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MongoDB I/O Access Patterns are under the Microscope

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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 (≠ in-production data)

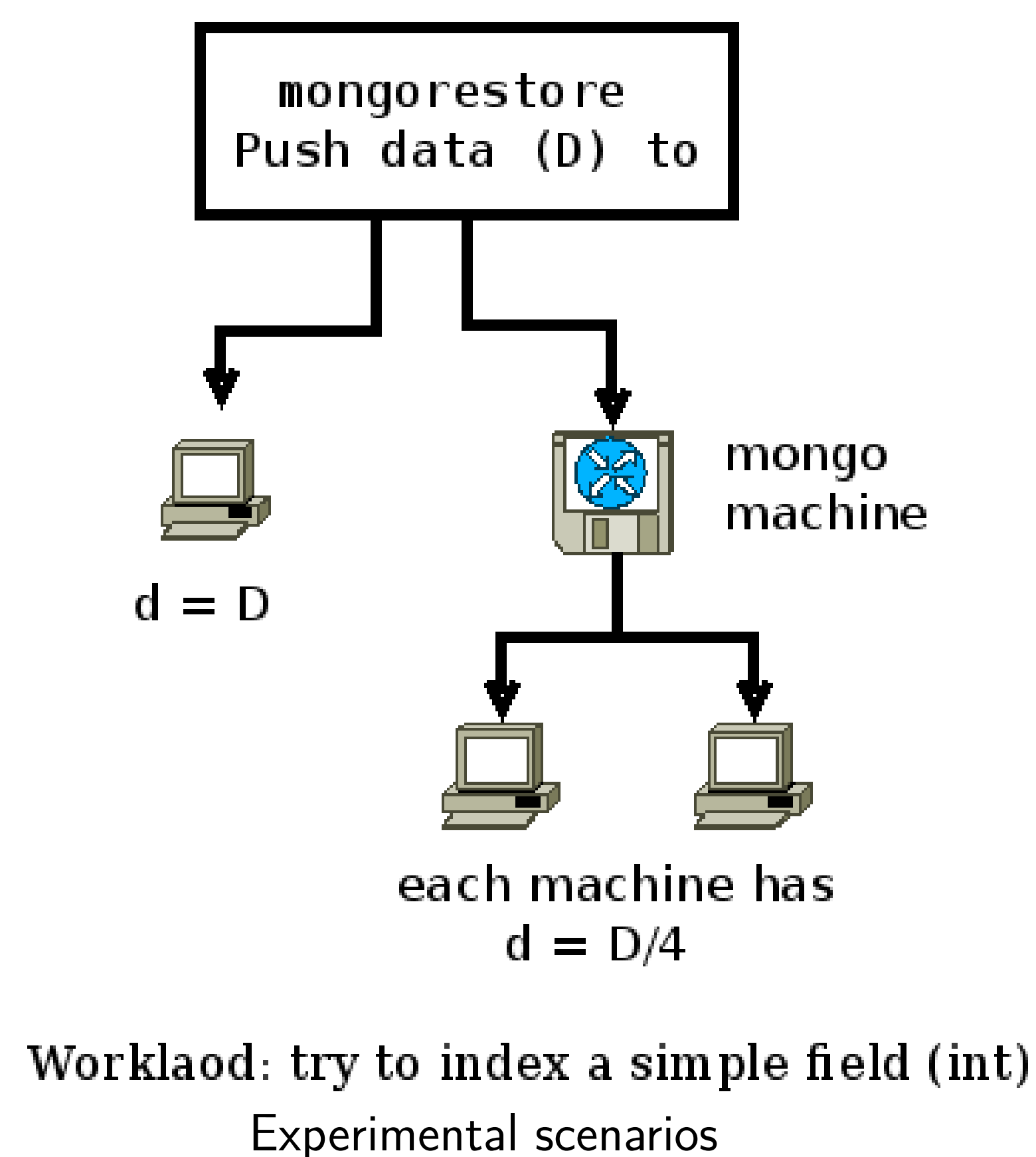
II. Objectives

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

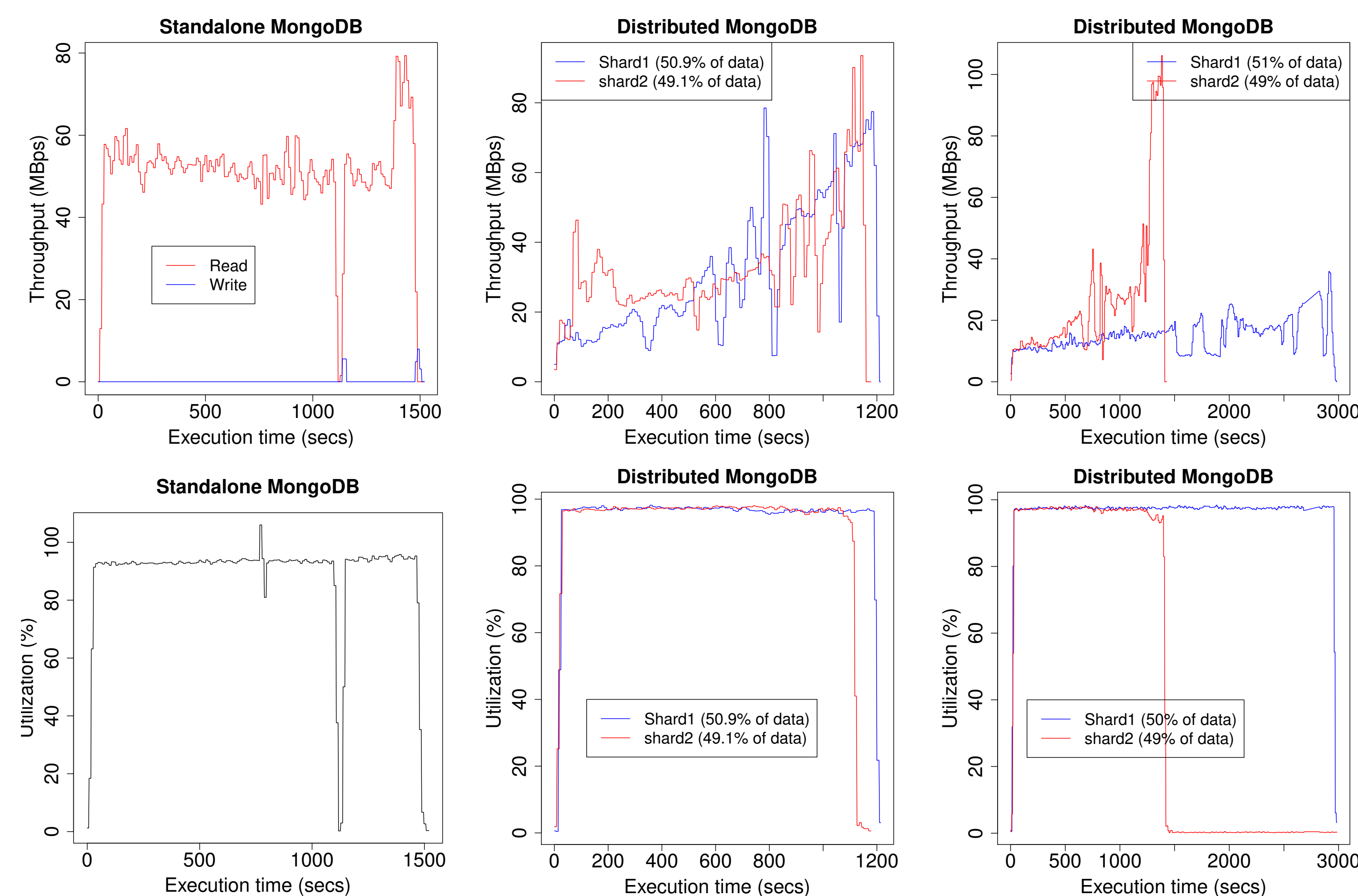
III. Experimental settings

- ▶ 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 `_ids`
- ▶ *MongoDB* storage engine (WT) stores each collection on a **separate file**



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?

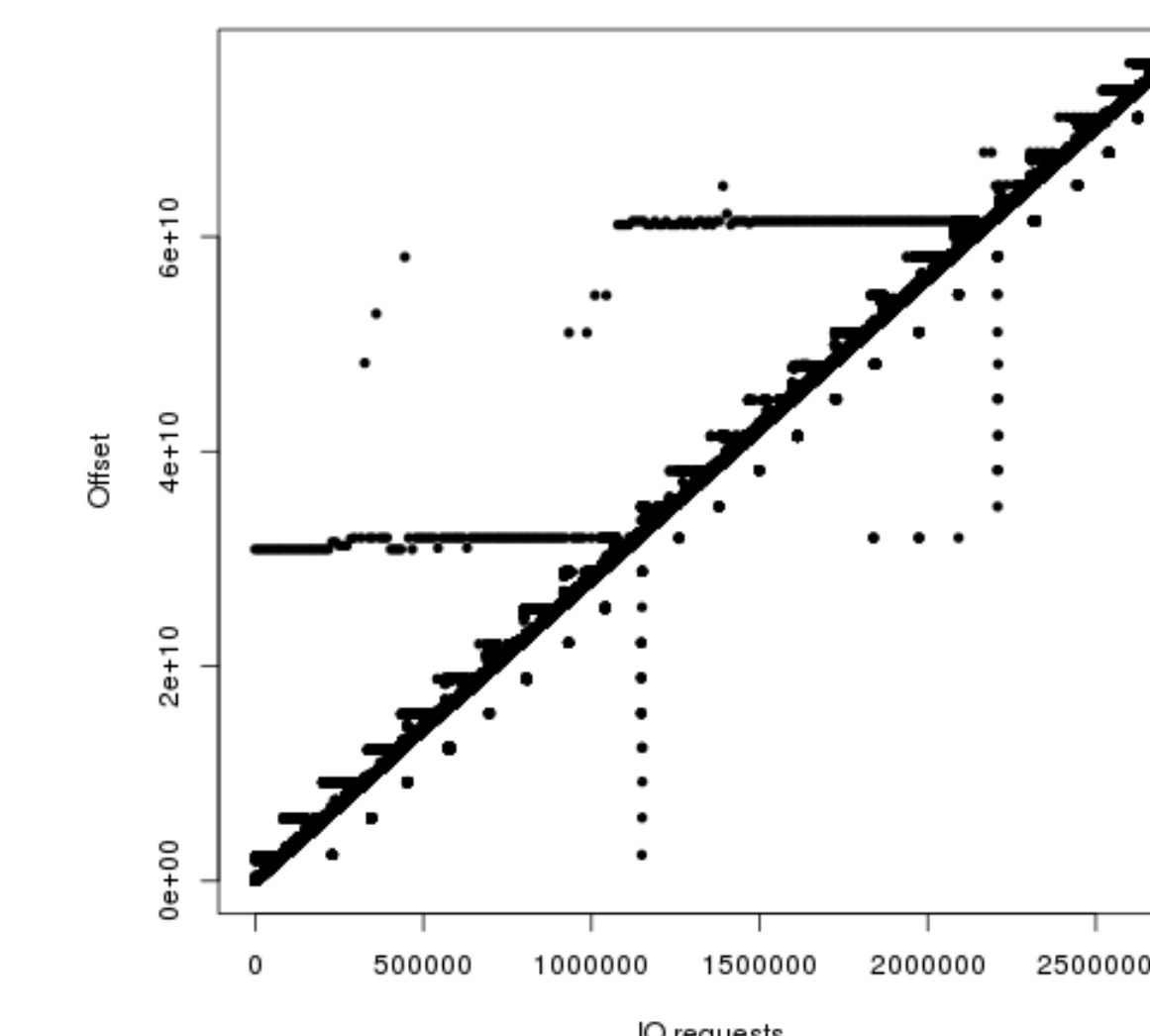
V. extended Berkeley Packet Filter (eBPF)

- ▶ 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**

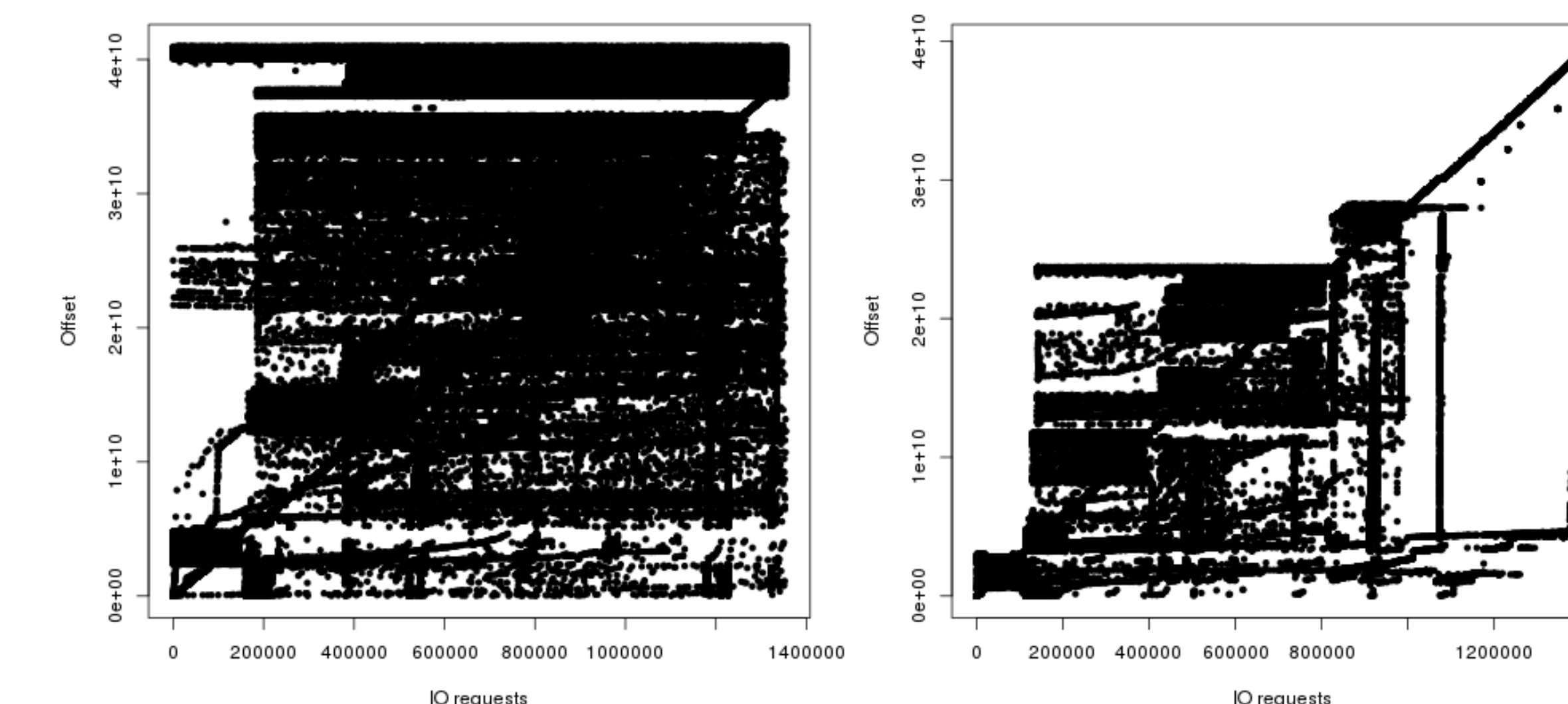
An **eBPF** tool is built to evaluate the I/O access patterns:

- ▶ 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



Two 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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