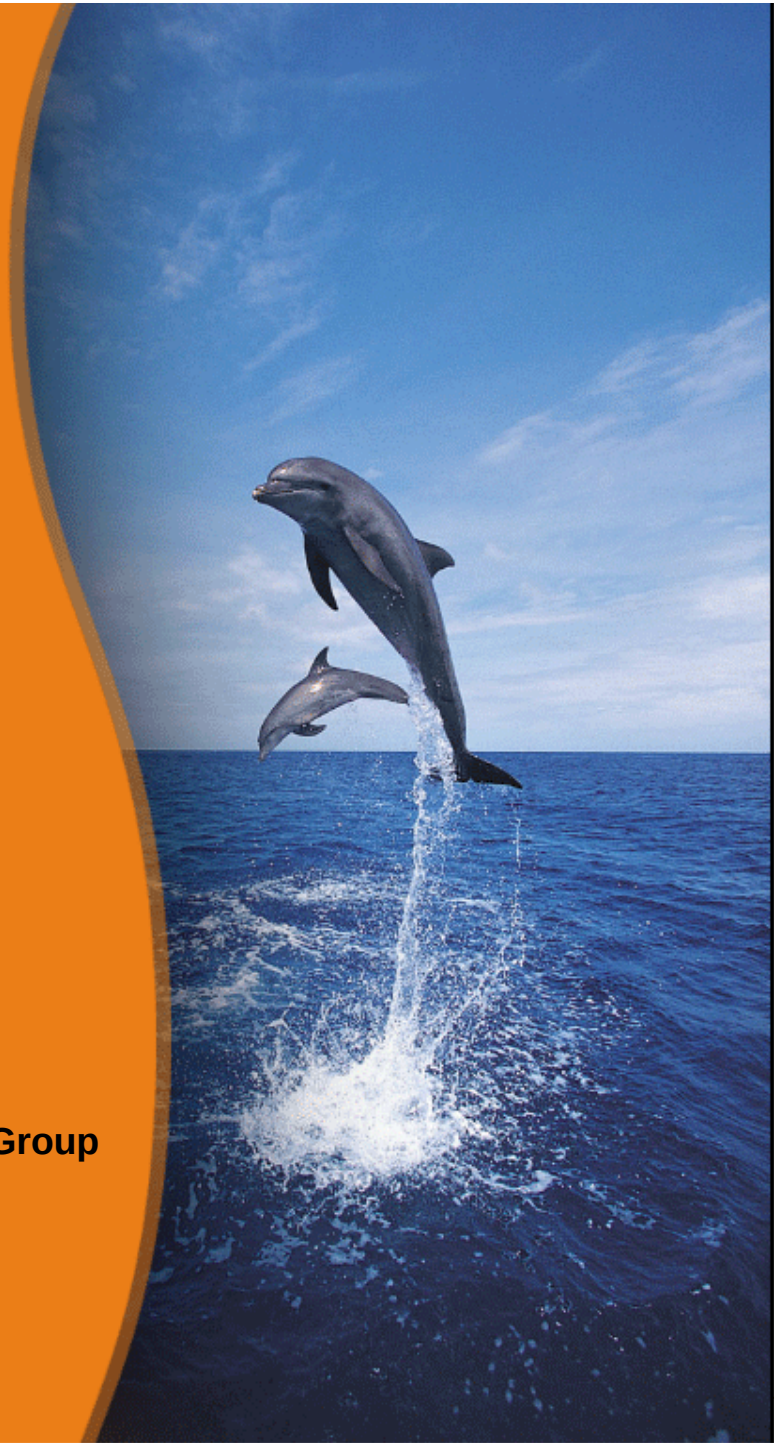
MySQL Performance Tuning Step by Step



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- Sun – MySQL Overview
- MySQL Performance Tuning
- Next Steps

About MySQL

- 13 Years of Development
- 400+ in Database Group
- 750+ Partners
- 70K+ Downloads Per Day

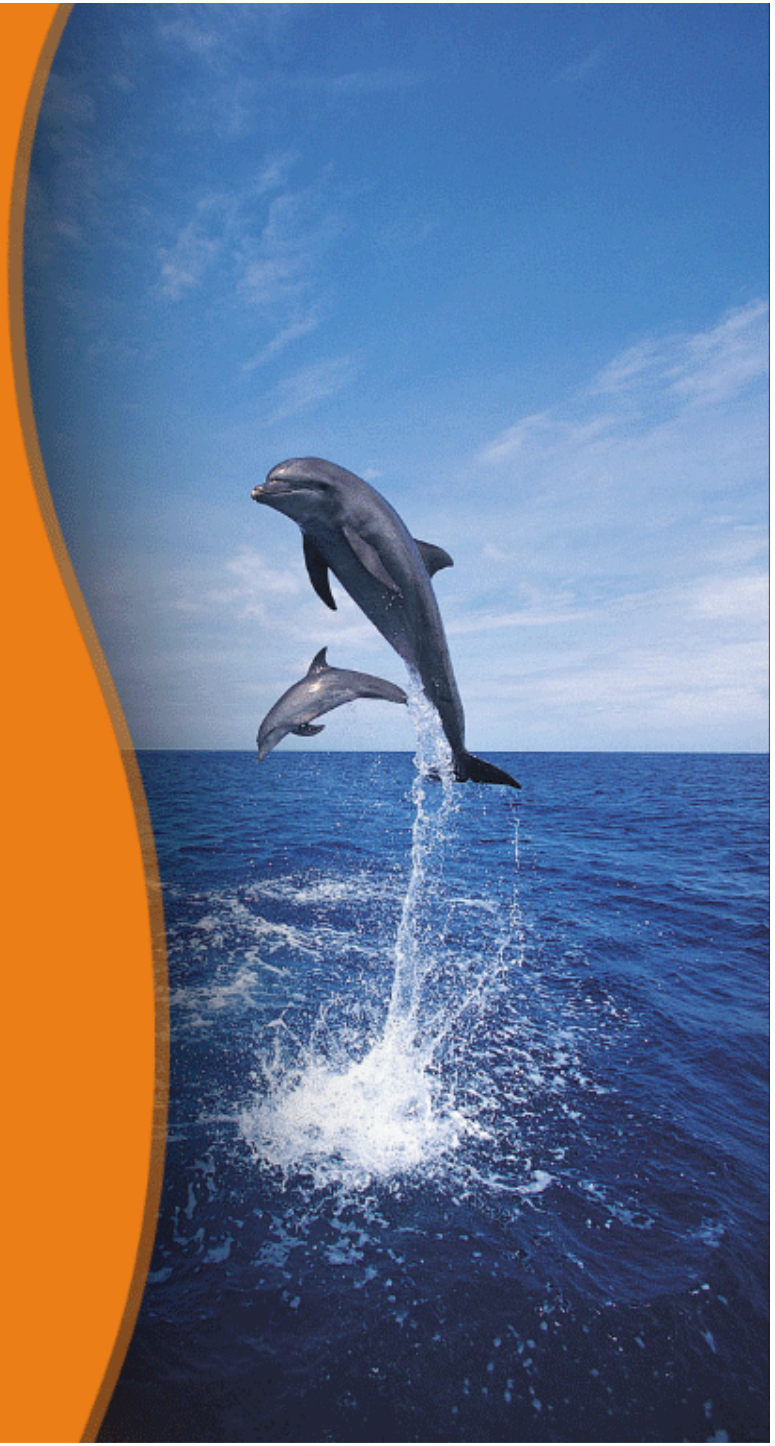
Customers across every major operating system, hardware vendor, geography, industry, and application type

High Performance ▪ Reliable ▪ Easy to Use

Serving Key Markets & Industry Leaders

MySQL 5.4 Performance Tuning Step by Step

MySql Server Performance Tuning Step-by-Step



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Agenda

- Overview
- Step 1 - Storage Engines
- Step 2 - Connections
- Step 3 - Sessions
- Step 4 - Query Cache
- Step 5 - Queries
- Step 6 - Schema
- What if I need more help?

Overview

- Focus of this talk is the MySQL server, not:
  - Operating System, Disk performance, Network performance, etc.
- Cover the main steps
  - Show at least one example for each step
  - Examples are things I run into most commonly in the field
  - Include links to MySQL manual for additional information
- This will be technical!
- I can't make you a performance tuning wizard in 45 minutes - PT Class is 4 day class
  - http://www.mysql.com/training/courses/performance_tuning.html
- MySQL Performance Forum
  - http://forums.mysql.com/list.php?24

What you will need to know first

- The MySQL server is controlled by "**System Variables**"
  - `mysql> SHOW VARIABLES [LIKE <str>];`
  - `linux1> mysqladmin -u <user> -p variables`
  - Set Via:
    - my.cfg
    - SET [GLOBAL] <variable>=<value>
    - command line
  - http://dev.mysql.com/doc/refman/5.1/en/server-system-variables.html
- You monitor how well your system variables are configured using "**Status Variables**"
  - `mysql> SHOW STATUS [LIKE <str>];`
  - `linux1> mysqladmin -u <user> -p extended`
  - **`linux1> mysqladmin ... ex -i 15 -r | grep -v ' 0 '`**
  - http://dev.mysql.com/doc/refman/5.1/en/server-status-variables.html
- Enabling the slow query log
  - http://dev.mysql.com/doc/refman/5.1/en/slow-query-log.html

MySQL Enterprise Monitor w/Query Analyzer

- Single, consolidated view into entire MySQL environment
- Auto discovery of MySQL Servers, Replication Topologies
- *Problem Query Detection, Analysis and Tuning – New!*
- Customizable rules-based monitoring and alerts
- Identifies problems ***before*** they occur
- Reduces risk of downtime
- Makes it easier to scale-out without requiring more DBAs

"Virtual MySQL DBA"

Assistant

Rules of Tuning

- Never make a change in production first
- Have a good benchmark or reliable load
- Start with a good baseline
- Only change 1 thing at a time
  - identify a set of possible changes
  - try each change separately
  - try in combinations of 2, then 3, etc.
- Monitor the results
  - Query performance - query analyzer, slow query log, etc.
    - throughput
    - single query time
    - average query time
  - CPU - top, vmstat
  - IO - iostat, top, vmstat, bonnie++
  - Network bandwidth
- Document and save the results

Were do I find a benchmark?

- Make your own
  - Can use general query log output
- DBT2
    - http://osdldbt.sourceforge.net/
    - http://samurai-mysql.blogspot.com/2009/03/settingup-dbt-2.html
- mysqlslap MySQL 5.1 +
  - http://dev.mysql.com/doc/refman/5.1/en/mysqlslap.html
- Sysbench
  - http://sysbench.sourceforge.net/
- supersmack
  - http://vegan.net/tony/supersmack/
- mybench
  - http://jeremy.zawodny.com/mysql/mybench/

Step 1 MySQL Supports Multiple Storage Engines

- **MyISAM** - Original Storage Engine, great for web apps
- **InnoDB** - Robust transactional storage engine
- **Memory Engine** - Stores all data in ***Memory***
- InfoBright - Large scale data warehouse with 10x or more compression
- Kickfire - Appliance based, Worlds fasted 100GB TPC-H
- To see what tables are in what engines
  - `mysql> SHOW TABLE STATUS ;`
- Selecting the storage engine to use ***is a tuning decision***
- *`mysql> alter table tab engine=myisam ;`*

Step 1 MyISAM

- Fastest storage engine 3x or more ***when appropriate***
  - Most web applications
  - Perfect for web search databases
  - 80/20 read/modify or higher
  - pure inserts and deletes with partitions or merge engine
  - no transactions
  - reporting DB/ Data Warehouse
- Most compact data of all non-compressed engines
- Table locking
- Supports concurrent inserts
- Full-Text and Geospatial support
- http://dev.mysql.com/doc/refman/5.1/en/myisam-storage-engine.html

Step 1 MyISAM Tuning

- The primary tuning factor in MyISAM are its two caches:
  - **key_buffer_cache** - should be 25% of available memory
  - system cache - leave 75% of available memory free
- Available memory is:
  - All on a dedicated server, if the server has 8GB, use 2GB for the **key_buffer_cache** and leave the rest free for the system cache to use.
  - Percent of the part of the server allocated for MySQL, i.e. if you have a server with 8GB, but are using 4GB for other applications then use 1GB for the **key_buffer_cache** and leave the remaining 3GB free for the system cache to use.
- Maximum size for a single key buffer cache is 4GB
- You can define multiple key buffer's
- For more details on configuring the MyISAM key cache see:
  - http://dev.mysql.com/doc/refman/5.1/en/myisam-key-cache.html

Step 1 Monitoring the MyISAM Key Buffer Cache

- `mysql>show status like 'Key%' ;`
- **Key_blocks_not_flushed** - Dirty key blocks not flushed to disk
- **Key_blocks_unused** - unused blocks in the cache
- **Key_blocks_used** - used Blocks in the cache
- *% of cache free : Key_blocks_unused /(Key_blocks_unused + Key_blocks_used)*
- **Key_read_requests** - key requests to the cache
- **Key_reads** - times a key read request went to disk
- *Cache read hit % : Key_reads / Key_read_requests*
- **Key_write_requests** - key write request to cache
- **Key_writes** - times a key write request went to disk
- *Cache write hit % : Key_writes / Key_write_request*
- `cat /proc/meminfo` to see the system cache in linux
  - MemFree + Cached = memory available for system cache

Step 1 InnoDB

- Transactional and fully ACID compliant
- Behavior most like traditional databases such as Oracle, DB2, SQL Server, etc.
- Data size is normally 2-3 X MyISAM
- MVCC = Non-blocking reads in most cases
- Fast, reliable recovery from crashes with zero committed data loss
- **Always** clustered on the primary key
  - Lookups by primary key, very fast
  - Range scans on primary key also very fast
  - Non-Primary key lookups use the primary key to find the record, this means 2 key lookups
  - Important to keep primary key small
- http://dev.mysql.com/doc/refman/5.1/en/innodb.html

Step 1 InnoDB

- Unlike MyISAM InnoDB uses a single cache for both index and data
  - **Innodb_buffer_pool_size** - should be 70-80% of available memory.
  - It is not uncommon for this to be very large, i.e. 44GB on a system with 40GB of memory
  - Make sure its not set so large as to cause swapping!
  - `mysql>show status like 'Innodb_buffer%' ;`
- InnoDB can use direct IO on systems that support it, linux, FreeBSD, and Solaris.
  - **Innodb_flush_method** = O_DIRECT
- For more InnoDB tuning see
  - http://dev.mysql.com/doc/refman/5.1/en/innodb-tuning-troubleshooting.html

Step 2 Connections

- MySQL Caches the threads used by a connection
  - **`thread_cache_size`** - Number of threads to cache
  - Setting this to 100 or higher is not unusual
- Monitor **`Threads_created`** to see if this is an issue
  - Counts connections **not** using the thread cache
  - Should be less that 1-2 a minute
  - Usually only an issue if more than 1-2 a second
- Only an issue is you create and drop a lot of connections, i.e. PHP
- Overhead is usually about 250k per thread
- **`Aborted_clients`** - http://dev.mysql.com/doc/refman/5.1/en/communication-errors.html
- **`Aborted_connections`** - http://dev.mysql.com/doc/refman/5.1/en/communication-errors.html

Step 3 Sessions

- Some session variables control space allocated by each session (connection)
  - Setting these to small can give bad performance
  - ***Setting these too large can cause the server to swap***!
  - Can be set by connection
    - SET `SORT_BUFFER_SIZE=1024*1024*128`
  - Set small be default, increase in connections that need it
- **`sort_buffer_size`** - Used for ORDER BY, GROUP
- BY, SELECT DISTINCT, UNION DISTINCT
  - Monitor **`Sort_merge_passes`** < 1-2 an hour optimal
  - Usually a problem in a reporting or data warehouse database
- Other important session variables
  - **`read_rnd_buffer_size`** - Set to 1/2 **`sort_buffer_size`**
  - **`join_buffer_size`** - (BAD) Watch **`Select_full_join`**
  - **`read_buffer_size`** - Used for full table scans, watch **`Select_scan`**
  - **`tmp_table_size`** - Max temp table size in memory, watch **`Created_tmp_disk_tables`**

Step 4 Query Cache

- MySQL's Jekyll and Hyde of performance tuning options, when it is useful it really helps, when it hurts, it really hurts
- MySQL Query Cache caches both the query and the full result set
  - **`query_cache_type`** - Controls behavior
    - 0 or OFF - Not used (buffer may still be allocated)
    - 1 or ON cache all unless **`SELECT SQL_NO_CACHE (DEFAULT)`**
    - 2 or DEMAND cache none unless **`SELECT SQL_CACHE`**
  - **`query_cache_size`** - Determines the size of the cache
- `mysql> show status like 'Qc%' ;`
- Gives great performance if:
  - Identical queries returning identical data are used often
  - No or rare inserts, updates or deletes
- Best Practice
  - Set to DEMAND
  - Add SQL_CACHE to appropriate queries
- See http://dev.mysql.com/doc/refman/5.1/en/query-cache-configuration.html

Step 5 Queries I

- Often the # 1 issue in overall performance
- ***Always, Always have your slow query log on***!
  - http://dev.mysql.com/doc/refman/5.1/en/slow-query-log.html
  - Use: **`log_queries_not_using_indexes`**
  - Check it regularly
  - Use **`mysqldumpslow`** : http://dev.mysql.com/doc/refman/5.1/en/mysqldumpslow.html
  - Best practice is to automate running **`mysqldumpslow`** every morning and email results to DBA, DBDev, etc.
- Understand and use `EXPLAIN`
  - http://dev.mysql.com/doc/refman/5.1/en/using-explain.html
- **`Select_scan`** - Number of full table scans
- **`Select_full_join`** - Joins without indexes
- MySQL Query Analyzer
  - http://www.mysql.com/products/enterprise/query.html

Step 5 Queries II

- The IN clause in MySLQ is very fast!
  - Select ... Where idx IN(1,23,345,456)
  - Much faster than a join
  - I have done tests with 80,000 items in the in list
    - 1,000-2,000 not unusual
- Don't wrap your indexes in expressions in Where
  - Select ... Where func(idx) = 20 [index ignored]
    - Select .. Where idx = otherfunc(20) [may use index]
  - Best practice : Keep index alone on left side of condition
- Avoid % at the start of LIKE on an index
  - Select ... Where idx LIKE('ABC%') can use index
  - Select ... Where idx LIKE('%XYZ') must do full table scan
- Use union all when appropriate, default is union distinct!
- Understand left/right joins and use only when needed
- http://dev.mysql.com/doc/refman/5.1/en/query-speed.html

MySQL Query Analyzer – New!

MyWeb1:13306 Browse Queries

Search Type	Query Search	Database	Time Display	Hours
Contains	SELECT	sakila	Interval	02

Query	Database	Execution (hh:mm:ss.ms) Count	Total	Max
SELECT `p` . * , paymen...t_orders . last_order ;	sakila	47,541	3:43.281	0.531
SELECT `p` . * , paymen...= `p` . customer_id) ;	sakila	11,640	1:30.000	0.141
SELECT COUNT(*) FROM ...E pad > ? AND pad < ? ;	sakila	6,345	23.594	0.234
SELECT hibinstanc0_ . i...frequency IS NOT NULL)	sakila	6,133	23.422	0.156
SELECT continent , regi... , Region WITH ROLLUP ;	sakila	6,123	23.125	0.109
SELECT Country . Name ,...) < City . Population ;	sakila	5,278	1:10.094	0.234

MyWeb1:13306 Browse Queries

Search Type	Query Search	Database	Time Display	Hours
Contains	SELECT	sakila	Interval	02

Query	Database	Execution (hh:mm:ss.ms) Count	Total	Max
SELECT `p` . * , paymen...t_orders . last_order ;	sakila	47,401	1:25.828	0.016
SELECT `p` . * , paymen...= `p` . customer_id) ;	sakila	11,442	1:27.531	0.141
SELECT COUNT(*) FROM ...E pad > ? AND pad < ? ;	sakila	6,313	23.938	0.234
SELECT hibinstanc0_ . i...frequency IS NOT NULL)	sakila	6,278	23.156	0.156
SELECT continent , regi... , Region WITH ROLLUP ;	sakila	6,221	23.125	0.109
SELECT Country . Name ,...) < City . Population ;	sakila	5,553	1:11.875	0.203

- Centralized monitoring of Queries across all servers with no reliance on Slow Query Logs
- Aggregated view of query execution counts, time, and rows returned = total query expense
- Saves time/effort parsing atomic executions for total query expense

Saves time finding most expensive queries across all Production, Dev, and QA servers so SQL can be tuned.

"Finds code problems *before* your customers do."

Step 6 Schema I

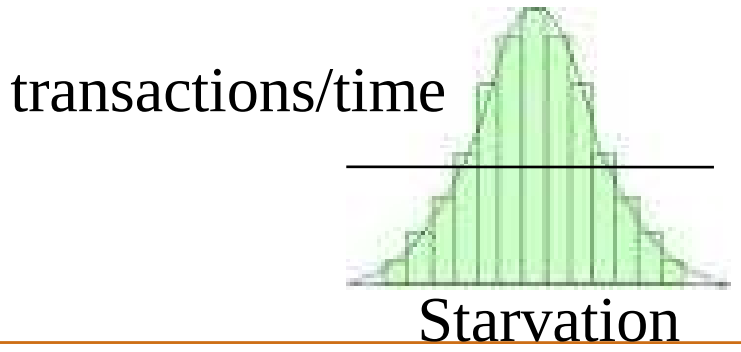
- Too many indexes slow down inserts/deletes
  - Use only the indexes you must have
  - Check often
- `mysql>show create table tabname ;`
- Don't duplicate leading parts of compound keys
  - index key123 (col1,col2,col3)
  - index key12 (col1,col2) <- Not needed!
  - index key1 (col1) <-- Not needed!
- Use prefix indexes on large keys
- Best indexes are 16 bytes/chars or less
- Indexes bigger than 32 bytes/chars should be looked at very closely
  - should have there own cache if in MyISAM
- For large strings that need to be indexed, i.e. URLs, consider using a separate column using the MySQL MD5 to create a hash key.

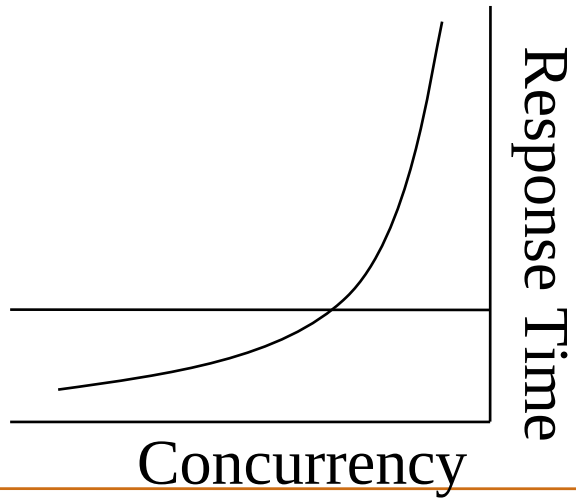
Step 6 Schema II

- Size = performance, smaller is better
  - Size right! Do not automatically use 255 for VARCHAR
    - Temp tables, most caches, expand to full size
- Use “procedure analyse” to determine the optimal types given the values in your table
  - http://dev.mysql.com/doc/refman/5.1/en/procedure-analyse.html
  - `mysql> select * from tab procedure analyse (64,2000) \G`
- Consider the types:
  - enum : http://dev.mysql.com/doc/refman/5.1/en/enum.html
  - set : http://dev.mysql.com/doc/refman/5.1/en/set.html
- Compress large strings
  - Use the MySQL `COMPRESS` and `UNCOMPRESS` functions
  - Very important in InnoDB!

MySQL PS Performance Tuning

- When: Before go-live, or for application already deployed
- What: Tuning of database configuration, SQL, schema
  - Performance Tuning typically 3-5 days
  - Analysis with benchmark, load testing
  - Results typically 50-100% gain, sometimes 500%-1000%
- Good for:
  - Applications with poor response times, hit wall recently?
  - Solving system scalability issues
  - Reduction of hardware $$$ outlay
  - Prevention of new complex scaling architecture
  - Load testing, benchmarking, capacity planning

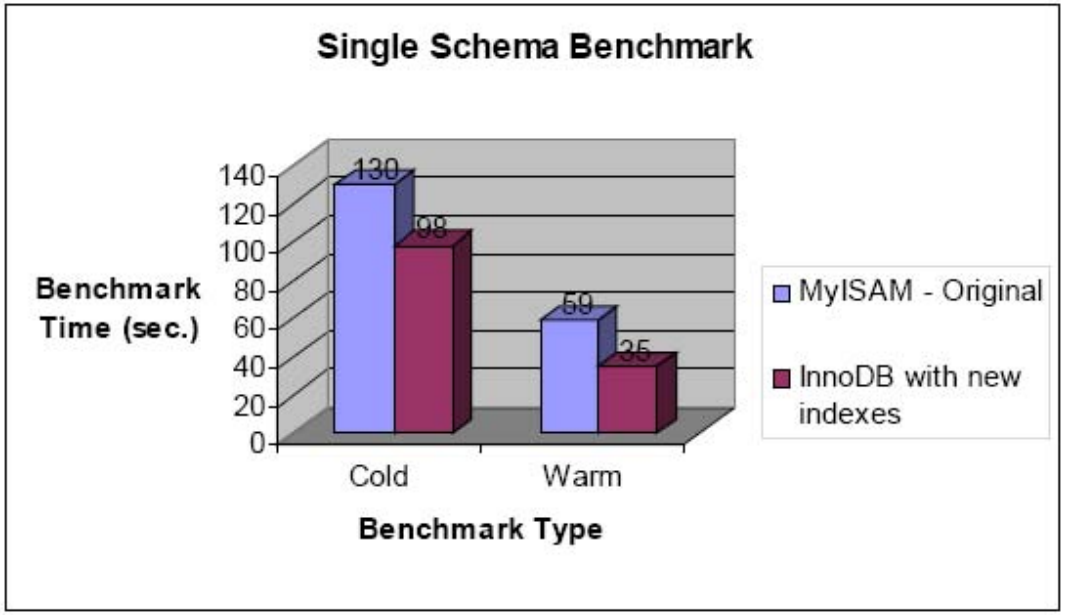




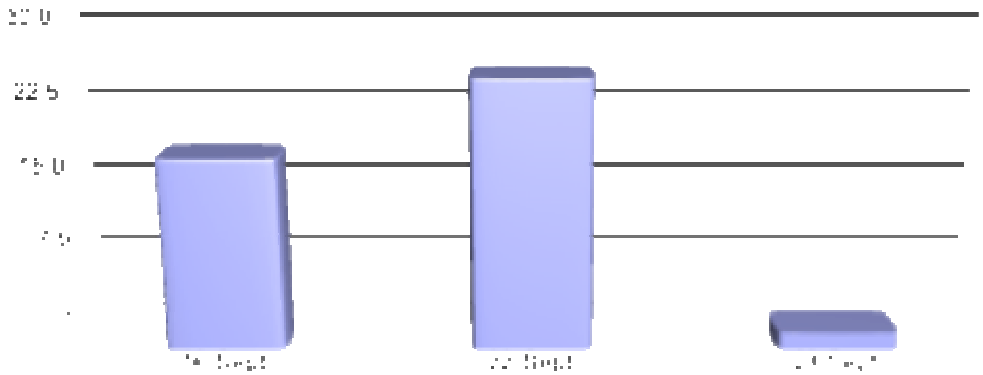
Case Study: Performance Tuning

- **Situation:**
  - Social Networking site having slow queries, crashes, & high disk i/o.
  - Large number of mysql servers being optimized
- **What we did:**
  - Benchmark based on general query log queries
  - The conversion of tables to InnoDB, and the optimization of these tables
  - Database configuration improvements and tuned for InnoDB
  - Over 67 schema changes including:
    - Adding multi-column indexes that are optimized for some queries
    - Column data type optimizations
    - The removal of unnecessary tables
    - The removal of unnecessary indexes
- **Results:**
  - 68% faster on warm benchmark
  - Dramatic reduction in disk i/o
  - No more database crashing and corruption

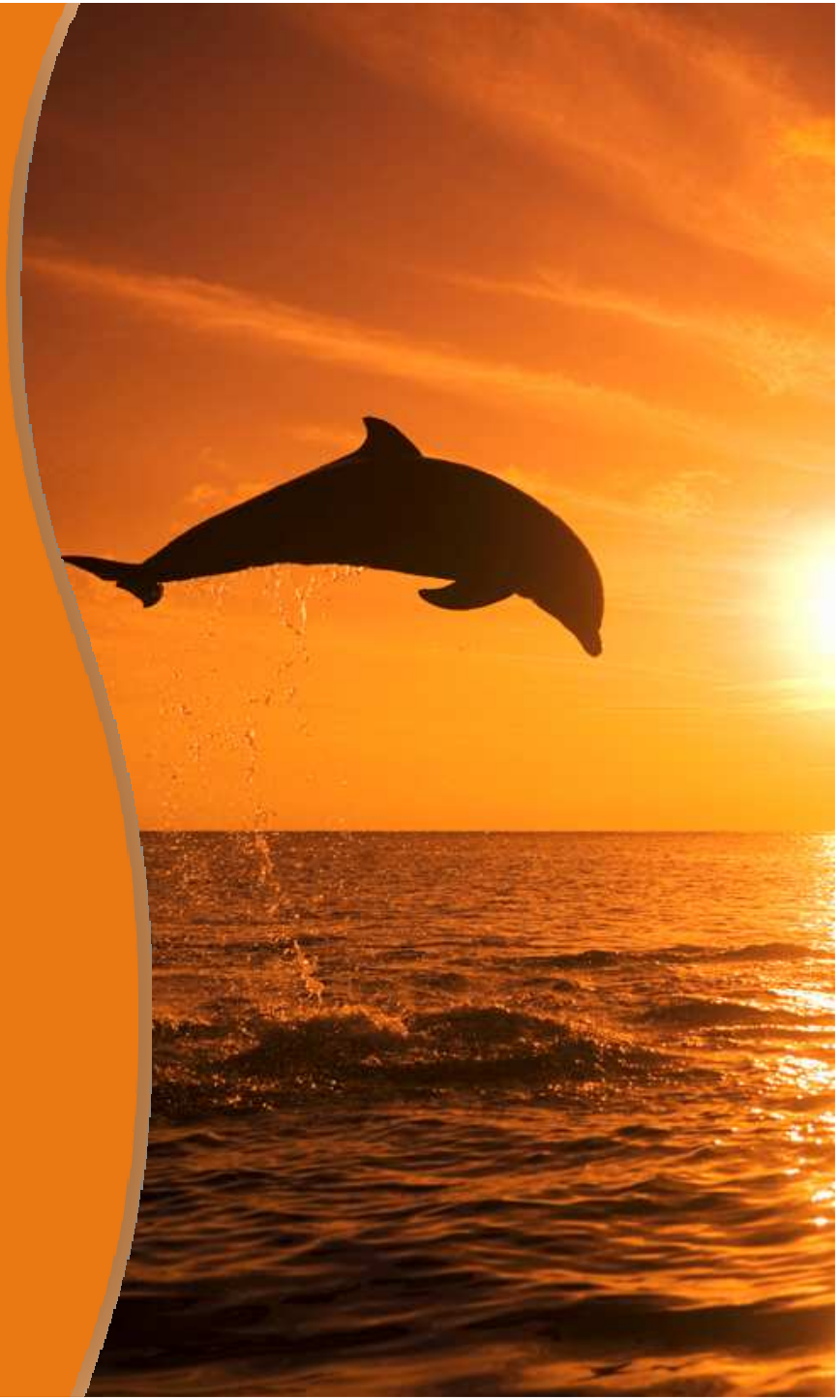
Case Study: Performance Tuning



Database system i/o wait %



Thank You



Next Steps

MySQL 5.4 Benchmarks In-Depth – Allan Packer - Today!

http://www.mysql.com/news-and-events/web-seminars/display-343.html

***Web Destination* - http://mysql.com/performance/**

- Benchmarks
- Articles
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http://www.mysql.com/consulting/

MySQL Training

MySQL Performance Tuning (4 Days)

- Manage an increasing amount of data in your MySQL applications
- Monitor, diagnose problem areas and tune MySQL for optimal performance
- Write queries that take advantage of the MySQL 5.0 and 5.1 performance enhancements dealing with queries and indexing?
- Evaluate the application architecture for efficient design, structure, caching, number of connections and other factors affecting performance

www.mysql.com/training/courses/performance_tuning.html

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Database

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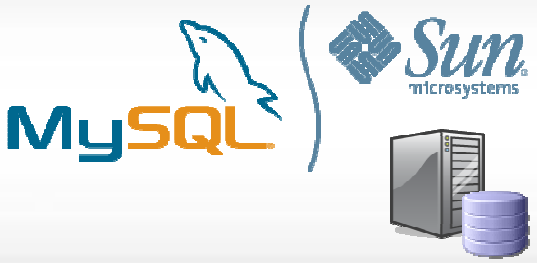

Monitoring

- Global Monitoring of All Servers
- Web-Based Central Console
- Built-in Advisors, Expert Advice
- Problem Query Detection/Analysis
- Specialized Scale-Out Help

Support

- Online Self help Knowledge Base
- 24 x 7 x 365 Problem Resolution
- Consultative Help
- High Availability and Scale Out

Sun's Recommended Solutions for MySQL

www.sun.com/mysqlsystems

X86 Performance ▪ Virtualization ▪ Backup

Multi-Tier Deployment ▪ Rich Media Storage

Questions?

Send them to
jimmy.guerrero@sun.com