



Cboe Europe Limited

Connectivity Manual

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Contents

1.	Introduction.....	3
2.	Scope of Services.....	3
3.	Simplified Network Diagram.....	4
4.	Connectivity Locations.....	4
5.	Connectivity Options.....	5
6.	Demarcation.....	6
7.	Estimated Latency to Equinix LD4.....	6
8.	Physical Interfaces.....	6
9.	Latency Guidance.....	7
10.	Market Data.....	7
11.	Bandwidth Guidance.....	9
12.	IP Addressing.....	11
13.	Certification.....	11
14.	Out of Hours Testing.....	11
15.	Order Form.....	11
16.	Port and Latency Tools.....	12
17.	Reference Data.....	12
18.	Disaster Recovery.....	12
19.	Specific TRF Connectivity Guidance.....	12
20.	Appendix A – Migration of CXE and BXE multicast PITCH feeds.....	13
	Revision History.....	16

1. Introduction

Cboe Europe Limited (Cboe) offers access to all order books (BXE & CXE) for both the UK trading venue and its affiliated EU trading venue (Cboe UK and Cboe EU, respectively), Trade Reporting Facility (TRF (UK and EU APA)), SI Quoting & SI Technology Services (SIS) and Large In Scale (LIS) over a single connection. Cboe also offers some services via the internet. This document explains the network connectivity options available.

Connectivity is charged as per [Connectivity Pricing](#)

Participants are responsible for:

- Choosing their connectivity provider and arranging for connectivity to the datacentre
- Paying all associated communications charges including cross-connects within the datacentre
- Managing and controlling network access and the traffic that traverses their chosen connectivity

Contacts

Phone: +44 20 7012 8905
Email: noceurope@cboe.com

All technical documentation including this document and protocol specifications is accessible at <http://markets.cboe.com/europe/equities/support/technical/>

2. Scope of Services

The following connectivity Cboe services are offered at all locations. All services are offered on a fair and non-discriminatory basis.

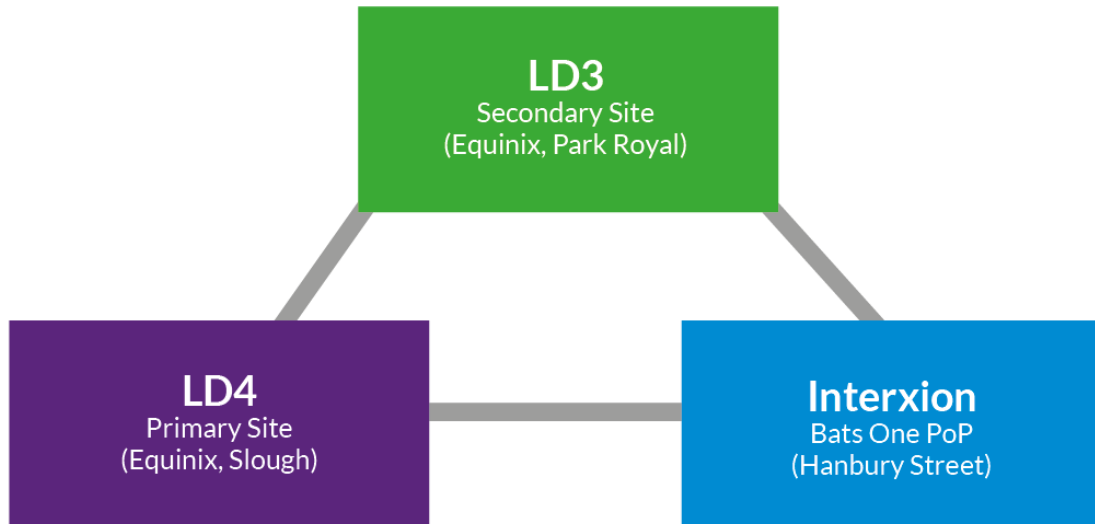
- Physical network ports
- Market data feeds
- Order entry ports
- DROP copy port

Cboe offers all services to all Participants subject to signing required agreements.

Equinix LD4 is the primary datacentre, Equinix LD3 is the secondary datacentre. Equinix offer a range of co-location services (as defined by MiFID II RTS10), these are offered independently of Cboe, these services include space, power, cooling and cross-connects. Any Cboe customer wanting to take co-location services from Equinix must negotiate with Equinix directly, Cboe is not involved in anyway. Details are available at: [Equinix co-location services](#)

Access to SI Technology Services is not available at Interxion.

3. Simplified Network Diagram



4. Connectivity Locations

Cboe connectivity is available at the following locations:

LD4	Primary datacentre, Slough
LD3	Secondary datacentre, Park Royal
Interxion	City of London point of presence

A limited number of services are available via the internet.

5. Connectivity Options

The following network connectivity options are supported:

- IPsec VPN via the Internet for certification and test access only
- Datacentre cross-connect
- Directly connected via metro ethernet
- Extranet
- Internet for TCP PITCH only
- TRF GUI via the internet

IPsec VPN

Participants may connect using IPsec over the Internet:

- Access to all TCP-based feeds for certification and test only
- Certification Multicast PITCH available using GRE tunnel
- LAN-to-LAN IPsec VPNs using registered IP addresses only

Datacentre Cross-Connect

Participants may take datacentre space and cross connect at any of the datacentres locations:

- The technical and commercial relationship is between the datacentre provider and the Participant
- Cboe is not involved
- Participant orders and pays for the cross-connect

Metro Ethernet

Participants may connect via a metro Ethernet circuit:

- No co-location space is required
- Telco's must deliver the circuit to the designated telco demarcations
- Cboe does not host telco equipment
- The cross-connect from telco demarcation point is ordered by Cboe and re-charged to the Participant

Extranet

Participants may connect using an extranet provider:

- Extranet provider provisions high-speed up links for multiple Participants
- The technical and commercial relationship is between the extranet provider and the Participant
- Not all extranets carry Multicast PITCH

Internet for Market Data

Participants may consume TCP PITCH via the internet:

- Non-resilient service from LD4 only
- Each set of TCP PITCH ports are charged as per [Connectivity Pricing](#)

6. Demarcation

- For each location Cboe offers a common physical network demarcation point
- All Participants are given the same access at each location and will have equal latency to the Cboe servers from each demarcation point
- The physical network demarcation point for all connectivity is the patch frame within the Cboe cage

7. Estimated Latency to Equinix LD4

All times are round trip, measured under normal operation. Latencies will increase if running on backup circuits.

Interxion 490uS

Equinix LD3 400uS

8. Physical Interfaces

The following physical interface specifications are supported:

LOCATION	SPEED	MEDIA
Equinix LD4 Slough	10G	LR (single-mode)
	1G	LX (single mode)
Equinix LD3 Park Royal	1G	LX (single mode)
Interxion (Hanbury Street)	10G	SR (multi-mode) & LR (single-mode)
	1G	SX (multi-mode) & LX (single-mode)

9. Latency Guidance

The latency of the trader experience will be impacted by:

Network port speed. 10G ports will give the lowest latency access option. Participants should take into account serialisation delays when choosing interface speed.

Multicast PITCH is the lowest latency market data feed available. WAN-shaped Multicast PITCH will experience queuing during busy times hence the Gig-shaped feed is recommended for the lowest latency experience.

Cboe offers FIX and BOE order entry protocols. As per the [BOE specification](#), it offers CPU and memory efficiency, application and session level simplicity. Participants should consider this when choosing which order entry protocol to use.

10. Market Data

There are four separate market data feeds

- BXE
- CXE
- TRF Trades
- SI Quote

There are two market data formats: [Multicast PITCH](#) and [TCP PITCH](#)

Market data pricing can be found at: [Market Data Pricing](#)

Multicast PITCH

Multicast PITCH has the following key features:

- Low-latency, faster than TCP PITCH
- Two bandwidth versions - Gig & WAN shaped
- Gap Response Proxy to recover data gaps
- Spin Server to efficiently recover from intra-day disconnects
- Efficient binary messaging and modify order message

Multicast PITCH Naming Prefixes (as used in Multicast PITCH spec)

Note: The BXE and CXE feeds are changing – please see Appendix A of this document.

LD4	LD3
<p>BXE uses the prefix B:</p> <ul style="list-style-type: none"> Gig shaped BA & BB WAN shaped BC & BD <p>CXE uses the prefix X:</p> <ul style="list-style-type: none"> Gig shaped XA & XB WAN shaped XC & XD <p>TRF uses the prefix T:</p> <ul style="list-style-type: none"> WAN shaped TC & TD <p>SI Quote uses the prefix Q:</p> <ul style="list-style-type: none"> Gig shaped QA & QB WAN shaped QC & QD 	<p>BXE uses the prefix B</p> <ul style="list-style-type: none"> WAN shaped BE <p>CXE uses the prefix X</p> <ul style="list-style-type: none"> WAN shaped XE <p>TRF uses the prefix T</p> <ul style="list-style-type: none"> WAN shaped TE <p>SI Quote uses the prefix Q</p> <ul style="list-style-type: none"> WAN shaped QE

Multicast PITCH Development Resources

The following resources are available specifically targeted at easing the process of developing for Multicast PITCH:

- Certification Multicast PITCH is available via the internet VPN using a GRE tunnel
- A test program to assist in debugging multicast infrastructure is available http://markets.cboe.com/resources/membership/mcast_pitch.zip
- Multicast PITCH historic data files are available via the Participant portal

TCP PITCH

TCP PITCH has the following features:

- Full TCP PITCH includes all symbols in all markets
- Unitised PITCH offers basic market selectivity and is best suited for Participants who only require a limited sub-set of market data to reduce the cost of wide area connectivity
- Participants are encouraged to take market data via Multicast PITCH as the infrastructure load is constant irrespective of the number of data consumers

Market Data Location Availability

Location	Sourced from LD4						Sourced from LD3		
	Gig A	Gig B	Wan C	Wan D	TCP	Unitised TCP	Wan E	TCP	Unitised TCP
LD4	✓	✓	✓	✓	✓	✓	✓	✓	✓
LD3							✓	✓	✓
Interxion	✓	✓	✓	✓	✓	✓	✓	✓	✓
Internet					✓				

11. Bandwidth Guidance

- Participants are strongly advised to provision bandwidth to cope with peak aggregate data rates and exceptional market conditions
- All Multicast PITCH feeds have bandwidth rate limiters, as published in the [Multicast PITCH spec](#)
- A single 1G cross connect will not support all Gig shaped Multicast PITCH feeds
- Gig shaped Multicast PITCH is only available to Participants with 1G or above
- Insufficient bandwidth will cause dropped packets and gaps in the Multicast PITCH feeds

TCP PITCH Observed Bandwidth Peaks

The peak 1, 5 and 10 second bandwidth peaks of the Full TCP PITCH feed per market seen to date are below. Participants consuming both the CXE & BXE feeds can expect to see twice these peaks.

INTERVAL	INTRA-DAY PEAKS (MBPS)	INCLUDING END OF DAY PEAK (MBPS)
1	47	47
5	31	31
10	24	24

Note: There will be sub-second microbursts that will exceed the one second peak rate. The extent to which the network connection to the Participant will cope with the microbursts exceeding the available bandwidth without packet loss will depend heavily on the buffers in the end to end path.

Order Entry Observed Bandwidth Peaks

The bandwidth for order entry via the FIX or BOE interface depends on the rate of message input:

FIX or BOE Message Rate	75/sec	150/sec	450/sec
Bandwidth	256kbps	512kbps	1.5Mbps

12. IP Addressing

The details below apply to all connectivity methods other than VPN:

- Cboe hosts use registered addresses for both unicast and multicast data flows
- Cboe supports publicly registered Participant addresses
- If required, Cboe can allocate a 10.x.y.z address block. Each Participant is allocated a /24 subnet by default. This subnet can be split to provide transit P2P and host/NAT subnets
- Cboe supports static routing and dynamic routing via BGP, for multicast, Cboe supports static and dynamic IGMP and PIM Sparse
- Each TCP separate feed is allocated a unique TCP port that is part of a port range. The port is determined by the Trade Desk during the provisioning process. The GRP and SPIN ports used by Multicast PITCH are not unique

13. Certification

There are certification environments for CXE, BXE, TRF, SIS & LIS at LD4. Furthermore a certification environment for CXE exists at LD3 that allows Participants to test intra-day datacenter failover.

Connectivity to the certification environments is available at all locations and also via an internet VPN (LIS certification is not available via VPN).

A certification Multicast PITCH feed also exists and is heavily bandwidth limited as per the [Multicast PITCH](#) specification. The feed is available over an internet VPN via a GRE tunnel.

14. Out of Hours Testing

Outside of the core trading hours during the week and all weekend all TCP ports will run TCP port listeners and all multicast feeds will heartbeat. This allows Participants to QA connectivity at any time.

15. Order Form

The Connectivity Order Form to request connectivity is published at: [Connectivity Order Form](#)

The associated Terms and Conditions are published at: [Connectivity Terms & Conditions](#)

16. Port and Latency Tools

Cboe provides Participants some valuable tools to monitor and manage their connectivity.

- Ports Dashboard – provides port statistics including TCP re-transmit count
- Real-Time Latency Portal – provides a large amount of latency data on order and order to quote

For further information see [Web Products](#).

17. Reference Data

Reference data is accessible via the internet or over customer trading connectivity.

Please consult the [Cboe reference data specification](#) for full details.

18. Disaster Recovery

In the event of a catastrophic failure at the primary datacentre (Equinix LD4, Slough) Cboe Europe may invoke disaster recovery at the secondary datacentre Equinix LD3, Park Royal.

The BXE, CXE, TRF & SIS environments run separately, the decision to invoke disaster recovery from LD4 to LD3 may be made for only one or all environments dependant on the nature of the failure.

The CXE certification environment has a disaster recovery environment at LD3, Participants should use this environment to test intra-day failover to LD3.

The LIS environment only exists within LD4.

A full disaster recovery guide is provided at: [Disaster Recovery Guide](#)

19. Specific TRF Connectivity Guidance

Participants of the TRF environment should note that they are strongly encouraged to have separate and resilient connectivity to both LD4 & LD3. Participants should satisfy themselves that they will be able to connect to the TRF environment under all scenarios, specifically:

1. Partial loss of a connectivity at LD4, ie the loss of any single cross connect or device
2. TRF environment running from LD3 with no network path via LD4

20. Appendix A – Migration of CXE and BXE multicast PITCH feeds

Summary

To provide new Cboe UK and Cboe EU venue multicast PITCH feeds, the CXE & BXE feeds are migrating to new feeds that will use completely new source IP's, multicast groups (including rendezvous points) and GRP & SPIN ports.

The new feeds will allow Participants to segregate the Cboe UK and Cboe EU venue multicast PITCH data consumption according to Participant preference. Further information on the jurisdiction split is at Appendix E and the GRP & SPIN port sections of the [multicast PITCH spec](#)

The new feeds are expected to be available from 15 February 2019. All Participants will need to migrate from the existing (legacy) feeds to the new feeds by 27 September 2019. There will be a further announcement of when the new GRP & SPIN ports are available to order as part of this migration.

There are no changes to the TRF Trade and SI Quote multicast PITCH feeds.

Data Content

The data content of the new CXE & BXE multicast PITCH feeds will always be consistent with the legacy feeds, as a consequence Participants will be able to arbitrate data between any combinations of the feeds for a single environment during the migration.

Bandwidth considerations

The bandwidth allocated to the new multicast PITCH feeds will be the same as the legacy feeds.

An important planning consideration for Participants will be to not subscribe to more bandwidth than each cross connect can sustain, especially where 10G cross connects are not in place. If this is not taken into account then there may be packet loss during network traffic peaks.

Participants should add the cumulative subscribed bandwidth as stated in the [multicast PITCH spec](#) section 7.8, in particular Participants should beware of consuming both the new and legacy feeds on the same cross connect where bandwidth is limited.

For the migration period only, the Cboe Europe NOC team will implement monitoring tools to monitor Participant multicast subscriptions and advise Participants if they are at risk of exceeding the bandwidth of the cross connect.

Naming Conventions

The [multicast PITCH spec](#) and Connectivity Manual (this document) will use the following nomenclature for the new feeds by appending the existing feed naming prefixes with “n”, as below.

LD4	LD3
<p><u>New feed naming convention</u></p> <p>BXE uses the prefix B:</p> <ul style="list-style-type: none"> Gig shaped BAn & BBn WAN shaped BCn & BDn <p>CXE uses the prefix X:</p> <ul style="list-style-type: none"> Gig shaped XAn & XBn WAN shaped Xcn & XDn 	<p><u>New feed naming convention</u></p> <p>BXE uses the prefix B</p> <ul style="list-style-type: none"> WAN shaped BEn <p>CXE uses the prefix X</p> <ul style="list-style-type: none"> WAN shaped XEn
<p><u>Legacy feed naming convention</u></p> <p>BXE uses the prefix B:</p> <ul style="list-style-type: none"> Gig shaped BA & BB WAN shaped BC & BD <p>CXE uses the prefix X:</p> <ul style="list-style-type: none"> Gig shaped XA & XB WAN shaped XC & XD 	<p><u>Legacy feed naming convention</u></p> <p>BXE uses the prefix B</p> <ul style="list-style-type: none"> WAN shaped BE <p>CXE uses the prefix X</p> <ul style="list-style-type: none"> WAN shaped XE

Certification

There are no changes to certification feeds.

Migration considerations

As per Cboe Europe’s standard approach, there will be multicast heartbeats available prior to the new data feeds going live. Additionally there will be TCP port listeners for GRP and SPIN connectivity. This will allow Participants to confirm all necessary network routing and connectivity in advance of the data feeds going live.

As the data content is identical on all intra-environment feeds, Participants can plan their migrations according to their own priorities and risk appetite. However Participants should note that the legacy feeds will be deprecated 27 September 2019.

Participants may wish to migrate to the new feeds on a per cross connect basis, an illustrative example is below. This approach could be further extended to migrate a single feed at a time, thereby creating four migration events.

Now

Cross Connect #1

Multicast subscriptions	XA, BA
Cumulative Bandwidth	950Mbps

Cross Connect #2

Multicast subscriptions	XB, BB
Cumulative Bandwidth	950Mbps

Migration event 1

Cross Connect #1 (no change)

Multicast subscriptions	XA, BA
Cumulative Bandwidth	950Mbps

Cross Connect #2

Multicast subscriptions	XBn, BBn
Cumulative Bandwidth	950Mbps

Migration event 2

Cross Connect #1

Multicast subscriptions	XAn, BAn
Cumulative Bandwidth	950Mbps

Cross Connect #2 (no change)

Multicast subscriptions	XBn, BBn
Cumulative Bandwidth	950Mbps

Revision History

19 July 2018	6	Physical interface options in LD4 and LD3 updated to Single Mode only
2 November 2018	20	Addition of Brexit multicast PITCH guidance for BXE and CXE
2 November 2018	1	Update to Introduction
