Technology FAQ and Best Practices: Options

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1. Scope and Disclaimer

This summary document is intended for informational purposes only to answer common questions regarding the technical architecture and implementation of the NYSE Group exchanges (the “Exchanges”) and in an effort to provide additional transparency on the Exchanges’ technology and recommend best practices so that all members can effectively integrate their systems with those of the Exchanges and better manage their operational risks. While the summary information provided is believed to be accurate at the time of publication, the document may become outdated as the Exchanges continuously evaluate new solutions and enhance technology to improve resiliency, performance, and scalability. Members should also refer to the Exchanges’ most current rules and product technical specifications for more definitive information, which information ultimately controls in the event of any inadvertent conflict with this document.

2. General Information

2.1 What markets are covered by this document?

NYSE American Options and NYSE Arca Options, also referred to as “NYSE Options” and/or the “Exchange(s)” throughout this document.

2.2 What are trading hours?

Trading on the Exchanges occurs between 9:30am and 4:15pm (ET) daily. Orders may be entered into the system beginning at 5:30am.

Further details are available at: https://www.nyse.com/markets/hours-calendars.

2.3 What securities are traded on each exchange?

The Exchanges both trade multiply-listed equity and index options.

2.4 What is the allocation model?

NYSE American Options is a price/pro-rata, Customer priority model that at each price, executes Customer orders in time sequence before non-Customer orders and allocates the remaining orders on a pro-rata basis.

NYSE Arca Options is a price-time market with certain allocation considerations to Lead Market Makers.

2.5 Is the market operating normally?

Members should refer to https://www.nyse.com/market-status/history for updates on any recent system issues and https://www.nyse.com/trader-update/history for general updates.

3. Equipment

3.1 What hardware do the Exchanges use?

This information is not disclosed and is subject to change.

3.2 What networking equipment do the Exchanges use?

This information is not disclosed and is subject to change.

3.3 What operating system do the Exchanges use?

NYSE Group markets operate on Linux-based platform.

4. Gateways and Messaging

4.1 How do firms connect to the Exchange?

Members connect to the Exchanges by establishing TCP/IP sessions with each market's gateway applications. Members can establish connectivity to the Exchanges beginning at 3:30am.

NYSE Options recommends that members maintain multiple gateway connections for each market so that, in the event of an interruption in the ability to send order flow, they will have the ability to direct orders to the Exchanges via a connection to an alternate gateway.

IP addresses for all NYSE Group exchanges can be found here.

4.2 What messaging protocols are supported?

The Exchanges offer two protocols for order entry and a separate protocol for Market Maker quote entry. The protocols are identical for each of the two markets.

Specifications for FIX order entry can be found here: FIX for Options.

Specifications for binary order entry can be found here: UGW for Options.

Specifications for quote entry can be found here: MMD for Options.

4.3 How many gateways are there?

On each exchange, multiple instances of each gateway application run in Production to allow for load balancing and redundancy. Internally, each gateway application provides access to all matching engines on that exchange. All matching engines reside in one physical hall within the Mahwah data center.

Gateway capacity (like the Exchanges' system operating capacity discussed below) is periodically reviewed to ensure high availability and consistent throughput across all participants.

The specific number of gateways is not disclosed, but members can expect that each market has multiple gateway instances.

4.4 Are TCP/IP and UDP both supported?

No. The Exchanges' gateways require TCP/IP connections between the client and the gateway application.

4.5 How do gateways transmit data to the matching engines?

Data is transmitted from the gateway to the matching engine via TCP connections.

4.6 Are customer sessions constrained to “one-in-flight” messaging?

No. Additional messages may be sent before prior message acknowledgments have been received.

4.7 Are customer sessions throttled?

Yes. Order gateways throttle each connection to one thousand messages per second. More details are available at: https://www.nyse.com/connectivity/specs.

4.8 Are dedicated gateways available to individual clients?

No. Gateways are a shared resource for the Exchanges’ participants. Gateway performance is managed as part of the capacity management process.

4.9 Are gateway reader threads always active?

Yes. The gateways maintain “hot” active TCP connections awaiting data arrival.

4.10 How is traffic balanced across gateways?

Connection assignments and re-assignments are performed by the Exchanges’ System Operations team to maintain appropriate system utilization and balance across market participants. Performance and message distribution are evaluated by the NYSE Capacity Planning team and adjusted as necessary.

4.11 Are Drop Copy messages available?

Yes. FIX trade drop copy is available. NYSE Options recommends that members maintain connections to drop copy servers so that, in the event of a gateway failure, members can

retrieve order status and execution reports from the drop copy. More information on drop copy can be found here: Drop Copy for Options.

4.12 Is testing available?

Yes. The Exchanges provide opportunities for members to test connectivity and functionality in certification environments and also support test symbols in production environments. Members should contact the Technology Member Services group for more information.

- Days available: Monday - Friday
- Hours available: 9am – 5pm
- Contact info: Tms@nyse.com or 212-896-2830 (option #2, #2)

5. Matching Engine

5.1 How many matching engines are used by each exchange?

The number of matching engines (also known as “trading units”) can be derived by referencing this file.

5.2 How are symbols mapped to matching engines?

The Exchanges monitor performance daily and periodically redistribute symbols across matching engines as needed. The Exchanges publish their daily symbol assignment here.

5.3 What pricing sources are used for away markets?

OPRA is used for away market quote data.

5.4 What is the system’s operating capacity?

This information is not disclosed.

5.5 How do orders enter the book?

The Exchanges’ matching engines process one message at a time, completing all requisite actions from the instruction (e.g., update the order book, execute trades, publish quote updates), before processing the next message.

5.6 How are inbound messages sequenced?

Multiple customer connections into each gateway are serviced in a round robin fashion (using edge triggered epoll), with processed messages internally queued in the gateways. Messages are then processed from multiple gateway queues by the matching engine, also in a round robin fashion.

Inbound messages are processed in time sequence as received by the matching engine.

5.7 Are Risk Management features available?

Yes. The Exchanges offer a full suite of risk management features. Please refer to this document for a comprehensive list of these features: Options Risk Controls.

6. Market Data

6.1 What market data is available?

The Exchanges publish their quote and trade data to OPRA and via proprietary data feeds. The proprietary data feeds also include a symbol download, a complex order feed, depth of book messages, BOLD mechanism messages (NYSE American only) and CUBE auction messages (NYSE American only).

Additional information on Options market data feeds is available at: XDP for Options.

6.2 When are timestamps generated?

For the Exchanges' proprietary market data feeds, the 'SourceTime' field is generated by the matching engine's instance at the start of the processing event. The 'SendTime' field is generated by the XDP Publisher just before sending the packet.

6.3 How do firms receive proprietary market data?

All proprietary market data feeds publish identical data over an A and a B multicast line for redundancy. These redundant lines can be received via the ICE Global Network (IGN), formerly known as Secure Financial Transaction Infrastructure (SFTI), IGN IP network by remote customers. Customers co-located in our Mahwah data center may receive proprietary market data feeds, in resilient form, over either the IP network or the LCN network. Customers should automatically arbitrate between the A- and the B-line so that if one line drops a packet it should be received over the other line.

In the case of doubly-dropped multicast packets, the customer can connect to a Request Server via TCP/IP to request retransmissions of missed messages. In case of customer late start or intraday failure, the customer can connect to the Request Server and request snapshot refreshes of the state of the market.

In addition, the Exchanges recommend that firms utilizing proprietary market data feeds maintain a connection to OPRA, and have the ability to switch between the proprietary market data feeds and the OPRA feed, in the event that one or the other fails.

NYSE Group can also provide data to customers in the Secaucus and Carteret data centers via IGN Wireless and via IGN LLN, a low latency fiber route. Note that IGN Wireless is a fair weather service and that neither IGN Wireless nor IGN LLN is a redundant service. Backup connectivity should be established.

7. Resiliency Best Practices

7.1 ICE Global Network (IGN)

NYSE Group recommends that members connecting to our markets from outside the Mahwah datacenter maintain connectivity to the IGN from multiple geographically diverse IGN Access Centers. In the event of an Access Center failure, firms should be able to route via another Access Center.

Additionally, members located in the Mahwah, NJ data center, including for colocation, should be able to access IGN from an external Access Center.

7.2 Disaster Recovery and Business Continuity Planning

NYSE Group recommends all members establish DR and BCP plans that anticipate potential outages or inaccessibility of its data centers and/or trading floors. Members that depend on physical trading floor presence for order entry are advised to establish electronic order entry capabilities as a backup should the floor be unavailable.

Members are advised to maintain connectivity to the NYSE Group disaster recovery facility in Chicago, IL (350 E Cermak). In the case of a Disaster Recovery event that impacts the Mahwah data center, the Exchanges will operate from Cermak per exchange rules and previously disseminated disaster recovery plans. NYSE Group recommends all members review the NYSE Group Disaster Recover FAQs. Firms may connect to Cermak using an ICE Global Network (IGN) Point of Presence, including from the 5th floor (preferred) or 8th floor (secondary) PoPs within the Cermak datacenter.

Members designed by the Exchange will be required to participate in annual DR testing pursuant to SEC Regulation SCI.

8. Additional Features and Functions

8.1 Do the Exchanges support a price improvement auction?

NYSE American Options' price improvement auction for both simple and complex paired orders is CUBE (Customer Best Execution). Details on CUBE can be found here: American CUBE.

NYSE Arca Options does not support a price improvement auction.

8.2 Do the Exchanges support Complex Order functionality?

Yes. Complex order functionality is available on both NYSE Options exchanges.

8.3 Do the Exchanges support a "step-up" functionality?

NYSE American Options supports a "step-up" functionality called BOLD (Broadcast Order Liquidity Delivery Mechanism). Details on BOLD can be found here: BOLD FAQs.

NYSE Arca Options does not support a "step-up" functionality.

8.4 Do the Exchanges support repricing functionality?

Yes. Both NYSE Arca Options and NYSE American Options support repricing orders and quotes. Additional information can be found on the Repricing Orders and Quotes FAQs.