

Retransmission and Snapshot User Guide

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REVISION HISTORY

Version	Date	Description
1.0	12/23/19	Initial Version Document
1.1	01/29/20	Updated section 3.7 Response Code
1.2	02/11/20	Added reference for SIAC CTA Pillar SIP Connection Request Form
1.3	02/20/20	Included redundant data stream for Retransmitted messages
1.4	04/20/20	Updated retransmission facility availability timelines
1.4a	06/12/20	Clarification for SIP Block Timestamp in retransmission block
1.5	01/15/21	Added support for OPRA retransmission
1.5a	02/19/21	Updated retransmission details upon Message Sequence Number Reset to 1 for OPRA (section 2.3)
1.5b	07/09/21	Updated limit on the number of retransmission requests per day
1.6	06/15/2021	• Extended Trading Hours Session naming convention replaced with Global Trading Hours along with an updated schedule, effective November 21, 2021
1.7	01/24/2022	Added section 2.5 to support Snapshot Request Message

REFERENCE MATERIAL

For CTA Technical Specifications visit <u>www.ctaplan.com</u> - and select Technical tab for the following:

- CTS and CQS Multicast Output Specifications
- CTS and CQS Input Specifications
- CQS Pillar Snapshot Specification
- Common IP Multicast Distribution Network Specification
- SIAC CTA Pillar SIP Connection Request Form

For OPRA Technical Specifications visit www.opraplan.com and select Document Library tab for the following via the Output Specs Binary section:

- Retransmission User Guide
- Common IP Multicast Distribution Network Specification
- OPRA Multicast Output Specification

FURTHER INFORMATION

- CTA Announcements including feed enhancements, traffic rates, etc. visit www.ctaplan.com
- OPRA Announcements including feed enhancements, traffic rates, etc. visit <u>www.opraplan.com</u>

FUTURE ENHANCEMENTS

Future enhancements and/or modifications may require system changes for your firm. Please refer to the CTA Plan website www.ctaplan.com to obtain the latest CTA Notifications and Technical Specification documents. To automatically receive these notifications by email, please subscribe at: https://www.ctaplan.com/subscribe. OPRA Notifications and Technical Specification documents can be located at: www.opraplan.com. To automatically receive these notifications by email, please subscribe at: OPRA Email Alerts

RELATED RESOURCES

For customers selecting to initiate connection through ICE Global Network (IGN), formerly known as the Secure Financial Transaction Infrastructure (SFTI):

- Submit a request at: https://www.theice.com/contact-us/connectivity
- Contact IGN Sales at: clientnetworks@theice.com
- For more information on IGN, including documentation such as Customer and Technical guides reach out to an IGN representative at: iceglobalnetwork-info@theice.com

1.0: Introduction

This document describes the procedure for retransmission of CTS and CQS data from the CTA SIP and the retransmission of OPRA data from the OPRA SIP.

1.1 Automated Retransmissions

SIAC supports an automated retransmission of Consolidated Tape System (CTS), Consolidated Quotation System (CQS), and Options Price Reporting Authority (OPRA) data.

Data Subscribers who directly receive from SIAC any of the data feeds can connect to the Retransmission Facility via the ICE Global Network (IGN) Communications Network. Data Subscribers will be required to provide their source addresses to facilitate the required provisioning/entitlement.

In addition to the IGN provisioning/entitlement requirements, Data Subscribers are also required to submit the SIAC CTA/OPRA Pillar SIP Connection Request Form in order to obtain from SIAC a unique User ID/User Password by sending your request to the CQS-CTS-OPRA Product Management team at, CTA-OPRA-Support@siac.com. Only one unique User ID/User Password is provided to direct connect Data Subscribers. Thus, clients of Service Providers would need to contact their provider to determine the mechanism employed for retransmission requests.

2.0: Retransmission Facility

2.1 Overview

The Retransmission Facility is designed to provide direct users of CTS, CQS and OPRA data with message retransmissions of stored data (not real-time) from the current trading day in the event the originally transmitted messages were not received. There are separate Retransmission Facilities for CTA, OPRA Regular Session and OPRA Global Trading Hours (GTH) Session and each have their own separate request connections. Data Subscribers can connect to the Retransmission Facility for CTA, OPRA or OPRA GTH via separate TCP/IP Addresses and Ports (see Appendix A).

Data Subscribers will be required to enter User ID/User Password, along with system, line, and sequence number information. Retransmissions will be disseminated over the current dedicated retransmission group multicast feeds.

2.2 Retransmission Messages

CTS, CQS, OPRA and OPRA GTH disseminate redundant production data feeds (A&B Streams). In the event a multicast Data Subscriber misses messages on one production data stream, the missing messages are available from the other redundant production stream. If messages are missed from one or both production data streams, retransmissions of the stored data (not real-time) from the current trading day are available from the Retransmission Facility. Note: The retransmitted messages will be sent over two redundant retransmission data feeds.

For CTS and CQS, originally transmitted messages contain the alphabetic uppercase character 'O', in the Retransmission Indicator field of the Message Header. For OPRA and OPRA GTH, originally transmitted messages contain a 'blank' in the Retransmission Requestor field of the Message Header. All retransmitted CTS, CQS and OPRA messages (sent as a result of a request received by the Retransmission Facility) contain the alphabetic upper-case character 'V' in the Retransmission Indicator field of the Message Header.

2.3 Functionality

- 1. Connectivity to Request Server
 - a) The Retransmission Facility supports two Request Servers per active data center to process retransmission requests of stored data (not real-time). Data Subscribers can connect to either one of the two request servers. A new connection will override the old connection i.e., if a client connects to second request server while it already had a connection established on a first request server, the previous connection will be disconnected.
 - b) Only one connection is allowed on each Request server.
 - The Request server for CTA supports retransmission for both systems; CTS & CQS. Clients can request retransmission of either CQS or CTS messages via a retransmission request on the same connection.

- The Request server for OPRA Regular and OPRA GTH lines are independent.
 Clients need to request retransmission of OPRA Regular and OPRA GTH
 messages via their respective retransmission connections. Retransmission of
 OPRA regular hours data cannot be requested on the OPRA GTH input
 retransmission connections, and vice versa
- Retransmission of CTS and CQS data cannot be requested on the OPRA / OPRA
 GTH input retransmission connections, and vice versa
- c) Clients may send several requests at the same time. Responses to all requests are published in the order in which they are received, although overlapping requests may be de-duplicated for efficiency.
- d) Duplicate requests of the same retransmissions being requested at the same time will not be processed.
- e) While it is possible to connect to the Request Server only as needed, and disconnecting after each request, the option is available to keep a connection established for the entire day
- f) The Retransmission Facility for both CQS and CTS will be available during 1:30 AM 8:05 PM, ET, for OPRA Regular sessions will be available during 1:30 AM 6:05 PM, ET and for OPRA Global Trading Hours sessions will be available during 8:15 PM 11:35 AM.

2. Prevention of invalid Data Subscribers and invalid requests

- a) When making a connection, each Data Subscriber is identified by a unique User ID/User Password within a defined timeframe. If the User ID/User Password are not received within the specific timeframe (30 seconds), the connection will close.
- b) The retransmission request contains the Data Subscriber's unique User ID/User Password.
- c) Requests from invalid Data Subscribers will not be processed.
- d) Request for CTS/CQS data on OPRA retransmission lines, or vice versa, will be rejected
- e) Request for OPRA data on OPRA GTH retransmission lines, or vice versa, will be rejected
- f) Incorrectly formatted Retransmission requests or invalid login attempts will be rejected. Reaching a limit of 100 rejects will result in Denial-of-Service for a minimum of 60 seconds.

3. Provide Timely Retransmissions

- a) A <u>maximum of 1 million</u> CTS, CQS or OPRA messages per request is allowed. Large requests will be broken down into smaller segments by the Retransmission Facility (Smaller requests will be processed in between segments of larger requests).
- b) If more than 1 million messages are required, multiple requests should be generated.
- c) Multiple retransmission requests can be placed in a packet (size of packet between Block Length and ETX is 1,002 bytes).

4. Retransmission Request Acknowledgements

Upon receiving retransmission request from a Data Subscriber, the system will send an acknowledgement back to the Data Subscriber with an appropriate response code, as listed under section '3.7 Response Code'

Functionality, continued

5. Message Sequence Number Rollover

In the event of CTS, CQS or OPRA message sequence number rollover, the Retransmission Facility will internally maintain the actual message sequence number (12 bytes). As such, the Data Subscriber would be required to request the actual message sequence number.

For example:

If a Data Subscriber experienced a gap before and after a message sequence number rollover from 4,294,967,292 to 0,000,000,003, the Data Subscriber would request a retransmission message using the actual message sequence numbers of 004,294,967,292 to 004,294,967,298.

Retransmission Facility Actual	
Message Sequence Number	Output Sequence Number
12 Bytes	4 Bytes
004,294,967,292	4,294,967,292
004,294,967,293	4,294,967,293
004,294,967,294	4,294,967,294
004,294,967,295	4,294,967,295
004,294,967,296 Reset Msg Seq Number	0,000,000,001 Reset Msg Seq Number
004,294,967,297	0,000,000,002
004,294,967,298	0,000,000,003

6. Message Sequence Number Reset to 1 (OPRA Regular and OPRA Global Trading Hours)

In addition to the message sequence number rollover, for OPRA the message sequence number can be reset to one (1) upon Disaster Recovery site activation or if OPRA experiences Production site failure and recovery. In such a case, a Reset Block Sequence Number (Category H, Type K) message is generated by OPRA to reset the line's sequence number to 1. Additional Reset Block Sequence Number messages may be generated, each incrementing the sequence number by value of 1.

Upon reset to sequence number 1 from a previous higher number, OPRA will internally maintain an offset from the last published sequence number up to the 4-byte maximum value of 4,294,967,295. As such, to request retransmission for any range of messages disseminated after a sequence reset to 1, Data Subscriber would be required to apply the offset up to 4,294,967,295 in the message sequence number.

Examples:

Scenario 1: Upon DR activation, output sequence on a line is reset from 2,123,456,789 to 0,000,000,001. If a Data Subscriber experienced a gap before and after the output sequence number reset, the Data Subscriber would request a retransmission by offsetting the message sequence numbers from 2,123,456,789 till 004,294,967,295.

Retransmission Facility Actual Message Sequence Number 12 Bytes	Output Sequence Number 4 Bytes
2,123,456,787	2,123,456,787
2,123,456,788	2,123,456,788
2,123,456,789	2,123,456,789
004,294,967,296 Reset Msg Seq Number	0,000,000,001 Reset Msg Seq Number
004,294,967,297 Reset Msg Seq Number	0,000,000,002 Reset Msg Seq Number
004,294,967,298 Reset Msg Seq Number	0,000,000,003 Reset Msg Seq Number
004,294,967,299	0,000,000,004
004,294,967,300	0,000,000,005

Note - In this example, message sequence range of 2,123,456,790 to 4,294,967,295 is not an actual gap and cannot be retransmitted.

Scenario 2: After output sequence number on a line rollover, upon subsequent DR activation output sequence is reset from 0,000,000,003 to 0,000,000,001. If a Data Subscriber experienced a gap before and after the output sequence number reset, the data subscriber would request a retransmission by offsetting the message sequence numbers from 004,294,967,298 till 008,589,934,590

Retransmission Facility Actual

Output Sequence	
Number rollover to	1

Output sequence number Resetto 1 upon DR activation

Message Sequence Number 12 Bytes	Output Sequence Number 4 Bytes
004,294,967,293	4,294,967,293
004,294,967,294	4,294,967,294
004,294,967,295	4,294,967,295
004,294,967,296 Reset Msg Seq Number	0,000,000,001 Reset Msg Seq Number
004,294,967,297	0,000,000,002
004,294,967,298	0,000,000,003
008,589,934,591 Reset Msg Seq Number	0,000,000,001 Reset Msg Seq Number
008,589,934,592 Reset Msg Seq Number	0,000,000,002 Reset Msg Seq Number
008,589,934,593 Reset Msg Seq Number	0,000,000,003 Reset Msg Seq Number
008,589,934,594	0,000,000,004
008,589,934,595	0,000,000,005

Note - In this example, message sequence range of 004,294,967,299 to 008,589,934,590 is not an actual gap and cannot be retransmitted.

2.4 Retransmission Request Procedure

NOTE: REFERENCE SECTION 3 FOR THE BELOW FIELD DESCRIPTIONS

1) Establish a TCP/IP connection:

A Data Subscriber can establish a TCP/IP connection and enter either a login request message or a retransmission request message. After establishing a TCP/IP connection, if the Data Subscriber does <u>not</u> send any request message within the specific timeframe (30 seconds) the TCP/IP connection will close.

Upon receipt of the login or retransmission request, the Retransmission Facility will generate a response back to the Data Subscriber, after which the Data Subscriber can close the TCP/IP connection or leave the TCP/IP connection up for the remainder of the day.

2) Enter a Login Request:

Upon establishing a TCP/IP connection, a data subscribe can send a login request information (User ID/User Password). Login Request message is optional, and retransmission can be requested without sending login message

Block Length	S O H	System	User ID	User Password	U S	~ ~	E T X	
						~		
3	1	4	5	5	1		1	

Example: 016<0x01>CTSA1234554321<0x03>

Login Response: Upon receipt of a Data Subscriber's login (User ID/User Password), the Retransmission Facility will send the following response which includes the original login request message information back to the Data Subscriber.

Block Length	S O H	Responding SIAC System	Response Code	System	User ID	User Password	U S	١ ،	E T X
2	1	4	2	4	5	_	1	~	1

Example: Successful connection (Response Code '01'):

022<0x01>CTSA01CTSA1234554321<0x03>

Retransmission Request Procedure, continued

3) Enter a Retransmission Request Message: A Data Subscriber is required to send the following retransmission request information regardless of whether or not they have already sent a login request.

Block Length	S O H	System	Multicast Line Number	Low Message Sequence Number	High Message Sequence Number	User ID	User Password	U S	~ ~	E T X
3	1	4	3	12	12	5	5	1	~	1

Example: If a Data Subscriber requests a retransmission for the range of messages with starting sequence number 1 and ending sequence number 5 whose user ID is '12345' and password is '54321', the request would look as follows:

043<0x01>OPRA0010000000000100000000051234554321<0x03>

Retransmission Request Message Response: Upon receipt of a retransmission request message, the Retransmission Facility will send the following response which includes the original retransmission request message information back to the Data Subscriber.

Block	S	Responding	Response	System	Multicast	Low Message	High Message	User	User			Е
Length	О	SIAC	Code		Line	Sequence	Sequence	ID	Password	U	~	T
	Н	System			Number	Number	Number			S	~	X
											~	
3	1	4	2	4	3	12	12	5	5	1		1

Example: Successful Request (Response Code '01'):

049<0x01>OPRA01OPRA00100000000000100000000051234554321<0x03>

Note: All retransmitted messages (sent as a result of a request received by the Retransmission Facility) will <u>only</u> contain the alphabetic upper-case character 'V' in the Retransmission Indicator field of the Message Header.

Note: Each block published on output multicast lines can contain multiple messages wherein the Block Header contains the Sequence Number of the first message in that block along with the number of messages in the block. Data Subscribers are required to keep track of total Messages received over the multicast lines and request retransmission based on the sequence number of missed messages. Retransmitted blocks can be packed differently from the original blocks and will have a SIP Block Timestamp representing when the first message in the retransmitted block was originally processed by SIP.

2.5 Snapshot Request Procedure

In addition to the Retransmission requests, the CTA Request server also supports Snapshot Request messages for CQS. The CQS Snapshot service provides direct data feed subscribers the current state of NYSE, NYSE American, NYSE Arca and CBOE BZX listed securities. This will allow the multicast data feed subscriber to quickly recover from a failure scenario as a supplement to using the retransmission functionality for all messages in the CQS multicast feeds.

The Snapshot output messages will be disseminated over two redundant Snapshot data feeds. Refer to the CQS Pillar Snapshot Specification for the Snapshot Message details published by CTA.

1) Snapshot Request Handling

- a) Data Subscribers can request a Snapshot of Security Symbols' state via the same connection that is used for submitting the Retransmission Requests.
- b) Data Subscribers will be required to enter the User ID/Password provided, along with other required information to request the Snapshot.
- c) Upon receiving the Snapshot request from a Data Subscriber, the system will send an acknowledgement back to the Data Subscriber with an appropriate response code, as listed under section '3.7 Response Code'
- d) Multiple Snapshot requests can be placed in a packet (the size of a packet between Block Length and ETX is 1,002 bytes)
- e) Only one Snapshot Request will be processed at a time
 - Responses to all requests are published in the order in which they are received, although overlapping requests may be de-duplicated for efficiency
 - Duplicate Snapshot requests being requested at the same time will not be processed
- f) A limit on the number of Snapshot requests per day will be imposed per Data Subscriber
 - Maximum of 50,000 Requests allowed when requesting Snapshot per Symbol
 - Maximum of 1,000 Requests allowed when requesting Snapshot per output multicast line
 - Maximum of 1,000 Requests allowed when requesting the full System Snapshot
- g) Snapshot Request service is only available for CQS, it is currently not available for CTS or OPRA

2) Snapshot Request Scope

Data Subscribers can define the scope for the Snapshot via the fields in the Snapshot Request message as follows:

System	Multicast Line Number	Security Symbol	Scope
<blank></blank>	<blank></blank>	Populated	Provide Snapshot for the specific symbol
Populated	Populated	<blank></blank>	Provide Snapshot for the specified CQS Tape A or Tape B Multicast Line Number
Populated	<blank></blank>	<blank></blank>	Provide Snapshot for all CQS Multicast Lines for the specified Tape
<blank></blank>	<blank></blank>	<blank></blank>	Provide complete Snapshot for all CQS Multicast Lines across Tape A and B

- a) When specifying the System, the field can only have values of CQSA or CQSB. When the System is not specified in the Snapshot Request, the field shall be space-filled.
- b) When specifying the Multicast Line Number, the field can have values between 1 12. When the Multicast Line Number is not specified in the Snapshot Request, the field shall be set to zero
- c) When specifying the Security Symbol, the field can have any valid symbol. When the Security Symbol is not specified in the Snapshot Request, the field shall be space filled

3) Snapshot Request Validation

- a) A Snapshot can only be requested by Data Subscribers who are entitled for retransmission or Snapshot requests
- b) Any incorrectly formatted Snapshot request message will be rejected
- c) When a request message is received for a specific Multicast Line number, System field must be specified, otherwise request will be rejected
- d) When a Snapshot request message is received for a specific Security Symbol, the System and Multicast Line number fields will be ignored, and request will be processed for the specified Symbol

4) Snapshot Request Message

A Data Subscriber is required to send the following Snapshot request information regardless of whether or not they have already sent a login request.

Block	S	System	Multicast	Security	User	User			Е
Length	Ο	_	Line	Symbol	ID	Password	U	~	T
_	Н		Number				S	~	X
								~	
3	1	4	3	11	5	5	1		1

Example: If a Data Subscriber requests a Snapshot for the messages for CQS Tape A multicast line 5 whose user ID is '12345' and password is '54321', the request would look as follows:

030<0x01>CQSA005 1234554321<0x03>

5) Snapshot Request Message Response: Upon receipt of a Snapshot request message, the following response, which includes the original Snapshot request message information, will be provided back to the Data Subscriber

Syste	Multicast	Securit	User	User			E
m	Line	y	ID	Password	U	~	T
	Number	Symbol			S	~	X
						~	
4	3	11	5	5	1		1
	1 -	m Line	m Line y	m Line y ID	m Line y ID Password	m Line y ID Password U	m Line y ID Password U ~ Number Symbol

Example: Successful Request (Response Code '01'):

036<0x01>CQSA01CQSA005 1234554321<0x03>

Note: Output messages to fulfill a Snapshot request will only be published on the Snapshot group multicast feeds

2.6 Request Thresholds

Capability	Description	Threshold
User Authorization	Requests with valid User ID/User Password will be processed. Incoming requests from Data Subscribers that are not in the enabled user ID list will not be processed.	N/A
Maximum number of Retransmission messages per request	A limit on the number of messages per request will be imposed. Note: If >1,000,000 the Data Subscriber must generate multiple TCP requests.	1,000,000
Maximum number of Retransmission requests per day	A limit on the number of retransmission requests per day will be imposed per Data Subscriber.	100,000
Maximum number of Snapshot requests per Symbol per day	A limit on the number of Snapshot requests per Day will be imposed per Data Subscriber, when requesting Snapshot for a Security Symbol	50,000
Maximum number of Snapshot requests per output multicast line	A limit on the number of Snapshot requests per Day will be imposed per Data Subscriber, when requesting Snapshot per output multicast line	1,000
Maximum number of Snapshot requests per System	A limit on the number of Snapshot requests per Day will be imposed per Data Subscriber, when requesting the full System Snapshot	1,000

3.0: Field Descriptions

3.1 Block Length

3 bytes, Numeric, Right Justified, Zero Filled. Indicates the total length of the message from the Start of Header (SOH) to the End of Text (ETX).

3.2 High Message Sequence Number

12 bytes, Numeric, Right Justified, Zero Filled. Identifies the end of the retransmission request message range.

3.3 Low Message Sequence Number

12 bytes, Numeric, Right Justified, Zero Filled. Identifies the start of the retransmission request message range. Lowest retransmission request message sequence number can be 1.

3.4 Multicast Line Number

3 bytes, Numeric, Right Justified, Zero Filled. Indicates the multicast line number over which the retransmission should be generated.

System	Description	Multicast Line Number
CTSA	Tape A	001-012
CTSB	Tape B	001-012
CTSI	Index Tape A&B	001-002
CQSA	Tape A	001-012
CQSB	Tape B	001-012
ODD 4	OPRA Regular	001-96
OPRA	OPRA GTH	201-204

Note: Reference the latest National Market System (NMS) Common IP Multicast Distribution Network Recipient Interface Specification for the CTS/CQS/OPRA Network and Multicast Line breakdown using the following links.

CTS/COS Link: https://ctaplan.com and select the Technical tab.

OPRA Link: https://opraplan.com, select the 'Pillar' tab for new Pillar specifications or 'Document Library' Tab for both Current and Pillar SIP specification.

3.5 SOH AND ETX

1 byte, The Start of Header (SOH) control character (0x01) indicates the beginning of the block, whereas an End of Text (ETX) control character (0x03) signifies the end of the block.

3.6 US

1 byte, The Unit Separator (US) control character (0x1F) is needed in multiple message blocks to signify the end of the preceding message but not the end of the block. An ETX control character delimits the last message.

FIELD DESCRIPTIONS, continued

3.7 Response Code

2 bytes, Numeric. Indicates one of the following response codes:

- 00 Connection refused
- 01 Successful connection/request
- 02 Invalid size
- 03 Invalid system
- 04 Invalid line
- 05 Incorrect format
- 06 Exceeded maximum retransmission request size
- 07 Exceeded maximum number of retransmission requests
- 08 Invalid message sequence number
- 09 User ID or User Password
- 10 Invalid Security Symbol
- 11 System missing for the specified Line
- 12 Exceeded maximum number of Snapshot requests
- 99 Temporary Internal Error

3.8 System / Responding SIAC System

4 bytes, Alphabetic, Right Justified. Indicates one of the following system names for the System the request is being sent to by the Data Subscriber and the Responding SIAC System.

<u>System</u>	<u>Description</u>
1) CTSA	Tape A
2) CTSB	Tape B
3) CTSI	Index - Tape A & B
4) CQSA	Tape A
5) CQSB	Tape B
6) OPRA	OPRA

3.9 User ID

5 bytes, Alpha Numeric, Right Justified. A unique identifier for each direct connect Data Subscriber (provided by SIAC).

3.10 User Password

5 bytes, Alpha Numeric, Right Justified. A unique password for each direct connect Data Subscriber (provided by SIAC).

FIELD DESCRIPTIONS, continued

3.11 Security Symbol

11 byte, Char [11]. Left justified, space filled. Identifies the Security Symbol for which Snapshot is requested. If populated, the field must have a valid symbol supported by CTA. If not provided, field shall be space-filled.

Appendix A – TCP/IP Addresses/Ports

CTA TCP/IP Addresses

	Production	Disaster Recovery
Request Primary	159.125.53.0/24	198.140.53.0/24
Request Backup	159.125.54.0/24	198.140.54.0/24

OPRA (Regular Hours) TCP/IP Addresses

	Production	Disaster Recovery
Request Primary	162.69.32.0/22	162.68.32.0/22
Request Backup	162.69.36.0/22	162.68.36.0/22

OPRA Global Trading Hours TCP/IP Addresses

	Production	Disaster Recovery
Request Primary	162.69.42.0/27	162.68.42.0/27
Request Backup	162.69.42.64/27	162.68.42.64/27

Note: Backup Data Center TCP/IP addresses activated only upon site failover.
