Technology FAQ and Best Practices: Equities

NYSE Group

September 6, 2016

Version 1

Copyright Information

Contents

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 While the summary information provided is believed to be accurate at the time of publication, the document may become outdated as the Exchanges continuously evaluate new solutions and enhance technology to improve resiliency, performance, and scalability.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 are trading hours?

Trading on NYSE and NYSE MKT occurs between 9:30am and 4:00pm daily. Orders may be entered into the system beginning at 7:30am.

Trading on NYSE Arca is available from 4:00am to 8:00pm daily, with the core trading session operating between 9:30am and 4:00pm. Orders may be entered into the system beginning at 3:30am.

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

2.2 What securities are traded on each exchange?

NYSE currently trades Tape A securities only.

NYSE Arca trades all NMS securities.

NYSE MKT currently trades subsets of both Tape B securities (all NYSE MKT-listed and select additional ETPs) and Tape C securities (approximately 72 NASDAQ-listed securities).

We anticipate all NMS securities will be available for trading on all three exchanges in 2017.

A directory of NYSE, NYSE Arca and NYSE MKT symbols can be found here:
https://www.nyse.com/listings_directory/stock

2.3 What is the trading algorithm?

NYSE and NYSE MKT utilize a price/parity model. The parity allocation model distributes executions in a round robin fashion to Designated Market Makers, Floor Brokers and orders in the electronic order book that are at the best price. Orders that set a price level are entitled to an additional allocation before parity allocations are considered.

NYSE Arca utilizes a price/time priority model.

Market orders have first priority. At a given price level, displayed orders have priority over non-displayed orders.

2.4 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 does the exchange use?

This information is not disclosed.

3.2 What networking equipment does the exchange use?

This information is not disclosed.

3.3 What operating system does the exchange use?

This information is not disclosed

4. Gateways and messaging

4.1 How do firms connect to the exchange?

Members connect to NYSE Group exchanges by establishing TCP/IP sessions with each market's gateway applications. Members can establish connectivity to NYSE Arca beginning at 3:30am and to NYSE and NYSE MKT at 7:00am.

NYSE Group recommends that member firms maintain multiple gateway connections for each market so that, in the event of a gateway application failure, they will have the ability to direct order flow to the exchange via a connection to an alternate gateway. Specifically for the New York Stock Exchange, these connections should be maintained in both physical halls within the Mahwah data center from which connections are provided. The NYSE Technology and Connectivity team can help members establish a presence in each hall.

4.2 What messaging protocols are supported?

NYSE, NYSE MKT, and NYSE Arca each offer FIX and binary protocols. Order entry specifications are available on the website. There is no fee difference between using FIX or binary, and customers should evaluate which protocol is most appropriate for their specific use case.

More details are available at: https://www.nyse.com/connectivity/specs

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 the exchange.

The specific number of gateway applications is not disclosed.

4.4 Are TCP/IP and UDP both supported?

No. All NYSE Group 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 internally on NYSE and NYSE MKT via TCP connections. Data is transmitted internally on NYSE Arca via InfiniBand.

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, though the specific message rates are subject to change. More details are available at: https://www.nyse.com/connectivity/specs

4.8 Are dedicated gateways available to individual clients?

No, however DMMs on NYSE and NYSE MKT use a distinct set of gateways to support DMM-specific messaging.

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.

4.11 Are Drop Copy messages available?

Yes. NYSE Group recommends that firms maintain connections to drop copy servers so that, in the event of a gateway failure, firms can retrieve order status and execution reports from the drop copy. NYSE Arca also supports 'full echo' of all message activity. Note that NYSE and NYSE MKT currently deliver drop copies via the order entry gateways, so drop copies will be impacted in the event of an order entry gateway failure.

4.12 Is testing available?

Yes. NYSE Group provides opportunities for members to test connectivity and functionality in certification environments and also supports test symbols in production environments. Members should contact the Firm Testing group for more information.

- Days available : Mon/Thur/Fri
- Hours available: Firm Testing Phone Support 9am – 5pm
- Contact info: firmtesting@nyse.com Phone: 212-896-2830 (option#2, #2)

5. Matching Engine

5.1 How many matching engines are used by each exchange?

NYSE, NYSE MKT and NYSE Arca each utilize multiple matching engines, but the specific quantity is not disclosed.

5.2 How are symbols mapped to matching engines?

NYSE and NYSE MKT and publish the daily symbol assignment by "trading unit" and datacenter hall on nyse.com.

NYSE Arca publishes its daily symbol assignment by "TXN" as well. On NYSE Arca, each TXN uses more than one matching engine, but the symbol to matching engine mapping is not disclosed.

5.3 What pricing sources are used for away markets?

NYSE and NYSE MKT currently use the SIP for all away markets.

NYSE Arca uses a combination of direct feeds and SIP quotes for away markets, with the SIP as back-up for all direct feeds.

5.4 What is the system's operating capacity?

NYSE, NYSE MKT and NYSE Arca are rigorously performance tested, but this information is not disclosed.

5.5 How are inbound messages from CCG (NYSE, NYSE MKT) and UGW (NYSE Arca) gateways sequenced?

Inbound messages are processed in a First In First Out manner, as received by the matching engine (NYSE and NYSE MKT) or sequencing module (NYSE Arca). These applications receive messages from the multiple gateway applications in a round robin fashion.

5.6 How do orders enter the book?

The matching engine processes 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.

5.7 Are Risk Management features available?

Yes. NYSE Group recommends that firms utilize the Risk Management Tool to supplement firms' internal risk management tools for trading on its equity exchanges. The Risk Management Tool (RMT) allows firms to:

- Define net exposure limits by risk group
- Track net notional exposure by risk group on NYSE/NYSE MKT or NYSE Arca
- View net notional exposure by symbol or mnemonic
- Receive email or web based alerts when nearing or breaching a firm defined limit
- Invoke a 'kill switch' to prevent further order entry by a mnemonic or risk group

Via the Risk Management Tool, firms can also bulk cancel orders in the event of a gateway outage.

Additionally, NYSE, NYSE MKT and NYSE Arca support Cancel On Disconnect, a feature which automatically cancels eligible open orders if exchange/client connectivity is lost. Members can enable Cancel On Disconnect on a session-by-session basis.

In the event that a NYSE Arca order entry gateway application disconnects internally from the NYSE Pillar system (e.g. due to application re-start), all open orders received from that gateway will be cancelled.

Please refer to the nyse.com market status page (https://www.nyse.com/market-status/history) for information about the status of open orders in the event of a system outage.

6. Market Data

6.1 What market data is available?

NYSE, NYSE MKT and NYSE Arca all publish their quote and trade data to both the SIPs and via proprietary data feeds. SIP data includes the Exchanges' top of book quotes, trades and regulatory information, while proprietary products include order book details (including order-by-order depth of book) and auction imbalance information.

More information is available at: http://www.nyxdata.com/Data-Products

6.2 When are timestamps generated?

On NYSE and NYSE MKT's proprietary market data feeds, the 'SourceTime' field is generated by the matching engine's Trade process and the 'SendTime' field is generated by the XDP Publisher just before sending the packet.

On NYSE Arca's proprietary market data feeds, the 'SourceTime' field is generated by the matching engine's message sequencing module and 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 multicast data over an A and a B multicast line for redundancy. These redundant lines can be received via the SFTI IP network by remote customers. Customers co-located in our Mahwah data center may receive proprietary market data feeds over either the IP network or, in resilient form, the LCN network. Customers should automatically arbitrate between the a- and the b-line so that if one line drops a packet, it normally can still be received over the other line.

In 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, NYSE Group recommends that firms utilizing proprietary market data feeds maintain a connection to the SIPs, and have the ability to switch between the proprietary market data feeds and the SIPs, 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 SFTI Wireless and via SFTI LLN, a low latency fiber route. Note that SFTI Wireless is a fair weather service and that neither SFTI Wireless nor SFTI LLN is a redundant service. Backup connectivity should be established.

7. Resiliency Best Practices

7.1 SFTI

NYSE Group recommends that firms maintain connectivity to the Secure Financial Transaction Infrastracture (SFTI) from multiple geographically diverse SFTI Access Centers. In the event of an Access Center failure, firms should be able to route via another Access Center.

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

7.2 Designated Market Makers

NYSE Group recommends that Designated Market Makers maintain the ability to function remotely, without a physical presence on the trading floor.

7.3 Auctions

NYSE Group recommends that firms maintain the ability to route auction orders to alternative venues in the case that the primary market is impaired.

NYSE will designate an alternate exchange's closing auction as the mechanism for establishing the Official Closing Price if it determines it will be unable to facilitate a closing auction at least an hour before the close. If the impairment occurs with less than 1 hour before the close, the Official Closing Price will be determined based on the VWAP of the consolidated last sale eligible trades during final five minutes of regular trading hours (pending implementation of rules approved in June 2016).

7.4 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. Firms 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. Firms should familiarize themselves with the alternative rules which apply in cases where either the physical trading floor or Mahwah data center are unavailable (e.g. NYSE's alternative auction procedure in cases where the DMM cannot participate).

Firms 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, NYSE Group exchanges will operate from Cermak per exchange rules and previously disseminated disaster recovery plans. The NYSE Technology and Connectivity team can help members establish access to the DR facility.