Cboe Australia
Connectivity Manual

Version 1.0.13

4 April 2024

Contents

1 Introduction

1.1 Overview

The Cboe Australia (CXA) primary trading platform will be housed in the Equinix SY5 data centre in Sydney, NSW. CXA maintains a Point of Presence (PoP) for participant connectivity in the Equinix SY2 data centre. Additionally, CXA introduced latency equalisation across the SY2/SY5 Equinix complex, meaning Participant connections to the new trading platform from either data centre will have latency profiles within single digit nanoseconds of one another. The production and certification environments for the Cboe Tech trading platform and BIDS Australia platform are available to connect to from both SY2 and SY5.

The Disaster Recovery (DR) data centre is hosted within the Global Switch data centre in Ultimo, NSW. Participants are strongly encouraged to establish connectivity to both data centres to minimise service disruption in the event of an issue at either data centre. Sydney SY5 is the "primary" or "hot" site, with Ultimo being "secondary" or "warm". Participants may receive market data from Ultimo, and they may connect and heartbeat with order entry systems in Ultimo. Orders submitted to the secondary site will be rejected unless CXA declares the primary site in Sydney "down."

It is the participant's responsibility to select their telecommunications provider and arrange for connections to the SY5 and Global Switch data centres.

CXA supports the following network connectivity choices:

- **IPsec VPN** via the Internet (only for certification or test sessions);

- **Co-location Cross-connect** (i.e., for participants co-located in the primary or DR data centres);

- **Extranet** connectivity;

- **Direct Carrier connection -** circuit extension from a carrier to CXA

1.2 Connectivity Matrix

	Sydney SY5 Latency Equalised	Sydney SY2 Latency Equalised	Ultimo Global Switch
Data centre Role	Primary	Primary PoP	Secondary
Data centre Provider	Equinix	Equinix	Global Switch
Site Location	Sydney, AU	Sydney, AU	Ultimo, AU
Site Status	Hot/Primary	PoP for Primary	Warm/Secondary
Accepts Co-location Cross-connects?	Yes	Yes	Yes
Accepts Circuit Extension from Telco?	Yes	Yes	Yes
Access to Production Sessions/Feeds?	Yes	Yes	Market Data Only
Access to Disaster Recovery Sessions/Feeds?	No	No	Yes
Access to Certification Sessions/Feeds?	Yes	Yes	No
Colocation of Network Equipment?	No	No	No
Supported Media Types	SMF	SMF	SMF

1.3 Physical Interfaces

The following standard physical interface specifications are supported in the SY5/SY2 and Ultimo data centres. For other interface specifications contact the Cboe APAC NOC (nocapac@cboe.com):

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

*Contact the Cboe APAC NOC for details on ER Optical Transceivers

2 Types of Connectivity

2.1 IPsec VPN

- Participants may connect via an IPsec Virtual Private Network (VPN) over the Internet for certification and test purpose order entry only. LAN-to-LAN IPsec VPN is supported.

- The IP address of the host presented to CXA must be registered.

- Participants must contact the Cboe APAC NOC for encryption details and to receive their pre-shared key.

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

2.2 Co-location Cross-connect

CXA participants may request cage space within the Equinix SY5/SY2 data centre from Equinix.

- Each physical port connection (1Gbps and 10Gbps) within the Primary and Secondary data centre/PoPs will be subject to a monthly recurring charge. See the CXA Fee Schedule for more information.

- Co-location cross-connect requests must come from a demarcation point on the data centre floor. Roof-top access requests will not be accepted.

With data centre co-location, participants may place equipment, terminate communications circuits, and establish a cross-connect to CXA (or other destinations) within their space. This provides the maximum amount of control to the participant. This option is neutral for the participant and provides the greatest flexibility for the participant in determining when and to whom to connect. Participants interested in co-location services should contact the data centre/PoP Point of Contact (refer to the Connectivity Matrix section for POC information).

2.3 Extranet

Participants may provision connectivity to CXA via an extranet.

- Extranets have provisioned redundant connections to CXA for use by multiple participants.

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 participant and CXA have an existing connection to the extranet).

2.4   Direct Carrier Connection

Participants may connect to CXA via Private Line Ethernet.

- No co-location space is required. Extending a cross-connect from Telco demarcation point to CXA network via an Ethernet interface will be required by the Carrier.
- Each physical port connection (1Gbps and 10Gbps) within the Sydney and Ultimo data centres/PoPs will be subject to a monthly recurring charge.

2.5   Cboe Connect

Cboe clients who have a presence in ASX's ALC data centre have the option of connecting via **Cboe Connect** to access their Cboe trading system services:

- Order entry and trading (FIX/BOE including BIDS)

- Purge ports

- Drop copies

- Market data (PITCH and TOP)

- Certification

Clients provision an ASX ALC cross connect between the client's ALC presence and Cboe's ALC presence and this provides the client with connectivity to the Cboe network to access those services the client has subscribed to, including:

- Cboe trading system services in Cboe Primary site in Equinix SY5

- Cboe trading system services in Cboe DR site in Global Switch (if the client has DR Connectivity)

- Certification test services

Similar to other connectivity methods:

1. The client orders their preferred ALC 1Gb fibre port(s) or 10Gb fibre port(s) via the web portal*

2. The Cboe NOC team responds with an LOA (letter of authority)

3. The client shares the LOA with the cross connect provider (ASX), who provisions the cross connect in communication with the Cboe team, for client use.

4. The Cboe NOC team will confirm completion of the link installation and confirm connectivity details with the client. Afterwards, the client can access Cboe trading system services via Cboe Connect.

Cboe Connect offers unique access solutions in ALC "Meet Me Room A" and "Meet Me Room B" to suit clients resilience models.

Within Cboe's own network, Cboe utilises redundant shared dark fibre lines between data centres.
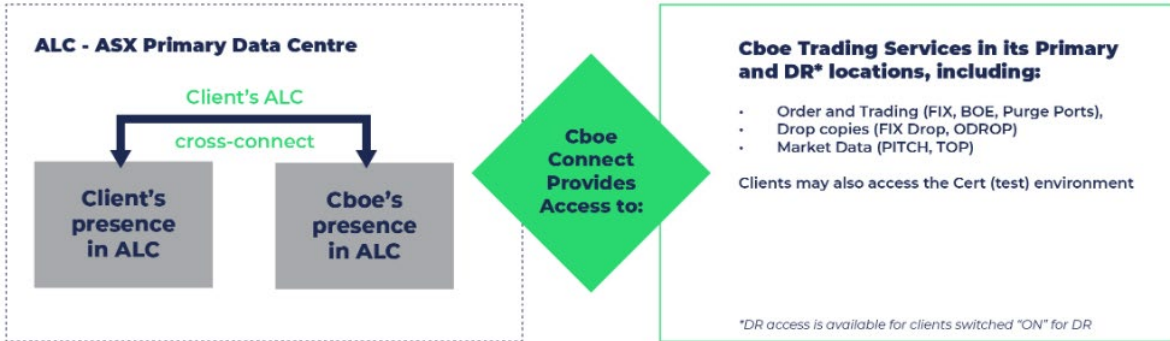
*The physical port connection (1Gbps and 10Gbps) will be subject to installation and recurring monthly charges.

Please direct questions or comments regarding this manual to nocapac@cboe.com. The Cboe APAC NOC provides CXA participants, extranets, and telecommunications providers with both initial setup support as well continuing support for all connectivity troubleshooting issues.

3   Latency Equalisation

Cross-connects originating within SY2 and SY5 data centres will be engineered to provide equivalent latency between participant demarcation points and CXA's order entry gateways in SY5. Equal fibre pathway latency will be determined by Optical Backscatter Reflectometer (OBR) testing. WAN circuits originating outside Sydney will also be subject to latency equalisation.

Cboe Australia Latency Equalisation
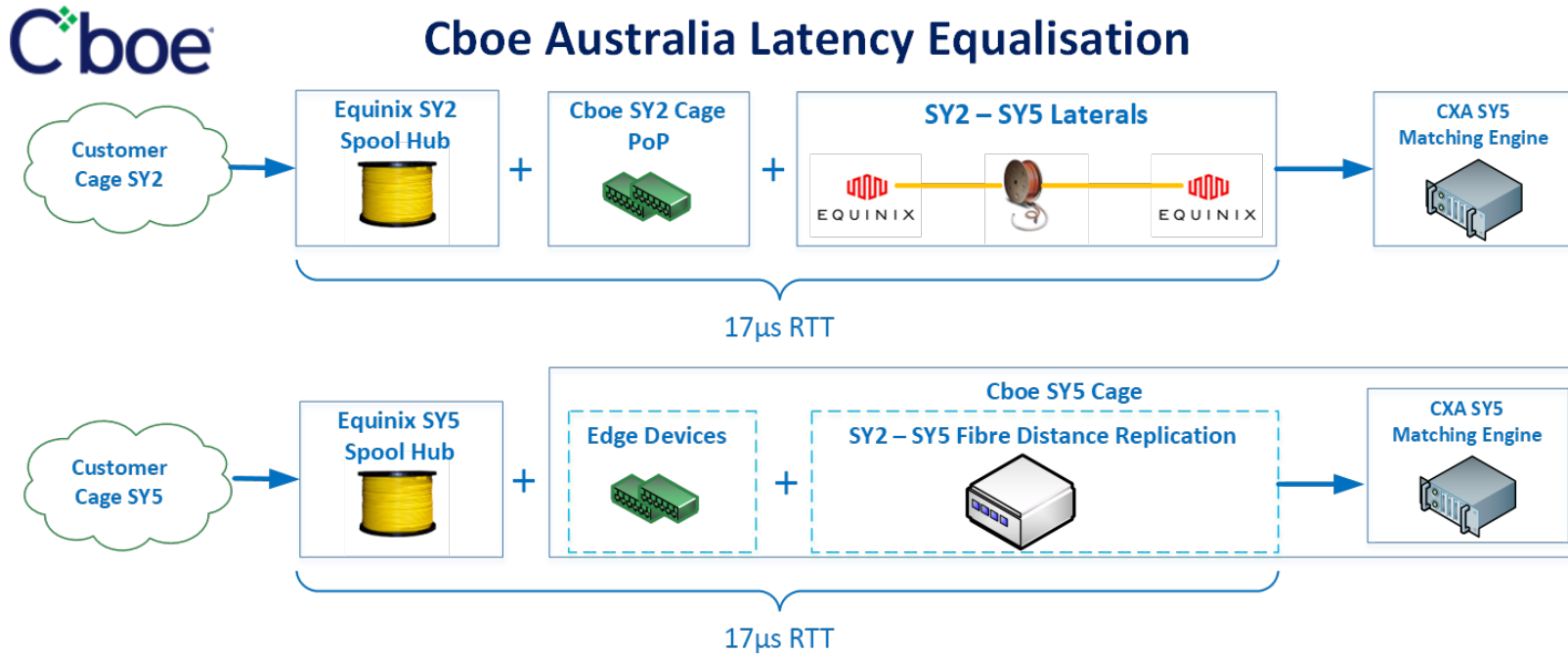
Cboe/Equinix Latency Equalisation Infrastructure provides an equal length of fibre to participants connecting in either the SY2 or SY5 Sydney data centre.

3.1 Spooling to Participant Cage

Fibre cross connects to participant cages are run from Equinix Latency Equalised Hubs using equal lengths of single-mode fibre to each participant cage. The additional slack fibre is stored on the CXA side of the cross connect. The fibre spool length is identical regardless of the participant's distance from the Equinix Latency Equalised Hub.

3.2 SY2 to SY5 Equalisation

Latency Equalised Hubs within SY2/SY5 are connected via fibre trunks to the matching engines in the SY5 data centre. Since the SY5 Latency Equalised Hub is much closer to the matching engines, these fibre trunks connect through additional lengths of fibre to replicate the distance between SY2 to SY5. It is imperative that participants order cross connects only in their local data centres. For example, the Letter of Authorization (LOA) for a participant cage located in SY2 will specify a SY2 demarcation. In this scenario, attempting to order a SY2-to-SY5 cross connect would greatly increase your fibre distance and overall latency to the matching engine in SY5 – duplicating the latency Equalised engineered distance. Participants with cages outside of SY2/SY5 Sydney campus should order cross connects to the SY2 Latency Equalised Hub for the lowest latency.

3.3 Fibre Patch and Testing

Finally, the fibre patch between assigned demarcation points and the CXA outside network device is adjusted to a custom length, ensuring the total fibre optical length is within acceptable tolerances. Every participant fibre path and trunk are tested end-to-end using a proprietary Optical Backscatter Reflectometer (OBR).

4 Bandwidth

4.1 Market Data

Participants taking CXA market data feeds should allocate a minimum of 100Mb each for the primary and secondary feeds. This will allow sufficient overhead for feed micro-bursting and for receiving gap response feeds.

Refer to the CXA Multicast PITCH Specification and CXA Multicast TOP Specification for complete details.

4.2 FIX Order Entry

Bandwidth recommended for submitting orders via FIX depends on expected participant order volume. If a participant intends to submit orders to CXA and will receive market data, it is advised the participant allocate at least 100Mb or greater per physical connection. The following table shows the maximum number of inbound orders (and/or cancels) per second that can be handled without buffering or delay for each connection capacity.

Example Connection Rates

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

5 CXA Unicast IP Addressing

Cboe uses registered ranges:

- 170.137.216.0/23 covering Equinix SY5 Certification and Production.
- 170.137.214.0/24 covering Global Switch DR.

5.1 Certification Environment

CXA Certification/UAT - SY5			
Connection Type	**Primary DC (SY5)**	**DR Site (Global Switch)**	**Port Range**
CXA Certification FIX Based and BOE	170.137.217.0/28	N/A	10000 - 14999
CXA Certification SPIN/GRP Unicast	170.137.216.240/28	N/A	18000 - 18999
CXA Certification Multicast Sources	170.137.217.16/28	N/A	N/A
CXA Certification Multicast Rendezvous Point	74.115.128.12/32	N/A	N/A
CXA BIDS Cert	170.137.216.0/27	N/A	31000-33000

5.2 Production Environment

CXA Production			
Connection Type	**Primary DC (Equinix SY5)**	**DR Site (Global Switch)**	**Port Range**
CXA Unicast FIX and BOE	170.137.217.128/25	170.137.214.64/26	10000 - 14999
CXA Unicast Primary FIX Drop / ODROP	170.137.216.208/28	170.137.214.32/28	10000 - 14999
CXA Unicast Secondary FIX Drop / ODROP	170.137.216.224/28	N/A	N/A
CXA SPIN-GRP Unicast Primary	170.137.217.32/28	170.137.214.0/28	18000 - 18999
CXA SPIN-GRP Unicast Secondary	170.137.217.48/28	N/A	18000 - 18999
CXA Multicast Sources Primary	170.137.217.64/28	170.137.214.16/28	N/A
CXA Multicast Sources Secondary	170.137.217.80/28	N/A	N/A
CXA Multicast A feed Rendezvous Point	74.115.128.10/32	N/A	N/A
CXA Multicast B feed Rendezvous Point	74.115.128.11/32	N/A	N/A
CXA (DR) Multicast DR - E feed Rendezvous Point	N/A	74.115.128.13/32	N/A
CXA BIDS Prod	170.137.216.0/27	N/A	31000-33000

Please see the Guide to Reference Data Files Specification for FTP access details or the Multicast PITCH Specification for Multicast group information.

6 Logical Port Provisioning across Primary and DR

Logical port types are available in Primary (Equinix) and DR (Global Switch). The table below describes how logical ports are set up when a participant requests a Primary data centre instance, and whether a DR data centre instance is automatically created. Note that DR Connectivity is subscribed ON or OFF at the firm level. When DR Connectivity is subscribed ON, the DR logical ports become chargeable.

	Equinix - Primary Data Centre	Global Switch - DR Data Centre
FIX **BOE** **Purge Port**	Primary Logical Port is created on request. *In the event of a primary process failover scenario, participants use the same IP/port connectivity details to access a standby server, also housed in Equinix Primary data centre.*	<u>If the participant has 'DR Connectivity' subscribed 'ON',</u> then for each primary logical port requested the participant will automatically have a 'twin' DR logical port created and synched with the primary instance (with different IP details). Note DR connectivity is available during normal operation, however, business messages are only possible after failover to the DR data centre. DR Logical ports may only be accessed by cross connects to Cboe's DR presence in Global Switch.
FIX Drop **ODROP**	Primary or Secondary Logical Port is created on request. FIX Drop and ODROPs are created on either the Primary or Secondary infrastructure in the Equinix Primary data centre as new requests are raised. Each are live and charged separately.	<u>If the participant has 'DR Connectivity' subscribed 'ON',</u> then for each primary or secondary logical port requested the participant will automatically have a 'twin' DR logical port created and synched with the primary instance (with different IP details). Note DR connectivity is available during normal operation, however, business messages are only possible after failover to the DR data centre. DR Logical ports may only be accessed by cross connects to Cboe's DR presence in Global Switch.
PITCH Multicast **TOP Multicast**	Stream-A 'bundle' is created on request and includes: - Multicast stream - 1 GRP 'primary' - 2 SPIN (one per unit) 'primary'	<u>If the participant has 'DR Connectivity' subscribed 'ON',</u> then for each Stream-A 'bundle' requested the participant will automatically have a Stream-E 'bundle' created which includes: - Multicast stream - 1 GRP 'DR' - 2 SPIN (one per unit) 'DR' Note DR Steam-E is available real time on trading days in line with Stream-A.

		DR Stream E connections may only be accessed by cross connects to Cboe's DR presence in Global Switch.
	Stream-B 'bundle' is created on request and includes: - Multicast stream - 1 GRP 'primary' - 2 SPIN (one per unit) 'primary'	*There is no automatically created DR GRP or SPIN when Stream-B 'bundle' is requested.*

7   L3 Network Overview

Cboe Australia CXA Network Diagram
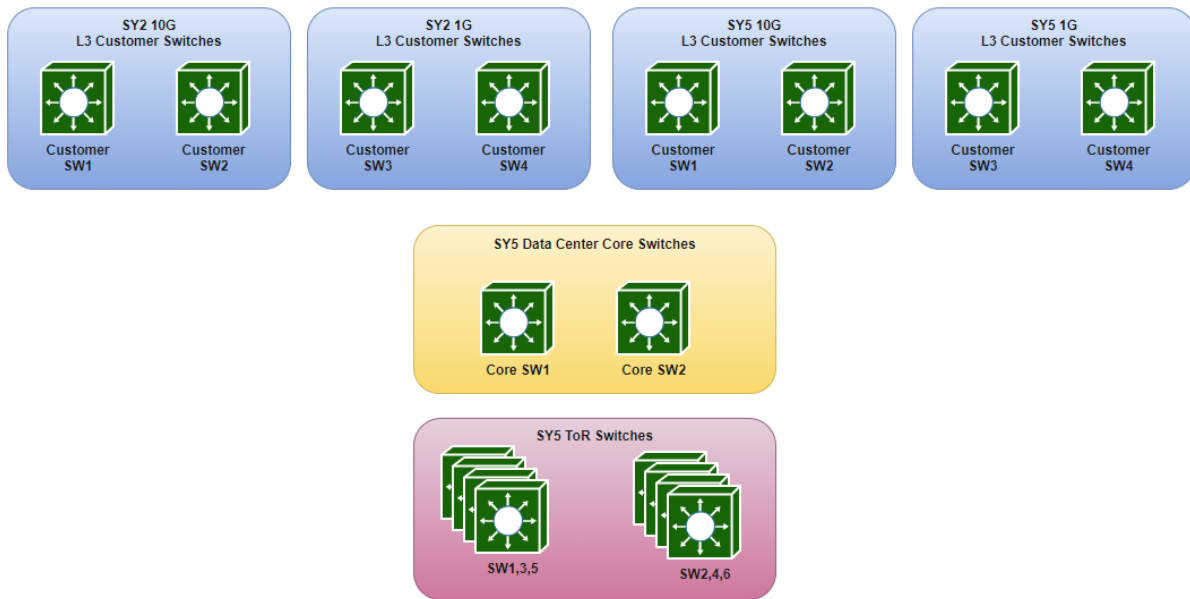
7.1   L3 Customer Access Layer

SY5/SY2 employs both 1G and 10G dedicated switches that serve as the network access point for customer connections. The number of switches is largely based on customer demand. Uplinks use the vendor default hashing algorithm.

DC Location	Quantity	Bandwidth	Uplink to DC Core	Make	Model	Switching Mode
SY5	2	1G	2x100G port-channel	Arista	DCS-7050SX3-96YC8	Cut-Through*
SY2	2	1G	2x100G port-channel	Arista	DCS-7050SX3-96YC8	Cut-Through*
SY5	2	10G	2x100G port-channel	Arista	DCS-7050SX3-96YC8	Cut-Through*
SY2	2	10G	2x100G port-channel	Arista	DCS-7050SX3-96YC8	Cut-Through*

*Switching mode is effectively store-and-forward one way due to speed change 1G to 100G or 10G to 100G.

7.2   L3 Data Center Core Layer

These are chassis-based switches designed to mesh the customer access layer with the Top of Rack layer. Uplinks between layers are all 2x40G port-channel using the vendor default hashing algorithm.

DC Location	Quantity	Uplink to ToR Switches	Make	Model	Switching Mode
SY5	2	2x40G port-channel	Arista	DCS-7260CX3-64E	Cut-Through

7.3   L3 Top of Rack (ToR) Layer

These switches function to connect order handler servers to the Data Center Core switches. Each server NIC is connected to two ToR switches in an active/passive redundancy model.

DC Location	Quantity	Uplink Bandwidth	Make	Model	Switching Mode
SY5	6	2x40G port-channel	Arista	DCS-7050SX3-48YC8	Cut-Through

8 Connectivity Testing

8.1 Production Connectivity Testing After Hours

- FIX and BOE Port Listeners are open from 19:30 to 4:30 AEST and a "connected successfully" message will appear.
- Feed A/B and Feed E multicast heartbeats are available 19:30 to 4:30 AEST.
- BIDS ports are closed and a "connection refused" message will appear after hours.

8.2 UAT/Certification Connectivity Testing

- Connectivity is available on Saturdays.
- FIX and BOE Port Listeners are closed on Sundays and a "connection refused" message will appear.

Please refer to Australian Equities Trading Hours for more information.

9 Support

Please direct questions or comments regarding this manual to nocapac@cboe.com. The Cboe APAC NOC provides CXA participants, Extranets, and telecommunications providers with both initial setup support as well continuing support for all connectivity troubleshooting issues.

9.1 Cboe Network Support

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  - nocapac@cboe.com

Revision History

Document Version	Date	Description
1.0.0	02/03/22	Initial version of Manual supporting Cboe/CXA integration.
1.0.1	12/08/22	Added IP/Port range tables.
1.0.2	15/08/22	Corrections to IP/Port range table.
1.0.3	31/08/22	Updated Public FTP Site. Updated CXA Unicast IP Addressing tables.
1.0.4	25/10/22	Updated Section 6: • IP info for Global Switch • IP info for FIX Drop / ODROP • BIDS systems
1.0.5	01/11/22	Inclusion of new section 7 describing Primary and DR logical ports provisioning.
1.0.6	08/11/22	Updated Section 1 to include details around timing of SY5 LE cross connects.
1.0.7	10/03/23	Included the DR IP for ODROP / FIX Drop in section 6.2.
1.0.8	17/05/23	Updated latency equalisation graphic.
1.0.9	30/05/23	Removed section 3: NTP Service.
1.0.10	15/06/23	Updated Round Trip Times for Latency Equalization.
1.0.11	02/10/23	Added Section 2.5. Updated the location of the Global Switch data centre to Ultimo. Added Cert and Prod port ranges in Sections 5.1 and 5.2.
1.0.12	06/02/24	Added new section 7: Connectivity Testing.
1.0.13	04/04/24	Added a new section 7: L3 Network Overview. Moved Connectivity Testing to section 8.