Some studies in Firebird Performance

Paul Reeves
IBPhoenix

mail: preeves at ibphoenix.com

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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.

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Introduction

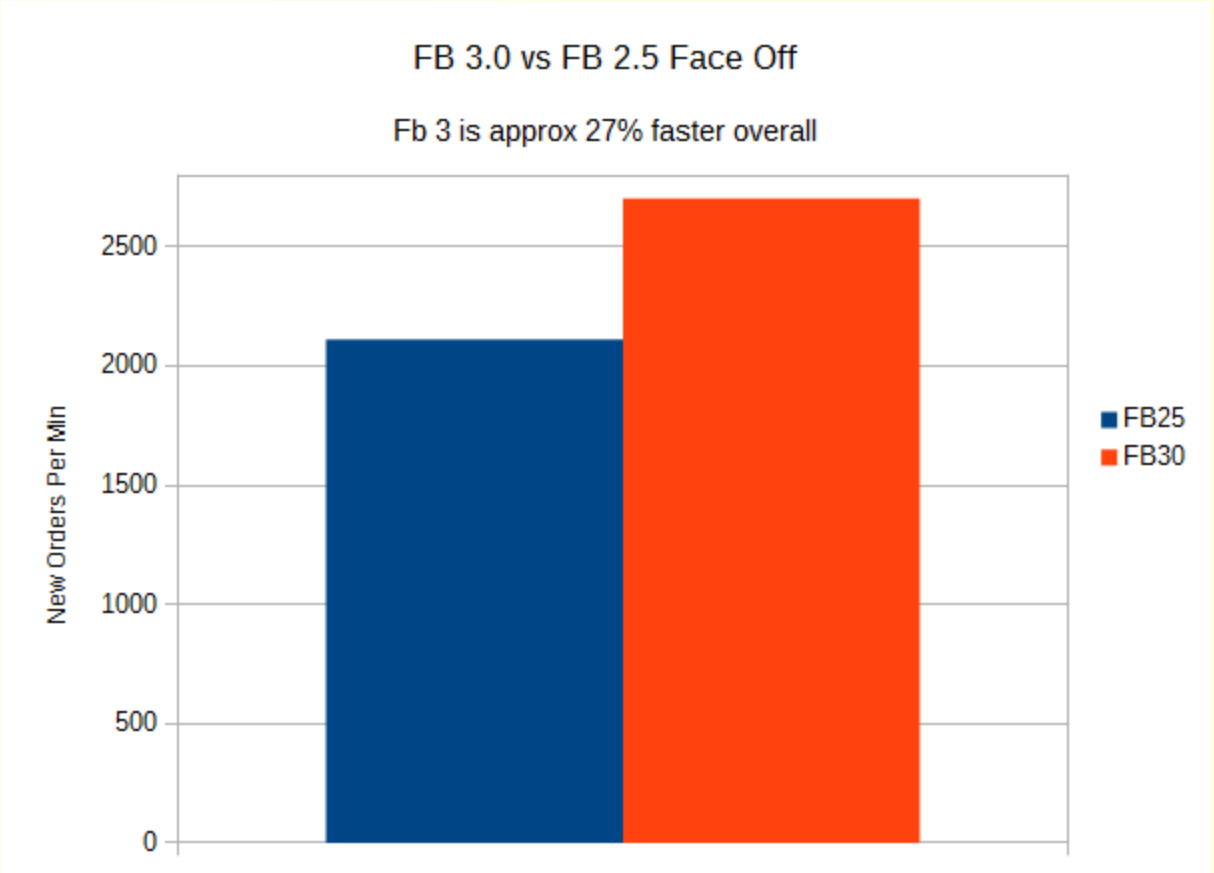
- Using benchmarking to study performance in a multi-user environment.
- Does the improved multi-threading of Firebird 3 bring benefits ?
- How do the different architectures compare in Firebird 3?
- Does database encryption sacrifice speed for security ?
- Building a test harness

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

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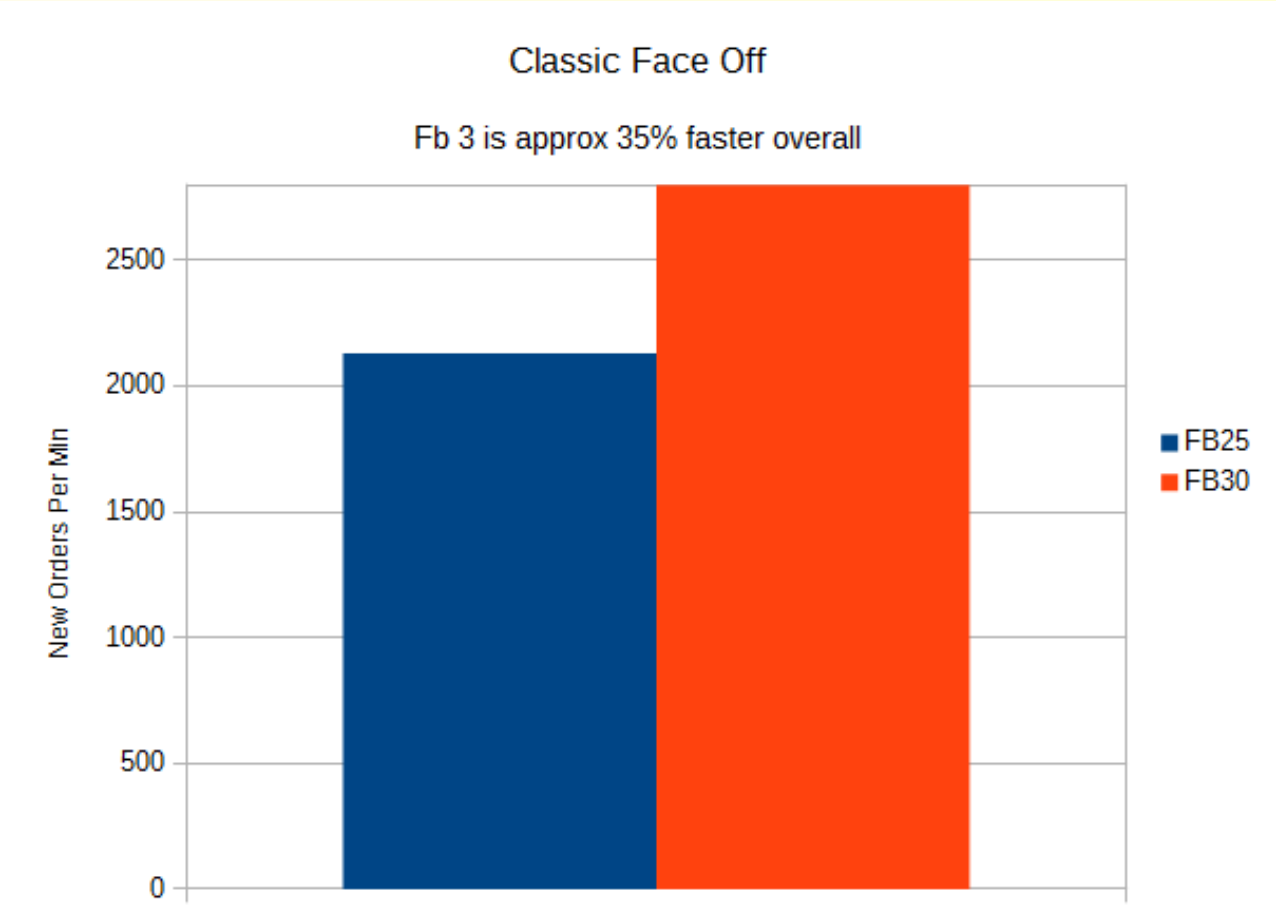
Firebird Configuration

- 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 de-liberately kept low.
- Defaults are used, except where specified.

Let's look at each architecture



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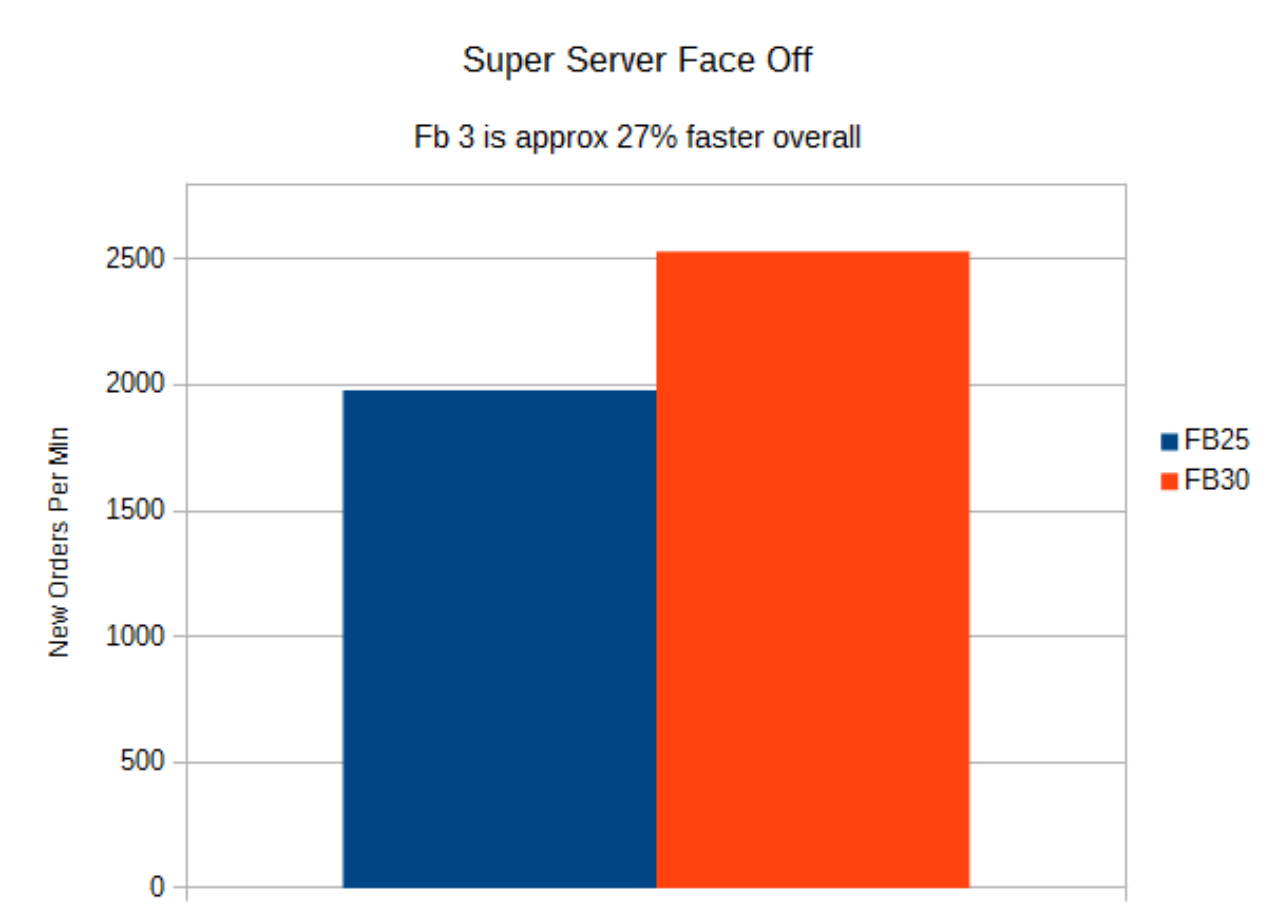
And for Super Server



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SuperClassic

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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.

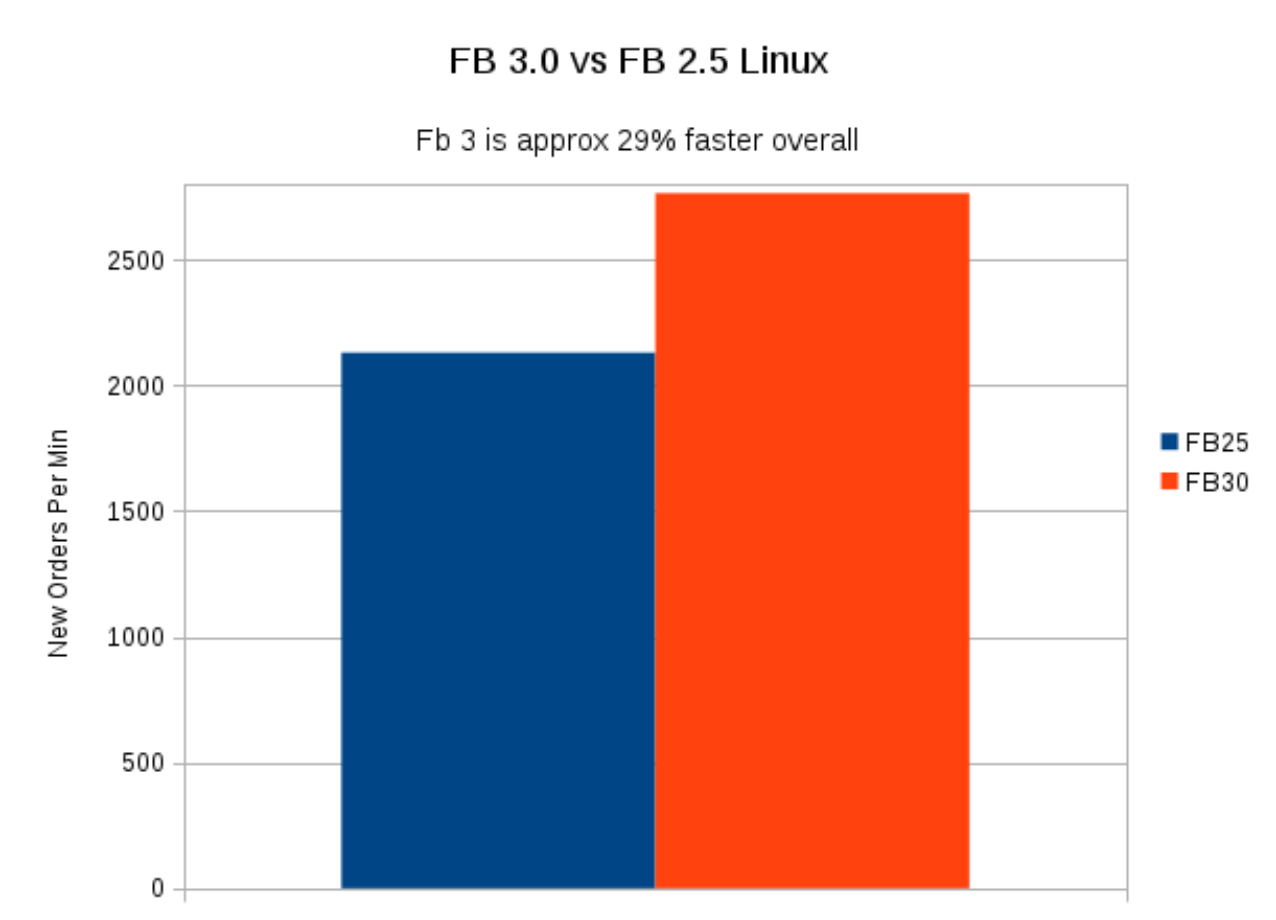
The limitations of TPC-C

- 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



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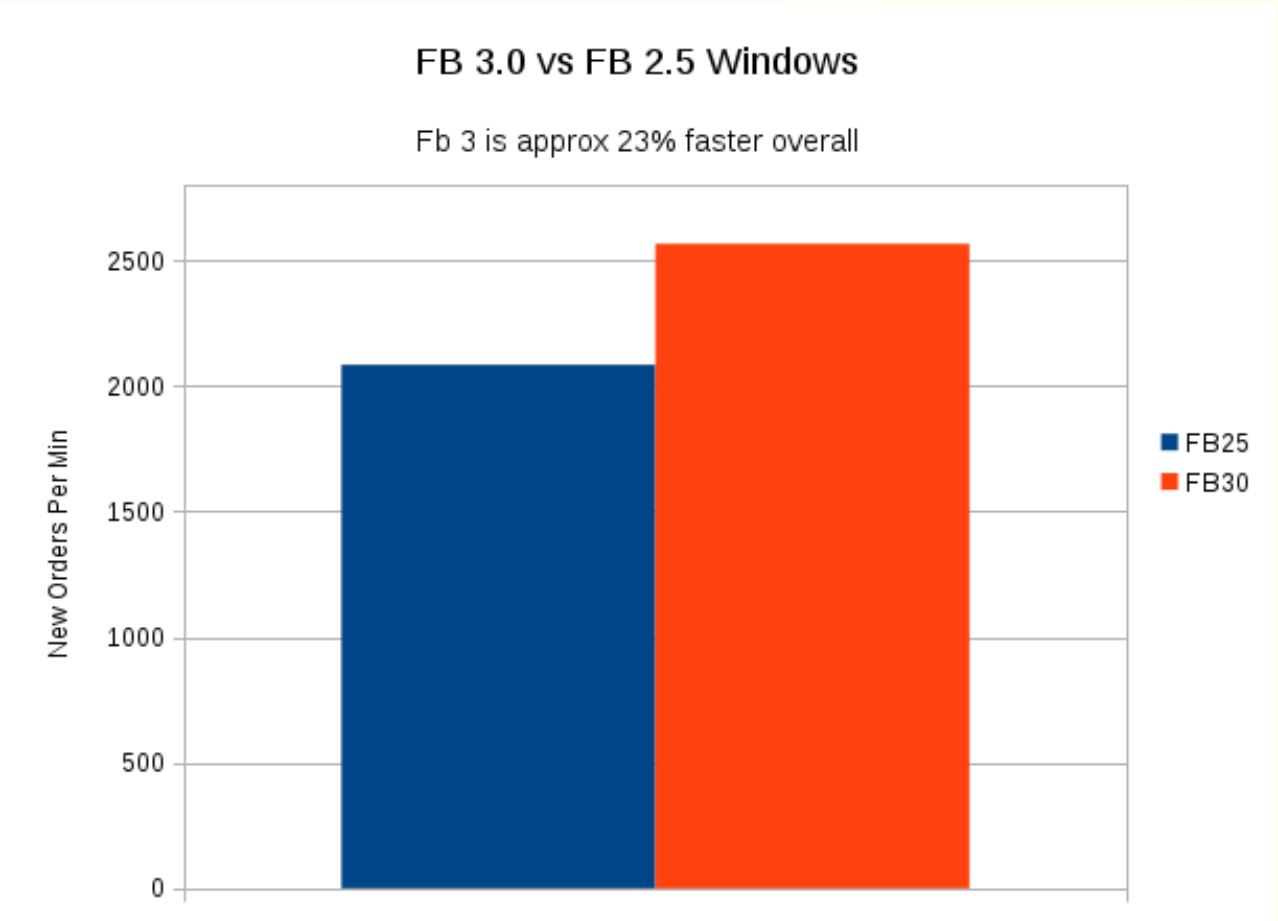
And what about windows?



- Hmmm…. Slightly worse than Linux
- But maybe insufficient data?

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OK, we get the picture.

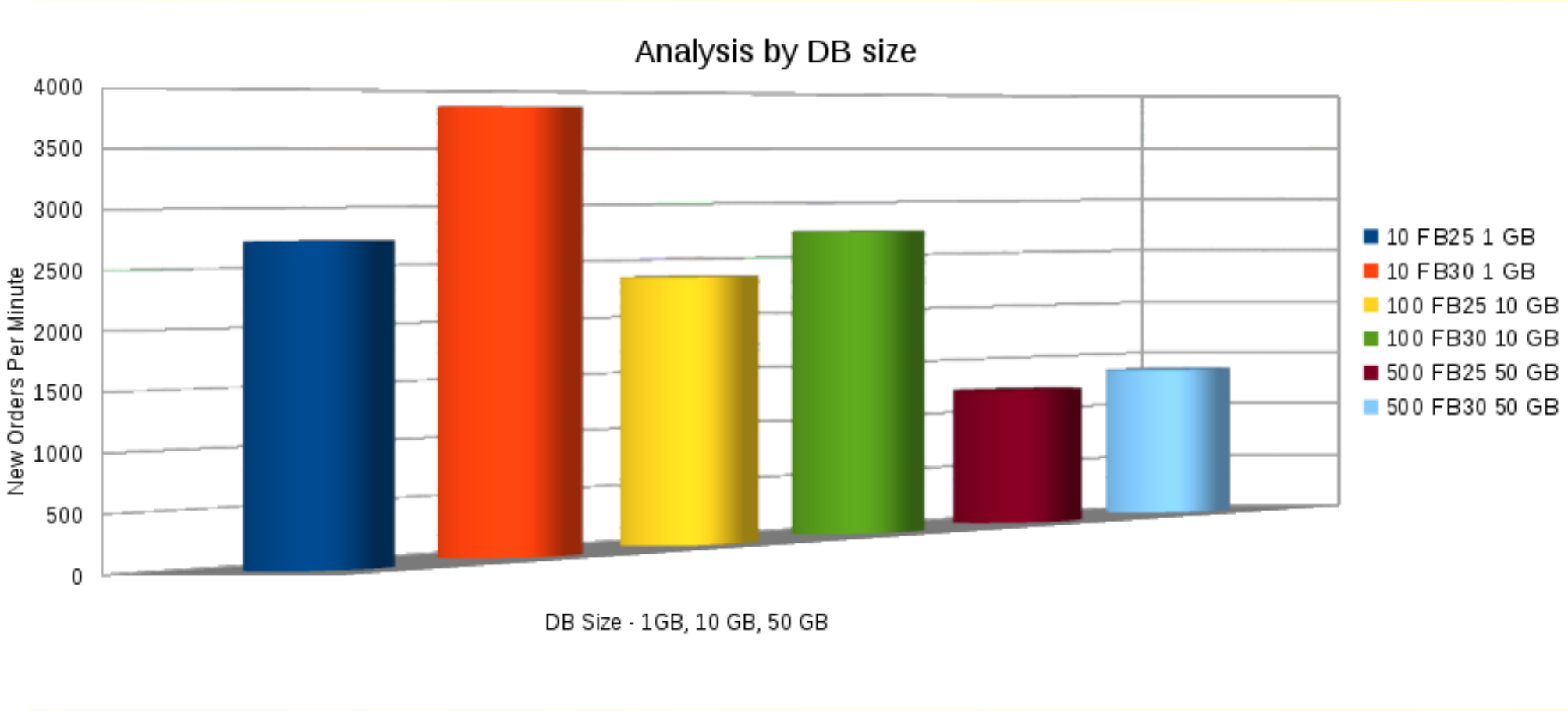
- FB 3 is faster than FB 2.5
- Before you all die of boredom, let's dig deeper

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



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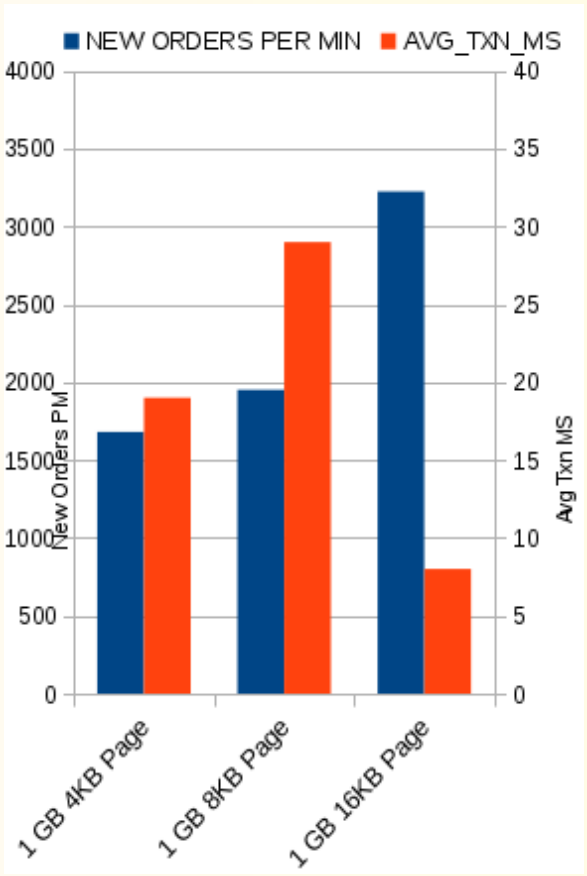
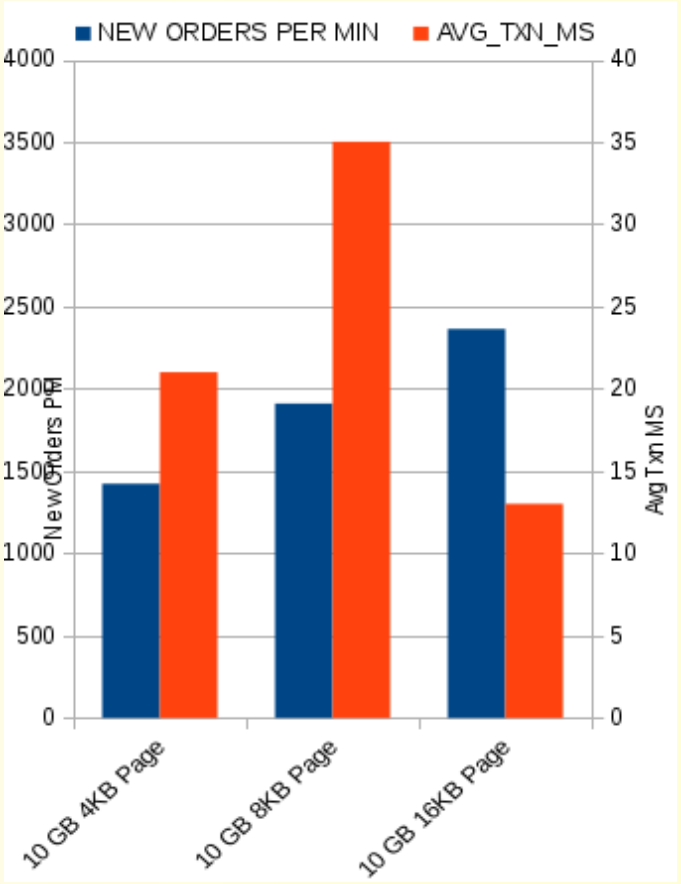
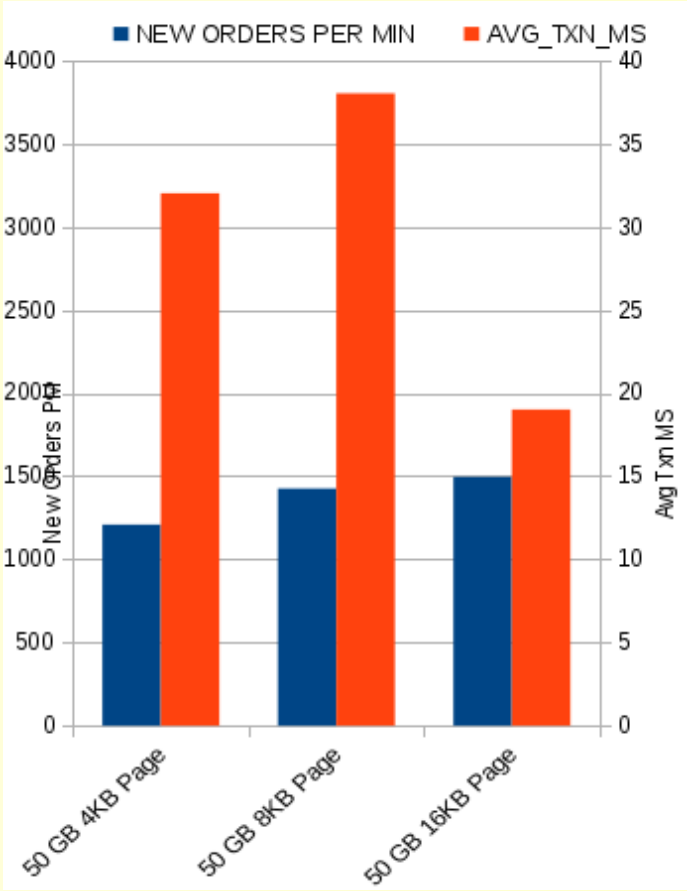
Performance drops heavily as data-base size increases

- 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

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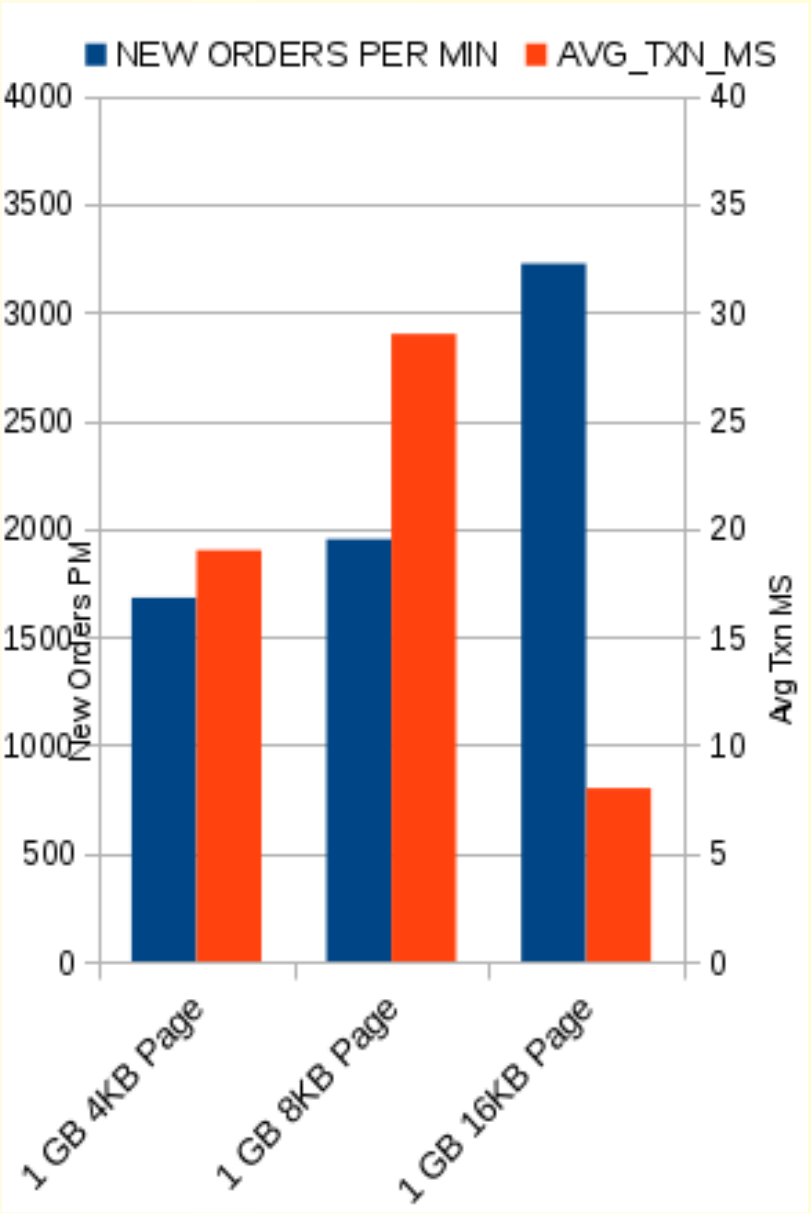
Page Size and Small databases



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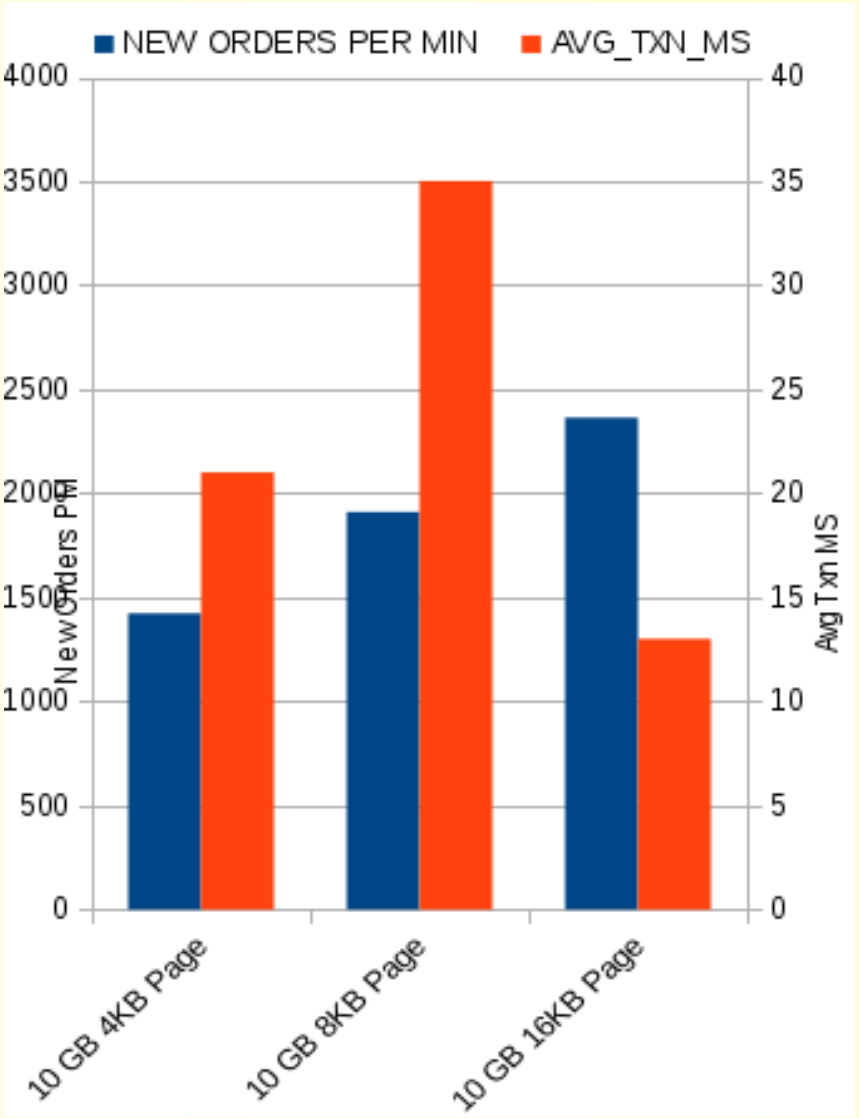
Page Size and Medium databases



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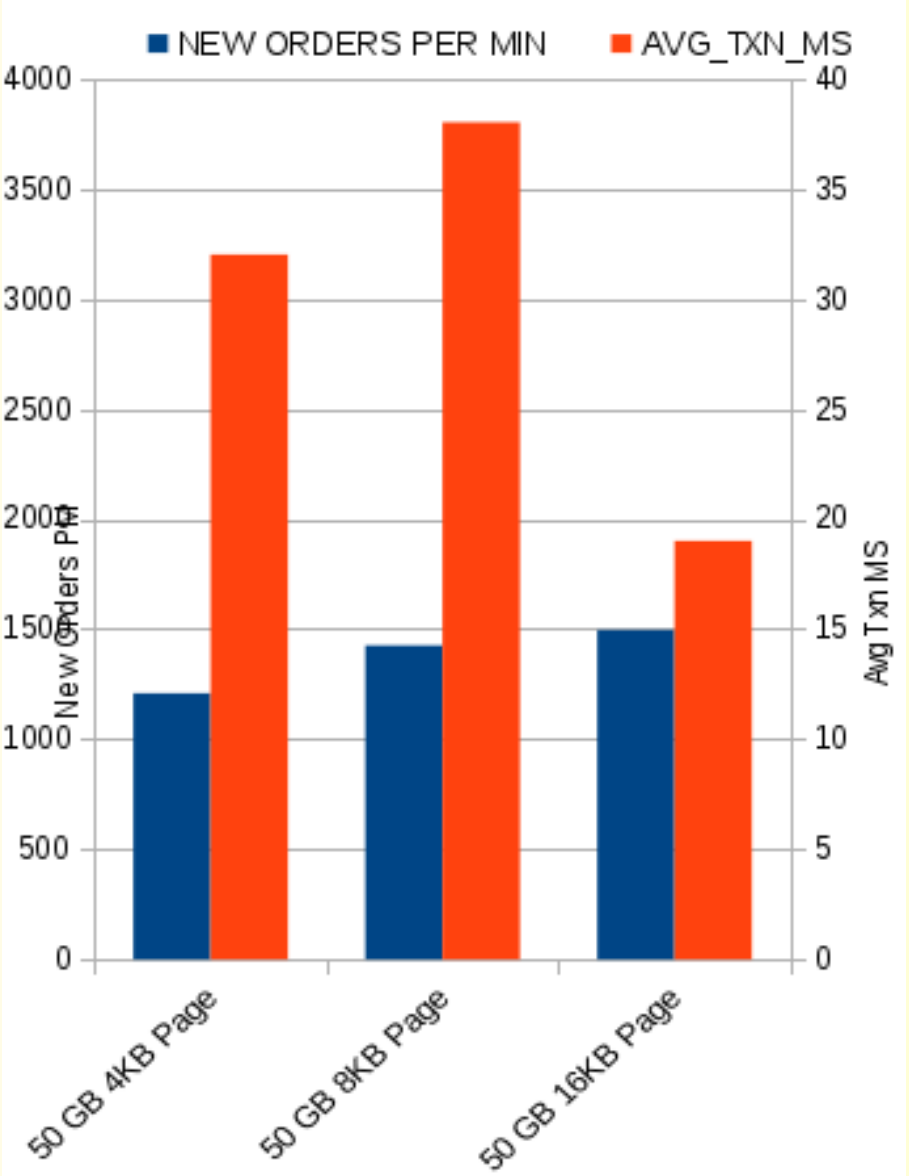
Page Size and Large databases



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Page Size - summary

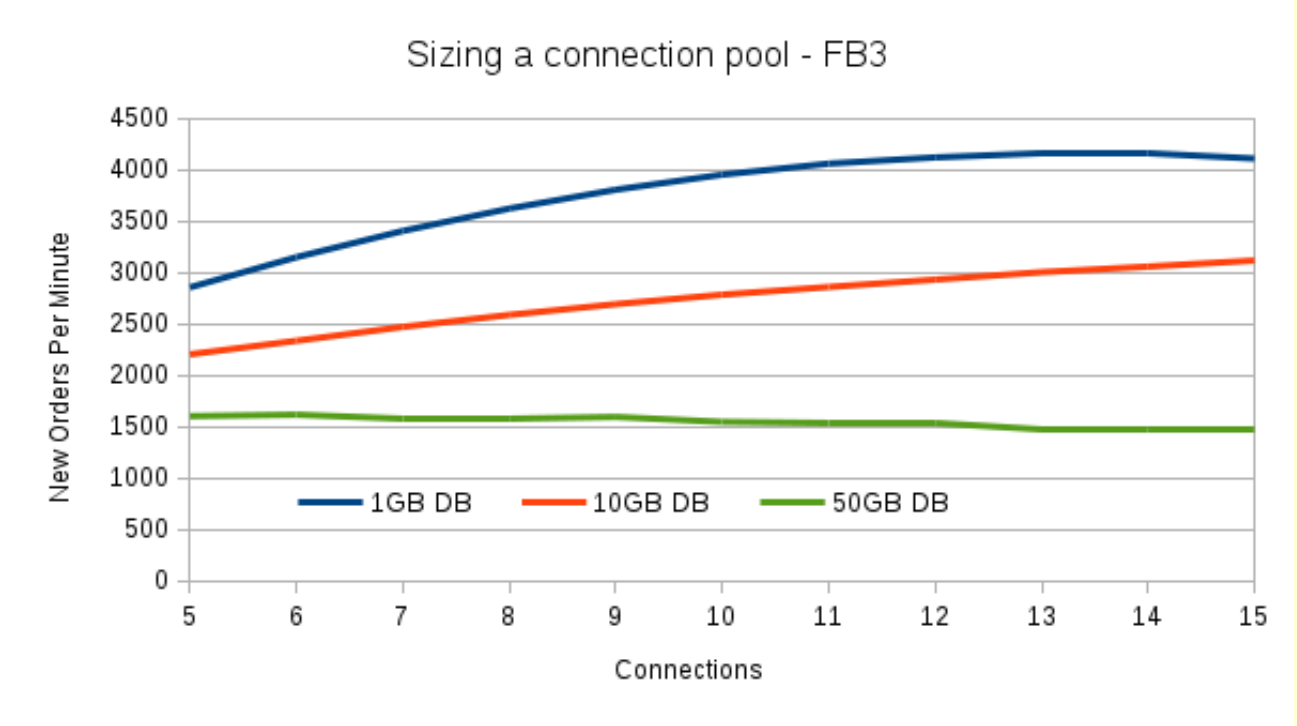
- Page size can make a big difference
- avg txn times don’t match changes in page size

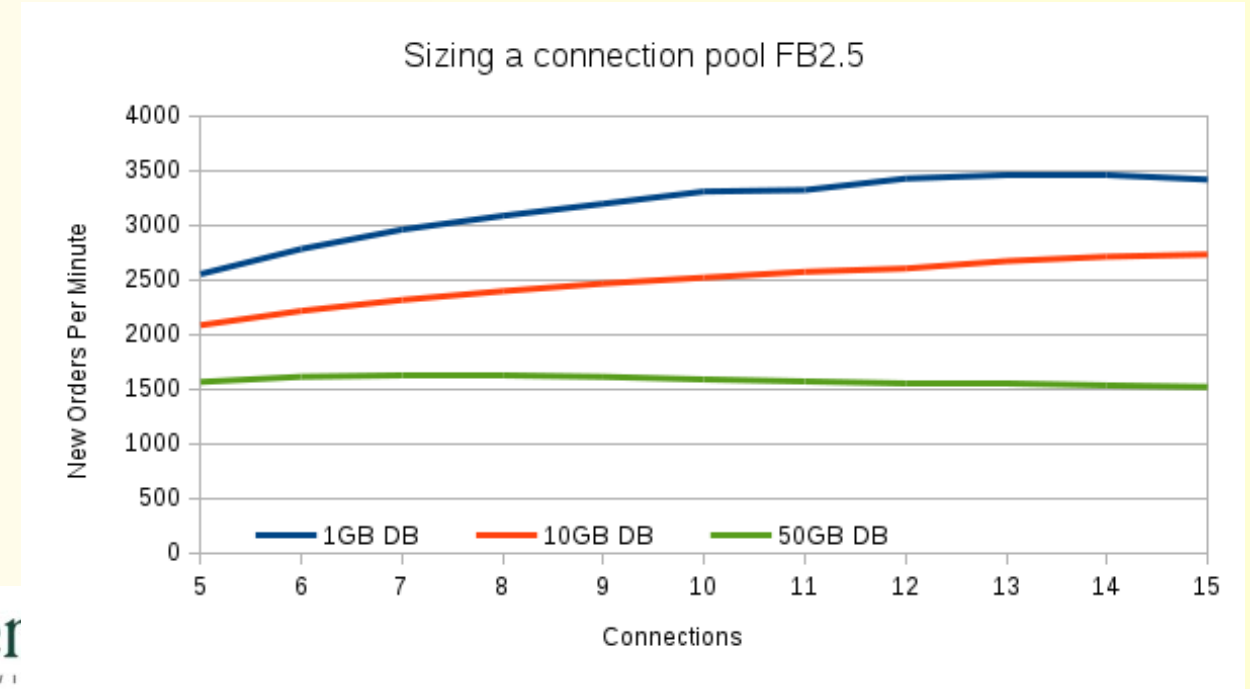
Using Benchmarking as a guide to server provisioning

Connections and user equivalents

- Connections in a multi-user benchmark are not equivalent to users.
- It is difficult to gauge equivalent number of con-current 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





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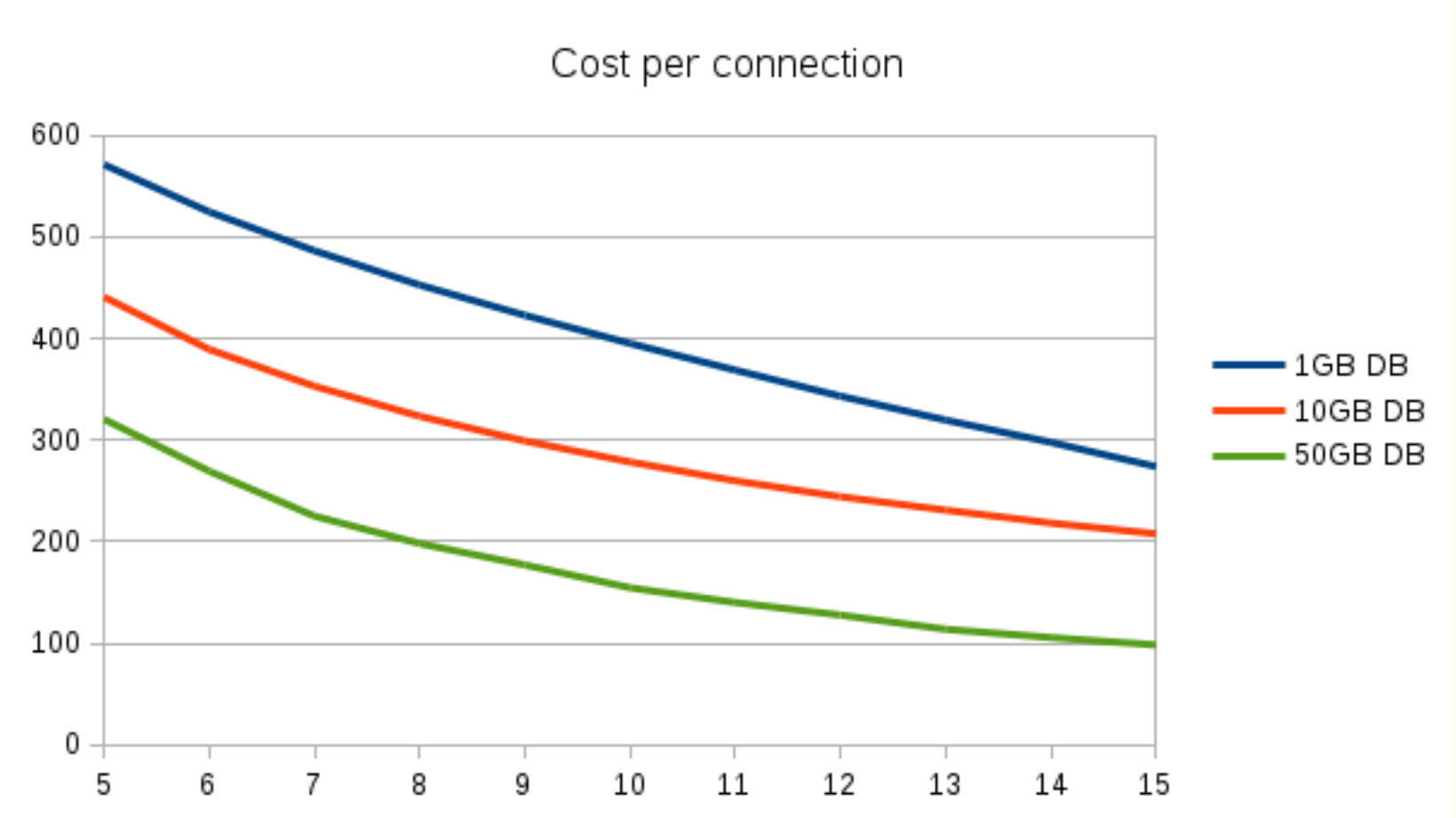
Cost per connection



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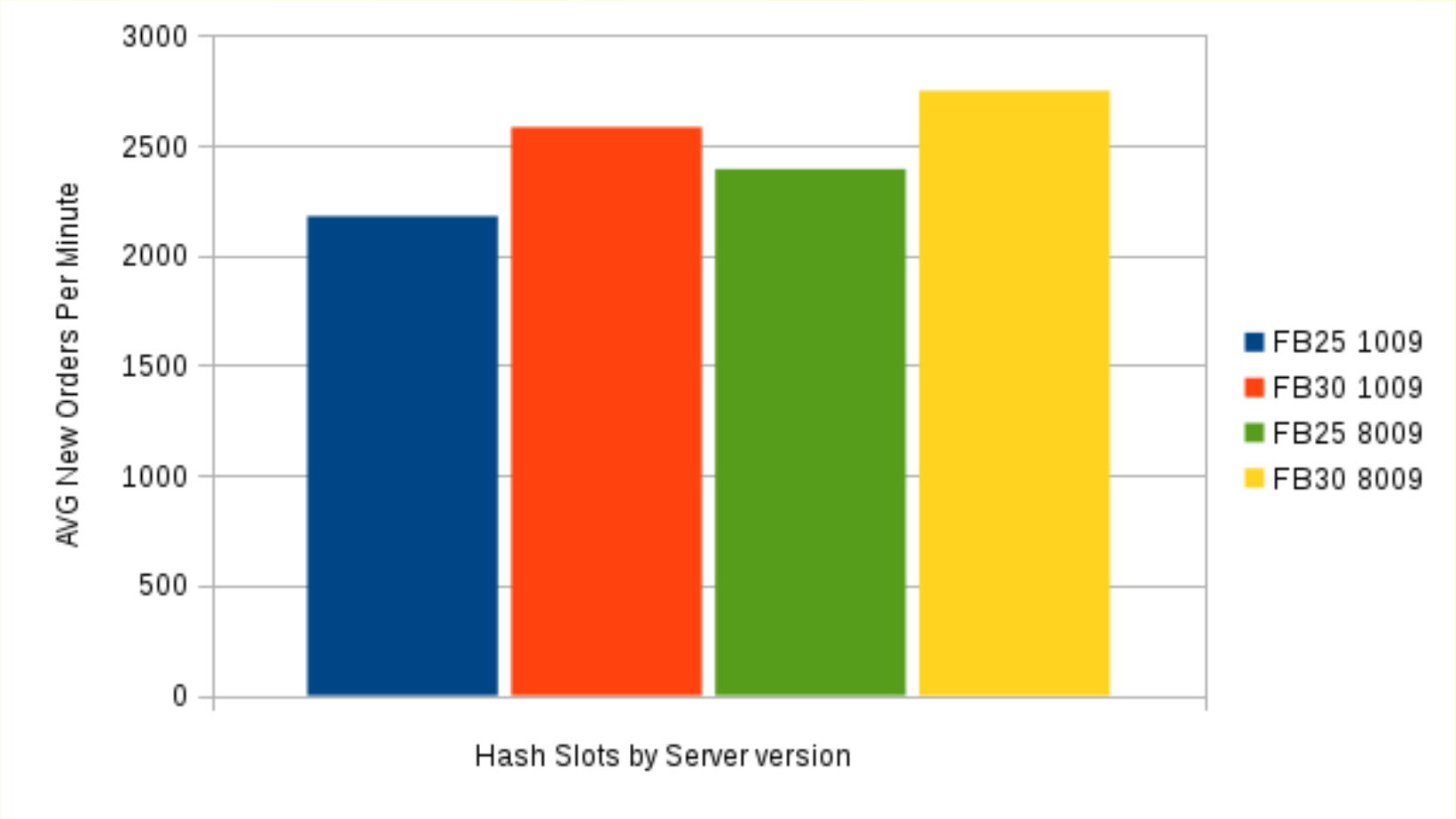
Pool sizing summary

- 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



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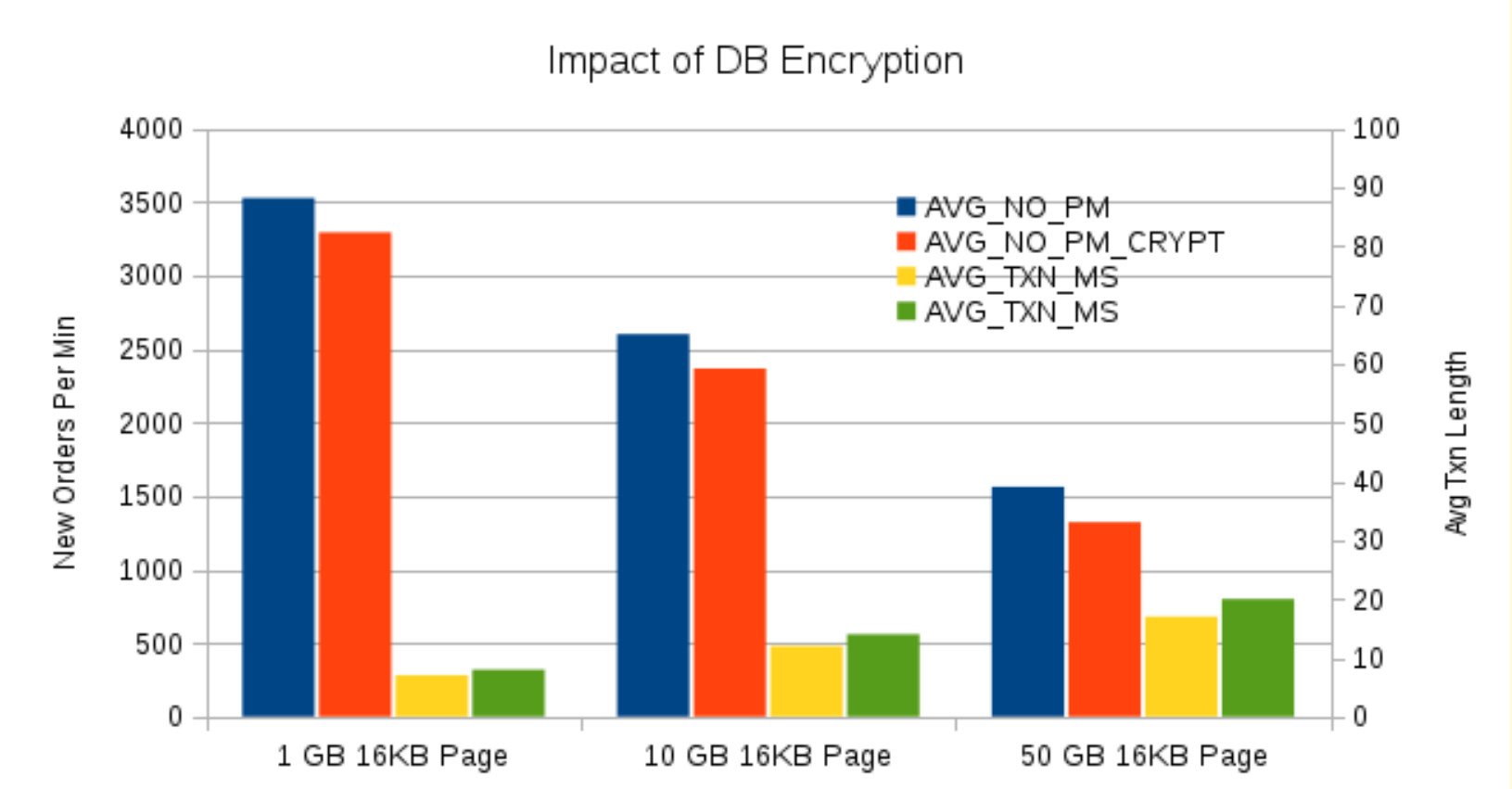
Database encryption



- 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

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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 elim-inated.

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?