Cboe Futures Exchange Connectivity Manual

Version 2.0.2

June 9, 2023

Contents

1 Introduction

1.1 Overview

The Cboe Futures Exchange ("CFE) trading platform and the CSMI (Index) platform are housed in the Equinix data center in Secaucus, New Jersey. The secondary data center is located at 350 Cermak Chicago, IL . Trading Privilege Holders ("TPH") and market data subscribers are strongly encouraged to establish connectivity to both locations to minimize service disruption in the event of an issue at either data center. Secaucus is the "primary" or "hot" site, with Chicago being "secondary" or "warm". A customer may receive market data from Chicago, and they may connect and heartbeat with order entry systems in Chicago. Orders submitted to Chicago will be rejected until Cboe declares the primary site in Secaucus "down."

TPHs can now request physical connectivity for Options on Futures ("OOF") which will be collocated within the CFE production environment.

It is the customer's responsibility to select their telecommunications provider and arrange for connections to Cboe data centers.

Cboe supports the following network connectivity choices:

- **IPSec VPN** via the Internet (only for certification or test sessions);
- **Co-location Cross-connect** (i.e. for customers co-located in the same data center as the CSMI/CFE trading platform);
- **Extranet** connectivity (See the Cboe Approved Extranet Provider section for a list of approved Extranet Providers); and
- **Private line Ethernet** (circuit extension from a carrier to Cboe, see the Carriers section for a list of Carriers)

1.2 Connectivity Matrix

	NY4/NY5 Latency Equalized	350 Cermak
Data Center Role	**Primary**	**Secondary**
Data Center Provider	Equinix	Cboe
Site Location	Secaucus, NJ	Chicago, IL
Site Status	Hot/Primary	Warm/Secondary
Accepts Co-location Cross connects?	Yes	Yes
Accepts Circuit Extension from Telco?	Yes	No
Access to Production Sessions/feeds?	Yes	No
Access to Disaster Recovery Sessions/feeds?	No	Yes
Colocation of Network Equipment?	No	Yes
Redundant Connectivity Required?	Yes	No
1G Monthly Recurring Connectivity Fees	See CFE Fee Schedule for details	
10G Monthly Recurring Connectivity Fees		
Supported Media Types	SMF	SMF, MMF
Round Trip Time to Production FIX gateways	~11µs	N/A
Connectivity Contact	Greg Nelson (312) 994-3906	Cboe NOC (913) 815-7005

1.3 Physical Interfaces

The following standard physical interface specifications are supported in the ORD1 and 350 Cermak data center. For other interface specifications contact noc@cboe.com.

10G	SR (multi-mode) , LR (single-mode) & ER (single-mode)
1G	SX (multi-mode), LX (single-mode) & 1000BaseT

The following standard physical interface specifications are supported in the NY4 and NY5 data center:

10G	ER* (single-mode)
10G	LR (single-mode)
1G	LX (single-mode)

*Contact Cboe NOC for details on ER Optical Transceivers

2 Types of Connectivity

2.1 IPSec VPN

- Customers may connect via an IPSec Virtual Private Network ("VPN") over the Internet for access to order entry and unicast market data feeds for certification and test purposes only. LAN-to-LAN IPSec VPN supported.
- IP address of the host presented to Cboe must be registered.
- Customers must contact Cboe NOC for encryption details and to receive their pre-shared key.

Note: Cboe does not offer multicast market data feeds over VPN.

2.2 Co-location Cross-connect

Customers may co-locate within the NY5 data center or a data center where a Cboe PoP is located and cross-connect to Cboe.

- Each physical port connection (1Gpbs and 10Gbps) within the Secaucus, Weehawken, and Chicago data centers will be subject to a monthly recurring charge. See the CFE Fee Schedule for more information regarding connectivity fees for current CFE environment.
- Cboe reserves the right to charge for one-time setup and monthly recurring fees incurred connecting TPHs or extranets. See the CFE Fee Schedule for more information regarding any setup or recurring fees that are currently applicable.
- TPHs may order the following physical connections for use with Options on Futures ("OOF") in the certification and production environments:
    - **10G Layer 3 Ports –** OOF and CFE unicast/multicast can be combined
    - **1G Layer 3 Ports –** OOF and CFE unicast/multicast can be combined
    - **10G Layer 1 Ports –** OOF multicast only
- OOF L1 and L3 ports used solely for testing OOF unicast and multicast functionality will be available free of charge until the OOF production launch date of **07/10/23**. TPHs will still be subject to connectivity charges by the data center provider.
- 1G/10G L3 ports that combine access to both CFE and OOF will continue to be subject to physical port fees according to the CFE Fee Schedule.

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

flexibility for the customer in determining when and to whom to connect. Customers interested in co-location services should contact the data center Point of Contact (refer to the Connectivity Matrix section for POC information).

2.3 Extranet

Customers may provision connectivity to Cboe via an extranet.

- Extranets have provisioned redundant connections to Cboe for use by multiple customers.
- Contact information for a variety of extranet providers is found below within the Cboe Approved Extranet Providers section below.

This method is an attractive alternative when:

- The customer 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 customer and Cboe have an existing connection to the extranet).

2.4 Directly Connected via Private Line Ethernet

Customers may connect to Cboe via Private Line Ethernet.

- No co-location space is required. Cross-connect from Telco demarcation point to Cboe network via an Ethernet interface.
- Each physical port connections (1Gpbs and 10Gbps) within the Secaucus, Weehawken, and Chicago data centers will be subject to a monthly recurring charge. Pricing for new physical ports is detailed in the CFE Fee Schedule.
- Cboe reserves the right to charge for one-time setup and monthly recurring fees incurred connecting TPHs or extranets. See the CFE Fee Schedule for more information regarding any setup or recurring fees that are currently applicable.
- TPHs may order the following physical connections for use with Options on Futures ("OOF") in the certification and production environments:
    - **10G Layer 3 Ports –** OOF and CFE unicast/multicast can be combined
    - **1G Layer 3 Ports –** OOF and CFE unicast/multicast can be combined
    - **10G Layer 1 Ports –** OOF multicast only

- OOF L1 and L3 ports used solely for testing OOF unicast and multicast functionality will be available free of charge until the OOF production launch date of **07/10/23**. TPHs will still be subject to connectivity charges by their carrier.
- 1G/10G L3 ports that combine access to both CFE and OOF will continue to be subject to physical port fees according to the CFE Fee Schedule.
- Contact your carrier of choice to arrange connectivity to Cboe. See the Carriers section below.

3 Ordering Cross Connects to Cboe

3.1 Submit Request via Customer Web Portal

A Customer Web Portal account is required to request a new cross connect or decommission existing connectivity to Cboe. Please see your firm's account administrator or contact the CFE Trade Desk for an account:

- CFE Trade Desk – (312) 786-8700
- Email – cfetradedesk@cboe.com

3.2 Required Information

- Location (NY5, NY4, EWR2, or 350 Cermak)
- Number and speed of connections requested (1G or 10G)
- Registered BGP ASN (Cboe NOC can assign a private ASN)
- Networks advertised to Cboe (registered public IP's or Cboe assigned private addresses are accepted
- Network and billing contact information
- Transit IP address (Public or private range assigned by Cboe NOC)

3.3 LOA-CFA

Upon approval of cross connect request, Cboe NOC will provide a Letter of Authorization - Customer Facility Assignment with the "Z-side" cage, cabinet, panel, and port pair assignment. The customer requesting the cross connect is known as the "A-Side."

3.4 Data Center Provider Request

The requesting customer submits a cross connect request with the appropriate data center provider:

- Equinix – NY5 and NY4
- Cboe – 350 Cermak

The data center provider will need the LOA-CFA and the "A-side" details to complete the connection. The "A-Side" customer is responsible for any data center setup fees and monthly recurring costs associated with the cross connect. As the "A-Side" customer, the customer is also responsible for initiating troubleshooting requests with the data center provider in the event of a down cross connect.

3.5 Latency Equalization

Cross connects originating within either NY4 or NY5 data centers will be engineered to provide equivalent latency between customer demarcation points and the Cboe order entry gateways in NY5. Equal fiber pathway latency will be determined by OBR testing. WAN circuits originating outside Secaucus, NJ will also be subject to latency equalization.

3.6 Connectivity Redundancy Requirement

Any party that maintains direct physical connectivity to CFE is required to maintain at least two (2) physical connections to the primary data centers due to the nature of 24 x 5 operations of CFE. Cboe NOC will work with CFE customers to provide maximum redundancy (fiber path, panel, and network devices). A CFE customer may have any combination of physical cross connects or PLE circuits in either primary data center. Extranet connectivity and L1 Market Data Distribution ports will not count towards a CFE customer's Connectivity Redundancy Requirement.

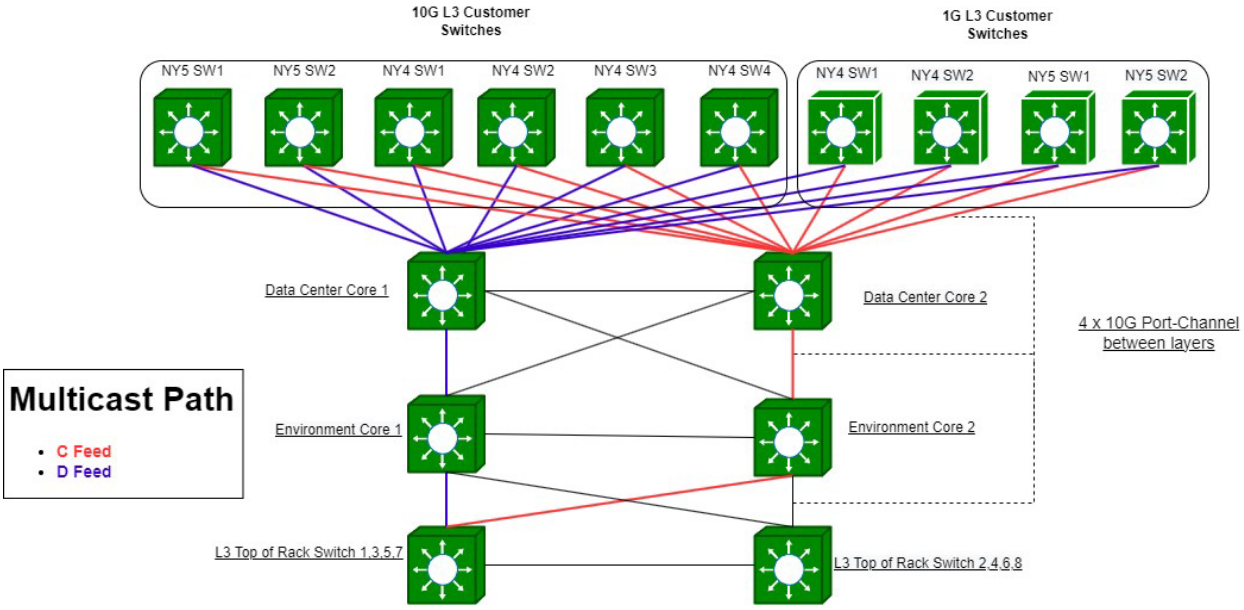
3.7 Inbound Bandwidth Limit (Effective 06/26/23)

CFE will monitor inbound bandwidth per 10 Gbps physical port at the TPH access switch level and will automatically disable any 10 Gbps physical network connection which receives inbound data exceeding a bandwidth limit of a 1 gigabit per second (1 Gbps) average measured over a two second time interval. This inbound bandwidth limit is based on observations of actual data traffic patterns and will be equally applied across all CFE TPH 10 Gbps physical ports.

The bandwidth limit is an inbound data limit and thus will not apply to outbound data, such as market data, received through a physical port. However, if a physical network connection is disabled due to exceeding the inbound bandwidth limit, the physical network connection will not be able to submit inbound data or receive outbound data until it is re-enabled.

To re-enable an impacted physical network connection disabled due to exceeding the inbound bandwidth limit, a TPH must contact the Cboe NOC and provide a written post-mortem outlining the issue that caused the bandwidth limit to be exceeded and the actions taken to remediate the issue. Any connection disabled a second time within the same trading day for exceeding the inbound bandwidth limit will be re-enabled only after an additional written post-mortem is received and TPH testing has been performed with the Cboe NOC during standard CFE maintenance hours.

4 Layer 3 Network Overview



4.1 L3 Customer Access Layer

Cboe Network Engineering uses a store-and-forward switching mode for CFE 10G Customer Access switches to allow for inbound bandwidth limit monitoring.

CFE employs both 1G and 10G dedicated switches that serve as the network access point for TPH connections. The number of switches is largely based on customer demand. Uplinks between layers are all 4x10G port-channel using the vendor default hashing algorithm.

DC Location	Quantity	Bandwidth	Make	Model	Switching Mode
NY4	2	1G	Cisco	Nexus 56128P	Cut-Through*
NY5	2	1G	Cisco	Nexus 56128P	Cut-Through*
NY4	4	10G	Arista	DCS -7050SX2-128-R	Store-and-Forward
NY5	2	10G	Arista	DCS -7050SX2-128-R	Store-and-Forward

*Switching mode is effectively store-and-forward one way due to speed change 1G to 10G.

4.2 L3 Data Center Core Layer

These are chassis-based switches designed to mesh the customer access layer with the Environment core layer. The Data Core layer services three environments – Cboe Futures, Options on Futures, and the Indices environment. Uplinks between layers are all 4x10G port-channel using the vendor default hashing algorithm.

DC Location	Quantity	Bandwidth	Make	Model	Switching Mode
NY5	2	4x10 port-channel	Arista	DCS-7050SX2-128	Cut-Through

4.3 L3 Environment Core Layer

This layer uses dedicated chassis-based switches for connecting the Cboe Futures, Options on Futures, or Indicies Top of Rack (ToR) switches with the DC Core layer. Uplinks between layers are all 4x10G port-channel using the vendor default hashing algorithm.

DC Location	Quantity	Bandwidth	Make	Model	Switching Mode
NY5	2	4x10 port-channel	Arista	DCS-7050SX2-128	Cut-Through

4.4 L3 Top of Rack (ToR) Layer

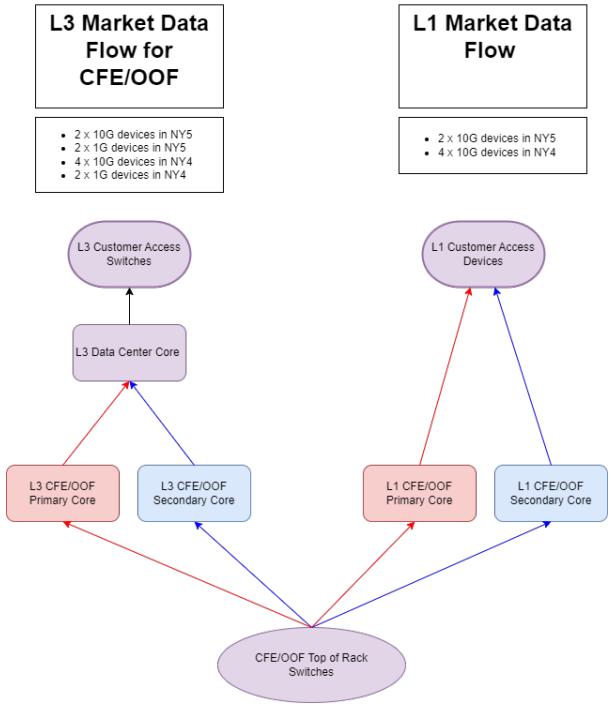
Switches at this layer connect the Cboe Futures and Options on Futures order gateways and market data feed servers. Hosts are connected to both a primary and secondary switch for redundancy using NIC teaming (Active/Passive). Uplinks between layers are all 4x10G port-channel using the vendor default hashing algorithm.

DC Location	Quantity	Bandwidth	Make	Model	Switching Mode
NY5	8	10G to Hosts 4x10 port-channel	Arista	DCS-7150S-52-CL	Cut-Through

5 Layer 1 Market Data Distribution

Cboe Futures and Options on Futures customers may order Layer 1 (L1) Market Data Only connections in the NY4/NY5 data centers. Similar to Layer 3 (L3) connections, they will be latency equalized to ensure the same total optical length between CFE customers.

5.1 L1 vs L3 Market Data Path



The expected latency advantage of an L1 connection compared to a L3 connection is between 2-4 microseconds. L1 connections will experience less jitter and reduced port-to-port latency (single nanoseconds) when compared to L3 market data connections.

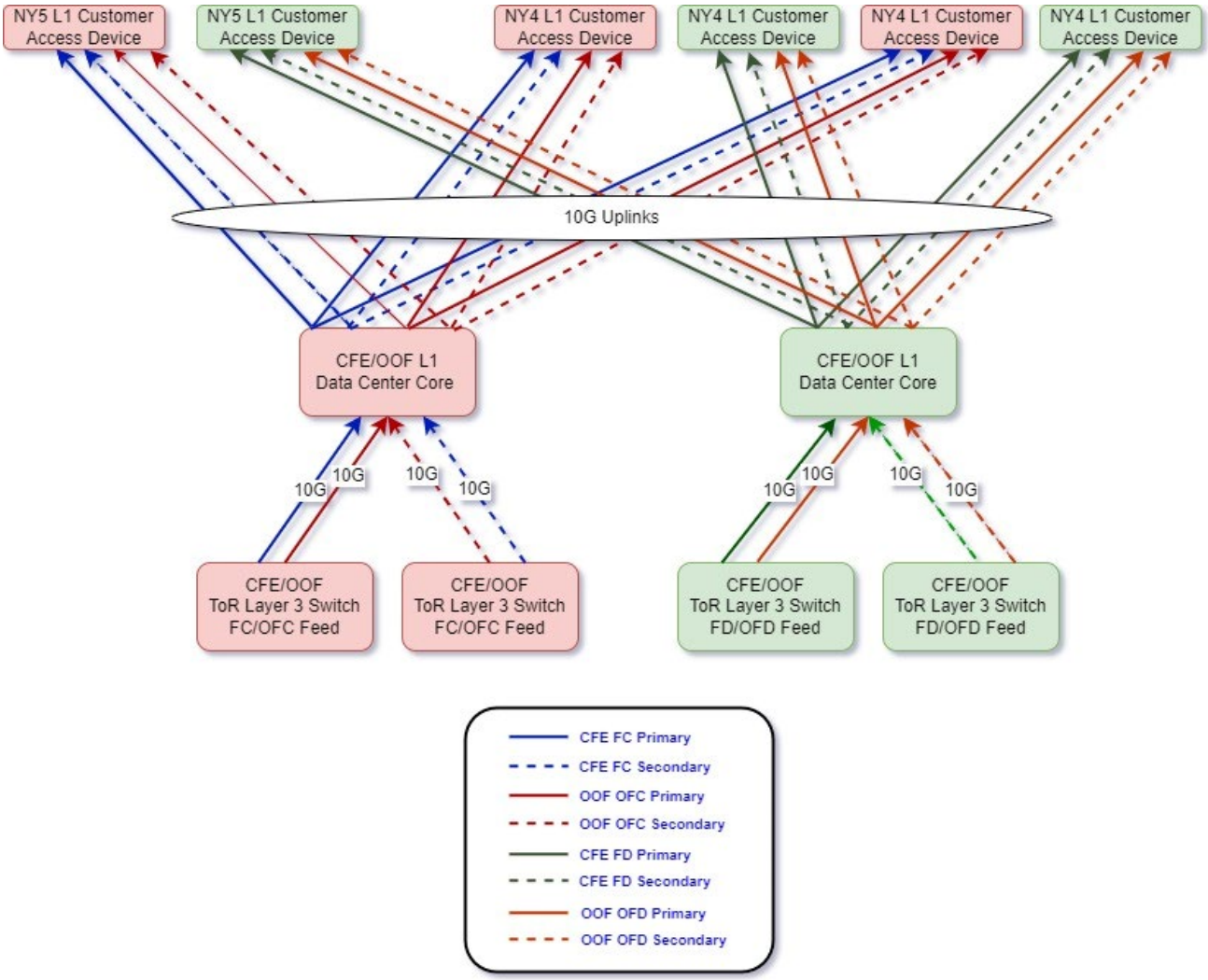
5.2 L1 Customer Access Layer

DC Location	Quantity	Bandwidth	Make	Model	Switching Mode
NY4	4	10G	Arista	Arista DCS-7130-48GS3	N/A
NY5	2	10G	Arista	Arista DCS-7130-48GS3	N/A

5.3 L1 Core Distribution Layer

DC Location	Quantity	Bandwidth	Make	Model	Switching Mode
NY5	2	10G	Arista	Arista DCS-7130-48GS3	N/A

5.4 L1 Network Diagram



5.4.1 L1 Market Data Only Connections - CFE

- Only Multicast Depth of Book feeds "FC" and "FD" are available via L1 Market Data connections. TCP PITCH , Spin, and Gap Repsonse Multicast are only available via the L3 path.
- Customer L1 devices are split evenly between the "FC" feed and "FD" feed path. A customer connected to an "FC" side enabled device will not receive "FD" side market data, and vice versa.
- L1 network devices do not support BGP or PIM. Once the connection is patched by Cboe NOC, the customer will receive market data only for the path for which their connection lands.
- Consistent with the provisions of the current CFE Fee Schedule, any party connecting to CFE through a physical port for a particular function is required to have a redundant physical port for that function, which may be the same type or a different type of physical port that allows for that function.
- L1 connections are offered in 10Gbps bandwidth only, 1Gpbs is not available.
- Cboe will impose a limit of eight cross connects, per TPH, per L1 network device. TPHs may distribute the eight connections across both CFE or OOF.
- L1 10G cross connects will be assigned random port numbers on the L1 device(s).
- Even though L1 data only flows over the receive side of the fiber optic pair, both the transmit and receive fibers are required to be connected for monitoring and administrative purposes.

5.4.2 L1 Market Data Only Connections – Options on Futures ("OOF")

- Only OOF Multicast Depth of Book feed "OFC" and "OFD" are available via L1 Market Data connections. TCP PITCH, Spin, and Gap Repsonse Multicast are only available via the L3 path.
- Customer L1 devices are split evenly between the "OFC" feed and "OFD" feed path. A customer connected to an "OFC" side enabled device will not receive "OFD" side market data, and vice versa.
- L1 network devices do not support BGP or PIM. Once the connection is patched by Cboe NOC, the customer will receive market data only for the path for which their connection lands.
- L1 connections are offered in 10Gbps bandwidth only, 1Gpbs is not available.
- Cboe will impose a limit of eight cross connects, per TPH, per L1 network device. TPHs may distribute the eight connections across both CFE or OOF.
- L1 10G cross connects will be assigned random port numbers on the L1 device(s).
- Even though L1 data only flows over the receive side of the fiber optic pair, both the transmit and receive fibers are required to be connected for monitoring and administrative purposes.

5.5 L3 Cross Connect Conversion to L1

A TPH may choose to convert one or more L3 cross connects to L1 connections. Cboe NOC personnel will move the fiber patch from the L3 switch to the applicable L1 network device.

- A conversion request must be made in writing by emailing noc@cboe.com. Please include:
    - The Equinix cross connect ID.
    - The peer IP address of the L3 connection(s) to be converted.

    - Requested L1 feed(s) – CFE FC/FD or OOF OFC/OFD
- Conversions from L3 to L1 will be performed only during a Friday maintenance window (8:00 – 11:00 p.m. ET).
- A conversion from L3 to L1 will restart the physical port start billing date. The 90-day minimum requirement will be based on the new start billing date.
- Conversions from L3 to L1 are not reversible as the L3 physical port configuration is deleted and the transit IP address(es) are reclaimed.
- Similar to a new L1 10G cross connect, converted L3 connections will be assigned a random port number on the L1 device(s).

6 Telecommunications Providers

Some telecommunications providers available within the Secaucus, Weehawken and Chicago data centers are listed below. This list is a summary and is not indicative of Cboe preference or recommendation. For telecommunications providers not included on the list, please contact the Cboe NOC to discuss.

6.1 Extranet Providers

Cboe has arrangements with several extranet providers to aggregate customer connectivity and provide low cost, value-added B2B services such as multicast market data feeds. Extranet providers are required to sign a Telecommunications Service Provider Agreement after meeting the requirements outlined in the Extranet Provider Manual.

6.1.1 Cboe Approved Extranet Providers

Company	Contact	Phone
BT Radianz www.btradianz.com	Gregory Knopp Gregory.Knopp@bt.com	(212) 205-1849
CenturyLink http://www.centurylink.com/technology	Danielle Durkin gems@centurylink.com	(973) 650-1107
ICE Data Services – Connectivity www.iceglobalnetwork.com	Connectivity Sales iceglobalnetwork-info@theice.com	US: (770) 661-0010 EU: +44 207 429 4610 APAC +613 9249 2093
IPC Systems, Inc. www.ipc.com	John Tarantino john.tarantino@ipc.com	(212) 709-1099
NetXpress www.netxpressllc.com	Craig Spital sales@netxpressllc.com	(312) 871-3190
Pico www.pico.net	Sales sales@pico.net	(646) 701-6120
TNSi www.tnsi.com	John Owens jowens@tnsi.com	+44 2073 361 526

6.1.2 Carriers

Telecom carriers provide a dedicated circuit between customers in different data centers to a demarcation point in the Secaucus, Weehawken or Chicago data centers. The circuit is extended from the demarc to a Cboe network device.

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

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

Company	Contact	Phone	Data Center
Anova Technologies www.anova-tech.com	Heather Cannon hcannon@anova-tech.com	(312) 540-9594 x1113	Weehawken Chicago
A T & T www.business.att.com	Dale Rife wr7024@att.com	(816) 275-2335	Weehawken
Hibernia Atlantic www.hiberniaatlantic.com	Hibernia Sales sales@hibernianetworks.com	(908) 516-4200 (888) 774-8080	Weehawken Chicago
Hudson Fiber www.hudsonfiber.com	Thomas Kennedy tkennedy@hudsonfiber.com	(201) 820-8206	Weehawken
Level(3) Communications www.level3.com	William Simmons william.simmons@level3.com	(913) 909-9009	Weehawken Chicago
Lightower Fiber Networks www.lightower.com	Christopher J. Schook cschook@lightower.com Jeffrey Mollica jmollica@lightower.com	(631) 974-4307 (516) 375-6808	Weehawken Secaucus
NexGen Networks www.nexgen-net.com	Jeffrey Barth jeffrey.barth@nexgen-net.com	(800) 310-2501	Weehawken Chicago
Optimum LightPath www.optimumlightpath.com	Colleen M. Capen ccapen@optimumlightpath.com	(201) 644-9610	Weehawken
Perseus www.perseus.co	Tony Gerace agerace@perseus.co	(347) 325-9416	Secaucus Weehawken Chicago
Sidera Networks www.sidera.net	Stephen Papa stephen.papa@sidera.net	(212) 324-5033	Weehawken Chicago
Spread Networks, LLC www.spreadnetworks.com	Spread Network Sales sales@spreadnetworks.com	(646) 837-0330	Weehawken Chicago
Verizon Financial Network www.verizonbusiness.com/solutions/finance/institutional/servicesnetwork.xml	Verizon Financial Network Sales vfnsales@verizon.com	(800) 825- 9196	Weehawken Chicago
XO Communications www.xo.com	Robert Bye robert.g.bye@xo.com	(630) 544-8512	Weehawken Chicago

Company	Contact	Phone	Data Center
Zayo Fiber Solutions/AboveNet www.abovenet.com	Travis Brown tbrown@above.net	(212) 803-5597	Weehawken Chicago

7 Support

Please direct questions or comments regarding this manual to noc@cboe.com. Cboe NOC is a one-call shop that supports customer and telecommunications providers during initial setup and continuing support of all connectivity issues.

7.1 Support Hours

- Phone – (913) 815-7005
- Email – noc@cboe.com
- Core phone support hours are 7:00 a.m. – 8:00 p.m. ET Monday – Friday.
- Outside of core support hours, to report a network issue that must be addressed prior to market open – leave a voice mail with the firm name, contact number, and the nature of the issue.
- For non-critical issues or for information, please email NOC and your request will be responded to on the next business day.

Revision History

Document Version	Date	Description
1.0.0	05/01/17	Initial version of Manual supporting Cboe/Bats integration changes for CFE.
1.1.0	05/18/17	Added Section 3.6 – Connectivity Redundancy Requirement.
1.1.1	08/30/17	Updated to include support for connectivity to the new CSMI platform scheduled for production activation on 01/22/18.
1.1.2	08/31/17	Various minor clarifications.
1.1.3	09/15/17	Updated Extranet Provider table.
1.1.4	10/17/17	Cboe branding/logo changes.
1.1.5	01/22/18	Update CFE Trade Desk phone number.
1.1.6	10/05/18	Updated data center provider information.
1.1.7	11/08/18	Updated data center provider information.
1.1.8	06/10/19	Various minor clarifications.
1.1.9	07/15/19	Updated Extranet Provider table.
1.2.0	07/07/20	Added provision for ER Optical Transceivers in NY4/NY5. Added Pico to Extranet Provider Table.
1.2.1	09/11/20	Updated CFE DR location from 400SL to 350 Cermak (effective 9/13/20).
1.2.2	02/14/22	Added new section 4 on L1 Market Data distribution.
1.2.3	02/18/22	Noted L1 Market Data Distribution ports will not count towards a TPH's connectivity redundancy requirement.
1.2.4	04/06/22	Post 10G L1 launch changes to section 4.
1.3.0	10/31/22	Added L3 network diagram and breakdown of switch functions. Noted change in Customer Access layer switch mode.
2.0.0	03/30/23	Added Options on Futures (OOF) connectivity. Increased L1 port limitation from four to eight.
2.0.1	05/30/23	CFE will monitor inbound bandwidth per physical port at the TPH access switch level and will automatically disable any physical network connection which receives inbound data that exceeds the bandwidth limit **(effective 06/26/23** ~~06/26/23~~**)**.
2.0.2	06/09/23	Updated effective date for CFE inbound bandwidth limit **(effective 06/26/23)**.