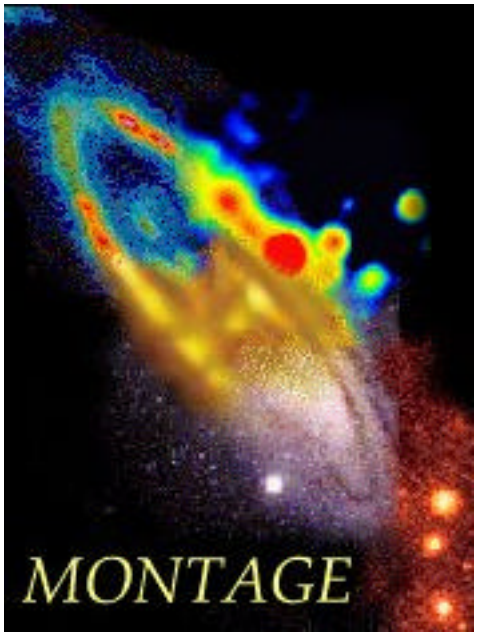


**Requirements Document for**

# MONTAGE

***An Astronomical Image Mosaic Service for the National Virtual Observatory***

**Version 2.0 (June 15, 2004)**



## MONTAGE REQUIREMENTS REVISION HISTORY

| Description of Revision | Date |
|---|---|
| Removed supergalactic coordinates; support for all WCS projections (not just the 10 in version 1.0). Clean-up of text based on team comments. Revised number of shalls – Version 2.0 | August 30, 2004 |
| Initial Release – Version 1.0 | May 31, 2002 |

# 1. Introduction

The technical requirements imposed on Montage are motivated by four concerns:

- Producing science-quality images of high astrometric and photometric accuracy.
- Facilitating parallel grid-based processing.
- Supporting portable software that can be run on high-end machines as well as "low-end" workstations.
- Deploying a modular software system for supporting functions such as background removal or image reprojection. These functions will be valuable as general astronomical services in their own right.

# 2. Data Sets Supported in Operations

D1. In operations mode on the TeraGrid, Montage shall deliver image mosaics from publicly released data from at leas the following three projects:

D1.1 2MASS
D1.2 SDSS
D1.3 DPOSS

# 3. Functional Requirements

F1. Montage shall support the following coordinate systems

F1.1 Equatorial (Besselian, any epoch)
F1.2 Equatorial (Julian, any epoch)

F1.3 Ecliptic (Besselian, any epoch)
F1.4 Ecliptic (Julian, any epoch)

F1.5 Galactic

F2. Montage shall be capable of processing input images in any WCS-compliant projection and producing output mosaics in any WCS-compliant projection.

F3. Montage shall support image rotation in all the projections listed in F2.

F4. Montage shall ensure conservation of energy in the delivered mosaics. That is, it shall preserve total flux from the input pixels to the output pixels.

F5. Montage shall support spatial sampling on angular scales of 0.1 arcseconds and greater.

F6. Montage shall "co-add" pixels in overlapping areas to obtain highest signal-to-noise possible. At a minimum, Montage shall provide the following algorithms for co-adding the fluxes:

F6.1 Co-addition by simple averages, with the option to weight inputs by accurate sky area coverage values

F6.2 Co-addition by calculation a median value for each output pixel, with the option to weight inputs by accurate sky area coverage values

F7. Montage shall optionally rectify background radiation attributable to sky and instrumental signatures images to a common level. The background removal will be based on algorithms for background radiation and instrumental signatures given by the data provider. These models shall be based on image-to-image differences in image overlap regions alone, and not on model fits to input data.

## 3. Portability

Serving the needs of the astronomical community demands that Montage run on both low-end (workstation or laptop) and high-end (TeraGrid) environments.

PO1. Montage modules shall be written in ANSI C. They shall compile with the GNU gcc compiler, and shall build with the GNU gmake utility.

PO2. Montage shall not use shared-memory, specific DBMS interfaces, or platform-specific libraries, and it will minimize its use of memory.

PO3. Montage shall support zt least the following UNIX platforms: Solaris, AIX, Linux and IRIX.

PO4. Montage shall run operationally on the TeraGrid.

## 4. Architecture

A1. Montage shall use, without any modification, standard open source astronomical software for reading FITS image files, performing coordinate system transformations, and handling image projection operations.

A2. Montage shall be capable of processing data as a set of standalone modules (or sets of modules) that build a mosaic as a discrete set of steps. This architecture ensures that functionality in individual modules can be employed in their own right, for use in reprojecting images etc. This architecture also permits coarse parallelization of the processing over as many processing nodes as are available. The processing steps will

include image reprojection/resampling, background fitting, image overlap processing, local/global background correction, and image merging (weighted coaddition, pixel median filter coaddition, replacement coaddition).

## 5. User Interfaces

Montage must support several calling modes:

U1. Montage shall be called by UNIX command-line execution of the individual modules by a scientific user.

U2. Montage shall support high-throughput execution of the modules on several machines simultaneously, for example within a Condor pool.

U3. Montage shall support processing on a computing grid via standard grid tools and processing environments, such as the Globus toolkit.

U4. Montage shall input bulk processing parameters (e.g. input image list, output image scale / projection / orientation) via ancillary ASCII data files.

U5. Montage shall provide the option to order intermediate data products produced at various stages in the processing.

U6. Montage shall provide interfaces through Web Browser forms and existing Java archive client portals for requesting and retrieving mosaics

U7. All interfaces described above shall support user-specified requests for image mosaics with respect to: coordinates, image projection, rotation, size, spatial sampling.

U8. Users shall have the option of selecting the co-addition algorithm for their mosaic

U9. Users shall have the option of background rectification, using built-in algorithms or user-specified algorithms.

## 6. Output products

O1. The principal data product shall be the image mosaic that meets the users input specifications, and any ancillary data products that were ordered

O2. Data products shall be FITS images or tables of parameters.

O3. Montage shall report to the user that the mosaic has been processed, along with ancillary status reporting messages.

O4: For mosaics ordered through the *TeraGrid*, Montage shall provide options for accessing the image; either by downloading the file or by ordering a subset of the file or by ordering a resampled image.

O5. Mosaics ordered through existing web portals shall be visualized through tools supplied with the portal. Visualization here includes the capability for sub-setting and subsampling.

O6. The intermediate files produced by the processing shall be delivered to the user if so requested.

O7. If the processing fails, partial results shall be returned to the user, together with sufficient information on error conditions to allow the user to gauge the cause of the failure.

## 6. Performance

PE1. Montage shall generate mosaics from 2MASS, DPOSS and SDSS with a sustained throughput of 30 square degrees (e.g. thirty 1 degree x 1 degree mosaics, one 5.4 degrees x 5.4 degrees mosaic, etc.) per minute on a 1024x400Mhz R12K Processor Origin 3000 *or machine equivalent* with sustained bandwidth to disk of 160 MB/sec and all input data previously staged on these disks.

## 7. Security

S1. When running in a Grid environment, Montage shall rely on the Globus toolkit security infrastructure to ensure that only publicly released data are accessible for processing, and that users have clearance to use the computational and storage services of the grid.

## 8. Error Handling

E1. Each Montage module shall trap errors and report their exit status via a structured message to the standard output stream. These messages must contain sufficient information that the controlling code (or the user if the module is being run interactively) can make an informed decision on how to proceed.

E2. All error conditions shall be reported to the user via a log file

## 9. Data Caching

D1. Commonly-requested mosaics will be pre-computed and staged in a cache.

D2.  When the user requests a mosaic, these cached images shall be searched f the image parameters overlap with those requested by the use. Any such images shall be suggested to the user as a deliverable mosaic before the mosaic request is processed

***The Montage requirements include 43 "shalls"(including sub requirements)***