A System for LSST Follow UP

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LSST Follow Up System
The Story So Far

- LSST is NSF focus of the next decade on the ground
- LSST event stream and annual data releases define a major objective for AURA facilities and reserouces in the LSST era
- Need: Comprehensive Follow Up System*
- Key element of OIR System Optimization*

*Elmegreen and Najita-Willman reports

LSST Follow Up System
The Goal

- Deliver an end to end Follow up System for Community use
- Support follow up science soon (e.g. ZTF public stream)
- Support LSST Science in commissioning and operation

Follow up system
The Approach

- NOAO mission evolving rapidly around large surveys, coherent data sets, tools to exploit data sets
- Develop end-to-end NOAO follow up resource
- Build on AURA facilities with key partnerships
- Preliminary development: NOAO/SOAR, Gemini, Las Cumbres Observatory (LCO)

What is in Hand and What Needs Doing

- Telescopes and Instruments:
  - Gemini: GMOS, GNIRS, OCTOCAM (broad wavelength coverage spectrograph) coming
  - SOAR: Goodman, TS4 (soon)
  - Blanco: DECam (non-LSST cadence, other filters)
- ANTARES broker (ZTF public stream, Spring 2018)
- Need development – interfaces
  - ANTARES to science based target and observation management (TOM)
  - dynamic scheduler totelescopes+instruments
- Need further (spectroscopic) pipeline/tool development

Follow Up Project
Development Path

- Phased delivery over ~ two years
- Start with:
  - limited observing nodes
  - limited observing modes
- Phased deployment
- System is modular and extensible to other NOAO resources and new non-Federal partners
- Provide full capability by LSST start of survey 2023

Follow Up Project Concept*
Three blocks

1) Broker (ANTARES)
2) Target and Observation Management (TOM)
3) Network (includes the magic of the scheduler and all control agents at the telescope level)
   - LCO network is robotic and redundant with homogenous nodes
   - AURA will add unique, non robotic, but automated nodes

* Najita-Willman Chapter 9

Follow Up Project
Development Path

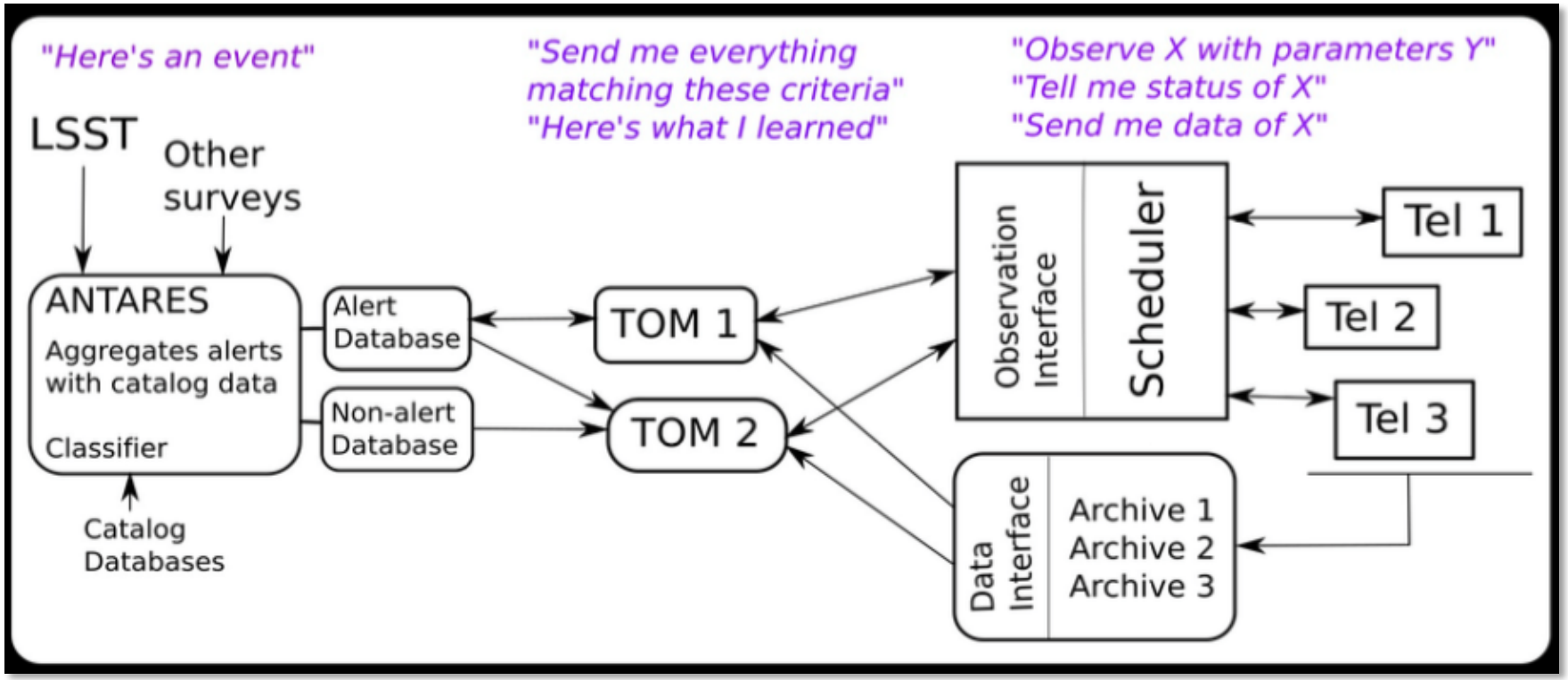

Image credit Rachel Street, LCO

Follow Up Project
Phased Implementation

- Phase 1
  - Connect LCO scheduler to SOAR
    - SOAR automation, data reduction, archive ingest/user access
    - Key goal: operate SOAR with dynamic schedule for one night
    - Complete by end FY18
  - In parallel ANTARES running on real event streams
  - Engage with Gemini for requirements in their new OCS.
- Phases overlap
- End of Phase 4 - Support community science with LSST commissioning and operation

Follow Up Project
What's happening now

- Working with Gemini, SOAR, LCO
  - preliminary design
  - scope of work for phase 1
  - assign work packages
  - resource estimates & funding
- LCO leading community based target and observation management (TOM) development
- SOAR working on automation, data pipelines, interfaces
- Gemini developing new OCS

Follow Up Project
Issues, opportunities

- Instrument upgrades in longer term
- SOAR and Blanco need queue observing support
- Common libraries for spectroscopic reduction
- Evolution of commuity use model to redirect telescope resources to dynamically scheduled modes

LSST Follow Up System
The Team

- Andy Adamson (Gemini)
- John Blakeslee (Gemini)
- Bob Blum (NOAO)
- Adam Bolton (NOAO)
- Todd Boroson (LCO)
- Cesar Briceño (NOAO/SOAR)
- Mark Bowman (LCO)
- Jay Elias (SOAR)
- Steve Heathcote (NOAO)
- Bryan Miller (Gemini)
- Steve Ridgway (NOAO)
- Eric Saunders (LCO)
- Rachel Street (LCO)
- Joanna Thomas-Osip (Gemini)
- Nikolaus Volgenau (LCO)

The End

Follow Up Phase II
Phases overlap

- Phase 2 minimal requirements for TOM functionality for phase 2.
  - Submit user described observations to LCO and SOAR
  - TOM can access pipeline data from web service
  - ANTARES in operation (with public stream from ZTF; a minimum demonstration of ZTF->ANTARES will be in hand at this point)
  - Open access to users (before LSST) with minimum protoype capability
  - TOM can interact with both LCO and SOAR observations
  - Scheduler drives automated observations on SOAR.
  - Minimal end-to-end system V1.0 (ZTF-ANTARES-TOM-LCO/SOAR) by end FY19
  - Add Gemini (proof of concept activity like SOAR in phase 1)

Follow Up Project II
Proposed Phased Implementation

- Phase 2b
  - Scheduler drives sequence of “time-domain only” observations on Gemini
- Phase 2c (“goal”)
  - Scheduler incorporates Gemini static queue into Gemini observing schedule
  - Reduced Gemini data available to users
  - Open access to users (before LSST)

Follow Up Project III
Proposed Phased Implementation

- Phase 3
  - All AURA and LCO facilities integrated
  - Hooks in place to accept other facilities
  - End to end system operating and supporting users for ZTF
  - Real-time data reduction for quality assessment, basic characterization
- Phase 4
  - Support community science with LSST commissioning and operation