MongoDB I/O Access Patterns are under the Microscope

Abdulqawi Saif, Lucas Nussbaum, Ye-Qiong Song

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I. Context

- *MongoDB* is a **document-based *NoSQL*** database
- *NoSQL* databases store **semi-structured and/or unstructured data**
- We need to **create indexes** to optimize querying data
- Based on certain industry reports, ***MongoDB* takes unjustified time to create indexes over a pre-stored data**
- Benchmarks report **high-level results** in general, they also use synthetic data ($\neq$ in-production data)

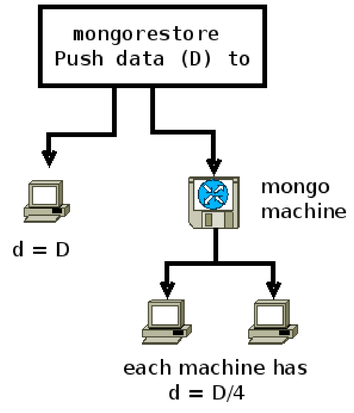
II. Objectives

- **Investigation on creating indexes** by *MongoDB*
- Introducing **new experimental methods** that could go beyond benchmarking high-level results

III. Experimental settings

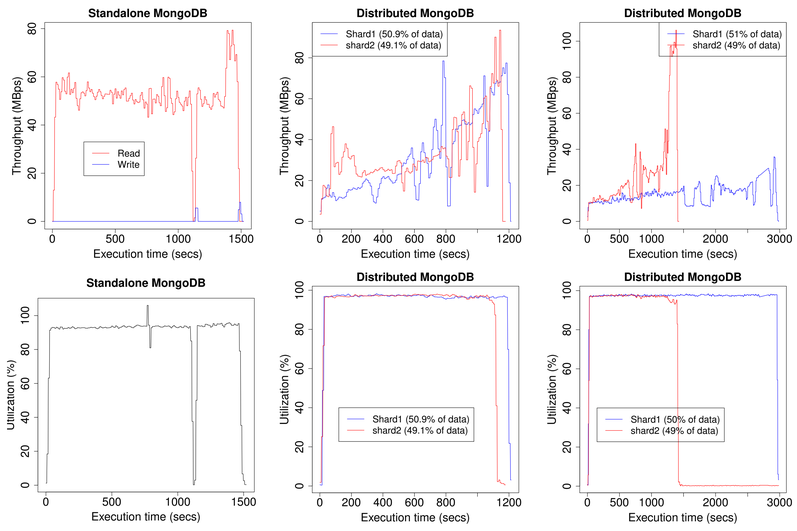
- A data set of **20 million doc.** is created; about 71 *GB*

- Experiments are performed on **Grid'5000 testbed**
- Ubuntu 14.04, Linux 4.9.13
- Tests are performed on **one HDD per machine**
- *MongoDB V3.4*, replicas are disabled, hash sharding, sharding on $\_id_s$
- *MongoDB* storage engine (WT) stores each collection on a **separate file**



Worklaod: try to index a simple field (int)
Experimental scenarios

IV. Performance results



Standalone throughput & disk util. Two shards throughput & disk util. Two shards (another execution)

- **Data distribution is poorly done** by *MongoDB*
- Every Shard uses a **different plan** for accessing data

How to get the main raison behind these results?

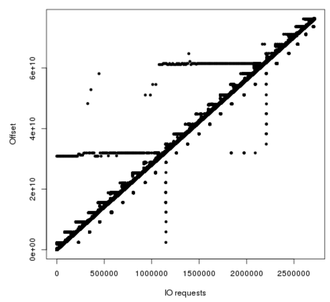
V. extended Berkeley Packet Filter (*eBPF*)

- It is a recent **dynamic tracing technique** in *Linux*
- It could connect to **all *Linux* data sources**
- Very negligible overhead (4 ns per syscall)
- **Fits with systems in production**

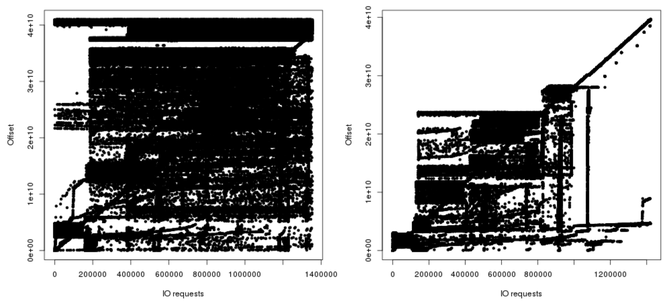
An *eBPF* tool is built to evaluate the I/O access patterns:

- A **generic tool**, could be used by other systems
- It traces **all I/O requests**
- It reports **offsets, request latencies & data size**
- Its results could be filtered by **accessed files**

VI. I/O access patterns using *eBPF*



I/O access pattern on standalone



Tow shards I/O access patterns (Every shard has 50% of data

VII. Conclusion

- A **performance study on *MongoDB*** I/O access pattern is done
- A **generic *eBPF* tool for testing I/O access patterns** is developed
- A new **experimental method to go beyond benchmarking results** is introduced

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