

The Future of the USAP Antarctic Internet Data Distribution System

A discussion on LDM Efforts at ASC with Satellite Ground Stations update

Andrew B. Archer – Antarctic Support Contract

Matthew A. Lazzara – University of Wisconsin-Madison/AMRC/SSEC
& Madison Area Technical College

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AMOMFW #10

U.S. Antarctic Program



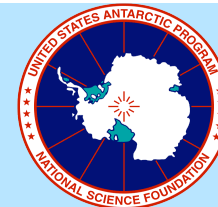


History and Background

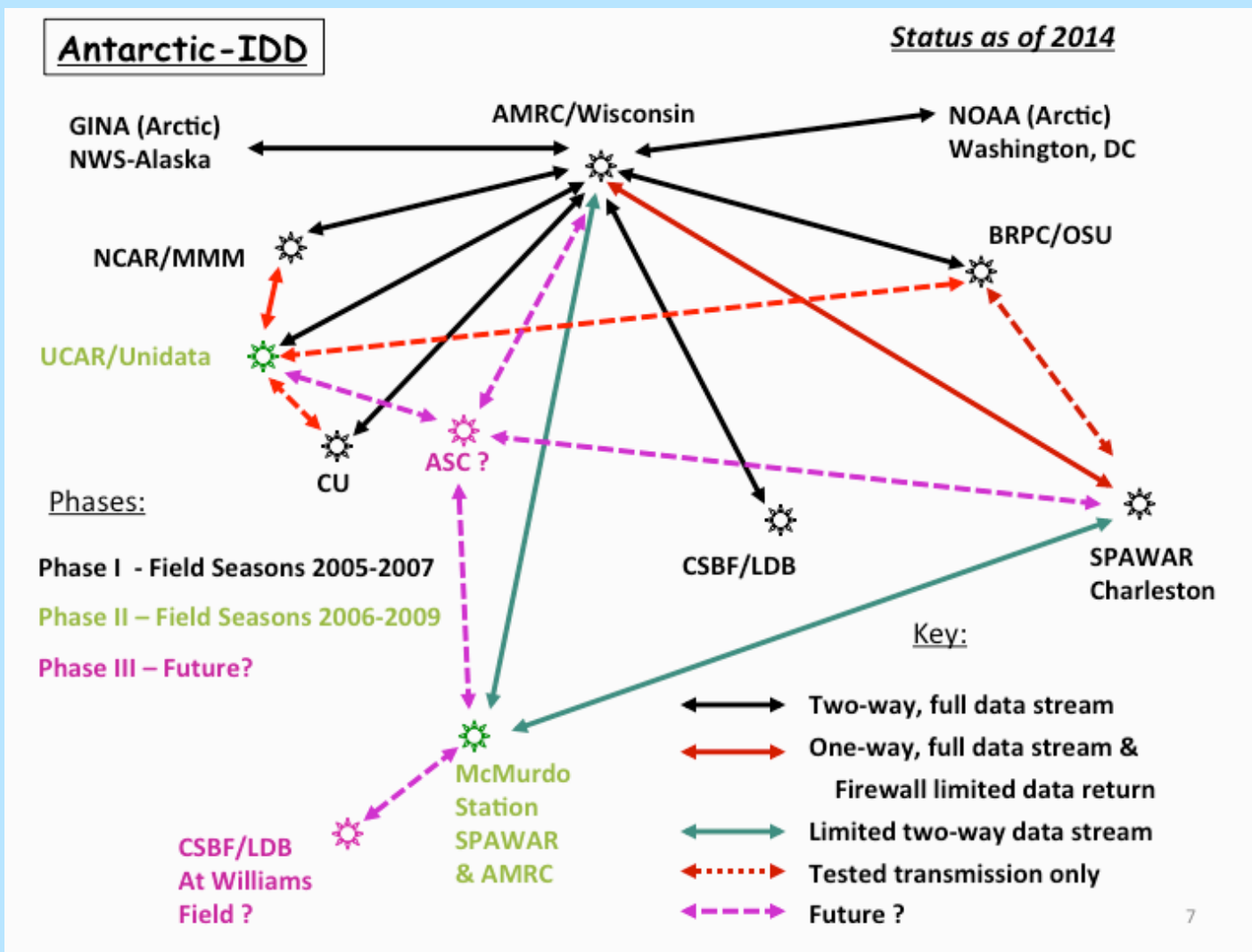
- Antarctic-Internet Data Distribution based on LDM (Local Data Manager)*
 - Born at an AWS-AMRC-AMPS meeting in Charleston, SC 2004.
- Adopted as a weather data transport mechanism from collection points in the Antarctic to be shared with the research community.
 - This was implemented by O-202-M/P/S University of Wisconsin in 2005. Through time and exposure it became a useful and necessary tool for operational weather forecasting and remains effective in delivering real time weather information to USAP forecasters.
- LDM works by moving weather data via a dedicated UNIX port #388.
 - Port 388 is a reserved service port with IANA (Internet Assigned Numbers Authority) and runs on an LDM UNIX protocol. In order for the USAP to provide weather data to the research community, port 388 must be open to outside known hosts.
- LDM in the USAP:
 - Automatic Weather Station data from researcher systems attached to the TeraScan ground station network to CONUS based researcher systems for analysis and display.
 - SOPP (SPAWAR Office of Polar Programs {Aviation forecasting}) taps into the LDM network to quickly receive AWS updates and review for ongoing forecasts.

* LDM is a product of UNIDATA, an NSF funded project <http://www.unidata.ucar.edu/software/ldm/>





Antarctic-IDD as of the end of 2014



7





Why We Need the LDM Capability

- AWS (Automatic Weather Station) information is valuable to weather forecasting. AWS data is moved through LDM to SOPP (SPAWAR Forecasting)
- Providing real time weather data in our operational area is critical to making aviation and field support decisions, this includes our two research vessels.
- Satellite data information can also be relayed through the LDM facility, read; we can look at moving NRT imagery out of the reception points to be used elsewhere if required.
- LDM is the ***only*** means to acquire monthly climatological and routine archive quality weather observations from McMurdo Station/Mac Weather.



Management Perspective

Who manages it? It's a federated system! (by design!)

Presently O-202-M/P/S AMRC and SOPP provide management of their own instances within the USAP LDM connection structure. NSF has requested that the primary contractor provide a managed operational solution with an LDM hub at Denver CONUS data center.

Security concerns: In order for USAP.gov to adhere to DHS Trusted internet connection, the NSF primary contractor should take over comprehensive oversight on the LDM architecture within USAP.gov.

LDM data will need to be evaluated on an ongoing basis to determine whether data flows should be configured for single directional distribution or bi-directional distribution.



Further Arguments For LDM

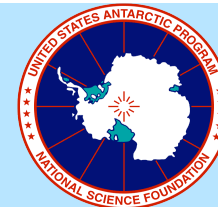
- LDM has proven very effective and robust for weather data delivery. There are no other industry standards that can match this service. Other methods require significant and unique programming.
- LDM in the USAP is already established with multiple customers dependent upon its continued functionality.
- LDM in the USAP can in the future provide further data distribution solutions if requested. For example the Blue Ribbon Report's request for an Antarctic observatory page 67, section 4.



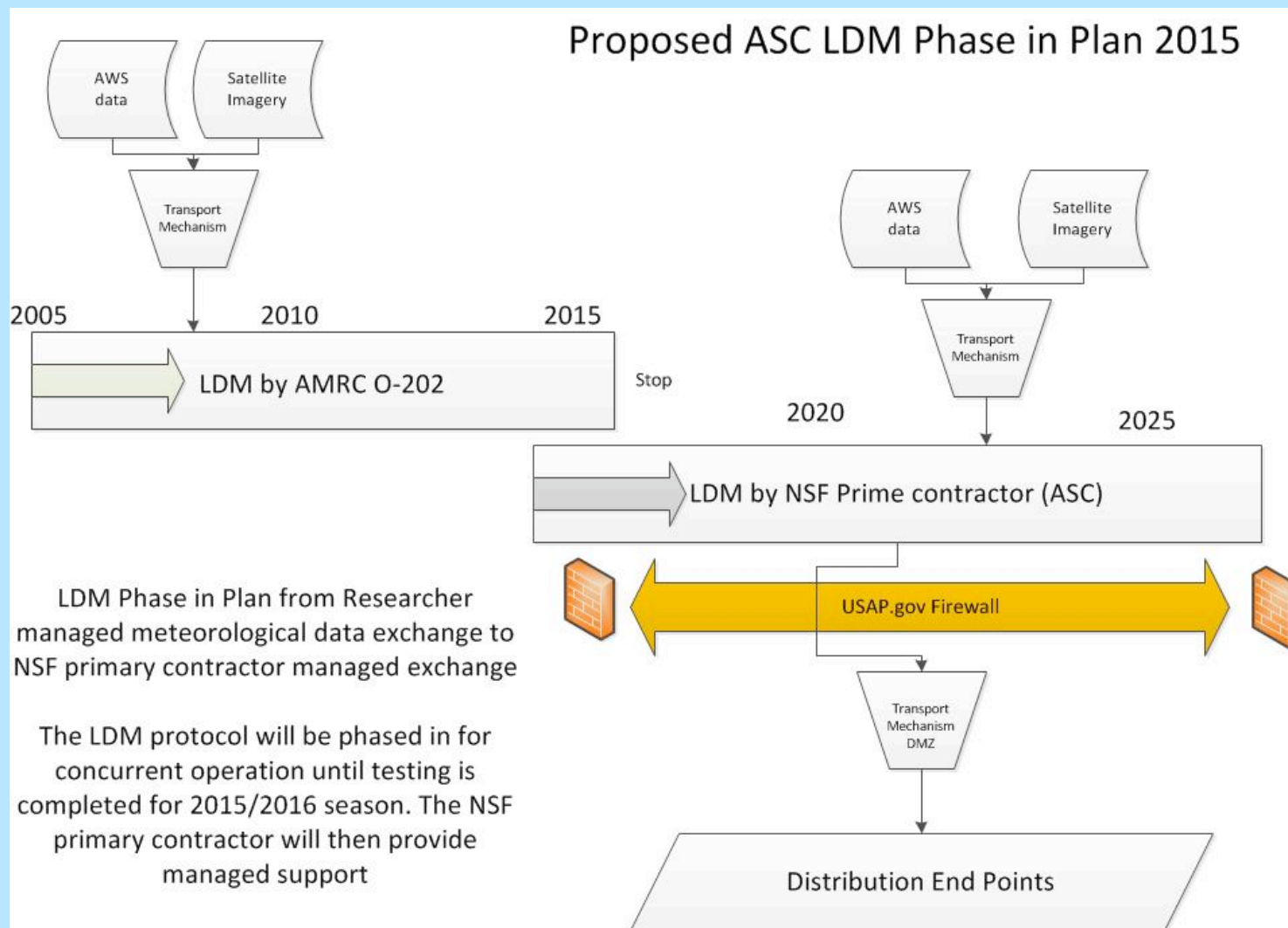
Proposed Solution

- Install and configure LDM on the primary Denver TeraScan* system Teocali.usap.gov. Use Teocali as the LDM hub on the inside of the USAP firewall. We are currently upgrading this system to a server class computer.
- Create a virtual LDM Linux server on the outside of the DMZ firewall and relay all pertinent and requested weather data to the outer server.
- Internal customers such as SOPP and funded researchers can pull LDM weather data directly from the Denver primary LDM server or through direct interconnections within the usap.gov intranet.
- Configure the two post processing TeraScan servers at McMurdo to provide LDM services to replace grantee systems or provide alternative data flow mechanisms.
- The Palmer Station satellite system will also be configured for LDM support. We are discussing further data inclusions at Palmer.

* TeraScan is the satellite tracking, reception and data processing system now being used in the USAP, it is a product of SeaSpace Corp..

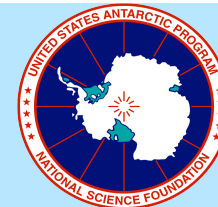


LDM Timeline



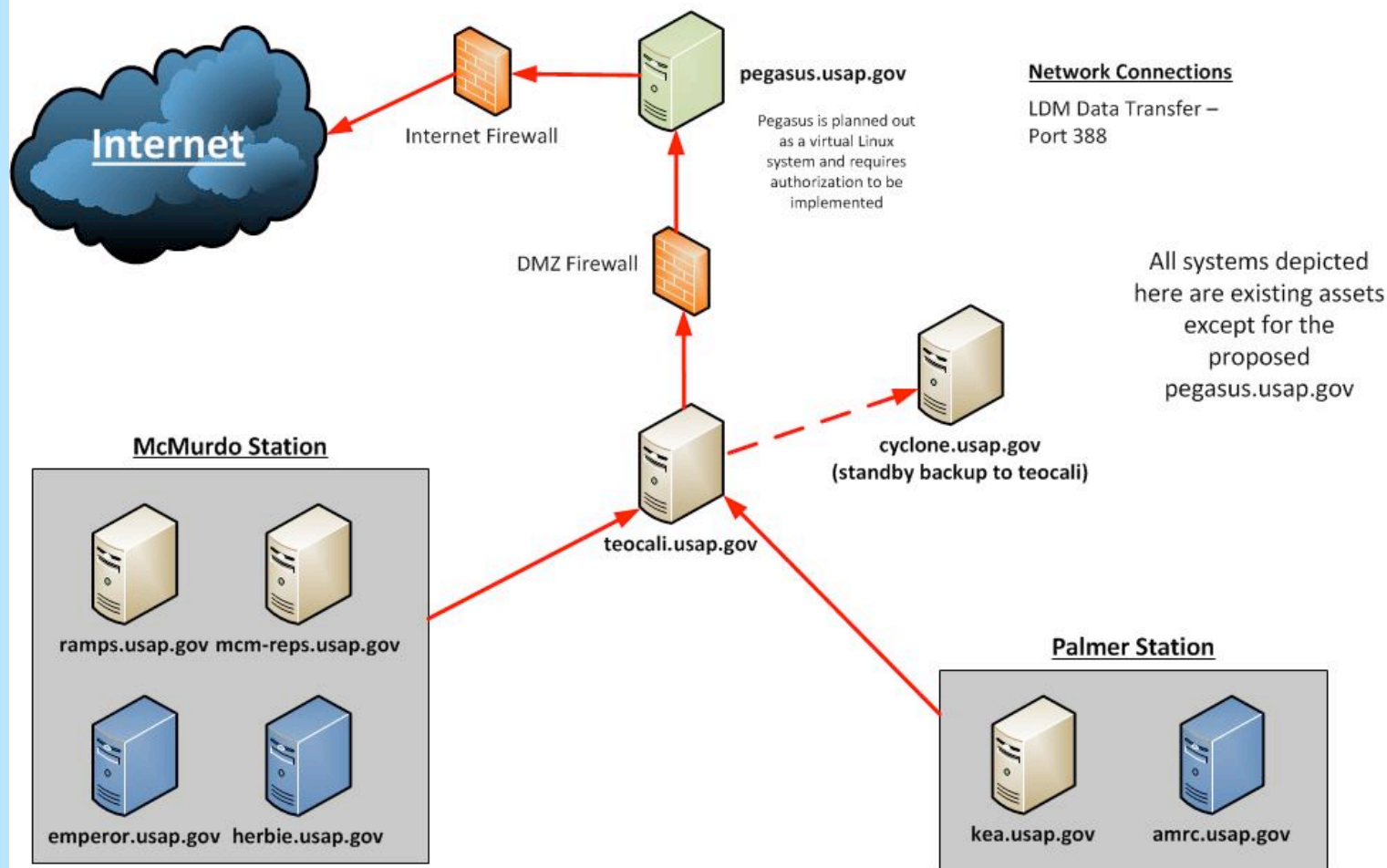
LDM Phase in Plan from Researcher managed meteorological data exchange to NSF primary contractor managed exchange

The LDM protocol will be phased in for concurrent operation until testing is completed for 2015/2016 season. The NSF primary contractor will then provide managed support



Basic Design Proposal

USAP MET DataTransfer Infrastructure

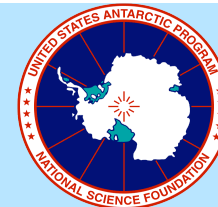




TeraScan Ground Station Update

- The Terascan systems at McMurdo Station are working very well at this time. We have redundant systems that schedule maximum complement of polar orbiting Met satellites to capture. 2005 first install, 2011 second install. We are capturing between 30 and 40 passes per 24 hour period. We are in a unique place at high latitude so there are almost too many options for the number of satellites we can capture. At least for now. N-18, N19, F-17, F-18, F-19, MetOp-B, AQUA, TERRA, NPP.
- FY-3B was tested, but unsuccessful – OS & TS upgrades required, scheduled for NOV 2015
- JPSS-1 primary good, secondary requires antenna parts in order to capture NPP/JPSS-1, there may be some EMI interference at building 165
- Suomi-NPP has been demonstrated, with UW-Madison/CIMSS/AMRC CSPP...see:
 - <http://amrc.ssec.wisc.edu/data/view-data.php?action=list&product=satellite/S-NPP>
- Metop-B is good on both systems – scheduling priorities have kept the majority of Metop-B collecting on the secondary system.
- Palmer Station is now operating 14 years past life cycle, limited reception, first installed 1994, site visit updates occurred in 1999, 2001 and 2014 – no significant upgrades. NOAA and DMSP only. All satellite imagery ends up at SPAWAR forecaster sites.





Satellite Data Capture Example

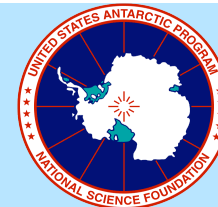
```
teradm@mcm-xls:~  
3 terra-1 teradb 2015/05/20 140 00:57:10 13:10 5415  
13 aqua-1 aquadb 2015/05/20 140 01:21:40 13:20 5324  
23 noaa-19 hrpt 2015/05/20 140 08:44:50 16:10 5321  
4 terra-1 teradb 2015/05/20 140 09:18:00 12:50 4474  
24 noaa-18 hrpt 2015/05/20 140 09:48:10 16:30 4979  
25 noaa-19 hrpt 2015/05/20 140 10:25:20 16:10 5033  
5 terra-1 teradb 2015/05/20 140 10:56:50 13:40 5369  
26 noaa-18 hrpt 2015/05/20 140 11:29:00 16:00 5494  
27 noaa-19 hrpt 2015/05/20 140 12:06:10 16:10 5106  
6 terra-1 teradb 2015/05/20 140 12:35:00 14:30 5930  
28 noaa-18 hrpt 2015/05/20 140 13:09:20 16:20 5125  
29 noaa-19 hrpt 2015/05/20 140 13:47:30 16:00 5101  
7 terra-1 teradb 2015/05/20 140 14:13:10 14:30 6057  
30 noaa-18 hrpt 2015/05/20 140 14:50:00 16:30 5200  
21 noaa-19 hrpt 2015/05/20 140 15:29:40 15:30 4969  
8 terra-1 teradb 2015/05/20 140 15:50:50 14:30 5647  
22 noaa-18 hrpt 2015/05/20 140 16:31:20 16:20 5201  
49 f-19 rtd 2015/05/20 140 17:05:20 16:10 10190  
9 terra-1 teradb 2015/05/20 140 17:28:20 14:30 0  
# satel telem date day time durat lines  
# state pri satel telem date day time durat post_process  
1 sched 1 noaa-18 hrpt 2015/05/20 140 18:13:30 15:30  
2 sched 2 terra-1 teradb 2015/05/20 140 19:05:50 14:30 None  
3 sched 1 noaa-18 hrpt 2015/05/20 140 19:56:40 14:10  
4 sched 2 terra-1 teradb 2015/05/20 140 20:43:40 14:30 None  
5 sched 2 terra-1 teradb 2015/05/20 140 22:21:50 14:30 None  
6 sched 3 npp nppdb 2015/05/20 140 23:52:20 13:50  
Wed May 20 17:27:57 2015  
[teradm@mcm-xls ~]$ trackkeye  
Sat:terra-1 Sensor:teradb Start:2015/05/20 17:28:20 Dur 14:30  
Latitude: -77.847 Longitude: 166.664 Magnetic Declination: 142.46  
Chain: 1 Ant: 1 Antenna Azimuth: -0.359  
Date Time azim elev head mc freq #lin S Sig fsync  
2015/05/20 17:33:00.467 110.29 22.08 -- A 8212.5 1668 I 2487 LOCK
```

```
teradm@chs-roc-met03/nexus/data1/products/tdf/McMurdo/full_pass  
-RW-RW-RW- 1 teradm terascan 106936778 May 19 18:41 150519.1825.noaa-18_full_pass  
-RW-RW-RW- 1 teradm terascan 218215180 May 19 18:58 150519.1841.f-17_full_pass  
-RW-RW-RW- 1 teradm terascan 217612022 May 19 18:16 150519.1900.f-19_full_pass  
-RW-RW-RW- 1 teradm terascan 106936778 May 19 20:23 150519.2008.noaa-18_full_pass  
-RW-RW-RW- 1 teradm terascan 218516574 May 19 20:40 150519.2024.f-17_full_pass  
-RW-RW-RW- 1 teradm terascan 217462989 May 19 20:58 150519.2042.f-19_full_pass  
-RW-RW-RW- 1 teradm terascan 217161948 May 19 22:49 150519.2234.f-18_full_pass  
-RW-RW-RW- 1 teradm terascan 106527698 May 20 00:32 150520.0018.noaa-19_full_pass  
-RW-RW-RW- 1 teradm terascan 106527698 May 20 02:16 150520.0200.noaa-19_full_pass  
-RW-RW-RW- 1 teradm terascan 107405258 May 20 03:16 150520.0302.noaa-18_full_pass  
-RW-RW-RW- 1 teradm terascan 106498508 May 20 03:58 150520.0342.noaa-19_full_pass  
-RW-RW-RW- 1 teradm terascan 107405258 May 20 05:00 150520.0444.noaa-18_full_pass  
-RW-RW-RW- 1 teradm terascan 106527698 May 20 05:39 150520.0523.noaa-19_full_pass  
-RW-RW-RW- 1 teradm terascan 217763484 May 20 08:42 150520.0528.f-18_full_pass  
-RW-RW-RW- 1 teradm terascan 107405258 May 20 06:42 150520.0626.noaa-18_full_pass  
-RW-RW-RW- 1 teradm terascan 218667348 May 20 06:58 150520.0642.f-17_full_pass  
-RW-RW-RW- 1 teradm terascan 106527698 May 20 07:20 150520.0704.noaa-19_full_pass  
-RW-RW-RW- 1 teradm terascan 217312252 May 20 07:26 150520.0710.f-18_full_pass  
-RW-RW-RW- 1 teradm terascan 107405258 May 20 08:24 150520.0807.noaa-18_full_pass  
-RW-RW-RW- 1 teradm terascan 218667348 May 20 08:40 150520.0823.f-17_full_pass  
-RW-RW-RW- 1 teradm terascan 106265132 May 20 09:01 150520.0844.noaa-19_full_pass  
-RW-RW-RW- 1 teradm terascan 107405258 May 20 10:05 150520.0948.noaa-18_full_pass  
-RW-RW-RW- 1 teradm terascan 218365850 May 20 10:21 150520.1004.f-17_full_pass  
-RW-RW-RW- 1 teradm terascan 106206828 May 20 10:41 150520.1028.noaa-19_full_pass  
-RW-RW-RW- 1 teradm terascan 107259748 May 20 11:45 150520.1129.noaa-18_full_pass  
-RW-RW-RW- 1 teradm terascan 218667350 May 20 12:02 150520.1145.f-17_full_pass  
-RW-RW-RW- 1 teradm terascan 106002890 May 20 12:22 150520.1206.noaa-19_full_pass  
-RW-RW-RW- 1 teradm terascan 107200172 May 20 13:26 150520.1309.noaa-18_full_pass  
-RW-RW-RW- 1 teradm terascan 218667348 May 20 13:42 150520.1325.f-17_full_pass  
-RW-RW-RW- 1 teradm terascan 105915548 May 20 14:03 150520.1347.noaa-19_full_pass  
-RW-RW-RW- 1 teradm terascan 107024540 May 20 15:06 150520.1450.noaa-18_full_pass  
-RW-RW-RW- 1 teradm terascan 218667348 May 20 15:23 150520.1506.f-17_full_pass  
-RW-RW-RW- 1 teradm terascan 105915548 May 20 15:45 150520.1529.noaa-19_full_pass  
-RW-RW-RW- 1 teradm terascan 106936778 May 20 16:48 150520.1631.noaa-18_full_pass  
-RW-RW-RW- 1 teradm terascan 2924 Oct 4 2012 full_pass.view  
[teradm@chs-roc-met03 full_pass]$
```

```
teradm@trident:~  
9 aqua-1 aquadb 2015/05/20 140 09:41:00 14:30 6526  
29 f-17 rtd 2015/05/20 140 10:04:30 16:20 8374  
24 metop-1 ahrpt 2015/05/20 140 10:37:10 15:30 5525  
10 aqua-1 aquadb 2015/05/20 140 11:18:40 14:30 6784  
30 f-17 rtd 2015/05/20 140 11:45:10 16:10 10112  
25 metop-1 ahrpt 2015/05/20 140 12:17:50 16:00 5297  
6 aqua-1 aquadb 2015/05/20 140 12:56:40 14:30 6828  
26 f-17 rtd 2015/05/20 140 13:25:40 16:10 9854  
21 metop-1 ahrpt 2015/05/20 140 13:58:10 15:50 5197  
7 aqua-1 aquadb 2015/05/20 140 14:35:30 14:10 6524  
27 f-17 rtd 2015/05/20 140 15:06:00 16:20 9700  
22 metop-1 ahrpt 2015/05/20 140 15:38:10 15:50 5732  
8 aqua-1 aquadb 2015/05/20 140 16:15:20 12:50 6592  
28 f-17 rtd 2015/05/20 140 16:46:50 16:20 8464  
23 metop-1 ahrpt 2015/05/20 140 17:18:10 15:40 0  
# satel telem date day time durat lines  
# state pri satel telem date day time durat post_process  
1 sched 4 f-17 rtd 2015/05/20 140 18:28:20 16:10  
2 sched 5 metop-1 ahrpt 2015/05/20 140 18:58:10 16:00  
3 sched 4 f-17 rtd 2015/05/20 140 20:10:50 15:10  
4 sched 5 metop-1 ahrpt 2015/05/20 140 20:38:30 15:50  
5 conf1 5 metop-1 ahrpt 2015/05/20 140 22:19:40 15:30  
6 sched 4 f-18 rtd 2015/05/20 140 22:22:10 14:10  
Wed May 20 17:28:52 2015  
[teradm@trident ~]$ trackkeye  
Sat:metop-1 Sensor:ahrpt Start:2015/05/20 17:18:10 Dur 15:40  
Latitude: -77.847 Longitude: 166.664 Magnetic Declination: 142.46  
Chain: 5 Ant: 2 Antenna Azimuth: 0.455  
Date Time azim elev head mc freq #lin S Sig fsync  
2015/05/20 17:33:00.357 249.07 10.80 -- D 1701.3 5193 I-55.09 LOCK
```

```
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-RW-RW-RW- 1 teradm terascan 27755084 May 20 07:26 150520.0710.f-18_big_ross  
-RW-RW-RW- 1 teradm terascan 29850116 May 20 08:27 150520.0803.aqua-1_big_ross  
-RW-RW-RW- 1 teradm terascan 13741948 May 20 08:24 150520.0807.noaa-18_big_ross  
-RW-RW-RW- 1 teradm terascan 27995846 May 20 08:40 150520.0823.f-17_big_ross  
-RW-RW-RW- 1 teradm terascan 13601668 May 20 08:01 150520.0844.noaa-19_big_ross  
-RW-RW-RW- 1 teradm terascan 13508560 May 20 09:10 150520.0856.metop-1_big_ross  
-RW-RW-RW- 1 teradm terascan 29850116 May 20 10:03 150520.0941.aqua-1_big_ross  
-RW-RW-RW- 1 teradm terascan 13741948 May 20 10:04 150520.0948.noaa-18_big_ross  
-RW-RW-RW- 1 teradm terascan 27995844 May 20 10:21 150520.1004.f-17_big_ross  
-RW-RW-RW- 1 teradm terascan 13601668 May 20 10:41 150520.1025.noaa-19_big_ross  
-RW-RW-RW- 1 teradm terascan 13508560 May 20 10:52 150520.1037.metop-1_big_ross  
-RW-RW-RW- 1 teradm terascan 29850116 May 20 11:41 150520.1118.aqua-1_big_ross  
-RW-RW-RW- 1 teradm terascan 13741948 May 20 11:45 150520.1129.noaa-18_big_ross  
-RW-RW-RW- 1 teradm terascan 27995848 May 20 12:01 150520.1145.f-17_big_ross  
-RW-RW-RW- 1 teradm terascan 13555068 May 20 12:22 150520.1206.noaa-19_big_ross  
-RW-RW-RW- 1 teradm terascan 13508560 May 20 12:34 150520.1217.metop-1_big_ross  
-RW-RW-RW- 1 teradm terascan 29850116 May 20 13:19 150520.1256.aqua-1_big_ross  
-RW-RW-RW- 1 teradm terascan 13741948 May 20 13:25 150520.1309.noaa-18_big_ross  
-RW-RW-RW- 1 teradm terascan 27995846 May 20 13:42 150520.1325.f-17_big_ross  
-RW-RW-RW- 1 teradm terascan 13555068 May 20 14:03 150520.1347.noaa-19_big_ross  
-RW-RW-RW- 1 teradm terascan 13508560 May 20 14:14 150520.1358.metop-1_big_ross  
-RW-RW-RW- 1 teradm terascan 29850585 May 20 14:29 150520.1413.terra-1_big_ross  
-RW-RW-RW- 1 teradm terascan 29850116 May 20 14:57 150520.1435.aqua-1_big_ross  
-RW-RW-RW- 1 teradm terascan 13695108 May 20 15:06 150520.1450.noaa-18_big_ross  
-RW-RW-RW- 1 teradm terascan 27995846 May 20 15:22 150520.1506.f-17_big_ross  
-RW-RW-RW- 1 teradm terascan 13555068 May 20 15:45 150520.1529.noaa-19_big_ross  
-RW-RW-RW- 1 teradm terascan 13508560 May 20 15:54 150520.1538.metop-1_big_ross  
-RW-RW-RW- 1 teradm terascan 29850116 May 20 16:36 150520.1615.aqua-1_big_ross  
-RW-RW-RW- 1 teradm terascan 13695108 May 20 16:47 150520.1631.noaa-18_big_ross  
-RW-RW-RW- 1 teradm terascan 27995844 May 20 17:03 150520.1646.f-17_big_ross  
-RW-RW-RW- 1 teradm terascan 27755463 May 20 17:21 150520.1705.f-19_big_ross  
[teradm@mcm-vis big_ross]$
```





Satellite Data Capture

Applications Places System Wed May 20, 9:13 PM TeraScan Admin

TeraCapCon (on mcm-xls)

System Schedule Search Help

Pass Filter
 In-View Scheduled Auto-Sched Online Cataloged ? Help

Status	Satel	Telem	Date	TI
045	f-18	rtd	2015/05/17 23:04	
014	aqua-1	equadb	2015/05/19 02:22	
015	aqua-1	equadb	2015/05/19 04:06	
016	aqua-1	equadb	2015/05/19 05:44	
017	aqua-1	equadb	2015/05/19 07:22	
018	aqua-1	equadb	2015/05/19 08:59	
019	aqua-1	equadb	2015/05/19 10:33	
020	aqua-1	equadb	2015/05/19 12:11	
011	aqua-1	equadb	2015/05/19 13:55	
012	aqua-1	equadb	2015/05/19 15:33	
046	f-19	rtd	2015/05/19 19:00	
047	f-19	rtd	2015/05/19 20:44	
048	f-18	rtd	2015/05/19 22:33	
02	terra-1	teradb	2015/05/19 23:11	
03	terra-1	teradb	2015/05/20 00:45	
013	aqua-1	equadb	2015/05/20 01:13	
04	terra-1	teradb	2015/05/20 09:11	
025	noaa-19	hrpt	2015/05/20 10:22	
05	terra-1	teradb	2015/05/20 10:45	
026	noaa-18	hrpt	2015/05/20 11:22	
027	noaa-19	hrpt	2015/05/20 12:04	
06	terra-1	teradb	2015/05/20 12:33	
028	noaa-18	hrpt	2015/05/20 13:09	
029	noaa-19	hrpt	2015/05/20 13:44	
07	terra-1	teradb	2015/05/20 14:11	
030	noaa-18	hrpt	2015/05/20 14:49	
021	noaa-19	hrpt	2015/05/20 15:22	
08	terra-1	teradb	2015/05/20 15:45	
022	noaa-18	hrpt	2015/05/20 16:33	
049	f-19	rtd	2015/05/20 17:06	
09	terra-1	teradb	2015/05/20 17:22	
023	noaa-18	hrpt	2015/05/20 18:11	
010	terra-1	teradb	2015/05/20 19:06	
024	noaa-18	hrpt	2015/05/20 19:54	
01	terra-1	teradb	2015/05/20 20:44	

013 aqua-1 equadb 2015/

Show Coverage Schedule

0xa10bd68
0xa112118
0xa1136e8

teradm@mcm-xls:- teracon (on mcm-xls) teracon (on mcm-xls)

Show Coverage (on mcm-xls)

Zoom: + - Reset Receiver Site: Current 77.85s 166.66e

Selection

<input checked="" type="checkbox"/> Red	046	f-19	rtd	2015/05/19 19:00:10 15:50	ols
<input checked="" type="checkbox"/> Green	048	f-18	rtd	2015/05/19 22:34:40 14:10	ols
<input checked="" type="checkbox"/> Blue	02	terra-1	teradb	2015/05/19 23:17:30 14:10	modis

Close ? Help



Future directions

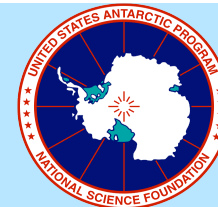
- System upgrades are in the works – We are looking at short range and long range improvements. We are looking at all available designs that suit out needs on the Polar environment and seeking solutions for long standing issues.
- Gap coverage – Radar? Fog or low cloud tracking for incoming aircraft.
- Integrative approach to weather data gathering and distribution.
- Subscription based satellite imagery for Polar MET support – Latent data – all possibilities so far are at least 90 minutes to a hour and a half old. Is that too much delay for aviation support? MetOp-B from EUMETCAST is delayed by 6 hours. Until we can solve the latency problem of store-forward/relay imagery data, then we still need to pursue direct readout or direct capture of polar orbiting meteorological satellites in order to properly support aviation and weather tracking. “Now-casting” is necessary for heavy flight support.
- For the Palmer Peninsula side of operations, it may be feasible to go with a subscription based satellite imagery solution since the majority of forecasting is for vessel support, in other words, latency may not have a negative effect in this area of interest. Analysis software will need to be acquired for forecasting.



Final thoughts

- USAP Aviation movement all year requires solid data feeds and comprehensive allocation of all possible resources.
- Operations and research efforts are not necessarily common goals, however, they are not mutually exclusive in our meteorological data gathering and handling of data.
- We wish to be more proactive with regard to international collaboration – and – how do we go about that?
- Please communicate your needs.

Questions?



McMurdo Gap with Estimated Radar Footprint

