MIAX Pearl Equities Exchange

Depth of Market Feed
DoM Interface Specification

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Version 1.3c

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1. Overview

MIAX Pearl Equities™ Depth of Market Feed (**DoM**) is a data feed that allows subscribers to receive real-time updates of the following information from the MIAX Pearl Equities Exchange.

- Displayed orders on MIAX Pearl Equities book: Display Price and Display Size of displayed orders are disseminated
- Order executions (trades) and Trade Cancellations
- Trading Status of symbols traded on MIAX Pearl Equities
- MIAX Pearl Equities System Status

DoM Features:

DoM messaging and the system architecture are designed for low latency and high throughput messaging. Some of the key features of the interface are:

- DoM uses binary message format, binary numeric fields and fixed length ASCII fields in messages in order to utilize bandwidth efficiently and assist in achieving **low latency**.
- Message formats are designed to use **less bandwidth**. Some examples: DoM disseminates a separate System Time message for the "seconds" part of the timestamp instead of sending this with every message. DoM messages use Symbol IDs in each message in place of a full canonical symbol.
- DoM is offered with redundant multicast feeds (A Feed & B Feed) to provide single point of failure hardware and network fault tolerance and to provide an opportunity for recipients to arbitrate the two feeds to auto-fill gaps.
- DoM real-time messages are disseminated over multicast to achieve a fair delivery mechanism. DoM requires the use of MIAX proprietary ESesM over TCP/IP protocol for retransmission lines in order to provide a **guaranteed delivery** mechanism for gap fills.
- The DoM retransmission service also provides a **3.2.2 Last Value Refresh Service** to facilitate fast intra-day recovery without a full day gap fill.
- DoM notifications provide current **system status** allowing the subscribers to take necessary actions immediately.

This specification is intended to be used by Pearl DoM subscribers only.

1.1 Exchange related information

1.1.1 Hours of operation for MIAX Pearl Equities Exchange

Please refer to MIAX website for details about times for each of these events/periods.

Note: Times specified below are in United States Eastern Time zone.

Start of Session: Start of dissemination of messages. After 3:00 a.m.

Early Trading Session: 4:00 a.m. to 9:30 a.m.

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Regular Trading Session: 9:30 a.m. to 4:00 p.m. (ends at 1:00 p.m. on early closing days).

Late Trading Session: 4:00 p.m. to 8:00 p.m. (starts at 1:00 p.m and ends at 5:00 pm on early closing days)

MIAX Pearl Equities may send trade related data following the end of trading session due to the issuance of manual trades, trade cancels or trade corrections for various operational reasons as needed.

1.1.2 Obtaining more information

Information such as (but not limited to) membership, rules, data feeds, fees and support can be obtained by sending an email to TradingOperations@miaxglobal.com or by referring to MIAX website.

1.2 Testing of DoM Subscription

MIAX Pearl can provide testing assistance on the MIAX Pearl Equities testing area for the DoM Feed and the DoM retransmission interface.

Please contact MIAX Trading Operations at TradingOperations@miaxglobal.com or (609) 897-7302 to obtain more information about the aforementioned.

1.3 Answers to FAQs

Subscription: Please contact Trading Operations for details about subscribing to DoM.

Symbol management: Subscribers to the data feed will get a list of all symbols that will be traded and sourced on that feed at the start of every session. If firms cannot start listening to the feed in time for the normal symbol broadcast, they can connect to the DoM Retransmission service and request for a Last Value Refresh Service (see section 3.2.2) or request all messages published and then subsequently process only the symbol messages to build their symbol list. The MIAX Pearl Equities assigned Symbol ID of each symbol will be sent in every message so that firms can tie each message to a symbol.

Retransmission: Gap-fill packets generated as a response to retransmission requests are only disseminated on the retransmission TCP channels and not on the real-time multicast feeds.

Redundant Feeds: In order to achieve higher availability, MIAX Pearl Equities offers the real-time DoM feed in two separate redundant and identical feeds named “A Feed” and “B Feed”. Firms are advised to arbitrate between the two feeds in order to mitigate gaps and achieve higher availability. “A Feed” is the primary feed from the primary data center and “B Feed” is the secondary feed from the secondary data center.

Refresh Service: Refresh service is provided only on the retransmission TCP channels and does not affect the real-time DoM feed.

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1.4 Data Types

The following table describes the data types used in DoM messaging:

Note: Time fields in all messages are as per timings of United States Eastern Time zone unless specified otherwise.

Data Type	Description
BinaryU	Unsigned, Intel x86 byte-ordered (**little-endian**), binary encoded numbers
BinaryS	Signed, Intel x86 byte-ordered (**little-endian**), binary encoded numbers
BinaryPrc6U	BinaryU Field with the last 6 (right most) digit places being decimal places
Flags	A special BinaryU type where a bit mask must be used to extract different values. The least significant bit is bit 0.
SecTime	BinaryU field that contains the Matching Engine transaction time in seconds since Epoch (January 1, 1970, 00:00:00 **UTC**)
NanoTime	BinaryU field that contains the Matching Engine transaction time in nanoseconds since past second
Alphanumeric	Each place can contain characters or numbers. Left justified and space-padded on the right

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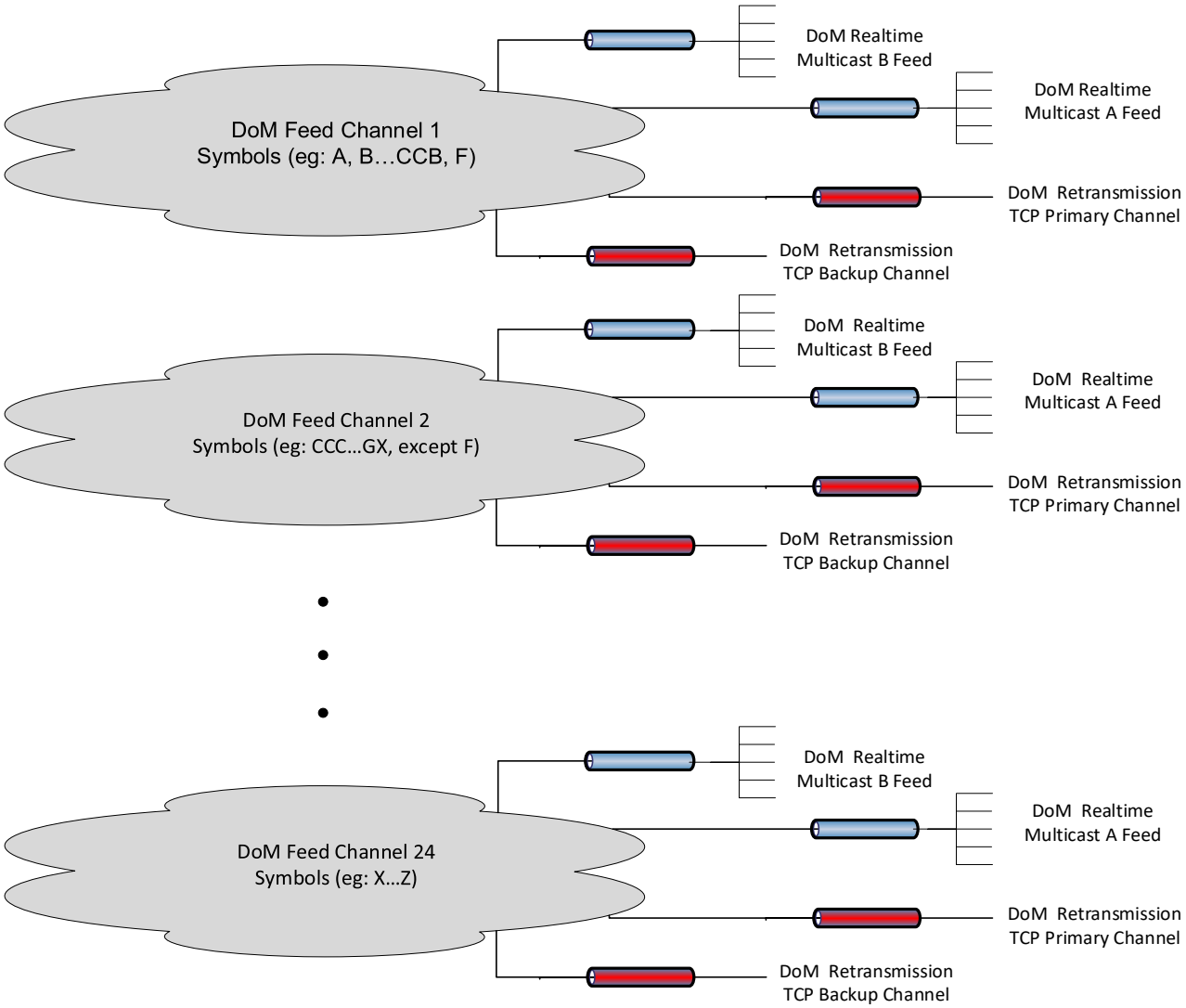
2. DoM Architecture

Depth of Market Feed (DoM) Architecture



Highlights:

- Real-time dissemination is separated out on to 24 separate Feed channels.
- A Feed channel will contain sourced data for a discrete set of symbols.
- A discrete set of symbols will only be sourced by a single feed channel on any given day.
- Each Feed channel sources independently from the other groups and hence has independent sequence numbers.
- All the messages on each feed channel will be published in FIFO sequence.

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- High availability is achieved by disseminating identical data on an “A Feed” and “B Feed” for each Feed channel
- Symbols may not be contiguously distributed according to symbol ranges in each Feed channel.
- Two separate TCP based retransmission channels for each Feed channel supply DoM retransmission via the DoM Retransmission interface.

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3. Session Level Protocol

3.1 Real-time DoM Feed

DoM real-time feed uses MIAX's proprietary **MACH protocol**. Each DoM Packet may have multiple application messages and each application message is encapsulated in a MACH protocol packet. Hence a single DoM packet may contain 1 or more sequenced MACH protocol packets.

Please refer to MACH document (available at MIAX website) for details about MACH protocol. This protocol layer offers low latency application messaging over multicast, sequencing of messages and heartbeats.

3.2 DoM Retransmission Interface

DoM Retransmission Interface uses MIAX's proprietary **ESeSM – TCP Session Management Protocol**.

Please refer to the latest ESeSM TCP Session Management document (available at the MIAX website) for details about ESeSM session management protocol. This protocol layer offers session management capabilities such as authentication, application messaging over TCP/IP, sequencing of messages, heartbeats and gap fills.

Firms must first use the `Login Request` with a requested sequence number of **zero** to login to the Interface. After receiving a successful `Login Response`, the firm can choose either the 3.2.1 ESeSM Gap Fill Service or 3.2.2 Last Value Refresh Service.

3.2.1 ESeSM Gap Fill Service

Firms can use the **Retransmission Request** session management message, available in the ESeSM protocol, to request retransmission of a specific range of packets, identified by sequence numbers.

3.2.2 Last Value Refresh Service

3.2.2.1 Request Message to MIAX Pearl Equities

Firms can use the **Unsequenced Data Packet,** available in the ESeSM protocol, to request a last value refresh of various market data and status information. The Refresh Request has the following format:

Field Name	Length	Data Type	Notes
ESeSM Packet Length	2	Binary	
ESeSM Packet Type	1	Alphanumeric	*'U' – ESeSM Unsequenced Packet*
Request Type	1	Alphanumeric	'R' – Refresh
Refresh Message Type	1	Alphanumeric	'S' – Symbol Update Refresh 't' – Security Trading Status Refresh 's' – System State Refresh

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Field Name	Length	Data Type	Notes
			'O' – Order Book Refresh

3.2.2.2 Response Message from MIAX Pearl Equities

The Retransmission feed will respond to the Refresh request with a series of ESeSM-TCP **Unsequenced Data Packets** based on the Refresh Message Type. Each response message will have the *following format:*

Field Name	Length	Data Type	Notes
ESeSM Packet Length	2	Binary	
ESeSM Packet Type	1	Alphanumeric	*'U' – ESeSM Unsequenced Packet*
Response Type	1	Alphanumeric	'r' – Refresh
Sequence Number	8	BinaryU	See notes below.
Application Message	Varies	See section 4	Based on the message type requested.

Points to note:

- The first ESeSM TCP packet to be received by the firms will be the 4.1 System Time Message (See section 4.1). The timestamp (combined with the nanosecond part in the subsequent messages) represents the most recent MIAX Pearl Equities Matching Engine transaction time. It is ***not*** the original timestamp from the MACH sequenced messages in the live feed.
- When Refresh Message Type in the request is 'S', 't' or 's', the sequence number in the refresh messages is the original sequence number from live feed. This sequence number may be used to arbitrate with the sequenced packets from live feed (e.g.: data with higher sequence number from either the refresh or the live feed represents latest information).
- When Refresh Message Type in the request is 'O' – Order Book Refresh, the sequence number in the refresh messages will be the same, which will be the last sequence number on the live feed at the time of the refresh request. The refresh will include the following messages in order *as of the time of refresh request.* The timestamp in all the refresh messages will be the most recent MIAX Pearl Equities Matching Engine transaction time *as of time of refresh request*
    - System Time message
    - Latest System State message
    - Latest Symbol Update message for each symbol
    - Latest Security Trading Status Notification message for each symbol
    - All Add Order messages necessary to build the book for each symbol

3.2.2.3 End of Refresh Notification from MIAX Pearl Equities

When the refresh is complete MIAX Pearl Equities will send the following message.

Field Name	Length	Data Type	Notes
ESeSM Packet Length	2	Binary	
ESeSM Packet Type	1	Alphanumeric	*'U' – ESeSM Unsequenced Packet*
Response Type	1	Alphanumeric	'E' – End of Request.

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Field Name	Length	Data Type	Notes
Refresh Message Type	1	Alphanumeric	from Refresh Request

3.2.3 Session Termination

After satisfying the retransmission request, DoM Retransmission Interface will send a `Goodbye Packet` and disconnect the TCP connection.

Note: Upon receipt of an unknown, malformed or illegal session message, MIAX Pearl Equities will send an ESeSM “Goodbye Packet” with a human readable reason text string and MIAX Pearl Equities will disconnect the line.

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4. Application Message Formats

This section consists of format of messages sent over the DOM feed.

The time specified in the *Timestamp* field in all the messages below is the time at which the MIAX Pearl Equities Matching Engine associated with that symbol group published the message. This is the same timestamp that will get included in the messages transmitted on the retransmission interface.

4.1 System Time Message

This message is used to disseminate the "seconds" part of the timestamp that is applicable to all messages that are sent in the current second.

Field Name	Length	Data Type	Notes
MACH Protocol Data			*Refer to MACH Protocol Specification*
Message Type	1	BinaryU	49
Time Stamp	4	SecTime	Seconds part of the time that applies to all messages that gets disseminated until this message gets sent again.

Points to note:

- Note that this message is only sent when there are any application messages that are going to be sent during any second. Firms are advised to not assume that there will be a message for every second of the day.

4.2 Symbol Update

This is the message format that will be used to disseminate all security symbols traded on MIAX Pearl Equities for the current trading session. The Symbol ID sent in this message will be disseminated in Depth of Market messages.

Field Name	Length	Data Type	Notes
MACH Protocol Data			*Refer to MACH Protocol Specification*
Message Type	1	BinaryU	1
Timestamp	4	NanoTime	Nanosecond part of Matching Engine time.
Symbol ID	4	BinaryU	Symbol ID mapped to a given symbol. It is assigned per trading session and is valid for that session. Firms are advised to download and use Symbol IDs for the current trading session as Symbol IDs could change across trading sessions.

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Field Name	Length	Data Type	Notes
Ticker Symbol	11	Alphanumeric	Ticker symbol for the security in NASDAQ Integrated Platform format.
Reserved	1	BinaryU	Reserved for future use
Test Security Indicator	1	Alphanumeric	'Y' – Yes 'N' – No
Reserved	1	BinaryU	Reserved for future use
Lot Size	2	BinaryU	Round Lot size in shares
Opening Time	8	Alphanumeric	Expressed in HH:MM:SS format. Eg: 04:00:00
Closing Time	8	Alphanumeric	Expressed in HH:MM:SS format. Eg: 20:00:00
Primary Market Code	1	Alphanumeric	'A' – NYSE American 'B' – NASDAQ BX 'C' – NYSE National 'H' – MIAX Pearl Equities 'I' – NASDAQ ISE 'J' – CBOE EDGA Exchange 'K' – CBOE EDGX Exchange 'L' – Long-Term Stock Exchange 'M' – NYSE Chicago 'N' – New York Stock Exchange 'P' – NYSE Arca 'Q' – NASDAQ 'U' – Members Exchange 'V' – Investors' Exchange 'W' – CBOE Stock Exchange 'X' – NASDAQ PHLX 'Y' – CBOE BYX Exchange 'Z' – CBOE BZX Exchange

Points to note:

- Entire Symbol list for the channel will be disseminated at the start of day.
- In each channel, firms will only receive the symbols associated with the Matching Engine that is servicing that channel.
- Intra-day updates will also be published as they occur.
- In case of an intra-day reconnection, users can request all symbols data from the DoM retransmission line.

4.3 System State

This is the message format that will be used to notify firms of the state changes of the system. This is a notification that applies to all symbols on the feed. Firms can use notifications as triggers in their system to ensure electronic synchronization of systems.

Field Name	Length	Data Type	Notes
MACH Protocol Data			*Refer to MACH Protocol Specification*

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Field Name	Length	Data Type	Notes
Message Type	1	BinaryU	83
Timestamp	4	NanoTime	Nanosecond part of Matching Engine time.
DoM Version	8	Alphanumeric	Eg: DoM1.0
Session ID	1	BinaryU	Current trading session identifier.
System Status	1	Alphanumeric	'S' = Start of System hours 'C' = End of System hours '1' = Start of Test Session (sent before tests). '2' = End of Test Session.

Points to note:

- Firms must ensure that messages sent on the DoM Feed from the beginning of "start of test session" to the end of "end of test session" will not affect their production session while allowing the firms to still be involved in production tests and dry runs.
- A change in Session ID will mean a restart at MACH sequence number 1 for that symbol group. Refer to MACH protocol specification for details about this. Firms must be able to handle more than one trading session in a single trading day.

4.4 Security Trading Status Notification

This message is used to notify firms of changes to the trading status of a particular security.

Field Name	Length	Data Type	Notes
MACH Protocol Data			*Refer to MACH Protocol Specification*
Message Type	1	BinaryU	4
Timestamp	4	NanoTime	Nanosecond part of Matching Engine time.
Symbol ID	4	BinaryU	Symbol ID mapped to a given symbol.
Trading Status	1	BinaryU	1 - Pre-Open 2 - Trading 3 - Halt 4 - Operational Halt 5 - Closed
Market State	1	BinaryU	1 - Pre-Opening 2 - Early Trading Session 3 - Regular Trading Session 4 - Late Trading Session
Short Sale Restriction	1	Alphanumeric	Current state of short sale restriction. 'Y' – Short Sale Restriction is in effect 'N' – Short Sale Restriction is not in effect

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4.5 Symbol Clear Message

This message format is used to indicate that the MIAX Pearl Equities book for a symbol has been cleared of all orders.

Field Name	Length	Data Type	Notes
MACH Protocol Data			*Refer to MACH Protocol Specification*
Message Type	1	BinaryU	5
Timestamp	4	NanoTime	Nanosecond part of Matching Engine time.
Symbol ID	4	BinaryU	Symbol ID mapped to a given symbol.

Points to note:

- This message will be sent anytime when MIAX Pearl Equities book is cleared of all orders including at startup each day and on Matching Engine recovery for all affected symbols

4.6 Add Order Message

This is the message format that will be used when a displayed order is received and added to MIAX Pearl Equities book. It includes an Order ID that is unique to the order across the exchange and across trading days.

Field Name	Length	Data Type	Notes
MACH Protocol Data			*Refer to MACH Protocol Specification*
Message Type	1	BinaryU	20
Timestamp	4	NanoTime	Nanosecond part of Matching Engine time.
Symbol ID	4	BinaryU	Symbol ID mapped to a given symbol.
Order ID	8	BinaryU	Matching engine assigned Order ID.
Order Side	1	Alphanumeric	Side of order. Valid values: B = Buy S = Sell
Price	8	BinaryPrc6U	Displayed price.
Size	4	BinaryU	Number of displayed shares of the order.
Attributable ID	4	Alphanumeric	MPID of the firm if attributed as such. “RTAL” if attributed as such. Space-filled if no attribution specified on the order by firm.

Points to note:

- Order open size can increase, decrease or increase after going down to zero due to routing and reintroduction activities.
- If an order’s size on the book is reduced to zero, other than by a trade, a Delete Order message will be published.
- It is possible that an order may be deleted and subsequently added back with the original Order ID. Subscribers must be able to handle this.

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- Orders fully executed, fully routed, rejected or cancelled immediately upon receipt are not disseminated.

4.7 Modify Order Message

This message format is used to publish price/size changes for an existing displayed order on MIAX Pearl Equities book.

Field Name	Length	Data Type	Notes
MACH Protocol Data			*Refer to MACH Protocol Specification*
Message Type	1	BinaryU	21
Timestamp	4	NanoTime	Nanosecond part of Matching Engine time.
Symbol ID	4	BinaryU	Symbol ID mapped to a given symbol.
Order ID	8	BinaryU	Provided in the Add Order message.
Price	8	BinaryPrc6U	Displayed price after this modify.
Size	4	BinaryU	Number of displayed shares after this modify.
Flags	1	Flags	**Bit 0: Order Position** 0 – Order kept its position in the book 1 – Order lost its position in the book **Bits 1-7:** undefined

4.8 Delete Order Message

This message format is used to indicate that a displayed order has been removed from the MIAX Pearl Equities book.

Field Name	Length	Data Type	Notes
MACH Protocol Data			*Refer to MACH Protocol Specification*
Message Type	1	BinaryU	23
Timestamp	4	NanoTime	Nanosecond part of Matching Engine time.
Symbol ID	4	BinaryU	Symbol ID mapped to a given symbol.
Order ID	8	BinaryU	Provided in the Add Order message.

4.9 Order Execution Message

This message format is used when a displayed order on the book executes in whole or in part. The execution is identified by a unique Trade ID that is unique across the exchange for the trading day. Subsequent partial executions of the order would be published with the same Order ID but different Trade ID.

Field Name	Length	Data Type	Notes
MACH Protocol Data			*Refer to MACH Protocol Specification*
Message Type	1	BinaryU	24
Timestamp	4	NanoTime	Nanosecond part of Matching Engine time.
Symbol ID	4	BinaryU	Symbol ID mapped to a given symbol.

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Field Name	Length	Data Type	Notes
Order ID	8	BinaryU	Provided in the Add Order message.
Trade ID	8	BinaryU	Unique ID assigned by the Matching Engine.
Price	8	BinaryPrc6U	Execution price.
Size	4	BinaryU	Number of shares executed.
Flags	1	Flags	**Bit 0: SIP Reporting** 0 – Not reportable to the SIP 1 – Reportable to the SIP **Bit 1: Traded Against Retail** 0 – Did not trade against Retail. 1 – Traded Against Retail **Bits 2-7: Reserved for future use** Note: Bit 0 is LSB.

Points to note:

- It is possible that two Order Execution messages are published with the same Trade ID when two orders already on the book trade. However, only the Sell side Order Execution message will be marked as 'Reportable to the SIP'.
- Trade ID assigned to a trade execution is used in subsequent Trade Cancel message if the trade is cancelled.
- If the execution is corrected, trade corrections are published with the same Trade ID as the original execution.
- For clients maintaining an order book, the order size is reduced by the executed size. If a trade execution is reported by the Order Execution message, there will be no other message to indicate this order size reduction.

4.10 Trade Message

This message format is used to publish trade executions for orders not displayed on the book. Executions for orders routed and executed in another trading center and trade corrections are also published using this message.

Field Name	Length	Data Type	Notes
MACH Protocol Data			*Refer to MACH Protocol Specification*
Message Type	1	BinaryU	10
Timestamp	4	NanoTime	Nanosecond part of Matching Engine time.
Symbol ID	4	BinaryU	Symbol ID mapped to a given symbol.
Trade ID	8	BinaryU	Unique ID assigned by the Matching Engine.
Correction Number	1	BinaryU	Trade correction number. Set to zero for new trades. Increments by 1 for each subsequent correction.
Price	8	BinaryPrc6U	Execution price.
Size	4	BinaryU	Number of shares executed.
Flags	1	Flags	**Bit 0: SIP Reporting** 0 – Not reportable to the SIP 1 – Reportable to the SIP

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Field Name	Length	Data Type	Notes
			Bit 1: Retail Trade Indicator 0 – Neither side is Retail 1 – At least one side is Retail **Bits 2-7: Reserved for future use** Note: Bit 0 is LSB.

Points to note:

- Trade ID assigned to a trade is used in subsequent Trade Cancel message if the trade is cancelled.
- Trade corrections will have the same Trade ID as the original trade, the Correction Number will be incremented for each subsequent correction.
- Trade messages do not alter the book and can be ignored by recipients that are not building a book.
- A complete view of all MIAX Pearl Equities executions can be built by using the Order Execution Messages, Trade Messages, and Trade Cancel Messages.

4.11 Trade Cancel Message

This message format is used to publish cancellation of a trade which was previously published via an Order Execution Message or a Trade Message.

Field Name	Length	Data Type	Notes
MACH Protocol Data			*Refer to MACH Protocol Specification*
Message Type	1	BinaryU	11
Timestamp	4	NanoTime	Nanosecond part of Matching Engine time.
Symbol ID	4	BinaryU	Symbol ID mapped to a given symbol.
Trade ID	8	BinaryU	Provided in the Order Execution or Trade message.
Correction Number	1	BinaryU	The latest correction number of the given Trade ID.
Price	8	BinaryPrc6U	The latest price of the given Trade ID.
Size	4	BinaryU	The latest size of the given Trade ID.

Points to note:

- Trade Cancel messages do not alter the book and can be ignored by recipients which are not building a book.

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Appendix A: DoM Subscription/Connectivity Information

Please visit MIAX website to obtain the most up-to-date information about the following:

- Real-time Feed multicast groups, ports for A feed and B Feed
- Retransmission IP addresses and ports for primary and backup channels.

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Appendix B: Contact List

Please visit MIAX website to obtain the most up-to-date contact list and other such information.

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Appendix C: Revision History

Revision Date	Version	Description
Jan 22, 2020	1.0	First official release.
Apr 02, 2020	1.1	Removed Tradable field from Symbol Update message. It is now replaced with a reserved field.
Jun 15, 2020	1.2	Added a Symbol Clear message. Minor clarification in the Order Execution message noting that if a trade execution is reported with an Order Execution message, no other message will be published to indicate the resulting size reduction for the order.
Jul 15, 2020	1.3	Added support for Order Book Refresh in the Last Value Refresh Service
Nov 05, 2020	1.3.a	Removed Security Type field from Symbol Update message, it is now replaced with a reserved field. Added clarification in Symbol Update message for Symbol ID field that it could change across trading sessions and firms are advised to download and use it for the current trading session.
Sept 25, 2023	1.3.b	Added the “Traded Against Retail” flag in the Order Execution and “Retail Trade Indicator” flag in the Trade Message
Aug 22, 2024	1.3.c	Updated the Hours of operation for MIAX Pearl Equities Exchange to support Early and Late Trading. Updated the Notes for the field “Market State” in the Security Trading Status Notification message to indicate support for ‘Early Trading Session’ and ‘Late Trading Session’.

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