

The Big Stuff

Focus on Big

- Lots of talks concerning or in anticipation of lots of data and/or lots of computation
- No surprise given session names: "Large Observatory Challenges", "Grid and Grid Virtualization", "Cross Catalog Matching",...
- The expected buzzwords: Grid, Cloud, VO....
- And (for me) some new ones: Hadoop, Pig,
 GPU

Typical "Big" Talk



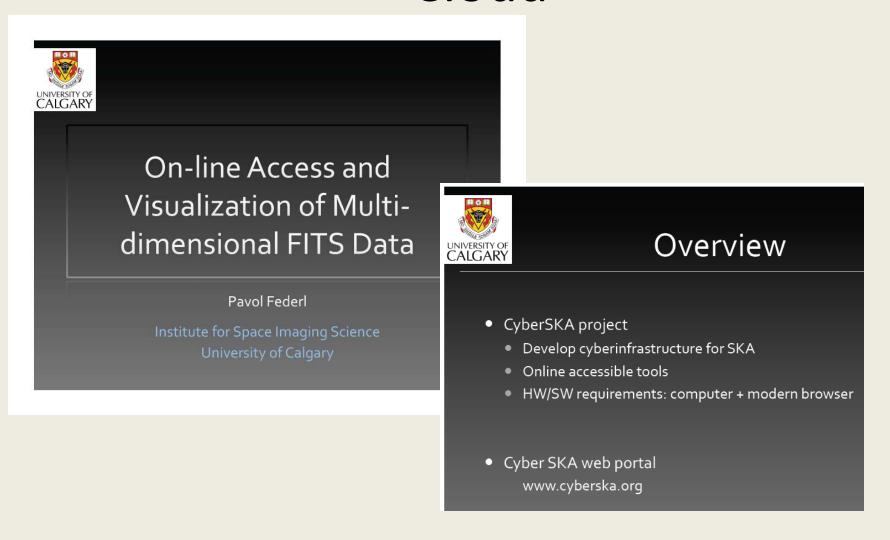
Amdahl's Laws and Extreme Data-Intensive Scientific Computing

Alex Szalay
The Johns Hopkins University

Summary

- · Large data sets are here, solutions are not
 - 100TB is the current practical limit
- · Science community starving for storage and IO
- · No real data-intensive computing facilities available
 - Changing with Dash, Gordon, Data-Scope, GrayWulf...
- · Even HPC projects choking on IO
- · Real multi-PB solutions are needed NOW!
- · Cloud hosting currently very expensive
- · Cloud computing tradeoffs different from science needs
- · Scientists are "frugal", also pushing the limit
- · Current architectures cannot scale much further
- · Astronomy representative for science data challenges

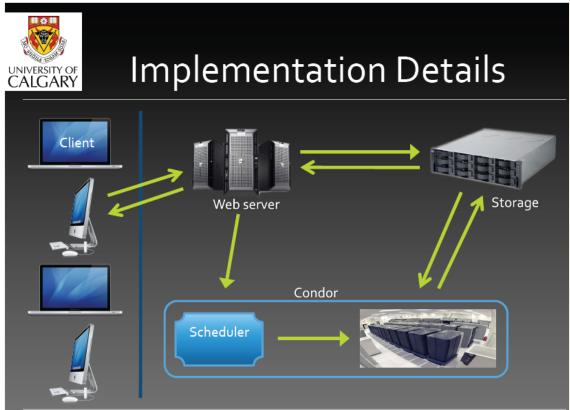
Cloud



Cloud cont'd



- Client side
 - HTML 5
 - JavaScript
 - Ajax
- Server side
 - PHP
 - Condor Pool
 - C++
 - NFS



Grid

Measure transverse motion of 730.000 stars - 1



How many stars are in the Pleiades besides the famous ones?





- Difficult to tell just from the right image
- > The only good way to find out is to look for common transverse motion

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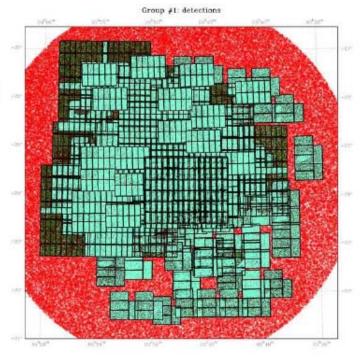
European Space Agency

Grid cont'd

Measure transverse motion of 730.000 stars - 2



- Use of Scigrid to process 520Gb of wide field images obtained from various space and ground based telescopes (Subaru, HST, CFHT, Isaac Newton Telescope) over a 12 years period
- ➤ The multi-epoch images were used to derive the transverse motion of every star (~730.000 in total) present in the 6deg x 6deg field of view of our observations
- The usage of Scigrid was critical, as it requires:
 - vast amount of storage
 - fast multi-threaded computers to extract the source photometry and astrometry
 - fast multi-threaded computers and vast amounts of RAM to cross-match
 - the multi-epoch catalogs and derive the kinematics of each star



H.Bouy et al

European Space Agency

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It worked!

- The result is a vector point diagram of the motion of all 730,000 star located in the Pleiades cluster. The diagram shows the Field and background objects are distributed randomly around (0,0) mas/yr, while the Pleiades members are all co-moving and form the locus near (15,-35) μ_δ [mas/yr]
- This allowed to unambiguously identify several thousands of members (when less than 1000 were known to date) down to the planetary mass regime.
- The scientific outcome will be extremely valuable and rich, from refining the mass function of the cluster, identifying planetary mass objects, and detailed studies of the internal dynamics.
- This new technique could be repeated for other regions of the sky

60 50 40 30 10 -10 -20 -30 -50 Pleiades -60 -70 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 $\mu_{\alpha}\cos\delta$ [mas/yr]

motion in RA (x-axis) and Dec (y-axis) H.Bouy et al

European Space Agency

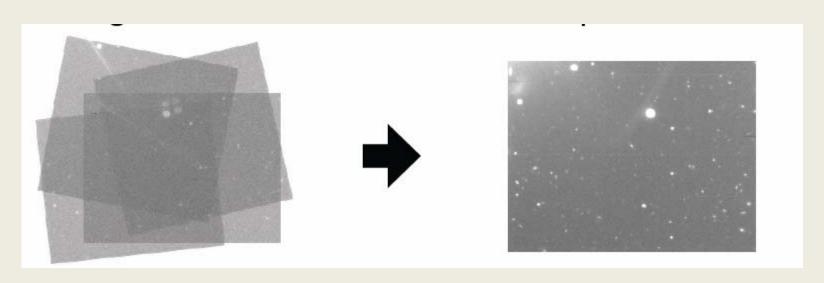
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Hadoop and Pig

- Hadoop is an Apache open-source project used by, e.g., Yahoo!, Facebook, Amazon.
- "The Apache Hadoop project develops opensource software for reliable, scalable, distributed computing."
- Main components include
 - HDFS: distributed file system
 - MapReduce: software framework for distrib. processing
- Intellectual basis apparently from Google.
 Implemented in Java.

Hadoop and Pig

Astronomical Imaging with Hadoop described how a Hadoop installation was use to do image addition:



Given region and images covering it crop, background-subtract, apply PSF, weight, etc.

Pig

- High-level language wrapping Hadoop, developed by Yahoo!
- See Pig as a Solution for Accessing Peta-scale
 Astronomical Datasets for more background
 on Pig and their db access problem.

Why Pig?

Because I bet you can read the following Pig script

```
users = load 'users.csv' as (username: chararray, age: int);
users_1825 = filter users by age >= 18 and age <= 25;

pages = load 'pages.csv' as (username: chararray, url: chararray);

joined = join users_1825 by username, pages by username;
grouped = group joined by url;
summed = foreach grouped generate group as url, COUNT(joined) AS views;
sorted = order summed by views desc;
top_5 = limit sorted 5;

store top_5 into 'top_5_sites.csv';
```

Why Pig?

The same in Hadoop MapReduce

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GPU

- Graphics Processing Unit
- Commodity item. They're improving faster than CPUs (gaming apps a strong incentive)
- Very, very parallel
- Can program like general-purpose cpu
- Only single-precision, but that may change soon. Single is often good enough (so people say).

GPU cont'd

- At least 4 talks (out of ~25 total) entirely on GPU apps:
 - Massively Parallel Fourier-Space Cross-Correlation for Analyzing Highly Dimensional Time Series Databases
 - Fitting Galaxies on GPUs
 - Distributed GPU Volume Rendering of ASKAP Spectral Data Cubes
 - And my favorite, Astrophysical N-body Simulation on a Cluster of GPUs

Challenges

To get a high efficiency on GPUs for hierarchical O(NlogN) or O(N) method (not on brute O(N²) method)

Treecode, FMM

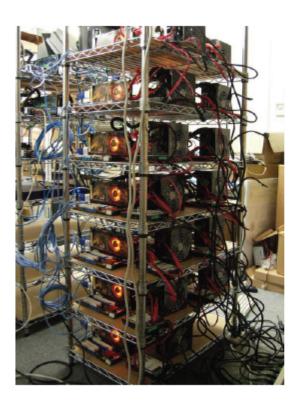
Multiple walk

To get a good scalability on commodity network (GbE)

Delegated Alltoallv

History of our GPU cluster

Mar 2008



Host: Core2Quad 2.4 GHz x 32

GPU: GeForce 8800GT x 32

Nov 2008





Host: Core2Quad 2.4 GHz x 128

GPU: GeForce 8800GTS x 256

~ 40 Tflops in cosmology sim.

Aug 2009



Power supply 600A -> 2000A

Host: Core2Quad 2.4 GHz x 166 GPU: GeForce 9800GTX+ x 256 GPU: GeForce GTX295 x 33



References

http://adass2010.cfa.harvard.edu/ADASS2010/Program/presentations.html