# A LSST Follow UP System

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# LSST Follow Up System
## The Story So Far

- LSST is NSF focus of the next decade on the ground
- NOAO seeks to maximize science impact of its facilities by providing capabilities to broad user community
- NOAO mission evolving rapidly around large surveys, coherent data sets, tools to exploit data sets
- NOAO has strong and accomplished history of supporting time domain science, follow up observing
- LSST event stream and annual data releases make for a golden opportunity (indeed stated need) for AURA facilities to be key elements in the LSST era
- Elmegreen and Najita-Willman reports, Follow Up System: key element of OIR System Optimization

# OIR System Optimization

## Need: Comprehensive Follow Up System

- End to End system capable of delivering science data products given merit based review, allocation of resources, brokering of alert streams, complex observation management, resource deployment, pipeline and data distribution.
- Build on AURA facilities with key partnerships is the best way to stand up a (phased) system.
- Leading a concept development with SOAR, Gemini, Las Cumbres Observatory (LCO) -> Follow Up project and proposal coming.
- New effort. Not yet funded. Will require new funds from NSF or other source.

# Follow Up System

## What is in Hand and What Needs Doing

- Broadly, in good shape with telescopes and instruments to start: SOAR, Gemini, Blanco, LCO. All noted in Kavli report
- Gemini has new broad wavelength coverage spectrograph (OCTOCAM) coming. GMOS/F2 in mean time.
- SOAR has Goodman and (soon) TS4.
- Blanco has DECam for non-LSST cadence, other filters
- NOAO developing ANTARES to broker LSST event stream
- Need development at interface of ANTARES and science based target management and interface between target management and network of resources (telescopes+instruments and a dynamic scheduler).
- Need further (spectroscopic) pipeline/tool development
- Several elements already included in current supplemental funding request (interface “language”, and spectroscopy primatives, ANTARES full scale broker, target and observation management)

# Follow Up System
## Development Path

- Favor a plan (and project) that starts with
  - limited observing nodes
  - limited observing modes
  - delivers capability in a phased way in next ~ two years
  - is modular and extensible
  - provides full capability by LSST start of survey 2023

# Follow Up Project

## Proposed Phased Implementation

- Phased deployment: AURA/LCO first. Phases can overlap
- Phase 1
  - Connect LCO scheduler to SOAR
  - Add Target Observation Manager
- Phase 2
  - Chain link LCO and SOAR observations
  - Add (p)ANTARES (need stream, or simulated stream)
  - Add Gemini
  - Open access to users (before LSST)
- Phase 3
  - All AURA and LCO facilities integrated
  - Hooks in place to accept other facilities
  - End to end system operating (2023) and supporting users

# Follow Up Project
## What's next

- Working with Gemini, SOAR, LCO on concept definition
- Organize and develop the concept (2017), assign work packages for development and resource estimates
- Seek supplemental resource to fund project
  - Integrated with aspects of base programs as appropriate
  - leverage expertise of all partners

# Follow Up System
## LCO/Najita-Willman Chapter 9

- Three blocks
  - 1) Broker (ANTARES, see Narayan/Soraisam talk)
  - 2) Target and Observation Management (this is a SCIENCE layer, Street, Arcavi, Howell)
  - 3) Network (includes the magic of the scheduler and all control agents at the telescope level)
    - For LCO network is robotic, redundant, homogenous nodes
    - AURA will add unique, non robotic, but automated nodes
    - One or multiple networks?

# Follow Up Project
## Issues, opportunities

- Instrument upgrades in longer term
- SOAR and Blanco need “Q” observing support (possibly could be handled by OA’s if modes are restricted)
- Common libraries for spectroscopic reduction
- Socializing community to need to redirect telescope resources to dedicated follow up mode

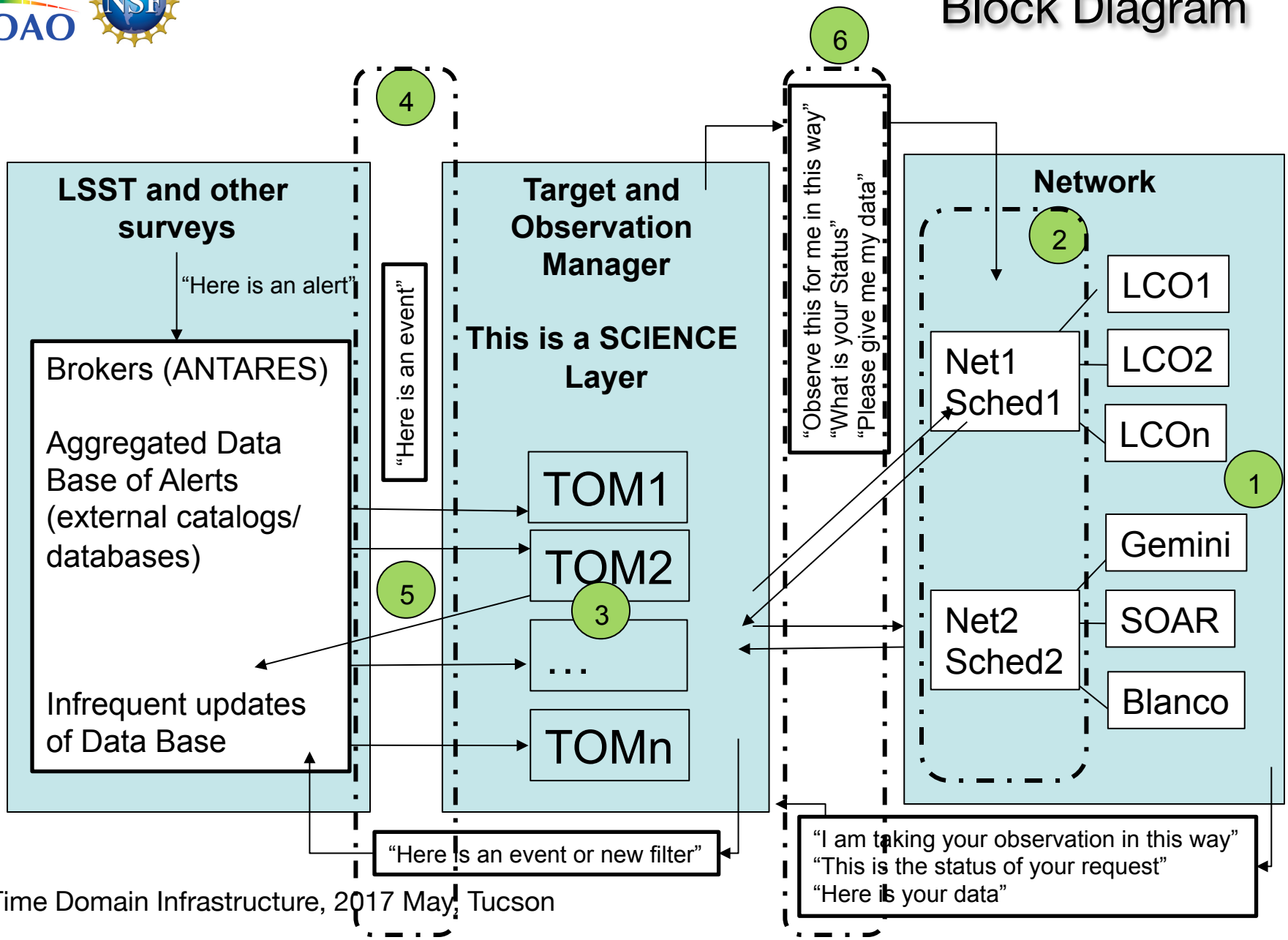
# End of Presentation

## System Under Construction!

# Follow Up Project

## Backup slides

# Follow Up System
## Block Diagram



# Follow Up System

## Work Areas for further development

1. Heterogeneous resources on the network (one network or parallel networks). Agents, interfaces.
2. Meta scheduler to handle different resource types and network(s) connectivity
3. Inter-TOM connectivity. Generic elements, TOM building tool kits, templates
4. Meta event layer-> getting actionable events to TOM science analysis
5. Science data bulletin board (sharing science data and real time updates to data base in the TOM layer or infrequent feedback to Broker layer
6. Language/API to communicate with heterogeneous resources on network(s)

# OIR System Optimization

## Maximizing science return in the era of LSST

- NSF guidance to NOAO in March 2016, in response to recommendations of Elmegreen et al. 2015
- Five categories of activity:
  I. Telescope time exchange & data access across the OIR system
  II. Planning new capabilities
  III. Event broker development, archives, and data-product serving
  IV. LSST follow-up coordination
  V. Community preparation for the LSST era
- Further input from Kavli-funded May 2016 workshop
- Initial NOAO response to NSF in May 2016
- Follow Up System is only a part of this response (see talk by Norman, this meeting)

# End to End Follow Up
## Pre-concept

| NOAO LSST Followup Project | | | |
|---|---|---|---|
| **LSST Followup Elements** | **NOAO Program** | **Partner** | **OIR Deliverable** |
| Community Training | CSDC | LSSTC | V |
| Proposal Preparation | TAC/CSDC | Gemini | I, V |
| Proposal Review | TAC | Gemini | I |
| Allocation | TAC | | I |
| Brokering | ANTARES | UA CIS | |
| Target selection | CSDC | LCO(GTN) | II, III |
| Dynamic Scheduling | NOAO ETS | LCO(GTN) | II, III, IV |
| Data Taking | Blanco, SOAR | Gemini, SOAR, LCO | II |
| Data transport | DMO | | II |
| Data Reduction | CSDC, DL | Gemini, SOAR, LCO | II, III |
| Data distribution | DMO | | III, IV |
| TDS tools | TDS, DL | | II, IV, V |
| Archive/data product serving | DMO, DL | | I, III, V |