Securities Industry Automation Corporation
P.O. Box 24270, Brooklyn, NY 11202-4270

January 23, 2008

To: OPRA Multicast Data Recipients

Subject: OPRA Symbology

Modification

OPRA is currently in the process of supporting the Options Symbology initiative. This initiative which overhauls the symbology used in representing listed option contracts in data transmissions between market constituents, includes modifications to the OPRA formats. Modifications will be made to OPRA FAST in order to support these changes. Pursuant to the OPRA notice dated January 7, 2008, (http://www.opradata.com/specs/opra_fast_update.pdf), these changes to OPRA FAST will also resolve the non-compliance issue. **As part of this effort, SIAC will reuse the multicast addresses that currently support the production ASCII network** (48 Equity/Index Production (24 A-Stream, 24 B-stream), 24 Retransmissions, and 24 Playback Test; total of 96).

The following enhancements will be introduced in the FAST for Symbology network representing changes to all Equity/Index message formats:

OPRA Symbology Message Format Enhancements

- A new Expiration Date field will be added, indicating the date the series expires. This field will be two (2) bytes, numeric.
- The Year field will be expanded to two (2) bytes, numeric.
- The Explicit Strike Price field will be reduced to six (6) bytes, numeric.
- The Reserved fields have been removed.
- Support for FCO's will not be provided in FAST for Symbology.
- Support for Line Integrity messages will be provided. (Category H, Type N)

OPRA Expanded Message Header

- The Time Stamp field will be expanded to include milliseconds. This field will be nine (9) bytes, numeric.
- The Message Sequence Number field will be expanded to 10 bytes, numeric.

FAST Packet Header Enhancements

- An OPRA FAST Version Number field will be added to each packet, representing the version of OPRA FAST contained within the current packet. This field will be one (1) byte, binary.
- A Packet Sequence Number field will be added to each packet representing the sequence number of the first message within the current packet. This field will be 10 bytes, ASCII, right justified.
- A Packet Messages field will be added to each packet representing the number of messages contained within the current packet. This field will be three (3) bytes, ASCII, right justified.

Migration Period

The OPRA FAST for Symbology network will begin to be disseminated live, in production, on March 31, 2007. There will be a phase in period of approximately three (3) months to allow Data Recipients to test and convert from the current FAST network to the FAST for Symbology network. During the phase in period dual networks will support both the current FAST and the FAST for Symbology formats, with retransmission requests disseminated over both networks. **The current FAST network will be terminated end of day June 27, 2008.**

Schedule	Date
New FAST for Symbology Documentation, Decoder	January 23, 2008
Afterhours Testing available	January 24, 2008
Support Current FAST and FAST for Symbology Dual Networks in Production	March 31, 2008 (SOD)
Current FAST Network Terminated	June 27, 2008 (EOD)

NOTE: Data Recipients will not be required to make any firewall and/or router filter configurations ***as the current source addresses and production ASCII multicast addresses will be utilized.*** *Data Recipients are encouraged to begin testing as early as possible.*

Specifications

Attached please find the FAST for Symbology technical document (Version 2.0 dated January 23, 2008), which includes sample OPRA reference code for decompression, based on FAST version 1.1. Also attached you will find a revised National Market Systems, Common IP Multicast Distribution Network, Recipient Interface Specification (Version 1.30, dated January 23, 2008), which contains the FAST for Symbology Multicast addresses (Appendix A). In addition, attached you will find the 'C' language OPRA FAST decoder supporting all OPRA message formats. The OPRA Data Recipient Interface Specification which includes the OPRA Symbology message format enhancements will be generated under separate cover.

Testing

Testing with the OPRA FAST for Symbology network will be available January 24, 2007. Data Recipient test scheduling should be coordinated through Joe Loughran at (212) 383-4908.

Technical Support

Technical support to assist Data Recipients with migration questions will be available. Please email your questions to Laura Guzzy (lguzzy@siac.com) or Mike Collazo (mcollazo@siac.com).

Sincerely,

Michael Collazo
Director
National Market Systems (NMS)
Product Planning & Management

cc:
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OPRA Policy Committee
OPRA Technical Committee

FAST for OPRA

SIAC Technical Information for
OPRA Data Recipients

Document Version: 02.00
Date: January 23, 2008

Revision History

VERSION 1.0 – December 8, 2006	
PAGE(S)	DESCRIPTION
All	Initial Version

VERSION 1.00.01 – February 27, 2007	
PAGE(S)	DESCRIPTION
2 3 3	- Updated URL link for FAST 1.1 specification - Updated the Template (Field Operator) Definition Table to reflect OPRA Field Name, Field Operator and Data Type - Added SOH, US, and ETX fields for start and end of packet

VERSION 1.00.02 – March 26, 2007	
PAGE(S)	DESCRIPTION
ALL	- Added Revision History - Added title to the FAST Template (Field Operator) descriptions table - Added additional FAST Template (Field Operator) descriptions - Updated definitions to reflect changes in how OPRA Fields are encoded - Added 1 byte Message Length (Message Size) field in front of every encoded message - Change BID_INDEX_VALUE field to be encoded as a STRING Data Type - Change OFFER_INDEX_VALUE field to be encoded as a STRING Data Type - Updated sample code to reflect new Message Length field - Added note regarding elimination of Unit Separator in encoded packets - Added note regarding location of message Category field in encoded messages - A sample ‘C’ language OPRA FAST decoder supporting all OPRA message formats has been provided in attached zip files

VERSION 2.00 – January 23, 2008	
PAGE(S)	DESCRIPTION
ALL	- Reflects Symbology enhancements in all message formats - Provides templates for all messages - Supports the current version (v1) of FAST for OPRA in new decoder - Supports FAST for Symbology (v2) Phase 1 and Phase 2 in new decoder - Reflects Packet header enhancements - Support for FCO's removed (v2) - Reserved Fields removed in FAST for Symbology (v2)message formats - Support for Line Integrity Messages

FAST

Overview:
FAST (http://www.fixprotocol.org/fast) is an acronym for **F**IX **A**dapted for **ST**reaming. The FAST protocol is defined by the FIX protocol Market Data Optimization Working Group, whose purpose is to develop recommended enhancements to support high frequency market data applications. A technical overview of the protocol can be downloaded from http://www.fixprotocol.org/documents/2801/FIX%20Adapted%20for%20STreaming%20-%20FAST%20Protocol.pdf

Why FAST:
FAST is designed to develop solutions for efficient dissemination of market data. The protocol optimizes communications in the electronic exchange of financial data by reducing the bandwidth between sender and receiver via algorithmic data compaction within each packet.

FAST for OPRA

The FAST protocol has been integrated with OPRA to reduce the bandwidth of OPRA messages. Pursuant to the OPRA notice dated January 23, 2008, beginning on March 31, 2008, OPRA will simultaneously disseminate production multicast data in a dual network mode: current FAST and FAST for Symbology encoded feeds.

Implementation:
FAST API (http://www.fixprotocol.org/documents/2317/fastapi-1.0.zip), a 'C' language implementation of the FAST Protocol, is used to encode OPRA message formats into the FAST format. The FAST Protocol API must be used by OPRA Data Recipients to decode the encoded OPRA messages. The API reference manual and sample implementation can be downloaded from http://www.fixprotocol.org/fastdownload

OPRA FAST Template (Field Operator):
OPRA encodes data utilizing FAST Templates (Field Operators) as described in the table below. A Field Operator defines the structure of encoded data and specifies how data in each field of the OPRA message format is encoded. Data recipients should use these Field Operators during their decoding process. Please refer to chapter 6 of FAST Specification Version 1.1 for a detailed explanation of the Field Operators.

Encode/Decode field Operator explanation:

COPY CODE: Fields that frequently have the same value in successive instances.
The copy operator specifies that the value of a field is optionally present in the stream. If the value is present in the stream it becomes the new previous value.
When the value is not present in the stream there are three cases depending on the state of the previous value:

- assigned – the value of the field is the previous value.

- undefined – the value of the field is the initial value that also becomes the new previous value. Unless the field has optional presence, it is a dynamic error [ERR D5] if the instruction context has no initial value. If the field has optional presence and no initial value, the field is considered absent and the state of the previous value is changed to empty.

- empty – the value of the field is empty. If the field is optional the value is considered absent. It is a dynamic error [ERR D6] if the field is mandatory.

The copy operator is applicable to all field types.

Description:

The value of **{F}** will be equal to the previous instance of **{F}** or **{V}** if it is the first instance of **{F}**. A protocol error should be signaled if there is no previous value and **{V}** has not been specified.
The value of **{F}** can be set to NULL if the field type supports a NULL value.

Examples:

Field Operator Entry	Previous Value	Field Content	Field Value
167=	[None]	[Empty]	[Error]
167=	FUT	[Empty]	FUT
167=FUT	[None]	[Empty]	FUT
167=FUT	IDX	[Empty]	IDX
167=FUT	IDX	FUT	FUT

INCREMENT: Fields that frequently have successive values which are incrementally larger than the previous value (sequence numbers).

The increment operator specifies that the value of a field is optionally present in the stream. If the value is present in the stream it becomes the new previous value.

When the value is not present in the stream there are three cases depending on the state of the previous value:

- assigned – the value of the field is the previous value incremented by one. The incremented value also becomes the new previous value.

• Undefined – the value of the field is the initial value that also becomes the new previous value. Unless the field has optional presence, it is a dynamic error [ERR D5] if the instruction context has no initial value. If the field has optional presence and no initial value, the field is considered absent and the state of the previous value is changed to empty.

• Empty – the value of the field is empty. If the field is optional, the value is considered absent. It is a dynamic error [ERR D6] if the field is mandatory.

The increment operator is applicable to integer field types.

An integer is incremented by adding one to it. If the value is the maximum value of the type it becomes the minimum value after the increment.

Description:

{N} is a numeric default value.
The value of **{F}**, if not specified in a message field, will be the value of the previous value of **{F}** incremented by one, or **{N}** if it is the first instance of **{F}**.
If a value is specified in the message it will be used as the current value of **{F}** and it will be used as the previous value in a subsequent instance of **{F}** in the same message.
The value of **{F}** can be set to NULL. The increment of NULL is NULL (which is essentially copy coding behavior for a NULL previous value).

Examples:

Field Operator Entry	Previous Value	Field Content	Field Value
34+	[None]	[Empty]	[Error]
34+	325	[Empty]	326
34+1	[None]	[Empty]	1
34+1	325	[Empty]	326
34+1	325	401	401

DELTA: Fields that frequently have values that are almost equal to the previous value in the same message.
The delta operator specifies that a delta value is present in the stream. If the field has optional presence, the delta value can be NULL. In that case the value of the field is considered absent. Otherwise the field is obtained by combining the delta value with a base value.

Delta = **element** delta { opContext }

The base value depends on the state of the previous value in the following way:

• assigned – the base value is the previous value.

• Undefined – the base value is the initial value if present in the instruction context. Otherwise a type dependant default base value is used.

• Empty – it is a dynamic error [ERR D6] if the previous value is empty.

The following sections define the delta value representations, the default base values and how values are combined depending on type.

Description:

The value of **{F}** will be the value of the previous instance of **{F}** plus the (delta) value specified for the current instance of **{F}** (the value given in the message is the delta from the previous instance of **{F}**). If the value is not specified, zero (0) is used as a default delta value.

FAST Field Encoding Specification 8 (10) 2006-01-13 * *
For character string fields, the delta is defined as being the tail characters of the field. As a consequence, the delta value coding can only be used on character string fields with a fixed length.
The value of **{F}** can be set to NULL if the field type supports a NULL value. The default delta of NULL is NULL (which is essentially copy coding behavior for a NULL previous value).

Examples:

Field Operator Entry	Previous Value	Field Content	Field Value
270-	[None]	[Empty]	[Error]
270-	[None]	1010	1010
270-	1010	[Empty]	1010
270-	1010	0	1010
270-	1010	-20	990
48-	[None]	[Empty]	[NULL]
48-	[None]	CME000150112	CME000150112
48-	CME000150112	[Empty]	CME000150112
48-	CME000150112	413	CME000150413
48-	CME000150413	0	CME000150410

General Template for all Messages

*Field is removed for Phase 2

ID defines the serialization of the encoding and decoding of FAST for OPRA messages.

FIELD NAME	ID	ENCODE Operator	DATA TYPE
MESSAGE_CATEGORY	**0**	**COPY CODE**	**Unsigned Integer**
MESSAGE_TYPE	**1**	**COPY CODE**	**Unsigned Integer**
PARTICIPANT_ID	**2**	**COPY CODE**	**Unsigned Integer**
RETRANSMISSION_REQUESTER	**3**	**COPY CODE**	**Unsigned Integer**
MESSAGE_SEQUENCE_NUMBER	**4**	**INCREMENT**	**Unsigned Integer**
TIME	**5**	**COPY CODE**	**Unsigned Integer**
SECURITY_SYMBOL	6	COPY CODE	STRING
EXPIRATION_MONTH	7	COPY CODE	Unsigned Integer
EXPIRATION_DATE	8	COPY CODE	Unsigned Integer
YEAR	9	COPY CODE	Unsigned Integer
STRIKE_PRICE_DENOMINATOR_CODE	10	COPY CODE	Unsigned Integer
EXPLICIT_STRIKE_PRICE	11	COPY CODE	Unsigned Integer
*STRIKE_PRICE_CODE	12	COPY CODE	Unsigned Integer
VOLUME	13	COPY CODE	Unsigned Integer
OPEN_INT_VOLUME	14	COPY CODE	Unsigned Integer
PREMIUM_PRICE_DENOMINATOR_CODE	15	COPY CODE	Unsigned Integer
PREMIUM_PRICE	16	COPY CODE	Unsigned Integer
OPEN_PRICE	17	COPY CODE	Unsigned Integer
HIGH_PRICE	18	COPY CODE	Unsigned Integer
LOW_PRICE	19	COPY CODE	Unsigned Integer
LAST_PRICE	20	COPY CODE	Unsigned Integer
NET_CHANGE_INDICATOR	21	COPY CODE	Unsigned Integer
NET_CHANGE	22	COPY CODE	Unsigned Integer
UNDERLYING_PRICE_DENOM	23	COPY CODE	Unsigned Integer
UNDERLYING_STOCK_PRICE	24	COPY CODE	Unsigned Integer
BID_PRICE	25	COPY CODE	Unsigned Integer
BID_SIZE	26	COPY CODE	Unsigned Integer
OFFER_PRICE	27	COPY CODE	Unsigned Integer
OFFER_SIZE	28	COPY CODE	Unsigned Integer
SESSION_INDICATOR	29	COPY CODE	Unsigned Integer
BBO_INDICATOR	30	COPY CODE	Unsigned Integer
BEST_BID_PARTICIPANT_ID	31	COPY CODE	Unsigned Integer
BEST_BID_PRICE_DENOMINATOR_CODE	32	COPY CODE	Unsigned Integer
BEST_BID_PRICE	33	COPY CODE	Unsigned Integer
BEST_BID_SIZE	34	COPY CODE	Unsigned Integer
BEST_OFFER_PARTICIPANT_ID	35	COPY CODE	Unsigned Integer
BEST_OFFER_PRICE_DENOMINATOR_CODE	36	COPY CODE	Unsigned Integer
BEST_OFFER_PRICE	37	COPY CODE	Unsigned Integer
BEST_OFFER_SIZE	38	COPY CODE	Unsigned Integer
NUMBER_OF_INDICES_IN_GROUP	39	COPY CODE	Unsigned Integer
NUMBER_OF_FOREIGN_CURRENCY_SPOT_VALUES_IN_GROUP	40	COPY CODE	Unsigned Integer
INDEX_SYMBOL	41	COPY CODE	STRING
INDEX_VALUE	42	COPY CODE	STRING
BID_INDEX_VALUE	43	COPY CODE	STRING
OFFER_INDEX_VALUE	44	COPY CODE	STRING
FCO_SYMBOL	45	COPY CODE	STRING
DECIMAL_PLACEMENT_INDICATOR	46	COPY CODE	Unsigned Integer
FOREIGN_CURRENCY_SPOT_VALUE	47	COPY CODE	Unsigned Integer
TEXT	48	COPY CODE	STRING
DEF_MSG	49	COPY CODE	STRING

Templates for individual messages

*Field is removed in Phase 2

ID defines the serialization of the encoding and decoding of FAST for OPRA messages.

Category ‘a’

FIELD NAME	ID	ENCODE Operator	DATA TYPE
MESSAGE_CATEGORY	**0**	**COPY CODE**	**Unsigned Integer**
MESSAGE_TYPE	**1**	**COPY CODE**	**Unsigned Integer**
PARTICIPANT_ID	**2**	**COPY CODE**	**Unsigned Integer**
RETRANSMISSION_REQUESTER	**3**	**COPY CODE**	**Unsigned Integer**
MESSAGE_SEQUENCE_NUMBER	**4**	**INCREMENT**	**Unsigned Integer**
TIME	**5**	**COPY CODE**	**Unsigned Integer**
SECURITY_SYMBOL	6	COPY CODE	STRING
EXPIRATION_MONTH	7	COPY CODE	Unsigned Integer
EXPIRATION_DATE	8	COPY CODE	Unsigned Integer
YEAR	9	COPY CODE	Unsigned Integer
STRIKE_PRICE_DENOMINATOR_CODE	10	COPY CODE	Unsigned Integer
EXPLICIT_STRIKE_PRICE	11	COPY CODE	Unsigned Integer
*STRIKE_PRICE_CODE	12	COPY CODE	Unsigned Integer
VOLUME	13	COPY CODE	Unsigned Integer
PREMIUM_PRICE_DENOMINATOR_CODE	15	COPY CODE	Unsigned Integer
PREMIUM_PRICE	16	COPY CODE	Unsigned Integer
SESSION_INDICATOR	29	COPY CODE	Unsigned Integer

Category ‘k’

*Field is removed in Phase 2
ID defines the serialization of the encoding and decoding of FAST for OPRA messages.

FIELD NAME	ID	ENCODE Operator	DATA TYPE
MESSAGE_CATEGORY	**0**	**COPY CODE**	**Unsigned Integer**
MESSAGE_TYPE	**1**	**COPY CODE**	**Unsigned Integer**
PARTICIPANT_ID	**2**	**COPY CODE**	**Unsigned Integer**
RETRANSMISSION_REQUESTER	**3**	**COPY CODE**	**Unsigned Integer**
MESSAGE_SEQUENCE_NUMBER	**4**	**INCREMENT**	**Unsigned Integer**
TIME	**5**	**COPY CODE**	**Unsigned Integer**
SECURITY_SYMBOL	6	COPY CODE	STRING
EXPIRATION_MONTH	7	COPY CODE	Unsigned Integer
EXPIRATION_DATE	8	COPY CODE	Unsigned Integer
YEAR	9	COPY CODE	Unsigned Integer
STRIKE_PRICE_DENOMINATOR_CODE	10	COPY CODE	Unsigned Integer
EXPLICIT_STRIKE_PRICE	11	COPY CODE	Unsigned Integer
*STRIKE_PRICE_CODE	12	COPY CODE	Unsigned Integer
PREMIUM_PRICE_DENOMINATOR_CODE	15	COPY CODE	Unsigned Integer
BID_PRICE	25	COPY CODE	Unsigned Integer
BID_SIZE	26	COPY CODE	Unsigned Integer
OFFER_PRICE	27	COPY CODE	Unsigned Integer
OFFER_SIZE	28	COPY CODE	Unsigned Integer
SESSION_INDICATOR	29	COPY CODE	Unsigned Integer
BBO_INDICATOR	30	COPY CODE	Unsigned Integer
BEST_BID_PARTICIPANT_ID	31	COPY CODE	Unsigned Integer
BEST_BID_PRICE_DENOMINATOR_CODE	32	COPY CODE	Unsigned Integer
BEST_BID_PRICE	33	COPY CODE	Unsigned Integer
BEST_BID_SIZE	34	COPY CODE	Unsigned Integer
BEST_OFFER_PARTICIPANT_ID	35	COPY CODE	Unsigned Integer
BEST_OFFER_PRICE_DENOMINATOR_CODE	36	COPY CODE	Unsigned Integer
BEST_OFFER_PRICE	37	COPY CODE	Unsigned Integer
BEST_OFFER_SIZE	38	COPY CODE	Unsigned Integer

Category ‘d’

*Field is removed in Phase 2

ID defines the serialization of the encoding and decoding of FAST for OPRA messages.

FIELD NAME	ID	ENCODE Operator	DATA TYPE
MESSAGE_CATEGORY	**0**	**COPY CODE**	**Unsigned Integer**
MESSAGE_TYPE	**1**	**COPY CODE**	**Unsigned Integer**
PARTICIPANT_ID	**2**	**COPY CODE**	**Unsigned Integer**
RETRANSMISSION_REQUESTER	**3**	**COPY CODE**	**Unsigned Integer**
MESSAGE_SEQUENCE_NUMBER	**4**	**INCREMENT**	**Unsigned Integer**
TIME	**5**	**COPY CODE**	**Unsigned Integer**
SECURITY_SYMBOL	6	COPY CODE	STRING
EXPIRATION_MONTH	7	COPY CODE	Unsigned Integer
EXPIRATION_DATE	8	COPY CODE	Unsigned Integer
YEAR	9	COPY CODE	Unsigned Integer
STRIKE_PRICE_DENOMINATOR_CODE	10	COPY CODE	Unsigned Integer
EXPLICIT_STRIKE_PRICE	11	COPY CODE	Unsigned Integer
*STRIKE_PRICE_CODE	12	COPY CODE	Unsigned Integer
OPEN_INT_VOLUME	14	COPY CODE	Unsigned Integer

Category ‘Y’

ID defines the serialization of the encoding and decoding of FAST for OPRA messages.

FIELD NAME	ID	ENCODE Operator	DATA TYPE
MESSAGE_CATEGORY	**0**	**COPY CODE**	**Unsigned Integer**
MESSAGE_TYPE	**1**	**COPY CODE**	**Unsigned Integer**
PARTICIPANT_ID	**2**	**COPY CODE**	**Unsigned Integer**
RETRANSMISSION_REQUESTER	**3**	**COPY CODE**	**Unsigned Integer**
MESSAGE_SEQUENCE_NUMBER	**4**	**INCREMENT**	**Unsigned Integer**
TIME	**5**	**COPY CODE**	**Unsigned Integer**
NUMBER_OF_INDICES_IN_GROUP	39	COPY CODE	Unsigned Integer
NUMBER_OF_FOREIGN_CURRENCY_SPOT_VALUES_IN_GROUP	40	COPY CODE	Unsigned Integer
INDEX_SYMBOL	41	COPY CODE	STRING
INDEX_VALUE	42	COPY CODE	STRING
BID_INDEX_VALUE	43	COPY CODE	STRING
OFFER_INDEX_VALUE	44	COPY CODE	STRING
FCO_SYMBOL	45	COPY CODE	STRING
DECIMAL_PLACEMENT_INDICATOR	46	COPY CODE	Unsigned Integer
FOREIGN_CURRENCY_SPOT_VALUE	47	COPY CODE	Unsigned Integer

Category ‘f’

*Field is removed in Phase 2

ID defines the serialization of the encoding and decoding of FAST for OPRA messages.

FIELD NAME	ID	ENCODE Operator	DATA TYPE
MESSAGE_CATEGORY	**0**	**COPY CODE**	**Unsigned Integer**
MESSAGE_TYPE	**1**	**COPY CODE**	**Unsigned Integer**
PARTICIPANT_ID	**2**	**COPY CODE**	**Unsigned Integer**
RETRANSMISSION_REQUESTER	**3**	**COPY CODE**	**Unsigned Integer**
MESSAGE_SEQUENCE_NUMBER	**4**	**INCREMENT**	**Unsigned Integer**
TIME	**5**	**COPY CODE**	**Unsigned Integer**
SECURITY_SYMBOL	6	COPY CODE	STRING
EXPIRATION_MONTH	7	COPY CODE	Unsigned Integer
EXPIRATION_DATE	8	COPY CODE	Unsigned Integer
YEAR	9	COPY CODE	Unsigned Integer
STRIKE_PRICE_DENOMINATOR_CODE	10	COPY CODE	Unsigned Integer
EXPLICIT_STRIKE_PRICE	11	COPY CODE	Unsigned Integer
*STRIKE_PRICE_CODE	12	COPY CODE	Unsigned Integer
VOLUME	13	COPY CODE	Unsigned Integer
OPEN_INT_VOLUME	14	COPY CODE	Unsigned Integer
PREMIUM_PRICE_DENOMINATOR_CODE	15	COPY CODE	Unsigned Integer
OPEN_PRICE	17	COPY CODE	Unsigned Integer
HIGH_PRICE	18	COPY CODE	Unsigned Integer
LOW_PRICE	19	COPY CODE	Unsigned Integer
LAST_PRICE	20	COPY CODE	Unsigned Integer
NET_CHANGE_INDICATOR	21	COPY CODE	Unsigned Integer
NET_CHANGE	22	COPY CODE	Unsigned Integer
UNDERLYING_PRICE_DENOM	23	COPY CODE	Unsigned Integer
UNDERLYING_STOCK_PRICE	24	COPY CODE	Unsigned Integer
BID_PRICE	25	COPY CODE	Unsigned Integer
OFFER_PRICE	27	COPY CODE	Unsigned Integer

Category ‘C’

ID defines the serialization of the encoding and decoding of FAST for OPRA messages.

FIELD NAME	ID	ENCODE Operator	DATA TYPE
MESSAGE_CATEGORY	**0**	**COPY CODE**	**Unsigned Integer**
MESSAGE_TYPE	**1**	**COPY CODE**	**Unsigned Integer**
PARTICIPANT_ID	**2**	**COPY CODE**	**Unsigned Integer**
RETRANSMISSION_REQUESTER	**3**	**COPY CODE**	**Unsigned Integer**
MESSAGE_SEQUENCE_NUMBER	**4**	**INCREMENT**	**Unsigned Integer**
TIME	**5**	**COPY CODE**	**Unsigned Integer**
TEXT	48	COPY CODE	STRING

Category ‘H’

ID defines the serialization of the encoding and decoding of FAST for OPRA messages.

FIELD NAME	ID	ENCODE Operator	DATA TYPE
MESSAGE_CATEGORY	**0**	**COPY CODE**	**Unsigned Integer**
MESSAGE_TYPE	**1**	**COPY CODE**	**Unsigned Integer**
PARTICIPANT_ID	**2**	**COPY CODE**	**Unsigned Integer**
RETRANSMISSION_REQUESTER	**3**	**COPY CODE**	**Unsigned Integer**
MESSAGE_SEQUENCE_NUMBER	**4**	**INCREMENT**	**Unsigned Integer**
TIME	**5**	**COPY CODE**	**Unsigned Integer**
TEXT	48	COPY CODE	STRING

Notes:

1. New OPRA packet format:

SOH	Version Number	Packet Sequence Number	Packet Messages	Message Length	Encoded Messages	- - - - -	ETX
1 Byte	1 Byte	10 Bytes	3 Bytes	1 Byte	Variable	- - - - -	1 Byte

2. The Start Of Header (SOH) and End Of Text (ETX) in ASCII.
3. An OPRA FAST Version Number field will be added to each packet, representing the version of OPRA FAST contained within the current packet. This field will be one (1) byte, binary.
4. A Packet Sequence Number field will be added to each packet representing the sequence number of the first message within the current packet. This field will be 10 bytes, ASCII, right justified.
5. A Packet Messages field will be added to each packet representing the number of messages contained within the current packet. This field will be three (3) bytes, ASCII, right justified.
6. Message Length indicates message length (MsgSize), is provided in front of every encoded OPRA FAST message.
7. If the encoded message length is larger than 254 then the new field will contain the binary value of 255 (0xFF). In this situation, the end of message will be determined by the ETX delimiter following the message.
8. The Unit separator will not be part of ORPA encoded message. The decoder will add the Unit Separator to comply with the OPRA specification.
9. The message Category field will be located at the beginning of the encoded message as opposed to it's position in the OPRA ASCII format. Please refer OPRA template provided above.
10. u32_to_ascii is a utility function that converts integers to ASCII.
11. A sample 'C' language OPRA FAST decoder supporting all FAST for OPRA message formats (current FAST, and Fast for Symbology Phase 1 and Phase 2) has been provided. This decoder can be used to reconstitute the original OPRA formatted packets. In order to reconstitute the original OPRA formatted packet, the appropriate fields should be decoded, converted and or added as described above. Data recipients are welcome to use any FAST decoder program that uses the FAST API described in FAST Specification Version 1.1. A general template has been provided in this document for this purpose.
12. In the event an invalid message category is received by OPRA, the entire message body would be encoded as a string.
13. STRIKE_PRICE_CODE is removed in FAST for Symbology (v2) Phase 2.
14. All Reserved fields have been removed in FAST for Symbology (v2) Phase 1 and Phase 2.
15. Support for Line Integrity messages.

Sample code for decoding category ‘k’ OPRA messages:

```
main
{
        OPRA_K_MSG kMsg;
        // add SOH if present – present in first message.
        If (decode_U32(START_OF_HEADER) != -1)
        //add SOH

        Check_OPRA_FAST_Version()

        codec = create_fast_codec()

        while (msgs)
        {
                fast_decode_new_msg(OPRA_BASE_TID)   // OPRA template ID


                msgCategory = decode_U32(MESSAGE_CATEGORY)
                switch(msgCategory)
                {
                        case ‘k’:
                                decode_equity_index_quote_with_size_ver#(kMsg)
                                break
                        ……..
                        ……..
                        ……..
                        default:
                                decode_opra_default_ver#( (kMsg)
                                break
                }

                // append decoded msg

                // append unit separator if present –not present in last message.
                If (decode_U32(UNIT_SEPERATOR) != -1)
                        //append US

                // append ETX if present – present in the last message.
                If (decode_U32(END_OF_TEXT) != -1)
                        //append ETX

                fast_decode_end_msg(OPRA_BASE_TID)
        }
        // append ETX

}

//following decode function is for Ver 2
decode_equity_index_quote_with_size_ver2(OPRA_K_MSG kMsg)
{

        kMsg.category = ‘k’
        kMsg.type = decode_u32(MESSAGE_TYPE);
        kMsg.participantId = decode_u32(PARTICIPANT_ID);
        kMsg.retran = decode_u32(RETRANSMISSION _REQUESTER)
        u32_to_ascii(kMsg.seqNumber, sizeof(kMsg.seqNumber),
                                        decode_u32(MESSAGE_SEQUENCE_NUMBER))
        u32_to_ascii(kMsg.time, sizeof(kMsg.time), decode_u32(TIME))

        memset(kMsg.symbol,' ',sizeof(kMsg.symbol))                    // left justified
        decode_str(SECURITY_SYMBOL, kMsg.symbol, sizeof(kMsg.symbol))
```

```
kMsg.expirationMonth = decode_u32(EXPIRATION_MONTH)
u32_to_ascii (kMsg.expirationDate, sizeof(kMsg.expirationDate), decode_u32(EXPIRATION_DATE))
u32_to_ascii (kMsg.year, sizeof(kMsg.year),  decode_u32(YEAR))
kMsg.strikePriceDenomCode = decode_u32(STRIKE_PRICE_DENOM_CODE)
u32_to_ascii(kMsg.explicitStrike, sizeof(kMsg.explicitStrike),
                                        decode_u32(EXPLICIT_STRIKE_PRICE))
kMsg.strikePriceCode = decode_u32(STRIKE_PRICE_CODE)
kMsg.premiumPriceDenomCode = decode_u32(PREMIUM_PRICE_DENOM_CODE)
u32_to_ascii(kMsg.bidQuote, sizeof(kMsg.bidQuote), decode_u32(BID_PRICE))
u32_to_ascii(kMsg.bidSize, sizeof(kMsg.bidSize), decode_u32(BID_SIZE))
u32_to_ascii(kMsg.askQuote,sizeof(kMsg.askQuote), decode_u32(ASK_PRICE))
u32_to_ascii(kMsg.askSize, sizeof(kMsg.askSize),  decode_u32(ASK_SIZE))
kMsg.sessionIndicator = decode_u32(SESSION_INDICATOR)
kMsg.bboIndicator = decode_u32(BBO_INDICATOR)
switch(kMsg.bboIndicator)
{
        case 'A': // No Best Bid Change, No Best Offer Change
        case 'B': // No Best Bid Change, Quote Contains Best Offer
        case 'D': // No Best Bid Change, No Best Offer
        case 'E': // Quote Contains Best Bid, No Best Offer Change
        case 'F': // Quote Contains Best Bid, Quote Contains Best Offer
        case 'H': // Quote Contains Best Bid, No Best Offer
        case 'I': // No Best Bid, No Best Offer Change
        case 'J': // No Best Bid, Quote Contains Best Offer
        case 'L': // No Best Bid, No Best Offer
        break;

        case 'C': // No Best Bid Change, Best Offer
        case 'G': // Quote Contains Best Bid, Best Offer
        case 'K': // No Best Bid, Best Offer
                kMsg.bbo.bestOffer.partId = decode_u32(BEST_OFFER_PART_ID)
                kMsg.bbo.bestOffer.denominator =
                                        decode_u32(BEST_OFFER_DENOM_CODE)
                u32_to_ascii(kMsg.bbo.bestOffer.price, sizeof(kMsg.bbo.bestOffer.price),
                                                decode_u32(BEST_OFFER_PRICE))
                u32_to_ascii(kMsg.bbo.bestOffer.size, sizeof(kMsg.bbo.bestOffer.size),
                                                decode_u32(BEST_OFFER_SIZE))

        break;

        case 'M': // Best Bid , No Best Offer Change
        case 'P': // Best Bid , No Best Offer
        case 'N': // Best Bid , Quote Contains Best Offer
                kMsg.bbo.bestBid.partId = decode_u32(BEST_BID_PART_ID)
                kMsg.bbo.bestBid.denominator = decode_u32(BEST_BID_DENOM_CODE)
                u32_to_ascii(kMsg.bbo.bestBid.price, sizeof(kMsg.bbo.bestBid.price),
                                                decode_u32(BEST_BID_PRICE))
                u32_to_ascii(kMsg.bbo.bestBid.size, sizeof(kMsg.bbo.bestBid.size),
                                                decode_u32(BEST_BID_SIZE))
                                        break;

        case 'O': // Best Bid , Best Offer
                kMsg.bbo.bestBidOffer.bestBid.partId = decode_u32(BEST_BID_PART_ID)
                kMsg.bbo.bestBidOffer.bestBid.denominator =
                                                decode_u32(BEST_BID_DENOM_CODE)
                u32_to_ascii(kMsg.bbo.bestBidOffer.bestBid.price,
                                        sizeof(kMsg.bbo.bestBidOffer.bestBid.price),
                                        decode_u32(BEST_BID_PRICE))
                u32_to_ascii(kMsg.bbo.bestBidOffer.bestBid.size,
                                        sizeof(kMsg.bbo.bestBidOffer.bestBid.size),
                                        decode_u32(BEST_BID_SIZE))

                kMsg.bbo.bestBidOffer.bestOffer.partId =
                                         decode_u32(BEST_OFFER_PART_ID)
                kMsg.bbo.bestBidOffer.bestOffer.denominator =
```

```
                                        decode_u32(BEST_OFFER_DENOM_CODE)
                u32_to_ascii(kMsg.bbo.bestBidOffer.bestOffer.price,
                                        sizeof(kMsg.bbo.bestBidOffer.bestOffer.price),
                                        decode_u32(BEST_OFFER_PRICE))
                u32_to_ascii(kMsg.bbo.bestBidOffer.bestOffer.size,
                                        sizeof(kMsg.bbo.bestBidOffer.bestOffer.size),
                                        decode_u32(BEST_OFFER_SIZE))

                break;
        }
}
```

National Market Systems

Common IP Multicast Distribution Network

Recipient Interface Specification

Prepared by:

Communications Engineering
Planning and Development

Document Number: ml101830001
Date: January 23, 2008
Revision: 1.30

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REVISION LOG

Document Number: ml10182000.doc

Title: National Market Systems Common IP Multicast Distribution Network Recipient Interface Specification

Version	Date	Rev by	Pages affected	Comments	Approval
1.2	3/13/97	ML		Initial Release	
1.3	11/24/97	ML	18	Typo, naming conformance issue	
1.4	12/15/1998	RL	All	Remove references to Bisync and make document present tense with respect to the NMS network; Remove appendix on required bandwidth	
1.5	12/03/99	MC	1	Added references for retransmission and playback data	
1.5	12/03/99	MC	19	Added Retransmissions & Playback IP Group Assignments	
1.9	3/23/00	RL	All	Clean up and Reorganize document. Removed section on logical lines because it served no purpose Added more information on multicast protocols Remove references to Frame Relay support New IP source addresses for RAPs and MPR boxes added as an appendix	
1.10	6/16/00	RL	Appendix C	Added new RAPS IPs for 2 new hosts: RAPSOPRA3 and RAPSOPRA4	
1.11	10/5/00	RL	All (major)	Add time beacon specifications; add new CTS and CQS group numbers	
1.12	10/18/00	RL	All (minor)	Incorporate review comments, fix page numbers	
1.13	7/11/01	RL	Appendix C Appendix C.2	Added Appendix C.2. Added text to Appendix C.	
1.14	11/15/01	RL	Entire document	Updates to reflect interface types available on a per service basis. T3 connectivity no longer	

Version	Date	Rev by	Pages affected	Comments	Approval
				available to new connections or upgrades.	
1.15	12/04/01	RL	Appendices C and C.2	New OPRA addresses are in production and therefore deleted Appendix C. Changed name of Appendix C.2 to C.	
1.16	08/28/02	RL, CE	All	Removed Legacy Options	
1.17 1.18				Internal draft update, not distributed	
1.19	12/17/02	RL, CE		Include BBO info	
1.20	1/03/03	RL		Correct Typo in Appendix A	
1.21	3/06/03	RL, CE		Updated IP addresses for Multicast playback and retransmissions.	
1.22	8/19/03	RL, CE		Removed non-BBO lines.	
1.23	1/12/04	RL, CE		Transitioned to SFTI interconnection. Deleted Appendix B, renamed appendix C as B, and Appendix D as C.	
1.24	1/20/05	LG	Appendix B; Throughout Document	Update of all source addresses. Removed reference to Site A and Site C. Replaced with Group A and Group B.	
1.25	2/15/05	LG	Appendix B	Additional source addresses added; source addresses identified by A & B Streams.	
1.26	11/02/05	MCP	Pages 1,3,4,6,7, 13 & 14 Appendix A & B	Page: 1, 4: Revised OPRA lines 1-9 to 'FCO 1' and OPRA 1-24 Page 3,4,6 & 7: Revised multicast totals Page 7, 13, &16: Added new address ranges Appendix A: Added new OPRA MCL addresses. Appendix B: Added two new source addresses.	
1.27	10/10/06	MCP	Appendix B (Page 17)	Page 17 – Added new CTS/CQS source addresses - Deleted OPRA 8 Line network Addresses	
1.28	12/13/06	MCP	Appedix B	Removed duplicate source ip's from CTS/CQS Production A & B stream as well as updated Time Beacon A & B stream	

Version	Date	Rev by	Pages affected	Comments	Approval
1.29	2/27/07	MCP	4.2 & Appendix A	Added OPRA FAST Multicast Addresses	
1.30	1/23/08	LG	4.2 & Appendix A	Added OPRA FAST for Symbology Multicast Addresses (Reused ASCII)	

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1 Overview

This document provides the interface specifications for customers connecting to the National Market Systems (NMS) distribution network. This includes recipients of the Consolidated Tape System (CTS), Consolidated Quote System (CQS), and the Options Price Reporting Authority (OPRA) real-time production data. Recipients should also use this specification for information related to receiving NMS real-time data retransmission, NMS after-hours playback data, and Time Beacon messages. The NMS distribution network disseminates all market data and Time Beacon information in the form of multicast addressed IP datagrams.

With respect to physical network connectivity, all data distributed by the NMS systems requires recipients to connect via the Secure Financial Transaction Infrastructure (SFTI). Recipients may connect directly to the physical edge of SFTI, or receive data via a third party value added service provider. For those choosing to connect directly to SFTI, a separate SFTI interface specification, "SFTI Network Interface Specification for directly connected Customers" should be referenced. For more information on the SFTI network and the services available via SFTI, please visit the SFTI website at http://sfti.siac.com, contact a SFTI Customer Support representative at SFTI@SIAC.com, or call 1-866-USE SIAC.

1.1 Data Available via the NMS Network

Throughout the remainder of this document there is reference to redundant data streams such that each NMS message is duplicated and available via two separate UDP-based IP Multicast groups, one from Group A and one from Group B. Group A and B refer to SIAC's data centers. Prior to the installation of SFTI, there were just two geographic points to which users could connect to the NMS network such that users would receive one set of multicast groups from each point, i.e. distribution choices were hardwired to restrict by originating site.

However, with the advent of the SFTI network, there are now several points to which to connect and receive NMS data via SFTI. As a result, now that there are more than two access points for receiving NMS data, directly connected recipients can coordinate with SIAC and choose which multicast groups they wish to receive via each of the SFTI connectivity points.

NMS Real-Time Production Data

Two copies of each NMS real-time production message are available from SIAC's operational sites, Group A and Group B. These redundant copies are delivered via two distinct multicast data streams. For each unique NMS line (CTS 1-4, CQS 1-5, FCO 1 and OPRA 1-24) there are two redundant multicast data streams. SIAC refers to these streams as the 'A' and 'B' streams. The 'A' stream is available from Group A and the 'B' stream from Group B. See Appendix A for the table of multicast group mappings.

NMS Real-Time Data Retransmission Data

The retransmission data streams are available via both sites, but are not delivered via redundant data streams. The recipient may choose to receive the retransmission data from either or both sites. See Appendix A for the table of multicast group mappings.

NMS After-Hours Playback Data

Playback data is available in two 'flavors':

- There is a set of Multicast data feeds dedicated for after-hours playback test data. This playback data is made available via a single set of multicast data streams and can be obtained from either site.
  See Appendix A for the table of multicast group mappings.

- In addition to the playback test data groups, SIAC will continue to provide dual-sited redundant after-hours playback via the production system expressly for the purposes of redundancy testing.

NMS Network Time Beacon

Each application that sources multicast data within the NMS network generates a single Time Beacon packet once a minute. Some of these applications are located at each site. Each site will issue Time Beacon packets to the same multicast group.

See Appendix A for the table of multicast group mappings.

Recipients may subscribe to these packets and use the enclosed time stamp for several functions including:

- Verifying the ability to subscribe to and receive multicast data sourced within the NMS network. The Time Beacon is available 24 hours a day, 7 days a week, except during occasional scheduled off-hours maintenance periods. These time packets therefore can serve as a "heartbeat" message for indicating that the multicast routing protocols are functioning and that the systems are available.

- Verifying the ability to receive multicast data from ten NMS multicast source systems.

- Synchronize to a time source accurate to within 1 second of the Global Positioning System (GPS).

The GPS is a U.S. Department of Defense developed, worldwide, satellite-based radio-navigation system. This system provides time transfer to Coordinated Universal Time (UTC) and is distributed to the NMS systems via redundant Network Time Protocol (NTP) servers. The NTP servers are connected directly to GPS based time clocks located at SIAC. These clocks receive GPS data via directly connected satellite dishes.

Bandwidth Requirements

Bandwidth requirements change with time and recipients are encouraged to contact the SFTI Help Desk and/or NMS planning representatives regarding bandwidth requirements of each of the NMS services. For more information on the SFTI network and the services available via SFTI, please visit the SFTI website at http://sfti.siac.com, contact a SFTI Customer Support representative at SFTI@SIAC.com, or call 1-866-USE SIAC.

Data recipients should connect to NMS via SFTI, via at least two access points in order to make full use of the resiliency of SFTI and the redundant data feeds available for each service. Recipients not connecting directly should consult with their value added service provider regarding connectivity options.

Additional considerations for all recipients:
In total, the ten Time Beacon sources contribute a relatively insignificant data rate requirement; (approximately 720Bytes/minute or <100bits/sec).

Message Formats

For details of the message formats utilized by the CTS, CQS, and OPRA systems, please reference the following:

- CTS: CTS, Consolidated Tape System, Output Multicast Line, Interface Specification (www.nysedata.com)
- CQS: CQS, Consolidated Quote System, Output Multicast Line, Interface Specification (www.nysedata.com)
- Options Price Reporting Authority - Data Recipient Interface Specification (www.opradata.com)

Please note that the message format of retransmission and playback data is also governed by the documents listed above.

The remainder of this specification addresses the communications interfacing requirements for all data types and also includes the message formats for the Time Beacon in Appendix C.

1.2 Multicast Primer

In a nutshell, Multicast is a form of subscription based IP broadcasting. In a traditional broadcasting environment, data is sent out on all links to all LANs (or sub-networks). In contrast, IP Multicasting provides a method for selective delivery of the data via a subscription-based protocol known as the Internet Group Management Protocol (IGMP). The local end-stations (e.g. application hosts) are typically responsible for issuing IGMP requests that are processed by the host's local intermediate-stations (e.g. routers/switches). In response to these IGMP requests a multicast capable network need only deliver the multicast data to those portions of the network that lay in the path between the subscribing host and the original source of the data.

Subscriptions are based on the target multicast group id (which is synonymous with multicast address and multicast host group). The NMS distribution network currently utilizes 68 multicast group ids for the production data, 34 groups for the retransmission data, 34 groups for the after-hours playback data, and 2 groups for the Time Beacon messages.

Those unfamiliar with multicast technology are encouraged to reference RFC 1075 -The Protocol Independent Multicast-Sparse Mode (PIM-SM)), and RFC 2117 and RFC 2362 - Host Extensions for IP Multicasting (which includes the Internet Group Management Protocol (IGMP). Also of notable assistance is the text titled "TCP/IP Illustrated, Volume I" by Richard M. Stevens which provides several sections detailing multicast protocols and IGMP.

Recipients are strongly recommended to consult the SFTI interface specification, which provides additional information and considerations for receiving multicast services via SFTI.

2 NMS Data Types

The NMS network distributes data via the multicast addressing and delivery protocols. Each of the three systems (CTS, CQS, OPRA and OPRA FAST) has a unique set of multicast addresses assigned to each of its data "lines". In each case there are redundant data streams provided for daytime production delivery of each line. There are currently 34 different data lines in total for the three systems, which include CTS1-4, CQS1-5, FCO 1 and OPRA1-24. Therefore there are 68 unique multicast groups allocated for the redundant delivery of these 34 lines (34 * 2 = 68).

Each system line has a single retransmission multicast address assigned to it (34 in total). Entitled recipients have the option of subscribing to any retransmission line as needed.

There are 34 additional multicast group ids allocated for supporting after-hours playback of the NMS data. Note that after-hours playback can also utilize the 68 production multicast groups.

There are 2 additional multicast group ids used for distributing the Time Beacon messages.

In all cases, recipients will only be permitted to receive data to which they are entitled. Note that all recipients are able to receive the Time Beacon messages.

Appendix A provides tables listing of all multicast group ids. The tables also include a listing of the UDP destination port numbers assigned to each data stream. The NMS distribution system utilizes the UDP protocol at the IP transport layer. In order to provide the recipient community with the highest level of flexibility, the NMS systems have assigned a unique UDP destination port number to each multicast data stream. Note that the real-time redundant data streams use unique multicast addresses at the IP layer and unique UDP destination port numbers at the transport layer.

Recipient application software may make use of the UDP port mappings in order to multiplex between each of the datastreams. Typically, applications use a "socket" programming interface which provides the means for requesting data on a per UDP port basis. If a port is not specified the application host's operating system might pass all IP broadcast data (including all multicast data) to a single process if the application has not specifically requested data on a per port basis. Please consult your application host's programming and system documentation for information particular to your environment.

3 Application Considerations

This section defines the application data framing and some of the key aspects of the IP distribution environment.

3.1 Application Encapsulation

In the IP environment the NMS application messages are also encapsulated in blocks, which in turn are encapsulated in an Ethernet frame as given in Figure 1 IP Data Block Format.

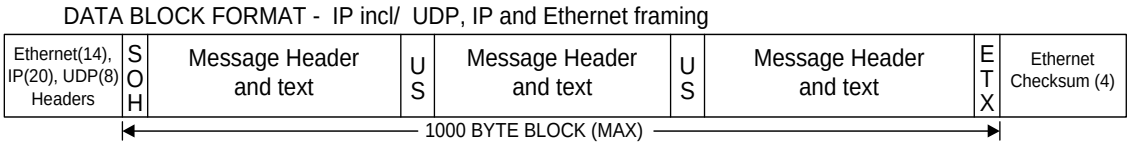
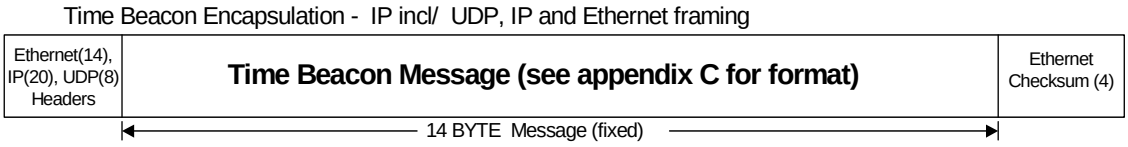


Figure 1 IP Data Block Format

There are actually several levels of encapsulation that occur within the Ethernet frame. The NMS data block, (which can be a maximum of 1000 bytes), is encapsulated within a UDP datagram, which in turn is encapsulated within an IP datagram which itself is encapsulated within an Ethernet frame. Each number shown in parentheses, e.g. IP (20), refers to the size of the particular header in bytes.

3.1.1 Time Beacon Message Encapsulation

The Time Beacon message encapsulation is illustrated below. Note that the message format for the Time Beacon is included in Appendix C of this document.



3.2 End to End Data Integrity

Integrity checking, on a per packet basis, is available via a checksum value in both the UDP header (Figure 2 UDP/IP Datagram Format) and the Ethernet frame check sequence.

In general, the Ethernet frame checksum validation is performed by the host's interface firmware and the IP checksum validation is performed within the TCP/IP stack and not by the application software.

Unlike TCP/IP based application services, the UDP/IP protocol has no "built-in" automatic retransmission functionality and therefore recipient host applications must examine the sequence numbers embedded within each NMS message on a per line basis in order to determine whether any data has been missed.

3.3 Line Concept

The term "LINE" refers to a specific logical data stream identified by the value pair formed by a unique IP multicast destination address and unique UDP destination port number.

Note that the following terms are all analogous to each other:

- multicast group
- multicast group id
- multicast host group
- multicast host group id
- multicast destination address

The NMS network currently utilizes 136 unique multicast group ids for the purposes of providing NMS data to the recipient community. Each multicast group id also has a UDP destination port number assigned to it, therefore each line of NMS data is uniquely identifiable by the value pair formed by its multicast group and UDP destination port number pair.

Appendix A provides the exact mappings of each line to its identifier pair. The list below summarizes those tables.

- 68 Production data streams for day-time dissemination (2 sets of 34 redundant data streams)
- 34 Production retransmission streams for day-time dissemination (1 set of data streams)
- 34 Playback test data streams for after-hours support (1 set of data streams)

The concept of "lines" does not apply to the Time Beacon. Each system in the NMS network that sources multicast also sources a single Time Beacon message once a minute. Currently there are ten such systems and these messages will be staggered to result in approximately one Time Beacon message every 6 seconds. Five of these messages will be destined to one multicast group id, and five to one other.

4 Network Layer Connectivity

4.1 IP Multicasting – Primer Part II

The Internet Protocol suite, referred to as IP, defines a data encapsulation method that allows data to traverse multiple networks through intermediate network devices known as routers.

4.1.1 Unicast IP Routing

Typically, IP packets are issued from a source host with a single destination host as the target. This type of addressing is usually referred to as "unicast addressing". Unicast addressed packets are routed by intermediate-stations (i.e. routers) based on the destination network number associated with the destination IP address listed in the IP header portion of the packet. The intermediate-station compares the destination with its local IP routing table and forwards the packet to the appropriate next hop device (router) or to a local host if the router is local to the destination network.

4.1.2 Multicast IP Routing

In contrast, IP multicasting uses a special class of IP addresses that are used to represent a "host group". These addresses are referred to as Class D and fall in the range of 224.0.0.0 to 239.255.255.255.

The host group id is both an actual number and a concept. It can refer to the actual Class D IP address that is placed in the IP header's destination address field of the IP multicast packet. It also refers to the

protocol's concept of a host group. A host group represents all end-stations, (or hosts), that have specifically subscribed to the multicast host group id. The subscription functionality and the multicast routing protocols provide the underpinnings that enable a single multicast addressed packet to be delivered to all LANs connected to at least one host that has subscribed to the host group in question.

Each multicast packet sourced by an originating host is forwarded by the local intermediate-stations supporting the multicast routing protocols. Intermediate-stations replicate and forward the multicast packets out each of its interfaces that meet one of the following two criteria.

1. The interface is directly connected to a LAN where a member of the host group is attached
2. The interface connects to, either directly or via a shared LAN, to any neighboring routers that lies in the path between a subscribing host and the host that originally sourced the multicast packet

In the NMS network, there may be as many as 68 unique host groups available at any given time during daytime production. This includes the 68 real-time production lines, 34 retransmission lines, and the 2 Time Beacon groups.

4.2 Multicast Addressing

Multicast addresses are known as Class D IP addresses and range from 224.0.0.0 to 239.255.255.255 (using standard IP address notation). The addresses in the range of 224.0.0.0-224.0.0.255 are reserved for local multicast and are non-routable.

The NMS network uses the following ranges, which are presented in further detail in Appendix A. Note that not all these addresses are in use.

224.0.2.192 - 224.0.2.255
224.0.5.128 - 224.0.5.159
224.0.5.176 - 224.0.5.191
224.0.5.240 - 224.0.5.255
233.43.202.1 – 233.43.202.24
233.43.202.33 – 233.43.202.56
233.43.202.65 – 233.43.202.88
233.43.202.97 – 233.43.202.120
233.43.202.128 – 233.43.202.152
233.43.202.160 – 233.43.202.184
233.43.202.192 – 233.43.202.216
233.43.202.224 – 233.43.202.248

4.3 UDP/IP Framing

The application data is encapsulated in an UDP/IP frame as shown in Figure 2 UDP/IP Datagram Format. The IP datagram includes the IP and UDP headers plus the application data. The datagram fields can be read left to right starting at the top and working your way down through the datagram. The size of each field (excluding the UDP data field) is represented in bits across the top and bytes going down. Bits are transmitted across the link starting with bit 0 ,1 ,2 and so forth. This is called the "big endian" representation where the most significant bits are transmitted first.

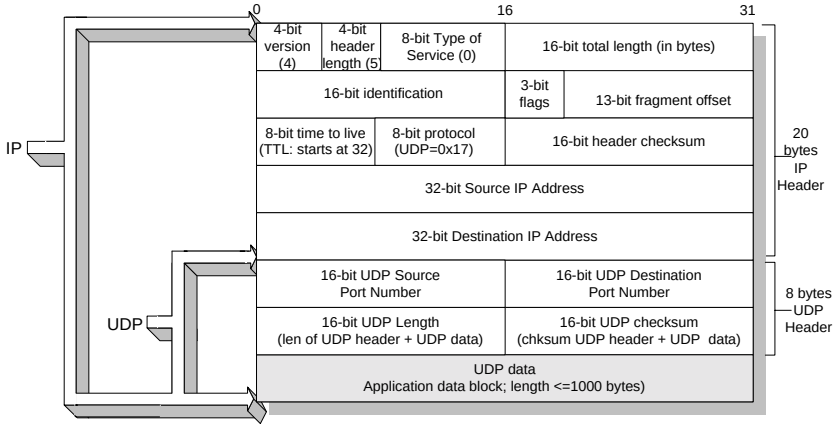


Figure 2 UDP/IP Datagram Format

4.3.1 IP Header Field Descriptions

- **Version** - This is a 4 bit field which defines the current version of the IP protocol. It is currently set to 4.
- **Header Length** - This 4 bit field contains the number of 32 bit words in the IP header portion of the datagram. For all multicast packets being generated by this network the IP header will be 20 bytes long, which means this field will contain the value 5.
- **Type of Service** - The first 3 bits are the precedence sub field and are ignored by most network equipment. The next four bits are flags that define minimize delay, maximize throughput, maximize reliability, and minimize monetary cost respectfully. They are set to zero (0) for this application. The last bit is always set to zero. Based on this description this field will always have the value of zero (0) for all multicast packets.
- **Total Length Field** - This 16 bit field contains the length in bytes of the entire IP datagram. This includes the IP and UDP header plus the application data (UDP data). Since the maximum size of the application data is 1000 bytes, the maximum value for this field is 1028.
- **Identification Field** - This 16 bit field contains a value that is incremented by one for each packet sent by the source system . It only has relevance on the receiving system when packets are either fragmented and/or TCP is used as the transport protocol. IP multicast packets use UDP and will not be fragmented by the multicast distribution network.
- **Flags and Fragment Offset** - The combined 16 bit field is only used when an IP datagram is fragmented. The multicast distribution network will not be fragmenting the data packets.

- **Time to Live (TTL)** - This 8 bit field contains a value that determines the number of routers that this datagram can pass through. Each router that forwards this datagram will decrement this value by one; when it reaches zero the next router throws it away. It is initially set to 32 by the multicast source systems.
- **Protocol** - This 8 bit field contains a value representing the next level encapsulated protocol. In this case it is UDP, which has a value of 0x17, which is 23 decimal.
- **Header Checksum** - This 16 bit field contains a checksum made up of the IP header fields only. The calculation is based on the ones complement sum of the header broken into 16 bit words.
- **IP Source Address** - This 32 bit field contains the IP address of the multicast datagram source system.
- **IP Destination Address** - This 32 bit field contains the IP Multicast Group address designated for this "line" (*see section 3.3)* of data packets. For the mapping of IP multicast group addresses to data lines please consult Appendix A of this document.

4.3.2 UDP Header Field Descriptions

- **UDP Source Port Number** - This 16 bit field identifies the sending process within the multicast source system. It is set by the source system.
- **UDP Destination Port Number** - This 16 bit field identifies the UDP process that should receive this datagram in the recipients receiving system. It will be uniquely set by the multicast source system based on the "line" of data being encapsulated within the packet. For the mapping of UDP port numbers to data lines please consult Appendix A.
- **UDP Length** - This 16 bit field contains the length in bytes of the UDP header plus the application data (UDP data). Its maximum value is 1008.
- **UDP Checksum** - This 16 bit field contains a checksum made up of the UDP header plus the application data (UDP data). In addition it also includes a UDP "pseudo" header, which is made up of selected fields from the IP header (IP Source Address, IP Destination Address, Protocol and UDP Length). The calculation is based on the one's complement sum of the datagram broken into 16 bit words.

4.4 Multicast Address Use

The multicast group addresses used by SIAC for the dissemination of application data on this network have been registered with the Internet Assigned Numbering Authority (IANA). No recipient will be allowed to connect to the NMS distribution network if it is found that they are using any of these addresses for their own use.

For a list of these addresses please view http://www.iana.org/assignments/multicast-addresses **.**

4.4.1 IGMP

Internet Group Management Protocol (IGMP) is a protocol that end systems use to communicate with multicast compliant routers and is defined in RFC 1112. Recipient host systems that wish to subscribe to multicast groups must be fully compliant with this RFC.

4.4.2 Subscription Control

In order to receive the multicast packets, applications running on recipient end-stations issue IGMP subscription (or "join group") packets on their locally attached LANs. The local router (which must also be

multicast compliant) adds the multicast group to its registration table and begins to forward all packets destined to that group onto the LAN.

Recipients have the option of subscribing to any combination of multicast groups but as mentioned previously, SIAC will allow recipients to receive only those groups to which they have been entitled.

4.4.3 How Multicast Delivery is Implemented via SFTI

As explained in detail by the SFTI interface specification, the SFTI architecture includes providing access to the NMS services via the use of the 802.1Q protocol, which provides for the definition of logically separate virtual LANs, or VLANs. In SFTI there is a single VLAN configured for transporting the aggregate multicast traffic.

In order to facilitate the delivery of Multicast data, SFTI must employ the use of a multicast routing protocol. SFTI uses Protocol Independent Multicast (PIM) to accomplish this task.

As the SFTI specification describes, customers will have two methods for receiving multicast data from SFTI. That specification refers specifically to the configuration of the customer router port connected to SFTI. Customers can implement any network solution they wish beyond that interface. Beyond the SFTI demarcation point, SIAC places no restrictions on the manner in which a customer designs its networks to support multicast reception. This is true from both from a protocol and physical topology perspectives. Customers are responsible for implementing a working design that best suits their environments.

The following applies to customers connecting directly to SFTI, and though it may also apply to customers connecting via a third party value added service provider, customers must consult with that entity with respect to specifications for receiving multicast data because their service offerings may deviate from the following.

Method I: For Customer routers supporting PIM Sparse-Dense Mode

- Configure PIM Sparse-Dense Mode on the router that connects to SFTI.
- Use “auto-RP” to learn the SFTI RP addresses and multicast group mappings.
- Configure RIP2 in listen mode to learn the routing information for the multicast source networks and the routes to the PIM RPs.

Method II: For Customer routers unable to support PIM Sparse-Dense Mode

- Customers can use PIM Sparse or Dense mode
- SIAC, upon the request of the customer, will define IGMP static joins on the SFTI edge router connected to the customer. This will result in statically forward all entitled multicast groups to the customer edge router;
- Customer routers learn multicast source routes by listening to RIP2.
- Customers can implement whatever solutions they require on their edge router in order to correctly forward the multicast data into their networks. Typically, router vendors provide the option of importing the multicast data at the edge into their routing trees using the routing information learned via RIP2. Some customers might implement "multicast proxies", which presumably would translate the header information of the multicast datagrams into unicast UDP destined to one or more end-stations within the customer network. As is the case with everything described within this specification, customers must check with their chosen vendor for protocol support and recommended solutions.

4.4.3.1 Multicast Entitlement Control

Multicast entitlement will be enforced at the SFTI Edge Routers by application of PIM join filters on the logical interface (and VLAN) connected to each individual Customer. The use of filters allows for the control of transmission/reception of multicast groups. Different customers will have different definitions based on their service entitlements. For those customers where SIAC has defined static IGMP joins on the SFTI edge, SIAC will by definition use the static joins to control entitlement.

Ingress traffic filters on the Edge Router logical interfaces (VLAN) supporting multicast will silently discard any incoming packets except those used by the multicast (PIM Sparse-dense mode) or unicast routing protocols. These filters will also be used to protect SFTI from any customer-originated multicast traffic.

SIAC can reconfigure these filters dynamically to allow for timely re-provisioning of entitlements.

4.4.4 Multicast Data Retransmission

Some of the multicast services offered via the various SIAC Financial Services Networks (FSNs) provide an inband retransmission request mechanism via unicast UDP based applications. These types of transmissions will not be supported via the same logical interfaces on which the Customer is receiving the multicast data. Unicast based retransmission requests will be routed handled by the unicast VLAN logical interface for the particular FSN involved. For example, CAP retransmission requests for multicast services will be handled by the CAP unicast VLAN, not by the multicast VLAN. This traffic will be transported through SFTI in the same manner as other unicast traffic to the particular destination FSN.

Inband retransmissions are not currently offered via the NMS Distribution Network, but plans are in place to provide this service in the future.

4.4.5 Availability of Multicast Services

Customers will receive a list of the multicast source networks, multicast destination group addresses, and all other relevant information from SFTI Customer Service once the customer becomes a licensed subscriber.

The multicast group addresses used by SIAC for the dissemination of application data on this network have been registered with the Internet Assigned Numbering Authority (IANA).

4.4.6 Multicast Transport Protocol

SFTI IP multicast datagrams will use the connectionless UDP protocol at the transport layer.

4.5 Logical Groups Mappings Versus Physical Access Points

In order to provide a resilient/redundant distribution environment for the recipient, the recipient is provided with the ability to connect to SFTI at several geographically diverse access centers. As of January 2004, there were eight operation access centers, including four in the New York Metro area, two in Chicago, IL, and two in the Boston, MA metro area.

As mentioned previously, each NMS message is provided via redundant data streams for the purpose of allowing recipients to leverage the redundancy of SIAC's data centers. Each multicast group is available via any and all of the SFTI access centers.

4.6 Data Entitlement

For a recipient host system to receive a particular data stream it must subscribe to the data stream's corresponding multicast group id via IGMP. Appendix A lists all multicast group id assignments.

In order to restrict a recipient from subscribing to data streams that they are not entitled to, outbound packet filters are employed on SIAC's distribution routers interfaces connecting to the recipients. These filters block data from being sent to non-entitled recipients on a per service basis (CTS, CQS, and OPRA).

4.7 IP Addressing Considerations

Please consult the SFTI interface specification for details.

4.8 Recipient Security

SIAC protects its network and hosts using several methods. Traffic filters and routing policies prevent sharing of information and data between entities connected to the SFTI network. Additional measures are in place as well, however these security measures maintain the integrity of SIAC's distribution environment by protecting SIAC's network and hosts from intentional or accidental access from within a recipient network.

These measures are in no way intended to provide the same level of security to the recipients themselves. If a recipient believes that additional security is required to protect their network they are encouraged to take action to implement additional security measures.

For the purposes of aiding in the implementation of security measures (e.g. traffic filters), the source IP addresses associated with the NMS systems have been provided in Appendix B.

5 Physical, Media Layer, and Network Connectivity

Please consult the SFTI interface specification.

6 Appendix A - NMS IP Multicast Addresses

This appendix contains the mapping of IP multicast group ID's (addresses) to the currently available data lines. To receive a particular data stream the recipient host system would typically subscribe to that particular multicast group ID. Two multicast group ID's are available for each real-time production data line. The data originating from Group A is generally referred to as the 'A' streams and the data from Group B as the 'B' streams. Also provided in the table are the UDP destination ports associated with each logical line.

The NMS data messages are encapsulated in an identical manner in both streams. For example, a datagram issued Group A on OPRA Line 2 destined to multicast group 233.43.202.2 will have a corresponding datagram (containing the identical UDP data payload, i.e. same NMS messages and same sequence number range) sourced from Group B destined to multicast group 233.43.202.34

Multicast Address Ranges:

NMS Production IP Multicast Feeds Group A:
224.0.2.192-224.0.2.207
224.0.2.224-224.0.2.239
233.43.202.1 – 233.43.202.24
233.43.202.128 – 233.43.202.152 (OPRA FAST)
233.43.202.1 – 233.43.202.24 (FAST for Symbology/Reused ASCii)

NMS Production IP Multicast Feeds Group B:
224.0.2.208 - 224.0.2.223
224.0.2.240 - 224.0.2.255
233.43.202.33 – 233.43.202.56
233.43.202.160 - 233.43.202.184 (OPRA FAST)
233.43.202.33 – 233.43.202.56 (FAST for Symbology/Reused ASCii)

The full table of address mappings is shown on the next page.

Production, Real-Time IP Multicast Feeds, Dual Sets

Group A Originated Data Lines	Multicast Group ID	Destination UDP Port Number	Group B Originated Data Lines	Multicast Group ID	Destination UDP Port Number
FCO 1 (OPRA)	224.0.2.192	53540	FCO 1 (OPRA)	224.0.2.208	53541
SPARE	224.0.2.193	53542	*SPARE*	224.0.2.209	53543
SPARE	224.0.2.194	53544	*SPARE*	224.0.2.210	53545
SPARE	224.0.2.195	53546	*SPARE*	224.0.2.211	53547
SPARE	224.0.2.196	53548	*SPARE*	224.0.2.212	53549
SPARE	224.0.2.197	53550	*SPARE*	224.0.2.213	53551
SPARE	224.0.2.198	53552	*SPARE*	224.0.2.214	53553
SPARE	224.0.2.199	53554	*SPARE*	224.0.2.215	53555
SPARE	224.0.2.200	53556	*SPARE*	224.0.2.216	53557
TIME BEACON	224.0.2.201	53558	TIME BEACON	224.0.2.217	53559
CQS 1	224.0.2.202	53560	CQS 1	224.0.2.218	53561
CQS 2	224.0.2.203	53562	CQS 2	224.0.2.219	53563
CQS 3	224.0.2.204	53564	CQS 3	224.0.2.220	53565
CQS 4	224.0.2.205	53566	CQS 4	224.0.2.221	53567
CTS 1	224.0.2.206	53568	CTS 1	224.0.2.222	53569
CTS 2	224.0.2.207	53570	CTS 2	224.0.2.223	53571
CTS 3	224.0.2.224	53572	CTS 3	224.0.2.240	53573
CTS 4	224.0.2.225	53574	CTS 4	224.0.2.241	53575
CQS 5	224.0.2.226	53576	CQS 5	224.0.2.242	53577
SPARE	224.0.2.235	53594	*SPARE*	224.0.2.251	53595
SPARE	224.0.2.235	53594	*SPARE*	224.0.2.251	53595
SPARE	224.0.2.236	53596	*SPARE*	224.0.2.252	53597
SPARE	224.0.2.237	53598	*SPARE*	224.0.2.253	53599
SPARE	224.0.2.238	53600	*SPARE*	224.0.2.254	53601
SPARE	224.0.2.239	53602	*SPARE*	224.0.2.255	53603
OPRA 1	233.43.202.1	11101	OPRA 1	233.43.202.33	12101
OPRA 2	233.43.202.2	11102	OPRA 2	233.43.202.34	12102
OPRA 3	233.43.202.3	11103	OPRA 3	233.43.202.35	12103
OPRA 4	233.43.202.4	11104	OPRA 4	233.43.202.36	12104
OPRA 5	233.43.202.5	11105	OPRA 5	233.43.202.37	12105
OPRA 6	233.43.202.6	11106	OPRA 6	233.43.202.38	12106
OPRA 7	233.43.202.7	11107	OPRA 7	233.43.202.39	12107
OPRA 8	233.43.202.8	11108	OPRA 8	233.43.202.40	12108
OPRA 9	233.43.202.9	11109	OPRA 9	233.43.202.41	12109
OPRA 10	233.43.202.10	11110	OPRA 10	233.43.202.42	12110
OPRA 11	233.43.202.11	11111	OPRA 11	233.43.202.43	12111
OPRA 12	233.43.202.12	11112	OPRA 12	233.43.202.44	12112
OPRA 13	233.43.202.13	11113	OPRA 13	233.43.202.45	12113
OPRA 14	233.43.202.14	11114	OPRA 14	233.43.202.46	12114
OPRA 15	233.43.202.15	11115	OPRA 15	233.43.202.47	12115
OPRA 16	233.43.202.16	11116	OPRA 16	233.43.202.48	12116
OPRA 17	233.43.202.17	11117	OPRA 17	233.43.202.49	12117
OPRA 18	233.43.202.18	11118	OPRA 18	233.43.202.50	12118
OPRA 19	233.43.202.19	11119	OPRA 19	233.43.202.51	12119
OPRA 20	233.43.202.20	11120	OPRA 20	233.43.202.52	12120
OPRA 21	233.43.202.21	11121	OPRA 21	233.43.202.53	12121
OPRA 22	233.43.202.22	11122	OPRA 22	233.43.202.54	12122
OPRA 23	233.43.202.23	11123	OPRA 23	233.43.202.55	12123
OPRA 24	233.43.202.24	11124	OPRA 24	233.43.202.56	12124

OPRA FAST PRODUCTION, REAL TIME IP Multicast Feeds, Dual Sets

Group A Originated Data Lines	Multicast Group ID	Destination UDP Port Number	Group B Originated Data Lines	Multicast Group ID	Destination UDP Port Number
FCO 1 (FAST)	233.43.202.128	16100	FCO 1 (FAST)	233.43.202.160	17100
OPRA 1	233.43.202.129	16101	OPRA 1	233.43.202.161	17101
OPRA 2	233.43.202.130	16102	OPRA 2	233.43.202.162	17102
OPRA 3	233.43.202.131	16103	OPRA 3	233.43.202.163	17103
OPRA 4	233.43.202.132	16104	OPRA 4	233.43.202.164	17104
OPRA 5	233.43.202.133	16105	OPRA 5	233.43.202.165	17105
OPRA 6	233.43.202.134	16106	OPRA 6	233.43.202.166	17106
OPRA 7	233.43.202.135	16107	OPRA 7	233.43.202.167	17107
OPRA 8	233.43.202.136	16108	OPRA 8	233.43.202.168	17108
OPRA 9	233.43.202.137	16109	OPRA 9	233.43.202.169	17109
OPRA 10	233.43.202.138	16110	OPRA 10	233.43.202.170	17110
OPRA 11	233.43.202.139	16111	OPRA 11	233.43.202.171	17111
OPRA 12	233.43.202.140	16112	OPRA 12	233.43.202.172	17112
OPRA 13	233.43.202.141	16113	OPRA 13	233.43.202.173	17113
OPRA 14	233.43.202.142	16114	OPRA 14	233.43.202.174	17114
OPRA 15	233.43.202.143	16115	OPRA 15	233.43.202.175	17115
OPRA 16	233.43.202.144	16116	OPRA 16	233.43.202.176	17116
OPRA 17	233.43.202.145	16117	OPRA 17	233.43.202.177	17117
OPRA 18	233.43.202.146	16118	OPRA 18	233.43.202.178	17118
OPRA 19	233.43.202.147	16119	OPRA 19	233.43.202.179	17119
OPRA 20	233.43.202.148	16120	OPRA 20	233.43.202.180	17120
OPRA 21	233.43.202.149	16121	OPRA 21	233.43.202.181	17121
OPRA 22	233.43.202.150	16122	OPRA 22	233.43.202.182	17122
OPRA 23	233.43.202.151	16123	OPRA 23	233.43.202.183	17123
OPRA 24	233.43.202.152	16124	OPRA 24	233.43.202.184	17124

FAST for Symbology Production, Real-Time IP Multicast Feeds, Dual Sets (Reused ASCII Multicast Feeds)

Group A Originated Data Lines	Multicast Group ID	Destination UDP Port Number	Group B Originated Data Lines	Multicast Group ID	Destination UDP Port Number
OPRA 1	233.43.202.1	11101	OPRA 1	233.43.202.33	12101
OPRA 2	233.43.202.2	11102	OPRA 2	233.43.202.34	12102
OPRA 3	233.43.202.3	11103	OPRA 3	233.43.202.35	12103
OPRA 4	233.43.202.4	11104	OPRA 4	233.43.202.36	12104
OPRA 5	233.43.202.5	11105	OPRA 5	233.43.202.37	12105
OPRA 6	233.43.202.6	11106	OPRA 6	233.43.202.38	12106
OPRA 7	233.43.202.7	11107	OPRA 7	233.43.202.39	12107
OPRA 8	233.43.202.8	11108	OPRA 8	233.43.202.40	12108
OPRA 9	233.43.202.9	11109	OPRA 9	233.43.202.41	12109
OPRA 10	233.43.202.10	11110	OPRA 10	233.43.202.42	12110
OPRA 11	233.43.202.11	11111	OPRA 11	233.43.202.43	12111
OPRA 12	233.43.202.12	11112	OPRA 12	233.43.202.44	12112
OPRA 13	233.43.202.13	11113	OPRA 13	233.43.202.45	12113
OPRA 14	233.43.202.14	11114	OPRA 14	233.43.202.46	12114
OPRA 15	233.43.202.15	11115	OPRA 15	233.43.202.47	12115
OPRA 16	233.43.202.16	11116	OPRA 16	233.43.202.48	12116
OPRA 17	233.43.202.17	11117	OPRA 17	233.43.202.49	12117
OPRA 18	233.43.202.18	11118	OPRA 18	233.43.202.50	12118
OPRA 19	233.43.202.19	11119	OPRA 19	233.43.202.51	12119
OPRA 20	233.43.202.20	11120	OPRA 20	233.43.202.52	12120
OPRA 21	233.43.202.21	11121	OPRA 21	233.43.202.53	12121
OPRA 22	233.43.202.22	11122	OPRA 22	233.43.202.54	12122
OPRA 23	233.43.202.23	11123	OPRA 23	233.43.202.55	12123
OPRA 24	233.43.202.24	11124	OPRA 24	233.43.202.56	12124

Retransmission and Playback Test Data, Single Sets

Unlike the production real-time feeds, the day-time production retransmission data and the after-hours playback test data are provided via a single stream only, i.e. redundant 'A' and 'B' streams are not available. Playback data is only available after-hours.

In addition to the playback test data groups as shown below, SIAC will continue to provide after-hours playback via the production system expressly for the purposes of redundancy testing. The multicast groups will be identical to those listed above for the real-time production system.

Recipients wishing to receive retransmission and/or playback feeds must subscribe to the multicast feeds based on the addressing information shown in the following table.

Multicast Address Ranges:

NMS Retransmission Multicast Group ID Ranges:

224.0.5.128 – 224.0.5.136
224.0.5.138 – 224.0.5.143
224.0.5.176 – 224.0.5.191
233.43.202.65 – 233.43.202.88
233.43.202.192-233.43.202.216 (OPRA FAST)
233.43.202.65 – 233.43.202.88 (FAST for Symbology/Reused ASCii)

NMS Playback Group ID Ranges:

224.0.5.144 – 224.0.5.155
224.0.5.154 – 224.0.5.159
224.0.5.240 – 224.0.5.255
233.43.202.97 – 233.43.202.120
233.43.202.224 - 233.43.202.248 (OPRA FAST)
233.43.202.97 – 233.43.202.120 (FAST for Symbology/Reused ASCii)

The full table of address mappings is shown on the next page.

Retransmission and Playback Test Data, Single Sets

Retransmission Group Assignments			Playback Test Group Assignments		
NMS Line Name available from both Group A and Group B	Multicast Group ID	Destination UDP Port Number	NMS Line Name available from both Group A and Group B	Multicast Group ID	Destination UDP Port Number
FCO 1 (OPRA)	224.0.5.128	54540	FCO 1 (OPRA)	224.0.5.144	55540
SPARE	224.0.5.129	54541	*SPARE*	224.0.5.145	55541
SPARE	224.0.5.130	54542	*SPARE*	224.0.5.146	55542
SPARE	224.0.5.131	54543	*SPARE*	224.0.5.147	55543
SPARE	224.0.5.132	54544	*SPARE*	224.0.5.148	55544
SPARE	224.0.5.133	54545	*SPARE*	224.0.5.149	55545
SPARE	224.0.5.134	54546	*SPARE*	224.0.5.150	55546
SPARE	224.0.5.135	54547	*SPARE*	224.0.5.151	55547
SPARE	224.0.5.136	54548	*SPARE*	224.0.5.152	55548
OPEN	224.0.5.137	54549	OPEN	224.0.5.153	55549
CQS IP line 1	224.0.5.138	54550	CQS IP line 1	224.0.5.154	55550
CQS IP line 2	224.0.5.139	54551	CQS IP line 2	224.0.5.155	55551
CQS IP line 3	224.0.5.140	54552	CQS IP line 3	224.0.5.156	55552
CQS IP line 4	224.0.5.141	54553	CQS IP line 4	224.0.5.157	55553
CTS IP line 1	224.0.5.142	54554	CTS IP line 1	224.0.5.158	55554
CTS IP line 2	224.0.5.143	54555	CTS IP line 2	224.0.5.159	55555
CTS IP line 3	224.0.5.176	54556	CTS IP line 3	224.0.5.240	55556
CTS IP line 4	224.0.5.177	54557	CTS IP line 4	224.0.5.241	55557
CQS IP line 5	224.0.5.178	54558	CQS IP line 5	224.0.5.242	55558
SPARE	224.0.5.187	54567	*SPARE*	224.0.5.251	55567
SPARE	224.0.5.188	54568	*SPARE*	224.0.5.252	55568
SPARE	224.0.5.189	54569	*SPARE*	224.0.5.253	55569
SPARE	224.0.5.190	54570	*SPARE*	224.0.5.254	55570
SPARE	224.0.5.191	54571	*SPARE*	224.0.5.255	55571
OPRA IP line 1	233.43.202.65	13151	OPRA IP line 1	233.43.202.97	14151
OPRA IP line 2	233.43.202.66	13152	OPRA IP line 2	233.43.202.98	14152
OPRA IP line 3	233.43.202.67	13153	OPRA IP line 3	233.43.202.99	14153
OPRA IP line 4	233.43.202.68	13154	OPRA IP line 4	233.43.202.100	14154
OPRA IP line 5	233.43.202.69	13155	OPRA IP line 5	233.43.202.101	14155
OPRA IP line 6	233.43.202.70	13156	OPRA IP line 6	233.43.202.102	14156
OPRA IP line 7	233.43.202.71	13157	OPRA IP line 7	233.43.202.103	14157
OPRA IP line 8	233.43.202.72	13158	OPRA IP line 8	233.43.202.104	14158
OPRA IP line 9	233.43.202.73	13159	OPRA IP line 9	233.43.202.105	14159
OPRA IP line 10	233.43.202.74	13160	OPRA IP line 10	233.43.202.106	14160
OPRA IP line 11	233.43.202.75	13161	OPRA IP line 11	233.43.202.107	14161
OPRA IP line 12	233.43.202.76	13162	OPRA IP line 12	233.43.202.108	14162
OPRA IP line 13	233.43.202.77	13163	OPRA IP line 13	233.43.202.109	14163
OPRA IP line 14	233.43.202.78	13164	OPRA IP line 14	233.43.202.110	14164
OPRA IP line 15	233.43.202.79	13165	OPRA IP line 15	233.43.202.111	14165
OPRA IP line 16	233.43.202.80	13166	OPRA IP line 16	233.43.202.112	14166
OPRA IP line 17	233.43.202.81	13167	OPRA IP line 17	233.43.202.113	14167
OPRA IP line 18	233.43.202.82	13168	OPRA IP line 18	233.43.202.114	14168
OPRA IP line 19	233.43.202.83	13169	OPRA IP line 19	233.43.202.115	14169
OPRA IP line 20	233.43.202.84	13170	OPRA IP line 20	233.43.202.116	14170
OPRA IP line 21	233.43.202.85	13171	OPRA IP line 21	233.43.202.117	14171
OPRA IP line 22	233.43.202.86	13172	OPRA IP line 22	233.43.202.118	14172
OPRA IP line 23	233.43.202.87	13173	OPRA IP line 23	233.43.202.119	14173
OPRA IP line 24	233.43.202.88	13174	OPRA IP line 24	233.43.202.120	14174

OPRA FAST Retransmission and Playback Test Data, Single Sets

Retransmission Group Assignments			Playback Test Group Assignments		
NMS Line Name available from both Group A and Group B	Multicast Group ID	Destination UDP Port Number	NMS Line Name available from both Group A and Group B	Multicast Group ID	Destination UDP Port Number
FCO 1 (OPRA)	233.43.202.192	18100	FCO 1 (OPRA)	233.43.202.224	19100
OPRA IP line 1	233.43.202.193	18101	OPRA IP line 1	233.43.202.225	19101
OPRA IP line 2	233.43.202.194	18102	OPRA IP line 2	233.43.202.226	19102
OPRA IP line 3	233.43.202.195	18103	OPRA IP line 3	233.43.202.227	19103
OPRA IP line 4	233.43.202.196	18104	OPRA IP line 4	233.43.202.228	19104
OPRA IP line 5	233.43.202.197	18105	OPRA IP line 5	233.43.202.229	19105
OPRA IP line 6	233.43.202.198	18106	OPRA IP line 6	233.43.202.230	19106
OPRA IP line 7	233.43.202.199	18107	OPRA IP line 7	233.43.202.231	19107
OPRA IP line 8	233.43.202.200	18108	OPRA IP line 8	233.43.202.232	19108
OPRA IP line 9	233.43.202.201	18109	OPRA IP line 9	233.43.202.233	19109
OPRA IP line 10	233.43.202.202	18110	OPRA IP line 10	233.43.202.234	19110
OPRA IP line 11	233.43.202.203	18111	OPRA IP line 11	233.43.202.235	19111
OPRA IP line 12	233.43.202.204	18112	OPRA IP line 12	233.43.202.236	19112
OPRA IP line 13	233.43.202.205	18113	OPRA IP line 13	233.43.202.237	19113
OPRA IP line 14	233.43.202.206	18114	OPRA IP line 14	233.43.202.238	19114
OPRA IP line 15	233.43.202.207	18115	OPRA IP line 15	233.43.202.239	19115
OPRA IP line 16	233.43.202.208	18116	OPRA IP line 16	233.43.202.240	19116
OPRA IP line 17	233.43.202.209	18117	OPRA IP line 17	233.43.202.241	19117
OPRA IP line 18	233.43.202.210	18118	OPRA IP line 18	233.43.202.242	19118
OPRA IP line 19	233.43.202.211	18119	OPRA IP line 19	233.43.202.243	19119
OPRA IP line 20	233.43.202.212	18120	OPRA IP line 20	233.43.202.244	19120
OPRA IP line 21	233.43.202.213	18121	OPRA IP line 21	233.43.202.245	19121
OPRA IP line 22	233.43.202.214	18122	OPRA IP line 22	233.43.202.246	19122
OPRA IP line 23	233.43.202.215	18123	OPRA IP line 23	233.43.202.247	19123
OPRA IP line 24	233.43.202.216	18124	OPRA IP line 24	233.43.202.248	19124

OPRA FAST for Symbology Retransmission and Playback Test Data, Single Sets (Reused ASCII Multicast Feeds)

Retransmission Group Assignments			Playback Test Group Assignments		
NMS Line Name available from both Group A and Group B	Multicast Group ID	Destination UDP Port Number	NMS Line Name available from both Group A and Group B	Multicast Group ID	Destination UDP Port Number
OPRA IP line 1	233.43.202.65	13151	OPRA IP line 1	233.43.202.97	14151
OPRA IP line 2	233.43.202.66	13152	OPRA IP line 2	233.43.202.98	14152
OPRA IP line 3	233.43.202.67	13153	OPRA IP line 3	233.43.202.99	14153
OPRA IP line 4	233.43.202.68	13154	OPRA IP line 4	233.43.202.100	14154
OPRA IP line 5	233.43.202.69	13155	OPRA IP line 5	233.43.202.101	14155
OPRA IP line 6	233.43.202.70	13156	OPRA IP line 6	233.43.202.102	14156
OPRA IP line 7	233.43.202.71	13157	OPRA IP line 7	233.43.202.103	14157
OPRA IP line 8	233.43.202.72	13158	OPRA IP line 8	233.43.202.104	14158
OPRA IP line 9	233.43.202.73	13159	OPRA IP line 9	233.43.202.105	14159
OPRA IP line 10	233.43.202.74	13160	OPRA IP line 10	233.43.202.106	14160
OPRA IP line 11	233.43.202.75	13161	OPRA IP line 11	233.43.202.107	14161
OPRA IP line 12	233.43.202.76	13162	OPRA IP line 12	233.43.202.108	14162
OPRA IP line 13	233.43.202.77	13163	OPRA IP line 13	233.43.202.109	14163
OPRA IP line 14	233.43.202.78	13164	OPRA IP line 14	233.43.202.110	14164
OPRA IP line 15	233.43.202.79	13165	OPRA IP line 15	233.43.202.111	14165
OPRA IP line 16	233.43.202.80	13166	OPRA IP line 16	233.43.202.112	14166
OPRA IP line 17	233.43.202.81	13167	OPRA IP line 17	233.43.202.113	14167
OPRA IP line 18	233.43.202.82	13168	OPRA IP line 18	233.43.202.114	14168
OPRA IP line 19	233.43.202.83	13169	OPRA IP line 19	233.43.202.115	14169
OPRA IP line 20	233.43.202.84	13170	OPRA IP line 20	233.43.202.116	14170
OPRA IP line 21	233.43.202.85	13171	OPRA IP line 21	233.43.202.117	14171
OPRA IP line 22	233.43.202.86	13172	OPRA IP line 22	233.43.202.118	14172
OPRA IP line 23	233.43.202.87	13173	OPRA IP line 23	233.43.202.119	14173
OPRA IP line 24	233.43.202.88	13174	OPRA IP line 24	233.43.202.120	14174

7 Appendix B - NMS IP Source Addresses

The following table lists all the possible source IP addresses associated with the each of the NMS Multicast Data services.

Service	Data Function Type	IP addresses listed as the source address in the Multicast packets (network number in parenthesis)
CTS/CQS	**Production (A Stream)**	198.140.61.161 (198.140.61.160/ 29) 198.140.61.162 (198.140.61.160/ 29) 198.140.61.163 (198.140.61.160/ 29) 198.140.61.164 (198.140.61.160/ 29) 198.140.61.165 (198.140.61.160/ 29) 198.140.62.161 (198.140.62.160/ 29) 198.140.62.162 (198.140.62.160/ 29) 198.140.62.163 (198.140.62.160/ 29) 198.140.62.164 (198.140.62.160/ 29) 198.140.41.161 (198.140.41.160/ 29) 198.140.41.162 (198.140.41.160/ 29) 198.140.41.163 (198.140.41.160/ 29) 198.140.41.164 (198.140.41.160/ 29) 198.140.41.165 (198.140.41.160/ 29) 198.140.42.161 (198.140.42.160/ 29) 198.140.42.162 (198.140.42.160/ 29) 198.140.42.163 (198.140.42.160/ 29) 198.140.42.164 (198.140.42.160/ 29)
CTS/CQS	**Production (B Stream)**	198.140.61.169 (198.140.61.168/ 29) 198.140.61.170 (198.140.61.168/ 29) 198.140.61.171 (198.140.61.168/ 29) 198.140.61.172 (198.140.61.168/ 29) 198.140.61.173 (198.140.61.168/ 29) 198.140.62.169 (198.140.62.168/ 29) 198.140.62.170 (198.140.62.168/ 29) 198.140.62.171 (198.140.62.168/ 29) 198.140.62.172 (198.140.62.168/ 29) 198.140.41.169 (198.140.41.168/ 29) 198.140.41.170 (198.140.41.168/ 29) 198.140.41.171 (198.140.41.168/ 29) 198.140.41.172 (198.140.41.168/ 29) 198.140.41.173 (198.140.41.168/ 29) 198.140.42.169 (198.140.42.168/ 29) 198.140.42.170 (198.140.42.168/ 29) 198.140.42.171 (198.140.42.168/ 29) 198.140.42.172 (198.140.42.168/ 29)

Note: Source IP Addresses that are <u>not</u> shaded are associated with the current CTS Non-Stop Production System.

NMS IP Source Addresses, cont'd

Service	Data Function Type	IP addresses listed as the source address in the Multicast packets (network number in parenthesis)
CTS/CQS	**After-hours Playback (A Stream)**	198.140.61.65 (198.140.61.64 / 29) 198.140.61.66 (198.140.61.64 / 29) 198.140.61.67 (198.140.61.64 / 29) 198.140.61.68 (198.140.61.64 / 29) 198.140.61.115 (198.140.61.112/ 29) 198.140.62.65 (198.140.62.64 / 29) 198.140.62.66 (198.140.62.64 / 29) 198.140.62.67 (198.140.62.64 / 29) 198.140.62.68 (198.140.62.64 / 29) 198.140.62.115 (198.140.62.112 / 29) 198.140.41.65 (198.140.41.64 / 29) 198.140.41.66 (198.140.41.64 / 29) 198.140.41.67 (198.140.41.64 / 29) 198.140.41.68 (198.140.41.64 / 29) 198.140.41.115 (198.140.41.112/ 29) 198.140.42.65 (198.140.42.64 / 29) 198.140.42.66 (198.140.42.64 / 29) 198.140.42.67 (198.140.42.64 / 29) 198.140.42.68 (198.140.42.64 / 29) 198.140.42.115 (198.140.42.112 / 29)
CTS/CQS	**After-hours Playback (B Stream)**	198.140.61.89 (198.140.61.88 / 29) 198.140.61.90 (198.140.61.88 / 29) 198.140.61.91 (198.140.61.88/ 29) 198.140.61.92 (198.140.61.88/ 29) 198.140.61.123 (198.140.61.120 / 29) 198.140.62.89 (198.140.62.88 / 29) 198.140.62.90 (198.140.62.88 / 29) 198.140.62.91 (198.140.62.88/ 29) 198.140.62.92 (198.140.62.88/ 29) 198.140.62.123 (198.140.62.120 / 29) 198.140.41.89 (198.140.41.88 / 29) 198.140.41.90 (198.140.41.88 / 29) 198.140.41.91 (198.140.41.88 / 29) 198.140.41.92 (198.140.41.88 / 29) 198.140.41.123 (198.140.41.120 / 29) 198.140.42.89 (198.140.42.88 / 29) 198.140.42.90 (198.140.42.88 / 29) 198.140.42.91 (198.140.42.88 / 29) 198.140.42.92 (198.140.42.88 / 29) 198.140.42.123 (198.140.42.120 / 29)

NMS IP Source Addresses, cont'd

Service	Data Function Type	IP addresses listed as the source address in the Multicast packets (network number in parenthesis)
CTS/CQS	**Production Retransmission/Afterhours Playback Test**	198.140.61.97 (198.140.61.96 / 29) 198.140.61.98 (198.140.61.96 / 29) 198.140.61.99 (198.140.61.96 / 29) 198.140.61.105 (198.140.61.104 / 29) 198.140.61.106 (198.140.61.104 / 29) 198.140.61.107 (198.140.61.104 / 29) 198.140.61.108 (198.140.61.104 / 29) 198.140.62.97 (198.140.62.96 / 29) 198.140.62.98 (198.140.62.96 / 29) 198.140.62.99 (198.140.62.96 / 29) 198.140.62.105 (198.140.62.104 / 29) 198.140.62.106 (198.140.62.104 / 29) 198.140.62.107 (198.140.62.104 / 29) 198.140.62.108 (198.140.62.104 / 29) 198.140.41.97 (198.140.41.96 / 29) 198.140.41.98 (198.140.41.96 / 29) 198.140.41.99 (198.140.41.96 / 29) 198.140.41.105 (198.140.41.104 / 29) 198.140.41.106 (198.140.41.104 / 29) 198.140.41.107 (198.140.41.104 / 29) 198.140.41.108 (198.140.41.104 / 29) 198.140.42.97 (198.140.42.96 / 29) 198.140.42.98 (198.140.42.96 / 29) 198.140.42.99 (198.140.42.96 / 29) 198.140.42.105 (198.140.42.104 / 29) 198.140.42.106 (198.140.42.104 / 29) 198.140.42.107 (198.140.42.104 / 29) 198.140.42.108 (198.140.42.104 / 29)

NMS IP Source Addresses, cont'd

Service	Data Function Type	IP addresses listed as the source address in the Multicast packets (network number in parenthesis)
OPRA/FAST/ FAST for Symbology	**Production (A Stream)**	198.140.61.49 (198.140.61.48 / 29) 198.140.61.50 (198.140.61.48 / 29) 198.140.61.51 (198.140.61.48 / 29) 198.140.61.57 (198.140.61.56 / 29) 198.140.61.58 (198.140.61.56 / 29) 198.140.61.59 (198.140.61.56 / 29) 198.140.62.49 (198.140.62.48 / 29) 198.140.62.50 (198.140.62.48 / 29) 198.140.62.51 (198.140.62.48 / 29) 198.140.62.57 (198.140.62.56 / 29) 198.140.62.58 (198.140.62.56 / 29) 198.140.62.59 (198.140.62.56 / 29) 198.140.41.49 (198.140.41.48 / 29) 198.140.41.50 (198.140.41.48 / 29) 198.140.41.51 (198.140.41.48 / 29) 198.140.41.57 (198.140.41.56 / 29) 198.140.41.58 (198.140.41.56 / 29) 198.140.41.59 (198.140.41.56 / 29) 198.140.42.49 (198.140.42.48 / 29) 198.140.42.50 (198.140.42.48 / 29) 198.140.42.51 (198.140.42.48 / 29) 198.140.42.57 (198.140.42.56 / 29) 198.140.42.58 (198.140.42.56 / 29) 198.140.42.59 (198.140.42.56 / 29)

NMS IP Source Addresses, cont'd

Service	Data Function Type	IP addresses listed as the source address in the Multicast packets (network number in parenthesis)
OPRA/FAST/ FAST for Symbology	**Production (B Stream)**	198.140.61.73 (198.140.61.72 / 29) 198.140.61.74 (198.140.61.72 / 29) 198.140.61.75 (198.140.61.72 / 29) 198.140.61.81 (198.140.61.80 / 29) 198.140.61.82 (198.140.61.80 / 29) 198.140.61.83 (198.140.61.80 / 29) 198.140.62.73 (198.140.62.72 / 29) 198.140.62.74 (198.140.62.72 / 29) 198.140.62.75 (198.140.62.72 / 29) 198.140.62.81 (198.140.62.80 / 29) 198.140.62.82 (198.140.62.80 / 29) 198.140.62.83 (198.140.62.80 / 29) 198.140.41.73 (198.140.41.72 / 29) 198.140.41.74 (198.140.41.72 / 29) 198.140.41.75 (198.140.41.72 / 29) 198.140.41.81 (198.140.41.80 / 29) 198.140.41.82 (198.140.41.80 / 29) 198.140.41.83 (198.140.41.80 / 29) 198.140.42.73 (198.140.42.72 / 29) 198.140.42.74 (198.140.42.72 / 29) 198.140.42.75 (198.140.42.72 / 29) 198.140.42.81 (198.140.42.80 / 29) 198.140.42.82 (198.140.42.80 / 29) 198.140.42.83 (198.140.42.80 / 29)

NMS IP Source Addresses, cont'd

Service	Data Function Type	IP addresses listed as the source address in the Multicast packets (network number in parenthesis)
OPRA/FAST/ FAST for Symbology	**After-hours Playback (A Stream)**	198.140.61.65 (198.140.61.64 / 29) 198.140.61.66 (198.140.61.64 / 29) 198.140.61.67 (198.140.61.64 / 29) 198.140.61.68 (198.140.61.64 / 29) 198.140.61.113 (198.140.61.112 / 29) 198.140.61.114 (198.140.61.112 / 29) 198.140.62.65 (198.140.62.64 / 29) 198.140.62.66 (198.140.62.64 / 29) 198.140.62.67 (198.140.62.64 / 29) 198.140.62.68 (198.140.62.64 / 29) 198.140.62.113 (198.140.62.112 / 29) 198.140.62.114 (198.140.62.112 / 29) 198.140.41.65 (198.140.41.64 / 29) 198.140.41.66 (198.140.41.64 / 29) 198.140.41.67 (198.140.41.64 / 29) 198.140.41.68 (198.140.41.64 / 29) 198.140.41.113 (198.140.41.112 / 29) 198.140.41.114 (198.140.41.112 / 29) 198.140.42.65 (198.140.42.64 / 29) 198.140.42.66 (198.140.42.64 / 29) 198.140.42.67 (198.140.42.64 / 29) 198.140.42.68 (198.140.42.64 / 29) 198.140.42.113 (198.140.42.112 / 29) 198.140.42.114 (198.140.42.112 / 29)
OPRA/FAST/ FAST for Symbology	**After-hours Playback (B Stream)**	198.140.61.89 (198.140.61.88 / 29) 198.140.61.90 (198.140.61.88 / 29) 198.140.61.91 (198.140.61.88 / 29) 198.140.61.92 (198.140.61.88 / 29) 198.140.61.121 (198.140.61.120 / 29) 198.140.61.122 (198.140.61.120 / 29) 198.140.62.89 (198.140.62.88 / 29) 198.140.62.90 (198.140.62.88 / 29) 198.140.62.91 (198.140.62.88 / 29) 198.140.62.92 (198.140.62.88 / 29) 198.140.62.121 (198.140.62.120 / 29) 198.140.62.122 (198.140.62.120 / 29) 198.140.41.89 (198.140.41.88 / 29) 198.140.41.90 (198.140.41.88 / 29) 198.140.41.91 (198.140.41.88 / 29) 198.140.41.92 (198.140.41.88 / 29) 198.140.41.121 (198.140.41.120 / 29) 198.140.41.122 (198.140.41.120 / 29) 198.140.42.89 (198.140.42.88 / 29) 198.140.42.90 (198.140.42.88 / 29) 198.140.42.91 (198.140.42.88 / 29) 198.140.42.92 (198.140.42.88 / 29) 198.140.42.121 (198.140.42.120 / 29) 198.140.42.122 (198.140.42.120 / 29)

NMS IP Source Addresses, cont'd

Service	Data Function Type	IP addresses listed as the source address in the Multicast packets (network number in parenthesis)
OPRA/FAST/ FAST for Symbology	**Production Retransmission/Afterhours Playback Test**	198.140.61.97 (198.140.61.96 / 29) 198.140.61.98 (198.140.61.96 / 29) 198.140.61.105 (198.140.61.104 / 29) 198.140.61.106 (198.140.61.104 / 29) 198.140.61.107 (198.140.61.104 / 29) 198.140.61.108 (198.140.61.104 / 29) 198.140.62.97 (198.140.62.96 / 29) 198.140.62.98 (198.140.62.96 / 29) 198.140.62.105 (198.140.62.104 / 29) 198.140.62.106 (198.140.62.104 / 29) 198.140.62.107 (198.140.62.104 / 29) 198.140.62.108 (198.140.62.104 / 29) 198.140.41.97 (198.140.41.96 / 29) 198.140.41.98 (198.140.41.96 / 29) 198.140.41.105 (198.140.41.104 / 29) 198.140.41.106 (198.140.41.104 / 29) 198.140.41.107 (198.140.41.104 / 29) 198.140.41.108 (198.140.41.104 / 29) 198.140.42.97 (198.140.42.96 / 29) 198.140.42.98 (198.140.42.96 / 29) 198.140.42.105 (198.140.42.104 / 29) 198.140.42.106 (198.140.42.104 / 29) 198.140.42.107 (198.140.42.104 / 29) 198.140.42.108 (198.140.42.104 / 29)

NMS IP Source Addresses, cont'd

Service	Data Function Type	IP addresses listed as the source address in the Multicast packets (network number in parenthesis)
Time Beacon	**(A Stream)**	198.140.61.49 (198.140.61.48 / 29) 198.140.61.50 (198.140.61.48 / 29) 198.140.61.51 (198.140.61.48 / 29) 198.140.61.57 (198.140.61.56 / 29) 198.140.61.58 (198.140.61.56 / 29) 198.140.61.161 (198.140.61.160 / 29) 198.140.61.162 (198.140.61.160 / 29) 198.140.61.163 (198.140.61.160/ 29) 198.140.61.164 (198.140.61.160/ 29) 198.140.61.165 (198.140.61.160/ 29) 198.140.62.49 (198.140.62.48 / 29) 198.140.62.50 (198.140.62.48 / 29) 198.140.62.51 (198.140.62.48 / 29) 198.140.62.57 (198.140.62.56 / 29) 198.140.62.58 (198.140.62.56 / 29) 198.140.62.161 (198.140.62.160 / 29) 198.140.62.162 (198.140.62.160/ 29) 198.140.62.163 (198.140.62.160/ 29) 198.140.62.164 (198.140.62.160/ 29) 198.140.41.49 (198.140.41.48 / 29) 198.140.41.50 (198.140.41.48 / 29) 198.140.41.51 (198.140.41.48 / 29) 198.140.41.57 (198.140.41.56 / 29) 198.140.41.58 (198.140.41.56 / 29) 198.140.41.161 (198.140.41.160 / 29) 198.140.41.162 (198.140.41.160 / 29) 198.140.41.163 (198.140.41.160/ 29) 198.140.41.164 (198.140.41.160/ 29) 198.140.41.165 (198.140.41.160/ 29) 198.140.42.49 (198.140.42.48 / 29) 198.140.42.50 (198.140.42.48 / 29) 198.140.42.51 (198.140.42.48 / 29) 198.140.42.57 (198.140.42.56 / 29) 198.140.42.58 (198.140.42.56 / 29) 198.140.42.161 (198.140.42.160 / 29) 198.140.42.162 (198.140.42.160/ 29) 198.140.42.163 (198.140.42.160/ 29) 198.140.42.164 (198.140.42.160/ 29)

NMS IP Source Addresses, cont'd

Service	Data Function Type	IP addresses listed as the source address in the Multicast packets (network number in parenthesis)
Time Beacon	**(B Stream)**	198.140.61.73 (198.140.61.72 / 29) 198.140.61.74 (198.140.61.72 / 29) 198.140.61.75 (198.140.61.72 / 29) 198.140.61.81 (198.140.61.80 / 29) 198.140.61.82 (198.140.61.80 / 29) 198.140.61.169 (198.140.61.168 / 29) 198.140.61.170 (198.140.61.168 / 29) 198.140.61.171 (198.140.61.168/ 29) 198.140.61.172 (198.140.61.168/ 29) 198.140.61.173 (198.140.61.168/ 29) 198.140.62.73 (198.140.62.72 / 29) 198.140.62.74 (198.140.62.72 / 29) 198.140.62.75 (198.140.62.72 / 29) 198.140.62.81 (198.140.62.80 / 29) 198.140.62.82 (198.140.62.80 / 29) 198.140.62.169 (198.140.62.168 / 29) 198.140.62.170 (198.140.62.168/ 29) 198.140.62.171 (198.140.62.168/ 29) 198.140.62.172 (198.140.62.168/ 29) 198.140.41.73 (198.140.41.72 / 29) 198.140.41.74 (198.140.41.72 / 29) 198.140.41.75 (198.140.41.72 / 29) 198.140.41.81 (198.140.41.80 / 29) 198.140.41.82 (198.140.41.80 / 29) 198.140.41.169 (198.140.41.168 / 29) 198.140.41.170 (198.140.41.168 / 29) 198.140.41.171 (198.140.41.168/ 29) 198.140.41.172 (198.140.41.168/ 29) 198.140.41.173 (198.140.41.168/ 29) 198.140.42.73 (198.140.42.72 / 29) 198.140.42.74 (198.140.42.72 / 29) 198.140.42.75 (198.140.42.72 / 29) 198.140.42.81 (198.140.42.80 / 29) 198.140.42.82 (198.140.42.80 / 29) 198.140.42.169 (198.140.42.168 / 29) 198.140.42.170 (198.140.42.168/ 29) 198.140.42.171 (198.140.42.168/ 29) 198.140.42.172 (198.140.42.168/ 29)

8 Appendix C - Time Beacon Message Format

The Time Beacon message is delivered as the data portion of a UDP/IP packet.

Each packet will contain a single message.

Each message is 14 bytes in length and consists of two fields, the MPR Identifier and the Time Stamp and is formatted as shown below.

MPR Identifier	Time Stamp
NN [2 Bytes]	**MMDDYYHHMMSS** [12 Bytes]

Description of each field:

Multicast Packet Replicator (MPR) Identifier:

2 Bytes, Numeric - Identifies the MPR that initiated the message.
As of 10/1/00 this number ranges from 1-10 but can change without notice.

Time Stamp:

12 Bytes, Alphanumeric/Special Character - Format is MMDDYYHHMMSS where,

M=Month
D=Day
Y=Year
H=Hours (specified as '0' through '23', in the same manner as military time)
M=Minutes
S=Seconds

The time stamp will reflect the current local time of the United States' Eastern Time zone. The time stamp will reflect daylight savings time when in effect.