SPECTRUM
Lighting up the market

SPECTRUM CLIENT CONNECTIVITY AND FAILOVER

DOCUMENT PHRASING	MEANING
"Exchange"	The Multilateral Trading Facility (MTF), legally named as Spectrum MTF Operator GmbH
“Member”	Trading Participant directly connected into the Exchange and submitting orders to trade in the case of a Broker or executable quotes when a Market Maker

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PURPOSE

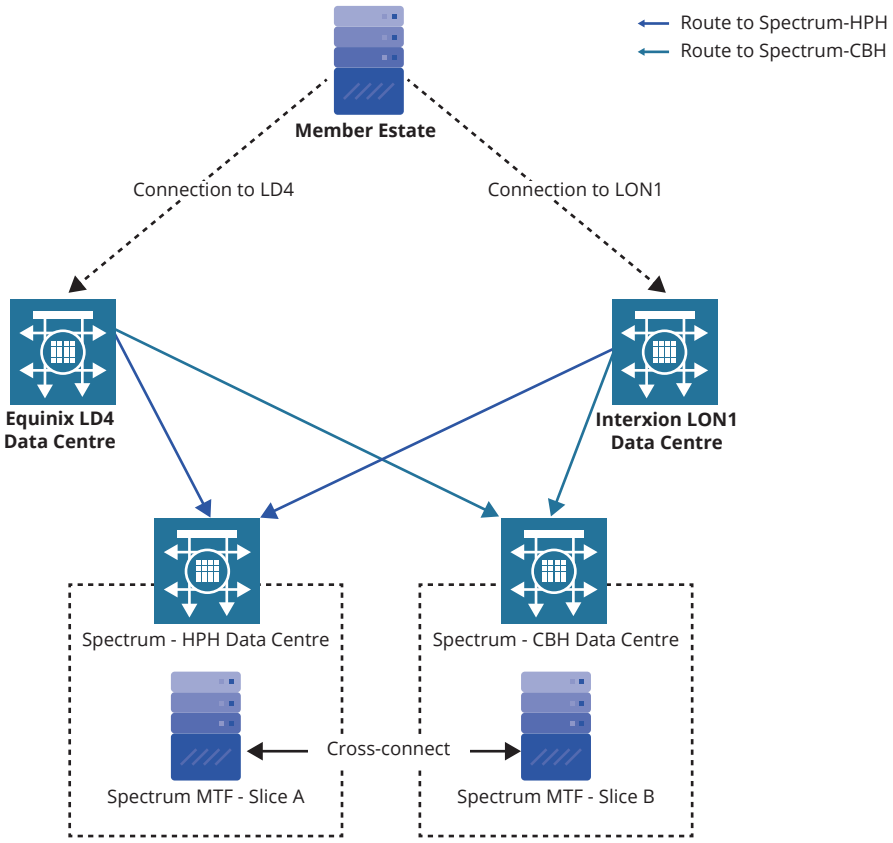
This document specifies the physical network connectivity options available to firms ("**Members**") wishing to participant on the Spectrum MTF Operator GmbH (the "**Exchange**"). This document also specifies the disaster recovery mechanism.

The Exchange runs Active/Active across two physically separated Spectrum data centres (Spectrum-HPH and Spectrum-CBH). Member firm connectivity is available via cross-connect to Spectrum's cabinets in **Equinix LD4** (https://www.equinix.com/), and **Interxion LON1** (https://www.interxion.com/). **Spectrum does not support Internet connectivity for member firms**. Spectrum exposes distinct IP addresses at LD4 and LON1 that route to each Spectrum data centre (Refer to Appendix A - IP Addresses).

- We **REQUIRE** that member firms are able to selectively target each of Spectrum's data centres. This requirement ensures that members can tolerate a failure of either one of Spectrum's data centres by targeting the survivor.
- We **RECOMMEND** (but do not require) that member firms establish cross-connects to Spectrum's cabinets at both LON1 and LD4. This allows the member to tolerate an outage at either one of LD4 or LON1 by routing through the survivor.

NOTE: During the onboarding process we will require the IP address(es) that the member will present to us.

OVERVIEW



FIX SERVICES

Spectrum provides **eight** FIX sessions for each member (See Spectrum+FIX+Rules+of+Engagement for the technical details of these services):

1. LIVE Market Data session x2
2. LIVE Trading session x2
3. DEMO Market Data session x2
4. DEMO Trading session x2

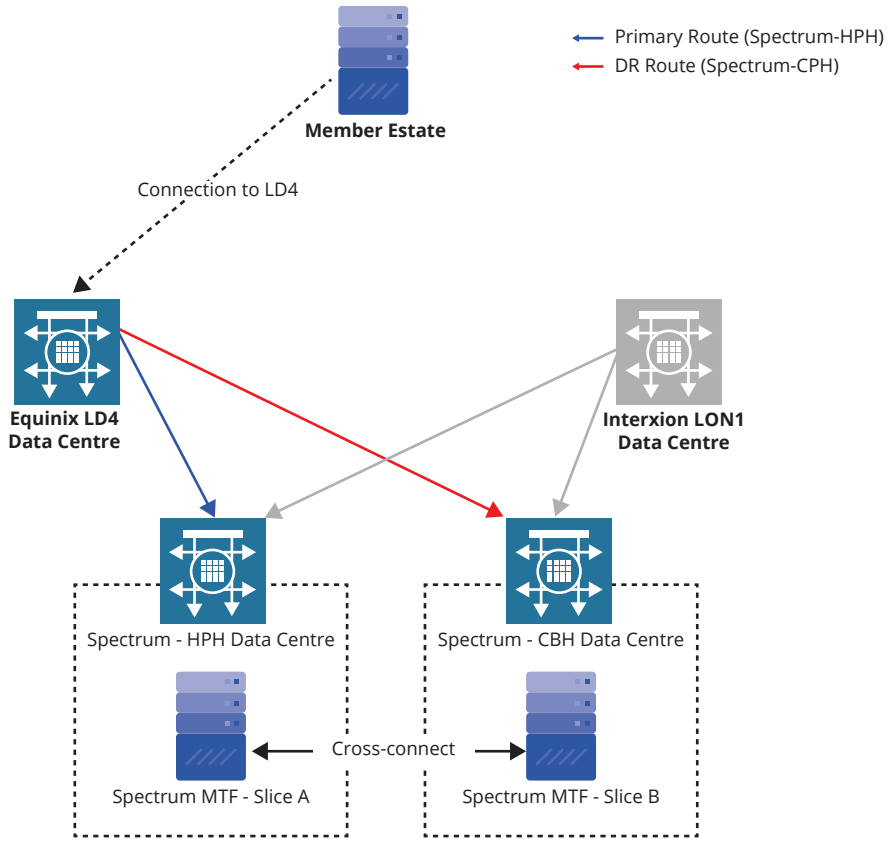
For the remainder of this document we focus on the LIVE environment. DEMO is a parallel environment running on exactly the same infrastructure.

One of each pair (LIVE market data + trading) is hosted at Spectrum-CBH, and the second pair is hosted at Spectrum-HPH. These FIX sessions are independent from each other, but they transport messages to the same underlying logical exchange. We require that members are able to connect to both Spectrum-HPH and Spectrum-CBH sessions, but do not require members to do so simultaneously. Each market data or trading FIX session is capable of routing requests for both Spectrum data centres, i.e. members do not have to be aware of where a given order book is hosted, the exchange routes requests to the correct location internally (however, members acting in a market-maker capacity may wish to route their orders directly to the Spectrum instance that hosts the target order book, for lowest possible latency).

MEMBER CONNECTED TO ONE SPECTRUM DATA CENTRE USING ONE CROSS-CONNECT (ACTIVE/STANDBY)

In this scenario the member establishes a cross-connect to Spectrum's cabinet at Equinix LD4, and under normal operation targets the FIX gateways in Spectrum-HPH only. In the event of a DR scenario where Spectrum-HPH is down, the member targets Spectrum-CBH.

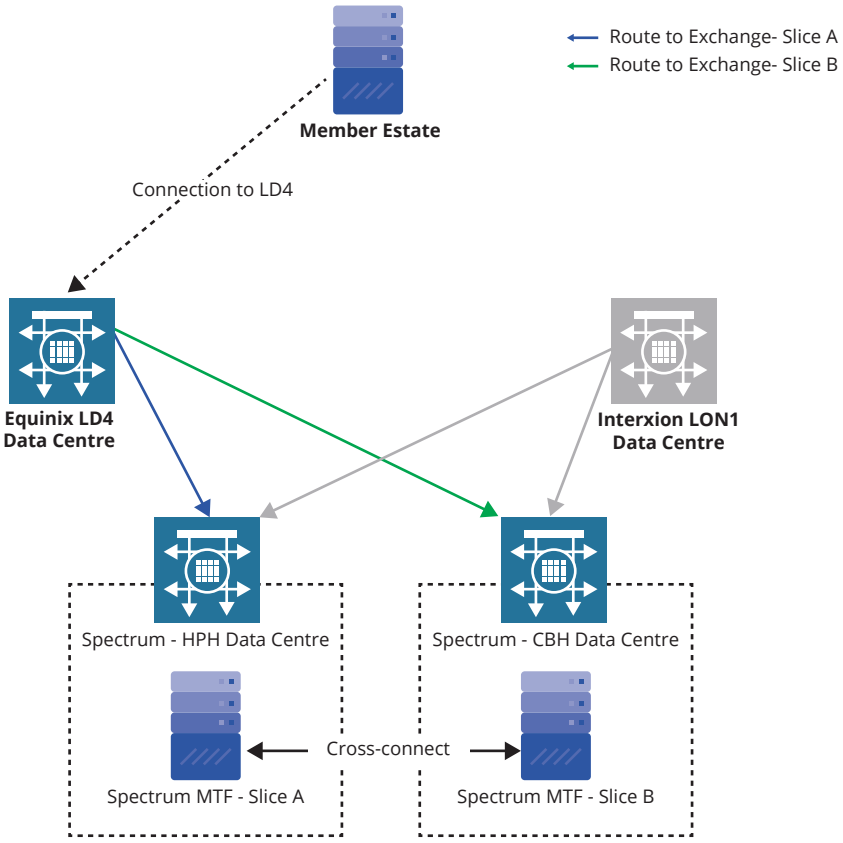
Note: In this connectivity scenario the member is exposed to a single point of failure at Equinix LD4.



MEMBER CONNECTED TO BOTH SPECTRUM DATA CENTRES USING ONE CROSS-CONNECT (ACTIVE/ACTIVE)

In this scenario the member establishes a cross-connect to Spectrum's cabinet at Equinix LD4, and targets FIX gateways in both Spectrum-HPH and Spectrum-CBH. The member routes quotes or orders to the Spectrum data centre that is hosting the relevant order book (this is made visible to members on a per-instrument basis in the instrument download from the market data FIX session). This provides the member with lowest possible latency to the order books.

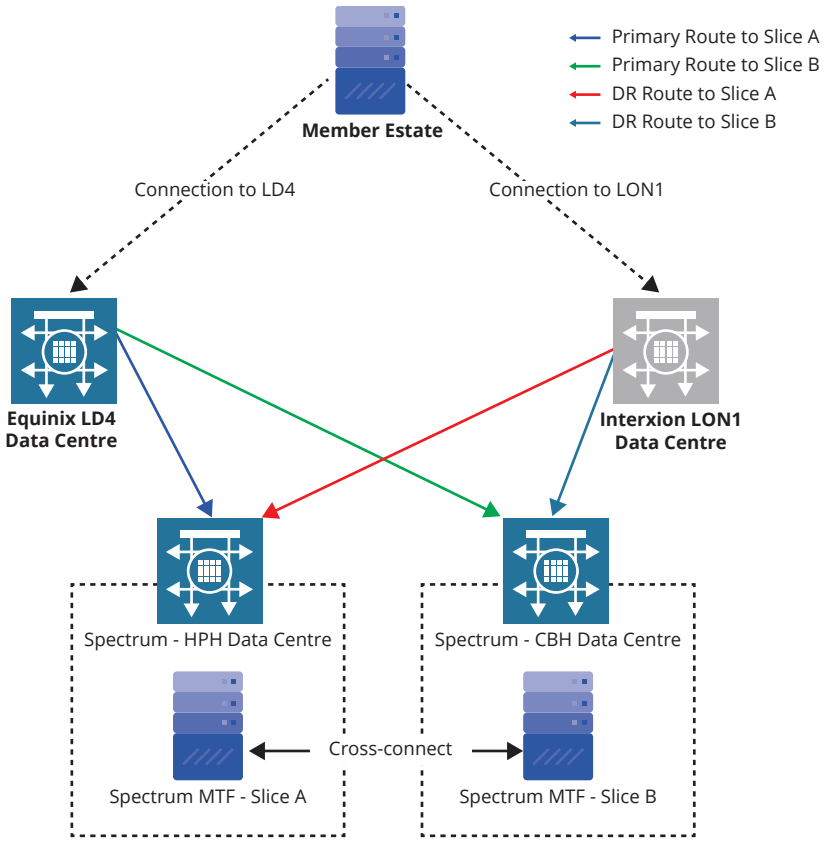
Note: In this connectivity scenario the member is exposed to a single point of failure at Equinix LD4.



MEMBER CONNECTED TO BOTH SPECTRUM DATA CENTRES USING TWO CROSS-CONNECTS (ACTIVE/ACTIVE, HIGHLY RESILIENT)

In this scenario the member establishes a primary cross-connect to Spectrum's cabinet at Equinix LD4, and a backup cross-connect at LON1. The member targets FIX gateways in both Spectrum-HPH and Spectrum-CBH, depending on where their target order book is hosted (hosting location is made visible to members on a per-instrument basis in the instrument download from the market data FIX session).

Note: In this connectivity scenario the member is fully resilient to DC failures, both at LON1/LD4, and Spectrum-HPH/Spectrum-CBH.



FAILOVER / RECOVERY

Under normal operation, Spectrum runs half of its order books in Spectrum-CBH, and the other half in Spectrum-HPH. The two Spectrum data centres share their internal state in realtime in order to provide resilience. In the event of a failure of one of Spectrum's data centres, the Spectrum instance in the surviving data centre takes ownership of the order books hosted in the failed data centre, and resumes trading after a brief delay. Members will be informed ahead of the resumption of trading of how long they can modify orders in the halt state before the markets are re-opened. During a DR event the Spectrum operations team will keep members informed and up-to-date on the member operations email channel (operations@spectrum-markets.com).

SCENARIO 1 – SPECTRUM DATA CENTRE FAILURE

In the event of a failure of one of Spectrum's data centres, the surviving Spectrum data centre will take ownership of order books formerly hosted within the failed Spectrum data centre. During the failover process the surviving Spectrum data centre will reconstruct the last-known state of the order books prior to failure, and then the markets will be re-opened for trading.

Note: It is possible that a small number of messages in flight within the failed exchange may be irrecoverably lost. In a non-graceful DR scenario we advise members to confirm the state of their orders by issuing a OrderMassStatusRequest (35=AF) message.

MEMBER IMPACT AND RECOVERY ACTIONS

In this scenario the member will lose FIX connection to the failed Spectrum data centre (if they were connected to it). The member will be unable to reconnect to FIX sessions hosted in the failed Spectrum data centre, re-connection attempts will result in network-layer timeouts. The next steps depend on the members's selected failover strategy:

- Scenario 1a - Member is running Active/Standby (see diagram above) and their selected Active Spectrum DC has failed: The member must redirect their FIX gateways to target IP addresses of the standby Spectrum DC. IMPORTANT: The member must reset their FIX sequence numbers before connecting to the stand-by DC. The member should connect (log in) their FIX sessions, and then wait for the Spectrum Operations team to announce that failover has completed. The member should then issue a OrderMassStatusRequest (35=AF) message to confirm the state of their orders.

- Scenario 1b - Member is running Active/Active (see diagram above): The member will lose FIX connectivity to the failed Spectrum data centre, but does not need to take any action regarding FIX connectivity as they already have an active connection to the surviving Spectrum data centre. The member should adjust their order routing to direct all order-flow and market data messages to the surviving Spectrum data centre's FIX sessions. For order books hosted in the failed data centre, the member should wait for the Spectrum Operations team to advise that failover has completed, and then issue a OrderMassStatusRequest (35=AF) message to confirm the state of their orders.

SCENARIO 2 – LON1 OR LD4 DATA CENTRE FAILURE

In the event of a failure of either the LON1 or LD4 data centre, members who were using the the failed data centre to connect to Spectrum will need to switch their network routing to the alternate data centre.

MEMBER IMPACT AND RECOVERY ACTIONS

- Scenario 2a - Member has only one cross-connect, and that DC has failed: If the member has chosen to set up a cross-connect at only one of LON1/LD4, and that data centre has failed, then the member must wait for the failed data centre to come back up. For this reason we advise (but do not require) members to establish redundant cross-connects at both LON1 and LD4.

- Scenario 2b - Member has only one cross-connect, and the other DC has failed: No immediate impact.

- Scenario 2c - Member has two cross-connects, and the one they are using as primary has failed: The member must switch their network routing to target the same Spectrum DCs as previously, but via the alternate cross-connect (e.g. if the member was routing to Spectrum services via LD4, and LD4 has failed, the member must swich their network routing to access Spectrum services via LON1).

- Scenario 2d - Member has two cross-connects, and the one they are using as backup has failed: No immediate impact.

NOTE: None of these scenarios requires the member to rest their FIX sequence numbers, as the member will be logging back into the same Spectrum-side FIX sessions via an alternate network route.

DATA CENTRE	TARGET SPECTRUM DATA CENTRE	LIVE ORDER-ENTRY FIX SERVER ADDRESS	DEMO ORDER-ENTRY FIX SERVER ADDRESS	LIVE MARKET DATA FIX SERVER ADDRESS	DEMO MARKET DATA FIX SERVER ADDRESS
LON1	Spectrum-CBH	(tbc)	(tbc)	(tbc)	
	Spectrum-HBH	(tbc)	(tbc)	(tbc)	
LD4	Spectrum-CBH	(tbc)	(tbc)	(tbc)	
	Spectrum-HBH	(tbc)	(tbc)	(tbc)	

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