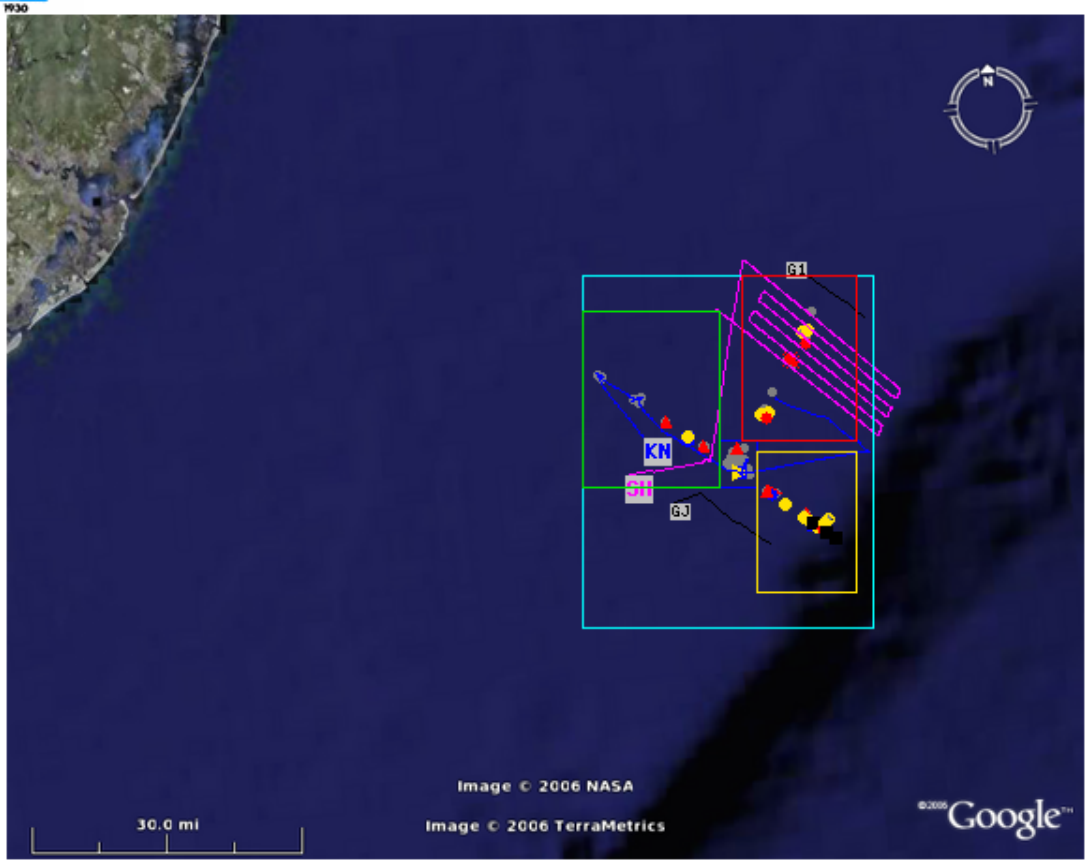
Shallow Water ‘06 Application

- Multi-platform / Multiple PI logistics support
- Recently completed
- 6 ships, 57 moorings, 25 PIs
- 2 (larger) ships as Satcom / WIFI gateways
- Moorings, gliders, ships, AUVs, aircraft.
- C-band, Ku-band, 802.11, low-speed RF, underwater acoustic comms, Iridium.
- Linux laptops run mirrored websites on all ships. Currently employs `rsync` in very controlled manner. DTN would provide a scalable solution for a future implementation.

Shallow Water '06 Application

SW06 Logistic Map - *Actual* Display

Current Time: 2006/08/05 10:25:50 GMT Display Time: 2006/07/31 00:44:00



Plan Actual Zoom: Full SW06 CTR NW NE SE

2006

Jul: 21 22 23 24 25 26 27 28 29 30 31

Aug: 01 02 03 04 05

Hour: 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23

View *Live!*

Events

07/30 21:46	codar	new codar update
07/30 21:46	glider	new glider update
07/30 22:33	weather	new weather update
07/30 22:46	codar	new codar update
07/30 22:46	glider	new glider update
07/30 23:46	codar	new codar update
07/30 23:46	glider	new glider update
07/31 00:44	weather	new weather update
07/31 00:47	codar	new codar update
07/31 00:47	glider	new glider update
07/31 01:47	codar	new codar update
07/31 01:47	glider	new glider update
07/31 02:47	codar	new codar update

Submit Text Event:

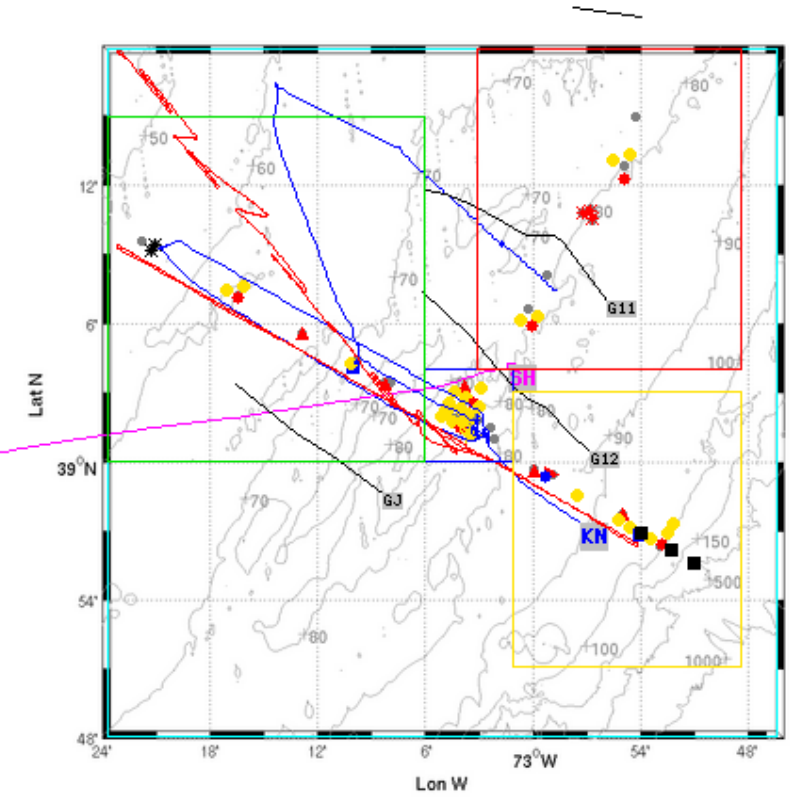
Report Viewers and Summaries

Significant Events	Daily Reports	Weather Reports	Logistics Forms	Related Links
Codar/SST Reports	Glider Reports	Model Reports	Satellite SAR	
Platforms	Ship Sch	Sat Sch	Freq Sch	Comms

Shallow Water '06 Application

SW06 Logistic Map - *Actual* Display

Current Time: 2006/08/05 10:30:45 GMT Display Time: 2006/08/03 00:54:11



Plan Actual Zoom: Full SW06 CTR NW NE SE

Events

08/02 21:49	weather	new weather update
08/02 21:53	codar	new codar update
08/02 21:53	glider	new glider update
08/02 22:53	codar	new codar update
08/02 22:53	glider	new glider update
08/02 22:54	glider	new glider update
08/02 23:54	codar	new codar update
08/02 23:54	glider	new glider update
08/03 00:54	codar	new codar update
08/03 00:54	glider	new glider update
08/03 01:00	weather	new weather update
08/03 01:54	codar	new codar update
08/03 01:55	glider	new glider update
08/03 02:55	codar	new codar update

Submit Text Event:

2006

Jul: 21 22 23 24 25 26 27 28 29 30 31

Aug: 01 02 03 04 05

Hour: 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23

View *Live!*

Report Viewers and Summaries

Significant Events	Daily Reports	Weather Reports	Logistics Forms	Related Links
Codar/SST Reports	Glider Reports	Model Reports	Satellite SAR	
Platforms	Ship Sch	Sat Sch	Freq Sch	Comms

Shallow Water '06 Application

SW06 Daily Report Viewer

Environmental Highlights Powerpoint for July 24.

Slide 1:

First, the surface data.
CODAR surface currents illustrate a direct path from the
NY Bight Apex out along the Hudson Shelf Valley that merges
with a general flow to the south in the SW06 area.
The same path is observed in the morning SST.
Warmer waters long the HSV out to about the 80 m isobath
that then turn south.
On the inner shelf, the strong upwelling from the recent
bursts of southerly winds dominates.

Slide 2:

On to the subsurface.
RU01 and Jane continued their weekend progress to the 100 m isobath.
The most striking feature here is the difference in the depth averaged

Select Source:	ALL
Title:	NWLI Daily Report
Source:	cool
Submitter:	Scott Glenn
Submitted:	2006/07/24 00:00:00
Descrip File:	cool.txt

2006

Jun: 16 18 19 20 21 22 23 26 27 28 29 30

Jul: 07 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

Aug: 01 02 03 04

Daily Report 1 of 2

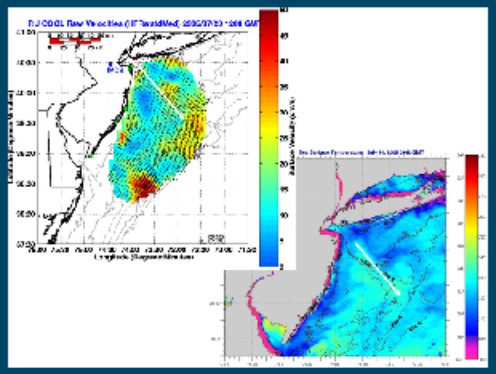


Figure 1

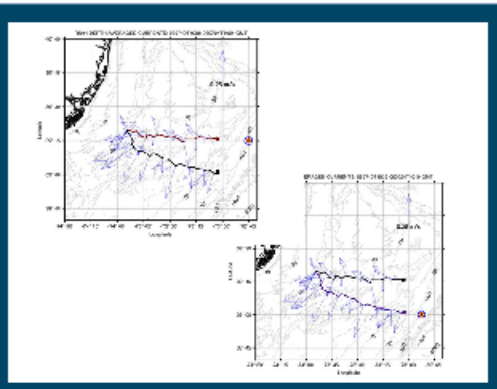


Figure 2

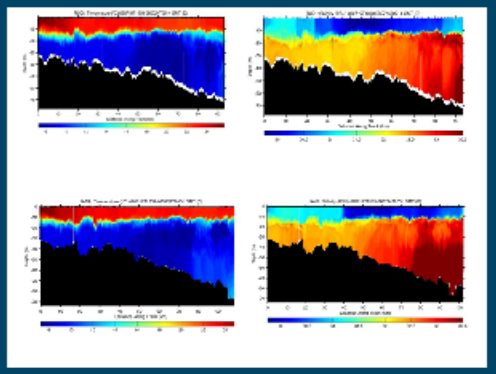
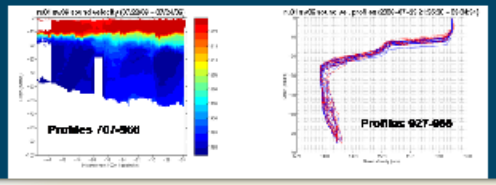
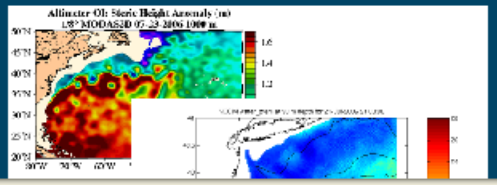
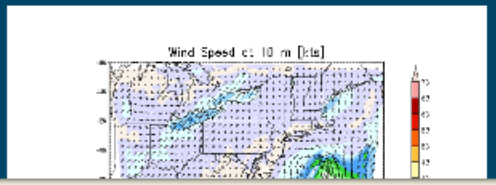


Figure 3







rsync v DTN

- rsync goodness
  - compression, bw limitation
  - efficient block differencing
  - regular unix application
- rsync downsides
  - TCP/IP only
  - no routing
  - no CoS or timeout notion
- might be useful as DTN CL
  - in TCP/IP environments at least

kfall@intel.com

amaffei@whoi.edu

Backups..