Extremely Large Databases in Astronomy: LSST

Extremely Large Databases Workshop
SLAC
October 25, 2007

Kian-Tat Lim
Stanford Linear Accelerator Center
Outline

Why?
What?
How?
What does this mean?
Outline

Why?
What?
How?
What does this mean?
LSST Overview

Proposed telescope to be built in Chile
Telescope

8.4 meter diameter mirror

3.2 gigapixel camera
Survey

Wide
Fast
Deep
Dark Matter and Energy

Photo: J. A. Tyson, W. Colley, E. L. Turner, and NASA
Variable Objects
Transient Objects
Moving Objects

Photo: D. Roddy, Lunar and Planetary Institute
Outline

Why?
What?
How?
What does this mean?
Data Challenge

Images

Database
Data Locations

Mountain Base Camp
Archive Center
Data Access Center
Non-Image Data In Database

- Moving Objects Catalog
- Object Catalog
- Source Catalog
- Difference Image Source Catalog
- Calibration
- Engineering and Facility Database
- Metadata
- Provenance
- Statistics
- Summaries
Sagans of Rows

49 billion objects
2.8 trillion sources
Lots of Columns

269 columns/Object
56 columns/Source
Denormalization

Load

Query
Database Size

Grows to 14 PB with indices
Managing The Database

Similar to commercial analytical data warehouses
Comparisons

- Google and few others are here
- Likely growth faster than linear
- We have 12 years to reach today’s commercial limits
- All numbers based on publicly available data

*All numbers based on publicly available data*
Outline

Why?

What?

How?

What does this mean?
Reliability

Duplicate
Buffer
Replicate
Backup
Mirror
Integrity

*Never modify raw data*

Provenance
Reprocessing
Scalability

Horizontally scalable
Portable code
Map/Reduce + SQL

1. Parses query
2. Splits, optimizes and routes it (aware of #db servers & mapping to "chunks")
3. Executes queries in parallel

Merges sub-results

Each db server specializes in some data "chunks", but can process any chunk. Entire data set available to each db server.

Hides physical location. Provides fault tolerance and discovery (adding more workers), load balancing and technology evolution (MSS, flash...)

Database servers

"Map"

"Reduce"

sub-queries

sub-results

Specialized file system

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs

fs
Outline

Why?
What?
How?
What does this mean?
What Can Vendors Do?

Mine! Mining
What Can Vendors Do?

Relax
Relax
Relax
What Can Vendors Do?

Maintain Maintenance
Many issues common to extremely large DBs