

MIAx Pearl Options Exchange

Pearl Liquidity Feed (PLF) Interface Specification

Revision Date: 10/05/2020
Version: 1.2

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1. Overview

Pearl Liquidity Feed (PLF) is a data feed that allows subscribers to receive real-time updates of the following information from the MIAX Pearl Options Market (referred to as Pearl for the rest of the document)

- Pearl Options orders (Please refer to the rules as to the types of orders published)
- Products traded on Pearl
- Pearl Options System status
- Pearl Underlying trading status

PLF Features:

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

- PLF uses binary message format, binary numeric fields and fixed length ASCII fields messages in order to utilize bandwidth efficiently and assist in achieving **low latency**. PLF messages use Product IDs in each message in place of a full canonical symbol.
- PLF 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.
- PLF real-time messages are disseminated over multicast to achieve a fair delivery mechanism. PLF requires the use of MIAX proprietary SesM over TCP/IP protocol for retransmission lines in order to provide a **guaranteed delivery** mechanism for gap fills.
- The PLF retransmission service also provides a 3.2.2 Last Value Refresh **Service** to facilitate fast intra-day recovery without a full day gap fill.
- PLF notifications provide current **electronic system status** allowing the subscribers to take necessary actions immediately.

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

1.1 Exchange Related Information

1.1.1 Hours of Operation for Pearl Options Exchange

Please refer to MIAX website at <http://www.MIAXOptions.com> for details about times for each of these events.

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

Start of Session: Start of dissemination of messages. After 5:00 a.m.

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

Trading Session for ETF and Index Options: 9:30 a.m. to 4:15 p.m. (ends at 1:15 p.m. on early closing days).

End of Order Cancel Acceptance: 4:25 p.m. (1:25 p.m. on early closing days). However, Pearl may send order messages following the end of order cancel acceptance due to manual actions of the trade desk for various operational reasons.

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 Trading Operations or by referring to MIAX website at <http://www.MIAXOptions.com>.

1.2 Testing of PLF Subscription

Pearl can provide testing assistance on the Pearl testing area for the PLF Feed and the PLF retransmission interface.

Please contact MIAX Trading Operations at TradingOperations@MIAXOptions.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 PLF.

Symbol management: Subscribers to the data feed will get a list of all option 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, they can connect to the PLF Retransmission service and request for a Last Value Refresh Service (see section 3.2.2 **Last Value Refresh Service**) or request all messages published and then subsequently process only the symbol to build their symbol list. The Pearl assigned Product ID of each option will be sent in every message so that firms can tie each message to an option 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, Pearl offers the real-time PLF 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 PLF feed.

1.4 Data Types

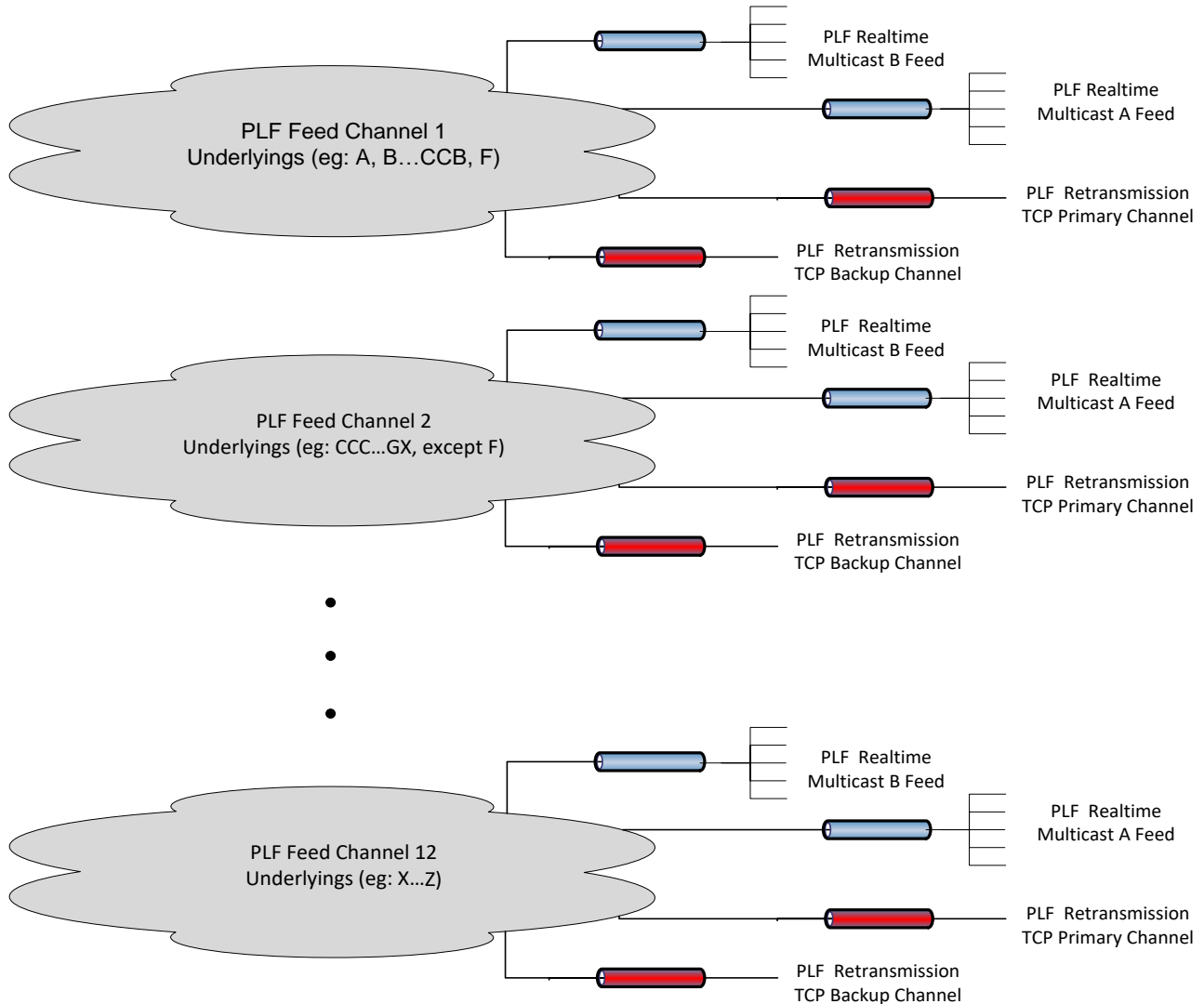
The following table describes the data types used in PLF messaging:

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
BinaryPrc4U	BinaryU Field with the last 4 (right most) digit places being decimal places
SecTime	BinaryU field that contain transaction time in seconds since Epoch (January 1, 1970, 00:00:00 UTC)
NanoTime	BinaryU field that contain transaction time in nanoseconds since past second
Alphanumeric	Each place can contain characters or numbers. Left justified and space-padded on the right

2. PLF Architecture

PEARL Liquidity Feed (PLF) Architecture



Highlights:

- Real-time dissemination is separated out on to 12 separate Feed channels.
- A Feed channel will contain sourced data for all options for a single underlying.
- Any options for any given underlying 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.
- High availability is achieved by disseminating identical data on an “A Feed” and “B Feed” for each Feed channel

- Underlyings may not be contiguously distributed according to symbol ranges in each Feed channel.
- Two separate TCP based retransmission channels for each Feed channel supply PLF retransmission via the PLF Retransmission interface.

3. Session Level Protocol

3.1 Real-time PLF Feed

PLF real-time feed uses MIAX’s proprietary **MACH protocol**. Each PLF Packet may have multiple application messages and each application message is encapsulated in a MACH protocol packet. Hence a single PLF 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 PLF Retransmission Interface

PLF Retransmission Interface uses MIAX’s proprietary **SesM – TCP Session Management Protocol**.

Please refer to the latest SesM TCP Session Management document (available at the [MIAX website](#)) for details about SesM 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 SesM Gap Fill **Service** or 3.2.2 Last Value Refresh **Service**.

3.2.1 SesM Gap Fill Service

Firms can use the **Retransmission Request** session management message, available in the SesM 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 Pearl

Firms can use the **Unsequenced Data Packet**, available in the SesM 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
SesM Packet Length	2	Binary	
SesM Packet Type	1	Alphanumeric	‘U’ – SesM Unsequenced Packet
Request Type	1	Alphanumeric	“R” – Refresh
Refresh Message Type	1	Alphanumeric	“P” - Series Update Refresh “U” – Underlying Trading Status Refresh “S” – System State Refresh

Field Name	Length	Data Type	Notes
			"O" – Order Book Refresh. (Refer to details below.)

3.2.2.2 Response Message from Pearl

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

Field Name	Length	Data Type	Notes
SesM Packet Length	2	Binary	
SesM Packet Type	1	Alphanumeric	'U' – SesM Unsequenced Packet
Response Type	1	Alphanumeric	"R" –Refresh
Sequence Number	8	BinaryU	Refer to details below.
Application Message	varies	See section 4. Application Message Formats	Based on the message type requested.

Points to note:

- The first SesM TCP packet to be received by the firms will be the 4.1 Pearl System Time Message (See section 4.1 Pearl System Time Message). The timestamp (combined with the nanosecond part in the subsequent messages) represents the most recent Matching Engine transaction time. It is **not** the original timestamp from the MACH sequenced messages in the live feed.
- Sequence Number
 - When the Refresh Message Type in the request is 'P', 'U' or 'S', the sequence number in the refresh message is the original sequence number from the 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 the 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 timestamp in all the refresh messages will be the most recent Pearl Matching Engine transaction time as *of the time of refresh request*. The refresh will include the messages listed below in that order *as of the time of refresh request*.
 - System Time message
 - Latest System State message
 - Latest Series Update message for all Option series traded on Pearl for the current session
 - Latest Underlying Trading Status Notifications for each underlying
 - All open orders messages necessary to build the book for each Product ID

For a possible way to use the Order Book Refresh, refer to Appendix C below.

3.2.2.3 End of Refresh Notification from Pearl

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

Field Name	Length	Data Type	Notes
SesM Packet Length	2	Binary	
SesM Packet Type	1	Alphanumeric	'U' – SesM Unsequenced Packet
Response Type	1	Alphanumeric	"E" – End of Request.
Refresh Message Type	1	Alphanumeric	from Refresh Request

3.2.3 Session Termination

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

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

4. Application Message Formats

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

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

4.1 Pearl System Time Message

This is the message format that will be 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
<i>MACH Protocol Data</i>			<i>Refer to MACH Protocol Specification</i>
Message Type	1	Alphanumeric	“1”
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 Series Update

This is the message format that will be used to disseminate all Option series traded on Pearl for the current session.

Field Name	Length	Data Type	Notes
<i>MACH Protocol Data</i>			<i>Refer to MACH Protocol Specification</i>
Message Type	1	Alphanumeric	“P”
Product Add/Update Time	4	NanoTime	Time at which this product is added/updated on Pearl system today.
Product ID	4	BinaryU	Pearl Product ID mapped to a given option. It is assigned per trading session and is valid for that session.
Underlying Symbol	11	Alphanumeric	Stock Symbol for the option.
Security Symbol	6	Alphanumeric	Option Security Symbol
Expiration Date	8	Alphanumeric	Expiration date of the option in YYYYMMDD format
Strike Price	4	BinaryPrc4U	Explicit strike price of the option. Refer to data types for field processing notes

Field Name	Length	Data Type	Notes														
Call or Put	1	Alphanumeric	Option Type "C" = Call "P" = Put														
Opening Time	8	Alphanumeric	Expressed in HH:MM:SS format. Eg: 09:30:00														
Closing Time	8	Alphanumeric	Expressed in HH:MM:SS format. Eg: 16:15:00														
Restricted Option	1	Alphanumeric	"Y" = Pearl will accept position closing orders only "N" = Pearl will accept open and close positions														
Long Term Option	1	Alphanumeric	"Y" = Far month expiration (as defined by Pearl rules) "N" = Near month expiration (as defined by Pearl rules)														
Active on Pearl	1	Alphanumeric	Indicates if this symbol is tradable on MIAX in the current session: "A" = Active (tradable) on Pearl "I" = Inactive (not tradable) on Pearl														
Pearl BBO Posting Increment Indicator	1	Alphanumeric	This is the Minimum Price Variation as agreed to by the Options industry (penny pilot program) and as published by Pearl <table border="1" data-bbox="824 930 1390 1125"> <thead> <tr> <th rowspan="2">Indicator</th> <th colspan="2">BBO Increments</th> </tr> <tr> <th>Price <= \$3</th> <th>Price > \$3</th> </tr> </thead> <tbody> <tr> <td>"P"</td> <td>Penny (0.01)</td> <td>Penny (0.01)</td> </tr> <tr> <td>"N"</td> <td>Penny (0.01)</td> <td>Nickel (0.05)</td> </tr> <tr> <td>"D"</td> <td>Nickel (0.05)</td> <td>Dime (0.10)</td> </tr> </tbody> </table>	Indicator	BBO Increments		Price <= \$3	Price > \$3	"P"	Penny (0.01)	Penny (0.01)	"N"	Penny (0.01)	Nickel (0.05)	"D"	Nickel (0.05)	Dime (0.10)
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Liquidity Acceptance Increment Indicator	1	Alphanumeric	This is the Minimum Price Variation for Quote/Order acceptance as per Pearl rules <table border="1" data-bbox="824 1203 1390 1398"> <thead> <tr> <th rowspan="2">Indicator</th> <th colspan="2">Quoting Increments</th> </tr> <tr> <th>Price <= \$3</th> <th>Price > \$3</th> </tr> </thead> <tbody> <tr> <td>"P"</td> <td>Penny (0.01)</td> <td>Penny (0.01)</td> </tr> <tr> <td>"N"</td> <td>Penny (0.01)</td> <td>Nickel (0.05)</td> </tr> <tr> <td>"D"</td> <td>Nickel (0.05)</td> <td>Dime (0.10)</td> </tr> </tbody> </table>	Indicator	Quoting Increments		Price <= \$3	Price > \$3	"P"	Penny (0.01)	Penny (0.01)	"N"	Penny (0.01)	Nickel (0.05)	"D"	Nickel (0.05)	Dime (0.10)
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"D"	Nickel (0.05)	Dime (0.10)															

Field Name	Length	Data Type	Notes																																												
Opening Underlying Market Code	1	Alphanumeric	Options opening will be triggered on receipt of Opening quote/trade from this Underlying market:																																												
			<table border="1"> <thead> <tr> <th>Market Code</th> <th>Description</th> </tr> </thead> <tbody> <tr><td>A</td><td>NYSE Amex</td></tr> <tr><td>B</td><td>NASDAQ OMX BX</td></tr> <tr><td>C</td><td>National Stock Exchange</td></tr> <tr><td>D</td><td>FINRA ADF</td></tr> <tr><td>E</td><td>Market Independent (Any market that opens first)</td></tr> <tr><td>H</td><td>MIAX Pearl Equities</td></tr> <tr><td>I</td><td>International Securities Exchange</td></tr> <tr><td>J</td><td>EDGA Exchange, Inc</td></tr> <tr><td>K</td><td>EDGX Exchange, Inc</td></tr> <tr><td>L</td><td>LTSE</td></tr> <tr><td>M</td><td>Chicago Stock Exchange</td></tr> <tr><td>N</td><td>NYSE Euronext</td></tr> <tr><td>P</td><td>NYSE Arca Exchange</td></tr> <tr><td>Q</td><td>NASDAQ OMX (via UTP Feed)</td></tr> <tr><td>T</td><td>NASDAQ OMX (via CTA Feed)</td></tr> <tr><td>U</td><td>MEMX</td></tr> <tr><td>V</td><td>IEX</td></tr> <tr><td>W</td><td>CBOE Stock Exchange (CBSX)</td></tr> <tr><td>X</td><td>NASDAQ OMX PHLX</td></tr> <tr><td>Y</td><td>BATS Y-Exchange, Inc</td></tr> <tr><td>Z</td><td>BATS Exchange Inc</td></tr> </tbody> </table>	Market Code	Description	A	NYSE Amex	B	NASDAQ OMX BX	C	National Stock Exchange	D	FINRA ADF	E	Market Independent (Any market that opens first)	H	MIAX Pearl Equities	I	International Securities Exchange	J	EDGA Exchange, Inc	K	EDGX Exchange, Inc	L	LTSE	M	Chicago Stock Exchange	N	NYSE Euronext	P	NYSE Arca Exchange	Q	NASDAQ OMX (via UTP Feed)	T	NASDAQ OMX (via CTA Feed)	U	MEMX	V	IEX	W	CBOE Stock Exchange (CBSX)	X	NASDAQ OMX PHLX	Y	BATS Y-Exchange, Inc	Z	BATS Exchange Inc
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Z	BATS Exchange Inc																																														
Reserved	12	BinaryU	** Reserved for future use **																																												

Points to note:

- Entire Options list will be disseminated at the start of day.
- In each channel, firms will only receive the series associated with the 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 Options series data from the PLF retransmission line.

4.3 System State

This message format is used to notify the firms of the state changes of the system. This is a notification that applies to each Underlying group. Firms can use notifications as triggers in their system to ensure electronic synchronization of systems.

Field Name	Length	Data Type	Notes
<i>MACH Protocol Data</i>			<i>Refer to MACH Protocol Specification</i>

Field Name	Length	Data Type	Notes
Message Type	1	Alphanumeric	"S"
Notification Time	4	NanoTime	Time at which this was generated by Pearl system.
PLF Version	8	Alphanumeric	Eg: PLF1.0
Session ID	4	BinaryU	Pearl assigned ID for the current trading session
System Status	1	Alphanumeric	Current system status: "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 PLF 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 that restarting at MACH sequence number 1 for that Underlying 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 Underlying Trading Status Notification

This message format will be used to notify firms of changes to the trading status of all the options of an underlying.

Field Name	Length	Data Type	Notes
<i>MACH Protocol Data</i>			<i>Refer to MACH Protocol Specification</i>
Message Type	1	Alphanumeric	"H"
Timestamp	4	NanoTime	Time at which this was generated by Pearl system.
Underlying Symbol	11	Alphanumeric	Underlying Symbol
Trading Status	1	Alphanumeric	"H" = Pearl has halted trading for this Underlying Symbol "R" = Pearl will resume trading (reopen) for this Underlying Symbol "O" = Pearl will open trading for this Underlying Symbol
Event Reason	1	Alphanumeric	"A" = This event resulted from automatic/market driven event "M" = Pearl manually initiated this event
Expected Event Time: Seconds Part	4	SecTime	Seconds portion of the expected time of the event. Always use in conjunction with the Nano-seconds part field.
Expected Event Time: Nano-Seconds Part	4	BinaryU	Nano-seconds portion of the expected time of the event. Specifies number of nano-seconds since the seconds specified in "Expected Event Time Seconds" field.

Points to note:

- When underlying trading status = "H", Expected Event Time Seconds/Nano-Seconds will be set to 0 (zero).
- When underlying trading status = "R" or "O", Expected Event Time (Seconds/Nano-Seconds Parts) will be set to the time at which the opening/reopening process will start for this Underlying Symbol.

4.5 Order Message

This is the message format that will be used to disseminate Pearl Options Orders.

Field Name	Length	Data Type	Notes
MACH Protocol Data			<i>Refer to MACH Protocol Specification</i>
Message Type	1	Alphanumeric	"F"
Timestamp	4	NanoTime	Time at which this was generated by Pearl system.
Action	1	Alphanumeric	Order Status. Valid Values: O = Open
Product ID	4	BinaryU	Pearl Product ID mapped to a given option. It is assigned per trading session and is valid for that session.
Order ID	8	BinaryU	Pearl assigned Order ID
Order Side	1	Alphanumeric	Side of order. Valid values: B = Buy S = Sell
Order Type	1	Alphanumeric	Order price type. Valid values: M = Market L = Limit
Order Price	4	BinaryPrc4U	Limit price of the order. Zero for market orders.
Order Original Volume	4	BinaryU	Number of contracts specified on the order.
Remaining Volume Open	4	BinaryU	Number of contracts that are still open for trading at Pearl.
Time In Force (TIF)	1	Alphanumeric	Specifies how long the order remains in effect. Valid values: G = GTC (Good Till Canceled) D = DAY
Origin	1	Alphanumeric	Specifies the order origin type. Valid values: 0 = Priority Customer 1 = Firm 2 = Broker/Dealer

Field Name	Length	Data Type	Notes
			4 = Market Maker (MM) 5 = Non-Member Market Maker 8 = Non-Priority Customer
Open/close indicator	1	Alphanumeric	Specifies if this order opens a position or closes a position. N/A when Origin is set to 4 = Market Maker or 5 = Non-Member Market Maker Valid values: O = Open C = Close “ ” = Not Applicable
Order instruction	1	Alphanumeric	Order instruction that came with the order. Valid values: R = Routable D = Do Not Route (DNR) P = Post Only
Reserved	8	BinaryU	** Reserved for future use **

Points to note:

- Only open orders are disseminated using this message. Close state of an order is disseminated using the Order Close Message (Message Type = “x”)
- Order open size can increase, decrease or increase after going down to zero due to routing and reintroduction activities. It is also possible that such activities can result in identical messages being published occasionally.
- It is possible that an order may be closed and then reopened. Subscribers must be able to handle this.
- Orders executed, rejected or canceled immediately upon receipt are not disseminated.

4.6 Order Close Message

This is the message format that will be used to disseminate Order Close for Pearl Options Orders.

Field Name	Length	Data Type	Notes
<i>MACH Protocol Data</i>			<i>Refer to MACH Protocol Specification</i>
Message Type	1	Alphanumeric	“x”
Timestamp	4	NanoTime	Time at which this was generated by Pearl system.
Order ID	8	BinaryU	Pearl assigned Order ID

Points to note:

- Order Close Message is disseminated for a fill or a cancel.
- Order ID is unique across all Pearl Options Orders and can be used to uniquely identify an order.

Appendix A: PLF Subscription/Connectivity Information

Please visit MIAX website at <http://www.MIAXOptions.com> 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.

Appendix B: Contact List

Please visit MIAX website at <http://www.MIAXOptions.com> to obtain the most up-to-date contact list and other such information.

Appendix C: Possible way to use the Order Book Refresh

- A subscriber connects to the live feed and detects a gap.
 - If gap is small, subscriber may choose to do a gap fill instead of refresh
 - If gap is large or otherwise, subscriber may choose to do a refresh
- Subscriber starts queuing the messages on the live feed and simultaneously connects to the PLF retransmission service.
- Subscriber makes a Last Value Refresh request with Refresh Message Type = "O" (Order Book Refresh).
- Subscriber stores the sequence number received as part of the response.
- All messages need to be consumed till the end of refresh.
- After the end of refresh for Order Book, subscriber discards all queued messages from live feed till the sequence number received on the response.
- If live feed sequence number > sequence number received in refresh, do a gap fill for that set, then process the live feed queue
- Subscriber processes all the remaining queued messages to be current with the feed and continue processing the live feed.

Appendix D: Revision History

Revision Date	Version	Author	Description
Sep 30, 2016	1.0	Vinay S. Rao	First release.
Feb 27 th 2017	1.0a	Vinay S. Rao	System startup time moved up
Apr 24 th 2018	1.1	Siddharth Sahoo	Order Message (Message Type = "F"): Removed Action = C (Close) Added a new message, Order Close Message (Message Type = "x")
Oct 05 th 2020	1.2	Mubasshir Poonawala	Support for Open Orders Refresh. Added new equities exchanges.

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