



Multicast Market Data Feed Specification (Binary Version)

Published Version 6.5p1

1-February-2022

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System response times may vary for a number of reasons including market conditions, trading volumes and system performance.

VERSION HISTORY

VERSION	DESCRIPTION	DATE
6.5p1	First Release	31-05-2021
6.5p2	Cboe rebranding	01-02-2022

1 Introduction

Cboe Australia (“Cboe”) provides a high performance, low latency trading system. The information processed by the Cboe trading system is made available to market participants and data vendors through the Cboe Market Data Feed (“Cboe MD Feed”).

This service provides clients with details concerning orders and trade information on a real time basis.

The Cboe MD Feed is available in both TCP (unicast) and multicast versions. This document describes the technical specification for the multicast version including the connection protocol, message types and message structures.

Cboe Multicast Market Data are available in ASCII/Binary versions. This document describes the Binary version. Technical aspect of this data feed including the connection protocol, message types and message structures etc are described in this document.

The Binary version use binary representation for numbers such as order reference in Market Data Messages. This representation provides more compact messages than the ASCII version. Also, the time precision is up to nanosecond while the ASCII version provides up to millisecond only.

Customers using the ASCII version should refer to the document “Multicast Market Data Feed Specification”.

Customers using the TCP version should refer to the document “Market Data Feed Specification (Binary Version)”.

For the purposes of clarification reference to “client” in this specification means a technology system.

1.1 Relevant documents

TITLE
Market Data Feed Specification (Binary Version)
Snapshot Recovery Service Specification (Binary Version)
Technical Connectivity Guide
Order Type Overview

Figure 1: Relevant Document(s)

2 Overview

The Multicast Cboe MD Feed (Binary) consists of three data services:

- Real-time Multicast Market Data Feed (CHIXMMD-Binary)
- Multicast Message Recovery Service (MMRS-Binary)
- Snapshot Recovery Service (SRS-Binary)

The real-time multicast market data feed delivers market data in UDP multicast packets streamed over the multicast market data network. These multiple data streams provide network resiliency by all carrying identical content. By subscribing to these data streams, market data clients receive the latest market data updates from the trading system.

The multicast message recovery service offers message recovery to market data clients. Clients can connect to a designated MMRS-Bin server and request message retransmission. This recovery process is done over a TCP connection.

The snapshot recovery service offers snapshot recovery to market data clients. Clients can connect to designated SRS-Bin server and request for latest snapshot. The process is done over a TCP connection established by the request client to the SRS-Bin server.

The three data services are available at the primary data centre site and one data service at the secondary data centre site for resilience purpose. Data streams published at the secondary site may be slightly slower than the primary site. Therefore, market data clients may want to rely on primary site services and switch to secondary site services only when necessary.

The following diagram shows the overall delivery mechanism:

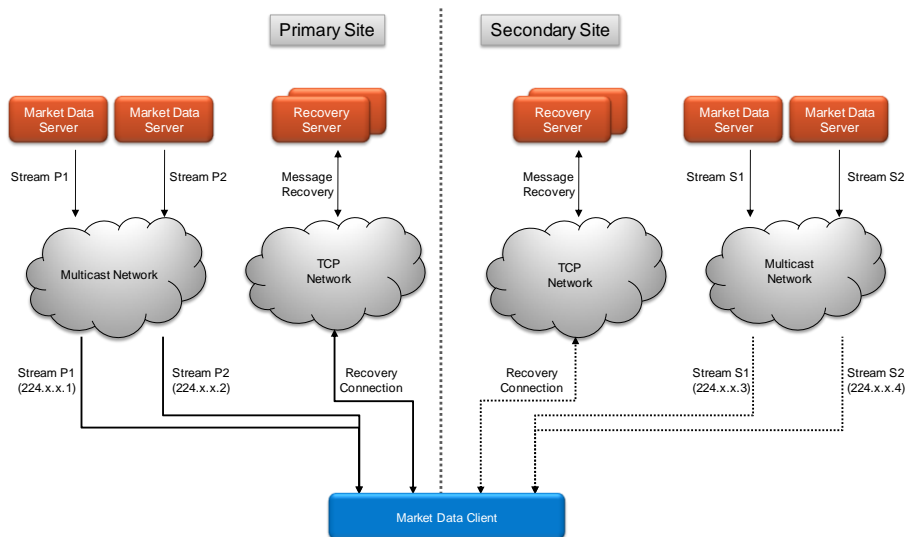


Figure 2: Multicast Market Data (Binary) Delivery Mechanism

[Please Note: Only a single stream will be in place in the secondary site]

2.1 Real-Time Multicast Market Data Feed Service (CHIXMMD-Binary)

The CHIXMMD-Binary feed delivers real-time market data in the form of UDP packet streams. There are two streams published from the primary site and one from the secondary site. They are published using different multicast addresses. Refer to section 2.4 for address details.

All data streams contain identical market data content. The protocol supports multiple messages in a UDP packet and different market data servers at different sites may apply this packing differently. Therefore, the streams may differ at UDP packet level. Market data clients need to be aware of this nature when processing the feed.

Every market data message carries a unique message sequence number which starts at 1 and increments by 1 in each subsequent message. Market data clients may use this sequence number to detect a message gap and recover accordingly in the event of connectivity loss.

There is a regular heartbeat of at least 1 message published in each data stream every 5 seconds to indicate line connection status. The heartbeat message does not increment the message sequence number and does not carry market data updates. It does carry the next expected sequence number so that a market data client can use it to detect missing message data. A heartbeat message is published every 5 seconds but may be skipped when a data stream is busy during high volume message transmission.

2.2 Multicast Message Recovery Service

Market data clients may use the service provided by MMRS-Binary Server to recover missing messages for the current trading day. This is done by establishing a TCP connection to a designated MMRS-Binary server and following the protocols described in this specification to initiate the request. In summary, the client application needs to submit a Login Request together with the sequence number of the first missing message. After validating this request, the Recovery Server replays messages to the client starting from the requested message.

Message volume replay is limited in a single recovery session. MMRS-Binary Server applies a limit check in serving recovery requests. If a request exceeds the pre-set limit, the server will disconnect the connection automatically. Market data clients are required to start a new session and continue from the last recovery point.

Session Time Limit	1 minute
--------------------	----------

Figure 3: MMRS Configuration Parameters

2.3 Snapshot Recovery Service

Market data clients may use the service provided by SRS-Binary Server for large-scale data recovery (e.g. Major outage or late joiners). This is done by establishing a TCP connection to a designated SRS-Binary server. Basically, the client application needs to submit a Login Request together with the mode = "0"/"1"/"2". After validation, the Snapshot Recovery Server replies the latest snapshot to the client.

The server will only reply the snapshot once for each connection. Just heartbeat message will be sent from the server once the snapshot is transferred. A client should send a Logout message to terminate the connection after received the complete snapshot or the server will disconnect the connection after a period.

Please refer to Cboe Snapshot Recovery Service Specification (Binary) for more detail.

2.4 Network Configuration Parameters

Please refer to the Technical Connectivity Guide for detailed network configuration parameters.

3 Protocol

3.1 CHIXMMD Protocol

The Real-time Multicast Market Data Feed protocol contains market data messages multicast packets. The market data messages describe activities of the trading system. For example, new orders and trade information. Format of the market data messages is described in section 4.

The multicast packet definition describes how market data messages are encoded in a multicast packet.

3.1.1 Multicast Packet Layout

Each multicast packet contains a packet header followed by one or more data messages as illustrated in the following diagram.

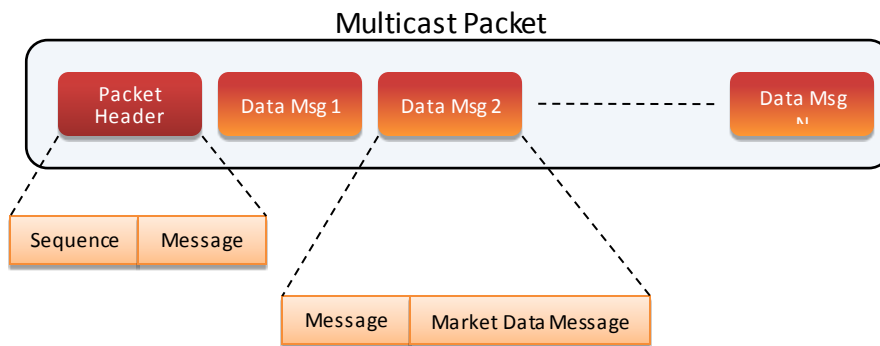


Figure 4: CHIXMMD Multicast Packet Layout

The following table describes the packet header layout.

PACKET HEADER				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Sequence	0	4	Binary	Sequence number of the first message in big-endian order
Message Count	4	2	Binary	Number of messages in the packet in big-endian order

The following table describes the data message layout. The following layout may repeat in the multicast packet to deliver multiple data messages in one packet.

DATA MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Length	Variable	2	Binary	Length of the Market Data Message in big-endian order
Market Data Message	Variable	Variable	Market Data Message	Content of the Market Data Message

3.1.2 Heartbeat Message

A heartbeat message is delivered in a single multicast packet and indicated by the message count value of zero in the packet header as below.

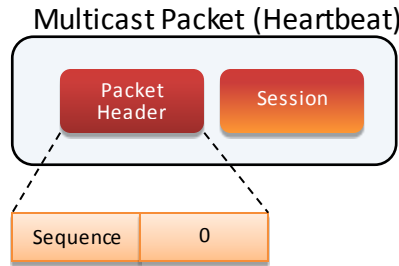


Figure 5: CHIXMMD-Bin Heartbeat Packet Layout

The following table describes the heartbeat message layout including the packet header.

HEARTBEAT MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Sequence	0	4	Binary	Sequence number of the next Market Data Message in big-endian order
Message Count	4	2	0	A zero value indicating this is a heartbeat message
Session	6	10	Alphanumeric	Current Session value

The Session field contains the current session of the market data stream being delivered. Client applications should use the value delivered in this field to populate the Session field in the Login Request of the Recovery Service.

The Session field will not normally change during a trading day. In an exceptional circumstance, such as the trading system is restarted in the middle of the day, the session value may change. This will in turn result in the sequence number being reset to 1.

3.2 MMRS Protocol

The Multicast Message Recovery Service protocol (Binary) follows the one used in the TCP version of Cboe MD Feed (Binary) in section 3.4. The protocol definition is described in the document “Market Data Feed Specification (Binary)”.

The following diagram describes a typical recovery scenario:

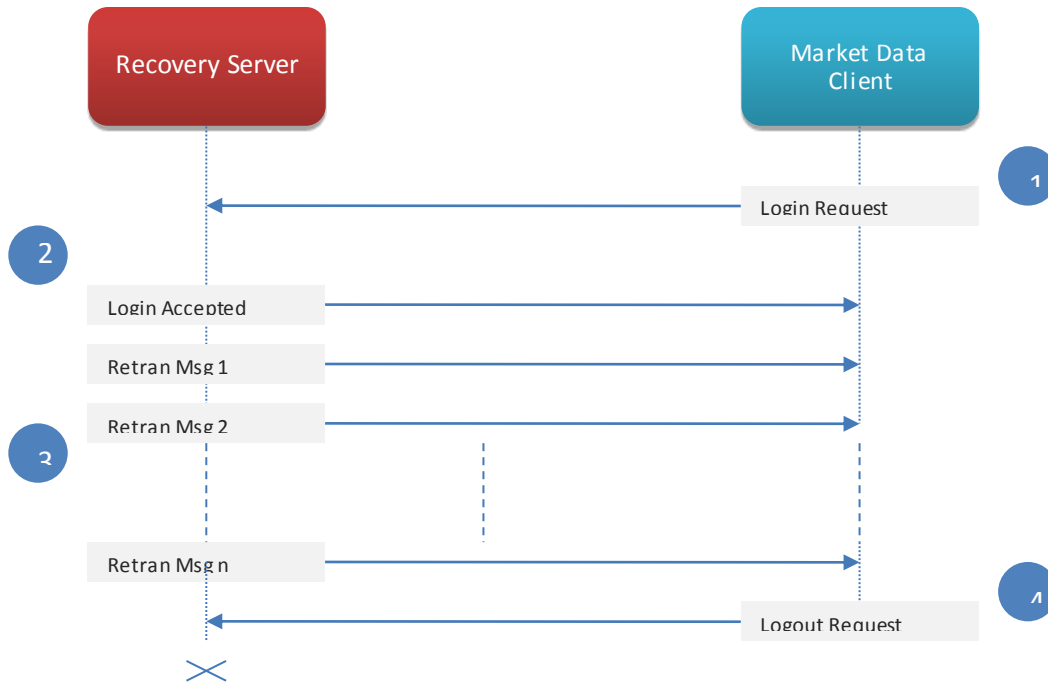


Figure 6: Example Recovery Scenario

In the diagram, there are 4 steps involved in the message recovery process.

Step 1: The client establishes a TCP connection with the recovery server and sends a Login Request message to request message retransmission.

Step 2: After receiving the login request, the Recovery Server will validate the user authentication information in the request. The session and message sequence number in the request will also be checked to ensure relevant messages are available for retransmission. A Login Accepted message will be sent to the client indicating the request has been accepted.

Step 3: The recovery server starts replaying the messages, starting from the one requested by the client.

Step 4: When the client receives the necessary retransmissions, it should send a Logout Request to disconnect the recovery session. After the request is sent, the client may close the TCP connection immediately.

There is a limit to the amount of message volume that can be replayed in a single recovery session. If the limit is reached, the server will terminate the connection. A new session can be started from the last recovery point. The recovery limit is described in the section 'Network Configuration Parameters'.

The recovery server will disconnect a client when playback of the past messages finishes. This is different from the CHIXMD-Binary feed which would continue to broadcast the real-time messages.

4 Market Data Messages

CHIXMMD Binary Feed contains a series of messages provide details of orders added to and removed from the Cboe order book, the execution of on-market trades plus Off-exchange trades reported to Cboe.

Cboe uses the same market data message format in both the multicast service and the recovery service.

4.1 Data Type

This section describes the available data types that are used in the Cboe Market Data Binary Feed.

4.1.1 Alphanumeric

Alphanumeric text fields consist of alphabetical letters or digits (or both). They are presented in left justification and are padded with spaces to the right. Data fields of alphanumeric data type include Stock (symbol).

4.1.2 Prices

Price data fields are unsigned 8-byte big-endian binary encoded integer. After decoded, the last 7 digits are the decimal places and the remaining parts are digits. The maximum value of this type is 922,337,203,685.4775807 (0x7fffffff).

4.1.3 Integer

Integer fields are unsigned big-endian (network byte order) binary encoded numbers. These fields are either 2 bytes, 4 bytes or 8 bytes. The maximum value of 2-byte integer is 32,767 (0x7fff), the maximum value of 4-byte integer is 2,147,483,647 (0x7fffffff), and the maximum value of 8-byte integer is 9,223,372,036,854,775,807 (0x7fffffffffffffff).

4.1.4 UTCTimestamp

String fields representing date and time combination represented in UTC in the YYYYMMDDHHMMSSsss format. Valid values: YYYY = 0000-9999, MM = 01-12, DD = 01-31, HH = 00-23, MM = 00-59, SS = 00-60 (60 only if UTC leap second), sss=000-999 (indicating milliseconds).

4.1.5 LocalTimestamp

String fields representing date and time combination represented in Local Time in the YYYYMMDDHHMMSSsss format. Valid values: YYYY = 0000-9999, MM = 01-12, DD = 01-31, HH = 00-23, MM = 00-59, SS = 00-60 (60 only if UTC leap second), sss=000-999 (indicating milliseconds).

4.2 Second Message

Second Message will be sent for every second for which there is at least one payload.

SECOND MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - second	0	4	Integer	The number of seconds since mid-night
Message Type	4	1	"T"	Second Message

4.3 System Event Message

System Event Message is used for signalling an event which affects all systems of Cboe.

SYSTEM EVENT MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	8	1	"S"	System Event Message
Event Code	9	1	Alphanumeric	Please see System Event Codes below
Market ID	10	4	Alphanumeric	Right-padded with spaces. If no market ID available (which means the Event Code applies to the whole system), then filled with space.

4.3.1 Market IDs

MARKET ID	DESCRIPTION	REMARKS
AUS	Australia Stock Market	Chi-X Continuous On-Market Trading
CXAW	Chi-X Australia - Warrants	Chi-X Warrants Trading
CXAE	Chi-X Australia - ETF	Chi-X ETF Trading
CXAR	Chi-X Australia - TraCR	Chi-X TraCR Trading
CXAQ	Chi-X Australia – QMF	Chi-X QMF Trading

4.3.2 System Event Codes

SYSTEM EVENT CODE	DESCRIPTION	REMARKS
O	Start of Messages	This is the first message of the day
S	Chi-X Open	This message indicates that Chi-X is open for continuous on-market trading and accepting orders. Before the Chi-X Open message you may receive Off-exchange Trade messages. Market ID field value is also provided in the event message which indicates which market this event belongs to.
E	Chi-X Close	This message indicates that Chi-X's continuous trading session is closed. Chi-X will not accept any more orders, except Market on Close ("MOC") orders, for the continuous trading session. Clients may still receive a Trade Message for MOC executions, Broken Trade, Order Cancel and Off-Exchange Trade messages after this session state. Market ID field value is also provided in the event message which indicates which market this event belongs to.
M	Chi-X MOC Close	This message indicates that MOC orders can no longer execute. Clients may still receive MOC Executions after this session state closes. Market ID field value is also provided in the event message which indicates which market this event belongs to.
H	Chi-X Halt	This message indicates that Chi-X is halted. Chi-

SYSTEM EVENT CODE	DESCRIPTION	REMARKS
		X will not accept any order or Off-Exchange Trade Report during this period. Clients may still receive Broken Trade and Order Cancel messages during this period. Market ID field value is also provided in the event message which indicates which market this event belongs to.
R	Chi-X Resume	This message indicates that Chi-X is resumed from halted state and accepting orders and Off-Exchange Trade reports. Market ID field value is also provided in the event message which indicates which market this event belongs to.
C	End of Messages	This is the last message of the day.
Z	Reset Orderbook	This message indicates that Chi-X has explicitly reset its order book for all securities.
N	No Operation	This message is a system reserved message. Recipients should ignore this message, but increase the next expected sequence.

4.4 Add Order Message

Add Order Message is used for acknowledging the acceptance of a visible order into the Cboe book. The message contains an Order Reference which is a unique key of the day assigned to the order by Cboe.

Add Order Message may be sent for accepting a revised order after the original order is cancelled. Please refer to [Section 4.7 Modification of Existing Orders](#) for detail.

ADD ORDER MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"A"	Add Order Message
Order Reference	5	4	Integer	Unique order reference number of the day.
Buy/Sell Indicator	9	1	"B" or "S"	"B" = Buy Order "S" = Sell Order
Shares	10	4	Integer	Total number of shares being added to the book. For undisclosed order, number of shares is zero. (The number of shares added to the book may be less than the actual number of shares entered because part of the order may trade before being posted to the book).
Stock	14	6	Alphanumeric	Stock symbol (which is right-padded with spaces).
Price	20	8	Price	The display price of the order.
Display	28	1	"Y"	"Y" = displayed in quote
Order Source	29	1	"C"	"C" = Visible Limit order

ADD ORDER MESSAGE (ATTRIBUTED MARKET)				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"F"	Add Order Message
Order Reference	5	4	Integer	Unique order reference number of the day.
Buy/Sell Indicator	9	1	"B" or "S"	"B" = Buy Order "S" = Sell Order
Shares	10	4	Integer	Total number of shares being added to the book. For undisclosed order, number of shares is zero. (The number of shares added to the book may be less than the actual number of shares entered because part of the order may trade before being posted to the book).
Stock	14	6	Alphanumeric	Stock symbol (which is right-padded with spaces).
Price	20	8	Price	The display price of the order.
Display	28	1	"Y"	"Y" = displayed in quote
Order Source	29	1	"C"	"C" = Visible Limit order
PID	30	5	Alphanumeric	Participant ID (which is right-padded with spaces)

4.5 Order Execution Message

When a visible order on the book is executed, either in whole or in part, an Order Execution Message is sent.

Please note that this behaviour also occurs when the visible portion of an iceberg order is executed.

ORDER EXECUTION MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"E"	Order Execution Message
Order Reference	5	4	Integer	The unique order reference number of the order which was executed.
Executed Shares	9	4	Integer	The number of shares executed on the trade.
Trade Reference	13	4	Integer	The unique trade reference number of the day.
Contra Order Reference	17	4	Integer	The unique order reference number of the contra order that matched with this order.
Order Source	21	1	"C"	"C" = Visible Limit Order

ORDER EXECUTION MESSAGE (ATTRIBUTED MARKET)				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"G"	Order Execution Message
Order Reference	5	4	Integer	The unique order reference number of the order which was executed.
Executed Shares	9	4	Integer	The number of shares executed on the trade.
Trade Reference	13	4	Integer	The unique trade reference number of the day.
Contra Order Reference	17	4	Integer	The unique order reference number of the contra order that matched with this order.
Order Source	21	1	"C"	"C" = Visible Limit Order
Contra PID	22	5	Alphanumeric	Contra Participant PID (which is right-padded with spaces)

4.6 Order Cancel Message

When an order on the book is cancelled completely, the quantity of an order is reduced or the price of a pegged order is revised, an Order Cancel Message is sent out.

ORDER CANCEL MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"X"	Order Cancel Message
Order Reference	5	4	Integer	The unique order reference number of the order which was cancelled. (Order Reference can be a reference of a previously sent Add Order Message.)
Cancelled Shares	9	4	Integer	Number of shares cancelled. For cancel undisclosed order, number of shares is always zero.

4.7 Modification of Existing Orders

4.7.1 Modification of Price

When the price on an existing order is modified, a Cancel Message for full quantity of the open order is sent out, followed by an Add Order Message which is assigned with the same Order Reference as the cancelled order.

4.7.2 Reduction of quantity

When there is a reduction of quantity on an existing order, a Cancel Message for the existing order is sent out which acknowledges the reduction of the number of shares pending in the referenced open order. If the number of currently pending shares for an order reaches zero, the order will be removed from the book.

4.8 Trade Message

When a trade occurs against order quantity not visible on the book (ie. a fully hidden Price Improvement order, the hidden portion of an iceberg order or an undisclosed order) or against a hidden MOC order, a Trade Message is sent out. Trade Messages fill in the gaps left when an order that is not visible on the book is executed.

Note: Order Execution Messages and Trade Messages together provide a complete picture of all executions that occur on Cboe. A Trade Message does not affect the book and can be ignored for book-building but can be used for time and sales and other execution based data aggregation.

Order Reference and Contra Order Reference are always set to 0 (zero) and the Buy/Sell Indicator to 'B'.

TRADE MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"P"	Trade Message resulting from hidden liquidity
Order Reference	5	4	Integer	The order reference number will always be set to 0
Buy/Sell Indicator	9	1	"B"	The indicator value is always set to B
Shares	10	4	Integer	Number of shares executed.
Stock	14	6	Alphanumeric	Stock symbol (right-padded with spaces)
Price	20	8	Price	Match price of the order
Trade Reference	28	4	Integer	Trade reference number generated for the trade.
Contra Order Reference	32	4	Integer	The contra order reference number will always be set to 0.
Trade Type	36	1	Alphanumeric	"B" = Broker Preferred Trade "N" = Trade resulting from normal matching logic
Trade Designation	37	1	Alphanumeric	"C" = CXAC (Limit) "P" = CXAP (Mid-Point) "N" = CXAN (Near Point) "F" = CXAF (Far Point) "M" = CXAM (MOC)

TRADE MESSAGE (ATTRIBUTED MARKET)				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"J"	Trade Message resulting from hidden liquidity
Order Reference	5	4	Integer	The order reference number will always be set to 0
Buy/Sell Indicator	9	1	"B"	The indicator value is always set to B
Shares	10	4	Integer	Number of shares executed.
Stock	14	6	Alphanumeric	Stock symbol (right-padded with spaces)
Price	20	8	Price	Match price of the order
Trade Reference	28	4	Integer	Trade reference number generated for the trade.

TRADE MESSAGE (ATTRIBUTED MARKET)				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Contra Order Reference	32	4	Integer	The contra order reference number will always be set to 0.
Trade Type	36	1	Alphanumeric	"B" = Broker Preferred Trade "N" = Trade resulting from normal matching logic
Trade Designation	37	1	Alphanumeric	"C" = CXAC (Limit) "P" = CXAP (Mid-Point) "N" = CXAN (Near Point) "F" = CXAF (Far Point) "M" = CXAM (MOC)
PID	38	5	Alphanumeric	Participant ID (which is right-padded with spaces)
Contra PID	43	5	Alphanumeric	Contra Participant ID (which is right-padded with spaces)

4.9 Broken Trade Message

When an execution is broken on Cboe, a Broken Trade Message is sent out. If a trade is broken, it cannot be reinstated.

Note: Broken Trade Message only affects applications which build on a time-and-sales database or maintain cumulative volumes or high/low calculations. A Broken Trade Message has no effect on the book and it can be ignored for book-building.

BROKEN TRADE MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"B"	Broken Trade Message
Trade Reference	5	4	Integer	The trade reference number of the execution that was broken. (The Trade Reference is from a previously sent Order Execution Message or Trade Message.)

4.10 Off-Exchange Trade Message

Off-Exchange Trade Message is sent once participants report an off-exchange trade to Cboe.

OFF-EXCHANGE TRADE MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"Q"	Off-Exchange Trade Message
Shares	5	4	Integer	Number of shares traded.

OFF-EXCHANGE TRADE MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Stock	9	6	Alphanumeric	Stock symbol (right-padded with spaces)
Price	15	8	Price	Reported price of the trade
Trade Reference	23	4	Integer	Trade reference number generated for the trade.
Trade Report Type	27	1	Alphanumeric	Trade report type of the Off-Exchange Trade message. Valid values: "B" – Block Trade "P" – Large Portfolio Trade "T" – Large Principal Transaction "S" – Trades With Price Improvement "L" – Permitted Trade During Post Trading Hours Period "M" – Permitted Trade During Pre Trading Hours Period "E" – Out Of Hours Trade "F" – ETF Trade Report for unit creations or redemptions
Transaction Time	28	17	UTCTimestamp	The date and time of Off-Exchange Trade as specified in the Trade Report submitted by the participant.

OFF-EXCHANGE TRADE MESSAGE (ATTRIBUTED MARKET)				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"K"	Off-Exchange Trade Message
Shares	5	4	Integer	Number of shares traded.
Stock	9	6	Alphanumeric	Stock symbol (right-padded with spaces)
Price	15	8	Price	Reported price of the trade
Trade Reference	23	4	Integer	Trade reference number generated for the trade.
Trade Report Type	27	1	Alphanumeric	Trade report type of the Off-Exchange Trade message. Valid values: "B" – Block Trade "P" – Large Portfolio Trade "T" – Large Principal Transaction "S" – Trades With Price Improvement "L" – Permitted Trade During Post Trading Hours Period "M" – Permitted Trade During Pre Trading Hours Period "E" – Out Of Hours Trade "F" – ETF Trade Report for unit creations or redemptions
Transaction Time	28	17	UTCTimestamp	The date and time of Off-Exchange Trade as specified in the Trade Report submitted by the participant.
PID	45	5	Alphanumeric	Participant ID (which is right-padded with spaces)

OFF-EXCHANGE TRADE MESSAGE (ATTRIBUTED MARKET)				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Contra PID	50	5	Alphanumeric	Contra Participant ID (which is right-padded with spaces)

4.11 Broken Off-Exchange Trade Message

When an off-exchange trade is broken on Cboe, a Broken Off-Exchange Trade Message is sent out. If a trade is broken, it cannot be reinstated.

BROKEN OFF-EXCHANGE TRADE MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time nanosecond	- 0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"C"	Broken Off-Exchange Trade Message
Trade Reference	5	4	Integer	The trade reference number of the off-exchange trade that was broken. (The Trade Reference is from a previously sent Off-Exchange Trade Message.)

4.12 Stock Status Message

This message indicates the current trading status of a stock. At the start of day, the feed will send out a stock status message for each of the symbols trading on Cboe. Subsequently, stock status messages will be sent when a stock is halted or is released for trading.

STOCK STATUS MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"H"	Stock Trading Action Message
Stock	5	6	Alphanumeric	Stock Symbol
Security Status	11	1	Alphanumeric	"T" = Active "H" = Halted "S" = Suspend
Reserved	12	1	Alphanumeric	Reserved for future use

4.13 Calculated Value Message

Cboe calculated market values will be conveyed through this message. This message will be sent regularly for each symbol that has calculated market value available. The frequency of these updates will be determined in agreement with the Issuers.

CALCULATED VALUE MESSAGE				
NAME	OFFSET	LENGTH	VALUE	REMARKS
Time - nanosecond	0	4	Integer	The number of nanoseconds since last Second Message Time Format: nnnnnn000
Message Type	4	1	"Y"	Calculated Value Message
Symbol	5	6	Alphanumeric	Symbol of the Calculated Value
Value Category	11	1	Alphanumeric	Category of the data conveyed in the "Value" field 1 – Closing Price 2 – iNAV values (ETF) 3 – Index values 4 – FX values 5 – EOD NAV from Issuer
Value	12	8	Price	Calculated Value
Value Generation Time	20	17	LocalTimestamp	Indicates when the Calculated Value is generated

5 Sample Data

5.1 Packet Message

5.1.1 Single message within packet

MESSAGE TYPE	CHIXMMD-BIN FEED MESSAGE
Trade Message	00 00 00 f5 00 01 00 26 03 e0 01 20 50 00 00 00 &... P... 00 42 00 00 03 09 58 58 58 20 20 20 00 00 00 00 .B....XXX 33 31 c6 20 07 bf a5 af 00 00 00 00 4e 4e 31.NN

FIELD	HEX	MEANING
Sequence Number	00 00 00 f5	Decimal Value = 245
Message Count	00 01	Decimal Value = 1
Message Length	00 26	Decimal Value = 38
Message	03 e0 01 20 50 00 00 00 00 42 00 00 03 09 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 07 bf a5 af 00 00 00 00 4e 4e	Time(Nanosecond) : 065012000 Message Type: P Order Reference: 0 Buy/Sell Indicator: B Shares: 777 Stock: XXX Price:85.89 Trade Reference: 130000303 Contra Order Reference: 0 Trade Type: N Trade Resignation: N

5.1.2 Multiple messages within packet

MESSAGE TYPE	CHIXMMD-BIN FEED MESSAGE
Order Cancel and Order Add Message in one packet	00 00 00 f6 00 02 00 0d 2d 3c 2f 58 58 00 00 00 -</XX... 19 00 00 03 e8 00 1e 2d 3c 2f 58 41 00 00 00 19 -</XA.... 53 00 00 03 e8 58 58 58 20 20 20 00 00 00 00 33 S....XXX3 31 c6 20 59 43 1. YC

FIELD	HEX	MEANING
Sequence Number	00 00 00 f6	Decimal Value = 246
Message Count	00 02	Decimal Value = 2
Message Length	00 0d	Decimal Value = 13
Message	2d 3c 2f 58 58 00 00 00 19 00 00 03 e8	Time(Nanosecond) : 758919000 Message Type: X Order Reference: 25 Shares: 1000
Message Length	00 1e	Decimal Value = 30
Message	2d 3c 2f 58 41 00 00 00 19 53 00 00 03 e8 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 59 43	Time(Nanosecond) : 758919000 Message Type: A Order Reference: 25 Buy/Sell Indicator: S Shares: 1000 Stock: XXX Price: 85.89 Display: Y Order source: C

5.1.3 Heartbeat message

MESSAGE TYPE	CHIXMMD-BIN FEED MESSAGE
Heartbeat Message	00 00 00 47 00 00 32 30 32 31 30 35 32 37 30 30 ...G..2021052700

FIELD	HEX	MEANING
Sequence Number	00 00 00 47	Decimal Value = 71
Message Count	00 00	Always zero
Session ID	32 30 32 31 30 35 32 37 30 30	ASCII String 2021052700

5.2 Market Data Message

5.2.1 Second Message

ACTION	HEX	MEANING
Second Message	00 00 d3 36 54	Time(Second) : 54070 Message Type: T

5.2.2 Order Added and Fully Traded

ACTION	HEX	MEANING
Sell of 100 XXX shares entered at 85.89. Order Reference 638 assigned.	02 55 e2 98 41 00 00 02 7e 42 00 00 00 64 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 59 43	Time(Nanosecond) : 039183000 Message Type: A Order Reference: 638 Buy/Sell Indicator: B Shares: 100 Stock: XXX Price: 85.89 Display: Y Order source: C
Matching buy order entered and order traded with Reference "130000355".	02 c4 7b 18 45 00 00 02 7e 00 00 00 64 07 bf a5 e3 00 00 02 7f 43	Time(Nanosecond) : 046431000 Message Type: E Order Reference: 638 Executed Shares: 100 Trade Reference: 130000355 Contra Order Reference: 639 Order source: C

Note: There is no Add Order Message for the matching buy order since it does not display on the book.

Buyer needs to conjecture the execution price based on the limit of the original order since the Order Execution Message has no price indicated.

5.2.3 Order Added, Fully Traded and Remaining Quantity of Matching Order is Placed on Book

ACTION	HEX	MEANING
Buy order of 111 XXX shares entered at 85.89. Order Reference "21" assigned.	1b 48 60 00 41 00 00 00 15 42 00 00 00 6f 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 59 43	Time(Nanosecond) : 457728000 Message Type: A Order Reference: 21 Buy/Sell Indicator: B Shares: 111 Stock: XXX Price: 85.89 Display: Y Order source: C

ACTION	HEX	MEANING
Matching sell order entered for 112 shares of XXX. Order Execution Message is sent out with Order Reference "22" and Trade Reference "13000301".	1c 81 f5 58 45 00 00 00 15 00 00 00 6f 07 bf a5 ad 00 00 00 16 43	Time(Nanosecond) : 478279000 Message Type: E Order Reference: 21 Executed Shares: 111 Trade Reference: 13000301 Contra Order Reference: 22 Order source: C
Add the remaining share (1) of the sell order onto the book.	1c 81 f5 58 41 00 00 00 16 53 00 00 00 01 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 59 43	Time(Nanosecond) : 478279000 Message Type: A Order Reference: 22 Buy/Sell Indicator: S Shares: 1 Stock: XXX Price: 85.89 Display: Y Order source: C

5.2.4 Price Revision

ACTION	HEX	MEANING
Sell order of 1000 XXX shares entered. Order Reference "25" assigned. The display price is 85.88.	27 46 2f 18 41 00 00 00 19 53 00 00 03 e8 58 58 58 20 20 20 00 00 00 00 33 30 3f 80 59 43	Time(Nanosecond) : 658911000 Message Type: A Order Reference: 25 Buy/Sell Indicator: S Shares: 1000 Stock: XXX Price: 85.88 Display: Y Order source: C
Price is revised to 85.89. An Order Cancel Message is sent out.	2d 3c 2f 58 58 00 00 00 19 00 00 03 e8	Time(Nanosecond) : 758919000 Message Type: X Order Reference: 25 Shares: 1000
An Add Order Message is sent after the Order Cancel Message. The Order Reference is the same. The display price changes to 85.89.	2d 3c 2f 58 41 00 00 00 19 53 00 00 03 e8 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 59 43	Time(Nanosecond) : 758919000 Message Type: A Order Reference: 25 Buy/Sell Indicator: S Shares: 1000 Stock: XXX Price: 85.89 Display: Y Order source: C

5.2.5 Reduction of Order Quantity

ACTION	HEX	MEANING
Sell order of 1000 XXX shares entered. Order Reference "26" assigned. The display price is 85.88.	33 35 ae 20 41 00 00 00 1a 53 00 00 03 e8 58 58 58 20 20 20 00 00 00 00 33 30 3f 80 59 43	Time(Nanosecond) : 859156000 Message Type: A Order Reference: 26 Buy/Sell Indicator: S Shares: 1000 Stock: XXX Price: 85.88 Display: Y Order source: C
The order quantity is cut down by 100 shares. An Order Cancel Message is sent informing client about the change.	39 2f 21 30 58 00 00 00 1a 00 00 00 64	Time(Nanosecond) : 959390000 Message Type: X Order Reference: 26 Shares: 100

Note: Client should calculate the remaining amount of the original order which is still open since Cboe currently does not support increase of total order quantity.

5.2.6 Order Revised and Executed

ACTION	HEX	MEANING
A visible sell order of 1666 XXX shares is placed on the book with the displayprice of 85.89.	23 06 10 80 41 00 00 00 17 53 00 00 06 82 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 59 43	Time(Nanosecond) : 587600000 Message Type: A Order Reference: 23 Buy/Sell Indicator: S Shares: 1666 Stock: XXX Price: 85.89 Display: Y Order source: C
A visible buy order of 1066 XXX shares is placed on the book with the displayprice of 85.88.	23 60 d6 c8 41 00 00 00 18 42 00 00 04 2a 58 58 58 20 20 20 00 00 00 00 33 30 3f 80 59 43	Time(Nanosecond) : 593549000 Message Type: A Order Reference: 24 Buy/Sell Indicator: B Shares: 1066 Stock: XXX Price: 85.88 Display: Y Order source: C
The buy order is revised to the displayprice of 85.89. An Order Cancel Message is sent out.	23 c1 59 d0 58 00 00 00 18 00 00 04 2a	Time(Nanosecond) : 599874000 Message Type: X Order Reference: 24 Shares: 1066
The trade is executed. An Order Execution Message is sent out.	23 c1 59 d0 45 00 00 00 17 00 00 04 2a 07 bf a5 ae 00 00 00 18 43	Time(Nanosecond) : 599874000 Message Type: E Order Reference: 23 Executed Shares: 1066 Trade Reference: 130000302 Contra Order Reference: 24 Order source: C

5.2.7 Execution of Fully Hidden Order

ACTION	HEX	MEANING
A hidden sell order of 777 XXX shares is placed on the book with the displayprice of 85.89.	[No message sent for hidden order.]	
A visible buy order of 1000 shares is entered at 85.89. A Trade Message is sent out corresponding to the hidden order quantity. MIC Venue is Near Point	03 e0 01 20 50 00 00 00 00 42 00 00 03 09 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 07 bf a5 af 00 00 00 00 4e 4e	Time(Nanosecond) : 065012000 Message Type: P Order Reference: 0 Buy/Sell Indicator: B Shares: 777 Stock: XXX Price:85.89 Trade Reference: 130000303 Contra Order Reference: 0 Trade Type: N Trade Resignation: N
The remaining quantity of the buy order is added to the book.	03 e0 01 20 41 00 00 00 1c 42 00 00 00 df 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 59 43	Time(Nanosecond) : 065012000 Message Type: A Order Reference: 28 Buy/Sell Indicator: B Shares: 223 Stock: XXX Price: 85.89 Display: Y Order source: C

5.2.8 Trades On Partially Hidden Order (Iceberg)

ACTION	HEX	MEANING
<p>A sell order of 10000 XXX shares is placed on the book with a visible quantity of 1000 shares. The displayprice is 85.89. An Add Order Message is sent out for the visible amount.</p>	<pre>04 a0 3c 10 41 00 00 00 1d 53 00 00 03 e8 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 59 43</pre>	<pre>Time(Nanosecond): 077610000 Message Type: A Order Reference: 29 Buy/Sell Indicator: S Shares: 1000 Stock: XXX Price: 85.89 Display: Y Order source: C</pre>
<p>A buy order of 500 shares is entered and crosses against the visible quantity of 1000 shares. 500 shares remain on the book.</p>	<pre>05 65 22 50 45 00 00 00 1d 00 00 01 f4 07 bf a5 b0 00 00 00 1e 43</pre>	<pre>Time(Nanosecond): 090514000 Message Type: E Order Reference: 29 Executed Shares: 500 Trade Reference: 130000304 Contra Order Reference: 30 Order source: C</pre>
<p>A buy order for 4000 shares is entered and crosses against the iceberg. An Order Execution Message for the visible trade of 500 shares is sent out.</p>	<pre>05 df 15 10 45 00 00 00 1d 00 00 01 f4 07 bf a5 b1 00 00 00 1f 43</pre>	<pre>Time(Nanosecond): 098506000 Message Type: E Order Reference: 29 Executed Shares: 500 Trade Reference: 130000305 Contra Order Reference: 31 Order source: C</pre>
<p>A Trade Message is sent out for the hidden quantity of 3500 shares.</p>	<pre>05 df 15 10 50 00 00 00 00 42 00 00 0d ac 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 07 bf a5 b1 00 00 00 00 4e 43</pre>	<pre>Time(Nanosecond): 098506000 Message Type: P Order Reference: 0 Buy/Sell Indicator: B Shares: 3500 Stock: XXX Price: 85.89 Trade Reference: 130000305 Contra Order Reference: 0 Trade Type: N Trade Resignation: C</pre>
<p>The peak is refreshed onto the book. An Add Order Message is sent out for 1000 shares.</p>	<pre>05 df 15 10 41 00 00 00 20 53 00 00 03 e8 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 59 43</pre>	<pre>Time(Nanosecond): 098506000 Message Type: A Order Reference: 32 Buy/Sell Indicator: S Shares: 1000 Stock: XXX Price: 85.89 Display: Y Order source: C</pre>

5.2.9 Trade Cancellation (Bust)

ACTION	HEX	MEANING
A sell order of 111 XXX shares is placed on the book. The displayprice is 85.89. An Add Order Message is sent out for the visible amount.	06 75 bf 60 41 00 00 00 21 42 00 00 00 6f 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 59 43	Time(Nanosecond) : 108380000 Message Type: A Order Reference: 33 Buy/Sell Indicator: B Shares: 111 Stock: XXX Price: 85.89 Display: Y Order source: C
An Order Execution Message is sent out on receiving a matching order. The Trade Reference is "130000306".	07 02 e4 30 45 00 00 00 21 00 00 00 6f 07 bf a5 b2 00 00 00 22 43	Time(Nanosecond) : 117630000 Message Type: E Order Reference: 33 Executed Shares: 111 Trade Reference: 130000306 Contra Order Reference: 34 Order source: C
When the trade is cancelled by Cboe, a Broken Trade Message is sent.	25 86 95 28 42 07 bf a5 b2	Time(Nanosecond) : 629577000 Message Type: B Trade Reference: 130000306

5.2.10 Undisclosed Order Added, Partially Traded, and then Fully Traded

ACTION	HEX	MEANING
An undisclosed buy order of 10000 XXX shares entered at 10.00. 0 share is displayed in the Add Order Message. Order Reference 8 assigned.	0f a6 7c 28 41 00 00 00 28 42 00 00 00 00 58 58 58 20 20 20 00 00 00 00 05 f5 e1 00 59 43	Time(Nanosecond) : 262569000 Message Type: A Order Reference: 40 Buy/Sell Indicator: B Shares: 0 Stock: XXX Price: 10.00 Display: Y Order source: C
A visible sell order of 5000 XXX shares is entered at 10.00. A Trade Message is sent out for the traded quantity of 5,000 shares.	10 10 23 08 50 00 00 00 00 42 00 00 13 88 58 58 58 20 20 20 00 00 00 00 05 f5 e1 00 07 bf a5 b5 00 00 00 00 4e 43	Time(Nanosecond) : 269493000 Message Type: P Order Reference: 0 Buy/Sell Indicator: B Shares: 5000 Stock: XXX Price: 10.00 Trade Reference: 130000309 Contra Order Reference: 0 Trade Type: N Trade Resignation: C
Another visible sell order of 5000 XXX shares is entered at 10.00. A Trade Message is sent out for the traded quantity of 5000 shares.	10 a8 77 20 50 00 00 00 00 42 00 00 13 88 58 58 58 20 20 20 00 00 00 00 05 f5 e1 00 07 bf a5 b6 00 00 00 00 4e 43	Time(Nanosecond) : 279476000 Message Type: P Order Reference: 0 Buy/Sell Indicator: B Shares: 5000 Stock: XXX Price: 10.00 Trade Reference: 130000310 Contra Order Reference: 0 Trade Type: N Trade Resignation: C
The undisclosed order is then cancelled by Cboe and an Order Cancel Message with 0 shares is sent out	10 a8 77 20 58 00 00 00 28 00 00 00 00	Time(Nanosecond) : 279476000 Message Type: X Order Reference: 40 Shares: 0

5.2.11 Execution of Market On Close Order

ACTION	HEX	MEANING
<p>A Trade Message is sent out for MOC trade with quantity of 3500 shares and price of 85.89.</p>	<pre>0d 4e c0 e8 50 00 00 00 00 42 00 00 0d ac 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 07 bf a5 b7 00 00 00 00 4e 4d</pre>	<pre>Time(Nanosecond): 223265000 Message Type: P Order Reference: 0 Buy/Sell Indicator: B Shares: 3500 Stock: XXX Price: 85.89 Trade Reference: 130000311 Contra Order Reference: 0 Trade Type: N Trade Resignation: M</pre>

5.2.12 Execution of Broker Preferred Order

ACTION	HEX	MEANING
<p>A broker preferred sell order (hidden) of 1000 shares in XXX is placed on the book with a price of 85.89.</p>	<p>[No message sent for hidden order.]</p>	
<p>A broker preferred buy order (hidden) of 3500 shares is entered at 85.89. A Trade Message is sent out for broker preferred trade with quantity of 1000 shares and price of 85.89. MIC Venue is Far Point.</p>	<pre>11 6b 51 f0 50 00 00 00 00 42 00 00 03 e8 58 58 58 20 20 20 00 00 00 00 33 31 c6 20 07 bf a5 b9 00 00 00 00 42 46</pre>	<pre>Time(Nanosecond): 292246000 Message Type: P Order Reference: 0 Buy/Sell Indicator: B Shares: 1000 Stock: XXX Price: 85.89 Trade Reference: 130000313 Contra Order Reference: 0 Trade Type: B Trade Resignation: F</pre>
<p>The remaining quantity of the buy order is added to the book.</p>	<p>[No message sent for hidden order.]</p>	