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Acoustic Network Summary
Nootka Mooring Test Deployment
December 4, 2003

1.0 Overview

The Nootka Acoustic Observatory Mooring was deployed for long term testing on November 23-4, 2003, from the *R/V Knorr*. The mooring performs acoustic data uplink from 3 different underwater sensors, six times daily, as shown below. Additional uplink transactions were performed, during scheduled down time, for on-site testing.

Nootka Observatory Acoustic Uplink Schedule

Time	Node	Description	Uplink duration	data rates	Throughput
00:10	2	OBS	up to 1:50	5300 bps	up to ~440 KB
02:10	4	U-W simulator	20 minutes	80, 250, 1300, 5300 bps	66816 bytes
03:10	3	ACM simulator	20 minutes	80, 250, 1300, 5300 bps	66816 bytes
00:10	2	OBS	up to 2 hours	5300 bps	up to ~440 KB
02:10	4	U-W simulator	20 minutes	80, 250, 1300, 5300 bps	66816 bytes
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Table 1: Acoustic link schedule with data rates and throughput

2.0 Network Deployment

The observatory acoustic network consists of the buoy with WHOI Micromodem and high data rate WHOI UAM receiver, an acoustic current meter with WHOI Micromodem, an ocean bottom seismometer with WHOI micromodem, and a standalone WHOI Micromodem simulating sensors to be provided by the University of Washington.

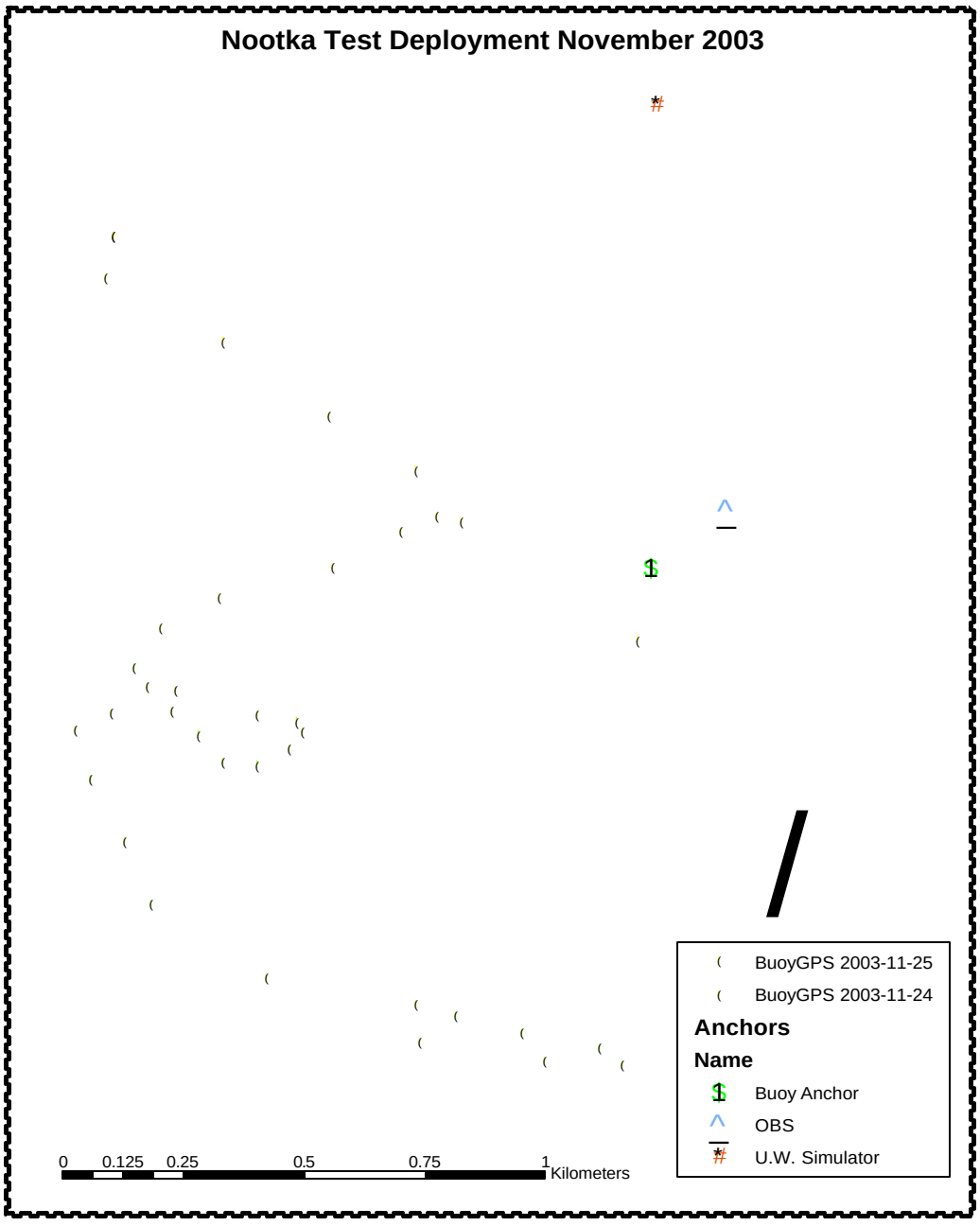

Figure 1: Nootka Acoustic Observatory deployed at 39 16.2872 N, 70 03.3993 W (buoy anchor).

3.0 Network Testing

While the *R/V Knorr* was on-station, we were able to monitor acoustic transactions in more detail, via *Freewave* RF modem. Acoustic link timing parameters were established for this network geometry, buoy UAM receiver parameters were optimized, and acoustic link performance was assessed.

3.1 Final Acoustic Link Timing

Acoustic network timing is managed by the application **modemd**, running on the buoy. This program is configured using 2 files: **modemd.conf**, and **link.conf**. The optimized file settings for this deployment geometry are:

modemd.conf:

```
/dev/ttyS2 19200 client 1 9 0
%
% extra UAM config below here (m-script syntax)
%

% rxch=[1 2];
% nch=length(rxch);
% RAWSAVE=1;
rxgain=30;
dthresh=25;
% IVTMPNCH=length(rxch);
```

link.conf:

```
0 120 0 5 7 9 0 20 30
1 120 0 5 7 9 0 20 30
2 120 5 0 7 9 7 20 30
3 120 5 0 7 9 7 20 30
4 120 5 0 7 9 7 20 30
```

The parameters above establish a 30 second packet cycle, allowing a maximum uplink rate of 4KB per minute. Following the transaction schedule above, a total acoustic data uplink of 1.6MB per day is expected.

3.2 UAM Receiver Parameters

Two receiver parameters were adjusted for this deployment geometry: UAM receiver gain was set to **30db**, after observing low signal amplitude at the buoy. The matched filter detector threshold was set to **25**, after establishing false alarm and missed detection rates by observing link throughput.

3.3 Acoustic Link Performance

Although satellite telemetry has been inconsistent, we can assess acoustic link performance simply by examining packet success rates, for the data which has been retrieved. Figure 2 shows the packet success rates (percent of uplink cycles where a packet was detected and decoded) for each of the 3 links.

Data begin on 11/25/2003 with system deployment, and continue through 12/03/2003. There was a 96 hour blackout in satellite telemetry, from 11/26 to 11/01. Some data from 11/30 was transferred when the iridium link was restored on 12/01.

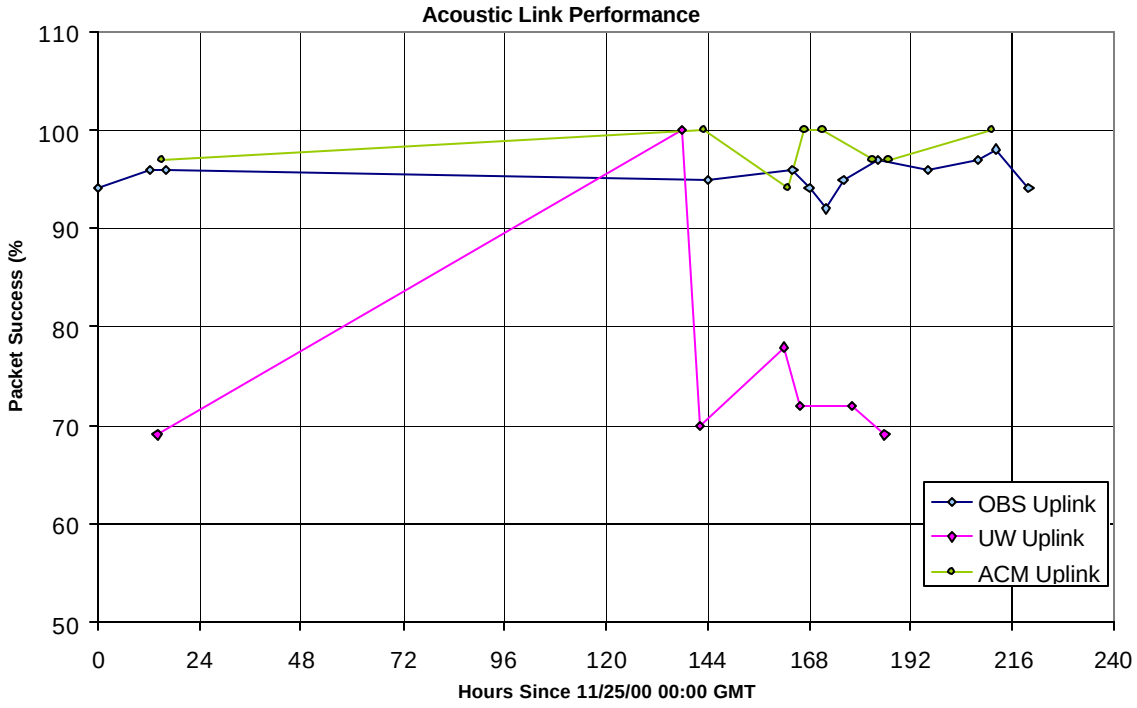

Figure 2: Acoustic Node uplink success rates

3.4 Satellite Link Performance

The buoy is connected to shore by means of Iridium satellite telephone dial-up, with PPP network connection.

This satellite link has not been performing optimally. One indicator of performance is PPP connection time. Figure 3 shows Satellite PPP link duration. We would expect this time to be commensurate with queued data to offload, as shown in table 1. Connect times of less than 2 minutes usually indicate that no data was transferred.

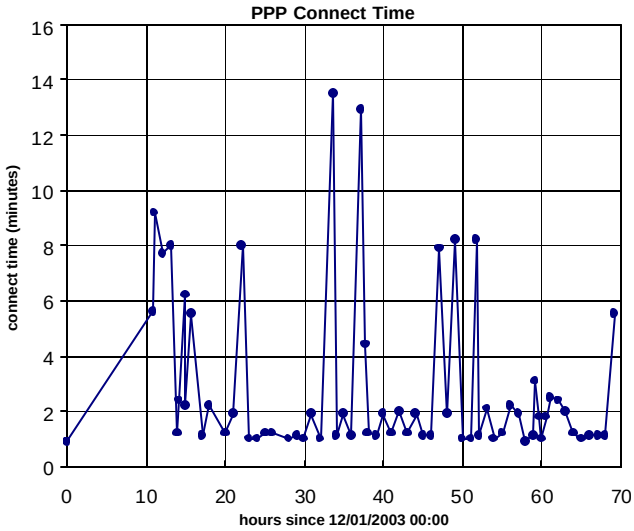

Figure 3: PPP duration as performance indicator

There are several possible causes for this sub-optimal performance: excessive weather induced platform motion, Iridium unit antenna problem, or possibly mis-configuration of PPP networking. Since there are periods of good performance, such as around hour 50 (see figure 3) it is unlikely to be a mis-configuration, or hardware failure.

4.0 OBS Data Pipeline

For this network deployment, the WHOI Ocean Bottom Seismometer (OBS) is the only acoustic node sensor package sending actual sensor data. This data is recorded on a Q330/Baler system. Data offload is initiated by acoustic command, and acoustic data transfer follows.

The Baler system logs and compresses OBS geophone time series data continuously, so any subset of data logged more than 24 hours ago can be requested. By default, a 4 hour block of low rate data from to previous day is selected, six times daily.

Data is offloaded from the Baler as files, and these files are divided into frames, for transmission. Currently the buoy transmits these frames to shore as received: they must reassembled into files, after reception. Currently the uplink protocol does not include data acknowledgment (ACK), so there are often missing data frames, as shown in section 3.3 above. This requires a format sensitive data reassembly algorithm, to validate the entire data link.

5.0 Conclusion

The Nootka Acoustic Observatory test deployment has demonstrated the feasibility of acoustic telemetry over a kilometer scale ocean bottom footprint. Data is currently transferred at 240KB per hour of link activity. These transfers are currently scheduled 6 times per day for each of 3 acoustically linked nodes.

5.1 Future Work

This test network deployment has successfully demonstrated acoustic data uplink, through the surface platform via satellite link to shore station. It has also shown several shortcomings, where improvements can be made before the final system deployment in 2004.

5.1.1 Special OBS Data Request Testing

- ☐ Request high rate data
- ☐ Request low rate data from 11/26->12/01 satellite link outage

5.1.2 OBS Data Reassembly

- ☐ Create partial files, when frames are missing
- ☐ Clean-up partial files: remove partial frames at beginning and end of each file.

5.1.3 modemd Improvements

- ☐ Add ACK protocol to file transfer (as implemented for commands)
- ☐ Improve parsing of UAM output files
  - ▫ Compute checksums on frames before use
  - ▫ Use contents of UAM status frames to control link (as implemented for FSK)
- ☐ File reassembly
- ☐ Find/fix bugs:
  - ▫ Status frame generation before file transfer complete?
  - ▫ Better duplicate command rejection.