



TMX Information Processor Protocol Specification and Service Access (PSSA)

Version 4.0

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Preface

Purpose

This document defines the technical requirements and protocol considerations that need to be addressed by data vendors interested in subscribing to the services of the TMX Information Processor (TMX IP).

Scope

This specification describes the services provided by the TSX for the TMX IP. It does not deal with issues of order entry or order routing. The document focuses on the protocol for market data message dissemination as opposed to the format used for business content. Information about business content specific to each service is provided in References [2] to [5].

Intended Audience

This document is intended for direct recipients of TMX IP services, including:

- Business staff involved with market data and its dissemination,
- Software developers,
- Network and other support personnel.

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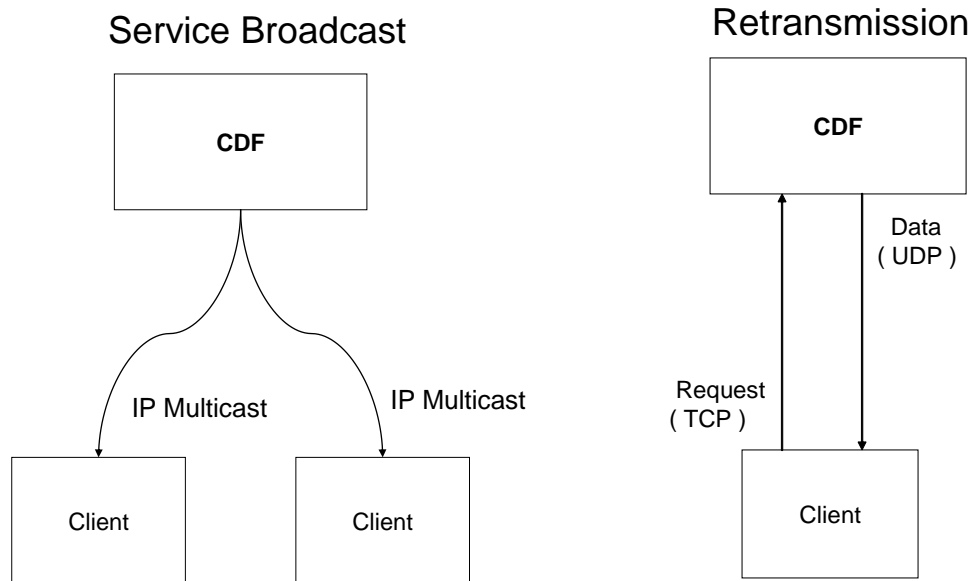
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1. Introduction

TMX Information Processor (TMX IP) provides a central source of consolidated Canadian equity market data that meets standards approved by regulators. The TMX IP products include the Consolidated Data Feed (CDF™), the Canadian Best Bid and Offer (CBBO®), the Consolidated Last Sale (CLS) and the Consolidated Depth of Book (CDB). The CDF provides access to consolidated pre and post trade market data from participating Canadian exchanges and ATSs ("market centers") trading Toronto Stock Exchange and TSX Venture Exchange traded securities through existing telecommunication links to the TSX. The CBBO feed provides real-time access to the consolidated Canadian best bid and offer. The CLS feed provides real-time access to the consolidated trade reports. The CDB provides a real-time consolidated depth of book by price by market centre. The CBBO, CLS and CDB is available for Toronto Stock Exchange listed securities "Service A" and TSX Venture listed, [CSE listed](#), and [Aequitas Neo listed](#) securities "Service B"

1.1. Infrastructure for Market Data Dissemination

The following diagrams illustrate the TMX IP architecture: (which is replicated across two sites for redundancy)



2. Service Message Protocol

2.1. Offered Services

In its role of as the official Information Processor for all Canadian Equities, TMX Information Processor (TMX IP) distributes market data for the following markets:

CDF Feeds				
Service	Service ID	Format	Content	Recovery Recommendation
Toronto Stock Exchange (TSX, Partition 1 & 2)	CDF	STAMP	Level 2 data (Trades, & Orders)	Message Arbitration
Chi- X Canada ATS	CDF	STAMP	Level 2 data	Message Arbitration
CX2	CDF	STAMP	Level 2 Data	Message Arbitration
Omega ATS	CDF	STAMP	Level 2 data	Message Arbitration
Lynx ATS	CDF	STAMP	Level 2 Data	Message Arbitration
TSX Alpha Exchange	CDF	STAMP	Level 2 data	Message Arbitration
Liquidnet Canada	CDF	STAMP	Trade data	Message Arbitration
TriAct Canada	CDF	STAMP	Trade data	Message Arbitration
TSX Venture Exchange (TSXV)	CDF	STAMP	Level 2 data	Message Arbitration
Canadian Securities Exchange (CSE)	CDF	STAMP	Level 2 data	Message Arbitration
Instinet Canada Cross (ICX)	CDF	STAMP	Trade data	Message Arbitration
Aequitas	CDF	STAMP	Level 2 Data	Message Arbitration

Consolidated Feeds - Service A (TSX Listed Securities)				
Service	Service ID	Format	Content	Recovery Recommendation
Canadian Best Bid and Offer 1	CB1	STAMP	Consolidated Top of Book Quotes for all TSX listed symbols A to L	Retransmission
Canadian Best Bid and Offer 2	CB1	STAMP	Consolidated Top of Book Quotes for all TSX listed symbols M to Z	Retransmission
Canadian Best Bid and Offer 1 - Protected Only	CP1	STAMP	Consolidated Top of Book Quotes for protected marketplaces on all TSX listed symbols A to L	Retransmission
Canadian Best Bid and Offer 2 - Protected Only	CP1	STAMP	Consolidated Top of Book Quotes for protected marketplaces on all TSX listed symbols M to Z	Retransmission
Consolidated Last Sale	LS1	STAMP	Consolidated Trade data for all TSX listed securities	Retransmission
Consolidated Depth of Book	BK1	STAMP	Consolidated Depth of Book data for all TSX listed securities	Retransmission

Consolidated Feeds - Service B (TSXV, Aequitas and CSE Listed Securities)				
Service	Service ID	Format	Content	Recovery Recommendation
Canadian Best Bid and Offer	CB2	STAMP	Consolidated Top of Book Quotes for all TSXV, Aequitas and CSE listed securities	Retransmission
Canadian Best Bid and Offer - Protected Only	CB2	STAMP	Consolidated Top of Book Quotes for all protected marketplaces on TSXV, Aequitas and CSE listed securities	Retransmission
Consolidated Last Sale	LS2	STAMP	Consolidated Trade data for all TSXV, Aequitas and CSE listed securities	Retransmission
Consolidated Depth of Book	BK2	STAMP	Consolidated Depth of Book data for all TSXV, Aequitas and CSE listed securities	Retransmission

2.2. Marketplace Inclusion by Service

The following table outlines the marketplaces that are included in each TMX IP Service Feed. Note, unprotected marketplaces are excluded from the CBBOP feed, and dark marketplaces are excluded from the CBBO, CBBOP and CDB feeds.

TMX IP Feeds					
MARKETPLACES	CDF	CBBO	CBBOP	CLS	CDB
TSX Alpha Exchange ¹	YES	YES	NO	YES	YES
TSX	YES	YES	YES	YES	YES
TSX Venture	YES	YES	YES	YES	YES
Chi-X	YES	YES	YES	YES	YES
CX2	YES	YES	YES	YES	YES
Omega	YES	YES	YES	YES	YES
Lynx	YES	YES	YES	YES	YES
Canadian Securities Exchange	YES	YES	YES	YES	YES
Aequitas Neo	YES	YES	YES	YES	YES
Instinet Canada Cross ²	YES	NO	NO	YES	NO
Triact MatchNow ²	YES	NO	NO	YES	NO
LiquidNet ²	YES	NO	NO	YES	NO

¹ Denotes unprotected marketplace

² Denotes Dark marketplace

2.3. Infrastructure for market data dissemination

Market data dissemination on the TMX Information Processor infrastructure provides the following benefits:

- Message framing is standardized across all services, to facilitate use of common feed readers.
- Use of the IP multicast protocol for feed delivery provides better scalability and flexibility. Vendors can subscribe to only the feeds they need.
- Dual feeds for each service facilitate message arbitration* and hence reduce the number of recoveries required.
- Message recovery for each service uses reliable TCP/UDP.

* For the consolidated feeds (CBBO, CBBOP, CLS, & CDB) the sequences and data packets of these services may vary slightly from each TMX IP site. This is a result of the TMX IP blending/consolidating up to seven data streams from multiple marketplaces into a single data stream. Incoming data messages may arrive at TMX IP facilities at different times and therefore be processed in a different sequence by the consolidator at one site. These differences are expected to be in the sub millisecond range but may impact the sequence and content of the TMX IP products between locations. For these TMX IP products one production site should be considered primary (Markham is recommended) and the other site should be considered back-up for disaster recovery purposes (Toronto).

2.4. Framing

Each market data market message uses the following basic structure:

STX	Header	Message	ETX
-----	--------	---------	-----

where, STX is the Start of Text character, or Hex 02, and ETX is the End of Text character, or Hex 03. The Message is the original market data content received from the originating exchange.

The Header is a 22-byte section coded in ASCII and structured as follows:

Field	Length	Contents
Length	4	Total length of header and message business content (excludes STX and ETX), padded with zeros to the left.
Sequence Number	9	Sequence number assigned at service broadcast, padded with 0s to the left. Blank on Circuit Assurance (heartbeat) messages.
ServiceID	3	Service identifier code to uniquely identify the service. "CDF" – Consolidated Data Feed "CB1" – Canadian Best Bid and Offer – Service A (split into two multicast feeds) "CP1" – Canadian Best Bid and Offer for Protected Only Markets– Service A (split into two multicast feeds) "LS1" – Consolidated Last Sale – Service A "BK1" – Consolidated Depth of Book – Service A "CB2" – Canadian Best Bid and Offer – Service B "CP2" – Canadian Best Bid and Offer for Protected Only Markets – Service B "LS2" – Consolidated Last Sale – Service B "BK2" – Consolidated Depth of Book – Service B
Retransmission Identifier	1	0 – Normal transmission
Continuation Indicator	1	0 – This is stand-alone packet (the message fits in one packet) 1 – This packet continues in the next sequential packet (the message spans at least 2 packets). 2 – This packet is the continuation of the previous packet 3 – This packet is both the continuation of the previous packet and continues in the next packet.
Message Type	2	"V" for heartbeat messages, blank otherwise
Exchange Identifier	2	Code assigned to the originating exchange/service (padded with blanks to the right): CDF feeds: "T" for TSX market "V" for TSX Venture Exchange market "C" for Chi-X Canada "H" for CX2 "O" for OMEGA ATS "P" for CSE Listed and CSE Other Listed Securities (formerly known as CNSX and PURE Trading) "A" for TSX Alpha Exchange "M" for TriAct Canada Match Now "L" for Liquidnet "I" for Instinet Canada Cross "Y" for Lynx ATS "E" for Aequis Consolidated Feeds: "B" for Consolidated Depth of Book (CDB)

		“S” for Consolidated Last Sale (CLS) “Q” for Canadian Best Bid and Offer (CBBO)
Total	22	

Every message is assigned a sequence number from 000000001 to 999999999 (decimal ASCII), with wrap-around. The sequence is reset to 1 each day and incremented by 1 for each packet sent.

The “Message” portion of the frame contains business content; this is specific to each service and market and follows the respective specification (see References [2] to [5]).

2.4.1. Retransmission Identifier

The Retransmission Identifier field is used to mark “stale” messages that are being disseminated “out of sequence” from their generation at the original market. This can be due to retransmissions to the TMX IP by the originating market or other unusual processing causing delay in message flow, e.g., a recovery from a problem or link failure.

The value of the Retransmission identifier field is set as follows:

0	Used for normal transmission, except Circuit Assurance messages on which it will always be blank.
---	---

NOTES:

- (a) The Retransmission Identifier is NOT used to mark messages requested for retransmission by customers.
- (b) The Retransmission Identifier field value is not changed when messages are sent on a retransmission requested by a customer.

2.4.2. Continuation Indicator

The header provides for message fragmentation by means of the *Continuation Indicator*, to allow for the possibility of market messages exceeding the Maximum Transmission Unit (MTU) size used with the IP protocol[†]. The maximum message size used by the TMX IP is currently set at 1,400 bytes. The Continuation Indicator will be set as follows:

- 0 – This is a stand-alone packet (the message fits in one packet).
- 1 – This packet is continued in the next sequential packet (the message spans at least 2 packets).
- 2 – This packet is a continuation of the previous sequential packet.
- 3 – This packet is both the continuation of the previous sequential packet and continues in the next sequential packet.

The contents of the header fields ServiceID, Retransmission Identifier, Message Type, and Exchange Identifier are included in all continuation packets of a single logical message.

Sequence numbers increase by 1 for each message regardless of the setting of the Continuation Indicator.

The continuation indicator is used to handle message segmentation when the original business content of a message exceeds the maximum length supported. If the original logical message has a length less than 1,400 bytes, it will be sent by the TMX IP as a stand-alone message on a single packet with the continuation indicator set to 0.

If the logical message has a length larger than 1,400 bytes but less than 2,800 bytes, it will be segmented into two or three packets, each of which is sent with a header and its own sequence number. The first packet in this set will contain the initial segment and its header will contain the continuation indicator set to 1. The second segment will be contained in the following packet and will have a continuation indicator set to 2.

If the message is longer than 2,800 bytes but less than 4,200 bytes, it will require three segments, and the continuation indicator values would be 1, 3, 2. If four segments were needed, the sequence would be 1, 3, 3, 2. And so on. The following table outlines the Continuation Indicator sequences:

[†] For IEEE 802.3, the MTU is 1,492 bytes.

Message Length	Continuation Indicator Sequence
1 – 1,400	0
1,401 – 2,800	1, 2
2,801 – 4,200	1, 3, 2
4,201 – 5,600	1, 3, 3, 2
5,601 – 7,000	1, 3, 3, 3, 2

NOTE:

This example is intended only to illustrate how a long message is split into packets for dissemination. In general, the maximum length of a physical message is subject to change. Message segmentation can occur when message length is less than 1,400.

2.5. Heartbeat Message

The Circuit Assurance (heartbeat) message is unsequenced.

The Circuit Assurance (heartbeat) message is sent every 30 seconds.

The heartbeat message provides three information sections regarding real time message delivery, delimited by brackets:

- HEARTBEAT section, including date and time and decimals seconds since 1970 up to the microsecond,
- LAST SENT section, including sequence number of last message sent, time sent, and decimal seconds up to the microsecond,
- LAST HB section, including the “last sent” information passed in the last heartbeat message sent.

The Circuit Assurance (heartbeat) message allows clients to track real time delivery latencies. The following layout defines the contents of the Circuit Assurance message (message type “V “):

Field	Length	Value	Description / Format
	1	“[”	Separator
	10	“HEARTBEAT”	Section identifier
Date	10		Date in format YYYY-MM-DD
	1	blank	Separator string
TimeOfDay	8		Time of day in format HH:MM:SS
	1	“_”	Separator string
SecondsSince1970	19	6 decimals with embedded decimal point	Formatted with “%012d.%06d” in C language
	2	“]”	Separator
	10	“LAST SENT ”	Section identifier
SeqNbrOfLastMsgSent	9		Last sequence number sent, padded with 0s to the left
	1	“_”	Separator
TimeLastMsgSent	8		Time last message sent in format HH:MM:SS
	1	“_”	Separator
SecondsSince1970LastMsg	19	6 decimals with embedded decimal point	Formatted with “%012d.%06d” in C language
	2	“]”	Separator
	10	“LAST HB ”	Section identifier – Last Heartbeat data, right-padded with blanks.
SeqNbrOfLastMsgSent	9		This number lets the client know if they missed a heartbeat
	1	“_”	Separator
TimeLastMsgSent	8		Time last message sent in format HH:MM:SS in last heartbeat
	1	“_”	Separator
SecondsSince1970LastMsg	19	6 decimals with embedded decimal point	Formatted with “%012d.%06d” in C language in last heartbeat
	1	“]”	Separator
OCSASubject	20		Reserved
OCSAInstance	2		Reserved
Hostname	8		ID of the originating host. Padded with blanks.
Version	4		Version of the service being delivered
Total	185		

2.6. Network Considerations

UDP datagrams may be the first to be discarded in heavy volumes of traffic by many vendor queuing algorithms, such as Cisco's WFQ (weighted fair queue), the default for interfaces operating at 2Mb/s and below. As well, common Layer 2 (Ethernet, Token ring, PPP) framing errors will cause entire frames containing several UDP datagrams to be lost, something which a TCP session (such as FTP, HTTP) may recover from, but UDP streams will not.

To avoid packet loss in the delivery of TMX IP market data sent over UDP, the following measures are recommended for the local customer network:

1. Ensure the Layer 2 service is running 100% clean:
 - (a) Check for CRC errors, runt frames, etc.
 - (b) Check for any possible line errors at the T1 (Telco) or Ethernet levels,
 - (c) Check for any possible timing/clocking errors,
 - (d) Clear any broadcast storms within the segment(s) your systems are located on,
 - (e) Check for switch port errors due to a Server NIC conflict (wrong speed or Duplex settings).
2. Ensure the UDP stream is given preferred treatment within the network to prevent UDP packets from being dropped in situations of heavy network traffic. Data vendors should institute QoS (Quality of Service) within their network. This could be a combination of "custom queuing", "priority queuing", "traffic shaping" or setting the IP precedence bit to a higher priority on the TMX IP incoming traffic.

The exact QoS policy to implement will depend on the network device vendor(s), firmware revision(s), and the particular network layout in general at the customer's site. A finely tuned QoS policy is required to ensure minimal UDP datagram loss occurs.

2.7. Multicast Addressing

TMX IP broadcasts each service using the Protocol Independent Multicast (PIM) Sparse Mode routing protocol.

TMX IP market data services are available for delivery over Multicast protocol on globally unique IP multicast addresses. Public IP multicast addresses, specified as per RFC 2770 ("GLOP" addresses), use the range 233.102.209.xxx. Public addresses are available for use on a public network. Please see Reference [11].

Different IP multicast group addresses have been assigned to each service and each site. Please refer to Section 4.3 for addresses of multicast groups.

Message retransmissions are point-to-point and are only available over UDP as described in Section 3.

3. Retransmission Protocol

3.1. Message Flow

The retransmission protocol provided consists of:

- Pre-assigned IP address and port number for each service provided,
- A retransmission request sent by the client via TCP,
- An acknowledgement response sent to the client by the TMX IP via TCP,
- Retransmission stream, sent via UDP, including header, requested market data, and trailer, optional Error Report, and heartbeat messages.

To initiate a retransmission, clients connect using TCP protocol to the IP address and port number of the TMX IP retransmission server for the service.

Each retransmission request received by the TMX IP market data system is responded to with an acknowledgment also sent in TCP protocol. Market data requested for retransmission is then sent to the client's retransmission destination IP address on a pre-assigned port number via UDP protocol.

For each service, retransmissions use a different port number than real time market data delivery. Retransmissions use pre-allocated bandwidth and run concurrently with real time market data delivery.

The following table summarizes the retransmission message flow between service recipients and the TMX IP:

TMX IP Market Data System	Flow	Client (Protocol)
	< =====	TCP Retransmission Request
Acknowledgment Response	===== >	TCP
StartOfTransmission Header	===== >	UDP Retransmission Stream
First Retransmitted Message	===== >	UDP
...		
Last Retransmitted Message	===== >	UDP
EndOfRetransmission Trailer	===== >	UDP
ErrorReport	===== >	UDP Sent only if retransmission is interrupted

The Error Report is optional and will be sent only when a retransmission fails to complete normally.

3.2. Retransmission Request

Requests can be made by Sequence Number only.

Request by Sequence Number

Field	Length	Value	Description
FormatCode	4	"SEQN"	Message Sequence Number format
StartSeqNbr	9	>=1	Padded with 0s to the left
EndSeqNbr	9	>= StartSeqNbr	Padded with 0s to the left
Total	22		

Messages with sequence number starting with *StartSeqNbr* and ending with *EndSeqNbr* inclusive will be sent. The number of messages to be retransmitted is (*EndSeqNbr* – *StartSeqNbr* + 1).

NOTE:

The TMX IP system will only process the first 22 characters for a SEQN type request. Any additional data appearing past these limits will be ignored.

STX and ETX characters are not used on the Retransmission Request or the Acknowledgement Response sent over TCP.

Retransmission Servers

To request a retransmission via TCP protocol, a client connects to the IP address of the TMX IP server associated with the service, at the site where their link access the TMX IP (See Section 4.2 for Service Access):

Services	Site Location	Retransmission Server IP Address	Port Number
TMX IP – Service A & B	TSX Markham	142.201.149.36	Service's port number (See Section 4.3)
TMX IP – CDF	TSX Markham	142.201.149.44	Service's port number (See Section 4.3)
TMX IP – Service A & B	TSX Toronto	142.201.157.36	Service's port number (See Section 4.3)
TMX IP – CDF	TSX Toronto	142.201.157.44	Service's port number (See Section 4.3)

If the point of access to the TMX IP is the TSX Markham site, depending of the service, address 142.201.149.36/44 should be used. If the point of access to the TMX IP is the TSX Toronto site, depending on the service, address 142.201.157.36/44 should be used. Cross site access is not supported.

For a given service, IP Multicast transmissions for real time market data dissemination and UDP retransmission are sent by the same host.

3.3. Acknowledgment Response

Field	Length	Value	Description
ResponseCode	4	"ACK " or "NACK"	Left-justified. Indicates success or failure
StartSeqNbr	9	Padded with zeros	0 is used when no data is sent
EndSeqNbr	9	Padded with zeros	0 is used when no data is sent
StatusCode	8	"ACCEPTED" "INVALID" "DENIED" "REJECTED"	
ErrorDescription	99	ASCII text	Additional information about the error. Padded with blanks.
ReceivedRequest	22	ASCII text	Retransmission request string received from client. Padded with blanks.
Total	151		

The Acknowledgement Response will contain an ACK code and Start and End sequence numbers of 0 when no data exists to be sent.

The Retransmission Requests and Acknowledgement Response do not include STX/ETX framing nor header sections.

ErrorDescription will include one of the following values depending on the StatusCode:

- ERR001: Wrong command code
- ERR002: Wrong command parameters
- ERR003: Requested message count is too large
- ERR004: Unable to Satisfy Request at this Time. Please try again later.
- ERR005: Retransmission already in progress to this recipient.
- ERR006: Retransmissions are disabled at this time. Please try again later.
- ERR008: Request not allowed, IP address not recognized.
- ERR009: Requested sequence number greater than last broadcast sequence.
- ERR010: Pushed retransmission in progress. Please try again later.
- ERR011: Requested sequence number less than first broadcast sequence

Field *ReceivedRequest* is not populated when error ERR006 (disabled retransmissions) or ERR008 (IP address validation failure) occurs.

After the Acknowledgment Response is sent, the TMX IP market data system will drop the connection. If the request was accepted (the returned *StatusCode* field is set to "ACCEPTED") the requested messages will then be sent via UDP on the retransmission port for the associated service.

A timeout of approximately 30 seconds should be used when waiting for the Acknowledgment Response and UDP delivery of the requested data. If there is more than one retransmission request to be submitted, the follow on request should not be submitted until the Trailer Control Message or an Error Report for the first request has been received, or the 30 second timeout has elapsed.

3.4. UDP Message Format for Retransmissions

Except for the Retransmission Request and Acknowledgment Response that are sent over TCP, all other messages are sent over UDP using the following frame format:

STX	Header	Message	ETX
-----	--------	---------	-----

Where STX is Hex 02 and ETX is Hex 03; the Header section is the same 22-byte ASCII section defined in Section 2.2; and Message is the original message being retransmitted or one of the retransmission control messages described below in Section 3.5.

For market messages being resent, the header and business content of the original message is sent. For retransmissions control messages described in Section 3.5 below, the header is populated except that fields Sequence Number, Retransmission Identifier and Message Type will be left blank.

For each of the retransmission response messages described in Section 3.5 (Header Control Message, Trailer Control Message, Error Report, and Heartbeat), the framing characters STX, ETX, and Header are not explicitly shown. For these messages, the header is populated as follows:

Field	Length	Contents
Length	4	Total length of header and message business content (excludes STX and ETX).
Sequence Number	9	Blank
ServiceID	3	Service identifier code to uniquely identify the service. Refer to Section 2.1
Retransmission Identifier	1	Blank
Continuation Indicator	1	0
Message Type	2	Blank
Exchange Identifier	2	Code assigned to the originating exchange/service (padded with blanks to the right): CDF feeds: "T" for TSX market "V" for TSX Venture Exchange market "C" for Chi-X Canada "H" for CX2 "O" for OMEGA ATS "P" for CSE Listed Securities (formerly known as CNSX) and CSE Other Listed Securities (formerly known as PURE Trading) "A" for TSX Alpha Exchange "M" for TriAct Canada Match Now "L" for Liquidnet "N" for CSE Listed Securities (formerly known as CNSX) "I" for Instinet Canada Cross "Y" for Lynx ATS "E" for Aequis

		<u>Consolidated Feeds:</u> "B" for Consolidated Depth of Book (CDB) "S" for Consolidated Last Sale (CLS) "Q" for Canadian Best Bid and Offer (CBBOP) "D" for Canadian Best Bid and Offer for Protected Only Marketplaces (CBBOP)
Total	22	

3.5. Retransmission of UDP Stream

The retransmission UDP stream will include the following:

- (1) Retransmission Header control message
- (2) Market data messages being retransmitted (content depends on the service being used.)
- (3) End Of Retransmission Trailer Control message.
- (4) Error Report control message (if an error occurs).
- (5) Heartbeat control messages.

3.5.1. Retransmission Header Control Message

Field	Length	Value	Description
TypeCode	5	"HDR "	
StartSeqNbr	9	>=1	Padded with 0s to the left
EndSeqNbr	9	>= StartSeqNbr	Padded with 0s to the left

The *StartSeqNbr* and *EndSeqNbr* are provided as notification of the sequence numbers to expect. For retransmission requests submitted by time, the client does not know the sequence numbers nor number of messages involved in the retransmission.

3.5.2. Retransmission Trailer Control Message

Field	Length	Value	Description
TypeCode	5	"TLR "	
CountOfMessagesRequested	9	Integer	>= 0
CountOfMessagesSent	9	Integer	(MessagesSent <= MessagesRequested)
StatusMessage	100	ASCII text	Optional status information

NOTE: If a client requests more messages than the maximum number allowed for the service, the *CountOfMessagesRequested* will be greater than the *CountOfMessagesSent*. In this case the *StatusMessage* will indicate "Maximum request size exceeded."

3.5.3. Error Report

The Error Report message is only sent when a scheduled retransmission does not complete normally.

Field	Length	Value	Description
TypeCode	5	"ERROR"	
ErrorCode	8	"CANCELED" "FAILED "	CANCELED: Retransmission aborted by the TMX IP FAILED: Retransmission interrupted by failure.
ErrorDescription	100	ASCII text	Additional information about the error.

The code CANCELED will be sent when a retransmission in progress is canceled by the TMX IP. This could happen, for example, when a pushed retransmission to all clients takes priority over a retransmission in progress at that time.

The code FAILED will be used when the TMX IP has encountered an internal problem and fewer messages than those requested were sent.

The ErrorDescription field will contain additional description of the error detected.

3.5.4. Retransmission Heartbeat

Field	Length	Value	Description
TypeCode	5	"HBEAT "	
	1	"["	Separator
	10	"HEARTBEAT"	Section identifier
Date	10		Date in format YYYY-MM-DD
	1	blank	Separator string
TimeOfDay	8		Time of day in format HH:MM:SS
	1	"_"	Separator string
SecondsSince1970	19	6 decimals with embedded decimal point	Formatted with "%012d.%06d" in C language
	1	"]"	Separator
Hostname	8		ID of the originating host.
Version	4		Version of the service being delivered
MaxMessages	9		Maximum number of messages allowed per retransmission request
Total	77		

The *Retransmission Heartbeat* message is sent on each service's retransmission UDP port every 30 seconds to inform the remote side the retransmission service is active. The sequence number in the header will be blank. The length of this message, including header, is 99 characters.

Circuit Assurance (heartbeat) messages sent during the original real time service delivery are not retransmitted.

3.6. Other Considerations

The following considerations must be taken into account when developing code for handling retransmissions.

- 1) The source IP address of the TCP request is used to authenticate the requester. This IP address must be known to the TSX for the request to be accepted. The Market Data System can validate at the subnet level. Vendors who wish to use this capability must pre-arrange it with the TSX. Error ERR008 will be sent if the source IP address received does not match the IP address expected.
- 2) Retransmitted data is sent to a client IP address previously registered with the TSX over UDP to the retransmission port assigned to the service.
- 3) No data messages will flow on UDP retransmission stream if the retransmission request is not accepted.
- 4) Once some data messages have been sent, an Error Report control message indicating the status will be sent by the TSX market data system if the retransmission ends abnormally. Another retransmission request is required for requested messages not retransmitted.
- 5) An Error Report is not sent when the number of messages requested exceeds the set limit of 1,000,000.
- 6) Customers should perform sequence number check on messages received on retransmissions to detect a missed packet. If a message is missed on a retransmission, it must re-requested on a new retransmission request.
- 7) Only one retransmission per customer can be active at any one time. This means that if a retransmission is active, a new retransmission can not be submitted until the Trailer Message or an Error Report has been received from the previous retransmission over UDP, indicating the completion of the previous retransmission
- 8) Retransmission service is intended for limited [gap](#) recovery and is bound by the following parameters:

- a) Maximum gap size (per individual request): 10,000
 - b) Maximum retransmission requests: 20,000 requests/day
 - c) Maximum number of packet recoverable in one day: 1,000,000
 - d) Maximum number of packets available for retransmission: the last 2 million messages.
- 9) The Retransmission Request is validated. The following outcomes are possible:
- (a) The request is accepted and honored; the StartSeqNbr and EndSeqNbr fields are set to the corresponding sequence numbers. The ResponseCode is set to "ACK" and StatusCode is set to "ACCEPTED". The requested data is sent in the UDP retransmission stream.
 - (b) The request is correctly formed but there is no data to send. This could happen when the retransmission request references data not yet eligible for retransmission, for example, "read ahead" in a delayed service. In this case, the Acknowledgement Response message is set to "NACK", StatusCode is set to "REJECTED", StartSeqNbr and EndSeqNbr are set to 0, and ErrorDescription is set to ERR009.
 - (c) The retransmission request is accepted but only a portion of the requested messages are actually retransmitted. This can happen when the number of messages requested exceeds the limit set by the TSX. The ResponseCode is set to "ACK", the StatusCode is set to "ACCEPTED", the maximum allowed number of retransmitted messages will be sent in the UDP retransmission stream. The End Of Transmission Trailer indicates the count of requested messages and count of messages actually sent.
 - (d) The request is rejected as invalid due to incorrect format, invalid start and end sequence numbers, or times, or source IP address not recognized. The ResponseCode is set to "NACK", the StatusCode is set to "INVALID", StartSeqNbr and EndSeqNbr are set to 0, and ErrorDescription is set to the corresponding error message. The field RequestReceived will be set to the user request received.
 - (e) The request is valid but is denied due to the TSX having disabled client retransmissions for the required service at the time the retransmission was requested. ResponseCode is set to "NACK", StatusCode is set to "DENIED", and the ErrorDescription is set to ERR006.

4. Technical Requirements

4.1. Retransmission Bandwidth Allocation

- (1) A fixed bandwidth allocation is reserved per client circuit for retransmissions and is shared by all services delivered over that circuit.
- (2) The retransmission bandwidth is fixed and common to all services.
- (3) Only one service retransmission is supported at a time per client circuit.

4.2. IP Addresses

- (1) Three IP addresses are involved to establish the subscription to a service over IP Multicast:
 - (a) Source IP multicast group address to which the market data is disseminated (See Section 4.3),
 - (b) The client's source IP address used when requesting a retransmission,
 - (c) The client's IP address used to deliver retransmissions over UDP.
- (2) Both client addresses must be provided to the TSX at the time of service subscription.
- (3) TMX IP services are disseminated on public (GLOP) IP multicast addresses (range 233.102.209.xxx). Public GLOP IP addresses are globally unique (see Reference [11]).

4.3. IP Port Numbers

TMX IP market data services are delivered as follows:

- (1) Each source is assigned a unique IP port number.
- (2) Market data is sent to the source's multicast group IP address as defined below.
- (3) A concurrent retransmission session, using a different IP port number, is added to the real time session for purposes of requesting missed messages.
- (4) Message delivery integrity is guaranteed through the use of sequence number checking and retransmission.

This section defines the specific IP port numbers, multicast group addresses, and bandwidth allocations associated with each service.

Service Public (GLOP) IP Addresses and Port Numbers for TMX IP Services

CDF Feeds										
Service	Service ID	IP Multicast Group Address		Port for Data Dissemination over IP Multicast		Retransmission Server IP Address		Port for Retransmission Request over TCP	Port for Retransmission Delivery over UDP	
		Markham	Toronto	Markham	Toronto	Markham	Toronto		Markham	Toronto
CDF-TL2P1	CDF	233.102.209.224	233.102.209.96	60000	60001	142.201.149.44	142.201.157.44	60020	60050	60051
CDF-TL2P2	CDF	233.102.209.240	233.102.209.112	61012	61013	142.201.149.44	142.201.157.44	61025	61060	61061
CDF-CHX	CDF	233.102.209.225	233.102.209.97	60002	60003	142.201.149.44	142.201.157.44	60021	60052	60053
CDF-OMG	CDF	233.102.209.226	233.102.209.98	60004	60005	142.201.149.44	142.201.157.44	60022	60054	60055
CDF-CSE	CDF	233.102.209.227	233.102.209.99	60006	60007	142.201.149.44	142.201.157.44	60023	60056	60057
CDF-ALP	CDF	233.102.209.230	233.102.209.102	60010	60011	142.201.149.44	142.201.157.44	60025	60060	60061
CDF-LQN	CDF	233.102.209.231	233.102.209.103	60012	60013	142.201.149.44	142.201.157.44	60026	60062	60063
CDF-TCM	CDF	233.102.209.229	233.102.209.101	60014	60015	142.201.149.44	142.201.157.44	60027	60064	60065
CDF-TSXV	CDF	233.102.209.234	233.102.209.106	61000	61001	142.201.149.44	142.201.157.44	60030	60071	60072
CDF-ICX	CDF	233.102.209.239	233.102.209.111	61010	61011	142.201.149.44	142.201.157.44	61024	61058	61059
CDF-CX2	CDF	233.102.209.244	233.102.209.115	61019	61020	124.201.149.44	142.201.157.44	61028	61066	61067
CDF-LYX	CDF	233.102.209.245	233.102.209.116	61021	61022	142.201.149.44	142.201.157.44	61029	61068	61069
CDF-AEQ	CDF	233.102.209.247	233.102.209.118	61023	61024	142.201.149.44	142.201.157.44	61030	61031	61032
Service A (TSX Listed Securities)										
CBBO-A1	CB1	233.102.209.228	233.102.209.100	60008	60009	142.201.149.36	142.201.157.36	60024	60058	60059
CBBO-A2	CB1	233.102.209.246	233.102.209.117	61070	61071	142.201.149.36	142.201.157.36	61072	61073	61074
CBBOP-A1	CP1	233.102.209.238	233.102.209.110	61075	61076	142.201.149.36	142.201.157.36	60031	60073	60074
CBBOP-A2	CP1	233.102.209.242	233.102.209.114	61077	61078	142.201.149.36	142.201.157.36	60032	60075	60076
CLS-A	LS1	233.102.209.232	233.102.209.104	60016	60017	142.201.149.36	142.201.157.36	60028	60068	60067
CDB-A	BK1	233.102.209.233	233.102.209.105	60018	60019	142.201.149.36	142.201.157.36	60029	60070	60069
Service B (TSXV, Aequitas and CSE Listed Securities)										
CBBO-B	CB2	233.102.209.235	233.102.209.107	61002	61003	142.201.149.36	142.201.157.36	61020	61050	61051
CBBOP-B	CP2	233.102.209.248	233.102.209.119	61008	61009	142.201.149.36	142.201.157.36	61023	61056	61057
CLS-B	LS2	233.102.209.236	233.102.209.108	61004	61005	142.201.149.36	142.201.157.36	61021	61052	61053
CDB-B	BK2	233.102.209.237	233.102.209.109	61006	61007	142.201.149.36	142.201.157.36	61022	61054	61055

NOTE:

RP: Markham – 142.201.52.45
 Advertise Routes: Markham – 142.201.149.32/28
 Markham – 142.201.52.45/32

Toronto – 142.201.52.1
 Toronto – 142.201.157.32/28
 Toronto – 142.201.52.1/32

Port Number for Real Time Data Dissemination over Multicast

This is the port number clients must listen to when receiving real time data for the service using the IP Multicast protocol. The TMX IP does not perform any check to confirm the client has received messages broadcast on this port.

Port Number for Retransmission Requests over TCP

Retransmission requests for a service use the TCP protocol and are sent to this port.

Port for Retransmission Delivery over UDP

Retransmissions are sent to this port using UDP. This port is different from the port used for real time data.

Clients need to allow directed unicast UDP initiated from TSX.

4.4. Operating cycle

Sequence Numbering

All services follow a daily operating cycle on which message sequence numbers revert back to 000000001. Sequence number roll-over will be scheduled at 0:30AM Eastern Time for all services. Please refer to the functional specifications of each service for specific operating sequence details (see References [2 to [5]).

4.5. Feed Reader Software

Recipients of TMX IP market data are responsible for their feed reader software to receive the new services. The following are the main considerations for feed handlers:

- Use of UDP or IP Multicast protocol.
- Differences in business content of the services delivered.
- Handling of message fragmentation (Continuation Indicator).
- Support for retransmission layer to automate retransmission of missed messages.
- Handling of pushed (unsolicited) retransmissions from the TMX IP
- Possible instancing of the feed reader to handle multiple TMX IP services.

Refer to the functional specifications (See References [2] to [5] on page 22) of each individual service for details about message contents.

4.6. Service Delivery

UDP Listening

Feed handlers for TMX IP subscribed services should be activated to listen to the port number assigned to the respective service. The TMX IP will continue delivery of market data to a client's destination with the assumption that the client is receiving the data.

Joining a Multicast Group

After binding the IP socket to the port number assigned to the service, clients receiving the service via IP multicast should add the IP address of the multicast group to the socket to join the multicast group for the service.

Integrity Checking

Client feed handler software must check the integrity of the message stream by comparing sequence numbers. Sequence numbers for successive incoming messages should always increase by 1. If a gap of missing messages is detected, a retransmission can be requested to have the missed messages resent by the TMX IP market data system, as described in Section 3.

During recovery after a service outage, duplicate messages might be sent by the TMX IP market data system. Duplicate messages should be discarded by clients.

5. Service Retransmission

TMX IP services will provide a retransmission capability for clients to handle situations of missed messages. All retransmission will be provided via Client-initiated mode. The retransmission protocol and message formats are as defined in Section 3.

5.1. Client Initiated Retransmissions

- (1) At the client's end, the feed reader must track the integrity of the message stream using message sequence numbers. Upon detection of one or more missing messages a retransmission request can be submitted to have the missed data resent.
- (2) Retransmission requests are sent to a TMX IP-assigned IP address and port number using the TCP protocol. The port number used identifies the desired service. The request includes the missing sequence numbers. If the request is accepted, the requested messages are retransmitted on the associated retransmission port number for the service using UDP.
- (3) Retransmissions request are limited to a maximum of 10,000 messages. If more than 10,000 messages are requested, only the first 10,000 messages will be re-sent and another retransmission request must be submitted for the remainder.
- (4) Retransmissions are not recoverable. If a retransmission fails or is interrupted for some reason it must be re-requested. Retransmissions can be aborted by the TMX IP. In this case, an error message (Error Report) is sent to the client with a reason code.
- (5) Heartbeat messages will be sent to the client's retransmission IP address and retransmission port number at periodic intervals to confirm the presence of an active connection. Original heartbeat messages sent with the real time service delivery are not retransmitted.
- (6) Only one retransmission per client is supported at any one time. Retransmission requests submitted when a TMX IP-initiated retransmission is in progress will be rejected.

5.2. Retransmission Availability

Retransmissions will be available to clients on demand. However, the TMX IP may disable retransmissions for some services at certain times of day. In this case, retransmission requests received during these periods will be denied.

Glossary

Acronym	Meaning
CO	Central Office
CRC	Cyclic Redundancy Check
FIX	Financial Information Exchange protocol
FTP	File Transfer Protocol
GLOP	Allocation of IP address bits as per RFC 2770
HTTP	Hypertext Transfer Protocol
ICMP	Internet Control Message Protocol
IP	Internet Protocol
LAN	Local Area Network
LANX	LAN Extension
MDS	Market Data Services, Market Data System
MTU	Maximum Transmission Unit
NIC	Network Interface Card
PIM	Protocol Independent Multicast
QOS	Quality Of Service
STAMP	Securities Trading Access Message Protocol
TBD	To Be Determined
TCP	Transmission Control Protocol
TSX	Toronto Stock Exchange
TSXV	TSX Venture Exchange
UDP	User Datagram Protocol

References

[1]	STAMP Specification, Version 4.0, TSX Markets, January 2003
[2]	Consolidated Data Feed CDF™ Functional Specifications
[3]	Consolidated Last Sale (CLS™) Functional Specifications
[4]	Canadian Best Bid and Offer (CBBO) Functional Specifications
[5]	Consolidated Depth of Book (CDB) Functional Specifications
[6]	RFC 768, <i>User Datagram Protocol</i> , J. Postel, September 1981, http://www.ietf.org
[7]	RFC 791, <i>Internet Protocol</i> , J. Postel, September 1981, http://www.ietf.org
[8]	RFC 792, <i>Internet Control Message Protocol</i> , J. Postel, September 1981, http://www.ietf.org
[9]	RFC 793, <i>Transmission Control Protocol</i> , J. Postel, September 1981, http://www.ietf.org
[10]	RFC 2117, <i>Protocol Independent Multicast Sparse Mode</i> , http://www.ietf.org
[11]	RFC 2770, <i>GLOP Addressing in 233/8</i> , http://www.ietf.org

Revision History

Rev.	Date	Changes Made
4.0	June 5, 2015	<p>Section 1.1 – Added CSE listed and Aequitas listed securities to Service B description.</p> <p>Section 2.1 – Added references to Canadian Best Bid and Offer for Protected Marketplaces only (CBBOP) Service A1, A2 and Service B. Updated Alpha name to TSX Alpha Exchange and removed TMX Select.</p> <p>Section 2.2 – Added new table listing marketplace inclusion by service feed.</p> <p>Section 2.4 – Added new ServiceID values CP1 & CP2 for CBBOP Service A & B, Removed Exchange Identifier "S" for TMX Select, changed description for Alpha to TSX Alpha Exchange.</p> <p>Section 4.3 - CDF Feed Table – Added IP addresses and port information for the new CBBOP feeds</p> <p>Section 4.3 - CDF Feed Table – Updated values for 'Service' to reflect 'A' for TSX Listed and 'B' for TSXV, Aequitas and CSE listed securities. Example: CBBO-TSX1 & CBBO-TSX2 is now CBBO-A1 & CBBO-A2</p>
3.9	March 19, 2015	Section 4.3 – Modified CDF-Aequitas port number for Retransmission delivery over UDP at Toronto site.
3.8	December 19, 2014	<p>Section 2.1 – Added Aequitas to list of CDF Feeds, and added Aequitas and CSE listed securities to description of Service B consolidated feeds</p> <p>Section 2.3 – Added Exchange Identifier "E" for Aequitas</p> <p>Section 3.4 - Added Exchange Identifier "E" for Aequitas</p> <p>Section 4.3 – Added Aequitas IP addresses and port information and amended heading of Service B port table to include Aequitas and CSE listed securities.</p>
3.7	August 31, 2014	<p>Section 2.1 – Removed reference to PURE Trading, and updated reference to CSE</p> <p>Section 2.3 – Updated Exchanged tag "P" to represent both CSE and CSE Other listed sec.</p> <p>Section 2.3 – Removed Exchanged tag "N"</p> <p>Section 3.3 – Corrected length of "ErrorDescription", "Received Request" and total length.</p> <p>Section 3.4 – Updated description of CSE in Exchanged tag</p> <p>Section 4.3 – Removed IP and Port information for CNSX and replaced CDF – PTX reference with CDF- CSE</p> <p>Section 4.5 – Updated page reference from 22 to 23</p>
3.6	Apr 17, 2014	Added new IPs and Ports for second multicast feed for CBBO Service A
3.5	Dec 12, 2013	New IP's and Ports for Lynx ATS
3.4	Mar 8, 2013	<p>Updated Sections 3.6 and 4.2 to exclude references to UDP retransmission to subnets.</p> <p>Removed references to SigmaX ATS</p> <p>New IP's and Ports for CX2</p>
3.3	Feb 29, 2011	<p>New retransmission server IP addresses for CDF services</p> <p>Clarification for recommended recovery and retransmission parameters</p>
3.2	March 31, 2011	<p>New Feeds – Canadian National Stock Exchange (CNSX), Instinet Canada Cross (ICX), TMX Select (SEL) and SigmaX ATS (SGM)</p> <p>New IP's and ports for Toronto Stock Exchange (TSE) partition two.</p>
3.1	Jan 28, 2011	Corrected the order of IP Multicast Address for Service B Feeds
3.0	Dec 20, 2010	CDB – TSX listed securities (Service A) , CDF-TSXV and Service B Feeds
2.2	Nov 4, 2009	New TMX IP Services
2.1	July 30, 2009	Change references to CDF and TSX to TMX IP
2.0	Sept 23, 2008	CBBO
1.0	May 15, 2008	Document created.