



NSX Depth of Book over  
Multicast Feed Specification  
V.1.11

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December 19, 2011

## Revision History

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1.0	12/20/07	Gennady Garber	Initial specification
1.1	4/09/08	Kevin Countryman	Draft
1.2	4/30/08	Stuart Munro	Network Connectivity information
1.3	5/05/08	Cynthia Rozenberg	Updated symbology table
1.4	6/19/08	Stuart Munro	Carrier & Extranet Options Appendixes
1.5	4/14/09	Michael Serafin	Update Appendix – Extranet Connectivity Options
1.6	11/04/09	Stuart Munro	Retransmission Connectivity
1.7	2/11/10	Chris Stuart	Appendix 5 & 6
1.8	3/23/10	Michael Serafin	Add Long Message for New Symbology Format
1.9	7/30/10	Michael Serafin	Extended Hours To 8pm ET
1.10	2/11/11	Michael Serafin	Update Appendix 5
1.11	12/19/11	Michael Serafin	Section 3.1.3 Fast Presence Map Definition

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## 1 Overview

In an effort to increase the market data offerings provided by NSX and take advantage of newer technologies for data delivery, NSX has created a Multicast version of its Depth of Book (DOB) feed. The use of Multicast transmission from NSX to its clients, takes advantage of allowing clients to subscribe to the DOB feed from multiple servers without the need to scale bandwidth based on the number of servers that need the connectivity, as would be the case in the traditional TCP/IP connectivity scenario. The NSX DOB multicast feed is a lightweight, fast compressed feed and provides real-time delivery of a set of sequenced messages to a client's machine(s) without establishing point-to-point connection.

Since Multicast uses UDP transmission of data and is therefore inherently unreliable, the NSX DOB Feed is based on two Multicast feeds, an A Feed and a B Feed. Each feed has identical data, but is sourced from separate servers and sent to different Multicast Group addresses. It is the responsibility of the client to subscribe to both A and B Feeds, and arbitrate between the two feeds on a per packet basis from each feed.

In the event that a subscriber misses a packet from both the A and B feed, a Unicast retransmission service will be available to fill in the gaps on any multicast feeds experienced.

### 1.1 Document Scope

The purpose of this document is to outline the network connectivity options and define the format of the Depth of Book over multicast feed Protocol by the National Stock Exchange Inc.<sup>®</sup> ("NSX<sup>®</sup>"). This document provides the layout of the messages, as well as their interpretations for processing.

### 1.2 Hours of Operation

The National Stock Exchange allows trading between the hours of 8AM ET and 8:00 PM ET<sup>1</sup>. The DEPTH OF BOOK over MULTICAST FEED will be active during these times.

### 1.3 Document Contact

For any questions regarding this document, call 1-800-THE-EXCH or email [NSXTrading@NSX.com](mailto:NSXTrading@NSX.com)

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<sup>1</sup> All times listed in this specification, unless otherwise indicated, are Eastern Time

## 2 Connectivity Options

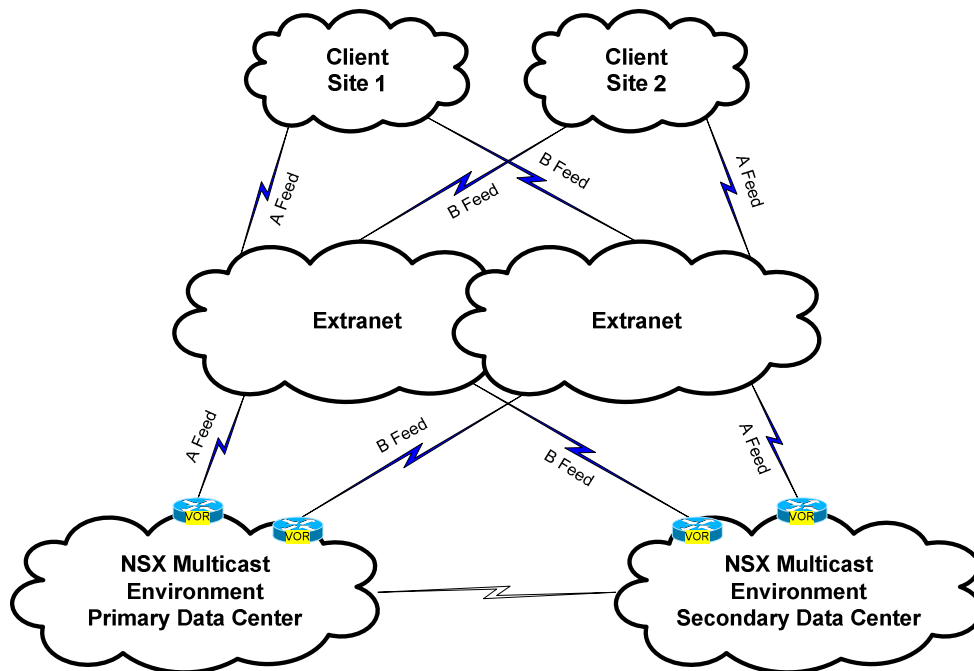
There are three primary ways of connecting to NSX, via extranet connectivity, direct fully redundant and direct site redundant connectivity, each of which are shown below.

### 2.1 Extranet Connectivity

Various extranet providers have a presence at the NSX data centers providing indirect access to NSX services through their infrastructure. NSX clients can therefore access NSX Services through their own connection to the same extranets providers that have a presence at NSX data centers. For a list of the current extranet providers that can deliver the NSX Multicast DOB service, please contact [NSXTrading@NSX.com](mailto:NSXTrading@NSX.com).

The extranet provider will be responsible for ensuring that the market data that enters its network is forwarded to the client subscribing to the feed. Figure 1 following shows the connectivity overview when connecting to NSX through an extranet, for more details information, clients are requested to contact their extranet of choice, or NSX, a list of extranets delivering NSX multicast feeds can be found in the Appendix on page 21, Clients are urged to contact their NSX representative for an up to date list.

Figure 1 - Extranet Connectivity



For information about client connectivity into any extranets, clients are requested to contact the extranet provider of choice to discuss options for the local loop and IP connectivity.

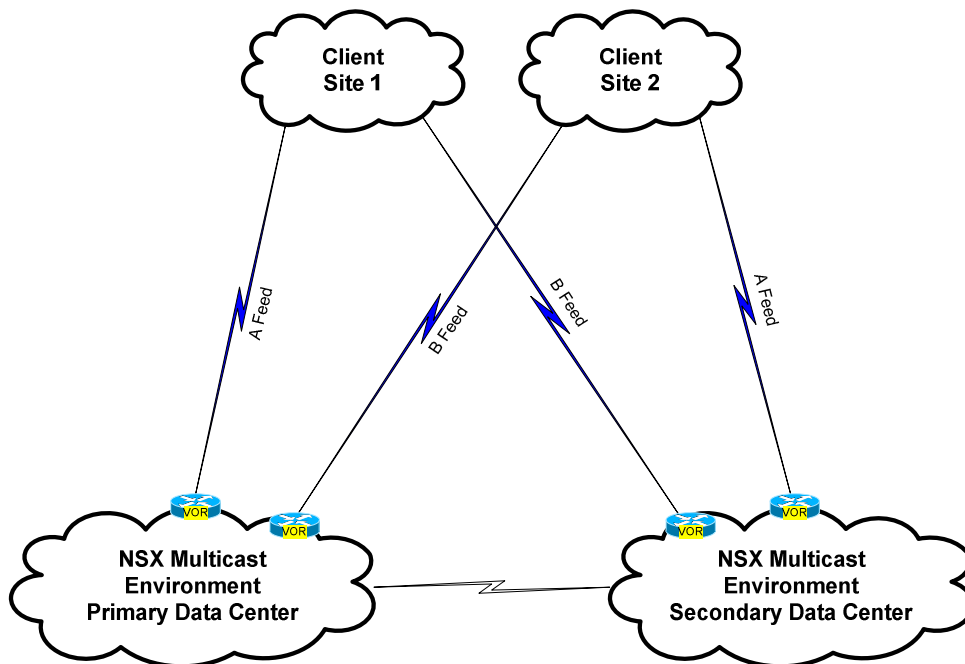
## 2.2 Direct Connectivity

Clients can opt for direct connectivity to NSX. Clients will be responsible for provisioning appropriately sized circuits as well as provisioning for carrier diversity, from their own data centers to the NSX data centers. Clients will be responsible for terminating those circuits with their own appropriately sized router within the NSX data center. Two version of the direct connectivity are recommended, fully redundant to multiple client sites and site redundancy from the NSX locations. Please refer to the Appendix on Page 21 for a list of carriers that have access to our data centers. Clients are urged to contact their NSX representative for an up to date list.

### 2.2.1 Fully Redundant Configuration

Fully redundant connectivity consists of diverse links from two client data centers to two of the NSX Data centers. Clients will be responsible for provisioning carrier diversity and routers to terminate those circuits, within the NSX Data center.

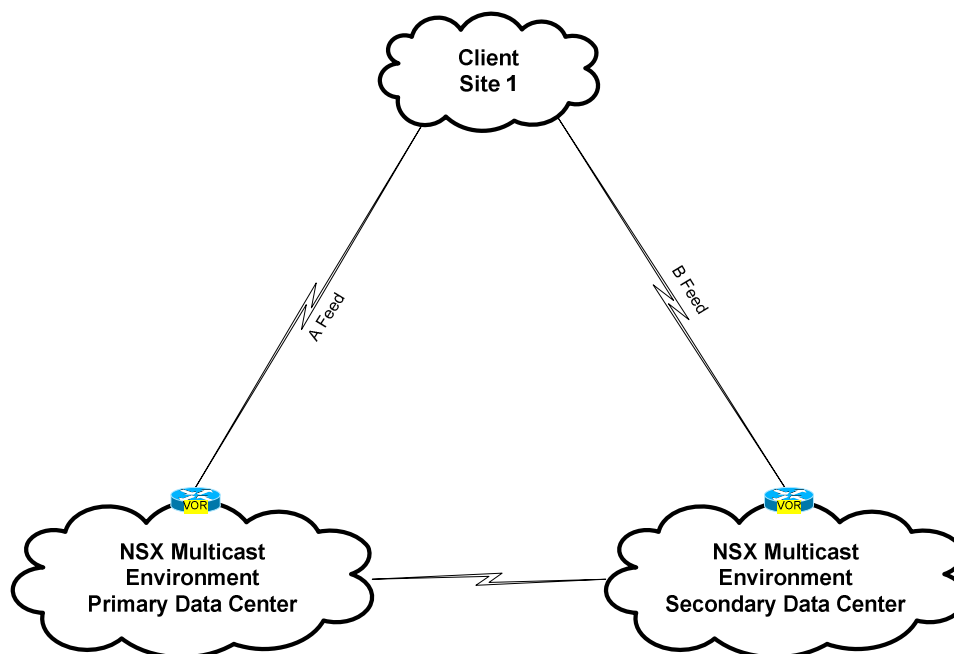
Figure 2 - Direct Connectivity - Fully Redundant



### 2.2.2 Site Redundant Configuration

Site Redundant Configuration consists of two diverse links from the client's primary data center to each of the NSX data centers, using diverse carriers and provisioning routers to terminate the circuits within the NSX data centers.

Figure 3 - Direct Connectivity - Site Redundancy



### 2.3 Bandwidth Recommendations

At the time of publication of this document, NSX estimates a minimum bandwidth requirement per A or B feed to be 10MBS, clients wishing to access both A and B Feeds over the same lines, should allocate a minimum of 20 MBS for that line. Since retransmissions should only occur if there is a major outage, minimal loss of both the A and B Feeds is expected, and so retransmission bandwidth is expected to be negligible.

### 2.4 Addressing Information

This section provides information on all aspects of the IP addressing information needed to receive the NSX Multicast feeds.

**2.4.1 Connectivity Addressing**

All IP addressing provided by NSX for both Multicast Feed and TCP Retransmission service will utilize registered addressing. Local interconnects between client routers and NSX, may use RFC1918 addressing.

Clients accessing NSX via an Extranet, should contact their Extranet Service Contact, for the locally addressing information between themselves and the Extranet.

Directly connected clients will be responsible for all IP addressing within their network equipment from their site to NSX. The Ethernet handoff between the Client router and NSX can be addressed in one of two ways.

- NSX can offer a /30 IP subnet per connection within the RFC1918 Range, which will be allocated within the following ranges depending on data center
  - Primary Data Center – 172.16.0.0/16
  - Secondary Data Center – 172.18.0.0/16
- Client may allocate a /30 within a registered IP address range.

**2.4.2 Routing Information**

Clients using Extranet Connectivity should contact their provider for routing options for receiving NSX routes from our Multicast environment.

The routing protocol of choice between NSX and direct clients is BGP. NSX uses a registered BGP ASN of 30192. Clients wishing to peer using BGP should provide NSX with their registered BGP ASN. BGP Peering will use the addressing on the local L3 Link utilizing the /30 addressing as noted in Section 2.4.1, NSX will also use BGP MD5 Peer authentication for all its BGP Peering.

The information in Table 1 below shows all the subnets that should be received by the client BGP Peer. Options for manipulating the routes should be discussed during the network design phase with the NSX Network Architecture and Engineering team.

**Table 1 - Routed Subnet information**

Primary DC Breakdown		Secondary DC Breakdown	
Subnet	Usage	Subnet	Usage
208.88.44.0/27	Multicast A Feeds	208.88.46.0/27	Multicast A Feeds
208.88.44.64/27	Multicast B Feeds	208.88.46.64/27	Multicast B Feeds
208.88.44.240/29	Multicast Retransmission	208.88.46.240/29	Multicast Retransmission
208.88.44.254/32	Multicast A Feed RP	208.88.46.254/32	Multicast B Feed RP

### 2.4.3 Multicast Groups

The multicast group address range assigned to NSX is based on Multicast GLOP addressing, which is derived from the BGP ASN assigned to NSX. The BGP assigned ASN is 30192, making the multicast range 233.117.240.0/24. This range has been split up to allocate for current multicast delivery information as well as expected future expansion. Table 2 below shows the addressing that has been assigned for the NSX DOB.

Table 2 - Multicast Group Addressing

A Feed Allocations:			B Feed Allocations:		
IP/Subnet	Port #	Usage	Subnet	Port #	Usage
233.117.240.0/28	N/A	DOB A Range	233.117.240.128/28	N/A	DOB B Range
233.117.240.1	50001	DOB A Feed 1	233.117.240.129	50129	DOB B Feed 1

### 2.4.4 Multicast Source Addressing

The source subnets for the A and B Feed can be seen in Table 3 below. In normal operation, all sources will appear from the Primary data center. In the event of a major failure, NSX will bring up the Multicast Services from the Secondary Data center.

Table 3 - Source Addressing

Primary Data Center Allocations:			Secondary Data Center Allocations:		
Subnet	Mask	Usage	Subnet	Mask	Usage
208.88.44.0/27	255.255.255.224	Multicast A Feeds	208.88.46.0/27	255.255.255.224	Multicast A Feeds
208.88.44.64/27	255.255.255.224	Multicast B Feeds	208.88.46.64/27	255.255.255.224	Multicast B Feeds

### 2.4.5 RP Addressing

If the client wishes, they may use the available RP's from NSX. Table 4 below shows the RP's associated with each of the groups of feeds.

Table 4 - RP Addressing

A Feed RP		B Feed RP	
Subnet	Usage	Subnet	Usage
208.88.44.254/32	Multicast A Feed RP	208.88.46.254/32	Multicast B Feed RP

#### 2.4.6 DOB Retransmission

If a client has gaps in both the DOB A and B feeds simultaneously, a retransmission feed is available to clients, through a TCP connection. Clients should open a TCP connection to the IP addresses in Table 5 below and request the starting message ID on the GAP range. Once the message gaps have been filled, the client should disconnect from the TCP session.

**Table 5 – Retransmission Connectivity**

Production Retransmission		DR Retransmission	
IP	Port	IP	Port
208.88.44.243	40101	208.88.46.243	40101

### 3 Packet structure

Packet consists of fixed size header and variable size payload. Header structures are described in Table 6.

Table 6 – Header Structure

Field description	Length	Type	Order
Sequence number of the first message in the packet	4 bytes	Unsigned	Network order
Number of messages in the packet	2 bytes	Unsigned	Network order
Payload length	2 bytes	Unsigned	Network order

Packet payload consists of number of Fast-encoded order messages. Partitioning of order messages is not allowed.

#### 3.1 Supported Messages

There are two types of messages supported: Session Level and Application Level.

Session Level:

- Heartbeat message

Application Level:

- Add Order message
- Modify Order
  - Order Execution message
  - Order Cancel message

##### 3.1.1 Session Messages

###### 3.1.1.1 Heartbeat

Heartbeat messages should be sent every 1 second if feed data is not available. Each message is sent as a separate packet (can not be combined with order messages). Packet containing Heartbeat message does not have payload, but only the header. Table 7 below describes Heartbeat header values

Table 7 - Heartbeat Headers

Field description	Value
Sequence number of the first message in the packet	Sequence number of the last sent message + 1
Number of messages in the packet	0
Payload length	0

### 3.1.2 Application Messages

#### 3.1.2.1 General

The DOB multicast feed allows receivers to create their copy of the NSX book. The DOB multicast feed messages will be sent in real-time to identify orders being added to the book, including odd-lot orders. Orders not entered into the book (e.g., Market Orders) will not be reported.

The general rule of thumb is that each order in the book will generate at least 2 DOB feed messages: the initial add, and at least 1 execution or cancel. An “Add” order will receive 1 “Execute” message for each contra party that the order executed against. If an order in the book is cancel-replaced, then a cancel message will be sent for the open shares, and an add one for the new open quantity.

Note: if the replace quantity is less than or equal to the previously executed quantity, then only a cancel will be sent, as the order will no longer have any open shares.

#### 3.1.2.2 Fast compression

In order to improve bandwidth utilization, all order messages are FAST compressed. Familiarity with FAST encoding method is assumed - please see Reference section for the link to detailed FAST specification. Table 8 shows the FAST tags, used for application messages compression/decompression.

Table 8 - FAST Tags

Tag type	Tag description
FAST_OP_DEFAULT	If field is in message – use it from the message, but do not update the cache. If field is not in message – use the default value from the cache.
FAST_OP_COPY	If field is in message – use it from the message, and update the cache with the message value. If field is not in message – use the cache value.

All message fields are of either numeric or string (alpha or alpha-numeric) type.

### 3.1.2.3 Add Order Message

An Add Order Message, as shown in Table 9 following, indicates that a new order has been accepted by the NSX system and added onto the displayable book. It includes a unique Order Reference Number assigned by NSX to the order.

#### Important Note:

Order Reference Number – is sent as a Base 36 representation of a long integer, and the method of base 36 is defined as 0-9 then A-Z (case is insensitive).

**Table 9 - Add Order Messages**

Field Name	Type	Default Value	FAST Tag	Notes
Soup Type	Alpha	"S"	FAST_OP_DEFAULT	To preserve compatibility with existing Depth Of Book feed.
Time Stamp (seconds)	Numeric	N/A	FAST_OP_COPY	Time Stamp – seconds
Time Stamp (milliseconds)	Numeric	N/A	FAST_OP_COPY	Time Stamp – milliseconds
Message Type	Alpha	N/A	FAST_OP_COPY	"A" for Add Order Message.
Order Reference Number	Alpha-Numeric	N/A	FAST_OP_COPY	The unique reference number (base 36) assigned to this new order. Increasing for each symbol, but not necessarily sequential.
Buy/Sell Indicator	Alpha	N/A	FAST_OP_COPY	"B" = for buy order. "S" = for sell order.
Shares	Numeric	N/A	FAST_OP_COPY	Total number of shares being added to the book (may be less than the number of shares entered).
Stock Symbol 1	Alpha	N/A	FAST_OP_COPY	First 4 letters of Stock symbol
Stock Symbol 2	Alpha	" "	FAST_OP_DEFAULT	Remaining 2 letters of Stock symbol (usually spaces)
Price 1	Numeric	N/A	FAST_OP_COPY	The limit price of the order in cents
Price 2	Numeric	"0"	FAST_OP_DEFAULT	Sub-penny part of order limit price.
Display	Alpha	"A"	FAST_OP_DEFAULT	"Y" - All orders are displayed. "A" - ETP Holder Attribution.
Client Attribution	Alpha-Numeric	N/A	FAST_OP_COPY	Represents the MPID of the ETP Holder; or "NSXX" if ETP Holder is anonymous. By default, all ETP Holders are anonymous.

### 3.1.2.4 Order Cancel

Order Cancel message are sent whenever an order in the book is modified as a result of being canceled in whole or in part. Table 10 shows the Fast Tag’s for these message types.

**Table 10 - Order Cancel Messages**

Field Name	Type	Default Value	FAST Tag	Notes
Soup Type	Alpha	“S”	FAST_OP_DEFAULT	To preserve compatibility with existing Depth Of Book feed.
Time Stamp (seconds)	Numeric	N/A	FAST_OP_COPY	Time Stamp – seconds
Time Stamp (milliseconds)	Numeric	N/A	FAST_OP_COPY	Time Stamp – milliseconds
Message Type	Alpha	N/A	FAST_OP_COPY	“X” for Order Cancel Message.
Order Reference Number	Alpha-Numeric	N/A	FAST_OP_COPY	The unique reference number (base 36) assigned to this new order. Increasing for each symbol, but not necessarily sequential.
Shares	Numeric	N/A	FAST_OP_COPY	The number of shares canceled.

### 3.1.2.5 Order Execution

This message is sent whenever an order on the book is executed in whole or in part, or when an order is sent to an Order Delivery participant. The execution price is always equal to the limit price of the order as indicated in the Add Order Message.

**Table 11 - Order Execution Messages**

Field Name	Type	Default Value	FAST Tag	Notes
Soup Type	Alpha	“S”	FAST_OP_DEFAULT	To preserve compatibility with existing Depth Of Book feed.
Time Stamp (seconds)	Numeric	N/A	FAST_OP_COPY	Time Stamp – seconds
Time Stamp (milliseconds)	Numeric	N/A	FAST_OP_COPY	Time Stamp – milliseconds
Message Type	Alpha	N/A	FAST_OP_COPY	“E” for Order Executed Message.
Order Reference Number	Alpha-Numeric	N/A	FAST_OP_COPY	The unique reference number (base 36) assigned to this new order. Increasing for each symbol, but not necessarily sequential.
Shares	Numeric	N/A	FAST_OP_COPY	The number of shares executed.
Match Number	Alpha-Numeric	N/A	FAST_OP_COPY	The day-unique Match Number of this execution.

### 3.1.2.6 Add Order – Long Message

The Add Order – Long Message is a specialized version of the Add Order message that is designed to accommodate 5-character root symbols. Table 12 shows the Fast Tag’s for this message type.

Table 12 – Add Order – Long Message

Field Name	Type	Default Value	FAST Tag	Notes
Soup Type	Alpha	“S”	FAST_OP_DEFAULT	To preserve compatibility with existing Depth Of Book feed.
Time Stamp (seconds)	Numeric	N/A	FAST_OP_COPY	Time Stamp – seconds
Time Stamp (milliseconds)	Numeric	N/A	FAST_OP_COPY	Time Stamp – milliseconds
Message Type	Alpha	N/A	FAST_OP_COPY	“d” for Add Order – Long Message.
Order Reference Number	Alpha-Numeric	N/A	FAST_OP_COPY	The unique reference number (base 36) assigned to this new order. Increasing for each symbol, but not necessarily sequential.
Buy/Sell Indicator	Alpha	N/A	FAST_OP_COPY	“B” = for buy order. “S” = for sell order.
Shares	Numeric	N/A	FAST_OP_COPY	Total number of shares being added to the book (may be less than the number of shares entered).
Stock Symbol 1	Alpha	N/A	FAST_OP_COPY	First 4 letters of Stock symbol
Stock Symbol 2	Alpha	“ ”	FAST_OP_DEFAULT	Remaining 4 letters of Stock symbol (usually spaces)
Price 1	Numeric	N/A	FAST_OP_COPY	The limit price of the order in cents
Price 2	Numeric	“0”	FAST_OP_DEFAULT	Sub-penny part of order limit price.
Display	Alpha	“A”	FAST_OP_DEFAULT	“Y” - All orders are displayed. “A” - ETP Holder Attribution.
Client Attribution	Alpha-Numeric	N/A	FAST_OP_COPY	Represents the MPID of the ETP Holder; or “NSXX” if ETP Holder is anonymous. By default, all ETP Holders are anonymous.

### 3.1.3 Section 3.1.3 Fast Presence Map Definition

The Presence Map (PMap) is a variable length bit field that indicates whether a particular field is present in a message. Table 13 indicates which field each bit represents.

Table -13 PMap definition

Bit	Field Name
0	Reserved for stop bit
1	Message Type ('A','X','E' or 'D')
2	Order Reference Number
3	Shares
4	Time Stamp (milliseconds)
5	Price 1
6	Stock Symbol 1
7	Buy/Sell Indicator
8	Reserved for stop bit
9	Client Attribution
10	Display
11	Match Number
12	Time Stamp (seconds)
13	Stock Symbol 2
14	Price 2
15	Soup Type

## 3.2 Recovery mechanism

Due to the fact that FAST compression algorithm is based on previous message encoding, receiving side may fail to decode messages if previous message(s) got lost. In order to enable recovery after packet loss, DOB multicast server will send uncompressed (i.e. won't use previous compression history) every 1000th message. It's up to the customer to restore missing sequence by requesting retransmission of missing message(s) from the Replay Server.

**Example:** Let's assume that client lost messages from 10403 to 10567. In order to recover, client should:

- Continue to receive DOB multicast feed, but discard all messages up to and including 11000th.
- Connect to Replay Server and request messages starting from 10403 up to and including 11000th.
- Disconnect from Replay Server once all desired messages (10403-11000) are received.
- Continue with DOB multicast feed starting from message 11001.

## 3.3 References

- *NSX DOB Feed Specification over TCP/IP*

www.nsx.com

- **FAST specification**  
<http://www.fixprotocol.org/fast>

## 4 Appendix – Symbology

### 4.1 NASDAQ Listed Securities

#### Current Nasdaq Equity Symbols

Nasdaq assigns symbols for all Nasdaq and OTC issues including OTCBB and Pink Sheets. Nasdaq symbols are up to 5 characters with no suffixes. The first 4 characters are the base symbol for the company. If there is a 5th character it represents one of the following:

Security Categorization	5 <sup>th</sup> Character
Class "A"*	A
Class "B"*	B
Issuer granted an exception to NASDAQ-quoted company standards for a limited time	C
New	D
Delinquent in filings with the SEC	E
Foreign	F
First bond	G
Second bond	H
Third bond	I
Voting	J
Non-voting	K
Misc	L
Fourth preferred	N
Third preferred	N
Second preferred	O
First preferred	P
Bankruptcy	Q
Rights	R
Shares of beneficial interest	S
With warrants or with rights	T
Units	U
When issued and when distributed	V
Warrants	W
Mutual Funds	X
American Depository Receipts	Y
Misc	Z

## 4.2 NYSE and AMEX Listed Securities

The following symbol suffixes are used to identify the security type.

Security Categorization	Suffix Symbology
Preferred	p
Preferred Class "A"	pA
Preferred Class "B"	pB
Class "A"	/A
Class "B"	/B
Preferred when distributed	p/WD
When distributed	/WD
Warrants	/WS
Warrants Class "A"	/WS/A
Warrants Class "B"	/WS/B
Called	/CL
Class "A" Called	/A/CL
Preferred called	p/CL
Preferred "A" called	pA/CL
Preferred "A" when issued	pAw
Emerging Company Marketplace	/EC
Partial Paid	/PP
Convertible called	/CV/CL
Rights	r
Units	/U
When issued	w
Rights when issued	rw
Preferred when issued	pw
Class "A" when issued	/Aw
Warrant when issued	/WSw

## 5 Appendix – Extranet Connectivity Options

### 5.1 Carlstadt NJ and Philadelphia PA

**Available Extranets:**

Sidera Networks (Formerly RCN)

SFTI

BT Radianz

Verizon Financial Network

SAVVIS

## 6 Appendix – Direct Connect Carrier Options

### 6.1 Carlstadt NJ

777 Central Blvd

Carlstadt, NJ 07072

NPA/NXX: 201/729

**Available Carriers:**

4 Connections

AT&T Local Services

Level 3

RCN

Verizon

Reliance Globalcom (Formerly Yipes)

Abovenet

Fibertech

Optimum Lightpath

Time Warner

Verizon Business (Legacy MCI)

### 6.2 Philadelphia PA

401 North Broad Street

Philadelphia PA 19108

NPA/NXX:215/351

**Available Carriers:**

AT&T Local Services

Verizon

Reliance Globalcom (Formerly Yipes)

Telcove

Cross Connect Solutions

Qwest

On Fiber

Cogent

Verizon Business (Legacy MCI)

Sunesys

Abovenet

Global Crossing

Level 3

Neon/RCN

Note: The carriers set forth above are those which NSX believes are available as of the publishing date of the date of this document. Reference to such carriers is neither an endorsement nor a recommendation of such carriers or

their offered services. Each DOB subscriber shall be solely responsible for establishing its respective relationship with any such carrier.