

**MIAx Emerald Options Exchange**

# **Administrative Information Subscriber Feed**

## ***AIS Interface Specification***

**Revision Date: 07/26/2020  
Version 1.0a**

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# 1. Overview

MIAX Emerald Administrative Information Subscriber Feed (**AIS**) is a data feed that allows subscribers to receive real-time updates of the following information from the MIAX Emerald Options Market

- Products traded on MIAX Emerald
- Trading status for MIAX Emerald and products traded on MIAX Emerald
- Liquidity seeking event notifications

MIAX Emerald is referred to as Emerald in the rest of the document.

## AIS Features:

- AIS messaging and the system architecture are designed for low latency messaging. Some of the key features of the interface are:
- AIS is offered with redundant multicast feeds (A Feed & B Feed) to provide single point of failure hardware and network fault tolerance and to provide an opportunity for recipients to arbitrate the two feeds to auto-fill gaps.
- AIS real-time messages are disseminated over multicast to achieve a fair delivery mechanism. AIS requires the use of MIAX proprietary SesM over TCP/IP protocol for retransmission lines in order to provide a **guaranteed delivery** mechanism for gap fills.
- The AIS retransmission service also provides a 3.2.2 Last Value Refresh Service to facilitate fast intra-day recovery without a full day gap fill.
- AIS notifications provide current **electronic system status** allowing the subscribers to take necessary actions immediately.

This specification is intended to be used by Emerald AIS Feed subscribers only.

## 1.1 Exchange related information

### 1.1.1 Hours of Operation for Emerald Options Exchange

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

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

- Start of Session: Start of dissemination of messages. After 5:00 a.m.
- Trading Session for Equity Options: 9:30 a.m. to 4:00 p.m. (ends at 1:00 p.m. on early closing days).
- Trading Session for ETF and Index Options: 9:30 a.m. to 4:15 p.m. (ends at 1:15 p.m. on early closing days).

### 1.1.2 Obtaining more information

Information such as (but not limited to) membership, rules, data feeds, fees, and support can be obtained by sending an email to Trading Operations or by referring to the MIAX website at <http://www.MIAXOptions.com>.

## 1.2 Testing of AIS Subscription

Emerald can provide testing assistance on Emerald testing area for the AIS Feed and the AIS retransmission interface.

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

## 1.3 Answers to FAQs

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

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

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

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

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

## 1.4 Data Types

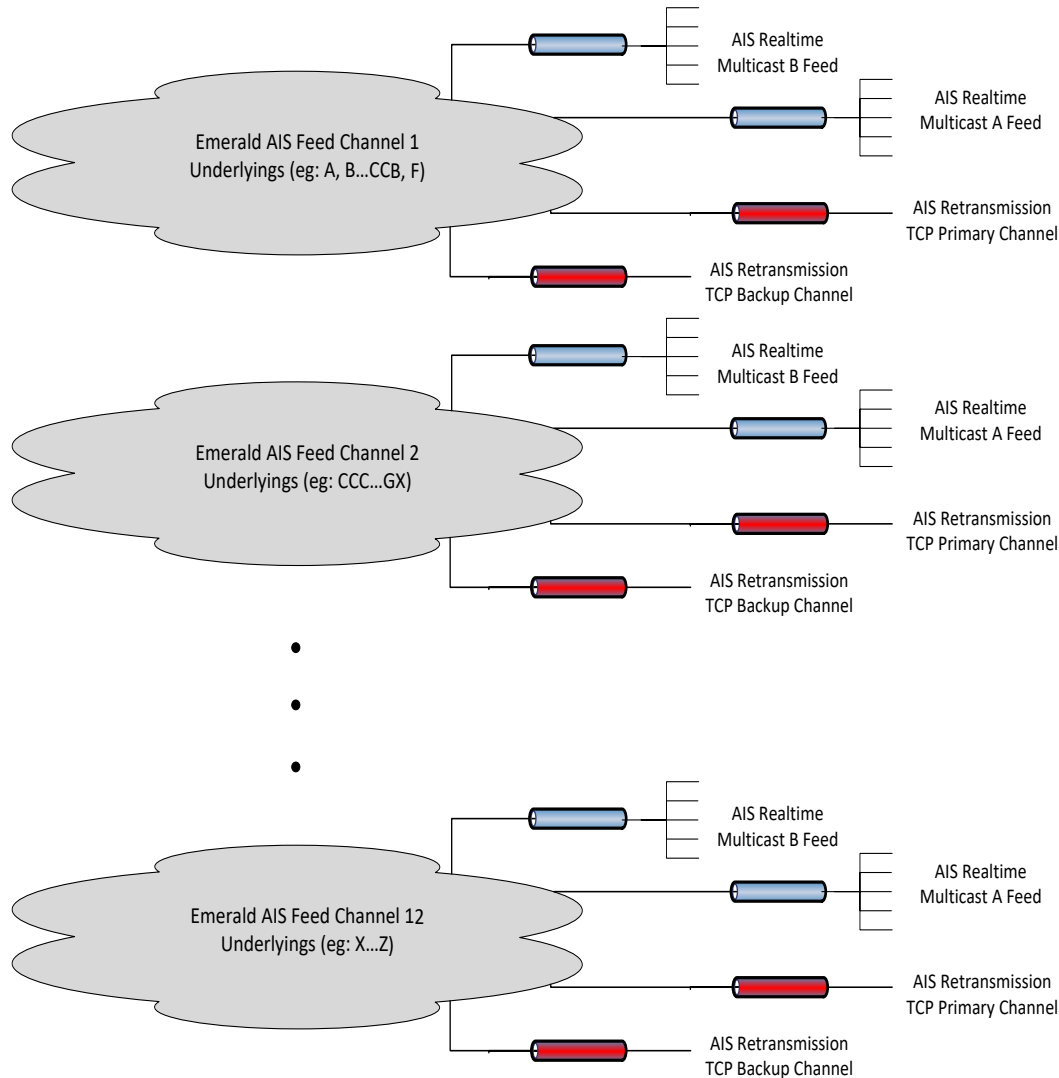
The following table describes the data types used in AIS messaging:

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

| Data Type           | Description  |
|---------------------|--|
| <b>BinaryS</b>      | Signed, Intel x86 byte-ordered ( <b>little-endian</b> ), binary encoded numbers                            |
| <b>BinaryU</b>      | Unsigned, Intel x86 byte-ordered ( <b>little-endian</b> ), binary encoded numbers                          |
| <b>BinaryPrc4S</b>  | BinaryS Field with the last 4 (right most) digit places being decimal places                               |
| <b>BinaryPrc4U</b>  | BinaryU Field with the last 4 (right most) digit places being decimal places                               |
| <b>BinaryPrc2U</b>  | BinaryU Field with the last 2 (right most) digit places being decimal places                               |
| <b>SecTime</b>      | BinaryU field that contain transaction time in seconds since Epoch (January 1, 1970, 00:00:00 <b>UTC</b> ) |
| <b>NanoTime</b>     | BinaryU field that contain transaction time in nanoseconds since past second                               |
| <b>Alphanumeric</b> | Each place can contain characters or numbers. Left justified and space-padded on the right                 |

## 2. AIS Architecture

### Emerald Administrative Information Subscriber (AIS) Architecture



#### Highlights:

- Real-time dissemination is separated out on to 12 separate Feed channels.
- A Feed channel will contain sourced data for all options for a single underlying.
- Any options for any given underlying will only be sourced by a single feed channel on any given day.
- Each Feed channel sources independently from the other groups and hence has independent sequence numbers.
- All the messages on each feed channel will be published in FIFO sequence.
- High availability is achieved by disseminating identical data on an “A Feed” and “B Feed” for each Feed channel
- Underlyings may not be contiguously distributed according to symbol ranges in each Feed channel.

- Two separate TCP based retransmission channels for each Feed channel supply AIS retransmission via the AIS Retransmission Interface.

## 3. Session Level Protocol

### 3.1 Real-time AIS Feed

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

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

### 3.2 AIS Retransmission Interface

AIS Retransmission Interface uses MIAX's proprietary **SesM – TCP Session Management Protocol**. Please refer to the latest SesM TCP Session Management document (available at the [MIAX website](#)) for details about SesM session management protocol. This protocol layer offers session management capabilities such as authentication, application messaging over TCP/IP, sequencing of messages, heartbeats and gap fills.

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

#### 3.2.1 SesM Gap Fill Service

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

#### 3.2.2 Last Value Refresh Service

##### 3.2.2.1 Request Message to Emerald

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

| Field Name                  | Length | Data Type    | Notes  |
|-----------------------------|--------|--------------|--|
| <b>SesM Packet Length</b>   | 2      | Binary       |  |
| <b>SesM Packet Type</b>     | 1      | Alphanumeric | 'U' – SesM Unsequenced Packet  |
| <b>Request Type</b>         | 1      | Alphanumeric | "R" – Refresh  |
| <b>Refresh Message Type</b> | 1      | Alphanumeric | "P" - Simple Series Update Refresh<br>"C" – Complex Strategy Definition Refresh<br>"U" – Underlying Trading Status Refresh<br>"S" – System State Refresh |

### 3.2.2.2 Response Message from Emerald

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

| Field Name          | Length | Data Type     | Notes  |
|---------------------|--------|---------------|--|
| SesM Packet Length  | 2      | Binary        |  |
| SesM Packet Type    | 1      | Alphanumeric  | 'U' – SesM Unsequenced Packet                |
| Response Type       | 1      | Alphanumeric  | "R" – AIS Refresh                            |
| Sequence Number     | 8      | BinaryU       | Original sequence number from the live feed. |
| Application Message | varies | See section 0 | Based on the message type requested.         |

The first SesM packet to be received by the firms will be the 4.1 Emerald System Time Message (See section 4.1 Emerald System Time Message). The timestamp (combined with the nanosecond part in the subsequent messages) represents the most recent Matching Engine transaction time. It is **not** the original timestamp from the MACH sequenced messages in the live feed. *The sequence number in the refresh messages may be used to arbitrate with the sequenced packets from live feed (e.g.: data with higher sequence number from either the refresh or the live feed represents latest information).*

### 3.2.2.3 End of Refresh Notification from Emerald

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

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

### 3.2.3 Session Termination

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

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



## 4. Application Message Formats

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

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

### 4.1 Emerald System Time Message

This is the message format that will be used to disseminate the “seconds” part of the timestamp that is applicable to all messages that are sent in the current second.

| Field Name                | Length | Data Type    | Notes  |
|---------------------------|--------|--------------|--|
| <i>MACH Protocol Data</i> |        |              | <i>Refer to MACH Protocol Specification</i>  |
| <b>Message Type</b>       | 1      | Alphanumeric | “1”  |
| <b>Time Stamp</b>         | 4      | SecTime      | Seconds part of the time that applies to all messages that gets disseminated until this message gets sent again. |

Points to note:

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

### 4.2 Simple Series Update

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

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

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

| Field Name                            | Length                     | Data Type    | Notes   |  |
|---------------------------------------|----------------------------|--------------|---|--|
| <b>Opening Underlying Market Code</b> | 1                          | Alphanumeric | Options opening will be triggered on receipt of Opening quote/trade from this Underlying market:  |  |
|                                       |                            |              | <b>Market Code</b>  | <b>Description</b>                               |
|                                       |                            |              | <b>A</b>  | NYSE Amex  |
|                                       |                            |              | <b>B</b>  | NASDAQ OMX BX                                    |
|                                       |                            |              | <b>C</b>  | National Stock Exchange                          |
|                                       |                            |              | <b>D</b>  | FINRA ADF  |
|                                       |                            |              | <b>E</b>  | Market Independent (Any market that opens first) |
|                                       |                            |              | <b>H</b>  | MIAX PEARL Equities                              |
|                                       |                            |              | <b>I</b>  | International Securities Exchange                |
|                                       |                            |              | <b>J</b>  | EDGA Exchange, Inc                               |
|                                       |                            |              | <b>K</b>  | EDGX Exchange, Inc                               |
|                                       |                            |              | <b>L</b>  | LTSE   |
|                                       |                            |              | <b>M</b>  | Chicago Stock Exchange                           |
|                                       |                            |              | <b>N</b>  | NYSE Euronext                                    |
|                                       |                            |              | <b>P</b>  | NYSE Arca Exchange                               |
| <b>Q</b>                              | NASDAQ OMX (via UTP Feed)  |              |   |  |
| <b>T</b>                              | NASDAQ OMX (via CTA Feed)  |              |   |  |
| <b>U</b>                              | MEMX                       |              |   |  |
| <b>V</b>                              | IEX                        |              |   |  |
| <b>W</b>                              | CBOE Stock Exchange (CBSX) |              |   |  |
| <b>X</b>                              | NASDAQ OMX PHLX            |              |   |  |
| <b>Y</b>                              | BATS Y-Exchange, Inc       |              |   |  |
| <b>Z</b>                              | BATS Exchange Inc          |              |   |  |
| <b>Priority Quote Width</b>           | 4                          | BinaryPrc4U  | Maximum allowable width for a quote for this Option during regular trading in order to be considered as Priority Quote.<br>0 when Priority Quote Width is not applicable. |  |
| <b>Reserved</b>                       | 8                          | BinaryU      | ** Reserved for future use **   |  |

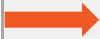


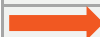
Points to note:

- Entire Options list will be disseminated at the start of day.
- In each channel, firms will only receive the series associated with the Engine that is servicing that channel.
- Intra-day updates will also be published as they occur.
- In case of an intra-day reconnection, users can request all Options series data from the AIS retransmission line.
- The Priority quote width specified in this message is not applicable to Opening. Please refer to Emerald rules and circulars for details about priority quote width applicable during Opening.

### 4.3 Complex Strategy Definition Update

This is the message format that will be used to disseminate stock option strategies traded on Emerald for the current session. The Strategy ID sent in this message is utilized by the Administrative Information Subscriber (AIS) Feed for Complex Liquidity Seeking Events, the Emerald - MIAX Order Feed (MOR) for Complex Order dissemination, the

Complex Top of Market Feed (cToM) for Complex Trade and Top of Market dissemination and the Emerald - MIAX Express Interface (MEI) for Complex eQuotes.

| Field Name   | Length | Data Type    | Notes   |
|--|--------|--------------|---|
| <b>MACH Protocol Data</b>  |        |              | <i>Refer to MACH Protocol Specification</i>   |
| <b>Message Type</b>  | 1      | Alphanumeric | "C"   |
| <b>Strategy Add Time</b>   | 4      | NanoTime     | Time at which this Strategy is added/updated on Emerald system today.   |
| <b>Strategy ID</b>   | 4      | BinaryU      | Emerald Strategy ID is assigned per trading day and is valid only for that day.   |
| <b>Underlying Symbol</b>   | 11     | Alphanumeric | Underlying Symbol for this strategy   |
| <b>Active on Emerald</b>   | 1      | Alphanumeric | Indicates if this strategy is tradable on Emerald in the current session:<br>"A" = Active (tradable) on Emerald<br>"I" = Inactive (not tradable) on Emerald |
| <b>Reserved</b>  | 1      | BinaryU      | ** Reserved for future use **   |
| <b>Update Reason</b>   | 1      | Alphanumeric | "N" – New strategy created<br>"U" - Updated   |
| <b>Reserved</b>  | 10     | BinaryU      | ** Reserved for future use **   |
| <b>Number of Legs</b>  | 1      | BinaryU      | Number of Legs. Variable from 2 to 8  |
|  <b>Product ID</b>    | 4      | BinaryU      | <i>Option leg:</i><br>Emerald Defined Series. See Simple Series Update Message.<br><i>Stock leg:</i><br>0 (zero)  |
|  <b>Leg Ratio Qty</b> | 2      | BinaryU      | The ratio of this individual leg.<br><br>Number of option contracts or Number of stock shares for this leg is:<br><br>$LegRatioQty * OrderQty$              |
|  <b>Leg Side</b>      | 1      | Alphanumeric | The side of this individual leg<br><br>Valid values are:<br><br>"B" = Bid<br><br>"A" = Ask  |
|  <b>Reserved</b>      | 8      | BinaryU      | ** Reserved for future use **   |

Points to note:

- Strategies may be created intra-day as orders are placed at the Emerald Exchange or pre-defined before the market open.

- In each channel, firms will only receive the Strategies associated with the Engine that is servicing that channel.
- In case of an intra-day reconnection, users can request all Strategies definitions from the AIS retransmission lines.
- The length of this message is **variable** based on the number of legs.
- When underlying halts, all strategies for that underlying are in a halted state. Firms should process Underlying Trading Status notification to determine current state of the strategies.
- This message might be published more than once per day. When Update Reason is “U”, the only field that can change is “Active on Emerald”.
- The tradability of a strategy can be tracked with the status of the underlying (message type “H”) or the individual series. (message type “P”)
- The Strategy ID and Product ID fields are separate and distinct fields with assigned ID’s per trading day and valid only for the current day. Their scope is limited to each field.

## 4.4 System State

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

| Field Name                | Length | Data Type    | Notes  |
|---------------------------|--------|--------------|--|
| <b>MACH Protocol Data</b> |        |              | Refer to MACH Protocol Specification   |
| <b>Message Type</b>       | 1      | Alphanumeric | “S”  |
| <b>Notification Time</b>  | 4      | NanoTime     | Time at which this was generated by Emerald system.  |
| <b>AIS Version</b>        | 8      | Alphanumeric | Eg: AIS1.0   |
| <b>Session ID</b>         | 4      | BinaryU      | Emerald assigned ID for the current trading session  |
| <b>System Status</b>      | 1      | Alphanumeric | Current system status:<br>“S” = Start of System hours<br>“C” = End of System hours<br>“1” = Start of Test Session (sent before tests).<br>“2” = End of Test Session. |

Points to note:

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

## 4.5 Simple Liquidity Seeking Event Notification

This is the message format that will be used to disseminate information each time a Liquidity seeking event (defined in Event Type field below) starts at Emerald.

| Field Name                | Length | Data Type    | Notes  |
|---------------------------|--------|--------------|--|
| <i>MACH Protocol Data</i> |        |              | <i>Refer to MACH Protocol Specification</i>  |
| <b>Message Type</b>       | 1      | Alphanumeric | "L"  |
| <b>Timestamp</b>          | 4      | NanoTime     | Time at which this notification was generated by Emerald system.   |
| <b>Product ID</b>         | 4      | BinaryU      | Emerald Product ID mapped to a given option. It is assigned per trading session and is valid for that session.   |
| <b>Event Type</b>         | 1      | Alphanumeric | Type of Event:<br>"O" – Opening/Reopening Imbalance Mechanism<br>"R" – Opening Route Mechanism<br>"P" – Emerald PRIME Paired order<br>"S" – Settlement Opening Imbalance Mechanism (future use)<br>"E" – Liquidity Exposure Process (future use)   |
| <b>Event ID</b>           | 4      | BinaryU      | Values:<br>When Event Type is 'O': always 0<br>When Event Type is 'R', or 'P': Unique Event ID for the current event.  |
| <b>Price</b>              | 4      | BinaryPrc4U  | Current price of the Event.<br><u>Usage:</u><br>Please refer to Appendix C for details.  |
| <b>Imbalance Side</b>     | 1      | Alphanumeric | This is the side of the excess liquidity that is waiting to get matched<br>'B' = Bid<br>'A' = Ask<br><u>Usage:</u><br>When Event Type is 'O': Imbalance Side.<br>When Event Type is 'R': Side that will be routed.<br><br>When Event Type is 'P': Agency side of Emerald PRIME order being auctioned.<br>Please refer to Appendix C for details. |
| <b>Quantity 1</b>         | 4      | BinaryU      | <u>Usage:</u><br>When Event Type is 'O', 'R', or 'P': MatchQty - Number of contracts ready to be matched (both buyers and sellers already present).<br>Other Event Types: 0 (zero)<br>Please refer to Appendix C for details.  |
| <b>Quantity 2</b>         | 4      | BinaryU      | <u>Usage:</u><br>When Event Type is 'O' or 'R': Routable Quantity. Number of contracts that may be routed.<br>Other Event Types: 0 (zero)<br>Please refer to Appendix C for details.   |
| <b>Quantity 3</b>         | 4      | BinaryU      | <u>Usage:</u><br>When Event Type is 'O' or 'R': Imbalance Quantity. Number of contracts on the <i>Imbalance Side</i> that cannot be matched. Other Event Types: 0 (zero)<br>Please refer to Appendix C for details.  |

| Field Name             | Length | Data Type    | Notes  |
|------------------------|--------|--------------|--|
| <b>Quantity 4</b>      | 4      | BinaryU      | <u>Usage:</u><br>When Event Type is 'O' or 'R': Must Fill Quantity. Number of contracts, on the provided <i>Side</i> , that <u>must</u> be matched at the provided <i>Price</i> . These contracts are crossing the provided <i>Price</i> and Emerald is seeking liquidity for these contracts.<br>Other Event Types: 0 (zero)<br>Please refer to Appendix C for details. |
| <b>Attributable ID</b> | 4      | Alphanumeric | Emerald assigned Attributable ID (Executing Broker MPID) of an Order. Otherwise, it is space filled.   |
| <b>Reserved</b>        | 8      | BinaryU      | ** Reserved for future use. **   |

Points to note:

- If there are any changes to the imbalance and if the functionality calls for an update to be published, firms will be notified using the same message format. Please refer to Appendix C for details.
- Firms must use the Event ID published in this notification when responding with Orders or Quotes.

## 4.6 Complex Liquidity Seeking Event Notification

This is the message format that will be used to disseminate information each time a Liquidity seeking event (defined in Event Type field below) starts at Emerald

| Field Name                | Length | Data Type    | Notes   |
|---------------------------|--------|--------------|---|
| <i>MACH Protocol Data</i> |        |              | <i>Refer to MACH Protocol Specification</i>   |
| <b>Message Type</b>       | 1      | Alphanumeric | "I" (lower case L)  |
| <b>Timestamp</b>          | 4      | NanoTime     | Time at which this notification was generated by Emerald system.  |
| <b>Strategy ID</b>        | 4      | BinaryU      | Emerald Strategy ID is assigned per trading day and is valid only for that day.   |
| <b>Event Type</b>         | 1      | Alphanumeric | Type of Event:<br>"C" – Complex Order Auction<br>"P" – cPRIME Auction<br>"E" – Complex Liquidity Exposure Process Auction   |
| <b>Event ID</b>           | 4      | BinaryU      | Unique Event ID for the current event.  |
| <b>Side</b>               | 1      | Alphanumeric | "B" – Bid<br>"A" – Ask<br>When Event Type is 'P': Agency side of the cPRIME order being auctioned   |
| <b>Price</b>              | 8      | BinaryPrc4S  | The net limit price for the strategy<br>If Side is "B": <ul style="list-style-type: none"> <li>• Positive number represents net debit</li> <li>• Negative number represents net credit</li> </ul> If Side is "A": <ul style="list-style-type: none"> <li>• Positive number represents net credit</li> <li>• Negative number represents net debit</li> </ul> Price of zero is net neutral transaction for either side. |

| Field Name                | Length | Data Type    | Notes  |
|---------------------------|--------|--------------|--|
|                           |        |              | When Event Type is 'P': Auction Start Price of the cPRIME auction  |
| <b>Matched Quantity</b>   | 4      | BinaryU      | <u>Usage:</u><br>Number of strategies ready to be matched (both buyers and sellers already present).   |
| <b>Imbalance Quantity</b> | 4      | BinaryS      | <u>Usage:</u><br>When Event Type is 'C': Number of strategies on the <i>Imbalance Side</i> that cannot be matched.<br><br>Other Even Types: 0 (zero) |
| <b>Attributable ID</b>    | 4      | Alphanumeric | Emerald assigned Attributable ID (Executing Broker MPID) of the Order. Otherwise, it is space filled.  |
| <b>Reserved</b>           | 8      | BinaryU      | ** Reserved for future use. **   |

Points to note:

- Firms must use the Event ID published in this notification when responding with auction responses (Orders or eQuotes).

## 4.7 Underlying Trading Status Notification

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

**Message Direction:** Emerald to Firm

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



| Field Name | Length | Data Type | Notes   |
|------------|--------|-----------|---|
|            |        |           | seconds specified in "Expected Event Time Seconds" field. |

Points to note:

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

# Appendix A: Emerald AIS Subscription/Connectivity Information

Please visit MIAX website at <http://www.MIAXOptions.com> to obtain the most up-to-date information about the following:

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

## Appendix B: Contact List

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

# Appendix C: Liquidity Seeking Event Notification Details

This section describes the content of the price, side, and quantity fields in the Liquidity Event Notification message generated by the system.

## Simple Liquidity Event Notification

| Prior to 9:30 or Quoting Qualification for Opening (Event Type 'O')  | Price | Imbalance Side   | Matched Quantity (Message Quantity #1)                             | Route Quantity (Message Quantity #2) | Imbalance Quantity (Message Quantity #3)   | Must Fill Quantity (Message Quantity #4)  |
|--|-------|--|--|--------------------------------------|--|---|
| Imbalance locking or priced through the Quote Range, but not priced through the Anticipated Opening Price on Emerald     | 0     | Side that cannot be filled locking or priced through Quote Range | Number of contracts matched on Emerald at Price                    | 0                                    | Number of contracts that cannot be filled by opposing liquidity when locking or priced through Price | 0   |
| Imbalance priced through the Anticipated Opening Price on Emerald  | 0     | Side priced through Expanded Quote Range                         | Number of contracts matched on Emerald at Price                    | 0                                    | Number of contracts that cannot be filled by opposing liquidity when locking or priced through Price | Number of contracts that cannot be filled by opposing liquidity when priced through the EQR price |
| Imbalance comprised of Market Order(s) with no valid width quotes present (No valid Quote Range or Expanded Quote Range) | 0     | Side of Larger Market Order                                      | Number of contracts matched on Emerald by opposing market order(s) | 0                                    | Number of contracts that cannot be filled by opposing liquidity                                      | Number of contracts that cannot be filled by opposing market order(s)                             |

| After 9:30 with Quoting Qualification for Opening (Event Type 'R') | Price   | Imbalance Side                  | Matched Quantity (Message Quantity #1)          | Route Quantity (Message Quantity #2)            | Imbalance Quantity (Message Quantity #3)   | Must Fill Quantity (Message Quantity #4)  |
|--|---|---------------------------------|---|---|--|---|
| Opening Route  | Best price to which opening interest will be routed | Side priced through Away BBO(s) | Number of contracts matched on Emerald at Price | Number of contracts Emerald will route at Price | Number of contracts that cannot be filled by opposing liquidity when locking or priced through Price | Number of contracts that cannot be filled by opposing liquidity when priced through the EQR price |

| After 9:30 with Quoting Qualification for Opening (Event Type 'O')   | Price                             | Imbalance Side   | Matched Quantity (Message Quantity #1)          | Route Quantity (Message Quantity #2)                      | Imbalance Quantity (Message Quantity #3)   | Must Fill Quantity (Message Quantity #4)  |
|--|-----------------------------------|--|---|---|--|---|
| Opening Imbalance Crossing Quote Range or non-Quality Market, not priced through Anticipated Opening Price or Expanded Quote Range (OpenPrice>QR & <EQR or Open Width>Quality) | Anticipated Opening price         | Side priced through Quote Range                              | Number of contracts matched on Emerald at Price | Number of contracts Emerald will route at Price           | Number of contracts that cannot be filled by opposing liquidity when locking or priced through Price | 0   |
| Opening Imbalance locking or Crossing ABBO, but not Crossing Emerald Quote Range or Expanded Quote Range   | Best price of unmatched liquidity | Side of unmatched liquidity                                  | Number of contracts matched on Emerald at Price | Number of contracts Emerald will route at Price or better | Unmatched liquidity at Price   | 0   |
| Opening Imbalance Locking or Crossing Anticipated Opening Price or Expanded Quote Range  | Anticipated Opening price         | Side locking or priced through the Anticipated Opening Price | Number of contracts matched on Emerald at Price | Number of contracts Emerald will route at Price           | Number of contracts that cannot be filled by opposing liquidity when locking or priced through Price | Number of contracts that cannot be filled by opposing liquidity when priced through the EQR Price |
| Emerald Quotes Cross Quotes, do not Cross Orders or ABBO   | Anticipated Opening price         | Side of Larger Quote   | Number of contracts matched on Emerald at Price | 0   | 0  | 0   |

| After 9:30 with Quoting Qualification for Opening (Event Type 'S')   | Price                     | Imbalance Side   | Matched Quantity (Message Quantity #1)        | Route Quantity (Message Quantity #2)          | Imbalance Quantity (Message Quantity #3)  | Must Fill Quantity (Message Quantity #4)  |
|--|---------------------------|--|---|---|---|---|
| Special Settlement Opening Imbalance Locking or Crossing Anticipated Opening Price or Expanded Quote Range | Anticipated Opening price | Side locking or priced through the Anticipated Opening Price | Number of contracts matched on MIA X at Price | Number of contracts MIA X will route at Price | Number of contracts that cannot be filled by opposing liquidity w hen locking or priced through Price | Number of contracts that cannot be filled by opposing liquidity through the EQR price |

| Free Trading – Liquidity Refresh (Event Type 'E')                              | Price  | Imbalance Side        | Matched Quantity (Message Quantity #1)   | Route Quantity (Message Quantity #2) | Imbalance Quantity (Message Quantity #3)  | Must Fill Quantity (Message Quantity #4)                            |
|--|--|-----------------------|--|--------------------------------------|---|---|
| Liquidity Exposure Process Timer (LEPT) (Published once per event, no updates) | Price at which the order is resting on the book during the Timer | Initiating Order Side | Number of contracts matched on the Emerald at the next available Emerald price | 0                                    | Number of contracts that cannot be filled and are locking or priced through the Price | Number of contracts that cannot be filled and are through the Price |

| Free Trading – Emerald PRIME Auction (Event Type 'P')        | Price   | Imbalance Side                  | Matched Quantity (Message Quantity #1) | Route Quantity (Message Quantity #2) | Imbalance Quantity (Message Quantity #3) | Must Fill Quantity (Message Quantity #4) |
|--|---|---------------------------------|--|--------------------------------------|--|--|
| Emerald PRIME Auction (published once per event, no updates) | Emerald PRIME Auction Start Price/ Stop Price | Emerald PRIME Agency Order Side | Emerald PRIME Auction Size             | 0                                    | 0  | 0  |

### Complex Liquidity Event Notification

| Free Trading – Complex Strategy Auction (Event Type 'C')     | Price   | Side  | Matched Quantity (Message Quantity #1)   | Route Quantity (Message Quantity #2) | Imbalance Quantity (Message Quantity #3)   | Must Fill Quantity (Message Quantity #4) |
|--|---|---|--|--------------------------------------|--|--|
| Complex Order Auction (Published once per event, no updates) | The order's limit price or the opposite side displayed Complex EBBO as derived from the Simple Market if the order is a market order or has a limit price that is equal to, or through, the | The Auction Side is the side that meets the requirements to begin an Auction. | The number of strategies that are matched at the Price without matching against liquidity in the simple order market | NA                                   | The number of strategies that are not matched at the Best Price without matching against liquidity in the Simple Market. | NA                                       |

|  |  |  |  |  |   |  |
|--|--|--|--|--|---|--|
|  | opposite side displayed<br>Complex EBBO. |  |  |  | Note: A negative Imbalance Quantity indicates an excess of liquidity at the Auction Price on the contra-side. |  |
|--|--|--|--|--|---|--|

| Free Trading – Complex Strategy Auction (Event Type ‘E’) | Price               | Side                                     | Matched Quantity (Message Quantity #1)   | Route Quantity (Message Quantity #2) | Imbalance Quantity (Message Quantity #3)   | Must Fill Quantity (Message Quantity #4) |
|--|---------------------|--|--|--------------------------------------|--|--|
| Complex Liquidity Exposure Process Auctions (cLEPA)      | Auction Start Price | Side of the Order that started the cLEPA | The number of strategies that are matched at the Price without matching against liquidity in the simple order market | 0                                    | The number of strategies that are not matched at the Best Price without matching against liquidity in the Simple Market. | 0  |

| Free Trading – cPRIME Auction (Event Type ‘P’)        | Price                                 | Side                     | Matched Quantity (Message Quantity #1) | Route Quantity (Message Quantity #2) | Imbalance Quantity (Message Quantity #3) | Must Fill Quantity (Message Quantity #4) |
|---|---------------------------------------|--------------------------|--|--------------------------------------|--|--|
| cPRIME Auction (Published once per event, no updates) | cPRIME Auction Start Price/Stop Price | cPRIME Agency Order Side | cPRIME Auction Size                    | NA                                   | 0  | NA                                       |

Notes:

- Transaction Reference Price (TRP): The reference price used during timers and other non-timer transactions.

## Appendix D: Revision History

| Revision Date | Version | Description                  |
|---------------|---------|------------------------------|
| Oct 9, 2018   | 1.0     | First release.               |
| Jul 26, 2020  | 1.0a    | Added new Equities exchanges |





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