Cboe One Feed Specification

Version 1.3.4

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Contents

1   Introduction

The Cboe One Feed delivers consolidated quote, trade, and Aggregated Depth At Price (ADAP) information for all Cboe US equities books via TCP/IP and UDP using the binary Cboe One protocol. The feed consists of `Clear Quote`, `Symbol Summary`, `Best Quote Update`, `Market Status`, `ADAP`, `RPI`, `Trade`, `Trade Break`, `Trading Status`, and `Opening/Closing Price` messages.

The TCP/IP delivered feed can be used as a standalone product or to augment the UDP feed for recovery and start up purposes. The TCP/IP feed is available from the Cboe One Server and sends a replay of missed trades and refreshes the current state of the Cboe books followed by real-time updates to the books after a connection is established.

The UDP delivered feed is sourced from the Cboe One Feed Server (FS). Users may also connect to the Cboe One Gap Request Proxy for retransmission of missed packets on the UDP feed by the Cboe One Gap Server (GS).

While the TCP/IP and UDP delivered feeds offer equivalent real-time updates with matching sequence numbers, the consumer should assume message framing will be different between the transmission protocols.

It is important to note that the Cboe One feed is an aggregated feed. Updates for a symbol are sent as capacity for the feed allows. The image for a symbol will be current at the time of delivery, but multiple updates maybe combined into a single update. The interval between updates is dependent on the market conditions and the capacity configuration of the particular Cboe One feed.

The Cboe One Feed is available with different combinations of ADAP levels and update rates to meet the needs of our members. Current Cboe One Feed Descriptions:

Name	Best Quote	ADAP Levels	Bandwidth
Cboe One Summary	Yes	0	100Mb
Cboe One Premium	Yes	5	250Mb

1.1   Cboe One Server (TCP)

The client connects to an assigned host and port using a TCP/IP socket.

Upon connection, the member must send a `Cboe One Login` message. The `Cboe One Login` message's *Next Sequence* field allows members to specify the next sequence number they expect to receive. If a member logs in after trading begins or after connection loss, the *Next Sequence* field can be used to tell the server to replay any `Trade` and `Trade Break` messages that have occurred since the last received `Trade` or `Trade Break` message.

If the *Next Sequence* field is set to 1 (one), then all `Trade` and `Trade Break` messages from the beginning of the day will be replayed after the server sends a successful `Login Response` message. Once the server has replayed any `Trade` and `Trade Break` messages, it will deliver relevant `Market Status` information, `RPI` information, `Trading Status` messages, and a spin of `Symbol Summary`, `Opening/Close Price` and `ADAP` messages from its cache for each active symbol. Then the server will send the member a `Replay Complete` message followed by the live stream of `Symbol Summary`, `Best Quote Update`, `ADAP`, `RPI`, `Trade`, `Trade Break`, `Market Status`, `Trading Status`, and `Opening/Closing Price` messages.

If the *Next Sequence* field is set to 0 (zero), then no `Trade` or `Trade Break` messages will be replayed after the server sends a successful `Login Response` message. However, the member may still receive a spin of `Market Status`, `RPI`, `Trading Status`, `Symbol Summary`, `Opening/Close Price` and `ADAP` messages followed by a `Replay Complete` message before receiving the live stream of `Symbol Summary`, `Best Quote Update`, `ADAP`, `RPI`, `Trade`, `Trade Break`, `Market Status`, `Trading Status`, and `Opening/Closing Price` messages.

If a member's process cannot keep up with the Cboe One feed's rate of transmission, the connection will be closed by the server. The client should then reconnect and login with the appropriate *Next Sequence* number to receive any missed trades, and spin of the latest image for all symbols.

1.2   Cboe One Feed Server (UDP)

The UDP delivered Cboe One Feed is sourced by the Cboe One Feed Server (FS). The FS generates the multicast events for the Cboe One feed and performs throttling of events to ensure the bandwidth requirements of the feed are not exceeded.

The FS does not receive messages from members and no login is necessary.

Multicast addresses and ports for the Cboe One feed are listed in the Multicast Configuration section of this document.

1.3   Cboe One Gap Request Proxy and Message Retransmission via Gap Server

Requesting delivery of missed data is achieved by connecting to a Cboe One Gap Request Proxy (Cboe One GRP). Members 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. Members 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. Larger sequence number gaps should be recovered via the Cboe One Server over TCP. Members will receive a total daily allowance of gap requested messages. In addition, each member is given renewable one second and one minute gap request limits.

If more than one gap request is received for a particular 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. Members will receive gap responses for their requested 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.

1.4   Cboe One Disaster Recovery

Users of Cboe One that are interested in disaster recovery must maintain connectivity to the Cboe Disaster Recovery ("DR") site in Chicago, IL. To establish new connectivity to the DR site, contact the Cboe NOC.

The Cboe One feed that is disseminated from the DR site takes the incoming SIP trade feeds and connects to Cboe PITCH services sourced in the DR site for BZX Exchange, BYX Exchange, EDGX Exchange, and EDGA Exchange. It serves the same data as is distributed from the Cboe Primary site in Secaucus, NJ all day long, so Cboe One customers can fail-over to or utilize the Cboe One feed out of the DR site at any time. However, note that sequence numbers are not guaranteed to be the same between the Primary and DR sites.

The Cboe DR site is designed to support Cboe One in the following DR scenarios:

1. Hardware failure in the primary Cboe One system. Customers always have the option to switch to the DR site at will if they don't want to wait for remediation of failed hardware in the Primary datacenter   to   take   place.

2. Failover of <u>one or more</u> of Cboe's equities platforms to their respective DR site. The Cboe One feed in the Primary site currently only connects up to PITCH for BYX Exchange, BZX Exchange, EDGA Exchange and EDGX Exchange within the Primary site. If one of the exchanges fails over to the DR site, then the Cboe One feed out of Primary site will not be able to disseminate updates

from that exchange's PITCH feed in the DR site. In this scenario, customers should take the Cboe One feed out of the DR site to regain full coverage.

3. Loss of any of the Cboe One input feeds. Similarly to scenario #2, if Cboe experiences a PITCH dissemination issue for BYX Exchange, BZX Exchange, EDGA Exchange or EDGX Exchange at the Primary site, but PITCH market data is valid for the problem exchange at the DR site, then Cboe One customers have the option to switch over to the DR Cboe One feed to regain full coverage. The same situation applies if Cboe experiences an outage at the Primary site with respect to receipt of SIP feed data. If those feeds are still being received at the DR site, then customers have the option to switch over to the DR site to regain full coverage.

2   Protocol

Cboe users may use the Cboe One protocol over TCP/IP and/or multicast to receive the Cboe One feed direct from Cboe.

Cboe One cannot be used to enter orders. For order entry, refer to the Cboe FIX or BOE specifications.

2.1   Message Format

The messages that make up the Cboe One protocol are delivered using `Sequenced Unit Header` which handles sequencing and delivery integrity. All messages delivered via TCP/IP or multicast 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 Cboe One Server or GRP may cross frames as the data will be delivered as a stream of data with the TCP/IP stack controlling Ethernet framing.

The Cboe One 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. Members 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.

2.2   Data Types

The following field types are used within Cboe One feed.

➢ 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).

➢ Binary 4.4 Price fields are unsigned Little Endian encoded 4 byte binary fields with 4 implied decimal places (denominator = 10,000).

➢ Binary 8.4 Price fields are unsigned 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 a 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 feed and site. The content of the multicast across feeds will be identical, but framing will not be consistent across feeds. Receiving processes that receive and arbitrate multiple feeds cannot use frame level arbitration.

2.4   Cboe Sequenced Unit Header

The `Sequence Unit Header` is used for all Cboe One messages delivered via multicast or TCP/IP.

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.

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 (0 for all Cboe One messages).
Hdr Sequence	4	4	Binary	Sequence of first message to follow this header.
Total Length = 8 bytes				

2.5 Heartbeat Messages

The `Sequenced Unit Header` with a *Hdr Count* field set to "0" will be used for heartbeat messages. During trading hours heartbeat messages will be sent from the Cboe One Server, GRP and all multicast addresses if no data has been delivered within 1 second. Heartbeat messages never increment the sequence number, 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. Heartbeats on gap multicast addresses will always have the *Hdr Sequence* field set to 0. All heartbeat messages sent to and from the Cboe One Server and GRP are considered un-sequenced and should have *Hdr Sequence* and *Hdr Unit* fields set to 0.

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 Cboe One Server and GRP on live connections no less than every 5 seconds. Failure to receive 2 consecutive heartbeat messages will result in the termination of the client connection.

3   Cboe One Server Session Messages (TCP)

The following messages are used for initializing a TCP/IP connection to the Cboe One Server. Members only need to implement the following messages if a TCP/IP connection to the Cboe One Server is desired. The following messages will not be delivered using multicast.

See the "Cboe One Update Messages" section of this document for a description of book and market related messages that are available from the Cboe One Server.

3.1   Cboe One Login

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

Cboe One Login				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	Length of this message including this field.
Message Type	1	1	0xA0	`Cboe One Login`
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
Next Sequence	22	4	Binary	Sequence number of the next sequenced message expected by the user.
Total Length = 26 bytes				

3.2   Login Response

The `Login Response` message is sent by the server to a member'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`
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			
'Q'	Next Sequence is ahead of sequence			

3.3   Replay Complete

The `Replay Complete` message is sent to indicate that messages related to refreshing the state of the Cboe books have been delivered. After receipt of the `Replay Complete`, message updates will be sent on the session as needed until the client disconnects.

`Market Status, RPI, Trading Status, Symbol Summary, Opening/Close Price,` and `ADAP` messages will be sent as needed to replay the current state of the Cboe books.

During the replay phase of the connection all messages with the exception of `Trade` and `Trade Break` messages will be un-sequenced.

Replay Complete				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0xA1	`Replay Complete`
Sequence	2	4	Binary	Sequence number that reflects that last update on the feed.
Total Length = 6 bytes				

4 Cboe One Gap Request Proxy Session Messages (TCP)

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

4.1 GRP Login

The GRP Login 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.

GRP Login				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0x01	GRP Login
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
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.

The `Gap Request` message for Cboe One is identical to the Multicast Pitch `Gap Request` message. The *Unit* field should be set to 0 since the Cboe One feed is not unitized.

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`
Unit	2	1	Binary	*Unit* that the gap is requested for (0 for Cboe One implementation).
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.

The `GAP Response` message for Cboe One is identical to the Multicast Pitch `Gap Response` message. The *Unit* field should be set 0 to since the Cboe One feed is not unitized.

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`
Unit	2	1	Binary	*Unit* the gap was requested for (0 for Cboe One implementation).
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.

5 Cboe One Update Messages (UDP & TCP)

The messages described in this section are delivered from the Cboe One Server (TCP), Cboe One Feed Server (UDP), and the Cboe One Gap Server (UDP gap responses).

5.1.1 Clear Quote

The `Clear Quote` message instructs feed recipients to clear all quotes and Summary and/or ADAP information for the specified symbol on the specified market(s). This message does not affect the executed volume of the symbol.

Clear Quote				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0xA2	`Clear Quote`
Last Update Timestamp	2	8	Binary	Timestamp of the last matching engine message that updated the quote information for this symbol in the Cboe One server's cache. Encoded as the number of nanoseconds since midnight.
Symbol	10	8	Alphanumeric	Symbol right padded with spaces.
Market Center	18	1	Alphanumeric	"*" = All Cboe Markets "Y" = BYX "Z" = BZX "A" = EDGA "X" = EDGX
Total Length = 19 bytes				

5.1.2 Long Symbol Summary

The `Long Symbol Summary` message delivers the Cboe consolidated best bid/offer and total executed volume across all 4 (four) equities books.

Long Symbol Summary				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0xA3	`Long Symbol Summary`
Last Update Timestamp	2	8	Binary	Timestamp of the last matching engine message that updated the quote information for this symbol in the Cboe One server's cache. Encoded as the number of nanoseconds since midnight.
Symbol	10	8	Alphanumeric	*Symbol* right padded with spaces.

	18	8	Binary	Cumulative number of shares traded today across all 4 Cboe books.
Cboe Cumulative Executed Volume				
Consolidated Best Bid Price	26	8	Binary 8.4 Price	Cboe Consolidated best bid price.
Consolidated Best Bid Quantity	34	8	Binary	Cboe Consolidated number of buy-side shares available for this symbol.
Consolidated Best Ask Price	42	8	Binary 8.4 Price	Cboe Consolidated best ask price.
Consolidated Best Ask Quantity	50	8	Binary	Cboe Consolidated number of sell-side shares available for this symbol.
SIP Cumulative Volume	58	8	Binary	Cumulative number of shares traded today as reported to the CTA and UTP SIPs.
Flags	66	1	Bit Field	Bit 0: SIP Volume Status 0: SIP volume data is complete. 1: SIP volume data may not be complete due to an unrecoverable gap on the incoming feed. Bits 1-7: Reserved.
Total Length = 67 bytes				

5.1.3   Short Symbol Summary

The `Short Symbol Summary` message delivers the Cboe consolidated best bid/offer and total executed volume across all 4 (four) equities books.

Short Symbol Summary				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0xA4	`Short Symbol Summary`
Last Update Timestamp	2	8	Binary	Timestamp of the last matching engine message that updated the quote information for this symbol in the Cboe One server's cache. Encoded as the number of nanoseconds since midnight.
Symbol	10	8	Alphanumeric	*Symbol* right padded with spaces.
Cboe Cumulative Executed Volume	18	4	Binary	Cumulative number of shares traded today across all 4 Cboe books.
Consolidated Best Bid Price	22	4	Binary 4.4 Price	Cboe Consolidated best bid price.
Consolidated Best Bid Quantity	26	4	Binary	Cboe Consolidated number of buy-side shares available for this symbol.

Consolidated Best Ask Price	30	4	Binary 4.4 Price	Cboe Consolidated best ask price.
Consolidated Best Ask Quantity	34	4	Binary	Cboe Consolidated number of sell-side shares available for this symbol.
SIP Cumulative Volume	38	4	Binary	Cumulative number of shares traded today as reported to the CTA and UTP SIPs.
Flags	42	1	Bit Field	Bit 0: SIP Volume Status 0: SIP volume data is complete. 1: SIP volume data may not be complete due to an unrecoverable gap on the incoming feed. Bits 1-7: Reserved.
Total Length = 43 bytes				

5.1.4 Best Quote Update

The `Best Quote Update` message is used to update one side of the Cboe consolidated quote information for a symbol. Since the message only updates one side of the quote the previous value for the other side of the quote remains in effect.

This message does not affect the executed volume of the symbol.

Best Quote Update				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0xA5	`Best Quote Update`
Last Update Timestamp	2	8	Binary	Timestamp of the last matching engine message that updated the quote information for this symbol in the Cboe One server's cache. Encoded as the number of nanoseconds since midnight.
Symbol	10	8	Alphanumeric	Symbol right padded with spaces.
Side Indicator	18	1	Alphanumeric	"B" = Buy Side "S" = Sell Side
Consolidated Best Quote Price	19	8	Binary 8.4 Price	Cboe Consolidated best price.
Consolidated Quote Quantity	27	8	Binary	Cboe Consolidated number of shares available for this symbol.
Total Length = 35 bytes				

5.1.5 Cboe Market Status

The `Cboe Market Status` message is disseminated to reflect a change in the status of a market. All markets should be assumed to be "Normal" unless otherwise indicated by a `Cboe Market Status` message.

The "Incomplete" market status is used to indicate that the feed has not delivered updates for all of a market center's symbols and that the feed is transitioning to "Normal". If a market center transitions from "Normal" to "Excluded" the feed will deliver updates of symbol quote/ADAP information to properly reflect the state of the combined book. At the start of a market center's transition from "Excluded" to "Normal" a `Cboe Market Status` message will be sent with "Incomplete" for the market center's status. Symbol quote/ADAP information will then be sent for all applicable symbols. Once the market center's symbol information has been disseminated a `Cboe Market Status` message will be delivered with a "Normal" market status.

Cboe Market Status				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0xA6	`Cboe Market Status`
Timestamp	2	8	Binary	Timestamp of when the Market Status changed for the specified Market Center. Encoded as the number of nanoseconds since midnight.
Market Center	10	1	Alphanumeric	"Y" = BYX "Z" = BZX "A" = EDGA "X" = EDGX
Market Status	11	1	Alphanumeric	"N" = Normal "E" = Excluded from Symbol Summary and ADAP updates "I" – Incomplete
Session Indicator	12	1	Alphanumeric	"R" = Regular trading session "P" = Pre- or post-market session
Total Length = 13 bytes				

5.1.6 ADAP

Each `ADAP` message delivers one or more updates for a Symbol's ADAP book. Each `ADAP` message contains one or more `ADAP Blocks`. A receiving process should interpret each `ADAP Block` as a replacement for any previously delivered `ADAP Blocks` at that price level.

A quantity of 0 indicates that the price level is either no longer available or the price level is not within the number ADAP levels maintained by the feed. In either case a receiving process should delete a price level with a 0 quantity from its cache.

ADAP				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field
Message Type	1	1	0xA7	`ADAP`
Last Update Timestamp	2	8	Binary	Timestamp of the last matching engine message that updated the quote information for this symbol in the Cboe One server's cache. Encoded as the number of nanoseconds since midnight.
Symbol	10	8	Alphanumeric	Symbol right padded with spaces.
Flags	18	1	Bit Field	**Bit 0:** Clear ADAP 0: Keep any ADAP information for this symbol. 1: Delete any ADAP information for this symbol before applying `ADAP Blocks`. **Bit 1:** ADAP Complete 0: The ADAP view for this symbol is complete. 1: More ADAP updates for this symbol to follow in another `ADAP` message. **Bit 2:** Short/Long Block(s) 0: Short Update `ADAP Block`(s) to follow 1: Long Update `ADAP Block`(s) to follow **Bits 3-7:** Spare
Spare	19	1		Spare
ADAP Blocks	20	1	Binary	Number of `ADAP Blocks` to follow
ADAP Block Size	21	1	Binary	Size of each `ADAP Block`
Header Length = 22 bytes				

Short Update ADAP Block				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Market Center	0	1	Alphanumeric	"Y" = BYX "Z" = BZX "A" = EDGA "X" = EDGX
Side	1	1	Alphanumeric	"B" = Buy Side "S" = Sell Side
Price	2	4	Binary 4.4 Price	*Price* level to add/update for Market Center's ADAP book.
Quantity	6	4	Binary	*Quantity* of shares at this price level in the Market Center's ADAP book. A value of zero implies deletion of this ADAP level.
Short ADAP Block Length Indicated by ADAP Block Size in Header				

Long Update ADAP Block				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Market Center	0	1	Alphanumeric	"Y" = BYX "Z" = BZX "A" = EDGA "X" = EDGX
Side	1	1	Alphanumeric	"B" = Buy Side "S" = Sell Side
Price	2	8	Binary 8.4 Price	*Price* level to add/update for Market Center's ADAP book.
Quantity	10	8	Binary	*Quantity* of shares at this price level in the Market Center's ADAP book. A value of zero implies deletion of this ADAP level.
Long ADAP Block Length Indicated by ADAP Block Size in Header				
Total Length = Variable → (Header Length [22 bytes] + ADAP Blocks x ADAP Block Size)				

5.1.7   Retail Price Improvement (RPI)

The `Retail Price Improvement (RPI)` message is a retail liquidity indicator that includes symbol and side, but not price and size. An `RPI` message will be disseminated when there is a retail price improving order present for a symbol on any Cboe Exchange order book OR to indicate a RPI order is no longer available. RPI orders offer price improvement in increments of $.001 to Retail Member Organizations.

RPI				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0xA8	`RPI`
Timestamp	2	8	Binary	Timestamp of the matching engine RPI message emitted by the specified Market Center. Encoded as the number of nanoseconds since midnight.
Symbol	10	8	Alphanumeric	Symbol right padded with spaces.
Market Center	18	1	Alphanumeric	"Y" = BYX "Z" = BZX "A" = EDGA "X" = EDGX
Retail Price Improvement	19	1	Alphanumeric	"B" = Buy Side RPI "S" = Sell Side RPI "A" = Buy & Sell RPI "N" = No RPI
Total Length = 20 bytes				

5.1.8   Trade

`Trade` messages are sent when an order is executed in whole or in part on a Cboe exchange. The last-sale eligible status (*Flags* field Bit 1) is derived based on four criteria:

1. The *Session Indicator* (see `Cboe Market Status`) must be in the regular session.
2. The *Last Quantity* must be at least one round lot.
3. The *Market Status* (see `Cboe Market Status`) for the executing exchange must be "Normal".
4. The *Transaction Time* of the event must be within 10 seconds of the current time.

Trade				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0xA9	`Trade`
Transaction Time	2	8	Binary	The time the trade occurred on the specified Market Center. Encoded as the number of nanoseconds since midnight.
Symbol	10	8	Alphanumeric	Symbol right padded with spaces.
Market Center	18	1	Alphanumeric	Market Center on which the last trade was executed: "Y" = BYX "Z" = BZX "A" = EDGA "X" = EDGX
Market Center Execution ID	19	8	Binary	Market center specific execution identifier of this Execution. *Execution ID* is also referenced in the Trade Break message.
Last Price	27	8	Binary 8.4 Price	Last trade price.
Last Quantity	35	8	Binary	Last trade quantity.
Cboe Cumulative Executed Volume	43	8	Binary	Cumulative number of shares traded today across all 4 Cboe books.
SIP Cumulative Volume	51	8	Binary	Cumulative number of shares traded today as reported to the CTA and UTP SIPs.
Flags	59	1	Bit Field	Bit 0: SIP Volume Status 0: SIP volume data is complete. 1: SIP volume data may not be complete due to an unrecoverable gap on the incoming feed. Bit 1: 0: Trade is not last-sale eligible 1: Trade is last-sale eligible Bits 2-7: Reserved.
Total Length = 60 bytes				

5.1.9 Trade Break

The `Trade Break` message is sent whenever an execution on a Cboe exchange is broken. Trade breaks are rare and only affect applications that rely upon Cboe execution based data.

Trade Break				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0xAA	`Trade Break`
Transaction Time	2	8	Binary	The time the trade break occurred on the specified Market Center. Encoded as the number of nanoseconds since midnight.
Symbol	10	8	Alphanumeric	Symbol right padded with spaces.
Market Center	18	1	Alphanumeric	Market Center on which the last trade was executed: "Y" = BYX "Z" = BZX "A" = EDGA "X" = EDGX
Market Center Execution ID	19	8	Binary	Market center specific execution identifier of trade to be broken.
Cboe Cumulative Executed Volume	27	8	Binary	Cumulative number of shares traded today across all 4 Cboe books.
SIP Cumulative Volume	35	8	Binary	Cumulative number of shares traded today as reported to the CTA and UTP SIPs.
Flags	43	1	Bit Field	Bit 0: SIP Volume Status 0: SIP volume data is complete. 1: SIP volume data may not be complete due to an unrecoverable gap on the incoming feed. Bits 1-7: Reserved.
Total Length = 44 bytes				

5.1.10 Trading Status

The `Trading Status` message is used to indicate the current trading status of a security on a Cboe exchange. A `Trading Status` message will be sent whenever a security's trading status changes.

A `Trading Status` message will be sent:
- for Regulatory "H"alts in any security as well as the "T"rading resumption for the same security.
- for Cboe Listed securities that are in a "Q"uoting period for auctions.
- to indicate a Reg SHO price test is in effect.

Trading Status				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0xAB	`Trading Status`
Timestamp	2	8	Binary	Timestamp of the matching engine trading status message emitted by the specified Market Center. Encoded as the number of nanoseconds since midnight.
Symbol	10	8	Alphanumeric	Symbol right padded with spaces.
Market Center	18	1	Alphanumeric	"Y" = BYX "Z" = BZX "A" = EDGA "X" = EDGX
Halt Status	19	1	Alphanumeric	"A" = Accepting Orders for Queuing "H" = Halted "Q" = Quote-Only "S" = Exchange Specific Suspension "T" = Trading
Reg SHO Action	20	1	Alphanumeric	"0" = No price test in effect "1" = Reg SHO price test restriction in effect
Total Length = 21 bytes				

5.1.11 Opening/Closing Price

The `Opening/Closing Price` message is used to indicate the Opening or Closing price of a security on the Cboe exchanges. An `Opening/Closing Price` message will be sent whenever the opening or closing price of a security is established. The opening or closing price is established once across all Cboe exchanges (not per-exchange).

- For Cboe listed securities, the opening and closing prices are received from the listing market.
- For non- Cboe listed securities, the opening price of a security is defined as the first eligible trade received that occurred on or after 9:30:00 from any Cboe exchange. If no eligible trade is received by 9:35:00, no opening price will be reported.
- For non- Cboe listed securities, the closing price of a security is the last eligible trade received when any Cboe exchange timestamp exceeds the end of the regular session (normally 16:00:00). If no eligible trade has occurred prior to the close, no closing price will be reported.

The *Market Center* will identify the Cboe exchange that set the Opening or Closing Price for this security.

Opening/Closing Price				
Field	**Offset**	**Length**	**Value/Type**	**Description**
Length	0	1	Binary	*Length* of this message including this field.
Message Type	1	1	0xB0	`Opening/Closing Price`

Timestamp	2	8	Binary	The time the eligible trade occurred on the specified Market Center. Encoded as the number of nanoseconds since midnight.
Symbol	10	8	Alphanumeric	Symbol right padded with spaces.
Market Center	18	1	Alphanumeric	"Y" = BYX "Z" = BZX "A" = EDGA "X" = EDGX
Open/Close Indicator	19	1	Alphanumeric	"O" = Price is the Opening price "C" = Price is the Closing price
Price	20	8	Binary 8.4 Price	Opening/Closing Price.
Total Length = 28 bytes				

6 Multicast Configuration

6.1 US Equities Production Environment Configuration

6.1.1 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. Members should ensure that their infrastructure is configured accordingly.
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 per session.

6.1.2 Cboe One Multicast Routing Parameters

Data center	Rendezvous Point
Primary Data Center (NY5)	74.115.128.156
Secondary Data Center (CH4)	174.136.181.252

6.1.3   Cboe One Multicast Addresses

The following tables describe the distribution across production multicast Cboe One feeds.

NY5 Primary Datacenter	Real-time MC (Src) IP Addr	Gap Resp. MC (Src) IP Addr
Cboe One Summary	224.0.131.130:32201 (174.136.169.12)	224.0.131.131:32201 (174.136.169.12)
Cboe One Premium	224.0.131.128:32200 (174.136.169.12)	224.0.131.129:32200 (174.136.169.12)

CH4 Secondary Datacenter	Real-time MC (Src) IP Addr	Gap Resp. MC (Src) IP Addr
Cboe One Summary	233.19.3.34:32201 (174.136.181.150)	233.19.3.35:32201 (174.136.181.150)
Cboe One Premium	233.19.3.36:32200 (174.136.181.150)	233.19.3.37:32200 (174.136.181.150)

6.2   US Equities Certification Environment Configuration

6.2.1   Cboe One Certification Multicast Routing Parameters

Data center	Rendezvous Point
Certification Data Center (NY5)	74.115.128.129

6.2.2   Cboe One Certification Multicast Addresses

The following tables describe the current unit distribution across certification multicast Cboe One feeds.

NY5 Primary Datacenter	Real-time MC (Src) IP Addr	Gap Resp. MC (Src) IP Addr
Cboe One Summary	224.0.74.222:32200 (174.136.174.253)	224.0.74.223:32200 (174.136.174.253)
Cboe One Premium	224.0.74.220:32200 (174.136.174.252)	224.0.74.221:32200 (174.136.174.252)

7   References

7.1   Symbology

For more information on Cboe Symbology, please refer to the [Cboe Symbology Reference](#) document.

8   Support

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

Revision History

Document Version	Date	Description
1.0.0	06/30/14	Initial version.
1.0.1	07/15/14	Renamed Binary Long Price data type to Binary 8.4 Price. Renamed Binary Short Price data type to Binary 4.4 Price and changed from 2 to 4 bytes.
1.0.2	07/23/14	Added Certification Multicast Addresses.
1.0.3	09/11/14	Added Production (NJ2) Multicast Addresses.
1.0.4	09/28/14	Updated Trading Status message to include "A" Accepting Orders for Queueing and "S" Exchange Specific Suspension. Also updated section explaining recovery spin processing.
1.0.5	11/26/14	Bats One production systems will now be offered from the NY5 datacenter as opposed to from NJ2. Target availability date pending SEC approval. Bats One certification will be available in NY5 effective 12/01/14 and will be decommissioned in NJ2 effective 12/15/14.
1.1.0	05/01/15	Added *SIP Cumulative Volume* and *Flags* fields to Long Symbol Summary, Short Symbol Summary, Trade, and Trade Break messages effective 5/15/15.
1.1.1	12/29/15	Added Bats One Disaster Recovery section.
1.2.0	02/19/16	Bats branding/logo changes.
1.3.0	05/16/16	Added *Session Indicator* to the Market Status message, effective 08/01/16. Added last-sale eligible to the *Flags* on the Trade message, effective 08/01/16. Added Opening/Closing Price new message, effective 08/01/16.
1.3.1	06/14/16	Opening/Closing Price message type changed to 0xB0.
1.3.2	06/22/16	Added *Session Indica*tor to the Market Status message, effective date updated to 08/15/16. Added last-sale eligible to the Flags on the Trade message, effective date updated to 08/15/16. Added Opening/Closing Price new message, effective date updated to 08/15/16.
1.3.3	08/15/16	Bats formatting updates. Cleanup of old effective date references.
1.3.4	10/17/17	Cboe branding/logo changes.