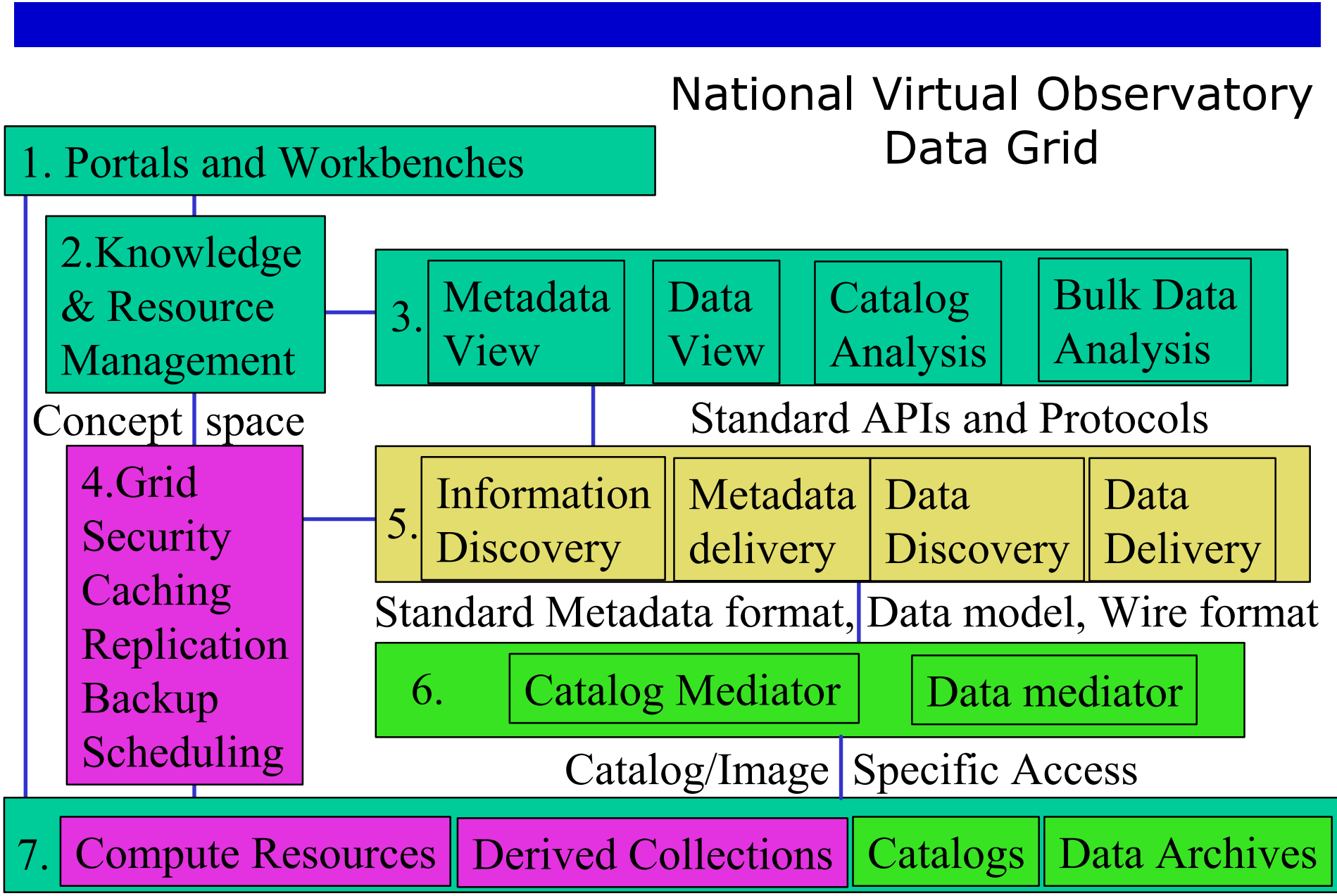
An Architecture for Access To A Compute Intensive Image Mosaic Service in the NVO

G. B. Berriman, D. Curkendall, J. Good, J. Jacob, D.S. Katz, M. Kong, S. Monkewitz, R. Moore, T.Prince, R. Williams


National Virtual Observatory
Data Grid
1. Portals and Workbenches
2.Knowledge & Resource Management
3.
Metadata View
Data View
Catalog Analysis
Bulk Data Analysis
Concept space
Standard APIs and Protocols
4.Grid Security Caching Replication Backup Scheduling
5.
Information Discovery
Metadata delivery
Data Discovery
Data Delivery
Standard Metadata format,
Data model, Wire format
6.
Catalog Mediator
Data mediator
Catalog/Image
Specific Access
7.
Compute Resources
Derived Collections
Catalogs
Data Archives

Montage - Custom Image Mosaics

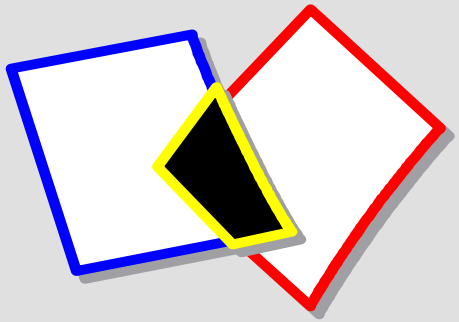
http://montage.ipac.caltech.edu

- User specified size, WCS projection, coordinates, spatial sampling, rotation
- Rectification of backgrounds in images
- Supports drizzle algorithm

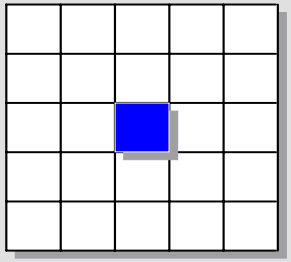
Science Drivers:
- Science Grade Images
- Analyze diverse images as if part of same "multi-wavelength image"

Delivery:
- Semi-annual deliveries from Feb 2003
- Final Delivery Jan 2005
- Available for download

Montage Reprojection Module

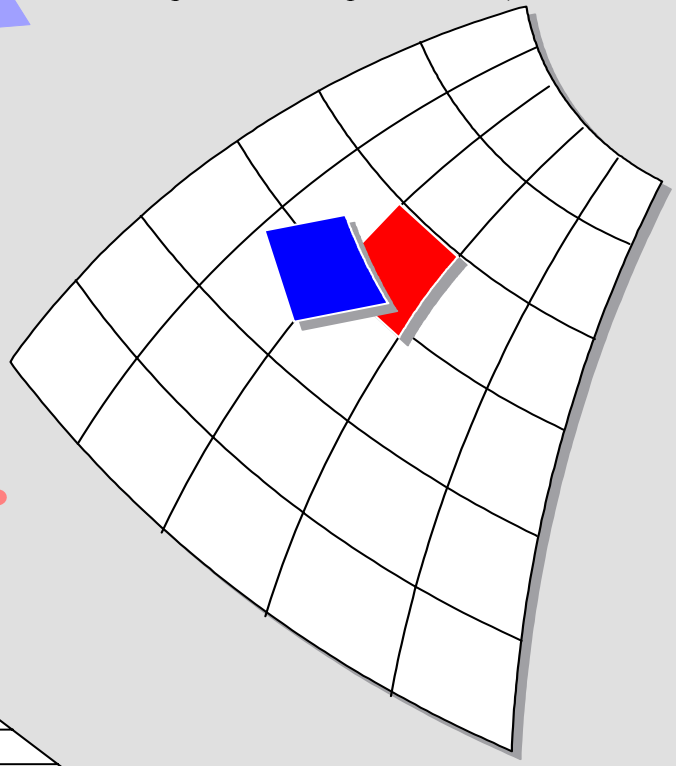


Arbitrary Input Image



Central to the algorithm is accurate calculation of the area of spherical polygon intersection between two pixels (assumes great circle segments are adequate between pixel vertices)

Input pixels projected on celestial sphere

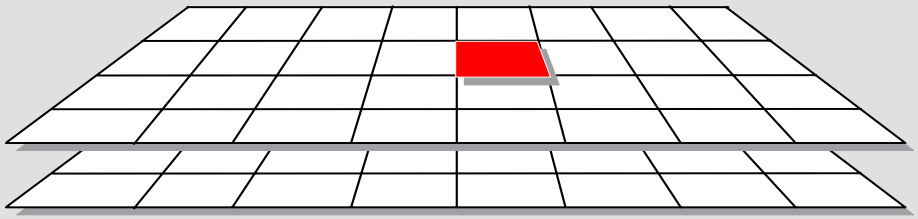


```
SIMPLE  =                    T /
BITPIX  =                  -64 /
NAXIS   =                    2 /
NAXIS1  =                 3000 /
NAXIS2  =                 3000 /
CDELT1  =        -3.333333E-4 /
CDELT2  =         3.333333E-4 /
CRPIX1  =               1500.5 /
CRPIX2  =               1500.5 /
CTYPE1  = 'RA---TAN'           /
CTYPE2  = 'DEC--TAN'           /
CRVAL1  =            265.91334 /
CRVAL2  =            -29.35778 /
CROTA2  =                   0. /
END
```

FITS header defines output projection

Output pixels projected on celestial sphere

Reprojected Image



Total Flux

Sky Area Coverage (steradians)

Montage Parallelization

Input Images

Coordinated Execution Across Multiple GRID Processors

mProject

mProject

mProject

```
SIMPLE  =                    T /
BITPIX  =                  -64 /
NAXIS   =                    2 /
NAXIS1  =                 3000 /
NAXIS2  =                 3000 /
CDELT1  =       -3.333333E-4 /
CDELT2  =        3.333333E-4 /
CRPIX1  =               1500.5 /
CRPIX2  =               1500.5 /
CTYPE1  = 'RA---TAN'           /
CTYPE2  = 'DEC--TAN'           /
CRVAL1  =            265.91334 /
CRVAL2  =           -29.35778 /
CROTA2  =                   0. /
END
```

FITS header

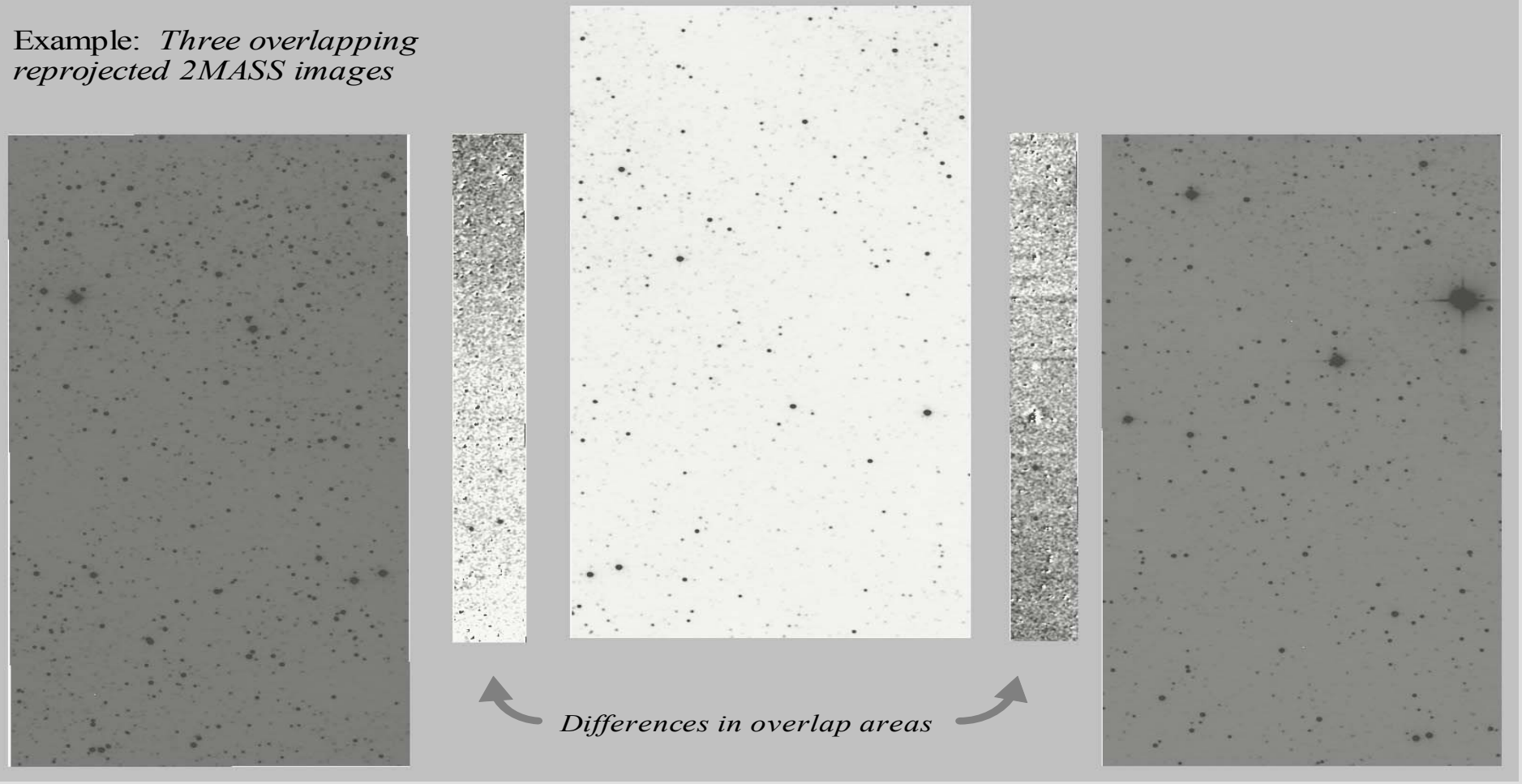
Reprojected Images

mAdd

Simple coadd for final mosaic (sky areas used as weights)

Montage Background Correction Procedure

Example: *Three overlapping reprojected 2MASS images*

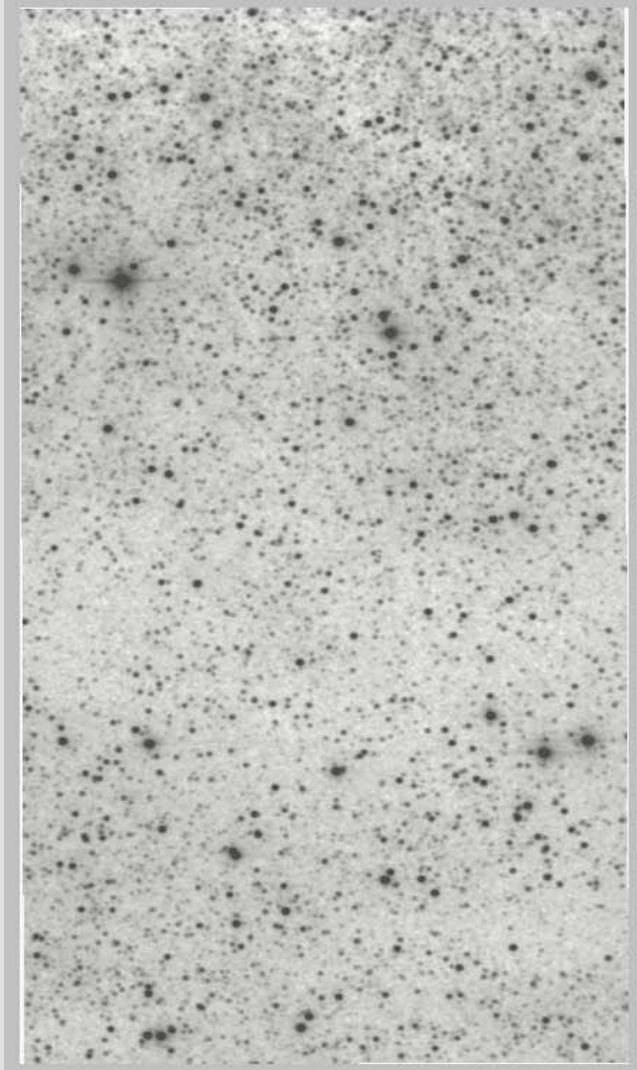


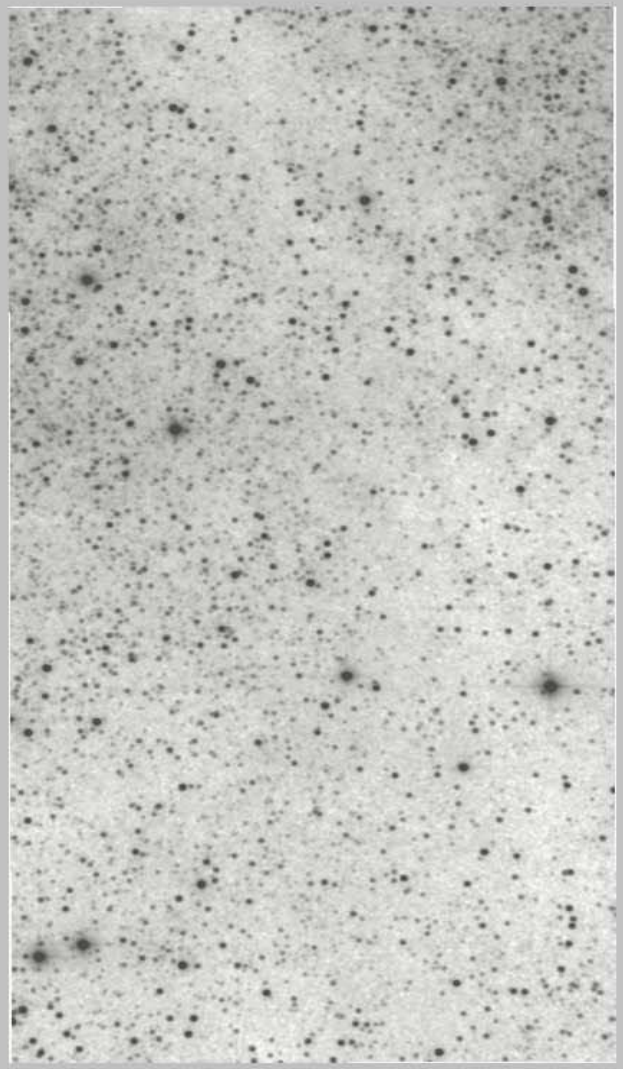
A correction is calculated for each image based on all the differences between it and its neighbors (an approximation to a least squares fit to the difference data with brightness outlier pixels excluded). The correction is currently a plane but could be a higher order surface.

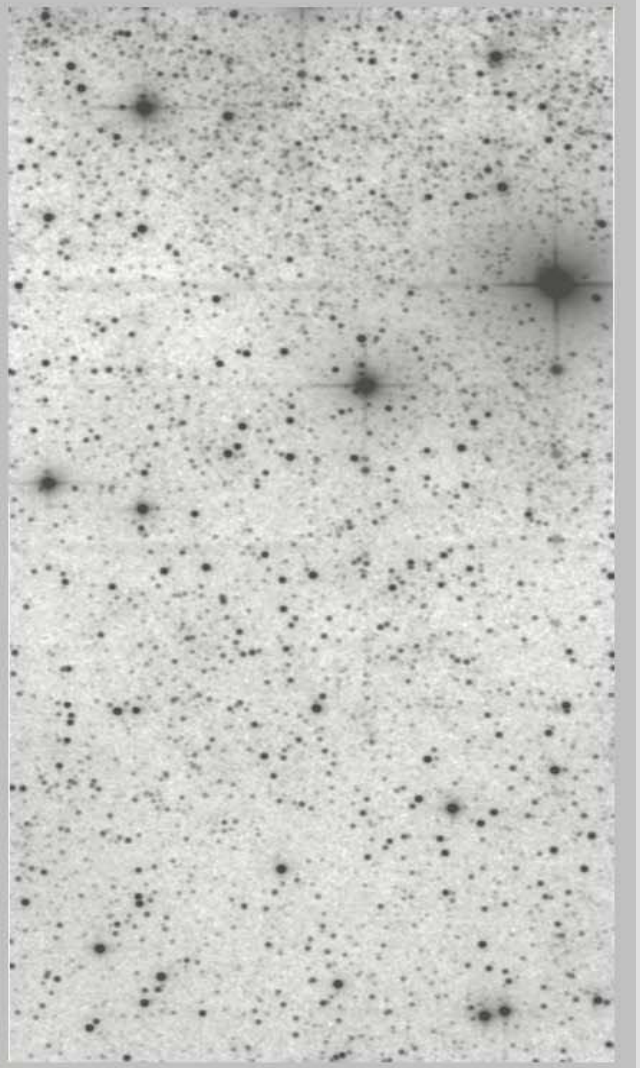
This is done for all images, then half the correction determined is applied (to a parameter database; equivalent numerically to applying it to the images).

The process is iterated until step differences for all images becomes small.

Montage Background Correction Results







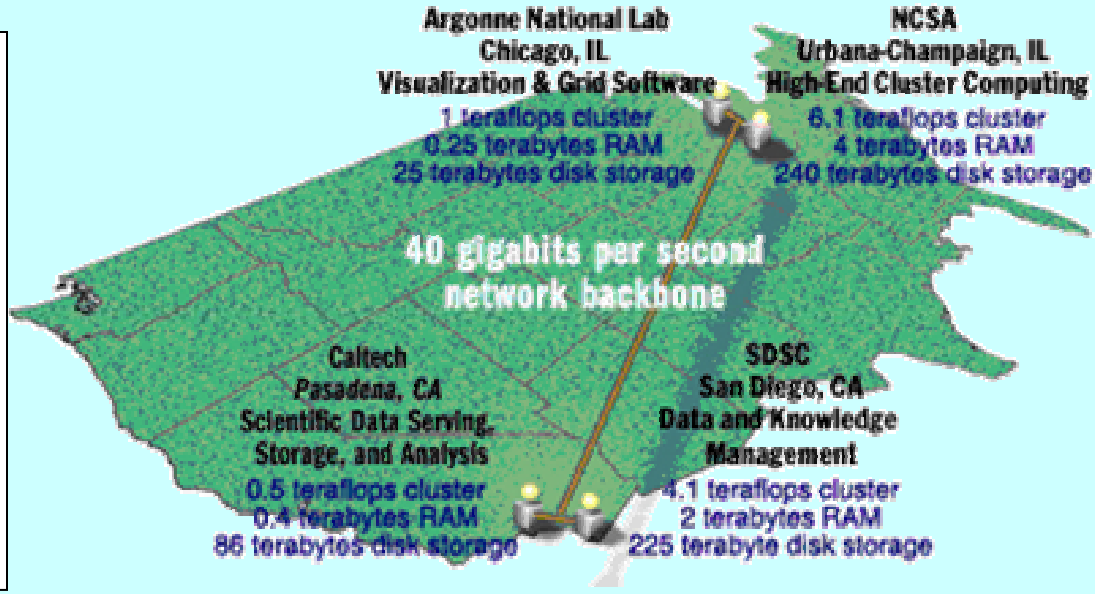
Reprojected Background Corrected Images

Deployment of Montage

Performance Goal:
Sustain a throughput of at least 30 square degrees per min on 1024 x 400 Mhz R12K O3000 or equivalent

Deploy operationally on the *Teragrid* by January 2005

Teragrid will be used by NVO for compute intensive services



Managing Requests For Compute Intensive Services

- Access compute intensive service or bulk data delivery service from existing clients
- Apache has no memory of requests, and so little control of multiple time intensive requests:
  - restart automatically after failed request
  - stop large requests as needed
  - monitoring of requests
  - load balancing

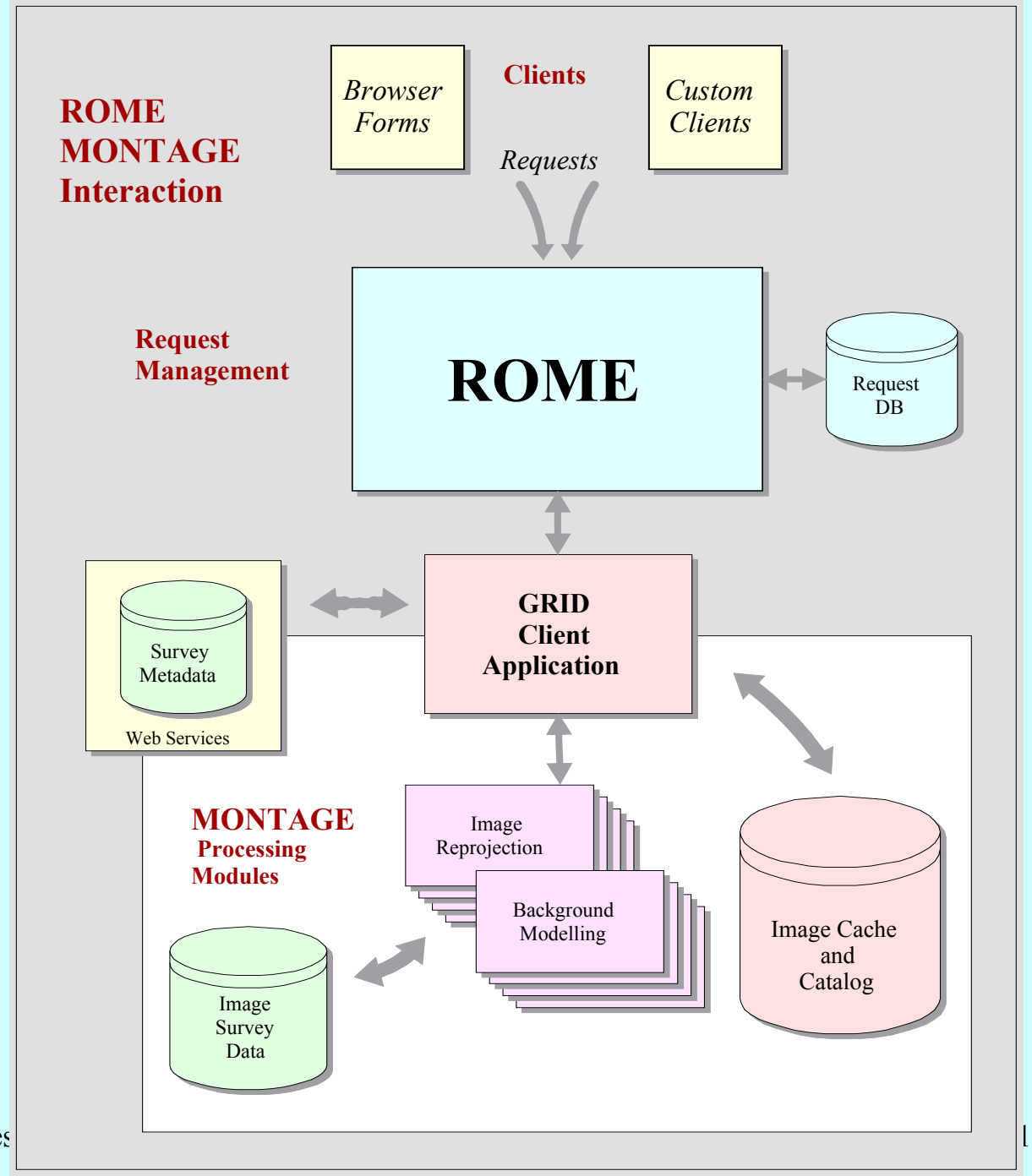
Solution:

Request Object Management Environment

What Is ROME?

- Application of ***Enterprise Java Bean*** e-business technology
  - Used everyday by e.g. banks to manage secure financial transactions
  - Mature technology based on specialized Java Virtual Machine, the EJB server
  - EJB's manage and persist transactions, perform load balancing, handle security

- Middleware that sits between client and processor whose role is straightforward
  - Accepts requests from clients through standard interfaces
  - Registers them in database
  - Sends them for processing
  - Capable of managing very large numbers of requests


ROME
MONTAGE
Interaction
Browser
Forms
Clients
Custom
Clients
Requests
Request
Management
ROME
Request
DB
Survey
Metadata
Web Services
GRID
Client
Application
MONTAGE
Processing
Modules
Image
Reprojection
Background
Modelling
Image Cache
and
Catalog
Image
Survey
Data

Management Environment