Load Test Report

Moscow Exchange Trading & Clearing Systems

10 September 2022

Contents

Testing objectives

To verify the trading and clearing systems operation under conditions of peak loading and an increased number of orders and trades, the trading systems of the following Moscow Exchange's markets were tested:

a. The Equity & Bond Market;

b. The FX Market;

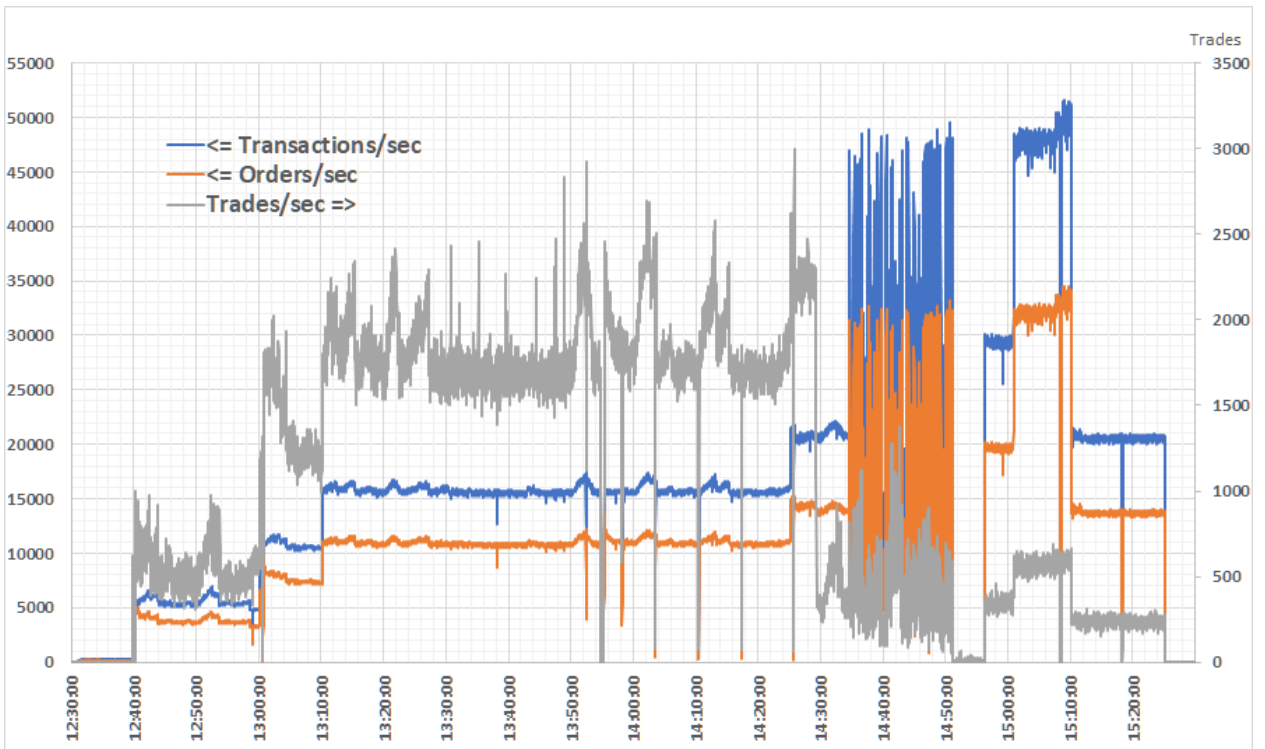c. The Derivatives Market.

Main results

The Equity & Bond Market trading and clearing system

The testing was carried out on the production version of the system with independent trading and clearing engines. Server configuration used during the tests was the same as it was expected to be in production.

The table below shows comparative performance in production environment. This choice is due to significant excess of peak performances above the values reached during 2021 load tests. The 'accepted transactions' term means all the incoming transactions that led either to order registration or to successful cancelation of an order.

	Transactions	Orders	Trades
Values reached (units), 2022	170 901 553	115 661 394	11 342 543
Maximum values, production environment	170 000 000	98 500 000	12 000 000
Max processing rate for accepted transactions (units per sec)	51 885	34 522	12 137

The graph below shows the frequency of transactions, orders, and transactions by clients – testing participants. The maximum system performance level was not reached during the load test.

Processing rate and latency for transactions of the Equity & Bond Market trading and clearing system was not changed comparative to 2021 testing results.

The share of client generated activity was 3%.

New SIMBA ASTS market data service infrastructure was tested under conditions similar to production version released on 10 October 2022. Service components were operating stable during tests, no failures have been registered.
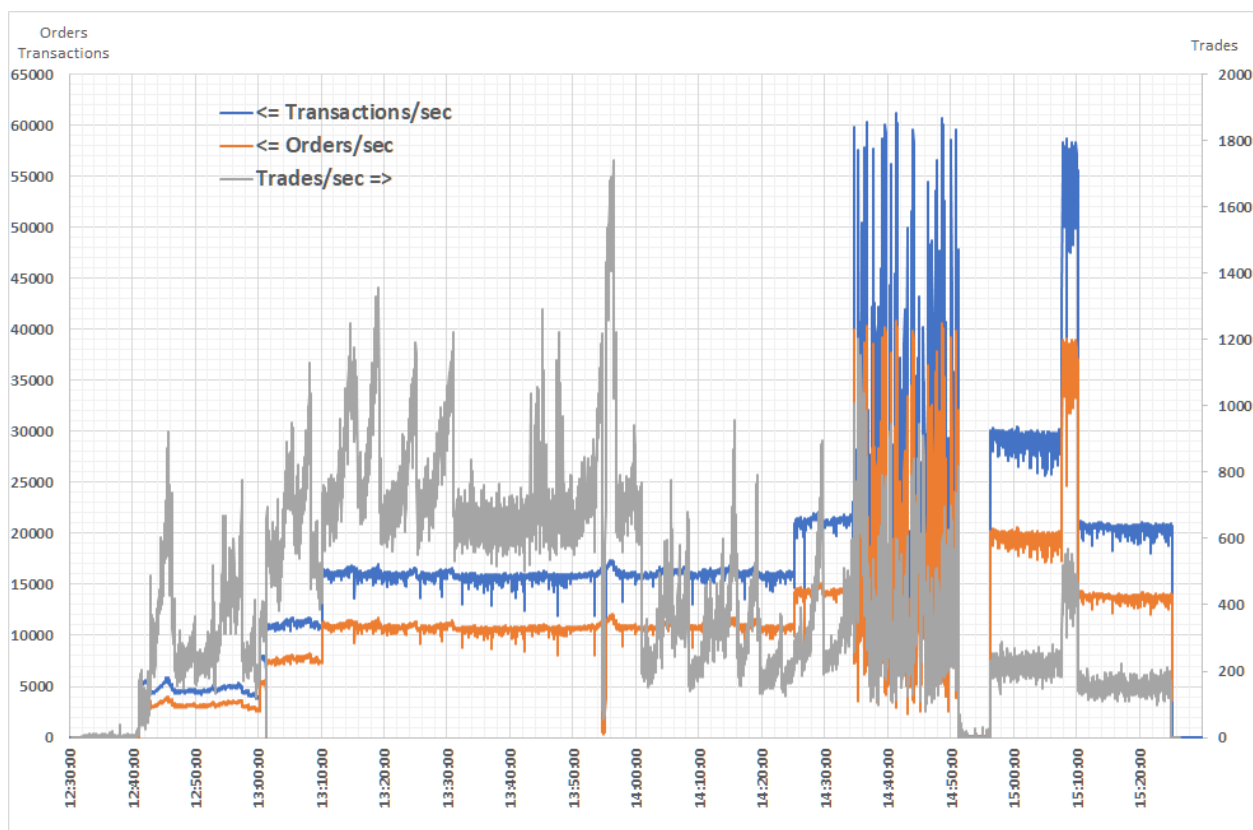
The FX Market trading and clearing system

The testing was carried out on the production version of the system with independent trading engine and several independent clearing engines. Server configuration used during the tests was similar to that expected to be in production.

The table below shows comparative performance in testing in 2021. The 'accepted transactions' term means all the incoming transactions that led either to order registration or to successful cancelation of an order.

	Transactions	Orders	Trades
Values reached (units), 2022	**165 558 023**	**110 814 687**	**4 468 692**
Values reached (units), 2021	107 480 432	55 173 416	2 878 998
Max processing rate for accepted transactions (units per sec), 2022	**61 139**	**40 802**	**1 741**

The graph below shows the frequency of transactions, orders, and transactions by clients – testing participants. The maximum system performance level was not reached during the load test.

The latency for transactions of the FX Market trading and clearing system comparative to 2021 testing results was not changed.

The share of client generated activity was 3% of all transactions.

New SIMBA ASTS market data service infrastructure was tested under conditions similar to production version released on 10 October 2022. Service components were operating stable during tests, no failures have been registered.

The Derivatives Market trading and clearing system

The testing was carried out on the SPECTRA system version 7.0 used in production since 28 May 2022 on the servers of the main Data Space and M1 data centers.

The order-to-trade ratio in the testing was near the production value. 283 million transactions were sent, and 9.3 million trades were executed during the testing. The peak processing rate was not reached during the load testing. The system performance of 135,000 transaction/sec was reached.

	Transactions	Orders	Trades
Values reached (units), 2022	283 317 819	131 462 509	9 345 351
Values reached (units), 2021	281 270 523	144 870 693	12 253 444
Processing rate reached (units per sec), 2022	135 000	-	-
Max processing rate (units per sec), 2021	171 000	-	-
Max processing rate, real trading (units per sec), 2022	25 000		

The graphs below show a transaction load on the Derivatives Market trading system. Clients participating in testing generated 2.21% of the transactions.
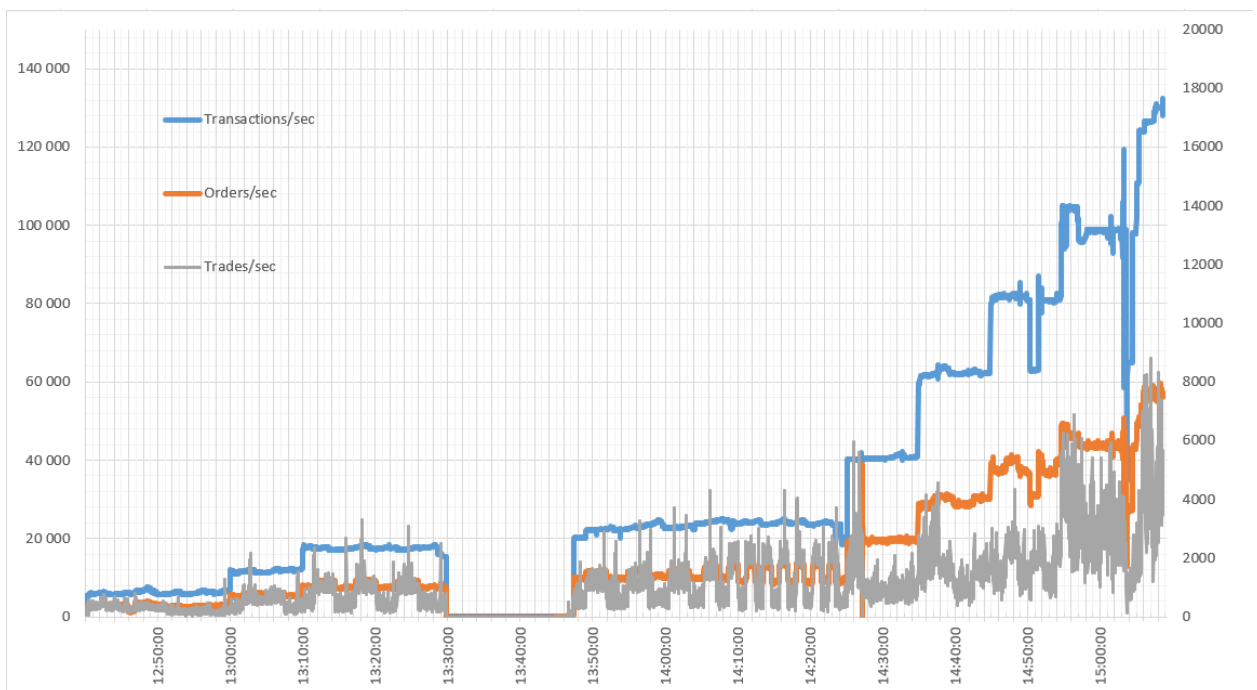
During the tests, we carried out the scheduled intraday clearing session. Clearing was performed as usual, clearing session was ended in 4 minutes 00 seconds.

By the end of the load tests, we carried out evening clearing session. Clearing operations was performed in 10 minutes.

Mentioned time values were as expected, considering increased Trades value.

Latency for transactions

Derivatives Market trading system

The internal Spectra monitoring system, Corvil solution and log files for client transactions have been used to measure the Derivatives Market latency.

Application Latency Trade
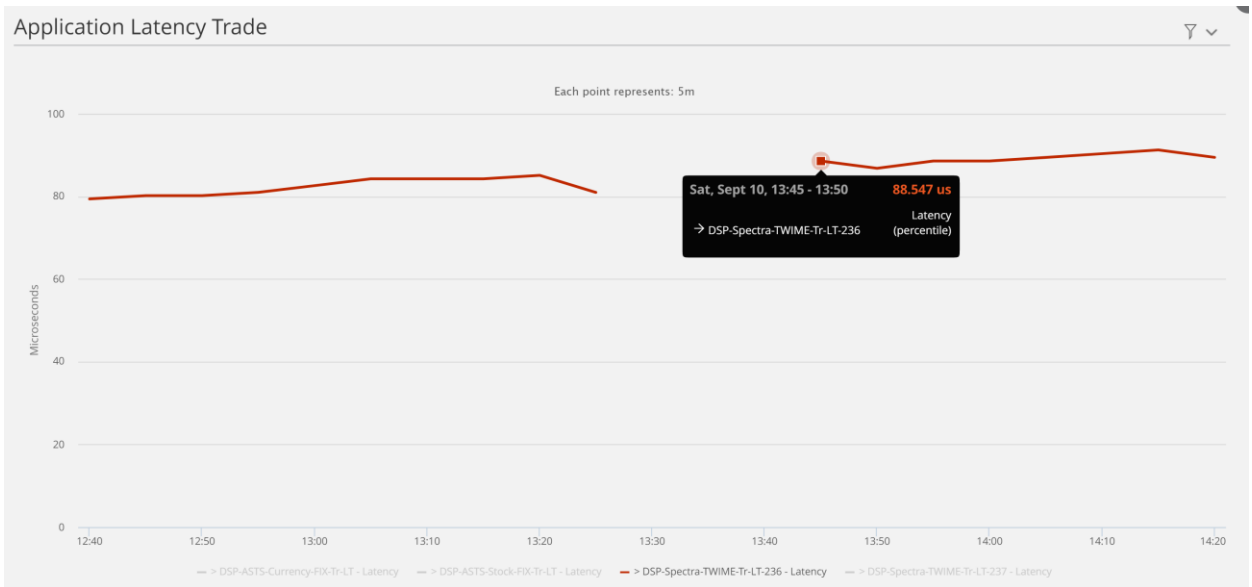
Within the range from 5,000 to 135,000 transactions per second, the average RTT for TWIME gate was changing from 80 microseconds to 110 microseconds. The intermission on the graph was caused by the intermediate clearing session.

FAST UDP multicast marketdata and SIMBA servers of the Derivatives Market

The Derivatives Market FAST and SIMBA servers' configuration was the same as in production. The servers have operated correctly at all load levels during the test.

Statistical data on TWIME protocol order accepted messages (Execution Report) relative to new order messages from the trading system (Full order log feed) in FAST FOL and SIMBA protocol has been collected using the Corvil equipment. The screen below shows subtraction of SIMBA timestamp from TWIME timestamp average values. The positive value shows that SIMBA overtakes TWIME on the average by 35 microseconds.

This data is being constantly collected during the normal trading. The average time of publication in the FAST feeds is shown in the screen below (the intermission on the graph was caused by the intermediate clearing session).

SIMBA versus TWIME comparison:

Latency Median- Feed A

Each point represents: 5m

Sat, Sept 10, 13:55 - 14:00   34.751 us

→ DSP-Spectra-SMB-TWIME-20....   Latency (percentile)

99% during the tests market data was published minimum 30 microseconds faster than TWIME transaction response. The principle of Public Data first is strictly observed.

Average publishing latencies at SIMBA transaction frequency of up to 20,000 tran/sec were 33 microseconds.

FAST UDP multicast traffic for the Derivatives Market reached 80 Mbps in each of copies A and B with bursts of up to 0.8 Gbps.

FAST UDP multicast traffic for the Derivatives Market reached 100 Mbps in each of copies A and B with bursts of up to 1.1 Gbps.

Bitrate MCAST

Each point represents: 5m

Bitrate MCAST Bursts

Each point represents: 5m

Sat, Sept 10, 14:10 - 14:15 — 760.86 Mbps

→ DMF-Spectra-FAST-LT-A — Microburst (1ms)

— > DMF-ASTS-FAST-LT-A - Microburst (1ms) — > DMF-ASTS-FAST-LT-B - Microburst (1ms) — > DMF-Spectra-FAST-LT-A - Microburst (1ms) — > DMF-Spectra-FAST-LT-B - Microburst (1ms) — > SMB-DC1SMB-all - Microburst (1ms) — > SMB-DC2SMB-all - Microburst (1ms)

The required network bandwidth for clients who wish to use the FAST service to receive ORDERS-LOG is minimum 100 Mbit/sec per feed. To receive two feeds, FEED A and FEED B, or data from more than one market, the 1-10 GBit/sec bandwidth is recommended.

Exchange network and colocation network parameters

The network monitoring system within the exchange perimeter and within the colocation zone perimeter (including the colocation zone core switches) showed that the network parameters had no deviation from normal work parameters. No retransmissions, packet loss or network latency growth were detected.

We remind you that network bandwidth recommendations and requirements are published on MOEX website at https://www.moex.com/a1160.

Conclusions

The Equity & Bond Market, the FX Market

1. The Equities Market and FX Market systems have significant margin on maximum values of trades and orders relative to production environment.

2. Mechanisms for removal of orders that get cancelled before execution from the system and information tables auto-extension operate sustainably. It is possible to exclude suspension of trading scenario due to tables overwhelming caused by abnormal market activity.

3. Performance of the production Equities Market and FX Market systems changes insufficiently compared to values reached in 2021. The testing result appears to be good considering increased complexity of trading and clearing systems.

4. Components of the new SIMBA ASTS market data service configurated similar as production version released on 10 October 2022 were operating stable.

Derivatives Market

1. SPECTRA's performance is sufficient to meet demands of participants even at peak loads with respect to order processing and market data distribution. Max processing rate is multiple times higher then peak loads detected for real trading (135,000 transactions per seconds during the tests vs 25,000 transactions per seconds during real trading). Peak performance values were not reached for HFT contour during tests.

2. Derivatives market system is ready in terms of performance for an increase in a number of clients and instruments due to equity options production launch.

3. We strongly recommend our clients to bring network bandwidth in line with requirements published at https://www.moex.com/a1160.

Comparison of load test parameters and peak load values in real trading

Comparison table including result values reached during load test and peak load values detected in real trading are presented below.

Due to information tables auto-extension maximum trades and orders values are not defined as initial tables size values. For main servers of the trading and clearing system, RAM size restriction is minimum of twice as high as result values.

Parameter	FX Market	Derivatives Market	Equities & Bonds Market
Detected peak load value, trades	1 500 000	5 774 168	12 000 000
Value reached in the load test, trades	4 468 000	9 345 351	11 342 000
Detected peak load value, orders	60 000 000	91 958 804	98 500 000
Value reached in the load test, orders	110 800 000	131 462 509	115 600 000
Maximum trades and orders number, production environment	Inapplicable		
Peak transaction frequency detected in real trading	8 000	25 000	7 500
Peak transaction frequency reached in the load test	61 139	135 000	51 585