



US Equity/Options Connectivity Manual

Version 5.1.2

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1 Introduction

1.1 Overview

The BATS BZX Equities trading platform is housed in the SAVVIS data center in Weehawken, New Jersey. The BATS BZX secondary data center is hosted by BT Radianz in Nutley, New Jersey. Members are strongly encouraged to establish connectivity to both data centers to minimize service disruption in the event of an issue at either data center. Weehawken is the “primary” or “hot” site, with Nutley being “secondary” or “warm” – members may receive market data from Nutley, and they may connect and heartbeat with order entry systems in Nutley. Orders submitted to Nutley will be rejected until BATS declares Weehawken “down”.

The BATS BZX Options and BYX Equities trading platforms are housed in the SAVVIS data center in Weehawken, New Jersey. At this time, there is no secondary datacenter for BZX Options and BYX Equities.

Members are responsible for choosing their telecommunications provider and arranging for connections to both BATS data centers.

BATS supports the following network connectivity choices for access to both Equities and Options:

- **IPSec VPN** via the Internet (only for order entry, not market data);
- **Co-location Cross-connect** (i.e. for members co-located in the same data center);
- **Extranet** connectivity (e.g. BT Radianz, TNSi, SFTI, SAVVIS, Reliance Globalcom, GuavaTech, NexGen, etc.); and
- **Private line ethernet.**

Other methods of connectivity may be possible, please contact BATS’ NOC for more information:

- **Phone:** 913-815-7005
- **Email:** noc@batstrading.com

2 Connectivity Choices

2.1 IPsec VPN

Members may connect to either data center via an IPsec Virtual Private Network (VPN) over the Internet. IPsec VPNs may be used for:

- Access to order entry and unicast market data feeds for certification and test;
- An IPsec VPN configuration may be maintained as a production or backup method for order entry only (no more than two (2) FIX sessions); and
- LAN-to-LAN IPsec VPNs supported. IP address of the host presented to BATS must be registered.

BATS highly recommends fixed connectivity due to the inherent delays and uncertainty of data delivery when using the Internet.

Note: BATS does not offer market data feeds over VPN.

2.2 Co-location Cross-connect

Equities members may co-locate within SAVVIS (BZX/BYX) and/or BT Radianz (BZX) data centers and cross-connect to BATS. Options members may co-locate within the SAVVIS datacenter and cross-connect to BATS.

- Equities members with their own space in either data center may request an in-house cross-connect from the member's Point of Presence (PoP) to the BATS network.
- Equities members not co-located can lease co-location space in either datacenter from the datacenter host (refer to the "Telecommunication Providers" section below for data center contact information).
- Options members with their own space in the SAVVIS data center may request an in-house cross-connect from the member's Point of Presence (PoP) to the BATS network.
- Options members not co-located can lease co-location space in the SAVVIS datacenter from SAVVIS (refer to the "Telecommunication Providers" section below for data center contact information).
- Cross-connection is made with copper Ethernet cabling (e.g. Cat6). In the cases where distance is too great for copper cable, BATS can support optical fiber on a case-by-case basis.

With data center co-location, members can place equipment, terminate communications circuits, and establish a cross-connect to BATS (or other destinations) in that space. This gives the maximum amount of control to the member. This option is neutral for the member and provides

the greatest flexibility for the member in determining when and to whom to connect. Members interested in co-location services should contact SAVVIS or BT Radianz directly (refer to the “Telecommunication Providers” section below for datacenter contact information).

2.3 Extranet

Members may provision connectivity to BATS via an extranet.

- Extranets have provisioned redundant, high speed connections to BATS for use by multiple members.
- Contact information for a variety of Extranet providers is found below within the “Telecommunications Providers” section below.

This method is an attractive alternative when:

- the member would otherwise have to provision a long-haul private line;
- outsourcing of network services and network management is an option; or
- the ease and speed of turn-up are important (when both the member and BATS have an existing connection to the extranet).

Connectivity to Extranet providers not listed in the “Telecommunications Providers” section below is possible. BATS is willing to connect via any open and available Extranet provider, based on member demand and cooperation from the Extranet provider (certain considerations apply – please contact the BATS NOC for information).

2.4 Directly Connected via Private Line Ethernet

Members may connect to BATS via Private Line Ethernet.

- No co-location space is required. Cross-connect from Telco demarcation point to BATS network via a Gigabit Ethernet interface.
- Contact your carrier of choice to arrange connectivity to BATS, see the “Telecommunications Providers” section below.

2.5 Directly Connected via Member Terminated Routers

Members may terminate circuits MetroE, OC-3, etc. on a member-provided and owned router or switch in the BATS controlled space.

- Communications equipment is owned and maintained by the member.
- For each BATS market center a member is connected to, BATS will provide physical space, 110VAC power, and adequate environment for up to four Rack Units of member-owned communications equipment (i.e. router, switch) necessary to connect to BATS. Servers cannot be supported.

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- All member equipment is placed into 2-post open relay-type racks, and BATS requires the use of routers/switches that are rack-mountable (mid-device rack ears are required for Weehawken).
- All equipment must be clearly labeled front and rear with the member (abbreviation such as MPID is acceptable) and a member-determined unique device name.
- To minimize the number of power circuits and rack space requirements, BATS requires that when a member router/switch solution necessitates a DSU/CSU that the DSU/CSU be incorporated within the router/switch.
- The demarcation point between the member and BATS would be Ethernet interface of the member's router/switch. Patches are made with copper Ethernet cabling (e.g. Cat6). For each site (Weehawken and Nutley), BATS will allow up to four physical ports (up to 1Gbps per port) per member at no cost for purposes of trading and/or receiving market data.
- Connections to third parties (market centers or other broker/dealers) from the member-provided equipment will not be permitted.
- BATS will not control or manage the member-owned router/switch, nor perform maintenance or other actions on behalf of the member. BATS can assist, when requested, in arranging hands-on access by datacenter personnel to the member-owned network devices in the BATS space. Activity that may be accomplished is limited to, generally, power cycling, and console access to perform very basic configuration steps that will enable the device to be manageable via a network or dial connection.
- Physical access by member representatives to the member's equipment is not possible at any time for any reason.
- BATS will pass to the member any charges by SAVVIS or BT Radianz to BATS related to trouble-shooting and/or maintaining the member's equipment (after initial install).

Do not order a circuit into either data center without first contacting BATS – doing so will delay your implementation. Contact BATS for information about circuit ordering details (e.g. NPA-NXX, LOA/CFA requirements, demarcation information, media and connector types, etc.). BATS will supply the in-house cross-connect of the circuit from the building's node-room / Meet-Me-room to the BATS space.

Members are strongly urged to order from the LEC a standard business telephone line to be brought to a member-supplied dial modem that is connected to the member's router(s)/switch(es) for remote access to the equipment. BATS will supply the dial line extension from the building's node room to the BATS space.

BATS requires members using this connectivity choice to ensure that their router(s)/switch(es) in this space are secured with strong passwords, and that those passwords are unique to the member's network devices at this location.

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BATS may, now and/or in the future, pass through some or all of the associated costs of circuit extension, power, space allocation, and co-location of the member's equipment to the member.

3 Bandwidth

3.1 Market Data Feeds

BATS offers five different types of market data feeds:

- Multicast PITCH
- TCP PITCH
- TCP FAST PITCH
- TOP
- Last Sale

BATS requires that members allocate a *minimum* of 1 Gb/s per Multicast PITCH Gig-Shaped feed and 100 Mb/s per Multicast PITCH WAN-Shaped feed. With respect to TCP PITCH, FAST PITCH and TOP feeds (not available in options), BATS understands that firms will have varying levels of sensitivity with respect to latency and as such encourages members to use the statistics provided below to make a well informed decision regarding the bandwidth they will require based on their organization's latency sensitivity.

The table below shows the bandwidth statistics for historical highs for BATS market data feeds. The table shows the bandwidth peaks for 1, 5, 10, 30, and 60-second intervals. 1 and 10 millisecond interval peaks are also included. The TCP statistics include 11 bytes for TCP/IP overhead per packet and do not include the data link layer overhead.

Interval Seconds	Multicast PITCH		TOP		TCP PITCH		TCP FAST PITCH	
	MPS	Mb/s	MPS	Mb/s	MPS	Mb/s	MPS	Mb/s
.001	3,408,000	382	331,000	86	638,000	251	638,000	93
.010	2,847,600	319	278,600	74	595,300	233	595,300	77
1	250,861	86	116,063	31	295,719	138	295,719	51
5	192,815	66	85,237	22	249,388	116	249,388	43
10	176,739	61	79,303	21	229,095	107	229,095	40
30	159,833	55	70,997	19	207,030	96	207,030	36
60	140,200	48	64,124	17	180,114	84	180,114	32

*Statistics as of 06/01/10.

It should be noted that BATS data will have microbursts within the one-second interval above, and that these microbursts will exceed the peak rates at the one-second interval. This is demonstrated within the 1 and 10 millisecond interval statistics. The extent to which the network connection to the member will cope with the microbursts exceeding the available bandwidth without packet loss will depend heavily on the buffers in the end to end path.

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During spikes in quote updates, members using less than sufficient bandwidth will experience queuing of their market data. Members using the same bandwidth to both receive quotes and transmit orders may expect their orders to be slightly delayed if they have less than sufficient bandwidth. Many members will find these delays unacceptable and should provision their bandwidth to reduce these delays. The following table demonstrates statistics regarding latency incurred as a result of queuing on Gig-Shaped and WAN-Shaped Multicast PITCH feeds.

	Gig-Shaped Multicast PITCH Serialization Delay (ms)	WAN-Shaped Multicast PITCH Serialization Delay (ms)
Average	.009	.041
Standard Deviation	.00002	1.125
Historical High	8.2	552

* Statistics as of 06/01/10.

**3 of the 12 Gig-Shaped units have never incurred latency due to serialization to date*.

As the volume on the BATS Exchange increases, the market data feed bandwidth required to accommodate peaks will also grow. Members can obtain the latest published market data bandwidth and serialization statistics within this Connectivity Manual. Additionally, monthly statistical updates are presented through the FIF Market Data Capacity working group.

3.1.1 Multicast PITCH

Key features include:

- Low latency, up to 50% latency reduction vs. TCP based PITCH.
- Two bandwidth versions:
 - Gig-Shaped, requires gigabit cross-connect.
 - WAN-Shaped, available via cross-connect, direct connect and via certain Extranets. Contact the BATS NOC for a current list of Extranets that have been certified for Multicast PITCH redistribution.
- Gap Response Proxy to recover small data gaps.
- Spin Server to efficiently recover from intra-day disconnects.
- Efficient binary messaging and new modify order message.

The US Equities/Options Multicast PITCH specification is published at:

http://www.batstrading.com/resources/membership/BATS_MC_PITCH_Specification.pdf

3.1.2 TCP PITCH & TCP FAST PITCH

For the TCP PITCH specification, refer to:

http://www.batstrading.com/resources/membership/BATS_PITCH_Specification.pdf

BATS' FAST PITCH protocol can achieve up to 73% compression on the BATS PITCH market data stream. For the TCP FAST PITCH specification, see:

http://www.batstrading.com/resources/membership/BATS_FAST_PITCH.pdf.

3.1.3 TOP

The BATS TOP feed offers up to 66% reduction in events and 84% reduction in bandwidth compared to the BATS PITCH market data feed. For the TOP specification, see:

http://www.batstrading.com/resources/membership/BATS_TOP_Specification.pdf

3.1.4 Last Sale

The Last Sale feed is ideal for market data distributors. It is a real-time, intraday TCP feed that disseminates matched trade price, volume and execution time from the BATS Exchange order book. Users only need 2Mb of bandwidth to take this extremely efficient feed in real-time. For the Last Sale Specification, refer to:

http://www.batstrading.com/resources/membership/BATS_US_Equities_Last_Sale_Specification.pdf

3.2 FIX Order Entry

Bandwidth recommended for submitting orders via FIX depends on expected member order volume. If a member intends to submit orders to BATS and will not receive market data, then it is possible that the member can connect with less than a T1 equivalent connection. The following table shows the maximum number of inbound orders (and/or cancels) per second that can be handled, with no buffering or delay, with different capacity connections.

Example Connection Rates

Order Protocol	256Kb	512Kb	1.5Mb
FIX Capacity	75/sec.	150/sec.	450/sec.

4 Telecommunications Providers

Some telecommunications providers available within the SAVVIS and/or BT Radianz data centers are listed below. This list is a summary and is not indicative of BATS preference or recommendation. For Telco's not included on the list, please contact the BATS NOC to discuss.

Company	Contact	Phone	Data Center
AboveNet www.abovenet.com	Travis Brown tbrown@above.net	(212) 803-5597	Weehawken Nutley
Atrium Networks www.atriumnetwork.com	Michael Horowitz mike.horowitz@atriumnetwork.com	(212) 361-0056	Weehawken Nutley
A T & T www.business.att.com	Gil Patterson gp8728@att.com	(816) 275-0068	Weehawken Nutley
BT Radianz www.btradianz.com	Pam Friedberg pam.friedberg@bt.com mailto:	(212) 205-1895	Weehawken Nutley
GuavaTech Inc www.guavatech.com	Michael Pappas mikep@guavatech.com	(312) 604-4581	Weehawken
HiberniaAtlantic www.hiberniaatlantic.com	Andrew Hornig ahornig@hiberniaatlantic.com	(212) 202-0388	Weehawken
Interactive Data 7ticks www.7ticks.com	Jason Bunyea sales@7ticks.com	(312) 896-0300	Weehawken Nutley
IPC www.ipc.com	Jamaal Thomas jamaal.thomas@ipc.com	(212) 709-1148	Weehawken
Level(3) Communications www.level3.com	Gerri McCormick gerri.mccormick@level3.com	(212) 487-0263	Weehawken Nutley
NexGen Networks www.nexgen-net.com	Jeffrey Barth jeffrey.barth@nexgen-net.com	(800) 310-2501	Weehawken Nutley
NYSE Euronext Advanced Trading Solutions (SFTI) www.nyse.com/tradingsolutions	Neil Wheatley nwheatle@nyse.com	(847) 392-6857	Weehawken Nutley
Optimum LightPath www.optimumlightpath.com	Lee Gartstein lgartse@cablevision.com	(201) 644-9120	Weehawken Nutley
Qwest Communications www.qwest.com	Natch Angles ignacio.angles@qwest.com	(913) 676-3942	Weehawken
RCN Business Solutions www.rcnbusinesssolutions.com	Stephen Papa stephen.papa@rcnmetro.com	(212) 324-5033	Weehawken Nutley
Reliance Globalcom www.relianceglobalcom.com	Adrian Bailey abailey@relianceglobalcom.com	(212) 735-8965	Weehawken Nutley
SAVVIS, Inc. www.savvis.net	Danielle Durkin teambats@savvis.net	(201) 472-2823	Weehawken Nutley

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Company	Contact	Phone	Data Center
TNSi www.tnsi.com	John Owens jowens@tnsi.com	++44 20 7336 1526	Weehawken Nutley
Verizon Financial Network verizonbusiness.com/us/	Verizon Financial Network Sales VFNSales@lists.verizonbusiness.com	(800) 825- 9196	Weehawken Nutley
XO Communications www.xo.com	Bob Miskiewicz robert.m.miskiewicz@xo.com	(212) 651-8362	Nutley

It is recommended that members use redundant connectivity via multiple telecommunications providers to each of the BATS data centers.

Contact BATS Network Support for information about circuit ordering details (e.g. NPA-NXX, LOA/CFA requirements, demarcation information, etc.).

5 Data Center Contact Information

5.1 SAVVIS – Weehawken, New Jersey

Dan Diversey

Sr. Sales Executive - Financial Markets

(312) 214-7912

Dan.Diversey@savvis.net

5.2 BT Radianz – Nutley, New Jersey

Carl Hunte

DMA Solutions Specialist

(212) 205-1894

Carl.Hunte@btradianz.com

or

Peter Brucia

DMA Solutions Specialist

(212) 415-4640

Peter.Brucia@btradianz.com

6 Support

Please e-mail questions or comments regarding this specification to noc@batstrading.com.

Revision History

Document Version	Date	Description
5.0.0	12/04/09	Converted former document to new spec template. SAVVIS contact information update. Physical port policy update.
5.0.1	12/10/09	BT Radianz contact information update.
5.0.2	12/29/09	Various updates to Bandwidth - Market Data Feed section.
5.0.3	02/10/10	RGC and IPC contact information update. Added Interactive Data 7ticks as a Telco Provider. Various updates to Bandwidth - Market Data Feed section.
5.0.4	02/22/10	Added allowance for member's of multiple BATS markets to utilize 4U of BATS rack space for connectivity per market.
5.0.5	04/14/10	RCN contact information update.
5.1.0	04/15/10	Added BYX Equities references.
5.1.1	06/01/10	Various updates to Bandwidth – Market Data Feed section. Added Nutley as supported site for Interactive Data 7ticks.
5.1.2	07/29/10	Removed FAT Networks LLC as an extranet. Amended Verizon Financial Network contact information. Added provision for VPN order entry ports.