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## **Project Title**

A Game-Inspired Benchmark of Memory-Resident Databases

## **Problem**

Databases are used for many different applications that have different needs. Benchmarks are needed to test the characteristics of a DBMS, and to try and find/create a DBMS that is well suited for the real world workloads that the benchmark will mimic.

Online applications in areas such as MMOs and trading, are getting larger in variety and in users. These applications use DBMSs to store user data, and thus raise a need for DBMSs to scale to ever greater data sizes and still maintain high throughput. This in turn creates the need for benchmarks to test all the DBMSs that are created to be used to fit the need of these types of applications. For example, in MMOs, spatial partitioning manifests in having a multidimensional space. At the same time, locality of reference is prevalent in user transactions since game logic often dictates that the user primarily has access to data only present in their local space. Finally, distribution is required for scalability on commodity hardware, to avoid really expensive solutions using top shelf hardware.

There exists a lot of benchmarks, each designed for a specific application, with different properties. To list a few, we have TPC-C [1] which is designed for mimicking a warehouse, SEATS [2] for mimicking an airline ticketing system, LinkBench [3] for mimicking Facebook, a social media site, TATP [4] for mimicking a mobile carrier and Wikipedia [5] for mimicking an online encyclopedia. However there is no benchmark, which have been designed to cover all of the mentioned properties in an extent fit for mimicking an MMO.

Writing a benchmark is a lengthy process, which is why it would be a good idea, to reuse existing code. A benchmarking framework OLTPBenchmark [6] have been developed, which has a lot of tools to measure the workload and support for many kinds of databases.

Is it possible to define a benchmark employing a workload inspired by MMO's? We propose to target the properties; spatial partitioning, locality, and distribution, with a benchmark implementation in the OLTPBenchmark framework.

## **Limitations**

- We do not have access to any MMO source and usage statistics, nor do we know any MMO developer that could give advice on how their workload behaves.
- The benchmark in the OLTPBenchmark framework will be run against MySQL, PostgreSQL and a commercial DBMSx.

## **Work tasks and time schedule**

### **Studying subjects/Reading**

We will need to study how database benchmarks function, how the OLTPBenchmark framework works and how to add a benchmark module in it and finally the type of workload that an MMO generates. We expect to use 5 % of our time on this task.

### **Defining a game-inspired benchmark**

We will define a benchmark that generates a workload which is inspired by an MMO, while targeting spatial partitioning, locality and distribution. This includes defining the tables and the game logic. We expect to use 20 % of our time on this task.

### **Implementing the benchmark in the OLTPBenchmark framework**

While we define the benchmark, we will implement it in the OLTPBenchmark framework, as a benchmark module. We expect to use 20 % of our time on this task.

### **Testing the implementation for correctness**

We want to test the correctness of our implementation of the benchmark, to ensure each part is functioning as expected and that the numbers generated by the benchmark are meaningful. We expect to use 10% of our time on this task.

### **Testing the benchmark on multiple types of DBMSs**

We will be running our benchmark against multiple types of DBMS, to ensure that we do not create anything that is system specific, and to create more data for later analysis. We expect to use 10 % of our time on this task.

### **Analyzing the measurements from running benchmarks**

When we run our benchmark, and gather measurements, we will also analyze the results, both by looking at the results and by creating plots of the results. We expect to use 5 % of our time on this task.

### **Writing report**

During the project, we will write a report, which will contain our findings and documentation of the project. This report is the end result of the project and is thus our main focus point. We expect to use 30 % of our time on this task.

### **Learning goals**

- Analyze how database benchmarks are created, how to implement a benchmark in the OLTPBenchmark framework, and how to mimic the game logic and workload of MMOs.
- Specify a benchmark that employs the characteristics of MMOs, by targeting the properties spatial partitioning, locality and distribution.
- Implement the specified benchmark in the OLTPBenchmark framework.

- Set up multiple DBMSs, and perform best-effort tuning for our benchmark, and mimic a system setup as close to the characteristics of MMOs as we can determine from our literature analysis.
- Analyze measurements collected from running the specified benchmark on multiple DBMSs, to ensure that our benchmark reaches the desired properties of MMOs.

## Relevant literature

[1]	Transaction Processing Performance Council. TPC Benchmark C standard specification. TPC, 2010.
[2]	Micheal Stonebraker, Andrew Pavlo. The SEATS Airline Ticketing Systems Benchmark. H-Store Brown University 2012.
[3]	Timothy G. Armstrong, Vamsi Ponnkanti, Dhruba Borthakur, Mark Callaghan. LinkBench: a Database Benchmark Based on the Facebook Social Graph. SIGMOD, 2013.
[4]	IBM Software Group Information Management. Telecommunication Application Transaction Processing (TATP) Benchmark description. Solid Information Technology 2009.
[5]	Udaneta, Guido, Pierre, Guillaume, van Steen, Maarten. Wikipedia workload analysis for decentralized hosting. Computer Networks, Volume 54, Issue 5, 8 April 2010, Pages 877-878.
[6]	Djellel Eddine Difa, Andrew Pavlo, Carlo Curin, Philippe Cudre-Mauroux. OLTP-Bench: An Extensible Testbed for Benchmarking Relational Databases. Proc. VLDB, 2013.
[7]	Transaction Processing Performance Council. TPC Benchmark H standard specification. TPC, 2014.
[8]	Visawee Angkanawaraphan. AuctionMark OLTP Benchmark Project Report. H-Store Brown University 2011.
[9]	Richard Cole, Florian Funke, Leo Giakoumakis, Wey Guy, Alfons Kemper, Stefan Krompass, Harumi Kuno, Raghunath Nambiar, Thomas Neumann, Meikel Poess, Kai-Uwe Sattler, Michael Seibold, Eric Simon, Florian Waas. The Mixed Workload CH-benCHmark. ACM, 2011.
[10]	Brian F. Cooper, Adam Silberstein, Erwin Tam, Raghu Ramakrishnan and Russell Sears. Benchmarking Cloud Serving Systems with YCSB. ACM Symposium on Cloud Computing (SoCC), Indianapolis, IN, USA, 2010.
[11]	Vivek Shah, Transactional Partitioning: A New Abstraction for Main-Memory Databases. Proc. VLDB, 2014.