LSST DB Prototype: Schema and Queries

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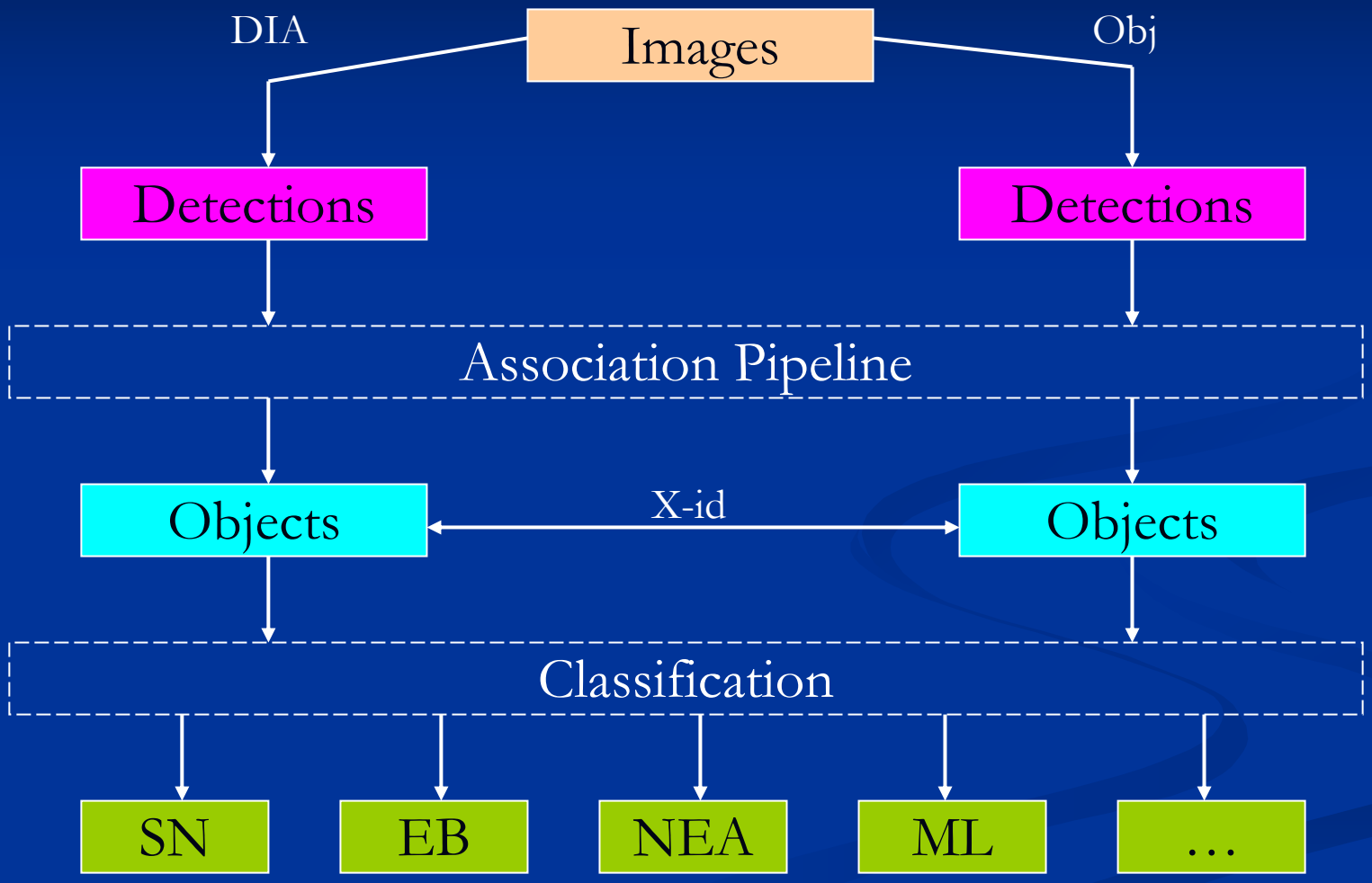
LSST Data Flow



REQUEST

Data Size

- Simulator: 2000-3000 images/night (best site);
  3 Gpix @ 2bytes/pix → 20 TB/night
- "Obj" Detection table (largest):
  20 gal/sq. min × (resolved galaxies)
  3600 sq.min/sq.deg ×
  10 sq. deg/image × (FOV)
  2500 images/night ×
  300 nights/year ×
  100 bytes/gal → 50 TB/year
- Fudge factor: 2x-6x (stars, l.o.s., unresolved gal., sim, σ)
  → 300 TB/year
- DIA Detection table: factor 0.1 – 0.01 in size
- Time req's:
  - DIA real time (alerts): 11 sec/image
  - Obj "almost" real time

Use Cases and Scenarios

Data Products	User Groups					
	Community Users			Pipeline Developers	Astronomers	…
	K-12	Amateur astronomers	…			
Images - Science	★	★				
- Calibration	⊘					
- Engineering						
- Co-added						
- Metadata						
Catalog - Detections						
- Objects						
Alerts - Notification						
- Registration						

USAGE SCENARIOS

- Inside cells, create usage scenarios incorporating algorithmic processing utilizing multiple query sets
- Use cases, scenarios, users and queries drive the schema development

REQUEST

Queries

- Science queries (issued by user) vs. algorithmic queries (hidden from user; SQL, UDF, …)
- "20 queries" list (e.g. SDSS)
  - Extract object time series (general variable objects)
  - Extract objects by cone search (anything)
  - Extract variable objects by type
  - Extract variable objects by variability parameters (amplitude, period, …)
  - Cone-magnitude-color search (WDs, quasars, brown dwarfs, …)
  - Extract galaxies + cone search (weak lensing)
  - Extract proper motion objects (gal. structure)
  - Extract parallax objects (solar neighborhood)
  - Extract new objects (transients, SS objects)
  - Extract transient object close to a galaxy object (SN)
  - Extract color gradient objects (blue core galaxies, AGN)
  - Cone+phot. redshift + shape (N-point corr. function)
  - Find stars of nearly constant brightness (photometric standards)
  - Identify objects indicating motion (to derive parallax or PM)
  - Select multi-band photometry (for photometric redshifts)
  - …

Queries: SQL Examples

```
SELECT Image.MJD, ObjDetection.Mag, ObjDetection.MagErr
FROM   ObjDetection o, Image i
WHERE o.ObjID = ObjectID AND
          o.ImageName = i.name AND
          o.filter = Filter
```

```
SELECT  VarObject.RA0, VarObj.Dec0
FROM    VarObject v, Object o
WHERE  abs(v.RA0-o.RA0) < DeltaRA AND
          abs(v.Dec0-o.Dec0) < DeltaDec AND
          o.Type = 'galaxy'
```

REQUEST

Query & Load Characterization

- Using SDSS and 2MASS DB access statistics
- Average number of users per hour, day, month, year (average load)
- Maximum number of users per hour, day, month, year (peak load)
- Top queries to the system
- How many queries are short/long
- How many queries need to touch lots of data (e.g. all data, 50%, 25%, ...).
- How many interactive queries (queries that require immediate response)
- Most searched attributes
- Top accessed objects
- Time series of arrival rate of requests to the server

Schema

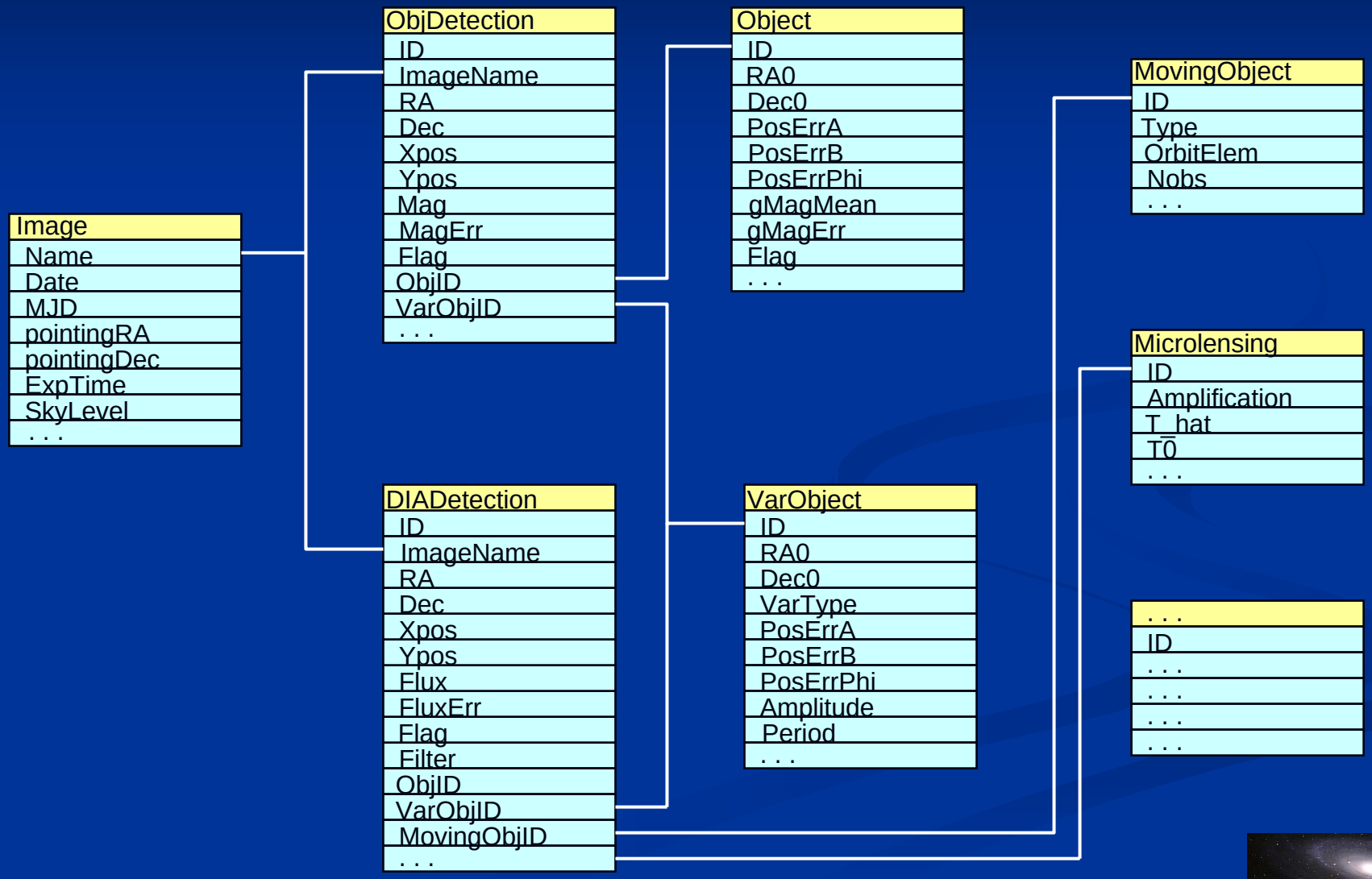


Image
Name
Date
MJD
pointingRA
pointingDec
ExpTime
SkyLevel
. . .
ObjDetection
ID
ImageName
RA
Dec
Xpos
Ypos
Mag
MagErr
Flag
ObjID
VarObjID
. . .
DIADetection
ID
ImageName
RA
Dec
Xpos
Ypos
Flux
FluxErr
Flag
Filter
ObjID
VarObjID
MovingObjID
. . .
Object
ID
RA0
Dec0
PosErrA
PosErrB
PosErrPhi
gMagMean
gMagErr
Flag
. . .
VarObject
ID
RA0
Dec0
VarType
PosErrA
PosErrB
PosErrPhi
Amplitude
Period
. . .
MovingObject
ID
Type
OrbitElem
Nobs
. . .
Microlensing
ID
Amplification
T_hat
T0
. . .
. . .
ID
. . .
. . .
. . .
. . .

Schema: Issues

- Frequency of updates
- Indexing
  - Partial re-indexing (MySQL)
- DB versioning (parents and children)
- Partitioning DB
  - Smaller tables (most accessed, e.g. light curves)
  - Federating across multiple platforms
- Optimizations (storage, index, query,…)
  - Parallel queries

REQUEST

DB prototyping

- SLAC
  - SM reduced data moved to SLAC (years 1-3)
  - 1 TB in size (including calibrated images)
  - SM year 4 and Essence data coming soon
- LLNL
  - 16-node dual-Xeon cluster
  - Integrate DB prototyping with ISP/GridDB