WISE Science Data Center Hardware Peer Review

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Review Panel

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- Sharon Brunett (CACR)
Charge to Panel

The panel is asked to comment on the following:

• Is the WSDC processing system capable of handling our expected data volume and throughput?
• Are there any fragilities that might impede our ability to smoothly manage the ops system for the mission duration?
• Are the backup plans sufficient to recover from hardware outages?
• Please share any cluster or high-volume disk server lessons learned.
What Is WISE?

- A NASA Medium Explorer (MIDEX) Mission launching Nov. ‘09
- The Wide-field Infrared Survey Explorer (WISE)
  - An all-sky survey at 3.3, 4.7, 12 & 23 μm with 3 to 6 orders of magnitude more sensitivity than previous surveys
  - A cold 40 cm telescope in a sun-synchronous low Earth orbit
- WISE will deliver to the scientific community
  - An Image Atlas containing ~20,000 calibrated, rectified images covering the whole sky in 4 infrared bands
  - A Source Catalog of ≈ 5 x 10^8 objects seen in these 4 IR bands
- WISE will find
  - The most luminous galaxies in the Universe.
  - The closest stars to the Sun.
  - Most Main Belt asteroids larger than 3 km.
Flight System

Payload (Space Dynamics Lab)
- 2-Stage Solid H₂ cryostat
  - **13.5 months life time (7 required)**
- All aluminum reflective optics: <17K
  - 40-cm telescope
- Dichroic beamsplitters separate wavelengths onto four 1024² pixel arrays (2.75”/pix)
- 2 HgCdTe detectors: 3.3, 4.7 microns (32K)
- 2 Si:As detectors: 12, 23 microns (7.8K)
- 3 electronics boxes (mounted in spacecraft)

Spacecraft (Ball Aerospace)
- Orbital Express architecture
- Augmented single string
- No mechanisms, no deployables, no propulsion
- 3-axis stabilized
- Pointing stability/accuracy: ~ 1”/ ~1’
- Ku band science data link: 100Mbps
- 3.5 days (96 GB) of science data storage
Simple Mission Design

- Delta 7320 launch – WTR
- 523 km, circular, polar sun-synchronous orbit
  - Nodal crossing time 6:00 PM
  - One month of checkout
  - 6 months of survey operations
  - Extended 13 month mission proposed
- One simple observing mode – half orbit scan
- Scan mirror “freezes” orbital motion enabling efficient mapping
  - 8.8-s exposure/11-s duty cycle
  - 10% frame to frame overlap
  - 90% orbit to orbit overlap
- Expect to achieve at least 8 exposures/position after losses to Moon and SAA
- Uplink, downlink, calibrations at poles
  - 4 TDRSS contacts per day
WSDC’s Role

• Critical Mission Operations Functions
  – Receive, decompress, archive raw telemetry
  – Support In Orbit Checkout to tune and commission instrument
  – Perform “quicklook” QA to confirm proper instrument function

• Science Processing Functions
  – Produce level-0 data archive
  – Process level-0 data to produce level-1 calibrated frame products
  – Perform multi-frame processing to produce final, level-3 products

• Data Access Functions
  – Provide data access to engineers and Science Team during ops
  – Provide public data access to data products
    • Preliminary: EOO+6 months
    • Final: EOO+17 months
WSDC Functional Block Diagram

HRP

White Sands

JPL

MOS

UCLA

Images

Ancillary data

H/K

Maneuvers

Missions Status

Science Team

Expectant Public

FTP Site

Ingest

Scan/Frame Pipelines

Multi-Frame Pipeline

WSDC

Ops Archive

QA

IRSA Archive

- Level-0,1b frames
- Coadds
- Frame index
- Calibration data
- Ancillary data
- 2MASS ref. catalog
- QA Data
- Meta-data

Archive

FPG

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Requirements and Limitations

Tim Conrow - IPAC
WSDC Lead Engineer
Data Volumes

– Ops archive
  • Raw telemetry: 25 GB/day (over 4 downlinks)
  • L0: 13 MB/FS * 7500 FS/day = ~100 GB/day
  • L1: 75 MB/FS * 7500 FS/day = ~570 GB/day (300 GB images)
  • L3: <100 GB/day (removable?)
  • Total: < ~800 GB/day uncompressed
    – 7 mo. Mission total: ~150 TB
  • Total: < ~650 GB/day compressed (33% image compression)
    – 7 mo. Mission total: ~120 TB
– Node-local temporary work space (mostly L2 images)
  • Max: 600 MB/FS * 7500 FS/day / 35 nodes = 130 GB/day/node
  • Min: 350 MB/FS * 7500 FS/day / 35 nodes = 75 GB/day/node
Requirements and Limitations

• **Top-level Throughput Requirements**
  
  – Quicklook results within 24 hours (L4WSDC-32).
  
  – Scan pipeline results within 3 days (L4WSDC-39). A different requirement may be driven by NEO-WISE turn-around requirements, but these have not been clarified.
  
  – Preliminary public data release EOO+6 mo.s (L4WSDC-4).
  
  – Final public data release EOO+17 mo.s (L4WSDC-8).

The preliminary data release might impose a more demanding requirement than the latency requirements since under some FPG scenarios they imply a need to do final reruns while we are still operating.
Requirements and Limitations

• Derived Throughput Requirements
  – 24 hours of data ingested in 2 hours
  – 24 hours of data processed by scan/frame pipelines in 6 hours
  – Daily ops coadds produced in 4 hours
    Note there is no top-level requirement imposed on ops coadds. These are for QA/trending and care and feeding of the Science Team but can be squeezed if needed
  – Daily ops allocation
    • 2 hours ingest
    • 6 hours scan/frame primary processing
    • 6 hours scan/frame re-processing
    • 4 hours ops coadds
    • 6 hours backups, msc. Maintenance and downtime
  – A goal is to fit 24 hours of scan/frame processing in 3 hours
• **Ops Archive size and network limitations**
  – Ops Archive size limited by
    • Budget
    • Backup Time (disaster recovery)
    • Network capacity
  – New ops archive processed data generated per day: ~800GB (uncompressed)
  – Estimated backup time for 1 TB: ~6 hours
  – Network usage assuming 1 TB data read/written
    • 6 hours: 1TB/6 hours = ~50 MB/s
    • 3 hours: ~100 MB/s
    • Assuming the sustained max. loads will be about twice average, the max. sustained network load is ~200 MB/s
  – Network usage by coadds still largely unknown
Requirements and Limitations

- **Node-local temporary work space usage**
  - Local storage limited by
    - Budget
    - Disk slots and rack space
    - Disk interface capacity
    - Clean-up latency
  - Read/write speed required
    - 130 GB / 6 hours = 6 MB/s average => ~12 MB/s sustained peak
    - 130 GB / 3 hours = 12/ MB/s average => ~25 MB/s sustained peak
  - Clean-up latency: how long can we wait before removing temp. files, i.e. how long do QA analysts have access to the data
    - 490 GB/node / 130 GB/day/node = 3.8 days max.
    - 490 GB/node / 75 GB/day/node = 6.5 days max.
Requirements and Limitations

• **RAM usage**
  – RAM usage limited by
    • Budget
    • Dell 1950 max. of 64 GB/node
  – More memory means fewer nodes at a trade rate of 8 GB added per node costs ~1 node
    • Could be cheaper using 3rd party RAM