CARMA’s heterogeneity is more than just dish sizes. BIMA OVRO, & SZA hardware, software differ in vintage, approach. The challenges to software group (6 FTEs, mix of “programming astronomers” and sw engineers) include:

- to improve functionality, performance, maintainability
- build a single control system for 3 different antenna types
- reuse code & algorithms where possible
- all the while keeping existing users happy
More formal than most of us are used to, but necessary because of distributed development and reliability requirements.

- Computing requirements laid out, prioritized
- Coding and documentation standards, style guide
- 50+ Work Packages
- Preliminary, conceptual, critical design reviews
- Code version control; unit testing; review & inspection
- Weekly telecons; email exploders; face-to-face meetings

In many ways, SW process mirrors HW process.

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Monitoring System

- Monitor everything possible
  - ~400 points per antenna plus continuum visibilities
  - hierarchical namespace, e.g. `carma.antenna4.LOsystem.Gunn3mm.biasVoltage`
- Single `struct` to describe many types of MPs
- Data sent to Array Control Computer in 0.5s frames
- Monitor data stored on several timescales
  - half-second frame rate
  - 1 minute average/min/max
  - Averaged to match astronomical integration time

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Frames are collected at each subsystem computer and transferred on the half-second to the Array Control Computer.

The gray arrows signify access using the hierarchical `MonitorPoint` API.

The black arrows show inter-computer data transport using the CORBA Notification Service.
Data Format Requirements

- Must be file-based in order to reuse existing BIMA archive infrastructure
- Must meet needs of both astronomers & engineers
  - Visibilities and monitor database
- Does not force observers to use a particular reduction package
  - Export most popular formats
- Allow extraction of metadata for archival searches
- Be feasible to implement and support by the software developers -- strict first-light schedule

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Data Rates

Visibilities:
- Two independent arrays
  1. 15 elements, 8x128 ch. bands, 2 sidebands, both path length corrected & uncorrected
  2. 8 elements, 16x32 ch. bands, 1 sideband
- Mean rate: 1.7 MB/s = 14.4 GB/day
- Peak rate: 10 x Mean rate = 144 GB/day

Monitor data:
- Max 900 KB/0.5 sec ~ 14 GB/day

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CARMA Data Flow and Archiving
(before May 2003)
CARMA Data Flow and Archiving
(after May 2003)
So What’s the Format?

- Obvious choice now is MIRIAD
  Pros:
    well-tested; large user base; compact format
  Cons:
    development frozen; potentially inefficient for large (many GB) files; visibility processing not easily parallelizable
- The Zen Format – “the format which is no format.”
  Visibility brick and header DB stored in NCSA archive; Export user-requested format on the fly.
The Changing Face of Observatory Software

Astronomers demand more & more of software systems in functionality, usability, reliability, performance, and supportability. The days of software as an afterthought are over.

<table>
<thead>
<tr>
<th>Project</th>
<th>% Budget for SW dev &amp; maint</th>
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</thead>
<tbody>
<tr>
<td>2MASS</td>
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<tr>
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