



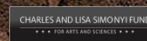
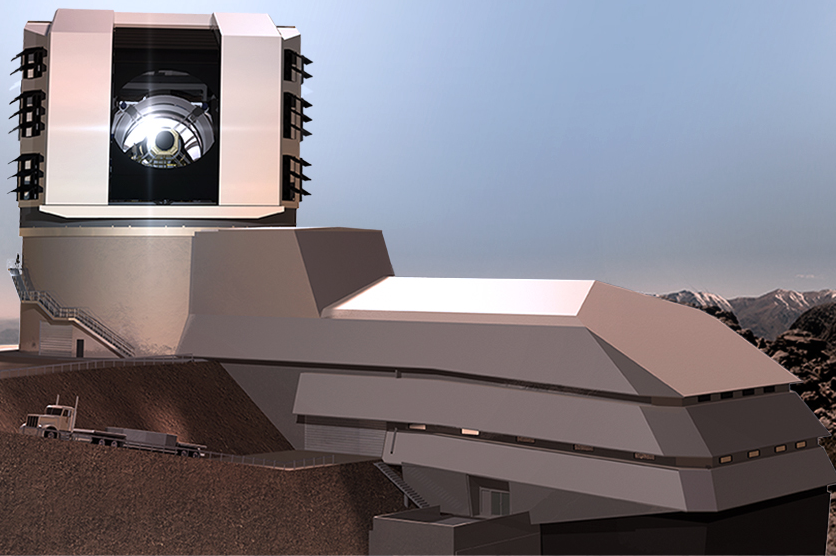
# LSST Distributed Computing and Networks

Jeffrey Kantor

Sr. Manager

TICAL 2019

September 3, 2019



# Large Synoptic Survey Telescope (LSST)



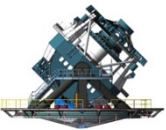
Is an 8.4 meter telescope  
being built in Chile

Will conduct a 10 year  
survey of the sky

Begins operations in late  
2022



Photo: Gianluca Lombardi



# LSST Observing Cadence and Data Rate

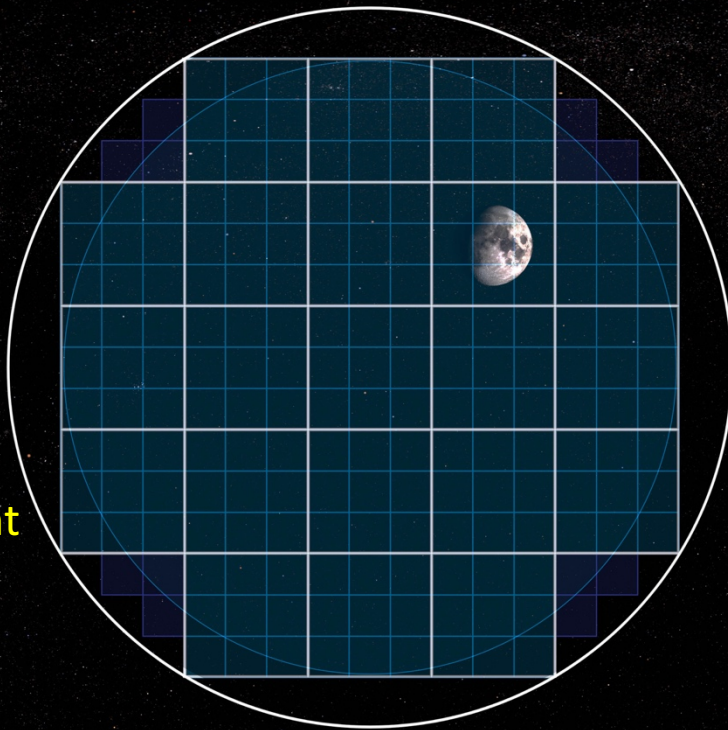


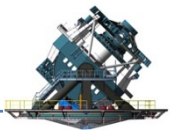
Each image is:

- 9.6 square degrees
- 3.2 gigapixels
- 6.4 GB of data

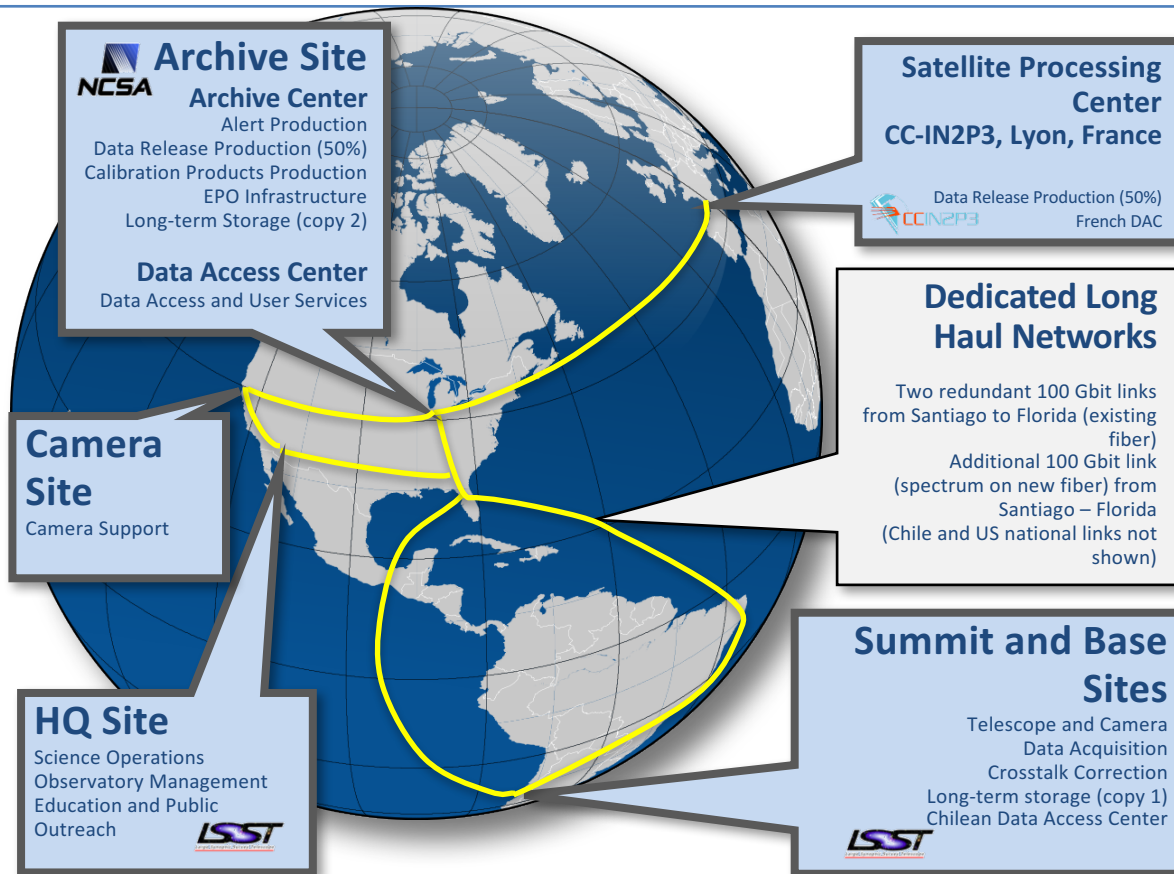
Observing is:

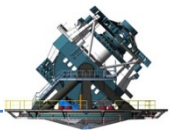
- 2 x 15 sec exposure/pointing
- ~2000 images/night
- 15 TB/night
- 7 PB/yr



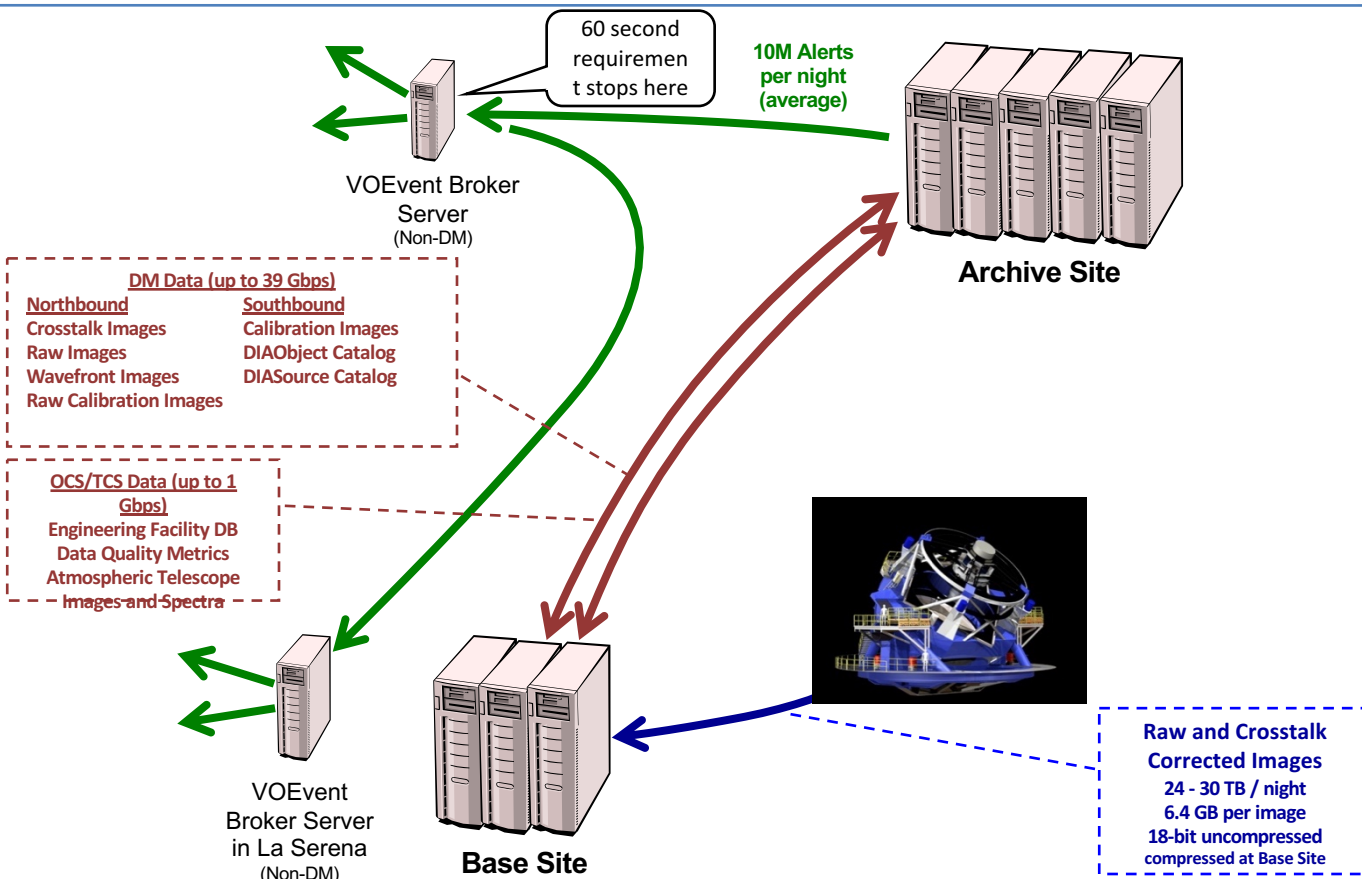


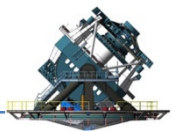
# LSST Sites and Long-Haul Networks



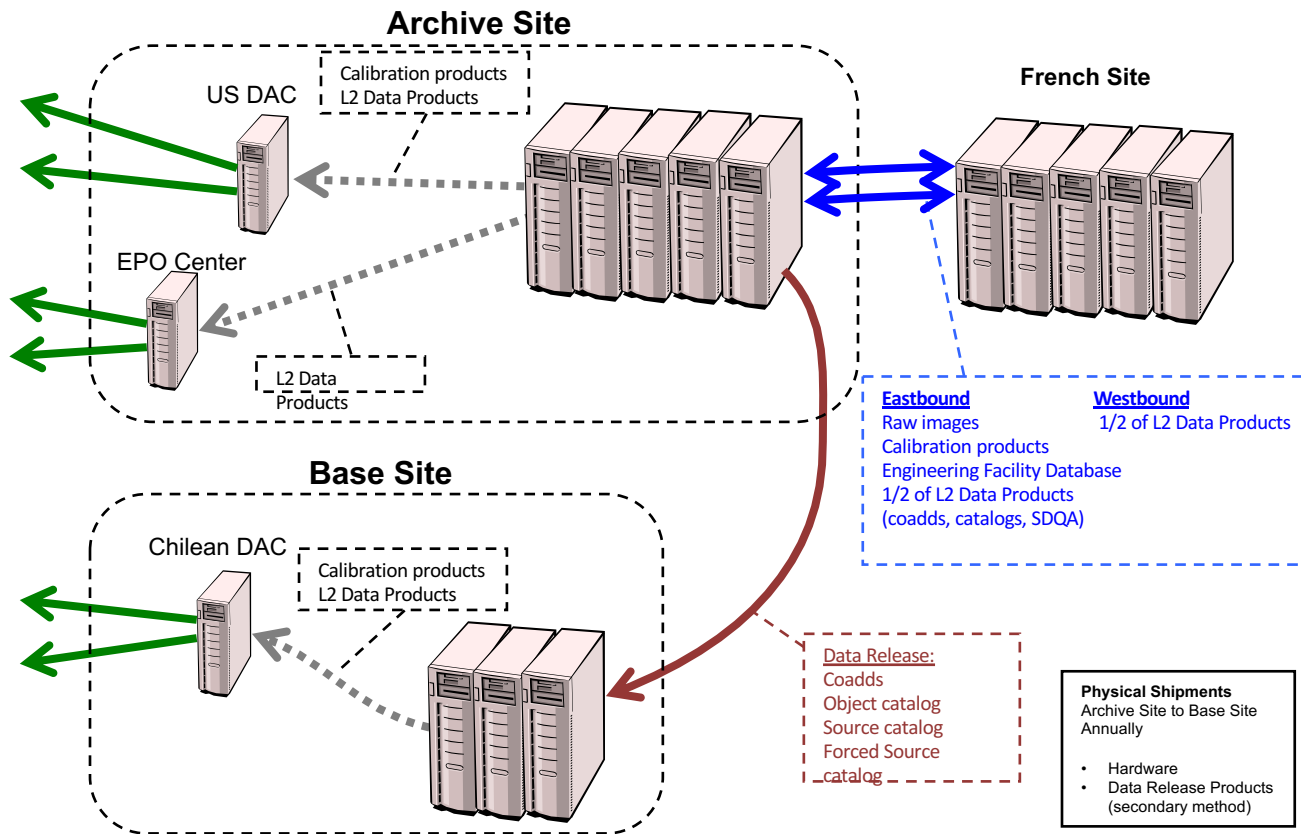


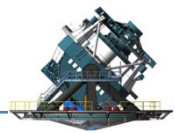
# Nightly Data Flows





# Non-Nightly Data Flows and Distributed Computing





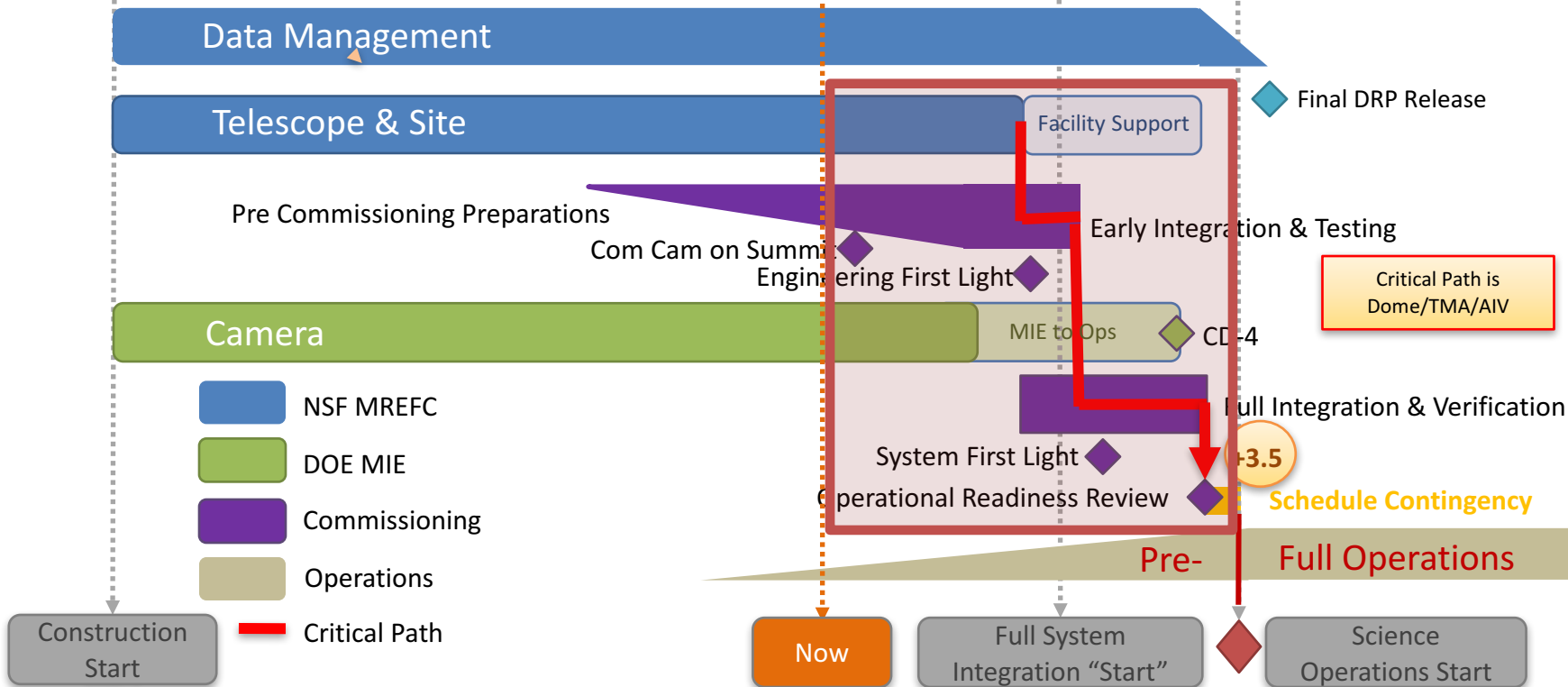
- Nightly data products
  - Alerts
  - Difference images and catalogs
  - 60s latency from time of readout from camera
- Annual data products
  - Process all accumulated data from start of survey (distributed US, France)
  - Produces all nightly data products plus
  - Catalogs of deep, faint objects
  - “Forced” photometric measurements
- Supporting community-developed data products
  - “Nearby” computing and storage at Data Access Centers
  - Software (middleware, pipelines, algorithms, tools)



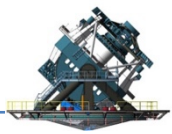
# Current LSST Schedule – 3.5 Months Contingency



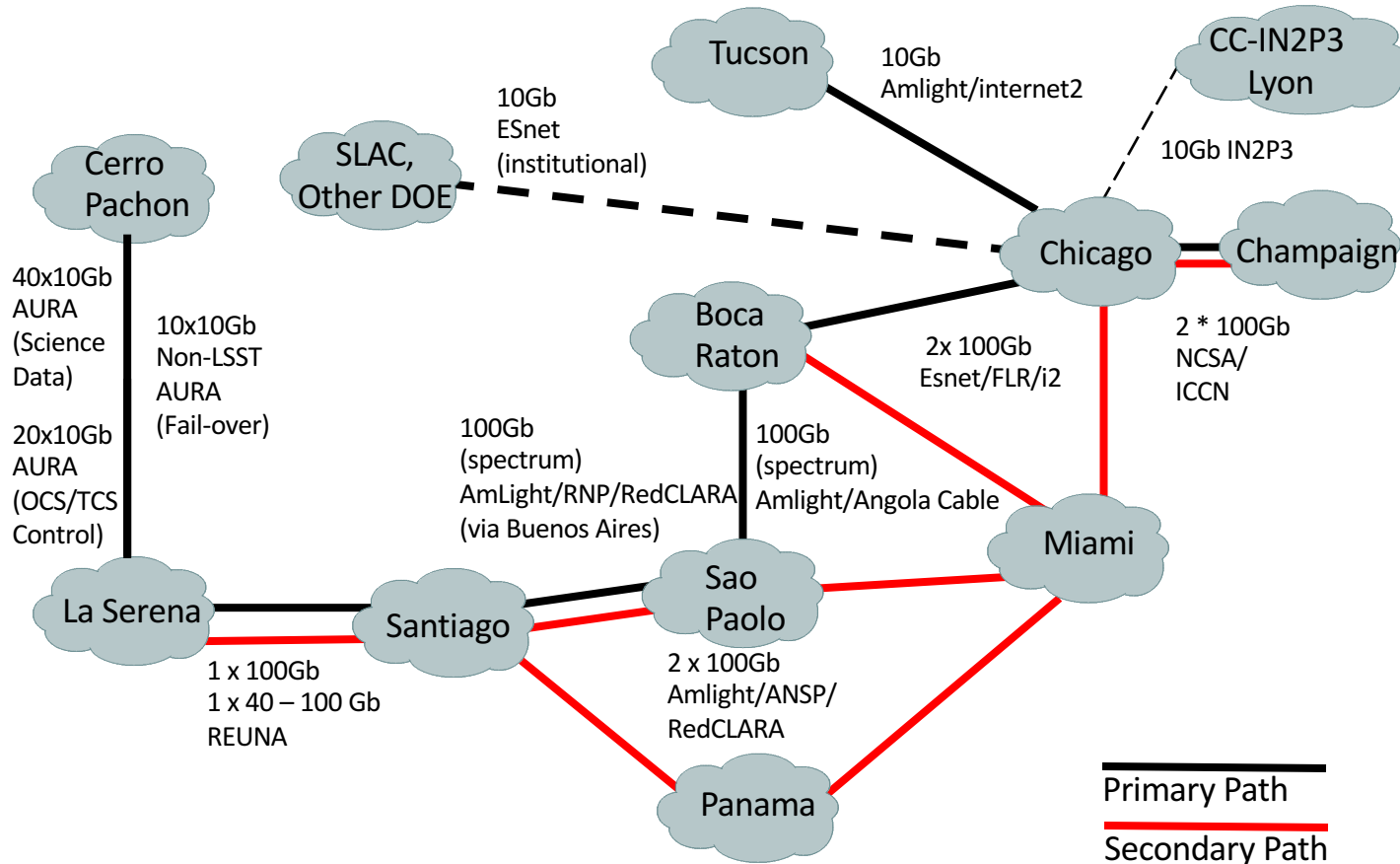
FY 2014				FY 2015				FY 2016				FY 2017				FY 2018				FY 2019				FY 2020				FY 2021				FY 2022				FY 2023				FY 2024			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4				

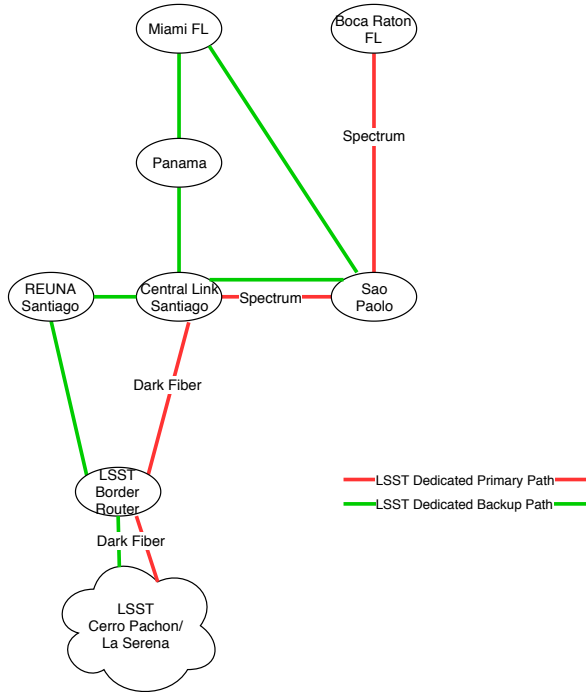
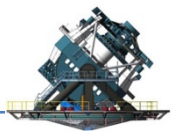


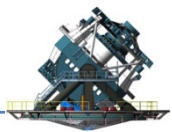




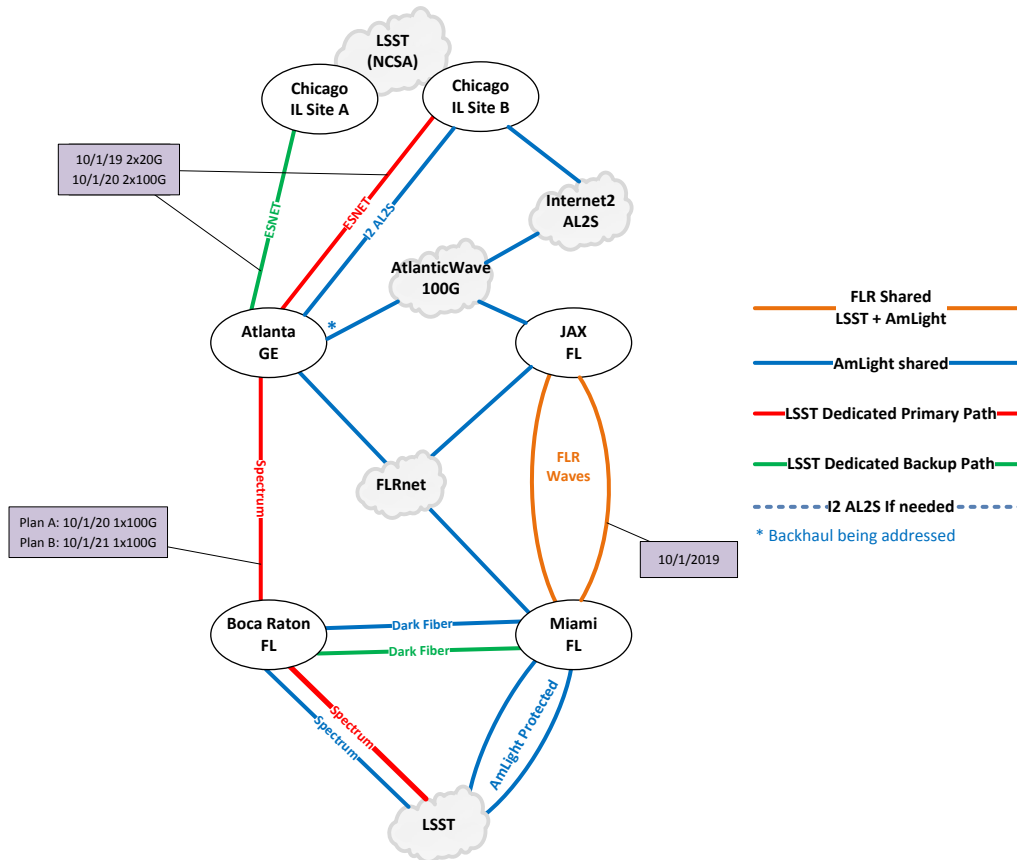
# LSST Long Haul Network Links (Baseline FY21)

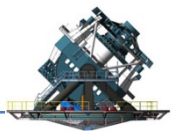




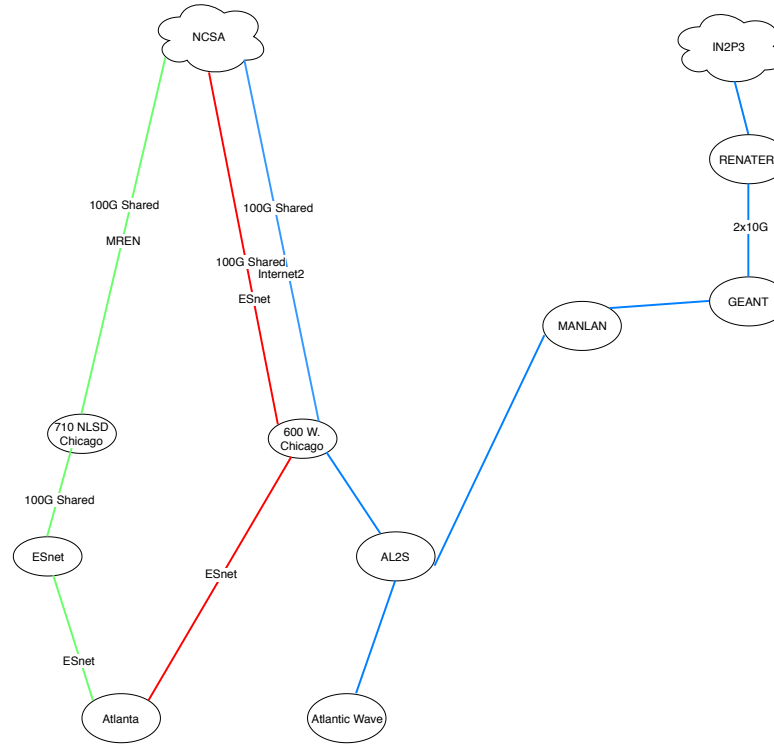


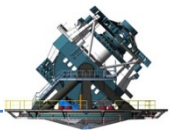
# LSST US Networks (Florida – Chicago)





# LSST Northern Networks (Champaign – Chicago – Lyon)





# ESNet for LSST

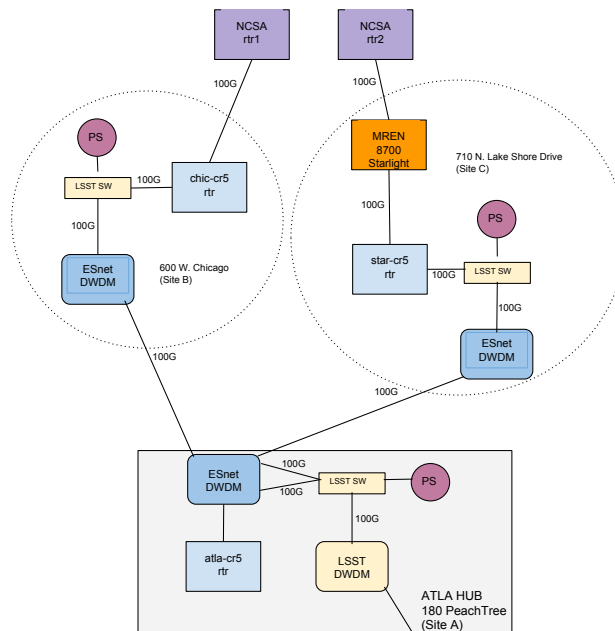


ESnet6 Optical Footprint: Add/Drops  
Wave options Atla-Chic



Ciena\_Map v12  
p1d 9/30/2016

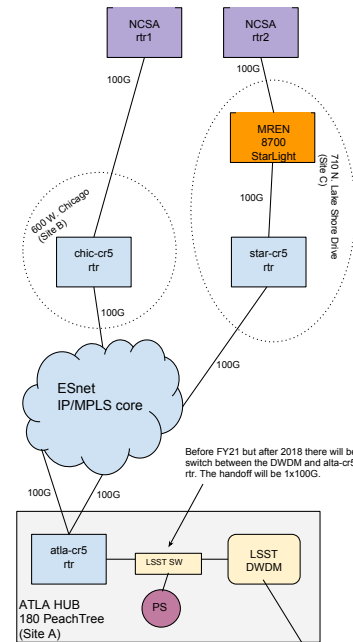
## FY20 (2 x 20 Gbps)



Last update 1/18/2018

to Florida

## FY21+ (2 x 100 Gbps)



Before FY21 but after 2018 there will be a switch between the DWDM and atla-cr5 rtr. The handoff will be 1x100G.

to Florida

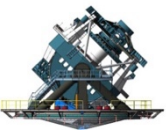


# End-to-End Network Bandwidth Evolution



MILESTONE LEVEL	ID	ACTIVITY	BASELINE FINISH	PROJECTED FINISH	END-TO-END B/W, Cerro Pachon - La Serena	Bandwidth Achieved through Demonstration
2	DM-NET-1	Base - Archive Network Functional 1 Gbps	6/11/15	6/11/15	0.5 Gbps	0.5 Gbps (operational)
2, 3	DM-NET-2, -3, 6, DMTC-6800-1310	Mountain - Base Network Functional 2 x 100 Gbps, Summit LAN Installed, Initial Network Ready (Summit), Network Acceptance/Verification Review for Early Integration	3/27/18	6/30/18	2 x 100 (shared AURA DWDM)	46Gbps (LSST First Light demo)
	DM-NET-4, DMTC-6800-1320	Base LAN installed, Network Acceptance/Verification Review for Full Integration	11/30/18, 7/3/19	10/15/19	DWDM) + 2 x 100 (shared AURA DWDM)	80Gbps (LSST SC18 demo)
		Auxiliary Telescope Spectrograph on Sky Observing		11/1/19		
3	DM-NET-5	Base - Archive Network Functional 100 Gbps	7/3/19	1/1/20	DWDM) + 2 x 100 (shared AURA DWDM)	
3	DMTC-6800-1330	Network Acceptance/Verification Review for Science Verification	7/6/20	7/6/20	6 x 100 (dedicated LSST DWDM) + 2 x 100 (shared AURA DWDM)	
		Data Preview 0 Start		12/15/20		
		Commissioning Camera on Sky Observing		4/23/21		
3	DMTC-6800-1340	Network Acceptance/Verification Review for Full Operations	7/2/21	7/2/21	6 x 100 (dedicated LSST DWDM) + 2 x 100 (shared	
		Data Preview 1 Start		8/24/21		
		Ful Camera on Sky Observing		10/12/21		
		Data Preview 2 Start		2/15/22		

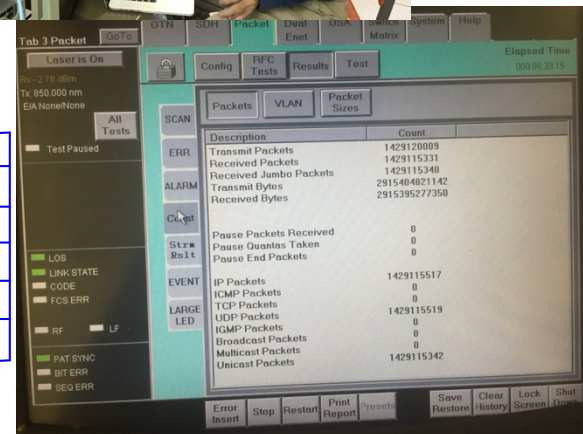
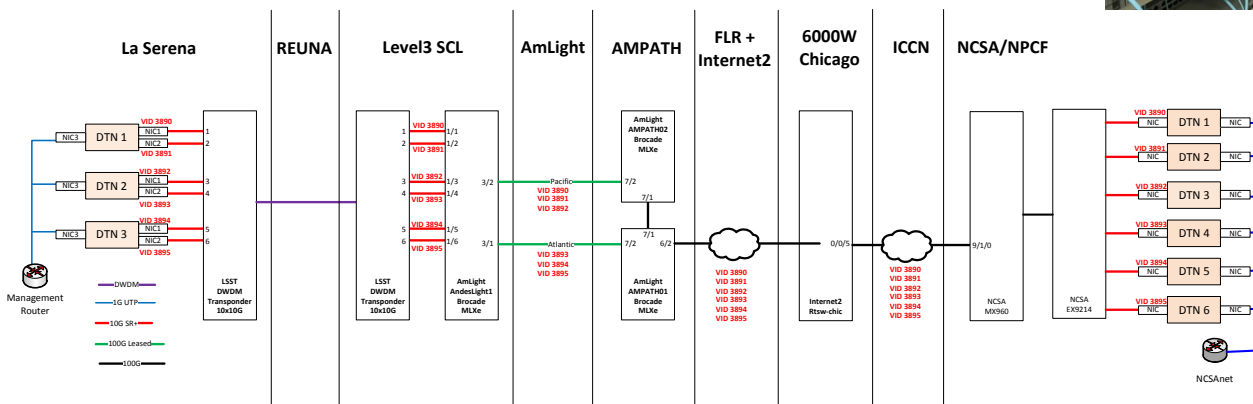
Note: LSST internet, web, voice, video go over AURA circuits, which are shared, and are currently limited by 1G Firewalls in LS and 10 Gbps internet2 links in the US. This will be improved by the end of FY19 by the move to 10 G firewalls in LS.

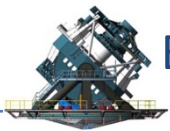


# First Optic Light Demonstration – December 2017



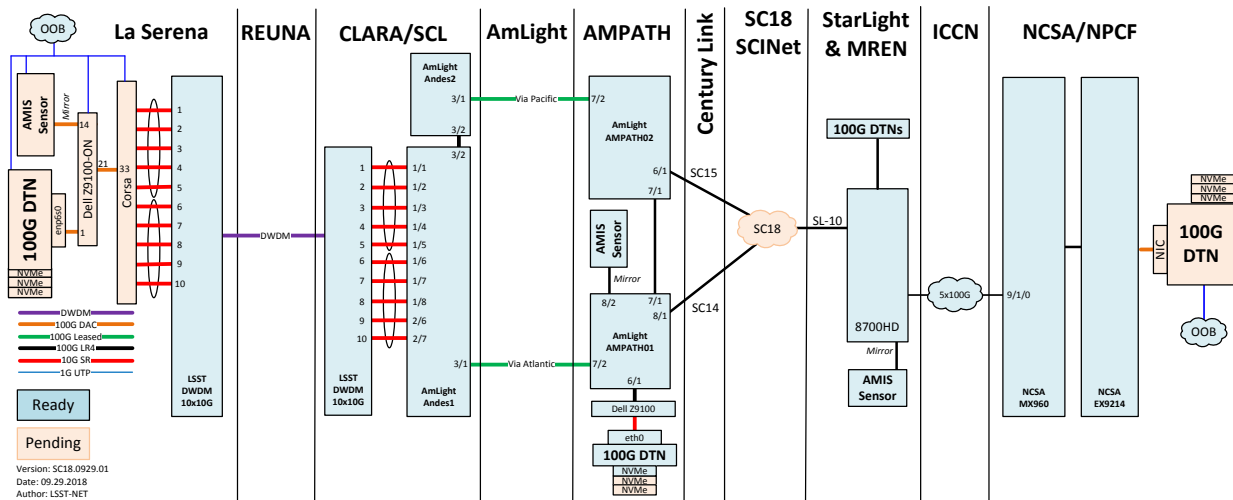
- The LSST Network Engineering Team (NET) completed the first successful transfer of digital data over LSST/AURA fiber optic networks from the Summit Site on Cerro Pachon, Chile to the Base Site in La Serena, Chile and on to the Archive Site at NCSA in Champaign. A set of 6 x 10 Gbps Network Interface cards on Data Transfer Nodes (DTN) configured with iPerf3 generated a sustained data rate of approximately 44 gigabits per second, over a period of 24 hours. This exceeded the test target of 40 gigabits per second.



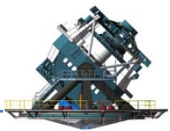


# Base – LDF 100 Gbps Network Demonstration – November 2018

- Following up on the first successful transfer of digital data over LSST/AURA fiber optic networks from the Summit Site on Cerro Pachon, Chile to the Base Site in La Serena, Chile and on to the Archive Site at NCSA in Champaign in December 2017, that achieved 44 Gbps sustained data rate.
- 100 Gbps demonstration from La Serena – NCSA November 14, during Supercomputing 2018. Data set is 10 TB of DECam public data. Using SCInet connections from Miami – Dallas – Chicago. DM-provided “watch” JupyterHub application will be used to monitor transfer from Data Transfer Node (DTN) to GPFS file-system/disk.







- The LSST Long-Haul Network is a single operational network implemented with diverse providers and links that must work seamlessly together
- The VNOC provides a single, integrated operational capability for end-to-end engineering, performance monitoring, security, maintenance, and all other operations
- The goal is complete visibility in all links and sites to all participants, with a single entry point for information and assistance

# Virtual Network Operations Center (VNOc) Sites

