TRANSIENT EVENTS IN LSST SURVEY DATA

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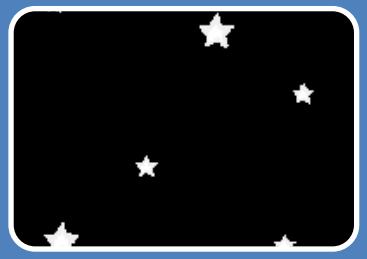
LSST data products

Level 1
Transient events
(variable and moving objects)



Level 2
Static objects
(catalogs, images)

Level 3
User services

Transient events

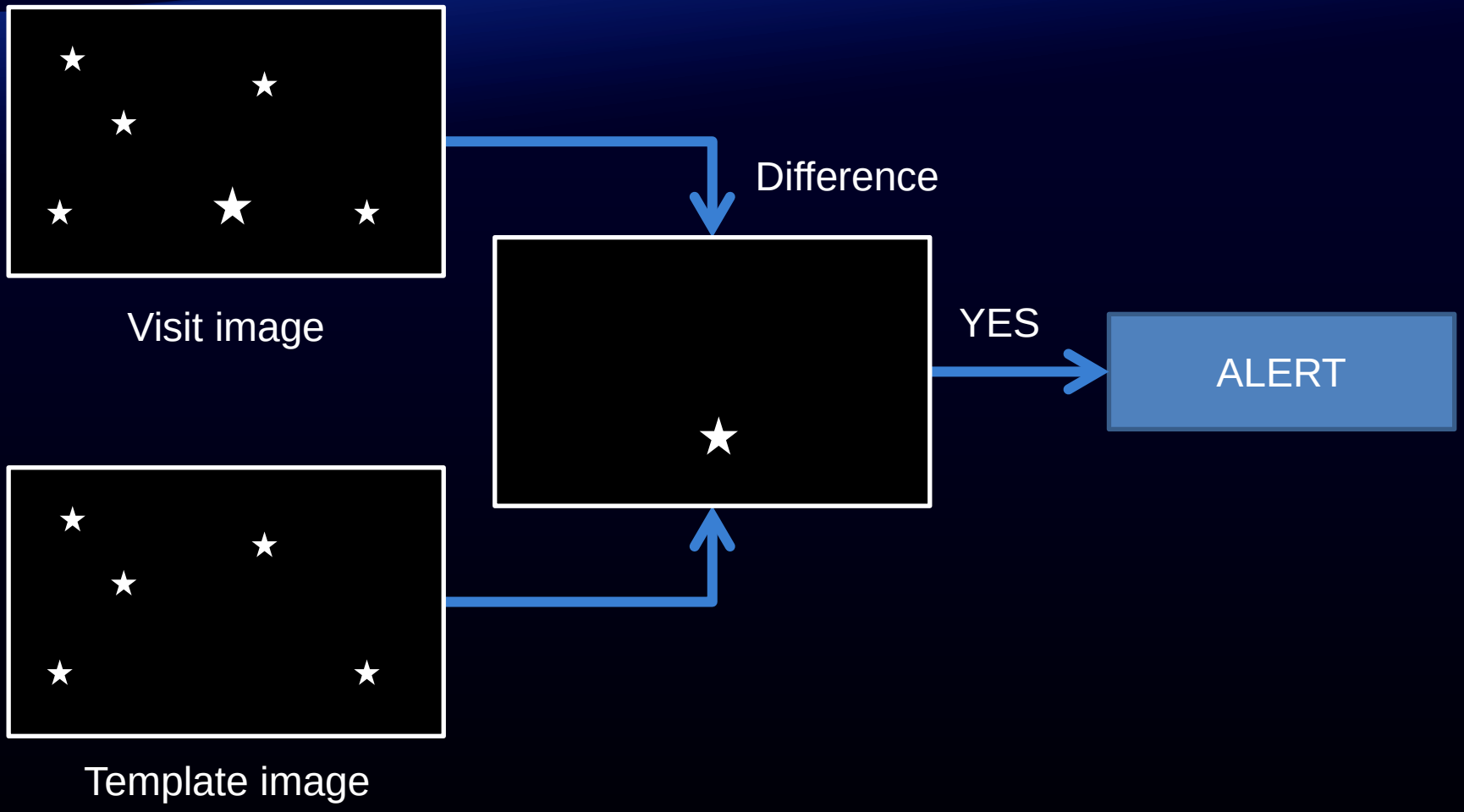
- Flux changes
  - Variable stars
    - periodic
    - cataclysmic
  - Eclipsing binaries
  - Transits of extrasolar planets
  - Galaxies
  - AGN
  - bursts (optical)
- Position changes
  - Planets
  - Asteroids
  - Comets
  - Trans-Neptunian objects

- Not stored as f(t)
- Moving objects: orbit(q,e,i,lan,aop,M)
- Variable objects: variability string

Characterizing objects (Event classification)

1. User contributed LCs and context data (time, flux, flux-error, filter)
2. generate a set of features for transient and variable objects
3. characterization & classification

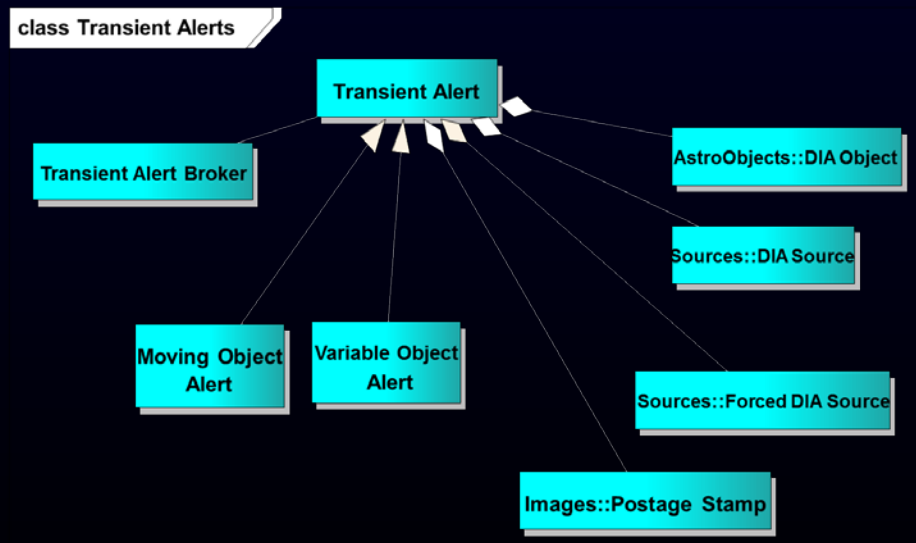
Basic procedure



Content of each alert

- alert ID
- timestamp
- level1 database ID
- Science data
  - position
  - flux, size, and shape
  - light curves in all bands (up to a ~year; stretch: all)
  - variability characterization (eg., low-order light-curve moments, probability the object is variable)
- cut-outs centered on the object (template, difference image)

Alert properties

- available world-wide within 1 min of visit acquisition
- ~10M per night, ~10k per visit
- format: VOEvent
- 

VOEvent

- 1visit ☞ ~10000 VOEvents ☞ identical metadata
- "VOEventGroup" header + per-alert data
- Need for inclusion “heavyweight” data (cut-out images) with the events

- Currently being discussed, not implemented yet
- LSST team will consider to propose IVOA some modifications for VOEvent standard

Big Data

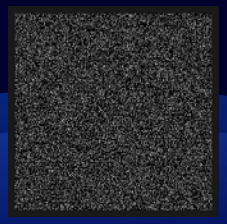
~10 million alerts per night

- Filtering
- Simulator

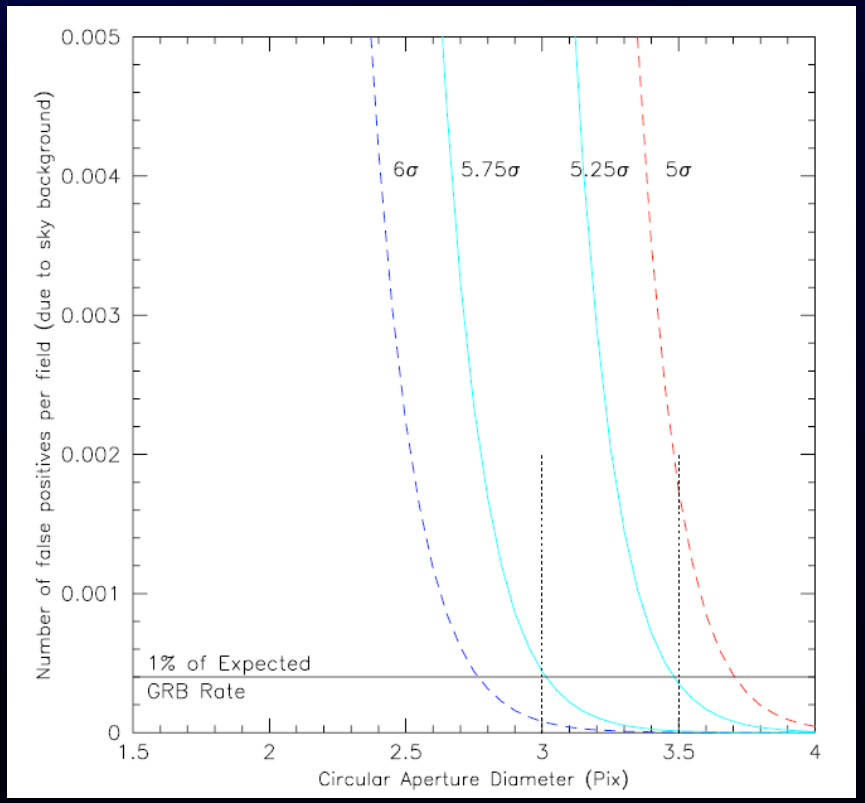
For more details about simulator
see poster Darko Jevremović
or attend the talk
AlertSim - Serbian contribution to LSST
(25.10. 17:30)

Requirements

1. generate realistic streams of alerts
2. simulate various failures or exceptional/extreme cases:
   a) large numbers of spurious detections
   b) unusually large numbers of detections
   c) disruptions in the event stream
   d) corruption of the event stream
   e) network connectivity interruptions
3. facilities to ease troubleshooting
4. configurable, automated, keeping provenance
5. follow standards and conventions
6. develop in coordination with group

How to deal with 

- Exact number of “variable” sources depends on the level of SNR at which ’variability’ is measured.
- Alerts issued when a new source is detected > 5σ above the sky noise background.
- Noise: ~80 “sources” per night



Lynne Jones, 2007.

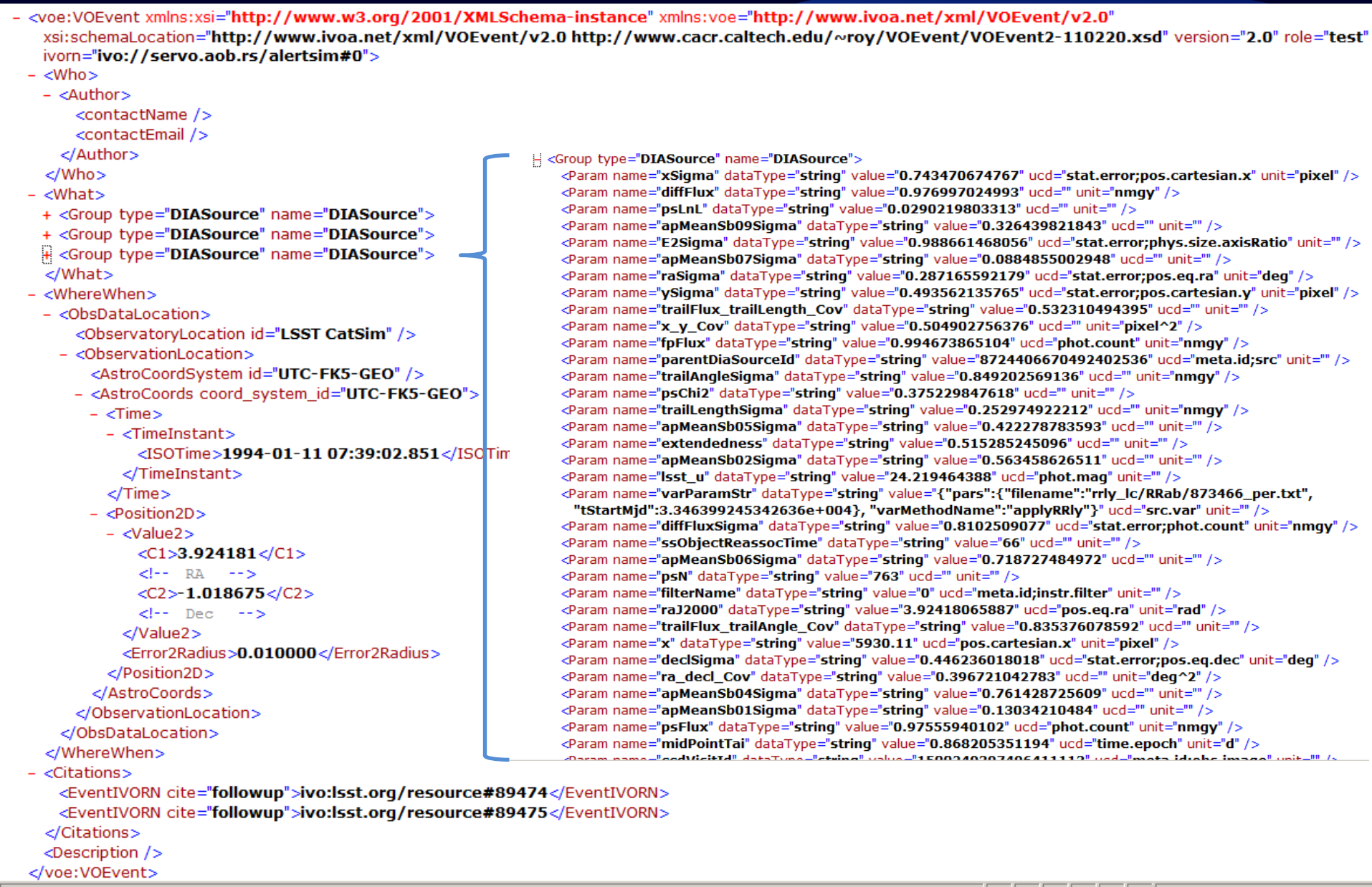
Number of expected transient sources per field

Cosmic Ray Coincidences	≈ 4000 CR per CCD
Solar System Moving Objects	Near ecliptic 2500/field > 5σ in 15s
Solar System Moving Object	Near ecliptic, 4500/field > 3σ in 30s
Mdwarf flares	100/field > 5σ
Cataclysmic variables	0.6/field > 5σ
White Dwarf Pulsators	??
RR Lyrae's and Cepheids	??
Delta Scuti Stars	??
Microlensing Events	Toward galactic bulge or Magellanic Clouds, 100-200/field
Supernova Ia	17/field
Gamma Ray Bursts	.004 / field
All kinds of variability, combined	≈ 2000/field
Sky Background Noise	≈ 0.0004 sources/field above +5.75σ, circular aperture 3 pix diam
Sky Background Noise	860 pix/field above +5σ
Sky Background Noise	≈ 0.05 sources/field above +5σ, circular aperture 3 pix diam
Sky Background Noise	≈ 4e6 pix/field above +3σ
Sky Background Noise	≈ 1500 sources/field above +3σ, circular aperture 3 pix diam

Time scales required for Alerts

Solar System Moving Objects	Minutes/Hours for objects with high Impact Probability
Solar System Moving Objects	Minutes/Hours for objects which have changed shape
Mdwarf flares	60s for large outbursts
Cataclysmic variables	60s for large outbursts
White Dwarf Pulsators	No alerts required
RR Lyrae's and Cepheids	No alerts required for normal behavior
Delta Scuti Stars	No alerts required
Microlensing Events	Hours/days
Supernova Ia	Hours/days
Gamma Ray Bursts	60s
Unknown transients	60s

Example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Goals / benefits

- Delivering functionality early, that is currently planned to be developed in Operations
- Reducing the need for help desk / technical support
- Reducing potential down-time and troubleshooting personnel costs

Summary

- Transient: observed changes in flux / position
- Alert: notification of the detection and characterization of a moving or variable object
- Simulations
- Requirements
- Goals / benefits: predictions, savings

THANK YOU FOR YOUR ATTENTION

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Grant support: III44002