NYSE
AN ICE EXCHANGE

Technology FAQ and Best Practices:
Equities

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 While the summary information provided is believed to be accurate at the time of publication, the document may become outdated as the Exchanges continuously evaluate new solutions and enhance technology to improve resiliency, performance, and scalability.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

NYSE, NYSE American Equities, NYSE Arca Equities, NYSE Chicago and NYSE National, also referred to as “the Exchanges” throughout this document.

2.2 What are trading hours?

	NYSE (Tape A)	NYSE (Tapes B and C)	NYSE American	NYSE Arca	NYSE Chicago	NYSE National
Trading Hours	9:30am - 4:00pm*	7:00am - 4:00pm	7:00am - 8:00pm	4:00am - 8:00pm	7:00am - 8:00pm	7:00am - 8:00pm
Order Entry	6:30am	6:30am	6:30am	2:30am	6:30am	6:30am

*9:30am - 4:00pm are core trading hours for all NYSE Equity trading platforms.

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

2.3 What securities are traded on each exchange?

All NYSE equities markets trade all NMS equity symbols.

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

2.4 What is the allocation model?

NYSE uses a price/parity model. The parity allocation model distributes executions in a round robin fashion to orders in the electronic order book, Floor Brokers and Designated Market Makers (DMMs) that are at the best price. Orders that set a price level are entitled to an additional allocation before parity allocations are considered. NYSE trading in Tape B and C symbols follows the same trading algorithm model without DMMs.

NYSE American, NYSE Arca, NYSE Chicago and NYSE National use a price/time priority model.

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

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 platforms.

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 2:30am, and to NYSE, NYSE American, NYSE Chicago and NYSE National beginning at 6:30am.

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

NYSE members may also trade from the 11 Wall St trading floor using floor broker handheld devices.

4.2 What messaging protocols are supported?

The Exchanges offer both 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 that exchange.

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 gateway applications is not disclosed and subject to change, but members can expect that each market has multiple gateway instances.

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 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, on NYSE, DMMs 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, based on session start times.

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. Sessions on Pillar native gateways are automatically balanced nightly based on historical message traffic. Performance and message distribution are evaluated by the NYSE Capacity Planning team and adjusted as necessary.

4.11 Are Drop Copy messages available?

Yes. NYSE Group 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. For NYSE, note that drop copies of CCG/BCCG messages are sourced from the order entry gateways themselves, so drop copies will be impacted in the event of an order entry gateway failure or impairment.

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 Technology Member Services group for more information.

- Days available - Monday - Friday
- Phone Support - 9am – 5pm
- Contact info: email: tms@nyse.com Phone: 212-896-2830, 2, 2

5. Matching Engine

5.1 How many matching engines are used by each exchange?

The number of matching engines can be derived by referencing this file.

5.2 How are symbols mapped to matching engines?

The Exchange publish their daily symbol assignment by trading unit or "TXN". Each trading unit uses more than one matching engine, and the symbol to matching engine mapping can be found here.

5.3 What pricing sources are used for away markets?

The Exchanges use a combination of direct feeds and SIP quotes for away markets, with the SIP as back-up for all direct feeds.

Details are available in the exchanges' rulebooks.

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 from CCG (NYSE) and Pillar native gateways (NYSE, NYSE American, NYSE Arca, NYSE Chicago and NYSE National) 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 the multiple gateway queues by the matching engine, also in a round robin fashion.

Inbound messages are processed in a First In First Out manner, as received by the sequencing module.

5.7 Are Risk Management features available?

Yes. **Pre-Trade Risk Controls** are available for optional use by entering firms and/or clearing firms (if authorized by the entering firm) within the Risk Module of the NYSE Pillar Trade Ops

Portal (TOP). Firms may view, set, and monitor risk controls and take Kill Switch actions to cancel open orders and/or block new order entry. Pre-Trade Risk Controls include:

- Single Order Maximum Quantity Limits
- Single Order Maximum Notional Value Limits
- Gross Credit Limits
- Kill Switch Functionality
- Defining automated actions to block new order entry and/or cancel open interest when breaching defined limits
- Configuring email and web-based alerts

Each NYSE Group equity market independently supports these Pre-Trade Risk Controls configured by MPID or by MPID + a SubID registered with the Exchange. Activity is aggregated across order entry ports.

For more information on Pre-Trade Risk Controls, please refer to: NYSE Pillar Pre-Trade Risk Controls - Functional Overview.

Cancel On Disconnect is a feature that 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 an 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?

The Exchanges 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 and depth of book) and auction imbalance information.

More information is available at: https://www.nyse.com/market-data/real-time

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), 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 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 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, members 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 NYSE 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 members maintain the ability to route auction orders to alternative venues in the case that the primary market is impaired.

NYSE, NYSE Arca, or NYSE American 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.

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. 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 should familiarize themselves with the alternative rules that 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. NYSE Group recommends all members review the NYSE Group Disaster Recovery 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.

Some members may be required to participate in annual DR testing and/or Market Wide Circuit Breaker testing pursuant to SEC Regulation SCI and NYSE Group exchange rules.