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# Information technology

Moscow Exchange is both a diversified venue for trading of financial instruments and a company with a sophisticated informational technology infrastructure including unique proprietary solutions across trading, clearing and risk management. The Group places a major emphasis on strengthening its IT systems and providing clients with highly reliable infrastructure and best-in-class services. MOEX's technologies for trading and settlements are based on state-of-the-art IT platforms on the level of the world's most sophisticated trading venues.

## INFRASTRUCTURE

MOEX's computing capacities are placed in two cutting-edge data processing centers (Data Centers), namely DataSpace (primary) and M1 (standby). DataSpace is the first commercial data processing center in continental Europe and Russia to be awarded Tier III Certification of Operational Sustainability-Gold, designations for the highest reliability and security.

On its platforms, MOEX operates the most advanced server and networking equipment offered by major global manufacturers.

## TECHNOLOGICAL ACCESS TO TRADING

Moscow Exchange Group offers a complete range of solutions to allow clients to begin trading, with options to select the most appropriate operational efficiency, including remote connections through networks of authorized operators, global financial networks, dedicated channels, Internet, and international points of presence in key financial centers, such as London, Chicago, New York and Frankfurt. In 2018, MOEX increased its presence in Asia and the Middle East, making it possible to connect in Singapore, Hong Kong, Shanghai, Dubai and Mumbai, and it opened a new connection point in Chicago Data Centre in Aurora, Illinois that is home to the core CME GLOBEX.

Clients can access trading on the Group's markets and distribution of stock-ticker data through standardized protocols FAST and FIX as well as proprietary protocols TWIME and Plaza II. In 2018, MOEX released an updated version of the FAST protocol and rolled out the auxiliary FAST service Full\_orders\_log Online, the fastest way to receive real-time information about all on-exchange trades and orders on the Derivatives Market with nanosecond breakdown. The new service was launched in the first quarter of 2019.

The colocation area located in the primary Data Center (DataSpace) provides the highest level of reliability, accessibility and security of connectivity for high-frequency trading customers operating on MOEX's markets. At present, approximately 40 professional market participants use the colocation services. In 2018, under the development process of a range of the colocation services, MOEX put into operation several new services, including, but not limited to, the possibility of allocation of extra electricity supply above the standard offering, booking stands for up to three months without feed supply with the possibility of assembly and commutation of customer's equipment and connection of intake units of global positioning systems (GPS, GLONASS, etc.) for customer use.

In 2018, MOEX switched to a new model of by-login billing that reduces paperwork and operational expenses for business continuity. Under the project, MOEX performed a fundamental update of its information systems and business processes that allowed for a uniform model of technical access across all markets, a uniform system of control and monitoring of identifier issuance and a uniform billing system for technical access services.

In 2018, the Group put into operation MOEX Dealing, an expanded version of an electronic chat with participants of the interbank market being able both to hold negotiations and agree upon terms of bilateral transactions related to interbank financing and trades with FX spot and swap and to fix and save the achieved arrangement in special data retention modules for their back offices. The first customers were connected to this system in 2018.

## RELIABILITY MANAGEMENT AND INFORMATION SECURITY

MOEX places great emphasis on reliability of its trading and settlement infrastructure. It completes the year with an availability indicator of 99.99%.

Uninterrupted functioning and fault tolerance is supported by "hot" and "warm" booking technologies that ensure quick recovery of trading and clearing systems.

MOEX's technical policy relating to IT infrastructure provides for reliability of the hardware systems: the server equipment servicing crucial trading and clearing transactions is under three years old, and networking equipment is under five years old. MOEX conducts regular information security audits, including tests for intrusion, regular anti-fishing tests and continues to improve the security systems.

In 2018, following the results of Lloyd's Register Quality Assurance, the Group received certificates of conformity with international standards ISO 27001:2013 (Information Security Management) and ISO 22301:2012 (Business Continuity Management) for organizers of on-exchange trading, clearing and provision of services at stock, derivatives, FX and money markets. The certification is voluntary, and it presupposes that MOEX and NCC completely comply with over 100 technical and administrative measures designed to ensure information security and business continuity.

In 2018, to improve safety, MOEX created a mobile standby office designed to ensure availability of services in case of emergency.

## MODERNIZATION OF TRADING AND CLEARING SYSTEMS

MOEX's markets are based on two trading and clearing systems, ASTS (Equity, Money, FX and Precious Metals Markets) and SPECTRA (Derivatives Market). The software systems have a modular architecture that provides for both operational efficiency and fault tolerance of exchange infrastructure. The operational efficiency of MOEX's trading systems is in line with those of other major global trading venues. In the aggregate, the systems are capable of processing up to 200,000 transactions per second.

In 2018, the Group implemented a version of the trading and clearing system of the FX Market with independent hardware cores for trading and clearing. This was the most significant technological update in the history of the FX Market's trading and clearing system. In addition to a new architectural solution with integration of physically divided trading and clearing components through the high-speed data bus Confinity Low Latency Messaging, the hardware platform underwent a fundamental upgrade. Now, all servers interact under a high-speed network built with the use of Infiniband cards. As a result of these updates, the total operational efficiency of the system grew 1.5 times.

In the trading and clearing system of the Derivatives Market, risk module functioning algorithms were completely revised to extend integration between the FX, Equity and Derivatives markets and to develop functionality of a single pool. The module operation is supported by AVX vector processors in the hardware platform that allowed 2.5-3 times acceleration of the necessary computations.

The Group implemented a system of preparation of compulsory regulatory reporting created with the use of the technological stack Apache HADOOP and Oracle Application Express/ExaData. This system reduces the time required for preparation of reporting forms by 3-6 times. The use of free distributed software reduced the cost of ownership approximately 2 times. Under of this project, the Group built a data repository in the data-lake architecture to accumulate and work with large heterogeneous arrays of historical data.