Some studies in Firebird Performance

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About the speaker

I work for IBPhoenix providing technical support.

I maintain the windows installer for Firebird and do the Windows builds.
Introduction

- Using benchmarking to study performance in a multi-user environment.
- Does the improved multi-threading of Firebird 3 bring benefits?
- How do the different architectures compare in Firebird 3?
- Does database encryption sacrifice speed for security?
- Building a test harness
About the test harness

- Modest hardware.
- Largely isolated from outside interference
- It provides multi-user activity to exercise fb locking, cpu synchronisation, and memory and disc access.
- It isn’t designed to test internal features of Firebird.
- The main aim is to provide a stable platform. By changing one parameter at a time we can build a database of performance statistics to understand how different configurations impact on performance.
So, is FB3 faster than FB2.5?
Is FB 3.0 faster than Fb 2.5?

We seem to have a clear winner.
Firebird Configuration

- Each arch has had buffers optimised
  - SS uses 16K or 32K buffers
  - SC uses 2K buffers
  - CS uses 1K buffers
- Hash Slots for FB 2.5 were increased to 8191
- Page sizes of 8KB and 16KB were tested.
- Connection pools consisted of 5 to 15 users
Other Config Notes

- Test Harness configured for durability, not performance
- No attempts made to overload the system
- All tests are multi-user, but connections deliberately kept low.
- Defaults are used, except where specified.
Let's look at each architecture
And for Super Server

Super Server Face Off
Fb 3 is approx 27% faster overall

New Orders Per Min

FB25
FB30
SuperClassic

Super Classic Face Off

Fb 3 is approx 13% faster overall

New Orders Per Min

FB25
FB30

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About the tests

- The tests are built around tpc-c which has some limitations
- Can the benchmark be trusted?
- Can any benchmark be trusted?
- Important to understand limitations of a benchmark implementation
- Building a test harness and benchmark is quite expensive in development time and time required for subsequent analysis.
The limitations of TPC-C

- Too simple. Most real world applications are a lot more complex.
- Small records, no blobs, SPs, triggers
- Bad design (like a lot of databases :-) )
- Locking anomalies which distort consistency of results.
- Not representative of a typical firebird database (But what is?)
But it is not all bad….

- Tests, although imperfect, do place stress on Firebird and the underlying hardware.
- A benchmark app is only a small part of the test harness.
- More importantly, multiple tests can be run and the results stored for analysis.
- Hundreds of tests are executed. Thereby limiting the errors caused by anomalous test runs.
- Analysis of trends in the data should be valid. (I hope.)
Performance under Linux

FB 3.0 vs FB 2.5 Linux

Fb 3 is approx 29% faster overall

New Orders Per Min

FB25
FB30
And what about windows?

Hmmm…. Slightly worse than Linux
But maybe insufficient data?
OK, we get the picture.

- FB 3 is faster than FB 2.5
- Before you all die of boredom, let's dig deeper
3 different database sizes have been tested

- Small DB – fits easily into available ram. Takes full advantage of database and file system cache.
- Medium DB – too big to fit into memory, but lots of data is served from cache.
- Large DB – lots of cache misses.

These sizes are relative. For the tests:
- Small DB - ~ 1 GB
- Medium DB - ~10 GB
- Large DB - ~50 GB
Breakdown By Database Size

Analysis by DB size

New Orders Per Minute

DB Size - 1GB, 10 GB, 50 GB

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Performance drops heavily as database size increases

- What can be done to alleviate this?
What is the influence of Page Size on Database Size?

Note: Data derived from a meta analysis from FB2.5 tests
Page Size and Small databases
Page Size and Medium databases
Page Size and Large databases

![Graph showing new orders per minute and average transaction time for different page sizes. The graph compares 50 GB 4KB Page, 50 GB 8KB Page, and 50 GB 16KB Page, with higher values indicating better performance.](image-url)
Page Size - summary

- Page size can make a big difference
- avg txn times don’t match changes in page size
Using Benchmarking as a guide to server provisioning
Connections and user equivalents

- Connections in a multi-user benchmark are not equivalent to users.
- It is difficult to gauge equivalent number of concurrent users.
- It is more accurate to think of a connection pool.
- The pool must be sized for the hardware.
- Overloading the system kills performance.
- But SuperServer seems to support heavier loads in an overloaded system.
- My current test harness can only support a pool of 15 to 20 users.
Performance impact of different pool sizes

Sizing a connection pool - FB3

Sizing a connection pool FB2.5
Cost per connection
Pool sizing summary

- Choosing a smaller pool size for Large Dbs would make sense
- It would also be interesting to try much larger buffer sizes for a smaller number of connections
Reducing contention with LockHashSlots

- The LockHashSlots parameter can improve queueing for locks under heavy concurrent load.
- Default for LHS increased to 8191 in FB3, from 1009 in FB2.5
- How has this affected performance?
Hash Slots

![Bar chart showing Hash Slots by Server version with AVG New Orders Per Minute on the y-axis and Hash Slots by Server version on the x-axis. The chart includes data for FB25 1009, FB30 1009, FB25 8009, and FB30 8009.]
Database encryption

- Yep, there is a cost
- Avg txn times are ~15% slower for the encrypted LDB
- This cost is outweighed by overall perf improvement in FB3
Nbackup performance

- No hard data available. Testing Nbackup broke the server.
- Again db size is a major factor
- Small dbs are no problem

- I had hoped to test the following:
  - Difference between internal and external backup
  - Impact of backup on active Large Dbs
  - Is it quicker to take the database off-line to perform the backup?
Building a Test Harness

- All benchmarks are artificial.
- The only way to reliably benchmark your application is to build your own test harness.
- At least 2 computers required.
- Ideally no other activity should be running on the server, unless they are part of the test.
- The test app runs on the client and generates threads to simulate multi-user activity.
- The results are stored in a separate database.
Identify your workloads

- For example, in TPC-C there are five, related to new orders, payments, delivery, order and stock checking.
- Each workload is weighted for frequency. Roughly a third each for orders, payments and delivery (which all include writes). Just a few percent each for the status checks.
- These weights are configurable.
- Jobs are assigned to available connections according to the weighting.
- A certain percentage of workloads must fail (rollback).
Only test ONE thing at a time

- Each of the following is a single test
  - for OS in linux, windows
    - for FBVER in fb25, fb30
      - for ARCH in superclassic, classic, superserver
    - for DISC in ssd, hdd
      - for PAGE_SIZE in 4,8,16
    - for TERMINALS in 5,10,15,20 etc
- Obviously some of the above can be eliminated.
Before a test session starts

- Database is swept.
- Gstat -r is run (and results saved.)
Track the results

As each txn completes some info is stored
- Type of workload
- Success or failure
- Update of min, average and max txn times
When the session finishes

- Lots of data is saved into the results database…
- Benchmark configuration
- Stats from MON$DATABASE
- Number of TXNs executed
- App specific stats such as New Orders placed.
- Gstat -r is run to see how much garbage has built up in the db. In the event of anomalies we can compare with the gstat -r from before the session starts.
About the results database

• Obviously some views and stored procedures are added to aid analysis

• Important to store as much data about a test run as possible, so that trends can be identified and questions answered that hadn’t been thought of when the project started.
Conclusions

- Benchmarks are about as reliable as the weather forecast.
- Sometimes they are correct.
- Firebird 3 would seem to be faster than Firebird 2.5 if we can believe this benchmark.
- In a multi-user environment changing one parameter has side effects if other factors change.
- The only reliable benchmark is your own app running on your own test harness. (And even then...)
Questions?