Overview of the STAC-M3 Benchmark specifications

Analyzing time-series data such as tick-by-tick price histories is crucial to many trading functions, from algorithm development to risk management. But the domination of liquid markets by automated trading—especially high-frequency trading—has made such analysis both more urgent and more challenging. As trading robots try to outwit each other on a microsecond scale, they dish out quotes and trades in ever more impressive volumes. This places a premium on technology that can store and analyze that activity efficiently. For example, the faster that algorithm developers can back-test or risk managers can value positions, the more opportunities a firm will be able to exploit it in the market.

The STAC Benchmark Council has developed the STAC-M3 Benchmarks in order to provide a common basis for quantifying the extent to which emerging hardware and software innovations improve the performance of tick storage, retrieval, and analysis.

STAC-M3 is proceeding in phases. The first phase focuses on I/O performance with respect to heavy historical data loads. The next phase will add benchmarks involving compute-intensive analytics and real-time data. The specifications test the ability of a solution stack such as columnar database software, servers, and storage, to perform a variety of operations on a large store of market data. The key metric is latency of query responses (i.e., response time). The benchmarks include setups with a single requesting client as well as setups with 100 requesting client threads.

As shown the high-level diagram below, the test setup for this version of STAC-M3 consists of the “stack under test” or “SUT” and the test clients. No architectural restrictions are placed on the SUT or clients.

Latency measurements are performed in the clients. A client thread gets a local timestamp \( t_{\text{submit}} \) then submits a query. When the first results arrive, the client gets another timestamp \( t_{\text{first}} \). When it receives the complete results (sorted appropriately), the client gets a third timestamp \( t_{\text{last}} \). For systems that
return all results in one chunk, the first-result and last-result timestamp are identical. As the diagram below illustrates, latencies are defined as follows:

First-result latency (LAT1) = \( t_{\text{first}} - t_{\text{submit}} \)

Last-result latency (LAT2) = \( t_{\text{last}} - t_{\text{submit}} \)

Note: In systems that do not return any results until they return all results, \( t_{\text{first}} \) and \( t_{\text{last}} \) will be identical.

Version 1 of STAC-M3 draws from client experience with equities and FX use cases. The database is synthetic, modeled on NSYE TAQ data (US equities). Synthetic data has three advantages that make it compelling for this version of STAC-M3:

- Synthetic data allows us to control the database properties exactly, which in turn allows us to randomize elements of queries from project to project while keeping the resulting workload exactly the same (e.g., we control how much volume is associated with each symbol).
- Synthetic data does not incur fee liability from a third party such as an exchange.
- Synthesizing the data allows us to run benchmarks against projected future data volumes.

The dataset consists of high-volume symbols and low-volume symbols in proportions that mimic NYSE data. The data volume was roughly double the volume on NYSE in April 2010. Based on historical growth in data volumes, this projects future volumes approximately 1 to 1.5 years out.

The queries in this version of STAC-M3 are deliberately light on compute and heavy on I/O. They require simple calculations over a large volume of data that yield a small result set. The core analytic is akin to VWAP (volume-weighted average price). However, VWAP operates on trades. Analytics that operate on quotes impose a much higher I/O burden on a system, because in most markets quotes outnumber trades by a large factor. STAC-M3 therefore uses an analytic called VWAB (volume-weighted average bid). VWAB uses bid and bid size in place of trade price and trade size, making it a much more onerous analytic than VWAP. To limit the size of the result set, STAC-M3 specifies a 4-hour VWAB, meaning there are just two results per trading day for each symbol.

The specs vary the time period over which the analytic must run (one day, 12 days, one year). In some cases, they require the analytic to apply only to quotes on a certain exchange, requiring the SUT to perform random access to historical data. And some specs call for just one requesting thread, while others call for 100 threads to submit queries to the system all within in one second. Two 100-Thread cases are defined: one in which there is no overlap among threads in the data of interest and one in which there is heavy overlap. Finally, the specs include one write operation, in which the SUT must write one day's worth of data to the database.

Members of the STAC Benchmark Council can access the benchmark specifications and other information at [www.STACresearch.com/m3](http://www.STACresearch.com/m3). Council members with a premium subscription can access non-public STAC-M3 test results and run STAC-M3 Benchmarks in the privacy of their own labs. Comparing internal results to STAC Reports enables a customer to quickly "mark its system to market."

For more information, please contact council@STACresearch.com.