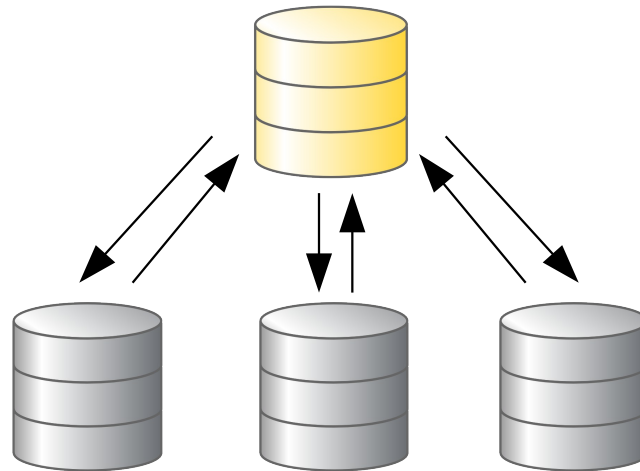


Distributed databases with MariaDB and Spider engine



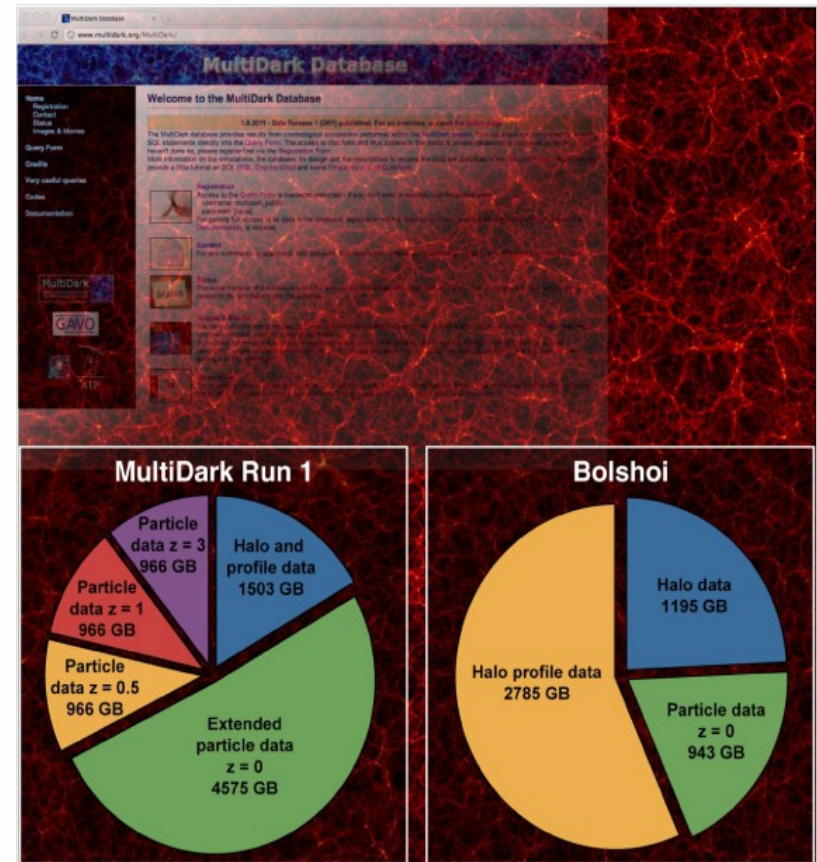
Developments from E-Science @ AIP Potsdam

Kristin Riebe



Example: MultiDark Database

- Collaboration with Spanish MultiDark project
- cosmological simulations in a database
- 2 simulations uploaded (14 TB, $1.5 \cdot 10^{11}$ rows)
- Webinterface: www.multidark.org
- > 150 registered users
- > 1.5 million queries in 3 years
- > 6 TB downloaded



Database server

- Current setup:
 - like (first) Millennium DB
 - 1 Microsoft SQL Server
- Issues:
 - **retrieval** times slow on full table scans (~ 30-40 min), cannot have index for every possible query
 - **index** on particle data (~ 10^{10} particles) takes ~ 1 week
 - **transaction logs** take time ... (but useful for data integrity)
 - if multiple servers: need to buy expensive **license** (unless you know the right people ;-))

Database server

- Goal:
 - **speed-up** queries involving full table scans
 - want to serve simulations with even **more particles** (at least factor 10)
 - use only **open source** software (enable mirroring services without expensive licenses)
- Solution:
 - distributed data over multiple servers with MariaDB/MySQL + Spider engine

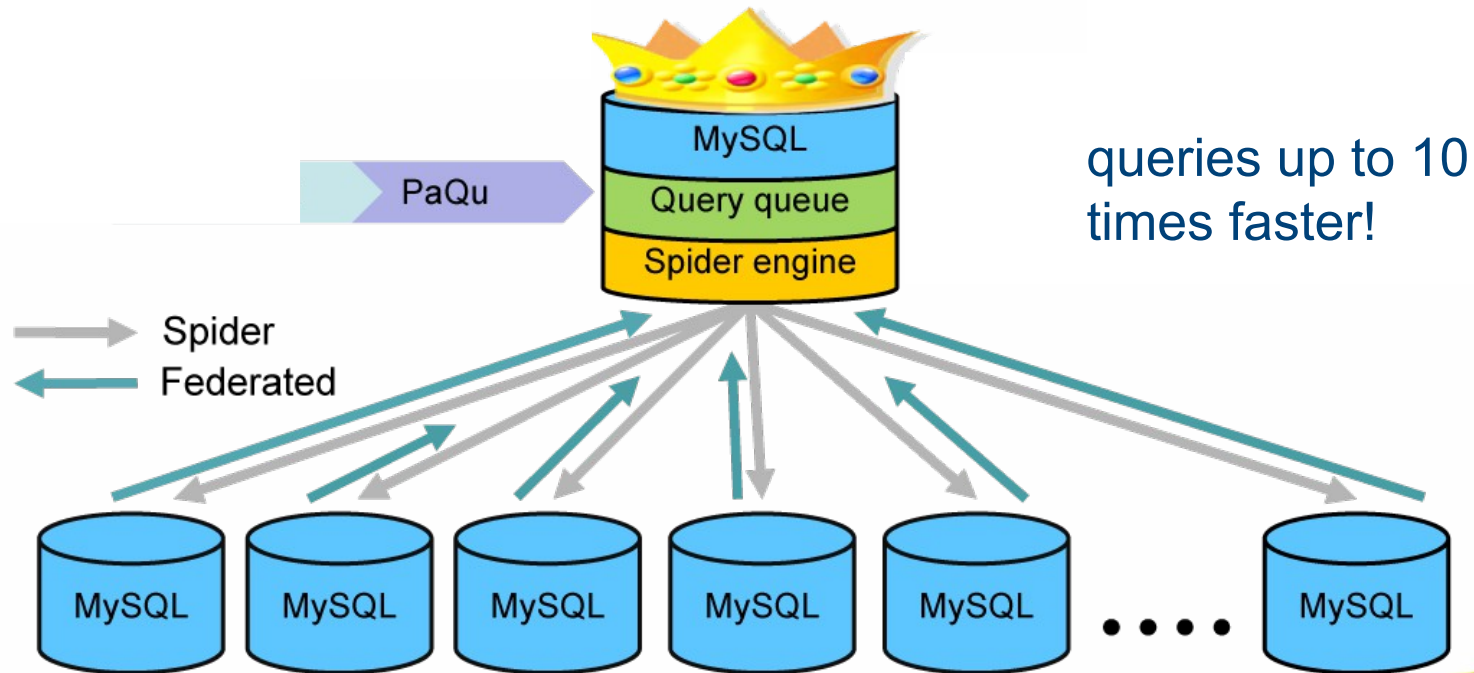
MySQL/MariaDB

- MySQL:
 - open source, plugin-system (C)
 - free choice of storage engine
 - MyISAM engine: no transactions
(need fast select, data changes are rare)
- MariaDB:
 - spin-off of MySQL
 - developed by original MySQL-developers
(left MySQL after it was taken over by Sun/Oracle)
 - “An enhanced, drop-in replacement for MySQL.” (<https://mariadb.org/>)
 - => no difference in interface, just exchange the sources
 - advantage:
 - Spider engine by Kentoku Shiba included (for distributed data)
 - more community driven, support for community developments



Spider engine

- data tables partitioned, distributed over 10 nodes using Spider engine
- PaQu reformulates queries, head node sends them to nodes
- head node collects data via federated table



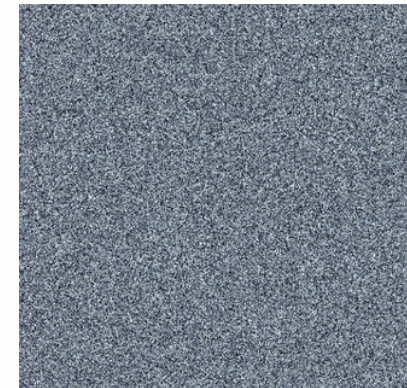
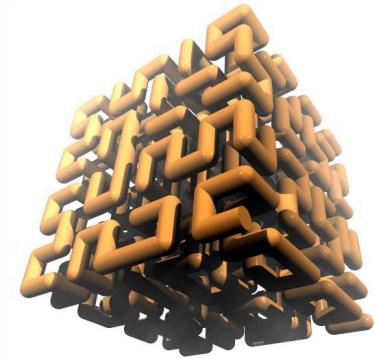
Additional developments

- PaQu:
 - reformulates queries, based on Shard-Query
 - e.g.: aggregate function: count
 - count on each node
 - sum on head node
- QueryQueue:
 - allow asynchronous jobs
 - plugin for MySQL, supports priorities
 - control number of executing jobs on server
 - jobs stored in user table for later retrieval

see <https://github.com/adrpar/>

Further MySQL plugins

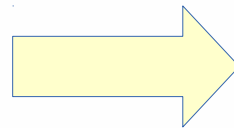
- C-library libhilbert
 - For creating indexes of space-filling Peano-Hilbert curve in up to 20 dimensions
- MySQL sprng
 - Based on SPRNG library (www.sprng.org)
 - Implements several random number generators
 - Better random sampling for large numbers than with built-in function



see <https://github.com/adrpar/>

mysql_sphere

- Functions of pgSphere converted to mysql_sphere
- Allows queries on a spherical surface (cut outs, angle-ranges)
- Especially important for observational databases



- ... now also ported to SQLite!

see <https://github.com/adrpar/>

Data download: VOTable dump

- fork of mysqldump
- dumps VOTable format 1.3, ASCII or binary format, directly from MySQL database tables
- => especially useful for large tables, no additional conversion on server needed
- for ucds, units: a json-like comment string is required

```
CREATE TABLE foo (  
  x DOUBLE COMMENT 'DQIMETA={"unit":"Mpc","ucd":"pos.cartesian.x"}',  
  y DOUBLE COMMENT 'DQIMETA={"unit":"Mpc","ucd":"pos.cartesian.y"}',  
  ...);
```

- Download from <https://github.com/adrpar/mysqldump-vo>

New portal: www.cosmosim.org

- with Spider nodes in background, PaQu, QueryQueue



The screenshot shows the CosmoSim beta website in a browser window. The page has a dark blue background with a starry pattern. At the top, there is a navigation bar with links for "Simulations", "Documentation", "Query", "Contact", and "Login". The main heading is "CosmoSim beta" in a large, bold font. Below the heading, there is a paragraph explaining that the database provides results from cosmological simulations performed within different projects: the MultiDark project, the BolshoiP project, and the CLUES project. Three columns of information are provided for each project: MultiDark (Multimessenger Approach for Dark Matter Detection), BolshoiP (Cosmological Simulations), and CLUES (Constrained Local Universe Simulations). Each column includes a brief description and a link to the project's website. A "Register to CosmoSim" button is located on the right side of the page. Below the project descriptions, there is a section for "Database access" which explains how to query the database using SQL statements. The footer of the page mentions that CosmoSim.org is hosted and maintained by the Leibniz-Institute for Astrophysics Potsdam (AIP) and is a contribution to the German Astrophysical Virtual Observatory (GAVO). It also notes that the MultiDark and Bolshoi simulations were run on the NASA's Pleiades supercomputer at the NASA Ames Research Center.

Web application: Daiquiri

- Developed by Jochen Klar und Adrian Partl
- <http://escience.aip.de/daiquiri/>
- Web application for publishing data
- Modular, highly customizable
- Using PHP, Zend-framework
- Modern interface using bootstrap, jQuery
- Authentication, Query Interface
- Wordpress integration
- One code base to serve most needs, open source, (easily) extendable
- supports SAMP and UWS



Summary

- need to speed-up database queries
- solution using distributed data with MariaDB and Spider engine is working
- => queries scale nicely
- plugin development for MySQL/MariaDB in C possible, could even write own storage engine etc.
- => everything adjustable, open source
- => MySQL/MariaDB is an alternative to commercial databases that shouldn't be ignored