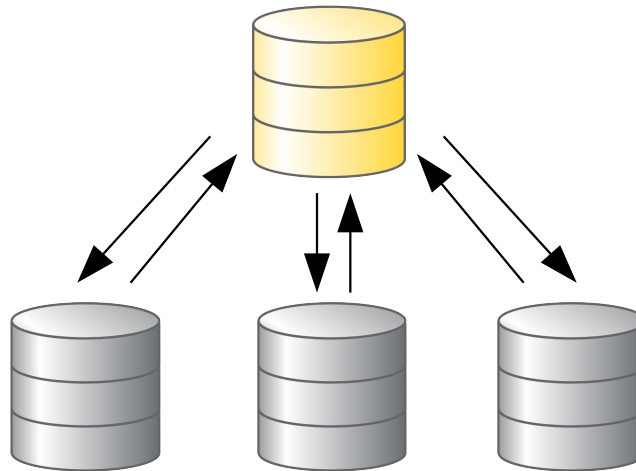


Distributed databases with MariaDB and Spider engine



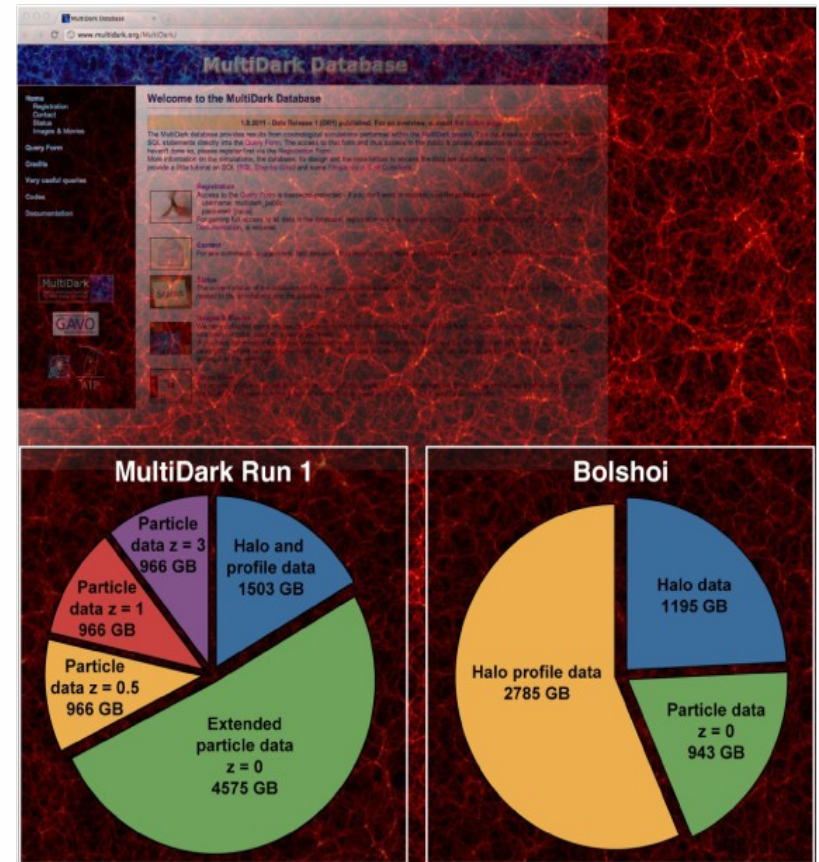
Developments from E-Science @ AIP Potsdam

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 ($\sim 30\text{-}40$ min), cannot have index for every possible query
 - **index** on particle data ($\sim 10^{10}$ 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

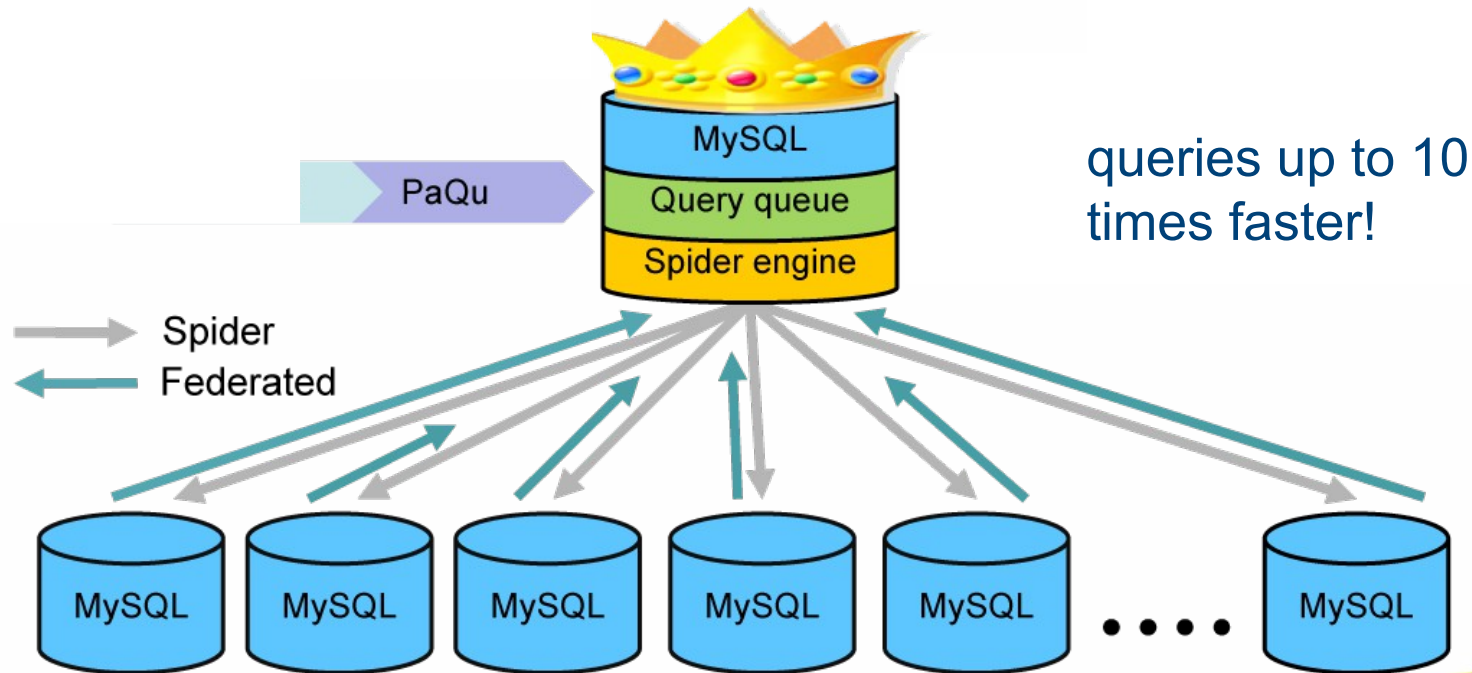
MySQL/MariaDB

- 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



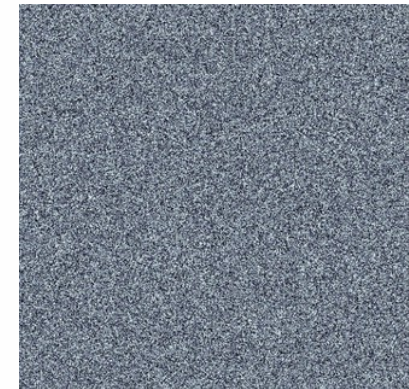
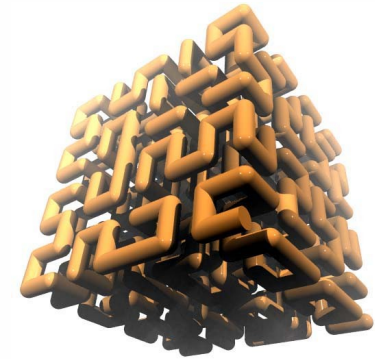
Additional developments

- 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

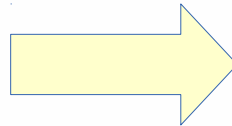
- C-library libhilbert
 - For creating indexes of space-filling Peano-Hilbert curve in up to 20 dimensions
- MySQL sprng
 - Based on SPRNG library (www.sprng.org)
 - Implements several random number generators
 - Better random sampling for large numbers than with built-in function



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



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