

EOS Science Networks Performance Report

This is a summary of EOS QA SCF performance testing for the 2nd quarter of 2013 -- comparing the performance against the requirements, including Terra, TRMM, QuikScat, Aqua, Aura, ICESat, NPP, and GEOS requirements.

There are still several sites with requirements, but are not tested: University of Washington, JRC (Ispra, Italy), JAXA (Japan), and the University of Auckland, NZ.

Current results can be found on the EOS network performance web site (ENSIGHT): http://ensight.eos.nasa.gov/active_net_measure.html. Or click on any of the site links below.

Highlights:

- Performance was mostly stable
 - **All but on node rated Excellent!** (GSFC → GHRC **Good**)
 - **GPA 3.93** (same as last quarter)

Ratings:

Rating Categories:

Excellent: median of daily worst cases > 3 x requirement

Good: median of daily worst cases > requirement

Adequate: median of daily worst cases < requirement
and
median of daily medians > requirement

Almost Adequate: requirement > median of daily medians > requirement / 1.5
(i.e., median thrupt is below requirement, but above requirement without contingency)

Low: median of daily medians < requirement / 1.5.

Bad: median of daily medians < requirement / 3.

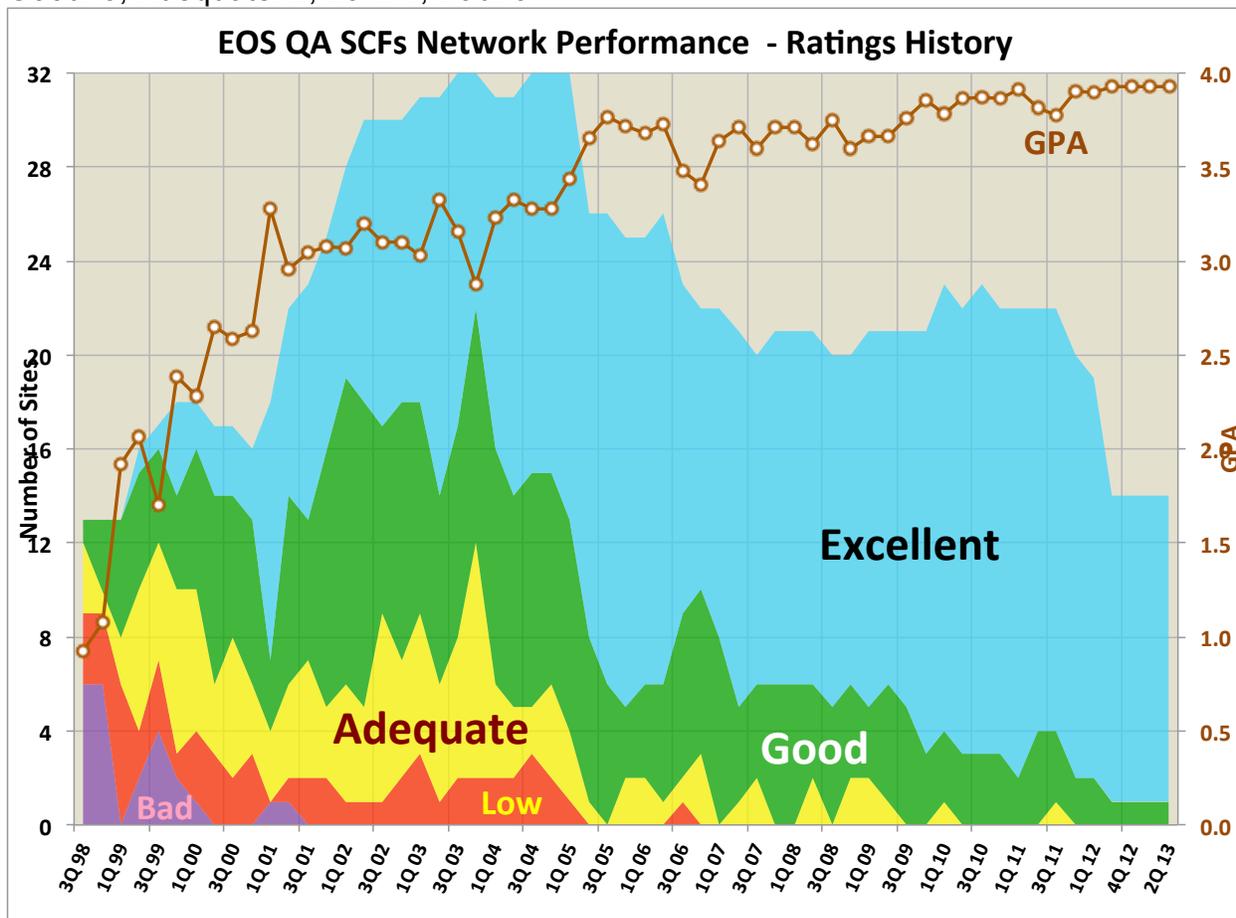
Ratings Changes:

Upgrades: ↑ None

Downgrades: ↓ None

Ratings History:

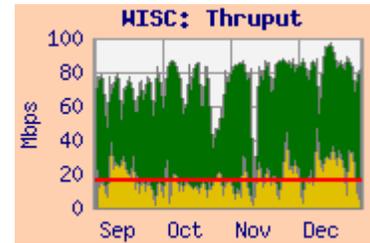
The chart below shows the number of sites in each classification since the testing started in 1998. Note that these ratings do NOT relate to absolute performance -- they are relative to the EOS requirements. The GPA is calculated based on Excellent: 4, Good: 3, Adequate: 2, Low: 1, Bad: 0



Notes: The number of sites included in this chart has changed since 1Q'05 due to:

- 2Q05: Moving the reporting for 6 SIPS sites to the "EOS Production Sites" Network Performance Report.
- 2006: Testing discontinued to SAGE III Nodes, NOAA, UMD, UIUC
- 2Q07: Testing discontinued to U Washington
- 1Q09: Testing added to BADC (RAL).
- 2010: Testing to Oxford restored, ICESAT functions of Ohio State were transferred to Buffalo, testing to Buffalo added, Testing to Ohio State discontinued.
- 3Q10: UIUC added [back]; Testing to MIT discontinued
- 2Q11: Testing discontinued to LANL, PNNL; requirements added to CCRS and Univ of Auckland
- 4Q11: Testing to JRC discontinued, Wisconsin moved to production sites report.
- 1Q12: Testing to Univ Auckland, NZ failing.
- 2-3Q12: Discontinued testing to Arizona, UCSD, Colo State, Miami, Montana, SUNY SB, and Buffalo – no longer any requirements. Added testing to Hawaii, ORNL.

Integrated Charts: Integrated charts are now included for selected sites with the site details. These charts are “Area” charts, with a pink background. A sample Integrated chart is shown here. The yellow area at the bottom represents the daily average of the user flow from the source facility (e.g., GSFC, in this example) to the destination facility (e.g., Wisconsin, in this example) obtained from routers via “netflow”. The green area is stacked on top of the user flow, and represents the “adjusted” daily average iperf thruput between the source-destination pair most closely corresponding to the requirement. This iperf measurement essentially shows the circuit capacity remaining with the user flows active. The adjustments are made to compensate for various systematic effects, and are best considered as an approximation. The red line is the requirement for the flow from the source to destination facilities.



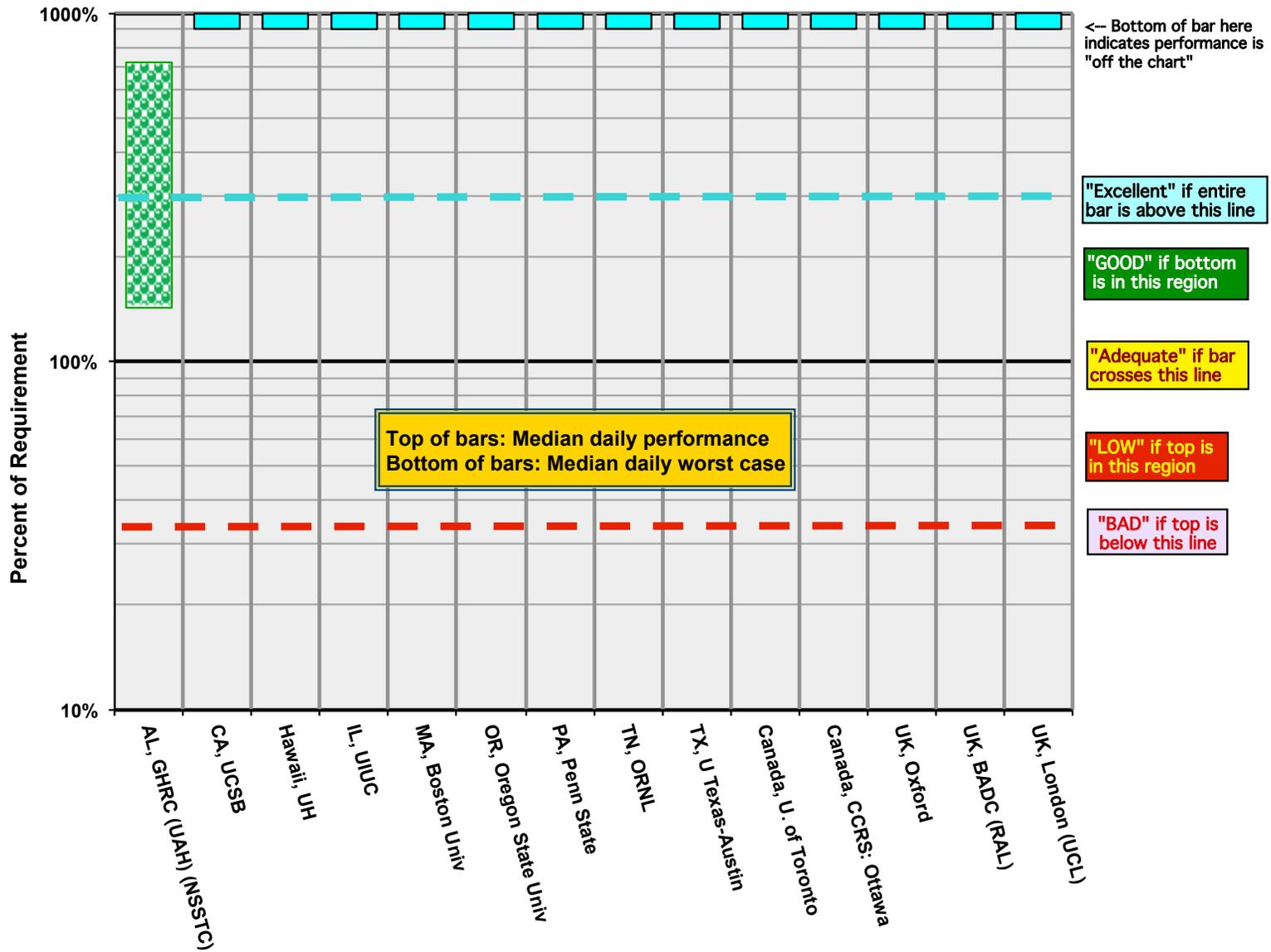
Note: User flow data is has not been available from LaRC since March 2007, so sites with primary requirements from LaRC will not include integrated graphs. (But JPL \leftrightarrow LaRC flow data is available from JPL, and GSFC \leftrightarrow LaRC is available from GSFC).

EOS QA SCF Sites Summary: Network Requirements vs. Measured Performance

2 nd Quarter 2013				Testing							
Destination	Team (s)	Requirements		Source Node	Median Daily Best	Median mbps	Median Daily Worst	Average User Flow	Rating re Current Requirements		Route Tested
		Database	Nov-07						2Q 2013	1Q 2013	
AL, GHRC (UAH) (NSSTC)	MODIS, LANCE	2.9	6.9	GSFC-MODIS	33.9	20.9	4.1	7.9	Good	Good	MAX - Internet2 - SOX - UAH
CA, UCSB	MODIS	0.17	3.1	GSFC-MODIS	156.3	154.2	141.1	0.6	Excellent	Ex	EBnet - MAX - Internet2 - CENIC
Hawaii, UH	MODIS	0.02		GSFC-ENPL	2071.4	1446.1	952.1	0.7	Excellent	Ex	EBnet - MAX - Internet2 - LA
IL, UIUC	MISR	0.56	1.1	LaRC PTH	186.2	184.6	172.3		Excellent	Ex	NISN - MAX - Internet2 - StarLight (Chicago)
MA, Boston Univ	MODIS, MISR	2.6	3.0	GES DISC	477.5	439.3	380.5	0.8	Excellent	Ex	StarLight (Chicago) - Internet2 - NOX
OR, Oregon State Univ	CERES, MODIS, MISR	0.7	7.6	LaRC ANGe	96.4	93.8	90.9		Excellent	Ex	NISN - MAX - Internet2 - PNW
PA, Penn State	MISR	0.6	2.6	LaRC PTH	59.3	57.0	46.6		Excellent	Ex	NISN - MAX - 3ROX
TN, ORNL	MODIS	10.1		GSFC-ENPL	4535.0	4317.2	3987.8		Excellent	Ex	MAX - ESnet
TX, U Texas-Austin	MODIS	0.7	11.1	GSFC-ESDIS-PTH	577.6	551.9	511.2		Excellent	Ex	NISN - MAX - Internet2 - TX-learn
WA, U Washington	MISR	2.4	2.4		n/a	n/a	n/a				Internet2 via NISN / MAX
Canada, U. of Toronto	MOPITT, GEOS	0.1	0.6	LaRC ASDC	58.7	56.7	22.1		Excellent	Ex	NISN - StarLight (Chicago) - CA*net
Canada, CCRS: Ottawa	CEOS, MODIS	1.1	3.8	GSFC-MODIS	132.8	131.8	108.2	3.8	Excellent	Ex	EBnet - MAX - Internet2 - CA*net
Italy, Ispra (JRC)	MISR	9.7	0.1		n/a	n/a	n/a				NISN / MAX / Géant (DC) / GARR
Japan, JAXA	MODIS, PPS	3.5	0.5		n/a	n/a	n/a				EBnet - MAX - Internet2 - LA - TransPAC
New Zealand, U Auckland	MISR	0.3	0.3		n/a	n/a	n/a				NISN - StarLight (Chicago) - PNW - PacWave
UK, Oxford	HIRDLS	0.4	0.5	GSFC-ENPL-PTH	2682.9	2088.4	545.5	1.3	Excellent	Ex	MAX - Géant (DC) - JAnet
UK, BADC (RAL)	HIRDLS	0.2	0.2	GSFC-ESDIS-PTH	25.8	21.6	16.3	0.1	Excellent	Ex	EBnet - MAX - Géant (DC) - JAnet
UK, London (UCL)	MISR, MODIS	0.6	1.0	LaRC PTH	36.5	28.8	6.9		Excellent	Ex	NISN - MAX - Géant (DC) - JAnet
								Summary			
*Rating Criteria:								Current:	Prev		
								2Q 2013	Report		
Rating											
Excellent								13	13		
Good								1	1		
Adequate								0	0		
LOW								0	0		
BAD								0	0		
Total								14	14		
GPA								3.93	3.93		

EOS QA SCF Sites

Daily Median and Worst Performance as a percent of Requirements



Details on individual sites:

Each site listed below is the DESTINATION for all the results reported in that section. Other tests are also listed. The three values listed are derived from [nominally] 24 tests per day. For each day, a daily best, worst, and median is obtained. The values shown below are the medians of those values over the test period.

1) AL, GHRC (UAH) (aka NSSTC)

Teams: AMSR, MODIS, LANCE

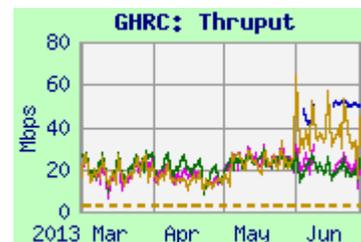
Web Page: <http://ensight.eos.nasa.gov/Missions/terra/NSSTC.shtml>

Rating: Continued **Good**

Domain: nsstc.uah.edu

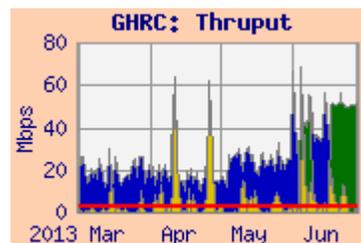
Test Results:

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
MODAPS-PDR	36.6	23.0	6.7	MAX / I2 / SOX
GSFC-EDOS	33.9	20.9	4.1	
GSFC-EDOS	52.2	49.8	41.5	NISN / MSFC
LaRC-PTH	30.3	21.1	3.6	NISN / MAX / I2 / SOX



Requirements:

Source Node	FY	Mbps	Rating
MODIS	'12 –	2.9	Good



Comments: Testing was initiated in December '10 from GSFC-EDOS via both NISN and Internet2 for LANCE flows. Testing from EDOS via NISN was resumed in June after being suspended in October 2012 while a new NISN host was sought. Testing from MODAPS-PDR via I2 was initiated in November '12, returned in June, and is used as the basis for the rating.

Thruput to the UAH address from the 3 sources to was very similar, with significant improvement late at night and on weekends. The median daily worst case from MODAPS-PDR via I2 was above the MODIS requirement, but by less than 3 x so the rating remains **Good**.

Performance from EDOS via NISN was higher and much steadier than via UAH.

User flow is now measured for GSFC to GHRC, combined for the NISN and UAH addresses (Both paths have significant user flows), as shown on the Integrated graph. **The average user flow this quarter was 7.9 mbps – well above the requirement!**

Notes:

- There is no longer a CERES requirement from LaRC (was 6.9 mbps).
- Testing between GHRC, RSS and NSIDC for AMSR-E (Aqua) is now in the "Production Sites" report.

2) CA, UCSB :

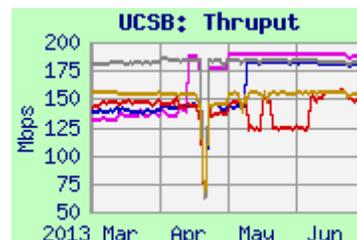
Ratings: GSFC: Continued **Excellent**
 Domain: ucsb.edu

Teams: MODIS

Web page: <http://ensight.eos.nasa.gov/Missions/terra/UCSB.shtml>

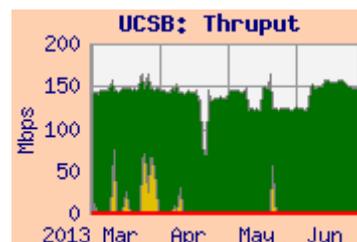
Test Results:

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
GSFC-MODIS	156.3	154.2	141.1	MAX / I2 / CENIC
GSFC-GES DISC	151.8	143.9	133.7	
GSFC-ENPL	190.0	189.6	182.7	
EROS-LPDAAC	180.7	180.1	147.0	StarLight / I2 / CENIC
EROS-PTH	184.1	183.7	178.2	



Requirements:

Source Node	FY	kbps	Rating
GSFC	'12 -	170	Excellent



Comments: The GSFC requirement was reduced (was 3.1 mbps), and the EROS requirement was eliminated (was 2.2 mbps) in the database.

Thruput from all sites is very stable. The rating from **GSFC-MODIS** remains **Excellent**. The user flow from GSFC averaged only 0.55 mbps this period, much lower than last month, but above the new requirement. The user flow from **EROS-LPDAAC** averaged 4.26 mbps this period, above the old requirement.

3) HI, University of Hawaii:

Ratings: GSFC: Continued **Excellent**
 Domain: uhnet.net

Team: MODIS

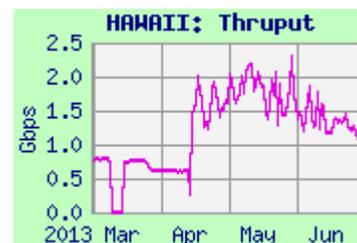
Web Page: <http://ensight.eos.nasa.gov/Missions/terra/HAWAII.shtml>

Test Results:

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
GSFC-ENPL	2071.4	1446.1	952.1	MAX / I2 / LA / UHnet

Requirements:

Source Node	FY	kbps	Rating
GSFC-MODIS	'12 -	21	Excellent



Comments: Testing was initiated to a PerfSonar node at UH in April '12, based on a [very small] MODIS requirement in the new ICD. Performance from **GSFC-ENPL** improved in April when testing was switched to use its 10 gig interface to a 10 gig PerfSonar node in Hawaii.

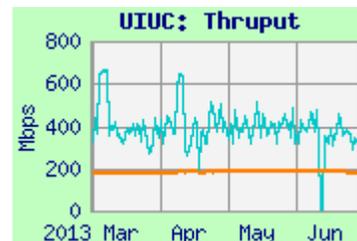
The thrupt is much more than the tiny requirement, so the rating remains **Excellent**

4) IL, UIUC:

Teams: MISR

Web page: <http://ensight.eos.nasa.gov/Missions/terra/UIUC.shtml>Rating: LaRC: **Excellent**
Domain: uiuc.edu**Test Results:**

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
LaRC PTH	186.2	184.6	172.3	NISN / StarLight / I2
GSFC-NISN	744.2	377.2	13.0	MAX / I2

**Requirements:**

Source Node	FY	kbps	Rating
LaRC ASDC	'12 -	556	Excellent

Comments: Testing was added to UIUC in August '10. Initially, SCP testing was initiated from GSFC and LaRC, sending files to UIUC. SCP thrupt was noisy from both sources, and somewhat bimodal.

In October '10, nuttcp testing was added, initiated by UIUC, receiving from GSFC and LaRC. Thrupt on these tests is steadier than SCP, **but much lower, apparently due to significant incoming packet loss (which is causing the noisiness on the SCPs as well).**

In March 2012, testing from **GSFC-NISN** and **LaRC PTH** was switched to a PerfSonar server at UIUC, with greatly improved thrupt. The SCP tests were discontinued in May 2012. The thrupt on the PerfSonar tests was well above the revised requirement (was 1.1 mbps previously); the rating remains **Excellent**. Note that thrupt from **LaRC PTH** is limited to 200 mbps by NISN.

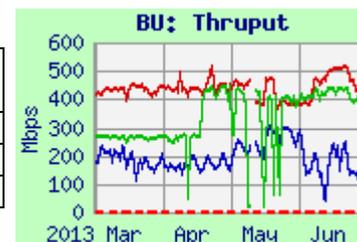
5) MA, Boston Univ:

Teams: MODIS, MISR

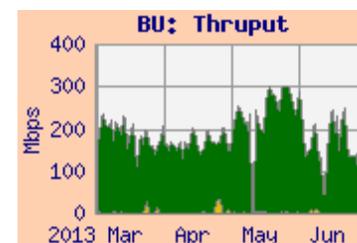
Domain: bu.edu

Ratings: EROS: Continued **Excellent**
LaRC: Continued **Excellent**Web Page: <http://ensight.eos.nasa.gov/Missions/terra/BU.shtml>**Test Results:**

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
EROS LPDAAC	253.9	193.0	46.3	StarLight / I2 / NOX
GSFC GES DISC	477.5	439.3	380.5	MAX / I2 / NOX
LaRC ASDC	439.2	402.9	97.7	NISN / MAX / I2 / NOX

**Requirements:**

Source Node	FY	mbps	Rating
EROS LPDAAC	'12 -	2.6	Excellent
LaRC ASDC DAAC	'12 -	0.7	Excellent



Comments: BU is well connected. Thrupt from **EROS LPDAAC** was noisy, but much better than the [revised lower, was 3.0 mbps] requirements, rating "**Excellent**". The user flow from **EROS** (shown on the integrated graph), averaged about 1.43 mbps for this period – pretty close to the requirement without contingency.

Thrupt from **GSFC GES DISC** was stable and much higher than the requirement. User flow from GSFC was about 0.84 mbps.

Thrupt from **LaRC ASDC DAAC** was noisy (as was **LaRC ASDC DAAC** to all other destinations), but also greatly exceeded the requirements.

6) OR, Oregon State Univ.:Ratings: LaRC ANGe: Continued **Excellent**

Teams: MISR

Domain: oce.orst.edu

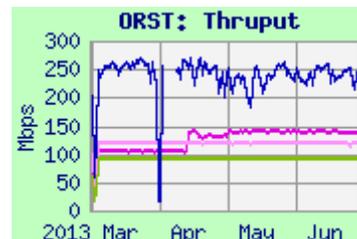
Web Page: <http://ensight.eos.nasa.gov/Missions/terra/ORST.shtml>**Test Results:**

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
LaRC ANGe	96.4	93.8	90.9	NISN / MAX / I2 / PNW
JPL	273.8	241.0	146.0	CENIC / I2 / PNW
GSFC-ESDIS-PTH	119.8	118.8	116.8	MAX / I2 / PNW
GSFC-ENPL	140.5	139.1	130.3	

Requirements:

Source Node	FY	kbps	Rating
LaRC ANGe	'12 -	694	Excellent
GSFC	'02 - '11	250	Excellent

Comments: The requirements were reduced (was 7.6 mbps from LaRC) since the requirements for CERES and MODIS have been eliminated. Thruput was stable from all sources for this period, and was well above the requirements. The rating from **LaRC ANGe** remains "**Excellent**". Results from the East coast sites are limited by a small window size at ORST. Thruput from **GSFC-ESDIS-PTH** improved in September 2012, with the EBnet firewall upgrade.

**7) PA: Penn State Univ.:**Rating: Continued **Excellent**

Team: MISR

Domain: psu.edu

Web Page: http://ensight.eos.nasa.gov/Missions/terra/PENN_STATE.shtml**Test Results:**

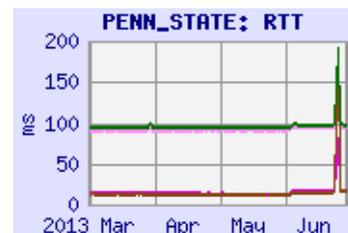
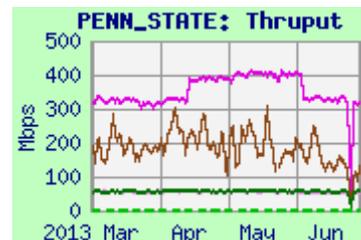
Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
LaRC-PTH	59.3	57.0	46.6	NISN / MAX / I2 / 3ROX
GSFC-ESDIS-PTH	56.9	55.7	50.0	MAX / I2 / 3ROX
GSFC-ENPL	403.5	384.7	319.0	
GSFC-ESTO	241.5	182.2	134.7	

Requirements:

Source Node	FY	kbps	Rating
LaRC ASDC DAAC	'03 -	556	Excellent

Comments: Thruput from NISN sources is much lower than from non-NISN sources, due to much longer RTT. Note that the forward route (to PSU) is OK (see above), but the return route to **LaRC** and **GSFC-ESDIS-PTH** is much longer -- now via peering with NISN in Chicago! But due to the low [reduced from 2.6 mbps] requirement, the rating remains **Excellent**.

From **GSFC-ESTO** (on the SEN at GSFC, not EBnet) and from **GSFC-ENPL** (direct GigE to MAX), the RTT is lower (due to the optimum return route), and the thruput is much higher than from other sources.



8) TN, Oak Ridge National Lab:

Teams: MODIS, DAAC

Web Page: <http://ensight.eos.nasa.gov/Missions/terra/ORNL.shtml>Rating: GSFC: **Excellent**

Domain: ornl.gov

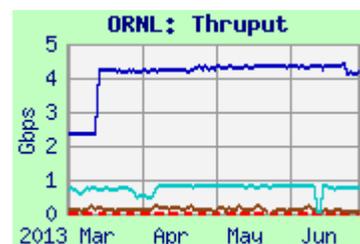
Test Results:

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
GSFC-NISN	864.2	810.4	534.9	NISN / MAX / ESnet
GSFC-ENPL-PS	4535.0	4317.2	3987.8	MAX / ESnet
GSFC-ESTO	170.1	112.0	79.1	MAX / ESnet

Requirements:

Source Node	FY	mbps	Rating
GSFC	'12 -	10.1	Excellent

Comments: Testing was added in October 2012 from **GSFC-ENPL-PS**, a 10 gig connected PerfSonar node at GSFC, to the PerfSonar node at ORNL, with excellent thrupt – which improved in March 2013 due to an ESnet upgrade.



Thruput stabilized from **GSFC-NISN** in December.. Performance was well above the requirement; the rating is therefore **Excellent**".

9) TX: Univ. of Texas - Austin:

Team: MODIS, ICESAT

Web Page: <http://ensight.eos.nasa.gov/Missions/icesat/TEXAS.shtml>Rating: Continued **Excellent**

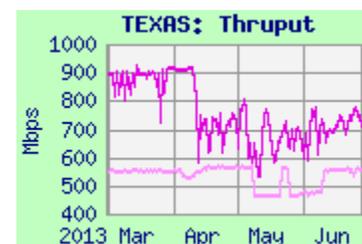
Domain: utexas.edu

Test Results:

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
GSFC-ENPL-PTH	859.8	711.5	390.6	MAX / I2 / TX
GSFC-ESDIS-PTH	577.6	551.9	511.2	

Requirements:

Source Node	FY	kbps	Rating
GSFC-MODIS	'12 -	666	Excellent



Comments: Performance from **GSFC-ESDIS-PTH** improved in September 2012, with the EBnet firewall upgrade, and was returned in November. The thrupt was well above 3 x the MODIS requirement, so the rating remains **Excellent**.

From **GSFC-ENPL**, outside most of the congested GSFC campus infrastructure, thrupt is even better. This test was moved to a PerfSonar node at UT in August 2012, with greatly improved results. [The test from **GSFC-ESDIS-PTH** remains to the SCF].

The previous 11.1 mbps ICESAT requirement has been eliminated, and testing from ICESAT discontinued.

10) Canada, Univ of Toronto:Rating: GSFC: Continued **Excellent**
LaRC: Continued **Excellent**

Team: MOPITT

Domain: utoronto.ca

Web Page: <http://ensight.eos.nasa.gov/Missions/terra/TORONTO.shtml>**Test Results:**

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
LaRC ASDC DAAC	58.7	56.7	22.1	NISN / StarLight / CA*net
LaRC PTH	173.2	162.0	118.6	
GSFC-ESDIS-PS	929.5	916.4	577.2	

Requirements:

Source Node	FY	kbps	Rating
LaRC DAAC	'02 -	100	Excellent
GSFC EOC	'02 -	512	Excellent



Comments: Thruput from LaRC ASDC DAAC dropped in late April '12 due to congestion at ASDC. Other destinations dropped similarly from LaRC ASDC at the same time; however, no such drop was observed from LaRC PTH, indicating that the problem was not a WAN problem but was local to LaRC ASDC.

The server at Toronto was rebooted in mid December 2012, with reduced window size, reducing thruput at that time. The parameters were corrected, and testing returned in early March, and thruput improved from all sources.

The ratings from both sources remain **Excellent**, due in part to the low requirements.

User flow from GSFC averaged 130 kbps this period.

11) Canada: CCRS (Ottawa)Rating: Continued **Excellent**
Domain: ccrs.nrcan.gc.ca

Teams: MODIS, CEOS

Web Page: <http://ensight.eos.nasa.gov/Missions/terra/CCRS.shtml>**Test Results:**

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
GSFC-MODAPS	132.8	131.8	108.2	MAX / I2 / CA*net
GSFC-ENPL	168.8	165.7	157.6	

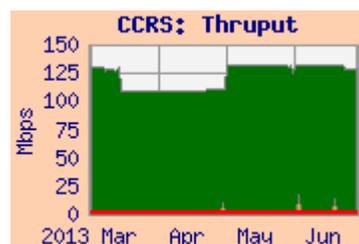
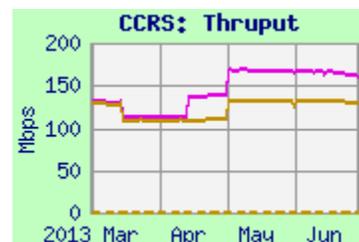
Requirement:

Source Node	FY	mbps	Rating
GSFC-MODAPS	'11 -	1.1	Excellent

The MODIS requirement was reduced from 3.8 mbps previously.

Thruput from GSFC-MODAPS was stable, and remained much more than 3 x the requirement, so is rated **Excellent**.

User flow from GSFC averaged 3.8 mbps this period, above the 0.5 mbps last quarter, and much higher than the requirement (but consistent with the old requirement).



12) UK, Oxford Univ.:

Team: HIRDLS

Web Page: <http://ensight.eos.nasa.gov/Missions/aura/OXFORD.shtml>Rating: Continued **Excellent**

Domain: ox.ac.uk

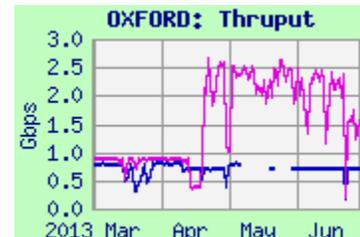
Test Results:

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
GSFC-ENPL-PTH	2682.9	2088.4	545.5	MAX / I2 / Géant (DC) / JAnet
GSFC-ENPL-PS	726.9	711.7	307.5	

Requirements: (IST Only)

Source Node	FY	kbps	Rating
GSFC	'03 –	368	Excellent

Comments: Beginning in late March 2012, testing was switched to a PerfSonar server at Oxford, using iperf. Testing previously had used, “flood pings”, which is a poor substitute for iperf, and provided much lower results. Performance improved again in June 2012 when the Oxford PerfSonar node was upgraded, and again in April 2013 by using a 10 gig interface from GSFC-ENPL-PTH. The rating continues **Excellent**.



User flow from GSFC to Oxford averaged 1.29 kbps for this period, above both the requirement and the previous period.

13) UK, London: (University College)

Teams: MODIS, MISR

Web Page: <http://ensight.eos.nasa.gov/Missions/terra/UCLSCF.shtml>Rating: Continued **Excellent**

Domain: ucl.ac.uk

Test Results:

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
LaRC PTH	36.5	28.8	6.9	NISN / MAX / Géant / JAnet
GSFC-ESDIS-PTH	32.4	27.8	12.1	MAX / I2 / Géant (DC) / JAnet
EROS-PTH	19.3	17.2	4.7	StarLight / I2 / Géant (DC) / JAnet

Requirements

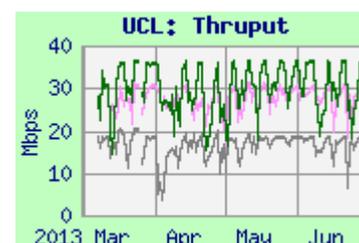
Source Node	FY	kbps	Rating
LaRC DAAC	'12 –	556	Excellent

Comments: Testing since November and December '10 is by nuttcp pulls, initiated at UCL.

NISN began peering with Géant in September '09, with improved thrupt from LaRC. Previously, the route from LaRC was via NISN peering with Teleglobe on the US west coast, unnecessarily increasing RTT and reducing thrupt.

Thruput from all sources was noisy but long-term stable. The median daily worst thrupt from LaRC PTH remained well above 3 x the requirement, so the rating remains **Excellent**.

From GSFC-ESDIS, performance has been stable the EBnet firewall upgrade in September 2012, Thruput from EROS is lower than the other sites, due to a longer RTT.



14) British Atmospheric Data Centre

Rating: Continued **Excellent**

(Rutherford Appleton Laboratory)

Team: HIRDLS

Domain: rl.ac.uk

Web Page: http://ensight.eos.nasa.gov/Missions/aura/UK_RAL.shtml

Test Results:

Source Node	Medians of daily tests (mbps)			Route
	Best	Median	Worst	
GSFC-ENPL	33.5	26.6	18.7	MAX / I2 / Géant (DC) / JAnet
GSFC-ESDIS-PTH	25.8	21.6	16.3	

Requirements:

Source Node	FY	kbps	Rating
GSFC	'02 –	190	Excellent

Comments: Thruput from **GSFC-ENPL** was very similar to that from **GSFC-ESDIS-PTH**. The thruput has consistently been much higher than the requirement, so the rating remains “**Excellent**”.

User flow averaged 110 kbps this quarter, consistent with the requirement without contingency.

