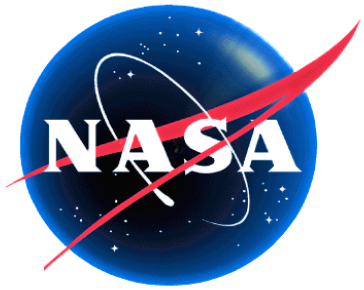


Parallel Processing

Majid AlMeshari

John W. Conklin

Outline

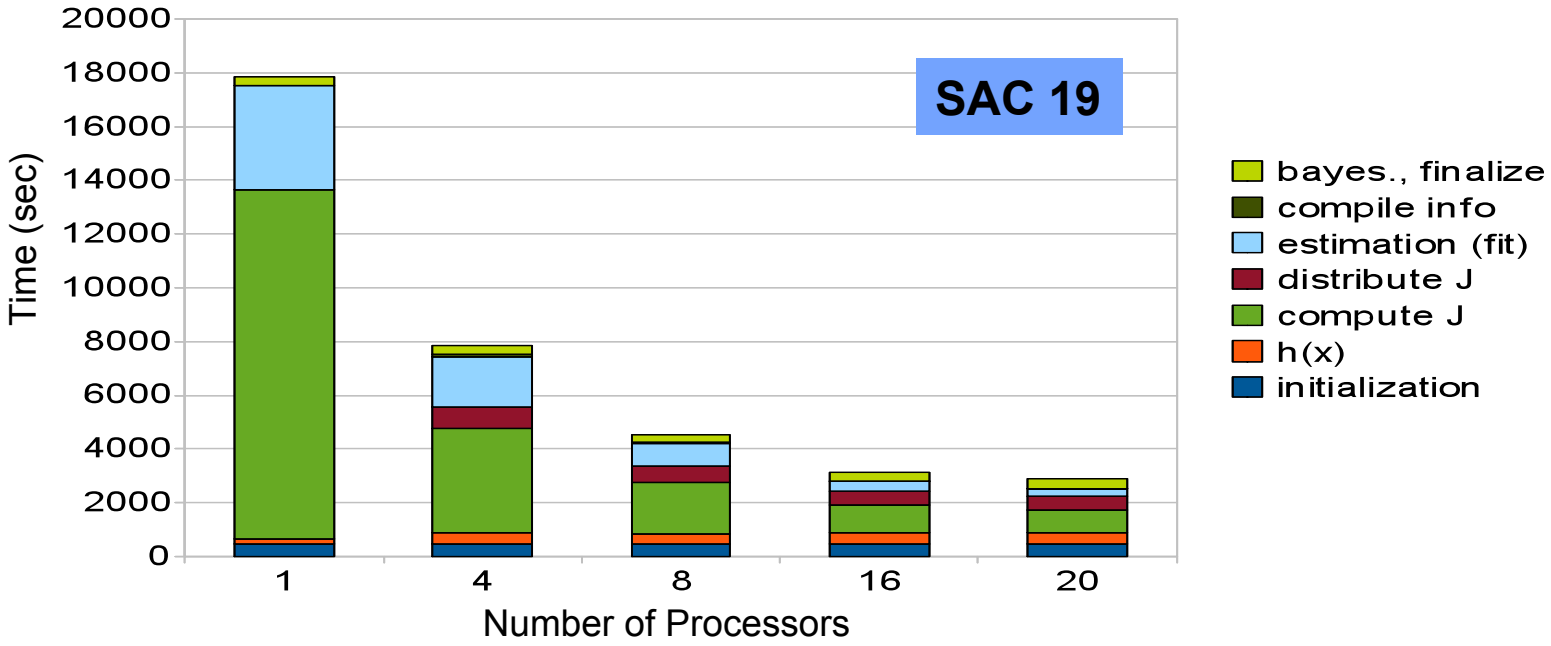
- Challenge
- Requirements
- Resources
- Approach
- Status
- Tools for Processing

Challenge

A computationally intensive algorithm is applied on a huge set of data. Verification of filter's correctness takes a long time and hinders progress.

Requirements

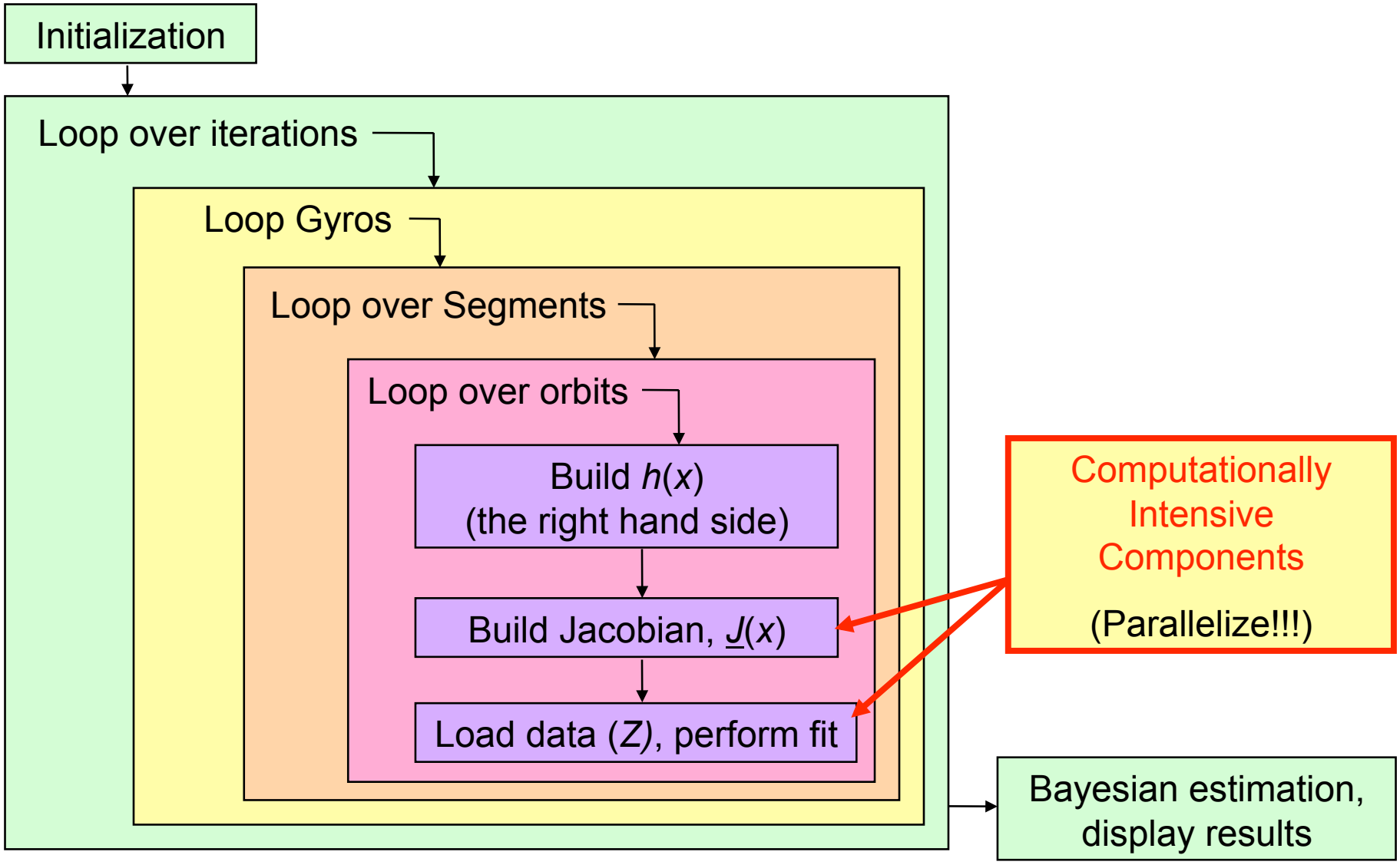
- Achieve a speed-up between 5-10x over serial version
- Minimize parallelization overhead
- Minimize time to parallelize new releases of code
- Achieve reasonable scalability



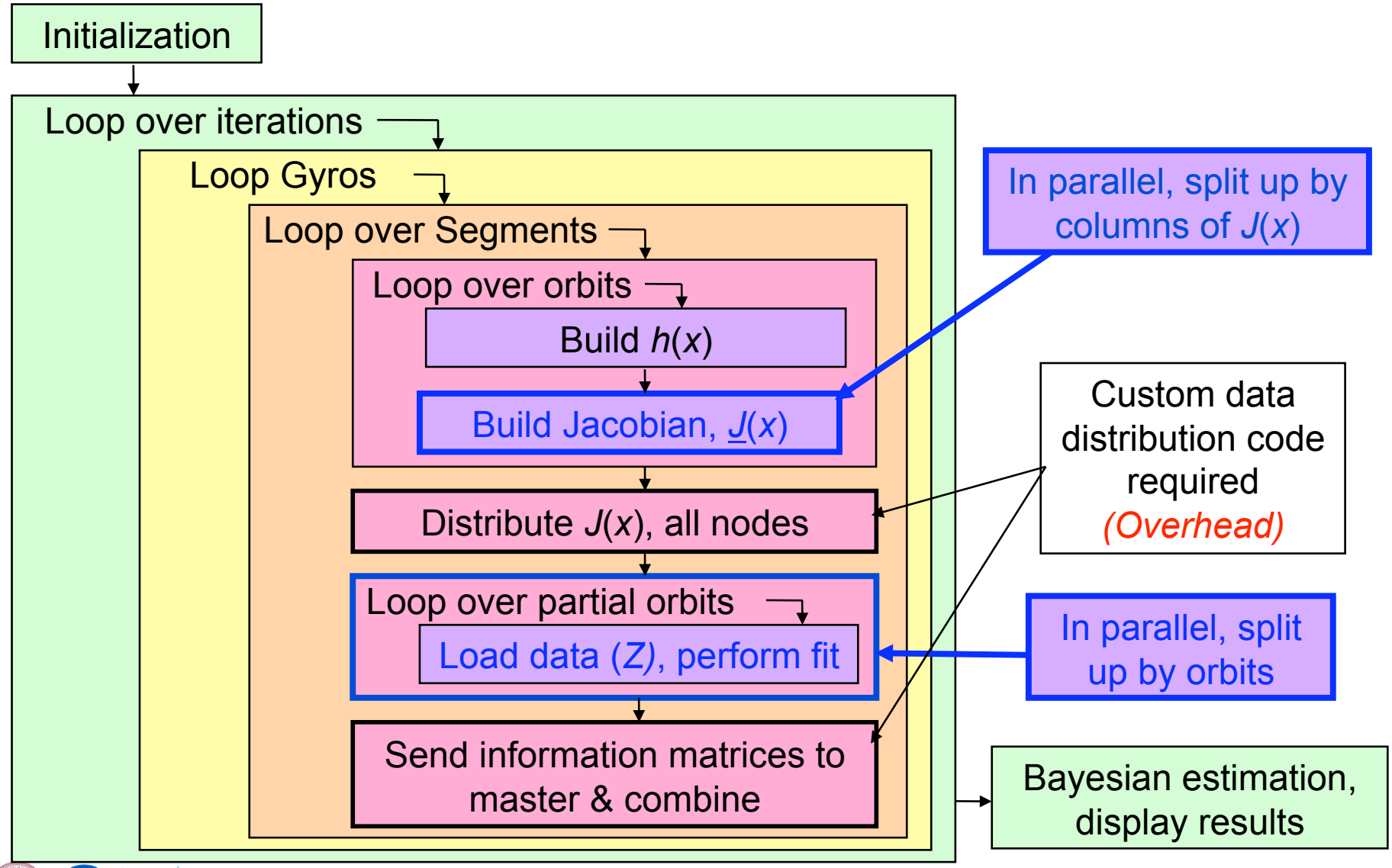
Resources

- **Hardware**
  - **Computer Cluster *(Regelation)*, a 44 64-bit CPUs**
    - **»64-bit enables us to address a memory space beyond 4 GB**
    - **»Using this cluster because:**
      (a) likely will not need more than 44 processors
      (b) same platform as our Linux boxes
- **Software**
  - **MatlabMPI**
    - **»Matlab parallel computing toolbox created by MIT Lincoln Lab**
    - **»Eliminates the need to port our code into another language**

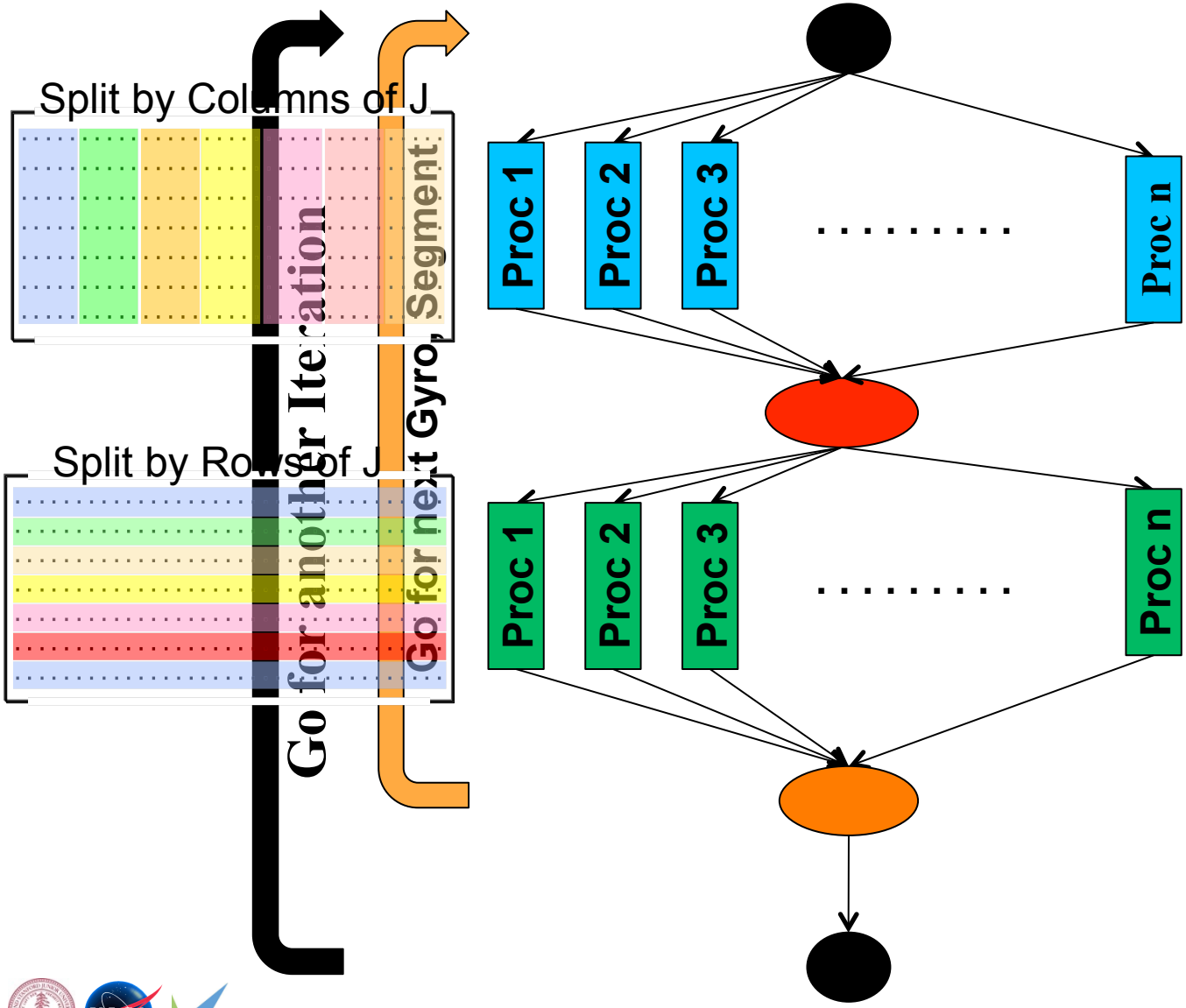
Approach - Serial Code Structure



Approach - Parallel Code Structure



Code in Action



Initialization

Compute h and Partial J

Sync Point
Get Complete J

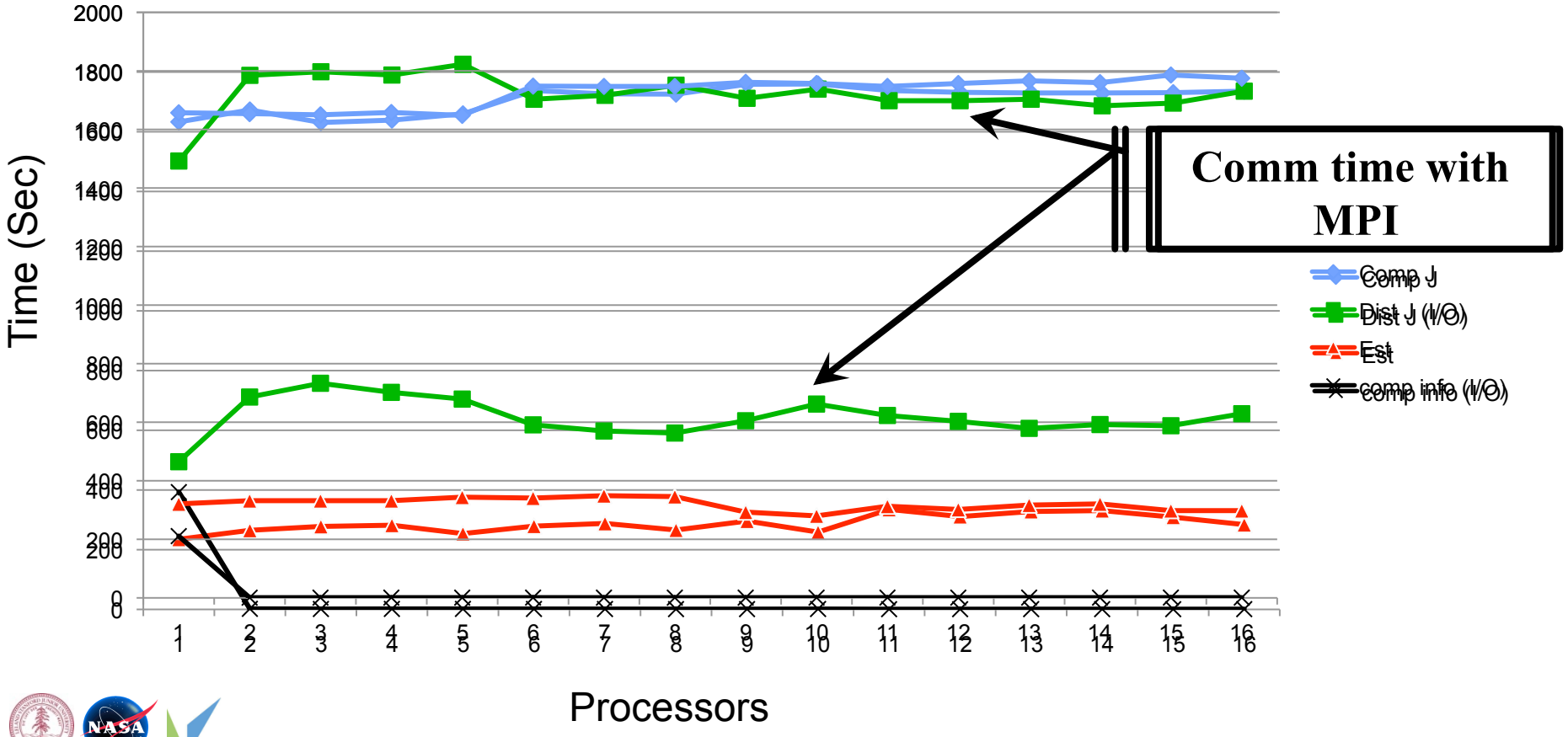
Perform Fit

Sync Point
Combine Info Matrix

Bayesian Estimation
Another Iteration?

Parallelization Techniques - 1

- **Minimize inter-processor communication**
  - **Use MatlabMPI for one-to-one communication only**
  - **Use a custom approach for one-to-many communication**



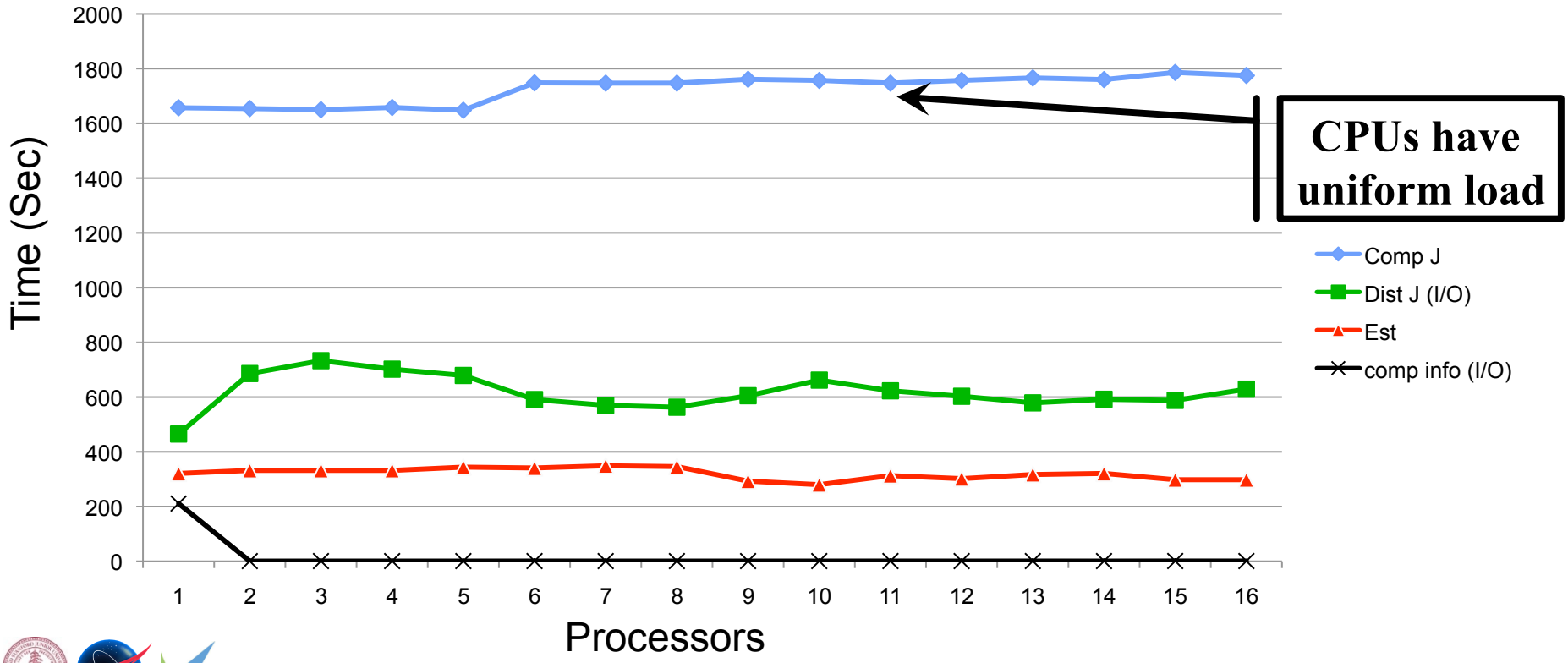
Parallelization Techniques - 2

- **Balance processing load among processors**

Load per processor =

$$\sum \text{length}(\text{reducedVector}_k)*(\text{computationWeight}_k + \text{diskIOWeight})$$

k: {RT, Tel, Cg, TFM, S_0}



Parallelization Techniques - 3

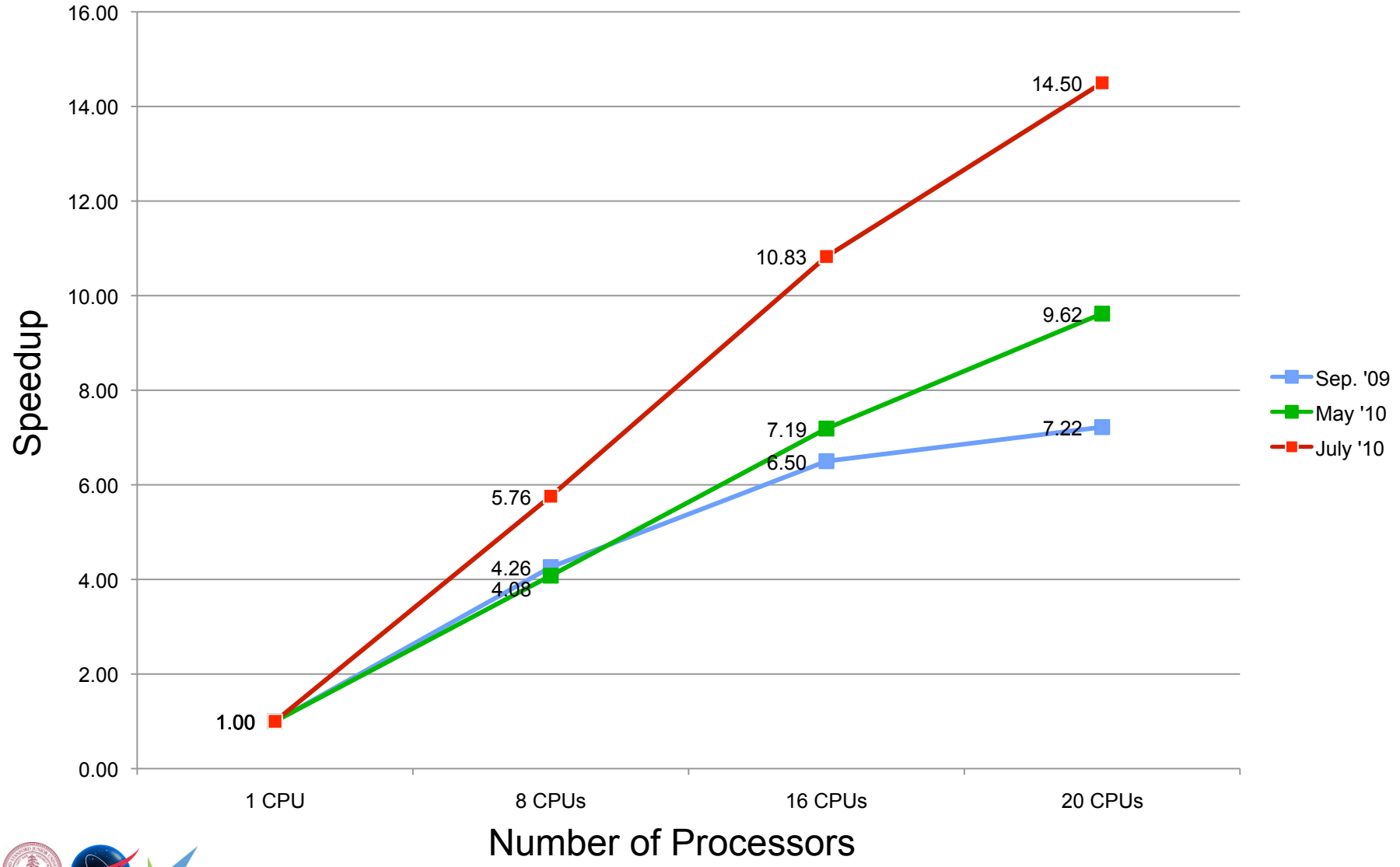
- **Minimize memory footprint of slave code**
  - **Tightly manage memory to prevent swapping to disk, or "out of memory" errors**
  - **We managed to save ~40% of RAM per processor and never seen "out of memory" since**

Parallelization Techniques - 4

- **Find contention points**
  - **Cache what can be cached**
  - **Optimize what can be optimized**

Example: Compute h Optimization

Status – Current Speed up



Tools for Processing - 1

- **Run Manager/Scheduler/Version Controller**
  - **Built by Ahmad Aljadaan**
  - **Given a batch of options files, it schedules batches of runs, serial or parallel, on cluster**
  - **Facilitates version control by creating a unique directory for each run with its options file, code and results**
  - **Used with large number of test cases**
  - **Helped us schedule 1048+ runs since January 2010**
    - » **and counting…**

Tools for Processing - 2

- **Result Viewer**
  - **Built by Ahmad Aljadaan**
  - **Allows searching for runs, displays results, plots related charts**
  - **Facilitates comparison of results**

Questions