



SECURITIES INDUSTRY AUTOMATION CORPORATION

National Market Systems

Common IP Multicast Distribution Network

Recipient Interface Specification

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Version	Date	Rev by	Pages affected	Comments
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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)
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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 Bor subnets “.41 and .61”. - Removed decommissioned source addresses on Network Bor 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

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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
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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
1.48	12/16/20	WG	Pages 16, 23 and 24 Page 35 Page 42	-Added new IP Ranges for OPRA Pillar -Added Source Addresses for OPRA Pillar -Added Appendix D with new Multicast IP Addresses for OPRA Pillar
1.49	1/22/21	WG	Page 45 Page 46	-Corrected Subnet IP Address - Added Missing Subnet IP Address
1.50	6/14/21	WG	Pages 44, 47 and 50 Pages 51 thru 53	-Removed inactive IP addresses from OPRA Extended Session -Added Appendix E for new OPRA GTH multicast IP Addresses
1.51	1/24/22	WG	Pages 10, 12, 16, 23, 24, 42 and 43	-Added references and tables for new Snapshot line and IP Addresses -Removed old OPRA legacy IP Addresses and tables

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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 201-204 (Global Trading Hours)**) 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 E 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 two distinct 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, OPRA lines 1-48 (Regular Session) and OPRA lines 201-204 (Global Trading Hours)**. The recipient may choose to receive the retransmission data from either or both sites. See Appendices A through E for the table of multicast group mappings. Note: CTS Index lines 1-2 for Snapshot retransmissions is not supported.

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 distinct 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, OPRA lines 1-48 (Regular Session) and OPRA lines 201-204 (Global Trading Hours)**. See Appendices A through E for the table of multicast group mappings. Note: CTA After-Hours Playback Data for Snapshot is not supported.
- 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
 - 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 (26 total)
 - CQS Network A lines 1-12, CQS Network B lines 1-12 (24 total)
 - OPRA lines 1-48 Regular Session (48 total)
 - OPRA lines 201-204 Global Trading Hours (4 total)
- 254 Multicast Group ID's for Production retransmission data streams for day-time dissemination
 - Multicast Group breakdown = 2 sets of 102 redundant data streams which include 24 new CQS lines for Snapshot service
 - CTS Network A lines 1-12, CTS Network B lines 1-12, CTS Index lines 1-2 (26 total)
 - CQS Network A lines 1-12, CQS Network B lines 1-12 (48 total)
 - OPRA lines 1-48 Regular Session (48 total)
 - OPRA lines 201-204 Global Trading Hours (4 total)
- 204 Multicast Group ID's for After-Hours Playback test data streams for after-hours support
 - 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 (26 total)
 - CQS Network A lines 1-12, CQS Network B lines 1-12 (24 total)
 - OPRA lines 1-48 Regular Session (48 total)
 - OPRA lines 201-204 Global Trading Hours (4 total)

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 201-204 (Global Trading Hours). Therefore there will be 204 unique multicast groups allocated for the redundant delivery of these 102 lines (102 * 2 = 204).

- Each system line has two retransmission multicast address groups 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 E 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 a 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.

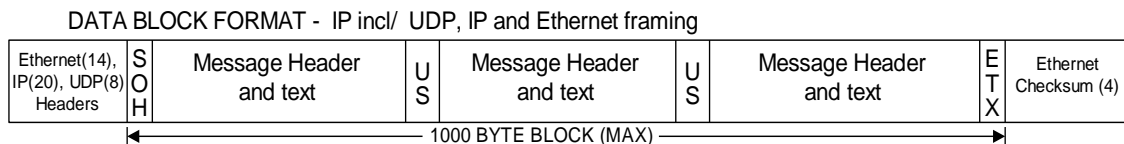


Figure 1 IP Data Block Format

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 E 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 E. Note that not all these addresses are in use.

SIAC Allocated Multicast IP Address Ranges

Starting Address	Ending Address
224.0.86.0	224.0.86.255
224.0.88.0	224.0.88.255
224.0.89.0	224.0.89.255
224.0.90.0	224.0.90.255
224.0.92.0	224.0.92.255
224.0.93.0	224.0.93.255
224.0.94.0	224.0.94.255
224.0.95.0	224.0.95.255

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.

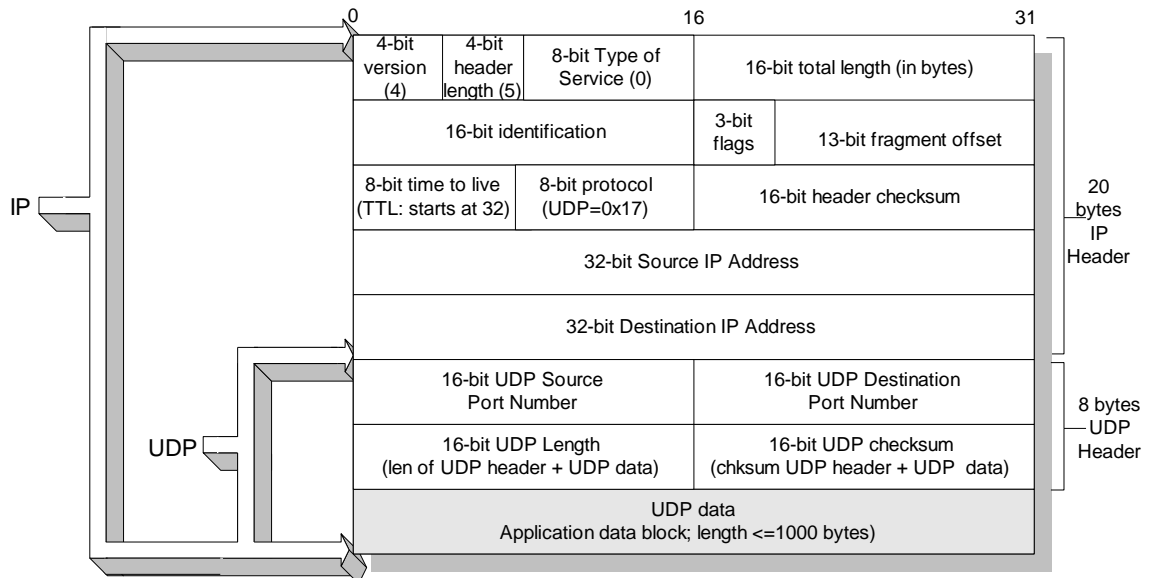


Figure 2 UDP/IP Datagram Format

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.

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 128 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 Edge 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 PIMRP’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 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 via BGP peering.

4.4.4.1 Multicast Entitlement Control

Multicast entitlement will be enforced at the ICE Global Network 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 ICE Global Network 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 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.

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 224.0.92.1 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 224.0.94.1

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:

- 224.0.86.0-224.0.86.15
- 224.0.86.112 - 224.0.86.115
- 224.0.86.126 - 224.0.86.127
- 224.0.86.120 - 224.0.86.122
- 224.0.88.0 - 224.0.88.127
- 224.0.89.0 - 224.0.89.63
- 224.0.90.0 - 224.0.90.63
- 224.0.92.0 - 224.0.92.127

NMS Production IP Multicast Feeds Group B:

- 224.0.86.128 – 224.0.86.143
- 224.0.86.240 - 224.0.86.243
- 224.0.86.248 - 224.0.86.250
- 224.0.86.254 - 224.0.86.255
- 224.0.88.128 - 224.0.88.255
- 224.0.89.128 - 224.0.89.191
- 224.0.90.128 - 224.0.90.191
- 224.0.94.0 - 224.0.94.127

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). OPRA, supports dual data stream sets for retransmission and playback test data feeds (Appendix D). 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:

- 224.0.86.16-224.0.86.31
- 224.0.86.116 – 224.0.86.119
- 224.0.86.144 - 224.0.86.159
- 224.0.88.0 - 224.0.88.255
- 224.0.89.64 - 224.0.89.127
- 224.0.90.64 - 224.0.90.127
- 224.0.92.128 - 224.0.92.255
- 224.0.94.128 - 224.0.94.255

NMS Playback Group ID Ranges:

- 224.0.86.32 – 224.0.86.47
- 224.0.86.136 - 224.0.86.143
- 224.0.86.160 - 224.0.86.175
- 224.0.86.244 – 224.0.86.247
- 224.0.89.192 - 224.0.89.255
- 224.0.90.192 - 224.0.90.255
- 224.0.93.0 - 224.0.93.127
- 224.0.95.0 - 224.0.95.127

7 Appendix B- Rendezvous Points and SIP Data Center Source Addresses

RENDEZVOUS POINTS FOR NMS NETWORK AND ICE GLOBAL NETWORK

NETWORK CONNECTION	RP Address - A STREAM	RP Address - B STREAM
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
OPRA Multicast A	162.69.40.0/24	162.68.40.0/24
OPRA Multicast B	162.69.41.0/24	162.68.41.0/24

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

8 Appendix C- 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- CQS Retransmission IP Multicast Feeds, Dual Set (Network 'A' / Network 'B')

MULTICAST DATA: RETRANSMISSION GROUP, DUAL SET

PRODUCT NAME:		CQS			
NETWORK SUBNETS:		TWO (2) 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- CQS Playback Test IP Multicast Feeds, Dual Set (Network 'A' / Network 'B')

MULTICAST DATA: PLAYBACK TEST GROUP, DUAL SET

PRODUCT NAME:		CQS			
NETWORK SUBNETS:		TWO (2) 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- CQS Snapshot Retransmission IP Multicast Feeds, Dual Set (Network 'A' / Network 'B')

MULTICAST DATA: SNAPSHOT RETRANSMISSION GROUP, DUAL SET

PRODUCT NAME:		CQS			
NETWORK SUBNETS:		TWO (2) NETWORK SUBNETS GROUPS PER DATA STREAM			
SNAPSHOT RETRANSMISSION "DATA STREAM - A" SUBNETS:					
224.0.88.0/27			224.0.88.0.32/27		
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CQS 1 / Tape A	224.0.88.0	43000	CQS 1 / Tape B	224.0.88.32	43000
CQS 2 / Tape A	224.0.88.1	43001	CQS 2 / Tape B	224.0.88.33	43001
CQS 3 / Tape A	224.0.88.2	43002	CQS 3 / Tape B	224.0.88.34	43002
CQS 4 / Tape A	224.0.88.3	43003	CQS 4 / Tape B	224.0.88.35	43003
CQS 5 / Tape A	224.0.88.4	43004	CQS 5 / Tape B	224.0.88.36	43004
CQS 6 / Tape A	224.0.88.5	43005	CQS 6 / Tape B	224.0.88.37	43005
CQS 7 / Tape A	224.0.88.6	43006	CQS 7 / Tape B	224.0.88.38	43006
CQS 8 / Tape A	224.0.88.7	43007	CQS 8 / Tape B	224.0.88.39	43007
CQS 9 / Tape A	224.0.88.8	43008	CQS 9 / Tape B	224.0.88.40	43008
CQS 10 / Tape A	224.0.88.9	43009	CQS 10 / Tape B	224.0.88.41	43009
CQS 11 / Tape A	224.0.88.10	43010	CQS 11 / Tape B	224.0.88.42	43010
CQS 12 / Tape A	224.0.88.11	43011	CQS 12 / Tape B	224.0.88.43	43011
SNAPSHOT RETRANSMISSION "DATA STREAM - B" SUBNETS:					
224.0.88.128/27			224.0.88.160/27		
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
CQS 1 / Tape A	224.0.88.128	43000	CQS 1 / Tape B	224.0.88.160	43000
CQS 2 / Tape A	224.0.88.129	43001	CQS 2 / Tape B	224.0.88.161	43001
CQS 3 / Tape A	224.0.88.130	43002	CQS 3 / Tape B	224.0.88.162	43002
CQS 4 / Tape A	224.0.88.131	43003	CQS 4 / Tape B	224.0.88.163	43003
CQS 5 / Tape A	224.0.88.132	43004	CQS 5 / Tape B	224.0.88.164	43004
CQS 6 / Tape A	224.0.88.133	43005	CQS 6 / Tape B	224.0.88.165	43005
CQS 7 / Tape A	224.0.88.134	43006	CQS 7 / Tape B	224.0.88.166	43006
CQS 8 / Tape A	224.0.88.135	43007	CQS 8 / Tape B	224.0.88.167	43007
CQS 9 / Tape A	224.0.88.136	43008	CQS 9 / Tape B	224.0.88.168	43008
CQS 10 / Tape A	224.0.88.137	43009	CQS 10 / Tape B	224.0.88.169	43009
CQS 11 / Tape A	224.0.88.138	43010	CQS 11 / Tape B	224.0.88.170	43010
CQS 12 / Tape A	224.0.88.139	43011	CQS 12 / Tape B	224.0.88.171	43011

Appendix C- 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- CTS Retransmission IP Multicast Feeds, Dual Set (Network 'A' / Network 'B')

MULTICAST DATA: RETRANSMISSION GROUP, DUAL SET

PRODUCT NAME:		CTS			
NETWORK SUBNETS:		THREE (3) 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- CTS Playback Test IP Multicast Feeds, Dual Sets (Network 'A' / Network 'B')

MULTICAST DATA: PLAYBACK TEST GROUP, DUAL SET

PRODUCT NAME:		CTS			
NETWORK SUBNETS:		THREE (3) 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

9 Appendix D- OPRA Regular Session Production, Real-Time IP Multicast Feeds, (Network 'A' only)

PRODUCT NAME:			OPRA Regular Session		
Network Subnet:			ONE (1) NETWORK SUBNET GROUP PER DATA STREAM		
PRODUCTION "DATA STREAM - A" SUBNET: 224.0.92.0/25					
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
OPRA 1	224.0.92.1	40001	OPRA 49	224.0.92.49	40049
OPRA 2	224.0.92.2	40002	OPRA 50	224.0.92.50	40050
OPRA 3	224.0.92.3	40003	OPRA 51	224.0.92.51	40051
OPRA 4	224.0.92.4	40004	OPRA 52	224.0.92.52	40052
OPRA 5	224.0.92.5	40005	OPRA 53	224.0.92.53	40053
OPRA 6	224.0.92.6	40006	OPRA 54	224.0.92.54	40054
OPRA 7	224.0.92.7	40007	OPRA 55	224.0.92.55	40055
OPRA 8	224.0.92.8	40008	OPRA 56	224.0.92.56	40056
OPRA 9	224.0.92.9	40009	OPRA 57	224.0.92.57	40057
OPRA 10	224.0.92.10	40010	OPRA 58	224.0.92.58	40058
OPRA 11	224.0.92.11	40011	OPRA 59	224.0.92.59	40059
OPRA 12	224.0.92.12	40012	OPRA 60	224.0.92.60	40060
OPRA 13	224.0.92.13	40013	OPRA 61	224.0.92.61	40061
OPRA 14	224.0.92.14	40014	OPRA 62	224.0.92.62	40062
OPRA 15	224.0.92.15	40015	OPRA 63	224.0.92.63	40063
OPRA 16	224.0.92.16	40016	OPRA 64	224.0.92.64	40064
OPRA 17	224.0.92.17	40017	OPRA 65	224.0.92.65	40065
OPRA 18	224.0.92.18	40018	OPRA 66	224.0.92.66	40066
OPRA 19	224.0.92.19	40019	OPRA 67	224.0.92.67	40067
OPRA 20	224.0.92.20	40020	OPRA 68	224.0.92.68	40068
OPRA 21	224.0.92.21	40021	OPRA 69	224.0.92.69	40069
OPRA 22	224.0.92.22	40022	OPRA 70	224.0.92.70	40070
OPRA 23	224.0.92.23	40023	OPRA 71	224.0.92.71	40071
OPRA 24	224.0.92.24	40024	OPRA 72	224.0.92.72	40072
OPRA 25	224.0.92.25	40025	OPRA 73	224.0.92.73	40073
OPRA 26	224.0.92.26	40026	OPRA 74	224.0.92.74	40074
OPRA 27	224.0.92.27	40027	OPRA 75	224.0.92.75	40075
OPRA 28	224.0.92.28	40028	OPRA 76	224.0.92.76	40076
OPRA 29	224.0.92.29	40029	OPRA 77	224.0.92.77	40077
OPRA 30	224.0.92.30	40030	OPRA 78	224.0.92.78	40078
OPRA 31	224.0.92.31	40031	OPRA 79	224.0.92.79	40079
OPRA 32	224.0.92.32	40032	OPRA 80	224.0.92.80	40080
OPRA 33	224.0.92.33	40033	OPRA 81	224.0.92.81	40081
OPRA 34	224.0.92.34	40034	OPRA 82	224.0.92.82	40082
OPRA 35	224.0.92.35	40035	OPRA 83	224.0.92.83	40083
OPRA 36	224.0.92.36	40036	OPRA 84	224.0.92.84	40084
OPRA 37	224.0.92.37	40037	OPRA 85	224.0.92.85	40085
OPRA 38	224.0.92.38	40038	OPRA 86	224.0.92.86	40086
OPRA 39	224.0.92.39	40039	OPRA 87	224.0.92.87	40087
OPRA 40	224.0.92.40	40040	OPRA 88	224.0.92.88	40088
OPRA 41	224.0.92.41	40041	OPRA 89	224.0.92.89	40089
OPRA 42	224.0.92.42	40042	OPRA 90	224.0.92.90	40090
OPRA 43	224.0.92.43	40043	OPRA 91	224.0.92.91	40091
OPRA 44	224.0.92.44	40044	OPRA 92	224.0.92.92	40092
OPRA 45	224.0.92.45	40045	OPRA 93	224.0.92.93	40093
OPRA 46	224.0.92.46	40046	OPRA 94	224.0.92.94	40094
OPRA 47	224.0.92.47	40047	OPRA 95	224.0.92.95	40095
OPRA 48	224.0.92.48	40048	OPRA 96	224.0.92.96	40096

Appendix D- OPRA Regular Session Production, Real-Time IP Multicast Feeds, (Network 'B' only)

PRODUCT NAME:		OPRA Regular Session			
Network Subnet:		ONE (1) NETWORK SUBNET GROUP PER DATA STREAM			
PRODUCTION "DATA STREAM - B" SUBNET: 224.0.94.0/25					
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
OPRA 1	224.0.94.1	40001	OPRA 49	224.0.94.49	40049
OPRA 2	224.0.94.2	40002	OPRA 50	224.0.94.50	40050
OPRA 3	224.0.94.3	40003	OPRA 51	224.0.94.51	40051
OPRA 4	224.0.94.4	40004	OPRA 52	224.0.94.52	40052
OPRA 5	224.0.94.5	40005	OPRA 53	224.0.94.53	40053
OPRA 6	224.0.94.6	40006	OPRA 54	224.0.94.54	40054
OPRA 7	224.0.94.7	40007	OPRA 55	224.0.94.55	40055
OPRA 8	224.0.94.8	40008	OPRA 56	224.0.94.56	40056
OPRA 9	224.0.94.9	40009	OPRA 57	224.0.94.57	40057
OPRA 10	224.0.94.10	40010	OPRA 58	224.0.94.58	40058
OPRA 11	224.0.94.11	40011	OPRA 59	224.0.94.59	40059
OPRA 12	224.0.94.12	40012	OPRA 60	224.0.94.60	40060
OPRA 13	224.0.94.13	40013	OPRA 61	224.0.94.61	40061
OPRA 14	224.0.94.14	40014	OPRA 62	224.0.94.62	40062
OPRA 15	224.0.94.15	40015	OPRA 63	224.0.94.63	40063
OPRA 16	224.0.94.16	40016	OPRA 64	224.0.94.64	40064
OPRA 17	224.0.94.17	40017	OPRA 65	224.0.94.65	40065
OPRA 18	224.0.94.18	40018	OPRA 66	224.0.94.66	40066
OPRA 19	224.0.94.19	40019	OPRA 67	224.0.94.67	40067
OPRA 20	224.0.94.20	40020	OPRA 68	224.0.94.68	40068
OPRA 21	224.0.94.21	40021	OPRA 69	224.0.94.69	40069
OPRA 22	224.0.94.22	40022	OPRA 70	224.0.94.70	40070
OPRA 23	224.0.94.23	40023	OPRA 71	224.0.94.71	40071
OPRA 24	224.0.94.24	40024	OPRA 72	224.0.94.72	40072
OPRA 25	224.0.94.25	40025	OPRA 73	224.0.94.73	40073
OPRA 26	224.0.94.26	40026	OPRA 74	224.0.94.74	40074
OPRA 27	224.0.94.27	40027	OPRA 75	224.0.94.75	40075
OPRA 28	224.0.94.28	40028	OPRA 76	224.0.94.76	40076
OPRA 29	224.0.94.29	40029	OPRA 77	224.0.94.77	40077
OPRA 30	224.0.94.30	40030	OPRA 78	224.0.94.78	40078
OPRA 31	224.0.94.31	40031	OPRA 79	224.0.94.79	40079
OPRA 32	224.0.94.32	40032	OPRA 80	224.0.94.80	40080
OPRA 33	224.0.94.33	40033	OPRA 81	224.0.94.81	40081
OPRA 34	224.0.94.34	40034	OPRA 82	224.0.94.82	40082
OPRA 35	224.0.94.35	40035	OPRA 83	224.0.94.83	40083
OPRA 36	224.0.94.36	40036	OPRA 84	224.0.94.84	40084
OPRA 37	224.0.94.37	40037	OPRA 85	224.0.94.85	40085
OPRA 38	224.0.94.38	40038	OPRA 86	224.0.94.86	40086
OPRA 39	224.0.94.39	40039	OPRA 87	224.0.94.87	40087
OPRA 40	224.0.94.40	40040	OPRA 88	224.0.94.88	40088
OPRA 41	224.0.94.41	40041	OPRA 89	224.0.94.89	40089
OPRA 42	224.0.94.42	40042	OPRA 90	224.0.94.90	40090
OPRA 43	224.0.94.43	40043	OPRA 91	224.0.94.91	40091
OPRA 44	224.0.94.44	40044	OPRA 92	224.0.94.92	40092
OPRA 45	224.0.94.45	40045	OPRA 93	224.0.94.93	40093
OPRA 46	224.0.94.46	40046	OPRA 94	224.0.94.94	40094
OPRA 47	224.0.94.47	40047	OPRA 95	224.0.94.95	40095
OPRA 48	224.0.94.48	40048	OPRA 96	224.0.94.96	40096

Appendix D- OPRA Regular Session Retransmission IP Multicast Feeds, (Network 'A' only)

PRODUCT NAME:			OPRA Regular Session		
Network Subnet:			ONE (1) NETWORK SUBNET GROUP PER DATA STREAM		
RETRANSMISSION "DATA STREAM - A" SUBNET: 224.0.92.128/25					
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
OPRA 1	224.0.92.128	41001	OPRA 49	224.0.92.176	41049
OPRA 2	224.0.92.129	41002	OPRA 50	224.0.92.177	41050
OPRA 3	224.0.92.130	41003	OPRA 51	224.0.92.178	41051
OPRA 4	224.0.92.131	41004	OPRA 52	224.0.92.179	41052
OPRA 5	224.0.92.132	41005	OPRA 53	224.0.92.180	41053
OPRA 6	224.0.92.133	41006	OPRA 54	224.0.92.181	41054
OPRA 7	224.0.92.134	41007	OPRA 55	224.0.92.182	41055
OPRA 8	224.0.92.135	41008	OPRA 56	224.0.92.183	41056
OPRA 9	224.0.92.136	41009	OPRA 57	224.0.92.184	41057
OPRA 10	224.0.92.137	41010	OPRA 58	224.0.92.185	41058
OPRA 11	224.0.92.138	41011	OPRA 59	224.0.92.186	41059
OPRA 12	224.0.92.139	41012	OPRA 60	224.0.92.187	41060
OPRA 13	224.0.92.140	41013	OPRA 61	224.0.92.188	41061
OPRA 14	224.0.92.141	41014	OPRA 62	224.0.92.189	41062
OPRA 15	224.0.92.142	41015	OPRA 63	224.0.92.190	41063
OPRA 16	224.0.92.143	41016	OPRA 64	224.0.92.191	41064
OPRA 17	224.0.92.144	41017	OPRA 65	224.0.92.192	41065
OPRA 18	224.0.92.145	41018	OPRA 66	224.0.92.193	41066
OPRA 19	224.0.92.146	41019	OPRA 67	224.0.92.194	41067
OPRA 20	224.0.92.147	41020	OPRA 68	224.0.92.195	41068
OPRA 21	224.0.92.148	41021	OPRA 69	224.0.92.196	41069
OPRA 22	224.0.92.149	41022	OPRA 70	224.0.92.197	41070
OPRA 23	224.0.92.150	41023	OPRA 71	224.0.92.198	41071
OPRA 24	224.0.92.151	41024	OPRA 72	224.0.92.199	41072
OPRA 25	224.0.92.152	41025	OPRA 73	224.0.92.200	41073
OPRA 26	224.0.92.153	41026	OPRA 74	224.0.92.201	41074
OPRA 27	224.0.92.154	41027	OPRA 75	224.0.92.202	41075
OPRA 28	224.0.92.155	41028	OPRA 76	224.0.92.203	41076
OPRA 29	224.0.92.156	41029	OPRA 77	224.0.92.204	41077
OPRA 30	224.0.92.157	41030	OPRA 78	224.0.92.205	41078
OPRA 31	224.0.92.158	41031	OPRA 79	224.0.92.206	41079
OPRA 32	224.0.92.159	41032	OPRA 80	224.0.92.207	41080
OPRA 33	224.0.92.160	41033	OPRA 81	224.0.92.208	41081
OPRA 34	224.0.92.161	41034	OPRA 82	224.0.92.209	41082
OPRA 35	224.0.92.162	41035	OPRA 83	224.0.92.210	41083
OPRA 36	224.0.92.163	41036	OPRA 84	224.0.92.211	41084
OPRA 37	224.0.92.164	41037	OPRA 85	224.0.92.212	41085
OPRA 38	224.0.92.165	41038	OPRA 86	224.0.92.213	41086
OPRA 39	224.0.92.166	41039	OPRA 87	224.0.92.214	41087
OPRA 40	224.0.92.167	41040	OPRA 88	224.0.92.215	41088
OPRA 41	224.0.92.168	41041	OPRA 89	224.0.92.216	41089
OPRA 42	224.0.92.169	41042	OPRA 90	224.0.92.217	41090
OPRA 43	224.0.92.170	41043	OPRA 91	224.0.92.218	41091
OPRA 44	224.0.92.171	41044	OPRA 92	224.0.92.219	41092
OPRA 45	224.0.92.172	41045	OPRA 93	224.0.92.220	41093
OPRA 46	224.0.92.173	41046	OPRA 94	224.0.92.221	41094
OPRA 47	224.0.92.174	41047	OPRA 95	224.0.92.222	41095
OPRA 48	224.0.92.175	41048	OPRA 96	224.0.92.223	41096

Appendix D- OPRA Regular Session Retransmission IP Multicast Feeds, (Network 'B' only)

PRODUCT NAME:		OPRA Regular Session			
Network Subnet:		ONE (1) NETWORK SUBNET GROUP PER DATA STREAM			
RETRANSMISSION "DATA STREAM - B" SUBNET: 224.0.94.128/25					
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
OPRA 1	224.0.94.128	41001	OPRA 49	224.0.94.176	41049
OPRA 2	224.0.94.129	41002	OPRA 50	224.0.94.177	41050
OPRA 3	224.0.94.130	41003	OPRA 51	224.0.94.178	41051
OPRA 4	224.0.94.131	41004	OPRA 52	224.0.94.179	41052
OPRA 5	224.0.94.132	41005	OPRA 53	224.0.94.180	41053
OPRA 6	224.0.94.133	41006	OPRA 54	224.0.94.181	41054
OPRA 7	224.0.94.134	41007	OPRA 55	224.0.94.182	41055
OPRA 8	224.0.94.135	41008	OPRA 56	224.0.94.183	41056
OPRA 9	224.0.94.136	41009	OPRA 57	224.0.94.184	41057
OPRA 10	224.0.94.137	41010	OPRA 58	224.0.94.185	41058
OPRA 11	224.0.94.138	41011	OPRA 59	224.0.94.186	41059
OPRA 12	224.0.94.139	41012	OPRA 60	224.0.94.187	41060
OPRA 13	224.0.94.140	41013	OPRA 61	224.0.94.188	41061
OPRA 14	224.0.94.141	41014	OPRA 62	224.0.94.189	41062
OPRA 15	224.0.94.142	41015	OPRA 63	224.0.94.190	41063
OPRA 16	224.0.94.143	41016	OPRA 64	224.0.94.191	41064
OPRA 17	224.0.94.144	41017	OPRA 65	224.0.94.192	41065
OPRA 18	224.0.94.145	41018	OPRA 66	224.0.94.193	41066
OPRA 19	224.0.94.146	41019	OPRA 67	224.0.94.194	41067
OPRA 20	224.0.94.147	41020	OPRA 68	224.0.94.195	41068
OPRA 21	224.0.94.148	41021	OPRA 69	224.0.94.196	41069
OPRA 22	224.0.94.149	41022	OPRA 70	224.0.94.197	41070
OPRA 23	224.0.94.150	41023	OPRA 71	224.0.94.198	41071
OPRA 24	224.0.94.151	41024	OPRA 72	224.0.94.199	41072
OPRA 25	224.0.94.152	41025	OPRA 73	224.0.94.200	41073
OPRA 26	224.0.94.153	41026	OPRA 74	224.0.94.201	41074
OPRA 27	224.0.94.154	41027	OPRA 75	224.0.94.202	41075
OPRA 28	224.0.94.155	41028	OPRA 76	224.0.94.203	41076
OPRA 29	224.0.94.156	41029	OPRA 77	224.0.94.204	41077
OPRA 30	224.0.94.157	41030	OPRA 78	224.0.94.205	41078
OPRA 31	224.0.94.158	41031	OPRA 79	224.0.94.206	41079
OPRA 32	224.0.94.159	41032	OPRA 80	224.0.94.207	41080
OPRA 33	224.0.94.160	41033	OPRA 81	224.0.94.208	41081
OPRA 34	224.0.94.161	41034	OPRA 82	224.0.94.209	41082
OPRA 35	224.0.94.162	41035	OPRA 83	224.0.94.210	41083
OPRA 36	224.0.94.163	41036	OPRA 84	224.0.94.211	41084
OPRA 37	224.0.94.164	41037	OPRA 85	224.0.94.212	41085
OPRA 38	224.0.94.165	41038	OPRA 86	224.0.94.213	41086
OPRA 39	224.0.94.166	41039	OPRA 87	224.0.94.214	41087
OPRA 40	224.0.94.167	41040	OPRA 88	224.0.94.215	41088
OPRA 41	224.0.94.168	41041	OPRA 89	224.0.94.216	41089
OPRA 42	224.0.94.169	41042	OPRA 90	224.0.94.217	41090
OPRA 43	224.0.94.170	41043	OPRA 91	224.0.94.218	41091
OPRA 44	224.0.94.171	41044	OPRA 92	224.0.94.219	41092
OPRA 45	224.0.94.172	41045	OPRA 93	224.0.94.220	41093
OPRA 46	224.0.94.173	41046	OPRA 94	224.0.94.221	41094
OPRA 47	224.0.94.174	41047	OPRA 95	224.0.94.222	41095
OPRA 48	224.0.94.175	41048	OPRA 96	224.0.94.223	41096

Appendix D - OPRA Regular Session Playback Test IP Multicast Feeds, (Network 'A' only)

PRODUCT NAME:			OPRA Regular Session		
Network Subnet:			ONE (1) NETWORK SUBNET GROUP PER DATA STREAM		
PLAYBACK TEST "DATA STREAM - A" SUBNET: 224.0.93.0/25					
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
OPRA 1	224.0.93.1	42001	OPRA 49	224.0.93.49	42049
OPRA 2	224.0.93.2	42002	OPRA 50	224.0.93.50	42050
OPRA 3	224.0.93.3	42003	OPRA 51	224.0.93.51	42051
OPRA 4	224.0.93.4	42004	OPRA 52	224.0.93.52	42052
OPRA 5	224.0.93.5	42005	OPRA 53	224.0.93.53	42053
OPRA 6	224.0.93.6	42006	OPRA 54	224.0.93.54	42054
OPRA 7	224.0.93.7	42007	OPRA 55	224.0.93.55	42055
OPRA 8	224.0.93.8	42008	OPRA 56	224.0.93.56	42056
OPRA 9	224.0.93.9	42009	OPRA 57	224.0.93.57	42057
OPRA 10	224.0.93.10	42010	OPRA 58	224.0.93.58	42058
OPRA 11	224.0.93.11	42011	OPRA 59	224.0.93.59	42059
OPRA 12	224.0.93.12	42012	OPRA 60	224.0.93.60	42060
OPRA 13	224.0.93.13	42013	OPRA 61	224.0.93.61	42061
OPRA 14	224.0.93.14	42014	OPRA 62	224.0.93.62	42062
OPRA 15	224.0.93.15	42015	OPRA 63	224.0.93.63	42063
OPRA 16	224.0.93.16	42016	OPRA 64	224.0.93.64	42064
OPRA 17	224.0.93.17	42017	OPRA 65	224.0.93.65	42065
OPRA 18	224.0.93.18	42018	OPRA 66	224.0.93.66	42066
OPRA 19	224.0.93.19	42019	OPRA 67	224.0.93.67	42067
OPRA 20	224.0.93.20	42020	OPRA 68	224.0.93.68	42068
OPRA 21	224.0.93.21	42021	OPRA 69	224.0.93.69	42069
OPRA 22	224.0.93.22	42022	OPRA 70	224.0.93.70	42070
OPRA 23	224.0.93.23	42023	OPRA 71	224.0.93.71	42071
OPRA 24	224.0.93.24	42024	OPRA 72	224.0.93.72	42072
OPRA 25	224.0.93.25	42025	OPRA 73	224.0.93.73	42073
OPRA 26	224.0.93.26	42026	OPRA 74	224.0.93.74	42074
OPRA 27	224.0.93.27	42027	OPRA 75	224.0.93.75	42075
OPRA 28	224.0.93.28	42028	OPRA 76	224.0.93.76	42076
OPRA 29	224.0.93.29	42029	OPRA 77	224.0.93.77	42077
OPRA 30	224.0.93.30	42030	OPRA 78	224.0.93.78	42078
OPRA 31	224.0.93.31	42031	OPRA 79	224.0.93.79	42079
OPRA 32	224.0.93.32	42032	OPRA 80	224.0.93.80	42080
OPRA 33	224.0.93.33	42033	OPRA 81	224.0.93.81	42081
OPRA 34	224.0.93.34	42034	OPRA 82	224.0.93.82	42082
OPRA 35	224.0.93.35	42035	OPRA 83	224.0.93.83	42083
OPRA 36	224.0.93.36	42036	OPRA 84	224.0.93.84	42084
OPRA 37	224.0.93.37	42037	OPRA 85	224.0.93.85	42085
OPRA 38	224.0.93.38	42038	OPRA 86	224.0.93.86	42086
OPRA 39	224.0.93.39	42039	OPRA 87	224.0.93.87	42087
OPRA 40	224.0.93.40	42040	OPRA 88	224.0.93.88	42088
OPRA 41	224.0.93.41	42041	OPRA 89	224.0.93.89	42089
OPRA 42	224.0.93.42	42042	OPRA 90	224.0.93.90	42090
OPRA 43	224.0.93.43	42043	OPRA 91	224.0.93.91	42091
OPRA 44	224.0.93.44	42044	OPRA 92	224.0.93.92	42092
OPRA 45	224.0.93.45	42045	OPRA 93	224.0.93.93	42093
OPRA 46	224.0.93.46	42046	OPRA 94	224.0.93.94	42094
OPRA 47	224.0.93.47	42047	OPRA 95	224.0.93.95	42095
OPRA 48	224.0.93.48	42048	OPRA 96	224.0.93.96	42096

Appendix D- OPRA Regular Session Playback Test IP Multicast Feeds, (Network 'B' only)

PRODUCT NAME:			OPRA Regular Session		
Network Subnet:			ONE (1) NETWORK SUBNET GROUP PER DATA STREAM		
PLAYBACK TEST "DATA STREAM - B" SUBNET: 224.0.95.0/25					
Originated Data Line	Multicast Group Address	Multicast Group Port	Originated Data Line	Multicast Group Address	Multicast Group Port
OPRA 1	224.0.95.1	42001	OPRA 49	224.0.95.49	42049
OPRA 2	224.0.95.2	42002	OPRA 50	224.0.95.50	42050
OPRA 3	224.0.95.3	42003	OPRA 51	224.0.95.51	42051
OPRA 4	224.0.95.4	42004	OPRA 52	224.0.95.52	42052
OPRA 5	224.0.95.5	42005	OPRA 53	224.0.95.53	42053
OPRA 6	224.0.95.6	42006	OPRA 54	224.0.95.54	42054
OPRA 7	224.0.95.7	42007	OPRA 55	224.0.95.55	42055
OPRA 8	224.0.95.8	42008	OPRA 56	224.0.95.56	42056
OPRA 9	224.0.95.9	42009	OPRA 57	224.0.95.57	42057
OPRA 10	224.0.95.10	42010	OPRA 58	224.0.95.58	42058
OPRA 11	224.0.95.11	42011	OPRA 59	224.0.95.59	42059
OPRA 12	224.0.95.12	42012	OPRA 60	224.0.95.60	42060
OPRA 13	224.0.95.13	42013	OPRA 61	224.0.95.61	42061
OPRA 14	224.0.95.14	42014	OPRA 62	224.0.95.62	42062
OPRA 15	224.0.95.15	42015	OPRA 63	224.0.95.63	42063
OPRA 16	224.0.95.16	42016	OPRA 64	224.0.95.64	42064
OPRA 17	224.0.95.17	42017	OPRA 65	224.0.95.65	42065
OPRA 18	224.0.95.18	42018	OPRA 66	224.0.95.66	42066
OPRA 19	224.0.95.19	42019	OPRA 67	224.0.95.67	42067
OPRA 20	224.0.95.20	42020	OPRA 68	224.0.95.68	42068
OPRA 21	224.0.95.21	42021	OPRA 69	224.0.95.69	42069
OPRA 22	224.0.95.22	42022	OPRA 70	224.0.95.70	42070
OPRA 23	224.0.95.23	42023	OPRA 71	224.0.95.71	42071
OPRA 24	224.0.95.24	42024	OPRA 72	224.0.95.72	42072
OPRA 25	224.0.95.25	42025	OPRA 73	224.0.95.73	42073
OPRA 26	224.0.95.26	42026	OPRA 74	224.0.95.74	42074
OPRA 27	224.0.95.27	42027	OPRA 75	224.0.95.75	42075
OPRA 28	224.0.95.28	42028	OPRA 76	224.0.95.76	42076
OPRA 29	224.0.95.29	42029	OPRA 77	224.0.95.77	42077
OPRA 30	224.0.95.30	42030	OPRA 78	224.0.95.78	42078
OPRA 31	224.0.95.31	42031	OPRA 79	224.0.95.79	42079
OPRA 32	224.0.95.32	42032	OPRA 80	224.0.95.80	42080
OPRA 33	224.0.95.33	42033	OPRA 81	224.0.95.81	42081
OPRA 34	224.0.95.34	42034	OPRA 82	224.0.95.82	42082
OPRA 35	224.0.95.35	42035	OPRA 83	224.0.95.83	42083
OPRA 36	224.0.95.36	42036	OPRA 84	224.0.95.84	42084
OPRA 37	224.0.95.37	42037	OPRA 85	224.0.95.85	42085
OPRA 38	224.0.95.38	42038	OPRA 86	224.0.95.86	42086
OPRA 39	224.0.95.39	42039	OPRA 87	224.0.95.87	42087
OPRA 40	224.0.95.40	42040	OPRA 88	224.0.95.88	42088
OPRA 41	224.0.95.41	42041	OPRA 89	224.0.95.89	42089
OPRA 42	224.0.95.42	42042	OPRA 90	224.0.95.90	42090
OPRA 43	224.0.95.43	42043	OPRA 91	224.0.95.91	42091
OPRA 44	224.0.95.44	42044	OPRA 92	224.0.95.92	42092
OPRA 45	224.0.95.45	42045	OPRA 93	224.0.95.93	42093
OPRA 46	224.0.95.46	42046	OPRA 94	224.0.95.94	42094
OPRA 47	224.0.95.47	42047	OPRA 95	224.0.95.95	42095
OPRA 48	224.0.95.48	42048	OPRA 96	224.0.95.96	42096

10 Appendix E- OPRA Global Trading Hours (GTH) Production, Real-Time IP Multicast Feeds, Dual Sets (Network 'A' / 'B' Data Streams)

PRODUCT NAME:	OPRA Global Trading Hours (GTH)	
NETWORK SUBNETS:	ONE (1) NETWORK SUBNET GROUP PER DATA STREAM	
PRODUCTION "DATA STREAM - A" SUBNET: 224.0.86.0/28		
Originated Data Line	Multicast Group Address	Multicast Group Port
OPRA 201	224.0.86.5	43005
OPRA 202	224.0.86.6	43006
OPRA 203	224.0.86.7	43007
OPRA 204	224.0.86.8	43008
PRODUCTION "DATA STREAM - B" SUBNET: 224.0.86.128/28		
Originated Data Line	Multicast Group Address	Multicast Group Port
OPRA 201	224.0.86.132	43005
OPRA 202	224.0.86.133	43006
OPRA 203	224.0.86.134	43007
OPRA 204	224.0.86.135	43008

Appendix E- OPRA Global Trading Hours (GTH) Retransmission IP Multicast Feeds, Dual Sets (Network 'A' / 'B' Data Streams)

PRODUCT NAME:	OPRA Global Trading Hours (GTH)	
NETWORK SUBNETS:	ONE (1) NETWORK SUBNET GROUP PER DATA STREAM	
RETRANSMISSION "DATA STREAM - A" SUBNET: 224.0.86.16/28		
Originated Data Line	Multicast Group Address	Multicast Group Port
OPRA 201	224.0.86.20	44005
OPRA 202	224.0.86.21	44006
OPRA 203	224.0.86.22	44007
OPRA 204	224.0.86.23	44008
RETRANSMISSION "DATA STREAM - B" SUBNET: 224.0.86.144/28		
Originated Data Line	Multicast Group Address	Multicast Group Port
OPRA 201	224.0.86.148	44005
OPRA 202	224.0.86.149	44006
OPRA 203	224.0.86.150	44007
OPRA 204	224.0.86.151	44008

Appendix E- OPRA Global Trading Hours (GTH) Playback Test IP Multicast Feeds, Dual Sets (Network 'A' / 'B' Data Streams)

PRODUCT NAME:	OPRA Global Trading Hours (GTH)	
NETWORK SUBNETS:	ONE (1) NETWORK SUBNET GROUP PER DATA STREAM	
PLAYBACK TEST "DATA STREAM - A" SUBNET: 224.0.86.32/28		
Originated Data Line	Multicast Group Address	Multicast Group Port
OPRA 201	224.0.86.36	45005
OPRA 202	224.0.86.37	45006
OPRA 203	224.0.86.38	45007
OPRA 204	224.0.86.39	45008
PLAYBACK TEST "DATA STREAM - B" SUBNET: 224.0.86.160/28		
Originated Data Line	Multicast Group Address	Multicast Group Port
OPRA 201	224.0.86.164	45005
OPRA 202	224.0.86.165	45006
OPRA 203	224.0.86.166	45007
OPRA 204	224.0.86.167	45008