MongoDB Performance Tuning

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MongoDB performance ~~tuning~~ Obsession

- Performance planning
- Order matters:
  1. Schema design
  2. Statement tuning
  3. Instance tuning

- Single server performance
- Not a single thing you do, it's an obsession
- Rinse and repeat
- **Understand *your* database workload**

Statement Tuning

- Profiler
  - Tuning tool/process to capture statements against db into a collection
  - Use regular queries to mine and prioritize tuning opportunities
  - Sometimes you can understand what to tune from this output alone, sometimes you need to explain it.

- Explain
  - Take statement from profiler, explain it
  - Gives detailed execution data on the query or statement
  - Interpret output, make changes
  - Rinse/Repeat

The MongoDB Profiler

- Data is saved in capped collections, 1 per shard
  - db.system.profile
- Turn it on, gather data, later analyze for tuning opportunities
  - db.setProfilingLevel(1,20)
  - db.getProfilingStatus()
  - 1 document per statement
  - show profile
  - db.system.profile.find()
  - leave it on, don't be scared.
- Use new Aggregation Framework
  - Allows for aggregated queries from loads of data
  - Examples: https://gist.github.com/995a3aa5b35e92e5ab57

Example

```
// simple profiler queries
// slowest
> db.system.profile.find({"millis":{$gt:20}})

// in order they happened, last 20
> db.system.profile.find().sort({$natural:-1}).limit(20)

// only queries
> db.system.profile.find().sort({"op":"query"})
```

- problem: lots of data!

Example

```
// use aggregation to differentiate ops
> db.system.profile.aggregate({ $group : { _id :"$op",
        count:{$sum:1},
        "max response time":{$max:"$millis"},
        "avg response time":{$avg:"$millis"}
}});
{
        "result" : [
                { "_id" : "command", "count" : 1, "max response time" : 0, "avg response time" : 0 },
                { "_id" : "query", "count" : 12, "max response time" : 571, "avg response time" : 5 },
                { "_id" : "update", "count" : 842, "max response time" : 111, "avg response time" : 40 },
                { "_id" : "insert", "count" : 1633, "max response time" : 2, "avg response time" : 1 }
        ],
        "ok" : 1
}
```

- contrast how many of an item vs response time
- contrast average response time vs max
- prioritize op type

Example

```
// use aggregation to differentiate collections
>db.system.profile.aggregate(
  {$group : { _id :"$ns", count:{$sum:1},  "max response time":{$max:"$millis"},
                    "avg response time":{$avg:"$millis"}  }},
   {$sort: { "max response time":-1}}
 );
{
   "result" : [
        { "_id" : "game.players","count" : 787, "max response time" : 111, "avg response time" : 0},
        {"_id" : "game.games","count" : 1681,"max response time" : 71, "avg response time" : 60},
        {"_id" : "game.events","count" : 841,"max response time" : 1,"avg response time" : 0},
        ....
],
         "ok" : 1
}
```

- keep this data over time!
- contrast how many of an item vs response time
- contrast average response time vs max
- more examples: https://gist.github.com/995a3aa5b35e92e5ab57

Profiler Attributes

- fastMod
  - Good! Fastest possible update. In-place atomic operator ($inc,$set)
- nretunred vs nscanned
  - If nscanned != nscannedObjects, you may have opportunity to tune.
  - Add index
- key updates
  - Secondary indexes. Minimize them
  - 10% reduction in performance for each secondary index
- moved
  - Documents grow > padding factor
  - You can't fix it other than to pad yourself manually
  - Has to update indexes too!
  - db.collection.stats() shows padding
  - https://jira.mongodb.org/browse/SERVER-1810 <-- vote for me!
  - ^---- 2.3.1+ usePowerOf2Sizes

Example

```
{
        "ts" : ISODate("2012-09-14T16:34:00.010Z"),        // date it occurred
        "op" : "query",                                    // the operation type
        "ns" : "game.players",                             // the db and collection
        "query" : { "total_games" : 1000 },                // query document
        "ntoreturn" : 0,                                   // # docs returned
        "ntoskip" : 0,
        "nscanned" : 959967,                               // number of docs scanned
        "keyUpdates" : 0,
        "numYield" : 1,
        "lockStats" : { ... },
        "nreturned" : 0,                                   // # docs actually returned
        "responseLength" : 20,                          // size of doc
        "millis" : 859,                                    // how long it took
        "client" : "127.0.0.1",                            // client asked for it
        "user" : ""                                        // the user asking for it
}
```

Example

```
{     "ts" : ISODate("2012-09-12T18:13:25.508Z"),
       "op" : "update",                                          // this is an update
       "ns" : "game.players",
       "query" : {"_id" : { "$in" : [ 37013, 13355 ] } },        // the query for the update
       "updateobj" : { "$inc" : { "games_started" : 1 }},        // the update being performed
       "nscanned" : 1,
       "moved" : true,                                           // document is moved
       "nmoved" : 1,
       "nupdated" : 1,
       "keyUpdates" : 0,                                  // at least no secondary indexes
       "numYield" : 0,
       "lockStats" : { "timeLockedMicros" : { "r" : NumberLong(0),"w" : NumberLong(206)},
              "timeAcquiringMicros" : {"r" : NumberLong(0),"w" : NumberLong(163)}},
       "millis" : 0,
       "client" : "127.0.0.1",
       "user" : ""
}
```

Example

```
{
        "ts" : ISODate("2012-09-12T18:13:26.562Z"),
        "op" : "update",
        "ns" : "game.players",
        "query" : {"_id" : { "$in" : [ 27258, 4904 ] } },
        "updateobj" : { "$inc" : { "games_started" : 1}},
        "nscanned" : 40002,                                    // opportunity
        "moved" : true,                                        // opportunity
        "nmoved" : 1,
        "nupdated" : 1,
        "keyUpdates" : 2,                                  // opportunity
        "numYield" : 0,
        ....
```

Statement Tuning

- Take any query when you build your app, explain it before you commit!
- Take profiler data, use explain() to tune queries.
  - Use prioritized list you built from profiler
  - Copy/paste into explain()
- Runs query when you call it, reports the plan it used to fulfill the statement
  - use limit(x) if it's really huge
- Attributes of interest:
  - nscanned vs nscannedObjects
  - nYields
  - covered indexes; what is this?
  - data locality (+ covered indexes FTFW)
- Sharding has extra data in explain() output
  - Shards attribute
    - How many Shards did you visit?
    - Look at each shard, they can differ! Some get hot.
    - Pick good keys or you will pay

Example

```
> db.games.find({ "players" : 32071 }).explain()
{
        "cursor" : "BtreeCursor players_1",
        "isMultiKey" : true,                                    // multikey type indexed array
        "n" : 1,                                                // 1 doc
        "nscannedObjects" : 1,
        "nscanned" : 1,                                         // visited index
        "nscannedObjectsAllPlans" : 1,
        "nscannedAllPlans" : 1,
        "scanAndOrder" : false,
        "indexOnly" : false,
        "nYields" : 0,                                          // didn't have to yield
        "nChunkSkips" : 0,
        "millis" : 2,                                           // fast
        "indexBounds" : {"players" : [ [ 32071, 32071 ] ] },    // good, used index
}
```

Example

```
// index only query
>db.events.find({ "user_id":35891},{"_id":0,"user_id":1}).explain()
{
        "cursor" : "BtreeCursor user_id_1",
        "isMultiKey" : false,
        "n" : 2,                                        // number of docs
        "nscannedObjects" : 2,
        "nscanned" : 2,
        "nscannedObjectsAllPlans" : 2,
        "nscannedAllPlans" : 2,
        "scanAndOrder" : false,                         // if sorting, can index be used?
        "indexOnly" : true,                             // Index only query
        "nYields" : 0,
        "nChunkSkips" : 0,
        "millis" : 0,
        "indexBounds" : { "user_id" : [ [ 35891, 35891 ] ] },
}
```

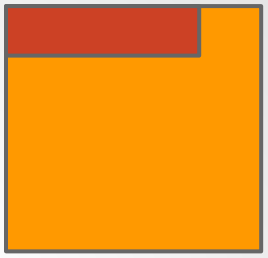
Data locality

query: db.mytest.find({"user_id":10}).count() = 3

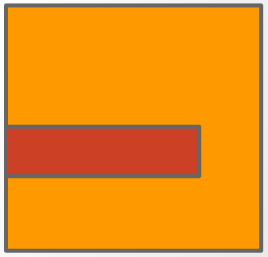
document; user_id:10

data block

bad!



good!



- No index organized collections... so...
- Control process that inserts the data (queue/etc)
- Perform reorgs (.sort()) on slaves then promote
- Schema design
- Bad data locality plus a cache miss are asking for trouble
- Update+Move reduce good data locality (very likely)
- Indexes naturally have good data locality!

Example;
Data Locality

```
> var arr=db.events.find(
      {"user_id":35891},
      {'$diskLoc':1, 'user_id':1}).limit(20).showDiskLoc()
> for(var i=0; i<arr.length(); i++) {
      var b=Math.round(arr[i].$diskLoc.offset/512);
      printjson(arr[i].user_id+" "+b);
      }

"35891 354"
"35891 55674"                    // what is this stuff?
```

examples at:
https://gist.github.com/977336

Instance tuning; Write performance

- Overall system performance function of write performance
- Partition systems, functional split first. Group by common workloads.
- Writes
  - Tune your writes!
    - fastMods where we can
    - Turn updates into inserts?
    - Secondary indexes checked?
  - Single writer lock in mongodb
    - Modified in 2.0+ for yield on fault
    - Modified in 2.2+ for lock scope per DB
    - All databases mutex; get over it.
    - Minimize time that writes take; you win
  - Lock %, write queues
  - Use bench.py to test your write performance (https://github.com/memsql/bench)
  - Write tuned I/O; Caches, SSD, etc
  - Sharding? Split **then** Shard
    - Balancer induces I/O and writes!

Instance tuning;
Read performance

- Overall system performance function of write performance
- Reads scale well as long as writes are tuned
- Partition systems, split first. Group by common workloads.
- Reads scale nicely, especially against slaves
  - inconsistency OK?
  - Know your workload!
- Statements tuned
  - Using indexes
  - Covered indexes
  - Data locality
- Sharding
  - See how I mentioned that last?

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https://www.objectrocket.com
https://github.com/kgorman/rocketstat