SIAC

SECURITIES INDUSTRY AUTOMATION CORPORATION

National Market Systems

Common IP Multicast Distribution Network

Recipient Interface Specification

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REVISION LOG

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Recipient Interface Specification**

Version	Date	Rev by	Pages affected	Comments
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, 19	Added references for retransmission and playback data, and 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 available to new connections or upgrades.

REVISION LOG

Version	Date	Rev by	Pages affected	Comments
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	Appendix B	Removed duplicate source IP's from CTS/CQS Production A & B stream as well as updated Time Beacon A & B stream

REVISION LOG

Version	Date	Rev by	Pages affected	Comments
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)
1.31	11/24/08	LP	- Entire Document - Appendix A - Appendix B	-Eliminated FCO References -Renamed OPRA FAST Multicast Addresses to spare OPRA addresses -Added CTS/CQS Production, and Time Beacon Source IP Addresses (reassigned CTS, CQS, and OPRA Playback Source IPs)
1.32	2/23/09	LP	Appendix A, and Pgs: 8, 10, 12, 14,	Addition of new CTS/CQS Production, Retransmission and Playback Test Data Multicast Addresses/Ports
1.33	2/27/09	LP	Appendix A, and Pgs: 8, 9, 10, 12, 14,	-Revision of new CTS/CQS Production, Retransmission and Playback Test Data Multicast Addresses/Ports
1.34	2/18/10	WG	Table of Contents update Appendix B (pages 29 – 38) Appendix C (pages 39 – 52) Appendix D (page 53)	-Addition of new CTS/CQS/OPRA/Time Beacon Production Source IP Addresses -Addition of CTS/CQS/OPRA After Hours Playback Source IP Addresses -Addition of Production Retransmission and After Hours Playback Test Source IP Addresses - Relabeled as "Current" Source Addresses on the page header - Appendix C, relabeled as "Future" Source Addresses on page header - Created new Appendix D
1.35	6/1/10	MC	Appendix C : pages 39-40	- Corrected typos in Source addresses
1.36	8/19/10	MCP	Pages : Appendix 'A' (23 & 27) Pages : 8,10 & 11 IP Source Addresses	- Added OPRA 25-48 HSL's - Revised OPRA "1-24" to 1-48" Appendix 'B' and Appendix C' updated to Appendix 'B' = Primary Site and 'C' for Disaster Recovery IP Source Addresses

Version	Date	Rev by	Pages affected	Comments
1.37	11/28/11	WG	Table of Contents Appendix B (pages 30 – 36) Appendix C (pages 39 – 41)	-Adjustment of page numbers -Addition of new Subnet ".53/.54" for CTS/CQS/OPRA/Time Beacon Production Source IP Addresses -Addition of new Subnet ".53/.54" for CTS/CQS/OPRA After Hours Playback and Retransmission Source IP Addresses
1.38	8/20/12	MCP	Table of Contents Page 15, 21, 24 Page 30	-Adjustment of page numbers -Addition of two Equity / Index Production test multicast lines (binary 3 and 4 to support binary output format over production) -Addition of a 48 line temporary dual network test group assignments (48-A Stream, 48-B stream) -Removed all references to SPARE addresses
1.39	6/18/13	MC	Page 28	-Addition of two Equity / Index Retransmission test multicast lines (binary 3 and 4 to support binary output format over production)
1.40	6/25/14	MCP	Page 9, 11, 12, 15, 21, 25 and 29	-addition of Extended Session
1.41	1/27/15	LP	Page 23, 27	-Removed Network A Index references (Indices Disseminated over Network B)
1.42	5/4/15	WG	Page 45 thru 49 Page 50 thru 54 Page 35 Page 36	- Added Appendix C - New Primary Data Center Source Addresses - Added Appendix C - New Disaster Recovery (Backup) Data Center Source Addresses - Removed decommissioned source addresses on Network B or subnets ".41 and .61". - Removed decommissioned source addresses on Network B or subnets ".42 and .62".
1.43	2/21/17	WG	Pages 15, 21, 23, 24, 29 and 31 Pages 23 thru 28 & 30 thru 33 Pages 27 and 28 Pages 33 thru 46 Pages 49 thru 58	-Added dedicated binary parallel multicast addresses -Added to Multicast Addresses the reference page of Source Addresses -Added CQS and CTS Temporary Dual Network Test Group Assignments -Strike through applied to IP Addresses being decommissioned -Added to Appendix C (Source Addresses) the reference page for Multicast Addresses

Version	Date	Rev by	Pages affected	Comments
1.43a	4/7/17	WG	Page 27 Page 27 and 28	-Corrected port assignments -Removed date from paragraph statement and added reference to updated notice
1.44	1/17/20	AA/MZ	All Pages Pages 19 thru 20	- Updated SFTI with ICE Global Network - Addition of Multicast Delivery over NMS Network
1.45	1/24/20	WG	Pages 16, 23 and 29 Pages 33 thru 47	-Added new Multicast IP Subnets -Added PILLAR SIP (CTS/CQS) Source and Multicast Addresses and Future OPRA Multicast Addresses
1.46	2/24/20	WG/AE	Appendix C	-Added redundant streams and revised addresses for Pillar SIP Retransmission and Playback test channels
1.47	8/6/20	AE	Whole document	-Removed all references to decommissioned Time Beacon; - Legacy CTA addresses removed

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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 Quotation 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 and NMS after-hours playback data messages. The NMS distribution network disseminates all market data information in the form of multicast addressed IP datagrams.

In order to receive NMS Services (CT/CQ and OPRA), the Consolidated Tape Association (CTA) and Options Price Reporting Authority (OPRA) recently introduced NMS dedicated Access Network. NMS Network offer low latency access to data providers and recipients looking to lower their latency as compared to IGN. NMS Network ports are dedicated for NMS Services only.

With respect to physical network connectivity, all data distributed by the NMS systems requires recipients to connect via the NMS Network and ICE Global Network (IGN). Recipients may connect directly to the physical edge of IGN, or receive data via a third party value added service provider. For those choosing to connect directly to ICE Global Network, a separate interface specification, "IGN Colo US Technical Specifications" should be referenced. For more information regarding the available connectivity options, please visit the ICE Global Network Website at https://www.theice.com/data-services/global-network, or contact ICE Global Network & Colocation Sales @ 1-212-896-2830 - Option 3 or send an email to iceglobalnetwork-Info@theice.com.

1.1 Data Available via the NMS Network

There are several access points to which to connect and receive NMS data via ICE Global Network. Directly connected recipients can coordinate with SIAC and choose which multicast groups they wish to receive via each of the ICE Global Network connectivity points.

NMS Real-Time Production Data
Two copies (Group A and Group B) of each NMS real-time production message are available. These redundant copies are delivered via two distinct multicast data streams. For each unique NMS line (**CTS Network A lines 1-12, CTS Network B lines 1-12, CTS Index lines 1-2, CQS Network A lines 1-12, CQS Network B lines 1-12, OPRA lines 1-48 (Regular Session) and OPRA lines 91-94 (Extended Session**) 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 Appendices A through C for the table of multicast group mappings. Therefore there will be 204 unique multicast groups allocated for the redundant delivery of these 102 lines (102 * 2 = 204).

NMS Real-Time Data Retransmission Data
The retransmission data streams are available via all network access points, and are **delivered via redundant data streams for CTS Network A lines 1-12, CTS Network B lines 1-12, CTS Index lines 1-2, CQS Network A lines 1-12, CQS Network B lines 1-12 only. OPRA remains available via a single set of multicast data stream.**. The recipient may choose to receive the retransmission data from either or both sites. See Appendices A through C for the table of multicast group mappings.

NMS After-Hours Playback Data
Playback data is available in two methods:

- There is a set of Multicast data feeds dedicated for after-hours playback test data. This playback data is made available via two redundant multicast data streams for (**CTS Network A lines 1-12, CTS Network B lines 1-12, CTS Index lines 1-2, CQS Network A lines 1-12, CQS Network B lines 1-12 only. OPRA remains available via a single set of multicast data stream.** See Appendices A through C 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.

Bandwidth Requirements

Bandwidth requirements change with time and recipients are encouraged to contact the ICE Global Network Help Desk and/or NMS Planning representatives regarding bandwidth requirements of each of the NMS services. For more information on the ICE Global Network and available services, please visit the ICE Global Network Website at https://www.theice.com/data-services/global-network, or contact ICE Global Network & Colocation Sales @ 1-212-896-2830 - Option 3 or send an email to iceglobalnetwork-Info@theice.com.

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

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.ctaplan.com)
- CQS: CQS, Consolidated Quotation System, Output Multicast Line, Interface Specification (www.ctaplan.com)
- OPRA: OPRA, Options Price Reporting Authority, Data Recipient Interface Specification (www.opraplan.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.

1.2 Multicast Primer

Generally speaking multicast can be considered as 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**:

- 204 Multicast Group ID's for Production data streams for day-time dissemination
- 204 Multicast Group breakdown = 2 sets of 102 redundant data streams:
    -CTS Network A lines 1-12, CTS Network B lines 1-12
    -CTS Index lines 1-2, CQS Network A lines 1-12, CQS Network B lines 1-12
    -OPRA lines 1-48 Regular Session (26+24+48=98) and OPRA lines 91-94 Extended Session (98+4=102)
- 102 Multicast Group ID's for Production retransmission streams for day-time dissemination (1 set of data streams)
- 102 Multicast Group ID's for After-Hours Playback test data streams for after-hours support (1 set of data streams)

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 ICE Global Network interface specification, which provides additional information and considerations for receiving multicast services via ICE Global Network.

2 NMS Data Types

The NMS network distributes data via the multicast addressing and delivery protocols. Each of the three systems (CTS, CQS, and OPRA) 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. The data lines for the three systems include CTS Network A lines 1-12, CTS Network B lines 1-12, CTS Index lines 1-2, CQS Network A lines 1-12, CQS Network B lines 1-12 and OPRA lines 1-48 (Regular Session) and OPRA lines 91-94 (Extended Session). Therefore there will be 204 unique multicast groups allocated for the redundant delivery of these 102 lines (102 * 2 = 204).

- Each system line has a single retransmission multicast address assigned to it. Entitled recipients have the option of subscribing to any retransmission line as needed.

- There are additional multicast group ID's allocated for supporting after-hours playback of the NMS data. Note that after-hours playback can also utilize the aforementioned production multicast groups.

- In all cases, recipients will only be permitted to receive data to which they are entitled.

Appendices A through C provides tables listing of all multicast group ID's. 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 data streams. 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.
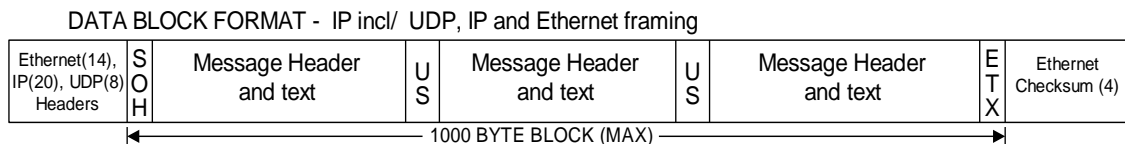
Figure 1 IP Data Block Format

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.

3.2 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 296 unique multicast group ID's 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.

Appendices A through C provides the exact mappings of each line to its identifier pair. Reference section 1.2 Multicast Primer for a list summarizing the multicast groups.

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.

4.1.1.1 BGP Peering

Dynamic Routing protocol; BGP (Border Gateway Protocol) is used for the exchange of Unicast IP Prefixes, Multicast Sources and Multicast RP Address(s). Customer Engineering Team will be allocating peering IP address, Autonomous System (AS) etc. as part of customer install package.

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:

- The interface is directly connected to a LAN where a member of the host group is attached

- 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

Reference section 1.2 Multicast Primer for a list summarizing the multicast groups detailing the total host groups available currently and future expansion of multicast 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 Appendices A through C. Note that not all these addresses are in use.

SIAC Allocated Multicast IP Address Ranges

Starting Address	Ending Address
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
224.0.86.0	224.0.86.255
233.200.79.0	233.200.79.255
224.0.89.0	224.0.89.255
224.0.90.0	224.0.90.255

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.
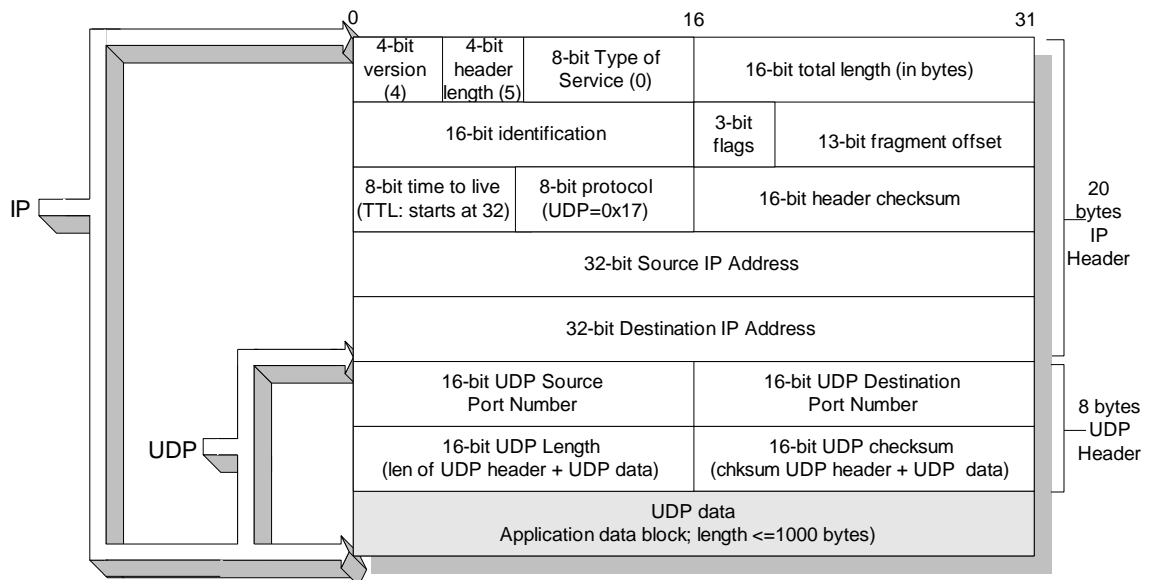
Figure 2 UDP/IP Datagram Format

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.

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4.3.1 IP Header Field Descriptions (continued)

- **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" of data packets. For the mapping of IP multicast group addresses to data lines please consult Appendices A through C 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 Appendices A through C.

- **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   Multicast Delivery over NMS Network

NMS Services CT/CQ/OPRA are provided by NMS Network. NMS Network ports are classic Ethernet interface (untagged) configured for transporting aggregate multicast traffic for all services. NMS Network lowers the overall latency while maintaining the redundancy and fairness throughout the network.

To facilitate the delivery of Multicast data, NMS Network employs the use of multicast routing protocol. Protocol Independent Multicast (PIM) Sparse mode is utilized to accomplish this task. PIM Sparse mode is used to signal delivery and reception of multicast data. PIM Sparse mode requires the use of Rendezvous Point (RP) to act as meeting point between subscribers and listeners of multicast data. Router behind which interested listeners are, send PIM-Join signal to RP for interested multicast groups to join the Shared Tree for the reception of data. At this stage if the source(s) is already publishing data and RP has established Multicast Tree towards the Source, the data starts flowing via RP Tree or Shared Tree

NMS Network customers will have below two methods for receiving multicast data. This specification refers to the configuration of the customer router port directly connected to NMS Network. Customers can implement any network solution they wish beyond that interface. SIAC has no restrictions on the manner in which a customer designs its networks to support multicast reception. This applies to both protocol and physical topology perspectives. Customers are responsible for implementing a working design that best suits their environment.

Method I: Dynamic Multicast Routing - PIM Sparse Mode

- **PIM Sparse Mode**: Configure PIM Sparse Mode on the router that connects to Access Network.

- **Rendezvous Point**: RP-A and RP-B IP-Addresses are propagated via dynamic BGP unicast routing for A and B Multicast group mappings.

- **Shared Tree**: Upon receipt of PIM (*, G) Join, Shared Tree is established which is rooted at the Rendezvous Point for Any Source Multicast (ASM) delivery.

- **Shortest Path Tree**: Upon receipt of (S, G) Source / Group Join, Shortest Path Tree (SPT) is established for delivery of Multicast packets.

Method II: Static Multicast Routing - IGMP Static Groups

- SIAC, upon the request of the customer, will define IGMP static joins on the NMS Network Adge router connected to the customer. This will result in forwarding of multicast data for the multicast groups that are statically configured. Static IGMP joins are matched against entitled multicast groups to the customer edge router.

- Customer routers learn multicast source routes via dynamic unicast routing as described in section 4.1.1.

Customers can implement appropriate 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 forwarding the multicast data at the edge into their routing trees using the routing information learned via dynamic unicast routing.

4.4.3.1   Multicast Entitlement Control

Entitlement for Proprietary Market Data Feeds subscribers will be enforced at the NMS Network Edge Routers through the application of PIM Join Policies on the logical network interface of each individual Customer. The use of Policies provides the mechanism to control the transmission/reception of multicast services for dynamic subscribers. For customers that chose not to use dynamic multicast routing protocols, SIAC will define IGMP static groups for the entitled market data services and applied logical network interface of each individual Customer .

Ingress traffic filters on the Edge Router logical interfaces supporting multicast will silently discard any incoming packets except those used by the required multicast (PIM) and/or unicast routing protocols (BGP). These filters will also be used to protect each of the network components within the NMS Network from any customer-originated multicast traffic. Filters can be reconfigured dynamically to allow for timely re-provisioning of entitlements.

4.4.3.2   Multicast Data Retransmission

NMS Multicast data service provides an in band retransmission request mechanism over a unicast TCP sockets based applications. NMS Multicast data service supports multicast retransmission over separate group ranges as defined in Appendix-A of this document. NMS Network subscribers are able to receive multicast retransmission over the same physical and/or logical interface as their primary production feeds.

4.4.4   Multicast Delivery over ICE Global Network

As explained in detail in the "ICE Global Network interface specification", the ICE Global Network architecture provides access to multiple services through an aggregate Ethernet Interface, this separation is realized through the use of Vlan Tagging; 802.1Q protocol. NMS Services are provided over this Tagged Ethernet interface where Unicast and Multicast are delivered over separate by Vlan or logical interfaces. It may be interesting to know that ICE Global Network delivers all data center originated Multicast Services over a single VLAN.

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

As the ICE Global Network specification describes, customers will have two methods for receiving multicast data from ICE Global Network. That specification refers specifically to the configuration of the customer router port connected to ICE Global Network.

Customers can implement any network solution they wish beyond that interface. Beyond the ICE Global Network 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 ICE Global Network, 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 third party provider may deviate from the following.

Method I: Dynamic Multicast Routing - PIM Sparse-Dense Mode

- Configure PIM Sparse-Dense Mode on the router that connects to ICE Global Network.

- Use "auto-RP" to learn the ICE Global Network RP addresses and multicast group mappings.

- Configure BGP in listen mode to learn the routing information for the multicast source networks and the routes to the PIM RP's.

PIM Sparse Mode ONLY customers

- Must use a Static RP Group Mapping configuration on their router to subscribe to NMS Multicast services

Method II: Static Multicast Routing - IGMP Static Groups

- Customers can use PIM Sparse or Dense mode; required to receive multicast traffic on their connected port.

- SIAC, upon the request of the customer, will define IGMP static joins on the ICE Global Network Adge 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 via BGP peering.

4.4.4.1 Multicast Entitlement Control

Multicast entitlement will be enforced at the ICE Global Network Adge 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 ICE Global Network Adge, 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 ICE Global Network components from any customer-originated multicast traffic.

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

4.4.5 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 ICE Global Network in the same manner as other unicast traffic to the particular destination FSN.

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

4.4.6 Availability of Multicast Services

Customers will receive a list of the multicast source networks, multicast destination group addresses, and all other relevant information from ICE Global Network 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).

4.4.7 Multicast Transport Protocol

ICE Global Network 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 ICE Global Network at several geographically diverse access centers. There are seven operation access centers, including five in the New York Metro area, and two in Chicago, IL.

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 ICE Global Network 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. Appendices A through C 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 ICE Global Network 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 ICE Global 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 Appendices C and D.

5 Physical, Media Layer, and Network Connectivity

Please consult the ICE Global Network 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: *(All below IP address ranges fall within the /24 Prefix and 255.255.255.0 netmask)*

NMS Production IP Multicast Feeds Group A:
- 224.0.86.0-224.0.86.7
- 233.43.202.1 – 233.43.202.24
- 233.43.202.128 – 233.43.202.152
- 224.0.86.112 - 224.0.86.115
- 224.0.86.126 - 224.0.86.127
- 224.0.86.120 - 224.0.86.122
- 224.0.89.0 - 224.0.89.63
- 224.0.90.0 - 224.0.90.63

NMS Production IP Multicast Feeds Group B:
- 224.0.86.128 – 224.0.86.135
- 233.43.202.33 – 233.43.202.56
- 233.43.202.160 - 233.43.202.184
- 224.0.86.240 - 224.0.86.243
- 224.0.86.248 - 224.0.86.250
- 224.0.86.254 - 224.0.86.255
- 224.0.89.128 - 224.0.89.191
- 224.0.90.128 - 224.0.90.191

Appendix A - NMS IP Multicast Addresses Cont'd

Retransmission and Playback Test Data, Single and Dual Sets

CTA supports dual data stream sets for the CTS and CQS retransmission and playback test data feeds (Appendix C). For OPRA, 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.

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:

- 224.0.86.8 – 224.0.86.15
- 233.43.202.65 – 233.43.202.88
- 233.43.202.192-233.43.202.216
- 224.0.86.116 – 224.0.86.119
- 224.0.89.64 - 224.0.89.127
- 224.0.90.64 - 224.0.90.127

NMS Playback Group ID Ranges:

- 224.0.86.8 – 224.0.86.15
- 233.43.202.97 – 233.43.202.120
- 233.43.202.224 - 233.43.202.248
- 224.0.86.244 – 224.0.86.247
- 224.0.86.136 - 224.0.86.143
- 224.0.89.192 - 224.0.89.255
- 224.0.90.192 - 224.0.90.255

7 Appendix B - OPRA Rendezvous Points and Primary Data Center Source Addresses

Rendezvous Points (RP) Addresses

NETWORK CONNECTION	RP ADDRESS - A STREAMS	RP ADDRESS - B STREAMS
NMS Network	159.125.52.194	159.125.52.195
ICE Global Network	198.140.33.2	198.140.33.5

MULTICAST DATA SOURCE: PRODUCTION "A-STREAM" & PRODUCTION "B-STREAM"

PRODUCT NAME:	OPRA / TIME BEACON				
NETWORK SUBNETS:	SIX (6) NETWORK SUBNET GROUPS PER DATA STREAM				
PRODUCTION "A – STREAM"					
ODD SUBNETS			EVEN SUBNETS		
159.125.45.0/27	159.125.45.32/27	159.125.45.64/27	159.125.40.0/27	159.125.40.32/27	159.125.40.64/27
159.125.45.1	159.125.45.33	159.125.45.65	159.125.40.1	159.125.40.33	159.125.40.65
159.125.45.2	159.125.45.34	159.125.45.66	159.125.40.2	159.125.40.34	159.125.40.66
159.125.45.3	159.125.45.35	159.125.45.67	159.125.40.3	159.125.40.35	159.125.40.67
159.125.45.4	159.125.45.36	159.125.45.68	159.125.40.4	159.125.40.36	159.125.40.68
159.125.45.5	159.125.45.37	159.125.45.69	159.125.40.5	159.125.40.37	159.125.40.69
159.125.45.6	159.125.45.38	159.125.45.70	159.125.40.6	159.125.40.38	159.125.40.70
159.125.45.7	159.125.45.39	159.125.45.71	159.125.40.7	159.125.40.39	159.125.40.71
159.125.45.8	159.125.45.40	159.125.45.72	159.125.40.8	159.125.40.40	159.125.40.72
159.125.45.9	159.125.45.41	159.125.45.73	159.125.40.9	159.125.40.41	159.125.40.73
159.125.45.10	159.125.45.42	159.125.45.74	159.125.40.10	159.125.40.42	159.125.40.74
159.125.45.11	159.125.45.43	159.125.45.75	159.125.40.11	159.125.40.43	159.125.40.75
159.125.45.12	159.125.45.44	159.125.45.76	159.125.40.12	159.125.40.44	159.125.40.76
159.125.45.13	159.125.45.45	159.125.45.77	159.125.40.13	159.125.40.45	159.125.40.77
PRODUCTION "B – STREAM"					
ODD SUBNETS			EVEN SUBNETS		
159.125.45.128/27	159.125.45.160/27	159.125.45.192/27	159.125.40.128/27	159.125.40.160/27	159.125.40.192/27
159.125.45.129	159.125.45.161	159.125.45.193	159.125.40.129	159.125.40.161	159.125.40.193
159.125.45.130	159.125.45.162	159.125.45.194	159.125.40.130	159.125.40.162	159.125.40.194
159.125.45.131	159.125.45.163	159.125.45.195	159.125.40.131	159.125.40.163	159.125.40.195
159.125.45.132	159.125.45.164	159.125.45.196	159.125.40.132	159.125.40.164	159.125.40.196
159.125.45.133	159.125.45.165	159.125.45.197	159.125.40.133	159.125.40.165	159.125.40.197
159.125.45.134	159.125.45.166	159.125.45.198	159.125.40.134	159.125.40.166	159.125.40.198
159.125.45.135	159.125.45.167	159.125.45.199	159.125.40.135	159.125.40.167	159.125.40.199
159.125.45.136	159.125.45.168	159.125.45.200	159.125.40.136	159.125.40.168	159.125.40.200
159.125.45.137	159.125.45.169	159.125.45.201	159.125.40.137	159.125.40.169	159.125.40.201
159.125.45.138	159.125.45.170	159.125.45.202	159.125.40.138	159.125.40.170	159.125.40.202
159.125.45.139	159.125.45.171	159.125.45.203	159.125.40.139	159.125.40.171	159.125.40.203
159.125.45.140	159.125.45.172	159.125.45.204	159.125.40.140	159.125.40.172	159.125.40.204
159.125.45.141	159.125.45.173	159.125.45.205	159.125.40.141	159.125.40.173	159.125.40.205

Note: Multicast Address can be referenced on the next following pages.

Appendix B - OPRA Primary Data Center Source Addresses Cont'd

MULTICAST DATA SOURCE: NON-PRODUCTION HOURS PRODUCTION "A-STREAM" & PRODUCTION "B-STREAM"

PRODUCT NAME:	OPRA	
NETWORK SUBNETS:	TWO (2) NETWORK SUBNET GROUPS PER DATA STREAM	
PRODUCTION "A – STREAM"		
ODD SUBNETS	EVEN SUBNETS	
159.125.57.64/26	159.125.52.64/26	
159.125.57.65	159.125.52.65	
159.125.57.66	159.125.52.66	
159.125.57.67	159.125.52.67	
159.125.57.68	159.125.52.68	
159.125.57.69	159.125.52.69	
159.125.57.70	159.125.52.70	
159.125.57.71	159.125.52.71	
159.125.57.72	159.125.52.72	
159.125.57.73	159.125.52.73	
159.125.57.74	159.125.52.74	
159.125.57.75	159.125.52.75	
159.125.57.76	159.125.52.76	
PRODUCTION "B – STREAM"		
ODD SUBNETS	EVEN SUBNETS	
159.125.57.128/26	159.125.52.128/26	
159.125.57.129	159.125.52.129	
159.125.57.130	159.125.52.130	
159.125.57.131	159.125.52.131	
159.125.57.132	159.125.52.132	
159.125.57.133	159.125.52.133	
159.125.57.134	159.125.52.134	
159.125.57.135	159.125.52.135	
159.125.57.136	159.125.52.136	
159.125.57.137	159.125.52.137	
159.125.57.138	159.125.52.138	
159.125.57.139	159.125.52.139	
159.125.57.140	159.125.52.140	

Note: Multicast Address can be referenced on the next following pages.

Appendix B - OPRA Primary Data Center Source Addresses Cont'd

MULTICAST DATA SOURCE: PRODUCTION RETRANSMISSION & NON-PRODUCTION HOURS PLAYBACK TEST

PRODUCT NAME:	OPRA	
NETWORK SUBNETS:	TWO (2) NETWORK SUBNET GROUPS SINGLE STREAM ONLY	
RETRANSMISSION DATA SOURCE AND PLAYBACK TEST DATA SOURCE		
ODD SUBNETS	EVEN SUBNETS
159.125.57.0/26	159.125.52.0/26
159.125.57.1	159.125.52.1
159.125.57.2	159.125.52.2
159.125.57.3	159.125.52.3
159.125.57.4	159.125.52.4
159.125.57.5	159.125.52.5
159.125.57.6	159.125.52.6
159.125.57.7	159.125.52.7
159.125.57.8	159.125.52.8
159.125.57.9	159.125.52.9
159.125.57.10	159.125.52.10
159.125.57.11	159.125.52.11
159.125.57.12	159.125.52.12

Note: Multicast Address can be referenced on the next following pages.

Appendix B - OPRA Disaster Recovery Data Center Source Addresses

MULTICAST DATA SOURCE: PRODUCTION "A-STREAM" & PRODUCTION "B-STREAM"

PRODUCT NAME:	OPRA / TIME BEACON				
NETWORK SUBNETS:	SIX (6) NETWORK SUBNET GROUPS PER DATA STREAM				
PRODUCTION "A – STREAM"					
ODD SUBNETS			EVEN SUBNETS		
198.140.45.0/27	198.140.45.32/27	198.140.45.64/27	198.140.40.0/27	198.140.40.32/27	198.140.40.64/27
198.140.45.1	198.140.45.33	198.140.45.65	198.140.40.1	198.140.40.33	198.140.40.65
198.140.45.2	198.140.45.34	198.140.45.66	198.140.40.2	198.140.40.34	198.140.40.66
198.140.45.3	198.140.45.35	198.140.45.67	198.140.40.3	198.140.40.35	198.140.40.67
198.140.45.4	198.140.45.36	198.140.45.68	198.140.40.4	198.140.40.36	198.140.40.68
198.140.45.5	198.140.45.37	198.140.45.69	198.140.40.5	198.140.40.37	198.140.40.69
198.140.45.6	198.140.45.38	198.140.45.70	198.140.40.6	198.140.40.38	198.140.40.70
198.140.45.7	198.140.45.39	198.140.45.71	198.140.40.7	198.140.40.39	198.140.40.71
198.140.45.8	198.140.45.40	198.140.45.72	198.140.40.8	198.140.40.40	198.140.40.72
198.140.45.9	198.140.45.41	198.140.45.73	198.140.40.9	198.140.40.41	198.140.40.73
198.140.45.10	198.140.45.42	198.140.45.74	198.140.40.10	198.140.40.42	198.140.40.74
198.140.45.11	198.140.45.43	198.140.45.75	198.140.40.11	198.140.40.43	198.140.40.75
198.140.45.12	198.140.45.44	198.140.45.76	198.140.40.12	198.140.40.44	198.140.40.76
198.140.45.13	198.140.45.45	198.140.45.77	198.140.40.13	198.140.40.45	198.140.40.77
PRODUCTION "B – STREAM"					
ODD SUBNETS			EVEN SUBNETS		
198.140.45.128/27	198.140.45.160/27	198.140.45.192/27	198.140.40.128/27	198.140.40.160/27	198.140.40.192/27
198.140.45.129	198.140.45.161	198.140.45.193	198.140.40.129	198.140.40.161	198.140.40.193
198.140.45.130	198.140.45.162	198.140.45.194	198.140.40.130	198.140.40.162	198.140.40.194
198.140.45.131	198.140.45.163	198.140.45.195	198.140.40.131	198.140.40.163	198.140.40.195
198.140.45.132	198.140.45.164	198.140.45.196	198.140.40.132	198.140.40.164	198.140.40.196
198.140.45.133	198.140.45.165	198.140.45.197	198.140.40.133	198.140.40.165	198.140.40.197
198.140.45.134	198.140.45.166	198.140.45.198	198.140.40.134	198.140.40.166	198.140.40.198
198.140.45.135	198.140.45.167	198.140.45.199	198.140.40.135	198.140.40.167	198.140.40.199
198.140.45.136	198.140.45.168	198.140.45.200	198.140.40.136	198.140.40.168	198.140.40.200
198.140.45.137	198.140.45.169	198.140.45.201	198.140.40.137	198.140.40.169	198.140.40.201
198.140.45.138	198.140.45.170	198.140.45.202	198.140.40.138	198.140.40.170	198.140.40.202
198.140.45.139	198.140.45.171	198.140.45.203	198.140.40.139	198.140.40.171	198.140.40.203
198.140.45.140	198.140.45.172	198.140.45.204	198.140.40.140	198.140.40.172	198.140.40.204
198.140.45.141	198.140.45.173	198.140.45.205	198.140.40.141	198.140.40.173	198.140.40.205

Appendix B - OPRA Disaster Recovery Data Center Source Addresses Cont'd

MULTICAST DATA SOURCE: NON-PRODUCTION HOURS PRODUCTION "A-STREAM" & PRODUCTION "B-STREAM"

PRODUCT NAME:	OPRA	
NETWORK SUBNETS:	TWO (2) NETWORK SUBNET GROUPS PER DATA STREAM	
PRODUCTION "A – STREAM"		
ODD SUBNETS	**EVEN SUBNETS**	
198.140.59.64/26	198.140.58.64/26	
198.140.59.65	198.140.58.65	
198.140.59.66	198.140.58.66	
198.140.59.67	198.140.58.67	
198.140.59.68	198.140.58.68	
198.140.59.69	198.140.58.69	
198.140.59.70	198.140.58.70	
198.140.59.71	198.140.58.71	
198.140.59.72	198.140.58.72	
198.140.59.73	198.140.58.73	
198.140.59.74	198.140.58.74	
198.140.59.75	198.140.58.75	
198.140.59.76	198.140.58.76	
PRODUCTION "B – STREAM"		
ODD SUBNETS	**EVEN SUBNETS**	
198.140.59.128/26	198.140.58.128/26	
198.140.59.129	198.140.58.129	
198.140.59.130	198.140.58.130	
198.140.59.131	198.140.58.131	
198.140.59.132	198.140.58.132	
198.140.59.133	198.140.58.133	
198.140.59.134	198.140.58.134	
198.140.59.135	198.140.58.135	
198.140.59.136	198.140.58.136	
198.140.59.137	198.140.58.137	
198.140.59.138	198.140.58.138	
198.140.59.139	198.140.58.139	
198.140.59.140	198.140.58.140	

Note: Multicast Address can be referenced on the next following pages.

Appendix B - OPRA Disaster Recovery Data Center Source Addresses Cont'd

MULTICAST DATA SOURCE: PRODUCTION RETRANSMISSION & NON-PRODUCTION HOURS PLAYBACK TEST

PRODUCT NAME:	OPRA	
NETWORK SUBNETS:	TWO (2) NETWORK SUBNET GROUPS PER DATA STREAM	
RETRANSMISSION DATA SOURCE AND PLAYBACK TEST DATA SOURCE		
ODD SUBNETS	EVEN SUBNETS	
198.140.59.0/26	198.140.58.0/26	
198.140.59.1	198.140.58.1	
198.140.59.2	198.140.58.2	
198.140.59.3	198.140.58.3	
198.140.59.4	198.140.58.4	
198.140.59.5	198.140.58.5	
198.140.59.6	198.140.58.6	
198.140.59.7	198.140.58.7	
198.140.59.8	198.140.58.8	
198.140.59.9	198.140.58.9	
198.140.59.10	198.140.58.10	
198.140.59.11	198.140.58.11	
198.140.59.12	198.140.58.12	

Note: Multicast Address can be referenced on the next following pages.

Appendix B - OPRA Production, Real-Time IP Multicast Feeds, Dual Sets (Network 'A' / Network 'B')

Production, Real-Time IP Multicast Feeds, Dual Sets (OPRA) – Regular Trading Session:

Production Group A Assignments			Production Group B Assignments		
Stream A Originated Data Lines	Multicast Group ID	Destination UDP Port Number	Stream 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
OPRA 25	233.43.202.129	16101	OPRA 25	233.43.202.161	17101
OPRA 26	233.43.202.130	16102	OPRA 26	233.43.202.162	17102
OPRA 27	233.43.202.131	16103	OPRA 27	233.43.202.163	17103
OPRA 28	233.43.202.132	16104	OPRA 28	233.43.202.164	17104
OPRA 29	233.43.202.133	16105	OPRA 29	233.43.202.165	17105
OPRA 30	233.43.202.134	16106	OPRA 30	233.43.202.166	17106
OPRA 31	233.43.202.135	16107	OPRA 31	233.43.202.167	17107
OPRA 32	233.43.202.136	16108	OPRA 32	233.43.202.168	17108
OPRA 33	233.43.202.137	16109	OPRA 33	233.43.202.169	17109
OPRA 34	233.43.202.138	16110	OPRA 34	233.43.202.170	17110
OPRA 35	233.43.202.139	16111	OPRA 35	233.43.202.171	17111
OPRA 36	233.43.202.140	16112	OPRA 36	233.43.202.172	17112
OPRA 37	233.43.202.141	16113	OPRA 37	233.43.202.173	17113
OPRA 38	233.43.202.142	16114	OPRA 38	233.43.202.174	17114
OPRA 39	233.43.202.143	16115	OPRA 39	233.43.202.175	17115
OPRA 40	233.43.202.144	16116	OPRA 40	233.43.202.176	17116
OPRA 41	233.43.202.145	16117	OPRA 41	233.43.202.177	17117
OPRA 42	233.43.202.146	16118	OPRA 42	233.43.202.178	17118
OPRA 43	233.43.202.147	16119	OPRA 43	233.43.202.179	17119
OPRA 44	233.43.202.148	16120	OPRA 44	233.43.202.180	17120
OPRA 45	233.43.202.149	16121	OPRA 45	233.43.202.181	17121
OPRA 46	233.43.202.150	16122	OPRA 46	233.43.202.182	17122
OPRA 47	233.43.202.151	16123	OPRA 47	233.43.202.183	17123
OPRA 48	233.43.202.152	16124	OPRA 48	233.43.202.184	17124

Note: Source addresses can be found on pages 25 - 30.

Production, Real-Time IP Multicast Feeds, Dual Sets (OPRA) – Extended Trading Session:

Production Group A Assignments			Production Group B Assignments		
Stream A Originated Data Lines	Multicast Group ID	Destination UDP Port Number	Stream B Originated Data Lines	Multicast Group ID	Destination UDP Port Number
OPRA 91	224.0.86.0	11301	OPRA 91	224.0.86.128	12301
OPRA 92	224.0.86.1	11302	OPRA 92	224.0.86.129	12302
OPRA 93	224.0.86.2	11303	OPRA 93	224.0.86.130	12303
OPRA 94	224.0.86.3	11304	OPRA 94	224.0.86.131	12304
OPRA 95*	224.0.86.4	11305	OPRA 95*	224.0.86.132	12305
OPRA 96*	224.0.86.5	11306	OPRA 96*	224.0.86.133	12306
OPRA 97*	224.0.86.6	11307	OPRA 97*	224.0.86.134	12307
OPRA 98*	224.0.86.7	11308	OPRA 98*	224.0.86.135	12308

*OPRA Lines 95-98 are reserved for future use.

Appendix B - OPRA Retransmission & Playback Test IP Multicast Feeds, Single Set (Regular Session)

Retransmission Group Assignments			Playback Test Group Assignments		
NMS Line Name	Multicast Group ID	Destination UDP Port Number	NMS Line Name	Multicast Group ID	Destination UDP Port Number
OPRA 1	233.43.202.65	13151	OPRA 1	233.43.202.97	14151
OPRA 2	233.43.202.66	13152	OPRA 2	233.43.202.98	14152
OPRA 3	233.43.202.67	13153	OPRA 3	233.43.202.99	14153
OPRA 4	233.43.202.68	13154	OPRA 4	233.43.202.100	14154
OPRA 5	233.43.202.69	13155	OPRA 5	233.43.202.101	14155
OPRA 6	233.43.202.70	13156	OPRA 6	233.43.202.102	14156
OPRA 7	233.43.202.71	13157	OPRA 7	233.43.202.103	14157
OPRA 8	233.43.202.72	13158	OPRA 8	233.43.202.104	14158
OPRA 9	233.43.202.73	13159	OPRA 9	233.43.202.105	14159
OPRA 10	233.43.202.74	13160	OPRA 10	233.43.202.106	14160
OPRA 11	233.43.202.75	13161	OPRA 11	233.43.202.107	14161
OPRA 12	233.43.202.76	13162	OPRA 12	233.43.202.108	14162
OPRA 13	233.43.202.77	13163	OPRA 13	233.43.202.109	14163
OPRA 14	233.43.202.78	13164	OPRA 14	233.43.202.110	14164
OPRA 15	233.43.202.79	13165	OPRA 15	233.43.202.111	14165
OPRA 16	233.43.202.80	13166	OPRA 16	233.43.202.112	14166
OPRA 17	233.43.202.81	13167	OPRA 17	233.43.202.113	14167
OPRA 18	233.43.202.82	13168	OPRA 18	233.43.202.114	14168
OPRA 19	233.43.202.83	13169	OPRA 19	233.43.202.115	14169
OPRA 20	233.43.202.84	13170	OPRA 20	233.43.202.116	14170
OPRA 21	233.43.202.85	13171	OPRA 21	233.43.202.117	14171
OPRA 22	233.43.202.86	13172	OPRA 22	233.43.202.118	14172
OPRA 23	233.43.202.87	13173	OPRA 23	233.43.202.119	14173
OPRA 24	233.43.202.88	13174	OPRA 24	233.43.202.120	14174
OPRA 25	233.43.202.193	18101	OPRA 25	233.43.202.225	19101
OPRA 26	233.43.202.194	18102	OPRA 26	233.43.202.226	19102
OPRA 27	233.43.202.195	18103	OPRA 27	233.43.202.227	19103
OPRA 28	233.43.202.196	18104	OPRA 28	233.43.202.228	19104
OPRA 29	233.43.202.197	18105	OPRA 29	233.43.202.229	19105
OPRA 30	233.43.202.198	18106	OPRA 30	233.43.202.230	19106
OPRA 31	233.43.202.199	18107	OPRA 31	233.43.202.231	19107
OPRA 32	233.43.202.200	18108	OPRA 32	233.43.202.232	19108
OPRA 33	233.43.202.201	18109	OPRA 33	233.43.202.233	19109
OPRA 34	233.43.202.202	18110	OPRA 34	233.43.202.234	19110
OPRA 35	233.43.202.203	18111	OPRA 35	233.43.202.235	19111
OPRA 36	233.43.202.204	18112	OPRA 36	233.43.202.236	19112
OPRA 37	233.43.202.205	18113	OPRA 37	233.43.202.237	19113
OPRA 38	233.43.202.206	18114	OPRA 38	233.43.202.238	19114
OPRA 39	233.43.202.207	18115	OPRA 39	233.43.202.239	19115
OPRA 40	233.43.202.208	18116	OPRA 40	233.43.202.240	19116
OPRA 41	233.43.202.209	18117	OPRA 41	233.43.202.241	19117
OPRA 42	233.43.202.210	18118	OPRA 42	233.43.202.242	19118
OPRA 43	233.43.202.211	18119	OPRA 43	233.43.202.243	19119
OPRA 44	233.43.202.212	18120	OPRA 44	233.43.202.244	19120
OPRA 45	233.43.202.213	18121	OPRA 45	233.43.202.245	19121
OPRA 46	233.43.202.214	18122	OPRA 46	233.43.202.246	19122
OPRA 47	233.43.202.215	18123	OPRA 47	233.43.202.247	19123
OPRA 48	233.43.202.216	18124	OPRA 48	233.43.202.248	19124

Note: Source addresses can be found on pages 25 - 30.

Appendix B - OPRA Retransmission & Playback Test IP Multicast Feeds, Single Set (Extended Session)

Retransmission Group Assignments			Playback Test Group Assignments		
NMS Line Name	Multicast Group ID	Destination UDP Port Number	NMS Line Name	Multicast Group ID	Destination UDP Port Number
OPRA 91	224.0.86.8	13301	OPRA 91	224.0.86.136	14301
OPRA 92	224.0.86.9	13302	OPRA 92	224.0.86.137	14302
OPRA 93	224.0.86.10	13303	OPRA 93	224.0.86.138	14303
OPRA 94	224.0.86.11	13304	OPRA 94	224.0.86.139	14304
OPRA 95*	224.0.86.12	13305	OPRA 95*	224.0.86.140	14305
OPRA 96*	224.0.86.13	13306	OPRA 96*	224.0.86.141	14306
OPRA 97*	224.0.86.14	13307	OPRA 97*	224.0.86.142	14307
OPRA 98*	224.0.86.15	13308	OPRA 98*	224.0.86.143	14308

*OPRA Lines 95-98 are reserved for future use.

8 Appendix C - Rendezvous Points and PILLAR SIP Data Center Source Addresses

RENDEZVOUS POINTS FOR NMS NETWORK AND ICE GLOBAL NETWORK

NETWORK CONNECTION	RP ADDRESS - A STREAMS	RP ADDRESS - B STREAMS
NMS Network	159.125.52.194	159.125.52.195
ICE Global Network	198.140.33.2	198.140.33.5

MULTICAST DATA SOURCE SUBNETS FOR PRIMARY AND DISASTER DATA CENTERS

System	Primary Source IP/Subnet	Disaster Source IP/Subnet
CTS & CQS Multicast A	159.125.42.0/24	198.140.42.0/24
CTS & CQS Multicast B	159.125.61.0/24	198.140.61.0/24

Note: Multicast Address can be referenced on the next following pages.

Appendix C - PILLAR SIP - CQS Production, Real-Time IP Multicast Feeds, Dual Sets (Network 'A' / Network 'B')

MULTICAST DATA: PRODUCTION "A-STREAM" & PRODUCTION "B-STREAM"

PRODUCT NAME:	CQS				
NETWORK SUBNETS:	FOUR (4) NETWORK SUBNETS GROUPS PER DATA STREAM				

PRODUCTION "DATA STREAM - A" SUBNETS:					
224.0.90.0/28		224.0.90.16/28	224.0.90.32/28		224.0.90.48/28

Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CQS 1 / Tape A	224.0.90.0	40000	CQS 1 / Tape B	224.0.90.32	40000
CQS 2 / Tape A	224.0.90.1	40001	CQS 2 / Tape B	224.0.90.33	40001
CQS 3 / Tape A	224.0.90.2	40002	CQS 3 / Tape B	224.0.90.34	40002
CQS 4 / Tape A	224.0.90.3	40003	CQS 4 / Tape B	224.0.90.35	40003
CQS 5 / Tape A	224.0.90.4	40004	CQS 5 / Tape B	224.0.90.36	40004
CQS 6 / Tape A	224.0.90.5	40005	CQS 6 / Tape B	224.0.90.37	40005
CQS 7 / Tape A	224.0.90.6	40006	CQS 7 / Tape B	224.0.90.38	40006
CQS 8 / Tape A	224.0.90.7	40007	CQS 8 / Tape B	224.0.90.39	40007
CQS 9 / Tape A	224.0.90.8	40008	CQS 9 / Tape B	224.0.90.40	40008
CQS 10 / Tape A	224.0.90.9	40009	CQS 10 / Tape B	224.0.90.41	40009
CQS 11 / Tape A	224.0.90.10	40010	CQS 11 / Tape B	224.0.90.42	40010
CQS 12 / Tape A	224.0.90.11	40011	CQS 12 / Tape B	224.0.90.43	40011

PRODUCTION "DATA STREAM - B" SUBNETS:					
224.0.90.128/28		224.0.90.144/28	224.0.90.160/28		224.0.90.176/28

Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CQS 1 / Tape A	224.0.90.128	40000	CQS 1 / Tape B	224.0.90.160	40000
CQS 2 / Tape A	224.0.90.129	40001	CQS 2 / Tape B	224.0.90.161	40001
CQS 3 / Tape A	224.0.90.130	40002	CQS 3 / Tape B	224.0.90.162	40002
CQS 4 / Tape A	224.0.90.131	40003	CQS 4 / Tape B	224.0.90.163	40003
CQS 5 / Tape A	224.0.90.132	40004	CQS 5 / Tape B	224.0.90.164	40004
CQS 6 / Tape A	224.0.90.133	40005	CQS 6 / Tape B	224.0.90.165	40005
CQS 7 / Tape A	224.0.90.134	40006	CQS 7 / Tape B	224.0.90.166	40006
CQS 8 / Tape A	224.0.90.135	40007	CQS 8 / Tape B	224.0.90.167	40007
CQS 9 / Tape A	224.0.90.136	40008	CQS 9 / Tape B	224.0.90.168	40008
CQS 10 / Tape A	224.0.90.137	40009	CQS 10 / Tape B	224.0.90.169	40009
CQS 11 / Tape A	224.0.90.138	40010	CQS 11 / Tape B	224.0.90.170	40010
CQS 12 / Tape A	224.0.90.139	40011	CQS 12 / Tape B	224.0.90.171	40011

Appendix C - PILLAR SIP - CTS Production, Real-Time IP Multicast Feeds, Dual Sets (Network 'A' / Network 'B')

MULTICAST DATA: PRODUCTION "A-STREAM" & PRODUCTION "B-STREAM"

PRODUCT NAME:	CTS				
NETWORK SUBNETS:	SIX (6) NETWORK SUBNETS GROUPS PER DATA STREAM				

PRODUCTION "DATA STREAM - A" SUBNETS:					
224.0.89.0/28		224.0.89.16/28		224.0.89.32/28 224.0.89.48/28	224.0.86.112/31 224.0.86.114/31

Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CTS 1 / Tape A	224.0.89.0	40000	CTS 1 / Tape B	224.0.89.32	40000
CTS 2 / Tape A	224.0.89.1	40001	CTS 2 / Tape B	224.0.89.33	40001
CTS 3 / Tape A	224.0.89.2	40002	CTS 3 / Tape B	224.0.89.34	40002
CTS 4 / Tape A	224.0.89.3	40003	CTS 4 / Tape B	224.0.89.35	40003
CTS 5 / Tape A	224.0.89.4	40004	CTS 5 / Tape B	224.0.89.36	40004
CTS 6 / Tape A	224.0.89.5	40005	CTS 6 / Tape B	224.0.89.37	40005
CTS 7 / Tape A	224.0.89.6	40006	CTS 7 / Tape B	224.0.89.38	40006
CTS 8 / Tape A	224.0.89.7	40007	CTS 8 / Tape B	224.0.89.39	40007
CTS 9 / Tape A	224.0.89.8	40008	CTS 9 / Tape B	224.0.89.40	40008
CTS 10 / Tape A	224.0.89.9	40009	CTS 10 / Tape B	224.0.89.41	40009
CTS 11 / Tape A	224.0.89.10	40010	CTS 11 / Tape B	224.0.89.42	40010
CTS 12 / Tape A	224.0.89.11	40011	CTS 12 / Tape B	224.0.89.43	40011
			CTS INDEX 1 / Tape B	224.0.86.112	40000
			CTS INDEX 2 / Tape B	224.0.86.113	40001

PRODUCTION "DATA STREAM - B" SUBNETS:					
224.0.89.128/28		224.0.89.144/28		224.0.89.160/28 224.0.89.176/28	224.0.86.240/31 224.0.86.242/31

Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CTS 1 / Tape A	224.0.89.128	40000	CTS 1 / Tape B	224.0.89.160	40000
CTS 2 / Tape A	224.0.89.129	40001	CTS 2 / Tape B	224.0.89.161	40001
CTS 3 / Tape A	224.0.89.130	40002	CTS 3 / Tape B	224.0.89.162	40002
CTS 4 / Tape A	224.0.89.131	40003	CTS 4 / Tape B	224.0.89.163	40003
CTS 5 / Tape A	224.0.89.132	40004	CTS 5 / Tape B	224.0.89.164	40004
CTS 6 / Tape A	224.0.89.133	40005	CTS 6 / Tape B	224.0.89.165	40005
CTS 7 / Tape A	224.0.89.134	40006	CTS 7 / Tape B	224.0.89.166	40006
CTS 8 / Tape A	224.0.89.135	40007	CTS 8 / Tape B	224.0.89.167	40007
CTS 9 / Tape A	224.0.89.136	40008	CTS 9 / Tape B	224.0.89.168	40008
CTS 10 / Tape A	224.0.89.137	40009	CTS 10 / Tape B	224.0.89.169	40009
CTS 11 / Tape A	224.0.89.138	40010	CTS 11 / Tape B	224.0.89.170	40010
CTS 12 / Tape A	224.0.89.139	40011	CTS 12 / Tape B	224.0.89.171	40011
			CTS INDEX 1 / Tape B	224.0.86.240	40000
			CTS INDEX 2 / Tape B	224.0.86.241	40001

Appendix C - PILLAR SIP - CQS Retransmission & Playback Test IP Multicast Feeds, Dual Set (Network 'A' / Network 'B')

MULTICAST DATA: RETRANSMISSION & PLAYBACK TEST GROUP, DUAL SET EACH

PRODUCT NAME:	CQS
NETWORK SUBNETS:	FOUR (4) NETWORK SUBNETS GROUPS PER DATA STREAM

RETRANSMISSION "DATA STREAM - A" SUBNETS:

224.0.90.64/28			224.0.90.96/28		
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CQS 1 / Tape A	224.0.90.64	41000	CQS 1 / Tape B	224.0.90.96	41000
CQS 2 / Tape A	224.0.90.65	41001	CQS 2 / Tape B	224.0.90.97	41001
CQS 3 / Tape A	224.0.90.66	41002	CQS 3 / Tape B	224.0.90.98	41002
CQS 4 / Tape A	224.0.90.67	41003	CQS 4 / Tape B	224.0.90.99	41003
CQS 5 / Tape A	224.0.90.68	41004	CQS 5 / Tape B	224.0.90.100	41004
CQS 6 / Tape A	224.0.90.69	41005	CQS 6 / Tape B	224.0.90.101	41005
CQS 7 / Tape A	224.0.90.70	41006	CQS 7 / Tape B	224.0.90.102	41006
CQS 8 / Tape A	224.0.90.71	41007	CQS 8 / Tape B	224.0.90.103	41007
CQS 9 / Tape A	224.0.90.72	41008	CQS 9 / Tape B	224.0.90.104	41008
CQS 10 / Tape A	224.0.90.73	41009	CQS 10 / Tape B	224.0.90.105	41009
CQS 11 / Tape A	224.0.90.74	41010	CQS 11 / Tape B	224.0.90.106	41010
CQS 12 / Tape A	224.0.90.75	41011	CQS 12 / Tape B	224.0.90.107	41011

RETRANSMISSION "DATA STREAM - B" SUBNETS:

224.0.90.80/28			224.0.90.112/28		
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CQS 1 / Tape A	224.0.90.80	41000	CQS 1 / Tape B	224.0.90.112	41000
CQS 2 / Tape A	224.0.90.81	41001	CQS 2 / Tape B	224.0.90.113	41001
CQS 3 / Tape A	224.0.90.82	41002	CQS 3 / Tape B	224.0.90.114	41002
CQS 4 / Tape A	224.0.90.83	41003	CQS 4 / Tape B	224.0.90.115	41003
CQS 5 / Tape A	224.0.90.84	41004	CQS 5 / Tape B	224.0.90.116	41004
CQS 6 / Tape A	224.0.90.85	41005	CQS 6 / Tape B	224.0.90.117	41005
CQS 7 / Tape A	224.0.90.86	41006	CQS 7 / Tape B	224.0.90.118	41006
CQS 8 / Tape A	224.0.90.87	41007	CQS 8 / Tape B	224.0.90.119	41007
CQS 9 / Tape A	224.0.90.88	41008	CQS 9 / Tape B	224.0.90.120	41008
CQS 10 / Tape A	224.0.90.89	41009	CQS 10 / Tape B	224.0.90.121	41009
CQS 11 / Tape A	224.0.90.90	41010	CQS 11 / Tape B	224.0.90.122	41010
CQS 12 / Tape A	224.0.90.91	41011	CQS 12 / Tape B	224.0.90.123	41011

Appendix C - PILLAR SIP - CTS Retransmission & Playback Test IP Multicast Feeds, Dual Set (Network 'A' / Network 'B')

MULTICAST DATA: RETRANSMISSION & PLAYBACK TEST GROUP, DUAL SET EACH

PRODUCT NAME:	CTS	
NETWORK SUBNETS:	SIX (6) NETWORK SUBNETS GROUPS PER DATA STREAM	

RETRANSMISSION "DATA STREAM - A" SUBNETS:

224.0.89.64/28			224.0.89.96/28		224.0.86.116/31
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CTS 1 / Tape A	224.0.89.64	41000	CTS 1 / Tape B	224.0.89.96	41000
CTS 2 / Tape A	224.0.89.65	41001	CTS 2 / Tape B	224.0.89.97	41001
CTS 3 / Tape A	224.0.89.66	41002	CTS 3 / Tape B	224.0.89.98	41002
CTS 4 / Tape A	224.0.89.67	41003	CTS 4 / Tape B	224.0.89.99	41003
CTS 5 / Tape A	224.0.89.68	41004	CTS 5 / Tape B	224.0.89.100	41004
CTS 6 / Tape A	224.0.89.69	41005	CTS 6 / Tape B	224.0.89.101	41005
CTS 7 / Tape A	224.0.89.70	41006	CTS 7 / Tape B	224.0.89.102	41006
CTS 8 / Tape A	224.0.89.71	41007	CTS 8 / Tape B	224.0.89.103	41007
CTS 9 / Tape A	224.0.89.72	41008	CTS 9 / Tape B	224.0.89.104	41008
CTS 10 / Tape A	224.0.89.73	41009	CTS 10 / Tape B	224.0.89.105	41009
CTS 11 / Tape A	224.0.89.74	41010	CTS 11 / Tape B	224.0.89.106	41010
CTS 12 / Tape A	224.0.89.75	41011	CTS 12 / Tape B	224.0.89.107	41011
			CTS INDEX 1 / Tape B	224.0.86.116	41000
			CTS INDEX 2 / Tape B	224.0.86.117	41001

RETRANSMISSION "DATA STREAM - B" SUBNETS:

224.0.89.80/28			224.0.89.112/28		224.0.86.118/31
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CTS 1 / Tape A	224.0.89.80	41000	CTS 1 / Tape B	224.0.89.112	41000
CTS 2 / Tape A	224.0.89.81	41001	CTS 2 / Tape B	224.0.89.113	41001
CTS 3 / Tape A	224.0.89.82	41002	CTS 3 / Tape B	224.0.89.114	41002
CTS 4 / Tape A	224.0.89.83	41003	CTS 4 / Tape B	224.0.89.115	41003
CTS 5 / Tape A	224.0.89.84	41004	CTS 5 / Tape B	224.0.89.116	41004
CTS 6 / Tape A	224.0.89.85	41005	CTS 6 / Tape B	224.0.89.117	41005
CTS 7 / Tape A	224.0.89.86	41006	CTS 7 / Tape B	224.0.89.118	41006
CTS 8 / Tape A	224.0.89.87	41007	CTS 8 / Tape B	224.0.89.119	41007
CTS 9 / Tape A	224.0.89.88	41008	CTS 9 / Tape B	224.0.89.120	41008
CTS 10 / Tape A	224.0.89.89	41009	CTS 10 / Tape B	224.0.89.121	41009
CTS 11 / Tape A	224.0.89.90	41010	CTS 11 / Tape B	224.0.89.122	41010
CTS 12 / Tape A	224.0.89.91	41011	CTS 12 / Tape B	224.0.89.123	41011
			CTS INDEX 1 / Tape B	224.0.86.118	41000
			CTS INDEX 2 / Tape B	224.0.86.119	41001

Appendix C - PILLAR SIP - CQS Retransmission & Playback Test IP Multicast Feeds, Dual Set (Network 'A' / Network 'B')

MULTICAST DATA: RETRANSMISSION & PLAYBACK TEST GROUP, DUAL SET EACH

PRODUCT NAME:	CQS
NETWORK SUBNETS:	FOUR (4) NETWORK SUBNETS GROUPS PER DATA STREAM

PLAYBACK TEST "DATA STREAM - A" SUBNETS:

224.0.90.192/28			224.0.90.224/28		
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CQS 1 / Tape A	224.0.90.192	42000	CQS 1 / Tape B	224.0.90.224	42000
CQS 2 / Tape A	224.0.90.193	42001	CQS 2 / Tape B	224.0.90.225	42001
CQS 3 / Tape A	224.0.90.194	42002	CQS 3 / Tape B	224.0.90.226	42002
CQS 4 / Tape A	224.0.90.195	42003	CQS 4 / Tape B	224.0.90.227	42003
CQS 5 / Tape A	224.0.90.196	42004	CQS 5 / Tape B	224.0.90.228	42004
CQS 6 / Tape A	224.0.90.197	42005	CQS 6 / Tape B	224.0.90.229	42005
CQS 7 / Tape A	224.0.90.198	42006	CQS 7 / Tape B	224.0.90.230	42006
CQS 8 / Tape A	224.0.90.199	42007	CQS 8 / Tape B	224.0.90.231	42007
CQS 9 / Tape A	224.0.90.200	42008	CQS 9 / Tape B	224.0.90.232	42008
CQS 10 / Tape A	224.0.90.201	42009	CQS 10 / Tape B	224.0.90.233	42009
CQS 11 / Tape A	224.0.90.202	42010	CQS 11 / Tape B	224.0.90.234	42010
CQS 12 / Tape A	224.0.90.203	42011	CQS 12 / Tape B	224.0.90.235	42011

PLAYBACK TEST "DATA STREAM - B" SUBNETS:

224.0.90.208/28			224.0.90.240/28		
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CQS 1 / Tape A	224.0.90.208	42000	CQS 1 / Tape B	224.0.90.240	42000
CQS 2 / Tape A	224.0.90.209	42001	CQS 2 / Tape B	224.0.90.241	42001
CQS 3 / Tape A	224.0.90.210	42002	CQS 3 / Tape B	224.0.90.242	42002
CQS 4 / Tape A	224.0.90.211	42003	CQS 4 / Tape B	224.0.90.243	42003
CQS 5 / Tape A	224.0.90.212	42004	CQS 5 / Tape B	224.0.90.244	42004
CQS 6 / Tape A	224.0.90.213	42005	CQS 6 / Tape B	224.0.90.245	42005
CQS 7 / Tape A	224.0.90.214	42006	CQS 7 / Tape B	224.0.90.246	42006
CQS 8 / Tape A	224.0.90.215	42007	CQS 8 / Tape B	224.0.90.247	42007
CQS 9 / Tape A	224.0.90.216	42008	CQS 9 / Tape B	224.0.90.248	42008
CQS 10 / Tape A	224.0.90.217	42009	CQS 10 / Tape B	224.0.90.249	42009
CQS 11 / Tape A	224.0.90.218	42010	CQS 11 / Tape B	224.0.90.250	42010
CQS 12 / Tape A	224.0.90.219	42011	CQS 12 / Tape B	224.0.90.251	42011

Appendix C - PILLAR SIP - CTS Retransmission & Playback Test IP Multicast Feeds, Dual Set (Network 'A' / Network 'B')

MULTICAST DATA: RETRANSMISSION & PLAYBACK TEST GROUP, DUAL SET EACH

PRODUCT NAME:	CTS				
NETWORK SUBNETS:	SIX (6) NETWORK SUBNETS GROUPS PER DATA STREAM				

PLAYBACK TEST "DATA STREAM - A" SUBNETS:					
224.0.89.192/28			224.0.89.224/28		224.0.86.244/31
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CTS 1 / Tape A	224.0.89.192	42000	CTS 1 / Tape B	224.0.89.224	42000
CTS 2 / Tape A	224.0.89.193	42001	CTS 2 / Tape B	224.0.89.225	42001
CTS 3 / Tape A	224.0.89.194	42002	CTS 3 / Tape B	224.0.89.226	42002
CTS 4 / Tape A	224.0.89.195	42003	CTS 4 / Tape B	224.0.89.227	42003
CTS 5 / Tape A	224.0.89.196	42004	CTS 5 / Tape B	224.0.89.228	42004
CTS 6 / Tape A	224.0.89.197	42005	CTS 6 / Tape B	224.0.89.229	42005
CTS 7 / Tape A	224.0.89.198	42006	CTS 7 / Tape B	224.0.89.230	42006
CTS 8 / Tape A	224.0.89.199	42007	CTS 8 / Tape B	224.0.89.231	42007
CTS 9 / Tape A	224.0.89.200	42008	CTS 9 / Tape B	224.0.89.232	42008
CTS 10 / Tape A	224.0.89.201	42009	CTS 10 / Tape B	224.0.89.233	42009
CTS 11 / Tape A	224.0.89.202	42010	CTS 11 / Tape B	224.0.89.234	42010
CTS 12 / Tape A	224.0.89.203	42011	CTS 12 / Tape B	224.0.89.235	42011
			CTS INDEX 1 / Tape B	224.0.86.244	42000
			CTS INDEX 2 / Tape B	224.0.86.245	42001

PLAYBACK TEST "DATA STREAM - B" SUBNETS:					
224.0.89.208/28			224.0.89.240/28		224.0.86.246/31
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CTS 1 / Tape A	224.0.89.208	42000	CTS 1 / Tape B	224.0.89.240	42000
CTS 2 / Tape A	224.0.89.209	42001	CTS 2 / Tape B	224.0.89.241	42001
CTS 3 / Tape A	224.0.89.210	42002	CTS 3 / Tape B	224.0.89.242	42002
CTS 4 / Tape A	224.0.89.211	42003	CTS 4 / Tape B	224.0.89.243	42003
CTS 5 / Tape A	224.0.89.212	42004	CTS 5 / Tape B	224.0.89.244	42004
CTS 6 / Tape A	224.0.89.213	42005	CTS 6 / Tape B	224.0.89.245	42005
CTS 7 / Tape A	224.0.89.214	42006	CTS 7 / Tape B	224.0.89.246	42006
CTS 8 / Tape A	224.0.89.215	42007	CTS 8 / Tape B	224.0.89.247	42007
CTS 9 / Tape A	224.0.89.216	42008	CTS 9 / Tape B	224.0.89.248	42008
CTS 10 / Tape A	224.0.89.217	42009	CTS 10 / Tape B	224.0.89.249	42009
CTS 11 / Tape A	224.0.89.218	42010	CTS 11 / Tape B	224.0.89.250	42010
CTS 12 / Tape A	224.0.89.219	42011	CTS 12 / Tape B	224.0.89.251	42011
			CTS INDEX 1 / Tape B	224.0.86.246	42000
			CTS INDEX 2 / Tape B	224.0.86.247	42001