US Options Complex Multicast PITCH Specification

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1 Introduction

1.1 Overview

Note that this specification will be the standard specification to be used for complex options on the Cboe EDGX and C2 Options Exchange platforms.

Cboe customers may use Complex Multicast PITCH to receive real-time depth of book quotations and execution information direct from Cboe. This feed will only include quotations and executions related to complex orders.

Complex Multicast PITCH cannot be used to enter orders. For order entry, refer to the appropriate US Options FIX or BOE Specifications.

A Gig-Shaped version of the Complex Multicast PITCH feed is available from both of Cboe's datacenters. Customers may choose to take one or more of the following Complex Multicast PITCH feed options depending on their location and connectivity to Cboe.

Complex Multicast PITCH Feed Descriptions:

Exchange	Shaping (Gig)	Served From Data Center (Primary/Secondary)	Multicast Feed ID
EDGX Options	Gig	Primary	EAC
EDGX Options	Gig	Primary	EBC
EDGX Options	Gig	Secondary	EEC
C2 Options	Gig	Primary	WAC
C2 Options	Gig	Primary	WBC
C2 Options	Gig	Secondary	WEC

1.2 Feed Connectivity Requirements

Gig Shaped feeds are available to customers with a minimum of 1 Gb/s of connectivity to Cboe via cross connect or dedicated circuit.

Customers with sufficient connectivity may choose to take more than one Gig-Shaped feed from the Cboe datacenters and arbitrate the feeds to recover lost data. It should be noted that feeds from the secondary datacenter will have additional latency for those co-located with Cboe in the primary datacenter due to proximity.

Cboe Complex Multicast PITCH real-time events are delivered using a published range of multicast addresses divided by symbol range units. Dropped messages can be requested using a TCP/IP connection to one of Cboe's Gap Request Proxy ("GRP") servers with replayed messages being delivered on a separate set of multicast ranges reserved for packet retransmission. Intraday, a spin of all open orders may be requested from a Spin Server. This allows a client to become current without requesting a gap for all messages up to that point in the day.

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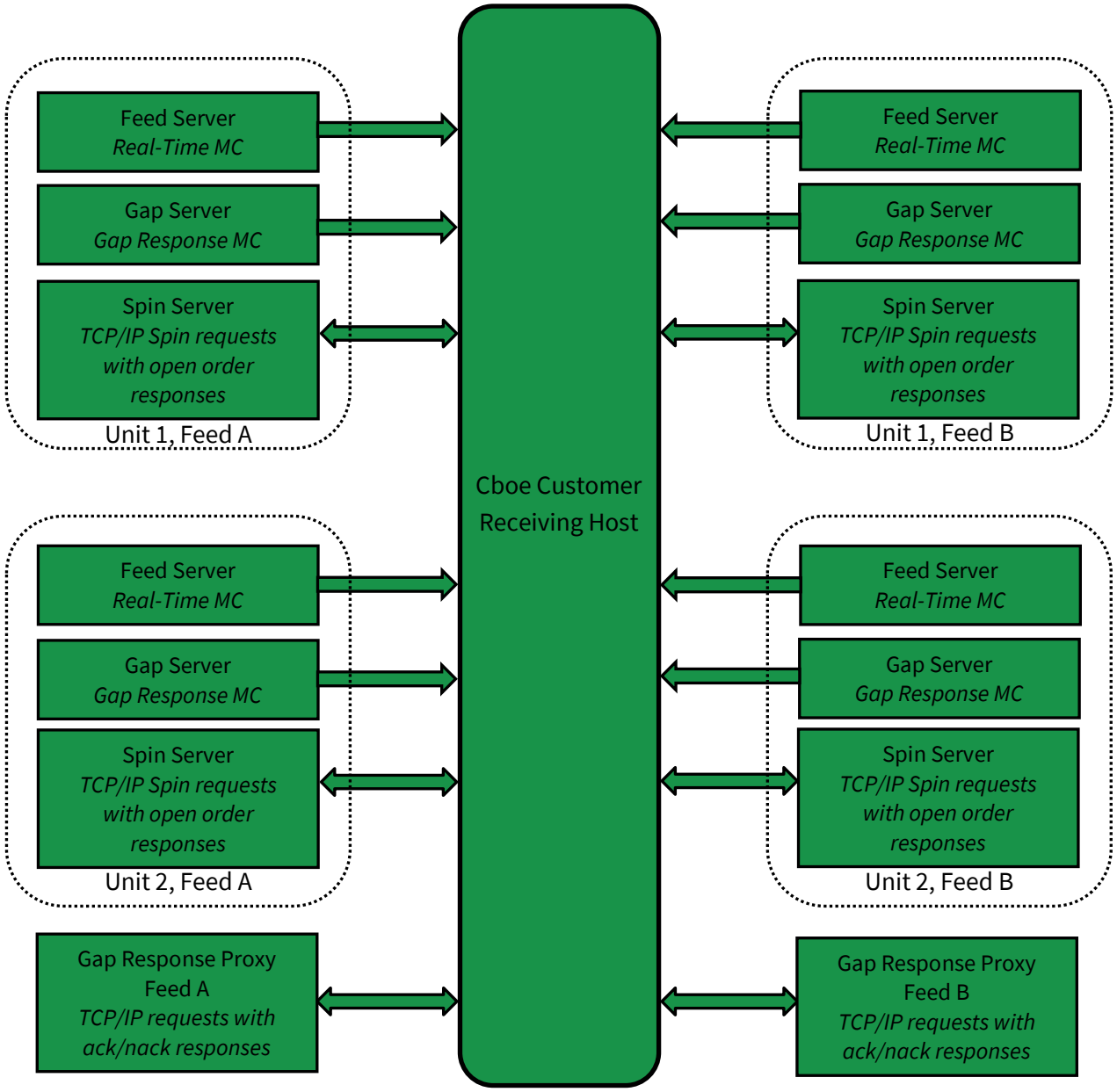
The following diagram is a logical representation Complex Multicast PITCH feed message flow between Cboe and a customer feed handler that is listening to the “A” and “B” instances of two units:



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1.3 Symbol Ranges, Units, and Sequence Numbers

Symbols will be separated by OSI root into units by a published alphabetical distribution. Symbol distribution will not change intra-day. Cboe does, however, reserve the right to add multicast addresses or change the symbol distribution with prior notice to customers. Care should be taken to ensure that address changes, address additions, and symbol distribution changes can be supported easily.

Message sequence numbers are incremented by one for every sequenced message within a particular symbol unit. It is important to understand that one *or more* units will be delivered on a single multicast address. As with symbol ranges, unit distribution across multicast addresses will not change intra-day, but may change after notice has been given.

Symbol distribution across units as well as unit distribution across multicast addresses are identical for real-time and gap response multicast addresses.

1.4 Complex Options Specific Symbol Processing

Cboe has implemented a Complex Instrument Creation ("CIC") process due to the seemingly infinite number of combinations that can make up a complex instrument. This allows the Complex Multicast PITCH specification to be consistent with the equities, standard and auction options Multicast PITCH specifications. This CIC process significantly reduces the size of the Complex Multicast PITCH feed and allows customers to use the same feed handler for Cboe equity, options, and futures exchanges.

Real-time CIC messages are available on each unit's multicast feed. `Complex Instrument Definition` messages are used to map the 6 character feed Complex Instrument ID ("CID") to the complex instrument definition. A complex instrument definition consists of two or more option legs. The complex instrument is valid only for the current trading date on which it was created. `Complex Instrument Definition` messages are sequenced messages and can be sent from pre-market through the end of trading. Once a complex instrument is created, it cannot be deleted or modified for the remainder of the trading day.

1.5 Gap Request Proxy and Message Retransmission

Requesting delivery of missed data is achieved by connecting to the Cboe Gap Request Proxy ("GRP") for the complex options data feed. Customers who do not wish to request missed messages do not need to connect to a GRP for any reason or listen to the multicast addresses reserved for message retransmission. Customers choosing to request missed data will need to connect to their assigned GRP, log in, and request gap ranges as necessary. All gap requests will be responded to with a `Gap Response` message. A `Gap Response` *Status* code of Accepted signals that the replayed messages will be delivered via the appropriate gap response multicast address. Any other `Gap Response` *Status* code will indicate the reason that the request cannot be serviced.

Gap requests are limited in message count, frequency, and age by the GRP. Gap requests will only be serviced if they are within a defined sequence range of the current multicast sequence number for the

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requested unit. Customers will receive a total daily allowance of gap requested messages. In addition, each customer is given renewable one second and one minute gap request limits.

If more than one gap request is received for a particular unit/sequence/count combination within a short timeframe, all requests will receive a successful `Gap Response` message from the GRP, but only a single replayed message will be sent on the gap response multicast address.

If overlapping gap requests are received within a short period of time, the gap server will only send the union of the sequence ranges across grouped gap requests. Customers will receive gap responses for their requested unit/sequence/count, but receivers should be prepared for the gap responses to be delivered via multicast in non-contiguous blocks.

Gap acknowledgements or rejects will be delivered to users for every gap request received by the GRP. Users should be prepared to see replayed multicast data before or after the receipt of the gap response acknowledgement from the GRP.

1.6 Spin Servers

A Spin Server is available for each unit. The server allows customers to connect via TCP and receive a spin of all complex instrument definitions and currently open orders with limited trading conditions on that unit. By using the spin, a customer can get the current complex book quickly in the middle of the trading session without worry of gap request limits. The Spin Server for each unit listens on its own address and/or TCP port.

Upon successful login and periodically thereafter, a `Spin Image Available` message is sent which contains a sequence number indicating the most recent message applied to the complex book. Using a `Spin Request` message, a customer may request a spin for the orders up to a sequence number noted within one of the last ten `Spin Image Available` messages distributed. If the `Spin Request` submitted does not present a sequence number that matches one of the last ten `Spin Image Available` messages distributed, the spin will return orders up to the next closest sequence number reported through a `Spin Image Available` message that is greater than the sequence number requested.

In the case a customer sends a sequence number in a `Spin Request` that is higher than the sequence number reported by the most recent `Spin Image Available` message, the next spin image to be generated will be returned when it is available. If the requested sequence number is still higher at that time, an "O" (Out of Range) error will be generated.

A spin consists only of `Complex Instrument Definition, Add Order` (long and/or short), `Trading Status` and `Time` messages. `Trading Status` messages will be sent in spins for all complex instruments that are not "S"uspended, which results in at least two messages for every complex instrument that has not been "S"uspended since system startup. Spins will not contain any message for an order which is no longer on the book. While receiving the spin, the customer must buffer

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multicast messages received. If the `Spin Image Available` message sequence number is the customer's reference point, multicast messages with larger sequence numbers should be buffered. If a non-`Spin Image Available` sequence number is the customer's reference point from which they send in their `Spin Request`, they should buffer from that point on, but note that the spin they will receive will contain sequence numbers beyond that point which may be disregarded. When a `Spin Finished` message is received, the buffered messages must be applied to spun copy of the book to bring it current.

Section 5.7 shows an example flow of messages between a customer and Cboe's Multicast PITCH feed and Spin Server.

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2 Protocol

Cboe users may use the PITCH 2.X protocol over multicast to receive real-time full depth of complex book quotations and execution information direct from Cboe.

PITCH 2.X cannot be used to enter orders. For order entry, refer to the appropriate US Options FIX or BOE Specifications.

All visible orders and executions are reflected via the PITCH 2.X feed. All orders and executions are anonymous, and do not contain any customer identity.

2.1 Message Format

The messages that make up the PITCH 2.X protocol are delivered using `Sequenced Unit Header` which handles sequencing and delivery integrity. All messages delivered via multicast as well as to/from the Gap Request Proxy (GRP) will use the `Sequenced Unit Header` for handling message integrity.

All UDP delivered events will be self-contained. Developers can assume that UDP delivered data will not cross frame boundaries and a single Ethernet frame will contain only one `Sequenced Unit Header` with associated data.

TCP/IP delivered events from the GRP may cross frames as the data will be delivered as a stream of data with the TCP/IP stack controlling Ethernet framing.

The PITCH data feed is comprised of a series of dynamic length sequenced messages. Each message begins with *Length* and *Message Type* fields. Cboe reserves the right to add message types and grow the length of any message without notice. Customers should develop their decoders to deal with unknown message types and messages that grow beyond the expected length. Messages will only be grown to add additional data to the end of a message.

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2.2 Data Types

The following field types are used within the `Sequenced Unit Header`, GRP messages, and PITCH 2.X.

- **Alphanumeric** fields are left justified ASCII fields and space padded on the right.
- **Binary** fields are unsigned and sized to "Length" bytes and ordered using Little Endian convention (least significant byte first).
- **Signed Binary** fields are signed and sized to "Length" bytes and ordered using Little Endian convention (least significant byte first).
- **Binary Signed Short Price** fields are signed Little Endian encoded 2 byte binary fields with 2 implied decimal places (denominator = 100). The short price range is -327.68 to +327.67. Prices outside of this range will use the long price.
- **Binary Signed Long Price** fields are signed Little Endian encoded 8 byte binary fields with 4 implied decimal places (denominator = 10,000).
- **Bit Field** fields are fixed width fields with each bit representing a boolean flag (the 0 bit is the lowest significant bit; the 7 bit is the highest significant bit).
- **Printable ASCII** fields are left justified ASCII fields that are space padded on the right that may include ASCII values in the range of 0x20 – 0x7e.

2.3 Message Framing

Depth of book update messages will be combined into single UDP frame where possible to decrease message overhead and total bandwidth. The count of messages in a UDP frame will be communicated using the `Sequenced Unit Header`. Framing will be determined by the server for each unit and site. The content of the multicast across feeds (e.g. A/B & Gig-Shaped) will be identical, but framing will not be consistent across feeds. Receiving processes that receive and arbitrate multiple feeds cannot use frame level arbitration to fill gaps.

2.4 Sequenced Unit Header

The `Sequence Unit Header` is used for all Cboe Complex Multicast PITCH messages as well as messages to and from the Gap Request Proxy ("GRP") and Spin Servers.

Sequenced and un-sequenced data may be delivered using the `Sequenced Unit Header`. Un-sequenced headers will have a 0 value for the sequence field and potentially for the unit field. All messages sent to and from the GRP and Spin Server are un-sequenced while multicast may contain sequenced and un-sequenced messages.

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Sequenced messages have implied sequences with the first message having the sequence number contained in the header. Each subsequent message will have an implied sequence one greater than the previous message up to a maximum of count messages. Multiple messages can follow a `Sequenced Unit Header`, but a combination of sequenced and un-sequenced messages cannot be sent with one header.

The sequence number for the first message in the next frame can be calculated by adding the *Hdr Count* field to the *Hdr Sequence*. This technique will work for sequenced messages and heartbeats.

Sequenced Unit Header				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Hdr Length	0	2	Binary	Length of entire block of messages. Includes this header and *Hdr Count* messages to follow.
Hdr Count	2	1	Binary	Number of messages to follow this header.
Hdr Unit	3	1	Binary	Unit that applies to messages included in this header.
Hdr Sequence	4	4	Binary	Sequence of first message to follow this header.
Total Length = 8 bytes				

2.5 Execution IDs

The 1st character of an *Execution ID* (after converting to a 9 character, base 36 number, zero-padded on the left) may be used to differentiate between internal matched trades and internal auction fills as follows:

- 0 (zero) = Cboe Internal Match
- C = Auction Fill

2.6 Heartbeat Messages

The `Sequenced Unit Header` with a count field set to "0" will be used for `Heartbeat` messages. During trading hours `Heartbeat` messages will be sent from the GRP and all multicast addresses if no data has been delivered within 1 second. `Heartbeat` messages never increment the sequence number for a unit, but can be used to detect gaps on the real-time multicast channels during low update rate periods.

`Heartbeats` on the real-time multicast addresses during trading hours will have a *Hdr Sequence* value equal to the sequence of the next sequenced message to be sent for the unit. `Heartbeats` on gap multicast addresses will always have the *Hdr Sequence* field set to 0. All `Heartbeat` messages sent to and from the GRP are considered un-sequenced and should have sequence and unit fields set to 0.

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Outside of trading hours Cboe sends `Heartbeat` messages on all real-time and gap channels with a sequence of "0" to help users validate multicast connectivity. `Heartbeat` messages may not be sent from 12:00 am – 1:00 am ET or during maintenance windows.

Cboe expects `Heartbeat` messages to be sent to the GRP on live connections no less than every 5 seconds. Failure to receive 2 consecutive `Heartbeat` messages will result in the GRP terminating the client connection.

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3 PITCH 2.X Messages

With the exception of `Time`, `Trading Status`, and `Complex Instrument Definition` messages, each PITCH message reflects the addition, deletion, modification, or execution of an order in the system.

3.1 Time

A `Time` message is sent whenever the source time for a unit passes over a second boundary. All subsequent time offset fields for the same unit will use the new `Time` value as the base until another `Time` message is received for the same unit.

Time				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x20	`Time` Message
Time	2	4	Binary	Number of whole seconds from midnight Eastern Time
Total Length = 6 bytes				

3.2 Unit Clear

The `Unit Clear` message instructs feed recipients to clear all orders for the Cboe complex book in the unit specified in the `Sequenced Unit Header`. This message will be sent at startup each day. It would also be distributed in certain recovery events such as a data center fail-over.

Unit Clear				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x97	`Unit Clear` Message
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Total Length = 6 bytes				

3.3 Complex Instrument Definition

A `Complex Instrument Definition` message represents a complex instrument that is available to place orders. It is sent as a sequenced message.

The `Complex Instrument Definition` message will contain two or more repeating groups of leg definitions. There is a limit of 12 leg definitions.

The *Leg Offset* field is provided to support adding additional fields to this message between the offset field and the Leg definitions. A *Leg Offset* of 1 means the leg definitions begin immediately following the *Leg Offset* field.

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Complex Instrument Definition				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x99	`Complex Instrument Definition` Message
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Complex Instrument Id	6	6	Printable ASCII	Complex Instrument Id right padded with spaces
Leg Count	12	1	Binary	The number of legs in this complex instrument
Leg Offset	13	1	Binary	Leg definitions begin this many bytes past this field
The following fields repeat *Leg Count* times (maximum of 12) for multi-leg strategies.				
Leg Ratio	13 + Leg Offset + (10 * Leg Index)	4	Signed Binary	Leg ratio (positive for buy-side, negative for sell-side)
Leg Symbol	13 + Leg Offset + (10 * Leg Index)	6	Printable ASCII	Option Symbol of leg right padded with spaces
Total Length = 13 + *Leg Offset* + (*Leg Count* * 10) bytes				

3.4 Add Order

An `Add Order` message represents a newly accepted visible order on the Cboe complex book. It includes a day-specific Order Id assigned by Cboe to the complex order.

Add Order (long)				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x21	`Add Order` Message (long)
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Order Id	6	8	Binary	Day-specific identifier assigned to this order
Side Indicator	14	1	Alphanumeric	"B" = Buy Order "S" = Sell Order
Quantity	15	4	Binary	Instrument quantity added to the complex book (may be less than the number entered).
Complex Instrument Id	19	6	Printable ASCII	*Complex Instrument Id* right padded with spaces.
Price	25	8	Binary Signed Long Price	The limit order price
Reserved	33	1	Reserved	Reserved
Total Length = 34 bytes				

Add Order (short)				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field

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Message Type	1	1	0x22	`Add Order` Message (short)
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Order Id	6	8	Binary	Day-specific identifier assigned to this order
Side Indicator	14	1	Alphanumeric	“B” = Buy Order “S” = Sell Order
Quantity	15	2	Binary	Instrument quantity being added to the complex book (may be less than the number entered).
Complex Instrument Id	17	6	Printable ASCII	Complex Instrument Id right padded with spaces.
Price	23	2	Binary Signed Short Price	The limit order price
Reserved	25	1	Reserved	Reserved
Total Length = 26 bytes				

Add Order (expanded)				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x2F	`Add Order` Message (expanded)
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Order Id	6	8	Binary	Day-specific identifier assigned to this order
Side Indicator	14	1	Alphanumeric	"B" = Buy Order "S" = Sell Order
Quantity	15	4	Binary	Instrument quantity being added to the complex book (may be less than the number entered).
Complex Instrument Id	19	8	Printable ASCII	Complex Instrument Id right padded with spaces.
Price	27	8	Binary Signed Long Price	The limit order price
Reserved	35	1	Reserved	Reserved
ParticipantID	36	4	Alphanumeric	*Optionally specified.* If specified the Executing Broker of firm attributed to this quote. Space filled otherwise.
Customer Indicator	40	1	Alphanumeric	"N" = Non-Customer "C" = Customer
Total Length = 41 bytes				

3.5 Order Modification Messages

Order Modification messages refer to an Order ID previously sent with an `Add Order` message. Multiple Order Modification messages may modify a single complex order and the effects are cumulative. Modify messages may update the size and/or the price of a complex order on the book. When the remaining size of a complex order reaches zero, the complex order is dead and should be removed from the book.

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3.5.1 Order Executed

`Order Executed` messages are sent when a visible complex order on the Cboe complex book is executed in whole or in part. The execution price equals the limit order price found in the original `Add Order` message or the limit order price in the latest `Modify Order` message referencing the *Order Id*.

Note even if there are single leg to complex order executions, this feed will only contain the order execution for the complex order. Any single leg execution information is available on the standard PITCH feed.

Order Executed				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x23	`Order Executed` Message
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Order Id	6	8	Binary	*Order Id* of a previously sent `Add Order` message that was executed
Executed Quantity	14	4	Binary	Instrument quantity executed
Execution Id	18	8	Binary	Cboe generated day-unique execution identifier of this execution. Execution Id is also referenced in the `Trade Break` message
Total Length = 26 bytes				

3.5.2 Order Executed at Price/Size

`Order Execution at Price/Size` messages are sent when a complex order on the Cboe complex book is executed in whole or in part at a different price than the limit price on the original `Add Order` message or the limit order price in the latest `Modify Order` message referencing the *Order Id*. If the *Remaining Quantity* field contains a 0 the complex order should be completely removed from the complex book.

`Order Execution at Price/Size` messages may also be sent in the event the existing size for Order Id is not equal to *Executed Quantity* + *Remaining Quantity*. In this case the complex order should be prioritized the same as a new complex order.

Order Executed at Price/Size				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x24	`Order Executed at Price/Size` Message
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp

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Order Id	6	8	Binary	*Order Id* of a previously sent `Add Order` message that was executed
Executed Quantity	14	4	Binary	Instrument quantity executed
Remaining Quantity	18	4	Binary	Number of contracts remaining after the execution
Execution Id	22	8	Binary	Cboe generated day-unique execution identifier of this execution. Execution Id is also referenced in the `Trade Break` message
Price	30	8	Binary Signed Long Price	The execution price of the order
Total Length = 38 bytes				

3.5.3 Reduce Size

`Reduce Size` messages are sent when a complex order on the Cboe complex book is partially reduced.

Reduce Size (long)				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x25	`Reduce Size` Message (long)
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Order Id	6	8	Binary	*Order Id* of a previously sent `Add Order` message that has been reduced
Canceled Quantity	14	4	Binary	Instrument quantity canceled
Total Length = 18 bytes				

Reduce Size (short)				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x26	`Reduce Size` Message (short)
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Order Id	6	8	Binary	*Order Id* of a previously sent `Add Order` message that has been reduced
Canceled Quantity	14	2	Binary	Instrument quantity canceled
Total Length = 16 bytes				

3.5.4 Modify Order

The `Modify Order` message is sent whenever an open complex order is visibly modified. The *Order Id* refers to the *Order Id* of the original `Add Order` message.

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Note that `Modify Order` messages that appear to be "no ops" (i.e. they do not appear to modify any relevant fields) will still lose priority.

Modify (long)				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x27	`Modify Order` Message (long)
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Order Id	6	8	Binary	*Order Id* of a previously sent `Add Order` message that has been modified
Quantity	14	4	Binary	Instrument quantity associated with this complex order after this modify (may be less than the number entered)
Price	18	8	Binary Signed Long Price	The limit order price after this modify
Reserved	26	1	Bit Field	Reserved
Total Length = 27 bytes				

Modify (short)				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x28	`Modify Order` Message (short)
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Order Id	6	8	Binary	*Order Id* of a previously sent `Add Order` message that has been modified
Quantity	14	2	Binary	Instrument quantity associated with this complex order after this modify (may be less than the number entered)
Price	16	2	Binary Signed Short Price	The limit order price after this modify
Reserved	18	1	Bit Field	Reserved
Total Length = 19 bytes				

3.5.5 Delete Order

The `Delete Order` message is sent whenever an open complex order is completely canceled. The *Order Id* refers to the Order Id of the original `Add Order` message.

Delete				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x29	`Delete Order` Message
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Order Id	6	8	Binary	*Order Id* of a previously sent `Add Order` message that has completely cancelled
Total Length = 14 bytes				

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3.6 Trade

The `Trade` message provides information about executions of complex order auctions on the Cboe complex book. `Trade` messages are necessary to calculate Cboe execution-based data. `Trade` messages do not alter the complex book and can be ignored if messages are being used solely to build a complex book.

No `Add Order` message is sent for complex auction orders, and thus, no order modification messages may be sent when complex auctions are executed. Instead, a `Trade` message is sent whenever a complex auction is executed in whole or in part. A complete view of all Cboe complex executions can be built by combining all `Order Executed` messages and `Trade` messages.

Trade (long)				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x2A	`Trade` Message (long)
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Order Id	6	8	Binary	*Order Id* of the executed order.
Side Indicator	14	1	Alphanumeric	Always "B" = Buy Order regardless of resting side
Quantity	15	4	Binary	Instrument quantity traded
Complex Instrument Id	19	6	Printable ASCII	*Complex Instrument Id* right padded with spaces.
Price	25	8	Binary Signed Long Price	The execution price of the order
Execution Id	33	8	Binary	Cboe generated day-unique execution identifier of this trade. *Execution Id* is also referenced in the `Trade Break` message.
Total Length = 41 bytes				

Trade (short)				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x2B	`Trade` Message (short)
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Order Id	6	8	Binary	*Order Id* of the executed order.
Side Indicator	14	1	Alphanumeric	Always "B" = Buy Order regardless of resting side
Quantity	15	2	Binary	Instrument quantity traded
Complex Instrument Id	17	6	Printable ASCII	*Complex Instrument Id* right padded with spaces.
Price	23	2	Binary Signed Short Price	The execution price of the order

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Execution Id	25	8	Binary	Cboe generated day-unique execution identifier of this trade. *Execution Id* is also referenced in the `Trade Break` message.
Total Length = 33 bytes				

3.7 Trade Break

The `Trade Break` message is sent whenever a complex execution on Cboe is broken. Trade breaks are rare and only affect applications that rely upon Cboe execution-based data. Applications that simply build a Cboe complex book can ignore `Trade Break` messages.

Trade Break				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x2C	`Trade Break` Message
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Execution Id	6	8	Binary	Cboe execution identifier of the execution that was broken. *Execution Id* refers to previously sent `Order Executed` or `Trade` message.
Total Length = 14 bytes				

3.8 Trading Status

The `Trading Status` message is used to indicate the current trading status of a complex instrument. A `Trading Status` message will be sent whenever a complex instrument trading status changes.

A `Trading Status` message will be sent for all complex instruments where the underlying security is Halted, Trading or Quoting.

Trading Status of "S" is to be implied at system startup for all series. Starting at 7:30AM ET, Cboe will send a *Trading Status* of "Q" once orders can be accepted for queuing in preparation for the market open. Sometime after 9:30AM ET, Cboe will send a *Trading Status* of "T" as series are open for trading on the Cboe platform. Note *Trading Status* of "Q" can also be explicitly disseminated during a Regulatory Halt Quoting Period.

A `Trading Status` message will also be sent:

- for a Regulatory Halt "Q"uoting Period in any series where the underlying has experienced a Regulatory Halt as well as the "T"rading resumption for the same series.
- in the event of an Exchange specific "S"uspension.
- for instruments that are in a "Q"uoting period for auctions.

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Trading Status				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	Length of this message including this field
Message Type	1	1	0x31	`Trading Status` message
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp
Complex Instrument Id	6	8	Printable ASCII	*Complex Instrument Id* right padded with spaces.
Trading Status	14	1	Alpha	"H" = Halted "Q" = Quote-Only "S" = Exchange Specific Suspension "T" = Trading
Reserved	15	3	Alpha	Reserved
Total Length = 18 bytes				

3.9 Auction Update

`Auction Update` messages are used to disseminate price and size information during Opening and Re-Opening (halt) auctions for complex instruments. The `Auction Update` messages are sent every five seconds during an opening period. Refer to the Cboe Options Complex Book Process specification for more information.

The `Auction Update` message has the following format:

Auction Update				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0x95	`Auction Update` Message
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp.
Complex Instrument Id	6	8	Printable ASCII	*Complex Instrument Id* right padded with spaces.
Auction Type	14	1	Alphanumeric	"O" = Opening Auction "H" = Halt Auction
Reference Price	15	8	Binary Signed Long Price	BBO Collared auction price (see Cboe Options Complex Book Process).
Buy Quantity	23	4	Binary	Instrument quantity on buy side at the *Reference Price*.
Sell Quantity	27	4	Binary	Instrument quantity on sell side at the *Reference Price*.
Indicative Price	31	8	Binary Signed Long Price	Price at which the auction book and the continuous book would match.
Auction Only Price	39	8	Binary Signed Long Price	Price at which the auction book would match using only *Eligible Auction Orders* (see Cboe Options Complex Book Process).
Total Length = 47 bytes				

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3.10 Auction Summary

`Auction Summary` messages are used to disseminate the results of an auction of a complex instrument. An Opening or Re-Opening `Auction Summary` message for each complex instrument is sent at the conclusion of its Opening or Re-Opening auction and represents Cboe opening price. Refer to the Cboe Options Complex Book Process specification for more information.

The `Auction Summary` message has the following format:

Auction Summary				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	Length of this message including this field.
Message Type	1	1	0x96	`Auction Summary` Message
Time offset	2	4	Binary	Nanosecond offset from last unit timestamp.
Complex Instrument Id	6	8	Printable ASCII	*Complex Instrument Id* right padded with spaces.
Auction Type	14	1	Alphanumeric	"O" = Opening Auction “H” = Halt Auction
Price	15	8	Binary Signed Long Price	Auction price
Quantity	23	4	Binary	Cumulative instrument quantity executed during the auction
Total Length = 27 bytes				

3.11 End of Session

The `End of Session` message is sent for each unit when the unit shuts down. No more sequenced messages will be delivered for this unit, but heartbeats from the unit may be received.

End of Session				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x2D	`End of Session` Message
Timestamp	2	4	Binary	Nanosecond offset from last unit timestamp
Total Length = 6 bytes				

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4 Gap Request Proxy Messages

The following messages are used for initializing a TCP/IP connection to the Gap Request Proxy ("GRP") and to request message retransmissions. Customers only need to implement the following messages if gap requests will be made. The following messages will not be delivered using multicast.

4.1 Login

The `Login` message is the first message sent to the GRP by a user's process after the connection to the GRP is established. Failure to login before sending any other message type will result in the connection being dropped by the GRP.

Login				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x01	`Login` Message
SessionSubId	2	4	Alphanumeric	*SessionSubId* supplied by Cboe
Username	6	4	Alphanumeric	*Username* supplied by Cboe
Filler	10	2	Alphanumeric	(space filled)
Password	12	10	Alphanumeric	*Password* supplied by Cboe
Total Length = 22 bytes				

4.2 Login Response

The `Login Response` message is sent by the GRP to a user's process in response to a `Login` message. The status field is used to reflect an accepted login or the reason the session was not accepted. If login fails, the connection will be dropped after the `Login Response` message is sent.

Login Response				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x02	`Login Response` Message
Status	2	1	Alphanumeric	Accepted or reason for reject
Total Length = 3 bytes				

Login Response - Status Codes	
'A'	Login Accepted
'N'	Not authorized (Invalid Username/Password)
'B'	Session in use
'S'	Invalid Session

4.3 Gap Request

The `Gap Request` message is used by a user's process to request retransmission of a sequenced message (or messages) by one of Cboe's gap servers.

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Gap Request				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x03	`Gap Request` Message
Unit	2	1	Binary	*Unit* that the gap is requested for
Sequence	3	4	Binary	*Sequence* of first message (lowest sequence in range)
Count	7	2	Binary	*Count* of messages requested
Total Length = 9 bytes				

4.4 Gap Response

The `Gap Response` message is sent by the GRP in response to a `Gap Request` message. The *Unit* and *Sequence* fields will match the values supplied in the `Gap Request` message. A `Gap Response` message, with a Status of Accepted or reason for failure, will be sent for each `Gap Request` message received by the GRP.

Gap Response				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x04	`Gap Response` Message
Unit	2	1	Binary	*Unit* the gap was requested for
Sequence	3	4	Binary	*Sequence* of first message in request
Count	7	2	Binary	*Count* of messages requested
Status	9	1	Alphanumeric	Accepted or reason for reject
Total Length = 10 bytes				

Gap Response - Status Codes	
'A'	Accepted
'O'	Out of range (ahead of sequence or too far behind)
'D'	Daily gap request allocation exhausted
'M'	Minute gap request allocation exhausted
'S'	Second gap request allocation exhausted
'C'	Count request limit for one gap request exceeded
'I'	Invalid Unit specified in request
'U'	Unit is currently unavailable

* - All non-'A' status codes should be interpreted as a reject.

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5 Spin Messages

5.1 Login

The `Login` message is the first message sent to the Spin Server by a user's process after the connection to the Spin Server is established. Failure to login before sending any other message type will result in the connection being dropped by the Spin Server.

The format of the `Login` message for the Spin Server is identical to that of the GRP described previously in Section 4.1.

5.2 Login Response

The `Login Response` message is sent by the Spin Server to a user's process in response to a `Login` message. The status field is used to reflect an accepted login or the reason the session was not accepted. If login fails, the connection will be dropped after the `Login Response` message is sent.

The format of the `Login Response` message for the Spin Server is identical to that of the GRP described previously in Section 4.2.

5.3 Spin Image Available

The `Spin Image Available` message is sent once per second and indicates through what sequence number a spin is available.

Spin Image Available				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x80	`Spin Image Available` Message
Sequence	2	4	Binary	Spin is available which is current through this sequence number
Total Length = 6 bytes				

5.4 Spin Request

The `Spin Request` message is used by a user's process to request transmission of a spin of the unit's order book. Refer to Section 1.6 for more complete details regarding *Sequence* specification as well as buffering requirements.

Spin Request				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x81	`Spin Request` Message
Sequence	2	4	Binary	Sequence number from a `Spin Image Available` message received by the customer

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Total Length = 6 bytes

5.5 Spin Response

The `Spin Response` message is sent in response to a user's `Spin Request` message indicating whether a spin will be sent.

Spin Response				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x82	`Spin Response` Message
Sequence	2	4	Binary	Sequence number from a `Spin Image Available` message received by the customer
Order Count	6	4	Binary	Number of `Add Order` messages which will be contained in this spin
Status	10	1	Alphanumeric	Accepted or reason for reject
Total Length = 11 bytes				

Spin Response - Status Codes	
'A'	Accepted
'O'	Out of Range (*Sequence* requested is greater than *Sequence* available by the next spin)
'S'	Spin already in progress (only one spin can be running at a time)

* - All non-'A' status codes should be interpreted as a reject.

5.6 Spin Finished

The `Spin Finished` message is sent to indicate that all messages for the spin requested have been sent. A `Spin Finished` message is only sent if a `Spin Request` was not rejected. Upon receipt of a `Spin Finished` message, any buffered multicast messages should be applied to the customer's copy of the book to make it current.

Spin Finished				
Field Name	**Offset**	**Length**	**Type/(Value)**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0x83	`Spin Finished` Message
Sequence	2	4	Binary	Sequence number from the `Spin Request` message
Total Length = 6 bytes				

5.7 Spin Server Usage Example

The following diagram (see next page) shows the exchange of messages over time between a customer and Cboe's Multicast PITCH feed and spin server. Note that while the example may seem to imply only `Complex Instrument Definition`, `Time` and `Add Order` messages would be sent on a spin, this is not the case. `Trading Status` and `Auction Update` messages may also be sent.

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At time 1, the customer has no state of the book and desires to become current. The customer caches the received Multicast PITCH messages (sequences 310172 and 310173) for later use. Since the customer has no book, they cannot yet be applied.

At time 5, the customer has successfully logged into the Spin Server and has cached another message, sequence 310174.

At time 7, the customer receives a `Spin Image Available` message which indicates that the spin server is capable of giving them a spin of all open orders as of sequence 310169. The customer does not have all messages cached after 310169 (they are missing 310170 and 310171), so this spin is not useful to the customer.

At time 10, the customer receives a `Spin Image Available` message which is useful since it would be a spin of all orders up to and including sequence 310175 and the customer has all messages after 310175 cached.

At time 11, the customer sends a `Spin Request` for all messages up to and including 310175 and continues to cache Multicast PITCH messages received.

At time 14, the spin server acknowledges the spin request and indicates that five messages will be sent (complex instrument definition and open orders).

At time 24, the spin server indicates that it has finished sending all messages. The customer must then apply the cached messages from sequence number 310176 through current.

Notes:

- Spin Servers are available for each unit. Customers may need to employ multiple Spin Servers depending upon their architecture.
- As a rule of thumb, in its options markets Cboe typically has ~300,000 complex instruments defined and ~3.2 million open orders across all units, or an average of about 9,375 complex instruments and 100,000 open orders per unit. The actual number per unit varies depending upon activity in individual symbols. Expect this number to increase and plan accordingly.

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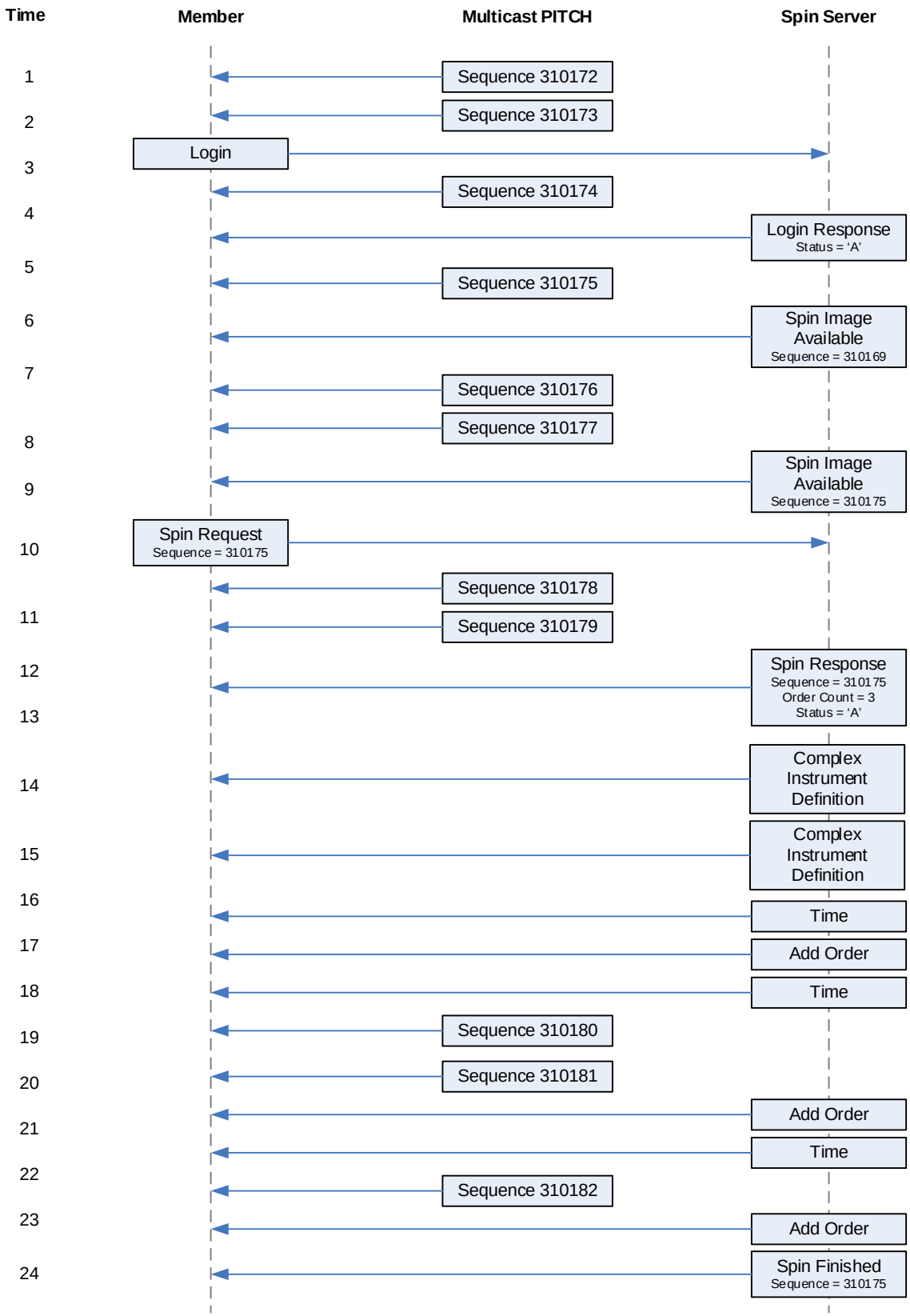

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6 Message Types

6.1 Gap Request Proxy Messages

0x01	Login
0x02	Login Response
0x03	Gap Request
0x04	Gap Response

6.2 Spin Server Messages

0x01	Login
0x02	Login Response
0x80	Spin Image Available
0x81	Spin Request
0x82	Spin Response
0x83	Spin Finished

6.3 PITCH 2.X Messages

0x20	Time
0x21	Add Order - Long
0x22	Add Order – Short
0x2F	Add Order – Expanded
0x23	Order Executed
0x24	Order Executed at Price/Size
0x25	Reduce Size – Long
0x26	Reduce Size – Short
0x27	Modify Order – Long
0x28	Modify Order – Short
0x29	Delete Order
0x2A	Trade – Long
0x2B	Trade – Short
0x2C	Trade Break
0x2D	End of Session
0x31	Trading Status
0x95	Auction Update
0x96	Auction Summary
0x97	Unit Clear
0x99	Complex Instrument Definition

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7 Example Messages

Each of the following message types must be wrapped by a sequenced or unsequenced unit header as described in Section 2.4. Note that in the following examples, each byte is represented by two hexadecimal digits.

7.1 Login Message

Length	16	22 bytes
Type	01	Login
SessionSubId	30 30 30 31	“0001”
Username	46 49 52 4D	“FIRM”
Filler	20 20	“ ”
Password	41 42 43 44 30 30 20 20 20 20	“ABCD00 ”

7.2 Login Response Message

Length	03	3 bytes
Type	02	Login Response
Status	41	Login accepted

7.3 Gap Request Message

Length	09	9 bytes
Type	03	Gap Request
Unit	01	Unit 1
Sequence	3B 10 00 00	First message: 4155
Count	32 00	50 messages

7.4 Gap Response Message

Length	08	8 bytes
Type	04	Gap Response
Unit	01	Unit 1
Sequence	3B 10 00 00	First message: 4155
Status	41	Accepted

7.5 Spin Image Available Message

Length	06	6 bytes
Type	80	Spin Image Available
Sequence	3B 10 00 00	Sequence: 4155

7.6 Spin Request Message

Length	06	6 bytes
Type	81	Spin Request
Sequence	3B 10 00 00	Sequence: 4155

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7.7 Spin Response Message

Length	0B	11 bytes
Type	82	Spin Request
Sequence	3B 10 00 00	Sequence: 4155
Order Count	42 00 00 00	66 orders
Status	41	Accepted

7.8 Spin Finished Message

Length	06	6 bytes
Type	83	Spin Finished
Sequence	3B 10 00 00	Sequence: 4155

7.9 Time Message

Length	06	6 bytes
Type	20	Time
Time	98 85 00 00	34,200 seconds = 09:30 AM Eastern

7.10 Unit Clear

Length	06	6 bytes
Type	97	Unit Clear
Time offset	18 D2 06 00	447,000 ns since last Time Message

7.11 Add Order – Long

Length	22	34 bytes
Type	21	Add Order - Long
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Side Indicator	42	Buy
Quantity	32 00 00 00	50
CID	43 30 30 30 31 32	C00012
Price	28 23 00 00 00 00 00 00	$0.9000
Reserved	00	Reserved

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7.12 Add Order – Short

Length	1A	26 bytes
Type	22	Add Order - Short
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Side Indicator	42	Buy
Quantity	32 00	50
CID	43 30 30 30 31 32	C00012
Price	0A 28	$102.50
Reserved	00	Reserved

7.13 Add Order – Expanded

Length	29	41 bytes
Type	2F	Add Order - Expanded
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Side Indicator	42	Buy
Quantity	32 00	50
CID	43 30 30 30 31 32 20 20	C00012
Price	28 23 00 00 00 00 00 00	$0.9000
Reserved	00	Reserved
Broker ID	41 42 43 44	ABCD
Customer Indicator	4E	Non-Customer

7.14 Order Executed

Length	1A	26 bytes
Type	23	Order Executed
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Executed Quantity	64 00 00 00	100
Execution Id	34 2B 46 E0 BB 00 00 00	0AAP09VEC

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7.15 Order Executed at Price/Size

Length	26	38 bytes
Type	24	Order Executed at Price/Size
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Executed Quantity	64 00 00 00	100
Remaining	32 00 00 00	50
Execution Id	34 2B 46 E0 BB 00 00 00	0AAP09VEC
Price	E8 A3 0F 00 00 00 00 00	$102.50

7.16 Reduce Size – Long

Length	12	18 bytes
Type	25	Reduce Size - Long
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Canceled Quantity	64 00 00 00	100

7.17 Reduce Size – Short

Length	10	16 bytes
Type	26	Reduce Size - Short
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Canceled Quantity	64 00	100

7.18 Modify Order – Long

Length	1B	27 bytes
Type	27	Modify Order – Long
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Quantity	4B 00 00 00	75
Price	E8 A3 0F 00 00 00 00 00	$102.50
Reserved	00	Reserved

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7.19 Modify Order – Short

Length	13	19 bytes
Type	28	Modify Order – Short
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Quantity	4B 00	75
Price	0A 28	$102.50
Reserved	00	Reserved

7.20 Delete Order

Length	0E	14 bytes
Type	29	Delete Order
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	

7.21 Trade – Long

Length	29	41 bytes
Type	2A	Trade - Long
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Side	42	Buy
Quantity	4B 00 00 00	75
CID	43 30 30 30 31 32	C00012
Price	E8 A3 0F 00 00 00 00 00	$102.50
Execution Id	34 2B 46 E0 BB 00 00 00	0AAP09VEC

7.22 Trade – Short

Length	21	33 bytes
Type	2B	Trade - Long
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Side	42	Buy
Quantity	64 00	100
CID	43 30 30 30 31 32	C00012
Price	0A 28	$102.50
Execution Id	34 2B 46 E0 BB 00 00 00	0AAP09VEC

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7.23 Trade Break

Length	0E	14 bytes
Type	2C	Trade Break
Time offset	18 D2 06 00	447,000 ns since last Time Message
Execution Id	34 2B 46 E0 BB 00 00 00	0AAP09VEC

7.24 End of Session

Length	06	6 bytes
Type	2D	End of Session
Time offset	18 D2 06 00	447,000 ns since last Time Message

7.25 Trading Status Message

Length	12	18 bytes
Type	31	Trading Status
Time offset	18 D2 06 00	447,000 ns since last Time Message
CID	43 30 30 30 31 32 20 20	C00012
Halt Status	54	T = Trading
Reserved	30 20 20	

7.26 Sequenced Unit Header with 2 Messages

Sequenced Unit Header:

Hdr Length	31 00	49 bytes, including header
Hdr Count	02	2 messages to follow
Hdr Unit	01	Unit 1
Hdr Sequence	01 00 00 00	First message has sequence number 1

Message 1: Add Order (Short)

Length	1A	26 bytes
Message format	22	Add Order – Short
Time offset	18 D2 06 00	447,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Side Indicator	42	Buy
Quantity	E1 02	737
CID	43 30 30 30 31 32	C00012
Price	01 00	0.01
Reserved	00	Reserved

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Message 2: Reduce Size (Short)

Length	10	16 bytes
Message format	26	Reduce Size – Short
Time offset	E8 D9 06 00	449,000 ns since last Time Message
Order Id	05 40 5B 77 8F 56 1D 0B	631WC4000005
Canceled Quantity	E1 02	737

7.27 Auction Update Message

Length	2F	47 bytes
Type	95	Auction Update
Time offset	18 D2 06 00	447,000 ns since last Time Message
CID	43 30 30 30 31 32 20 20	C00012
Auction Type	4F	O = Opening
Reference Prc	E8 A3 0F 00 00 00 00 00	$102.50
Buy Side Qty	4B 00 00 00	75
Sell Side Qty	64 00 00 00	100
Indicative Prc	E8 A3 0F 00 00 00 00 00	$102.50
Auct. Only Prc	E8 A3 0F 00 00 00 00 00	$102.50

7.28 Auction Summary Message

Length	1B	27 bytes
Type	96	Auction Summary
Time offset	18 D2 06 00	447,000 ns since last Time Message
CID	43 30 30 30 31 32 20 20	C00012
Auction Type	4F	O = Opening
Price	E8 A3 0F 00 00 00 00 00	$102.50
Quantity	4B 00 00 00	75

7.29 Complex Instrument Definition Message

Length	22	34 bytes
Type	99	Complex Instrument Definition
Time offset	18 D2 06 00	447,000 ns since last Time Message
CID	43 30 30 30 31 32	C00012
Leg Count	02	2 legs
Leg Offset	01	One byte
Leg Ratio	01 00 00 00	1 = Buy 1
Leg Symbol	30 30 30 30 30 31	000001
Leg Ratio	FF FF FF FF	-1 = Sell 1
Leg Symbol	30 30 30 30 30 32	000002

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8 Multicast Configuration

8.1 Production Environment Configuration

8.1.1 Limitations/Configurations

The following table defines Cboe current configuration for network and gap request limitations. These limitations are session based. Cboe reserves the right to adjust the gap request limitations to improve the effectiveness of the gap request infrastructure.

Period/Type	Limit/Setting	Notes
MTU	1500	Cboe will send UDP messages up to 1500 bytes. Customers should ensure that their infrastructure is configured accordingly.
Gig-Shaped Throttle	1 Gb/s	The real-time and gap multicast head ends are configured to shape their output to this level to minimize packet loss.
Gap Response Delay	2 ms	The Gap Server will delay resending sequenced messages via multicast for the specified limit in order to satisfy multiple GRP gap requests with one multicast response.
Count	100	Any single gap request may not be for more than this number of dropped messages.
1 Second	320 Requests	This is the maximum number of retransmission requests allowed per second for each session. This is renewed every clock second.
1 Minute	1500 Requests	This is the maximum number of retransmission requests allowed per minute for each session. This is renewed every clock minute.
Day	100,000 Requests	This is the maximum number of retransmission requests allowed per day for each session.
Within Range	1,000,000 Messages	Users' retransmission requests must be within this many messages of the most recent sequence sent by the real-time feed.

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8.1.2 Unit/Symbol Distribution (Effective through 4/13/18)

The following table describes an updated Cboe symbol distribution across units for EDGX and C2 Options.

Unit	EDGX Symbol Range	C2 Symbol Range
1	A - ADRZZ	A - ADRZZ
2	ADS – AMZMZ	ADS – AMZMZ
3	AMZN – AOZZZ	AMZN – AOZZZ
4	AP – BACAZ	AP – BACAZ
5	BACB – CASZZ	BACB – CASZZ
6	CAT – CMGAZ	CAT – CMGAZ
7	CMGB – CYGZZ	CMGB – CYGZZ
8	CYH – DOWAZ	CYH – DOWAZ
9	DOWB – FASTZ	DOWB – FASTZ
10	FASU – FOWZZ	FASU – FOWZZ
11	FOX – GOLFZ	FOX – GOLFZ
12	GOLG – GPBZZ	GOLG – GPBZZ
13	GPC – HULZZ	GPC – HULZZ
14	HUM – IPAAZ	HUM – IPAAZ
15	IPAB – IWLZZ IWMA - LDLAZ	IPAB – IWLZZ IWMA - LDLAZ
16	LDLB – MCDAZ	LDLB – MCDAZ
17	MCDB – MTVZZ	MCDB – MTVZZ
18	MTW – NKEAZ	MTW – NKEAZ
19	NKEB – PCLMZ	NKEB – PCLMZ
20	PCLN – PCLNZ	PCLN – PCLNZ
21	PCLO – QQPZZ QQQA - REGNZ	PCLO – QQPZZ QQQA - REGNZ
22	REGO – SNEAZ	REGO – RUSZZ RUTA – RUTVZZ RUTWA – SNEAZ
23	SNEB – SPXZZ SPYA – TLLPZ	SNEB – SPXZZ SPYA – TLLPZ
24	TLLQ – TTMAZ	TLLQ – TTMAZ
25	TTMB – USFZZ	TTMB – USFZZ
26	USG – VRWZZ	USG – VRWZZ
27	VRX – WFLZZ	VRX – WFLZZ
28	WFM – XLPAZ	WFM – XLPAZ
29	XLPB – ZZZZZ	XLPB – ZZZZZ
30	IWM	IWM
31	QQQ	QQQ
32	SPY	SPY
33	N/A	RUT, RUTW

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8.1.3 Unit/Product Distribution (Effective 4/14/18)

Unit	Symbol Range	C2 Symbol Range
1	A – ADOZZ	A – ADOZZ
2	ADP – AMZMZ AMZNA – ANETZ	ADP – AMZMZ AMZNA – ANETZ
3	ANEU – BAAAZ	ANEU – BAAAZ
4	BAAB – BKNFZ	BAAB – BKNFZ
5	BKNG – BZZZZ	BKNG – BZZZZ
6	C – CLGXZ	C – CLGXZ
7	CLGY – CSXAZ	CLGY – CSXAZ
8	CSXB – DISAZ	CSXB – DISAZ
9	DISB – ETFBZ	DISB – ETFBZ
10	ETFC – FIVDZ	ETFC – FIVDZ
11	FIVE – GLDAZ	FIVE – GLDAZ
12	GLDB – GOOGZ	GLDB – GOOGZ
13	GOOH – HSXZZ	GOOH – HSXZZ
14	HSY – IWLZZ	HSY – IWLZZ
15	IWM – JNJAZ	IWM – JNJAZ
16	JNJB – LMTAZ	JNJB – LMTAZ
17	LMTB – MLNXZ	LMTB – MLNXZ
18	MLNY – MUAAZ	MLNY – MUAAZ
19	MUAB – NTESZ	MUAB – NTESZ
20	NTET – OXYAZ	NTET – OXYAZ
21	OXYB – QGENZ	OXYB – QGENZ
22	QGEO – RHAAZ	QGEO – RHAAZ
23	RHAB – SMGZZ	RHAB – RUSZZ RUTA – RUTVZ RUTWA – SMGZZ
24	SMH – SPXZZ SPYA – SYEZZ	SMH – SPXZZ SPYA – SYEZZ
25	SYF – TSKZZ	SYF – TSKZZ
26	TSL – UALAZ	TSL – UALAZ
27	UALB – VLOAZ	UALB – VLOAZ
28	VLOB – WDCAZ	VLOB – WDCAZ
29	WDCB – XLDZZ	WDCB – XLDZZ
30	XLE – ZZZZZ	XLE – ZZZZZ
31	AMZN	AMZN
32	SPY	SPY
33	N/A	RUT, RUTW

Note - Cboe reserves the right to add units and/or change symbol distribution with 48 hours of notice and no migration period. Notice will be given that the distribution will change on a certain date. Care should be taken to support mappings in these tables via software configuration.

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8.1.4 EDGX Options Multicast Routing Parameters

Data Center	Rendezvous Point
NY5 Primary Data Center A feed	74.115.128.162
NY5 Primary Data Center B feed	74.115.128.163
CH4 Secondary Data Center E feed	174.136.181.240

8.1.5 C2 Options Multicast Routing Parameters

Data Center	Rendezvous Point
NY5 Primary Data Center A feed	74.115.128.176
NY5 Primary Data Center B feed	74.115.128.177
400SL Secondary Data Center E feed	170.137.16.134

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8.1.6 EDGX Options Address/Unit Distribution

The following tables describe the unit distribution across the EDGX Complex Options Multicast PITCH feeds.

NY5 Primary Datacenter		Gig-Shaped [EAC] 174.136.164.32/28		Gig-Shaped [EBC] 174.136.164.48/28	
Unit	**IP Port**	**Real-time MC**	**Gap Resp. MC**	**Real-time MC**	**Gap Resp. MC**
1	30551	224.0.131.152	224.0.131.154	233.130.124.152	233.130.124.154
2	30552				
3	30553				
4	30554				
5	30555				
6	30556				
7	30557				
8	30558				
9	30559				
10	30560				
11	30561				
12	30562				
13	30563				
14	30564				
15	30565				
16	30566				
17	30567	224.0.131.153	224.0.131.155	233.130.124.153	233.130.124.155
18	30568				
19	30569				
20	30570				
21	30571				
22	30572				
23	30573				
24	30574				
25	30575				
26	30576				
27	30577				
28	30578				
29	30579				
30	30580				
31	30581				
32	30582				

Note - Cboe reserves the right to add multicast addresses with prior notice, but no migration period. Notice will be given that the distribution will change on a certain date. Care should be taken to support mappings in these tables via software configuration. Addresses in the gray area are pre-assigned but not available. Customers should not configure their networks or systems for these addresses.

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CH4 Secondary Datacenter		Gig-Shaped [EEC] 174.136.174.144/28	
Unit	**IP Port**	**Real-time MC**	**Gap Response MC**
1	31951	233.19.3.136	233.19.3.138
2	31952		
3	31953		
4	31954		
5	31955		
6	31956		
7	31957		
8	31958		
9	31959		
10	31960		
11	31961		
12	31962		
13	31963		
14	31964		
15	31965		
16	31966		
17	31967	233.19.3.137	233.19.3.139
18	31968		
19	31969		
20	31970		
21	31971		
22	31972		
23	31973		
24	31974		
25	31975		
26	31976		
27	31977		
28	31978		
29	31979		
30	31980		
31	31981		
32	31982		

Note - Cboe reserves the right to add multicast addresses with prior notice, but no migration period. Notice will be given that the distribution will change on a certain date. Care should be taken to support mappings in these tables via software configuration.

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8.1.7 C2 Options Address/Unit Distribution

The following tables describe the unit distribution across the C2 Complex Options Multicast PITCH feeds.

NY5 Primary Datacenter		Gig-Shaped [WAC] 174.136.164.64/28		Gig-Shaped [WBC] 174.136.164.80/28	
Unit	**IP Port**	**Real-time MC**	**Gap Resp. MC**	**Real-time MC**	**Gap Resp. MC**
1	30301	224.0.131.248	224.0.131.250	233.130.124.248	233.130.124.250
2	30302				
3	30303				
4	30304				
5	30305				
6	30306				
7	30307				
8	30308				
9	30309				
10	30310				
11	30311				
12	30312				
13	30313				
14	30314				
15	30315				
16	30316				
17	30317	224.0.131.249	224.0.131.251	233.130.124.249	233.130.124.251
18	30318				
19	30319				
20	30320				
21	30321				
22	30322				
23	30323				
24	30324				
25	30325				
26	30326				
27	30327				
28	30328				
29	30329				
30	30330				
31	30331				
32	30332				
33	30333				

Note - Cboe reserves the right to add multicast addresses with prior notice, but no migration period. Notice will be given that the distribution will change on a certain date. Care should be taken to support mappings in these tables via software configuration. Addresses in the gray area are pre-assigned but not available. Customers should not configure their networks or systems for these addresses.

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400SL Secondary Datacenter		Gig-Shaped [WEC] 170.137.17.96/29	
Unit	**IP Port**	**Real-time MC**	**Gap Response MC**
1	31301	233.182.199.104	233.182.199.106
2	31302		
3	31303		
4	31304		
5	31305		
6	31306		
7	31307		
8	31308		
9	31309		
10	31310		
11	31311		
12	31312		
13	31313		
14	31314		
15	31315		
16	31316		
17	31317	233.182.199.105	233.182.199.107
18	31318		
19	31319		
20	31320		
21	31321		
22	31322		
23	31323		
24	31324		
25	31325		
26	31326		
27	31327		
28	31328		
29	31329		
30	31330		
31	31331		
32	31332		
33	31333		

Note - Cboe reserves the right to add multicast addresses with prior notice, but no migration period. Notice will be given that the distribution will change on a certain date. Care should be taken to support mappings in these tables via software configuration.

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8.2 Certification Environment Configuration

8.2.1 Unit/Symbol Distribution (Effective through 4/13/18)

The following table describes the EDGX and C2 Options symbol distribution across certification units.

Unit	EDGX Symbol Range	C2 Symbol Range
1	A - ADRZZ	A - ADRZZ
2	ADS – AMZMZ	ADS – AMZMZ
3	AMZN – AOZZZ	AMZN – AOZZZ
4	AP – BACAZ	AP – BACAZ
5	BACB – CASZZ	BACB – CASZZ
6	CAT – CMGAZ	CAT – CMGAZ
7	CMGB – CYGZZ	CMGB – CYGZZ
8	CYH – DOWAZ	CYH – DOWAZ
9	DOWB – FASTZ	DOWB – FASTZ
10	FASU – FOWZZ	FASU – FOWZZ
11	FOX – GOLFZ	FOX – GOLFZ
12	GOLG – GPBZZ	GOLG – GPBZZ
13	GPC – HULZZ	GPC – HULZZ
14	HUM – IPAAZ	HUM – IPAAZ
15	IPAB – IWLZZ IWMA - LDLAZ	IPAB – IWLZZ IWMA - LDLAZ
16	LDLB – MCDAZ	LDLB – MCDAZ
17	MCDB – MTVZZ	MCDB – MTVZZ
18	MTW – NKEAZ	MTW – NKEAZ
19	NKEB – PCLMZ	NKEB – PCLMZ
20	PCLN – PCLNZ	PCLN – PCLNZ
21	PCLO – QQPZZ QQQA - REGNZ	PCLO – QQPZZ QQQA - REGNZ
22	REGO – SNEAZ	REGO – RUSZZ RUTA – RUTVZZ RUTWA – SNEAZ
23	SNEB – SPXZZ SPYA – TLLPZ	SNEB – SPXZZ SPYA – TLLPZ
24	TLLQ – TTMAZ	TLLQ – TTMAZ
25	TTMB – USFZZ	TTMB – USFZZ
26	USG – VRWZZ	USG – VRWZZ
27	VRX – WFLZZ	VRX – WFLZZ
28	WFM – XLPAZ	WFM – XLPAZ
29	XLPB – ZZZZZ	XLPB – ZZZZZ
30	IWM	IWM
31	QQQ	QQQ
32	SPY	SPY
33	N/A	RUT, RUTW

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8.2.2 Unit/Product Distribution (Effective 4/14/18)

Unit	Symbol Range	C2 Symbol Range
1	A – ADOZZ	A – ADOZZ
2	ADP – AMZMZ AMZNA – ANETZ	ADP – AMZMZ AMZNA – ANETZ
3	ANEU – BAAAZ	ANEU – BAAAZ
4	BAAB – BKNFZ	BAAB – BKNFZ
5	BKNG – BZZZZ	BKNG – BZZZZ
6	C – CLGXZ	C – CLGXZ
7	CLGY – CSXAZ	CLGY – CSXAZ
8	CSXB – DISAZ	CSXB – DISAZ
9	DISB – ETFBZ	DISB – ETFBZ
10	ETFC – FIVDZ	ETFC – FIVDZ
11	FIVE – GLDAZ	FIVE – GLDAZ
12	GLDB – GOOGZ	GLDB – GOOGZ
13	GOOH – HSXZZ	GOOH – HSXZZ
14	HSY – IWLZZ	HSY – IWLZZ
15	IWM – JNJAZ	IWM – JNJAZ
16	JNJB – LMTAZ	JNJB – LMTAZ
17	LMTB – MLNXZ	LMTB – MLNXZ
18	MLNY – MUAAZ	MLNY – MUAAZ
19	MUAB – NTESZ	MUAB – NTESZ
20	NTET – OXYAZ	NTET – OXYAZ
21	OXYB – QGENZ	OXYB – QGENZ
22	QGEO – RHAAZ	QGEO – RHAAZ
23	RHAB – SMGZZ	RHAB – RUSZZ RUTA – RUTVZ RUTWA – SMGZZ
24	SMH – SPXZZ SPYA – SYEZZ	SMH – SPXZZ SPYA – SYEZZ
25	SYF – TSKZZ	SYF – TSKZZ
26	TSL – UALAZ	TSL – UALAZ
27	UALB – VLOAZ	UALB – VLOAZ
28	VLOB – WDCAZ	VLOB – WDCAZ
29	WDCB – XLDZZ	WDCB – XLDZZ
30	XLE – ZZZZZ	XLE – ZZZZZ
31	AMZN	AMZN
32	SPY	SPY
33	N/A	RUT, RUTW

Note - Cboe reserves the right to add units and/or change symbol distribution with 48 hours of notice and no migration period. Notice will be given that the distribution will change on a certain date. Care should be taken to support mappings in these tables via software configuration.

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8.2.3 Options Multicast Routing Parameters

Data Center	Rendezvous Point
NY5 Certification Data Center	74.115.128.129

8.2.4 EDGX Options Address/Unit Distribution

The following table describes the unit distribution across certification EDGX Complex Options Multicast PITCH feeds out of the NY5 datacenter.

Primary Datacenter		Certification 174.136.174.176/28	
Unit	IP Port	Real-time MC	Gap Resp. MC
1	32551	224.0.74.184	224.0.74.186
2	32552		
3	32553		
4	32554		
5	32555		
6	32556		
7	32557		
8	32558		
9	32559		
10	32560		
11	32561		
12	32562		
13	32563		
14	32564		
15	32565		
16	32566		
17	32567	224.0.74.185	224.0.74.187
18	32568		
19	32569		
20	32570		
21	32571		
22	32572		
23	32573		
24	32574		
25	32575		
26	32576		
27	32577		
28	32578		
29	32579		
30	32580		
31	32581		
32	32582		

Note - Cboe reserves the right to add multicast addresses with prior notice, but no migration period. Notice will be given that the distribution will change on a certain date. Care should be taken to support mappings in these tables via software configuration.

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8.2.5 C2 Options Address/Unit Distribution

The following table describes the unit distribution across certification C2 Complex Options Multicast PITCH feeds out of the NY5 datacenter.

Primary Datacenter		Certification 174.136.160.80/28	
Unit	**IP Port**	**Real-time MC**	**Gap Resp. MC**
1	32251	224.0.74.160	224.0.74.162
2	32252		
3	32253		
4	32254		
5	32255		
6	32256		
7	32257		
8	32258		
9	32259		
10	32260		
11	32261		
12	32262		
13	32263		
14	32264		
15	32265		
16	32266		
17	32267	224.0.74.161	224.0.74.163
18	32268		
19	32269		
20	32270		
21	32271		
22	32272		
23	32273		
24	32274		
25	32275		
26	32276		
27	32277		
28	32278		
29	32279		
30	32280		
31	32281		
32	32282		
33	32283		

Note - Cboe reserves the right to add multicast addresses with prior notice, but no migration period. Notice will be given that the distribution will change on a certain date. Care should be taken to support mappings in these tables via software configuration.

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9 Connectivity

9.1 Supported Extranet Carriers

Cboe has certified a number of carriers defined in the Cboe US Equity/Options Connectivity Manual with respect to redistribution of Cboe Multicast data feeds. For more information on receiving Multicast PITCH through any of these providers, reach out to the vendor contact noted in the Extranet Providers section of the Connectivity Manual.

9.2 Bandwidth Recommendation

The Gig-shaped feeds require 1Gbps of bandwidth. Cboe will use 90% of these respective bandwidths for Multicast PITCH to allow customers to use the same physical connection for FIX order entry if desired.

9.3 Multicast Test Program

The ZIP file located at http://www.batstrading.com/resources/membership/mcast_pitch.zip contains a sample program that may be used to test Multicast PITCH feed connections and to troubleshoot Multicast issues. Refer to the included README file for build and usage information.

10 References

For more information on Cboe Symbology, please refer to the Cboe Symbology Reference document.

11 Support

Please e-mail questions or comments regarding this specification to tradedesk@bats.com.

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Revision History

Document Version	Date	Description
2.0.0	05/11/17	Initial version of US Options Complex Multicast PITCH Specification based on Multicast PITCH 2.X.
2.0.1	05/18/17	Various minor updates and clarification added.
2.0.2	07/28/17	Added Multicast IPs/Ports for Certification environment. Added `Auction Update` and `Auction Summary` messages.
2.0.3	08/08/17	Added Multicast IPs/Ports for Production environment.
2.0.4	09/01/17	Added C2 Options references.
2.0.5	10/17/17	Cboe branding/logo changes.
2.0.6	11/24/17	Added C2 Options Certification IP and Port information. Added RUT, RUTW options (C2 Options Only) to distinct unit (unit 33).
2.0.7	02/05/18	Removed the "A" *Trading Status* field value as this is used for equities only. Added C2 Options Production IP and Port information.
2.0.8	03/08/18	Updated Unit Distribution ranges.
2.0.9	03/23/18	Unit Distribution ranges **Effective Date updated to 4/14/18**.

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