Known Solar System Object Association (SSOID)

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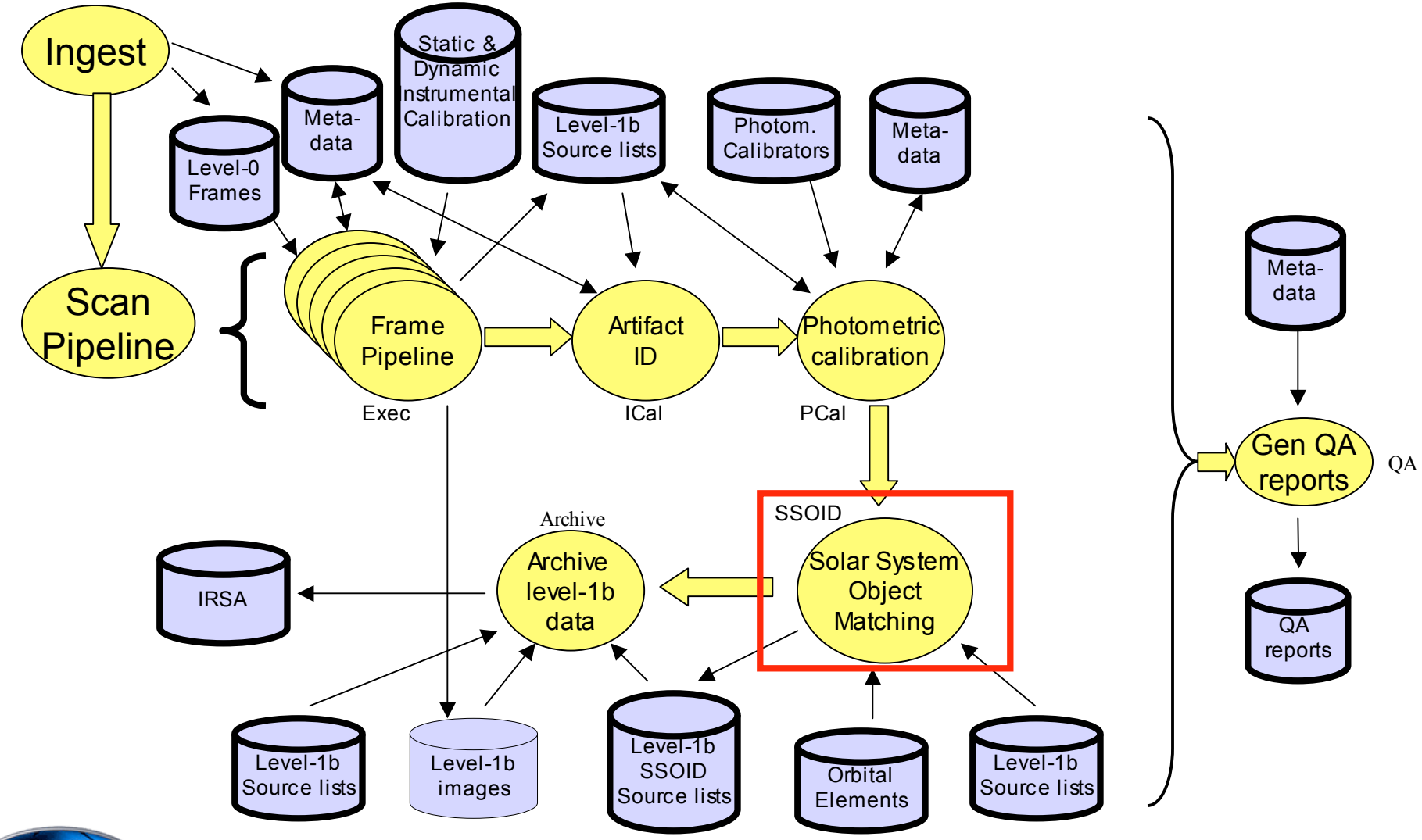
WSDS Scan Pipeline



Driving Requirements

L4WSDC-027	The WSDC shall identify and compile a listing of known solar system objects that are positionally associated with source extractions in the WISE single-epoch image frames.
L4WSDC-028	The solar system objects associated with WISE single-epoch extractions shall include asteroids, comets, planets, and planetary satellites.

Object Association - 1

- Basic design involves a comparison of WISE source coordinates with ephemerides of solar system objects
  - Ephemerides referred to mean equator and equinox of J2000, thus compatible with WISE source positions
  - Ephemeris positions accompanied by two-dimensional error estimates; numbered asteroids good to an arcsecond, while unnumbered asteroids have orbits of variable quality
  - Use contemporary orbits for comets to avoid the effect of non-gravitational forces
  - Ephemeris positions accompanied by plane-of-sky velocities so that small time deltas can be handled without recomputing ephemeris

Object Association - 2

- Can be rapidly implemented by relying on code developed for 2MASS project
  - 2MASS restricted attention to objects with reasonably reliable ephemerides (numbered asteroids, multi-opposition unnumbered asteroids, comets, planets; most single-opposition asteroids were excluded; planetary satellites were not considered)
  - Current orbit catalogs include over 330,000 such objects, approximately four times the number of objects that 2MASS considered
  - Catalogs updated on a monthly basis from orbits published by the Minor Planet Center
  - Orbits integrated to epochs of osculation at 100-day intervals, thus never more than 50 days from an epoch

Object Association - 3

- Efficiency of 2MASS approach can be improved
  - Candidate list prepared by finding all known objects that fell within a scan region (plus buffer), specified by the coordinates of its corners
  - Involved computing ephemeris position for every object in the catalog at every input time (one per record)
  - Detected source positions compared with ephemeris position and estimated error ellipse (9 arcseconds maximum error allowed)
  - First pass can be use to compute solar elongation of all objects and eliminate those far from the region of interest that cannot possible move into it
  - Requires picking the "natural" time scale of a processing batch

Code Modifications - 1

- Existing code designed to work with two fixed terrestrial observatory sites utilized by 2MASS
  - Will be necessary to provide position of WISE spacecraft to ephemeris routine or compute it from frequently updated two-body elements
  - Parallax about 10 arcseconds per inverse topocentric distance in AU, so main-belt asteroids can have 3 to 5 arcseconds of ephemeris error if parallax ignored, more for near-Earth asteroids, less for distant objects
  - Easiest to implement if spacecraft ephemeris also referred to mean equator and equinox of J2000

Code Modifications - 2

- Existing code written for 2MASS used fixed-size arrays to conform to FORTRAN 77 standard
  - Required updating of source code as object catalogs increased in size (or wasted memory)
  - Wide availability of Fortran 90/95 compilers now allows use of memory allocation (variable-size arrays), thus eliminating the need to update source code and recompile

Code Modifications - 3

- Existing code not designed to deal with planetary satellites
  - Uses two-body computations for speed
  - Outer satellites of Jupiter and Saturn experience significant solar perturbations, rendering two-body ephemerides of unacceptable accuracy once time from epoch of osculation exceeds about two weeks, depending on the object
  - Requires three-body numerical integrations

Development Schedule - 1

- May 2008: make design decisions
  - Method for computing spacecraft ephemeris
  - "Natural" time scale for processing batches
- June 2008: update SIS used for 2MASS
- August 2008: implement code to handle parallax for a moving observer
- August 2008: implement code to allocate orbital element arrays based on size of catalogs
- December 2008: implement three-body code to handle outer satellites of giant planets

Development Schedule - 2

- March 2009: deliver tested code
- Launch: deliver updated orbital element catalog

Issues/Concerns

- Will need synthetic spacecraft ephemeris positions or orbital elements to permit testing of code modifications
- Will need synthetic input data to permit testing
- Unclear how trailed (nearby) objects will be handled
- How many updates to the orbital element catalog will be desired?
- How will unknown moving objects be handled?