JSE CLIENT CONNECTIVITY STANDARDS AND BANDWIDTH REQUIREMENTS DOCUMENT

May 2017

Version 3.0

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1. DOCUMENT INFORMATION

1.1. DOCUMENT VERSION

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1.2. DOCUMENT REVISION HISTORY

Date	Version	Description
2 November 2011	1.1	Initial Draft
5 March 2012	2.0	Updated to include new bandwidth requirements for the Equity Market
24 July 2012	2.1	Updated to include: - new line connections of 100Mbps - revised minimum bandwidth for Equity Market Level 1 service
20 January 2014	2.2	Updates to include the JSE Colocation Service standards and requirements as well as those of the JSE London Point of Presence (PoP)
12 December 2014	2.3	JSE template and Corporate branding change and minor document corrections
1 July 2015	2.4	Amendments to the bandwidth requirements
29 July 2015	2.5	Minor corrections
03 March 2016	2.6	Updated to include:- • revised Equity Market Bandwidth Requirements for Integrated Trading and Clearing (ITaC) Project 1a due to Equity Market enhancements which come into effect 26 September 2016 • Connectivity and bandwidth requirements for ITaC project 1b & 1c will be included in due course
10 February 2017	3.0	Updated to include the revised connectivity standards and minimum bandwidth requirements for the Integrated Trading and Clearing (ITaC) Project 1b (Equity Derivatives) and Project 1c (Currency Derivatives)

2. INTRODUCTION

The purpose of this document is to detail the various connectivity options and requirements for Clients who require connectivity to the JSE and its services across all JSE Markets. The Customer Access Network (CAN) including the JSE London Point of Presence (PoP) and the Colocation Service align to the JSE's strategic goal for ease of access to markets through various connectivity options available to Clients.

The JSE currently offers several methods of connectivity, each with different levels of management and performance depending on the specific Market and service requirements.

In line with the JSE's principle of protecting market integrity through minimum prescribed standards, it is a requirement for Clients to have sufficient connectivity and bandwidth to both the JSE's Primary Data Centre (Primary Data Centre) and JSE Remote Disaster Recovery Site (Remote DR Site).

Please note that this document also forms part of the JSE Services Documentation as defined in the JSE Services Agreement (JSA) entered into by Clients of the JSE and will be reviewed from time to time as the JSE introduces new services and/or requirement changes.

Client means any JSE Client requiring connectivity to the JSE for the purposes of subscribing to any of the JSE services outlined in this document.

3. CONNECTIVITY PRINCIPLES

The Client Connectivity Standards and Requirements document has been drafted with the following principles in mind:

3.1. PRINCIPLE 1 – CLIENT CONNECTIVITY TO THE JSE

Clients of the ~~Equity~~JSE Markets are required to have a Primary connection to the JSE Primary Data Centre. They are also required to have a Backup connection to the JSE and Clients may choose whether this back up connection is to the Primary Data Centre or to the Remote DR Site subject to complying with principle 2 and principle 3. Clients of all ~~other~~ JSE Markets ~~are required to have at least one connection to the JSE Primary Data Centre and~~ will be required to connect to the Remote DR Site when the JSE invokes the Remote DR Site.

3.2. PRINCIPLE 2 – SUFFICIENT BANDWIDTH TO JSE PRIMARY DATA CENTRE FOR ~~EQUITY~~JSE MARKETS ~~CLIENTS~~

Currently clients of the JSE ~~Equity~~ Markets ~~Clients~~ are required to have a Primary and Backup connection to the JSE. All ~~Equity Market~~ clients are required to ensure they have sufficient bandwidth to the JSE Primary Data Centre to cover both the A and B feeds for any market data services they subscribe to in addition to any other JSE services (i.e. trading, post-trade etc)~~that are~~ accessed across these connections~~ese lines~~. If clients choose to take the A feed on one connection and the B feed on another connection this is acceptable provided both connections are to the JSE Primary Data Centre and that the duration of a failure of any connection will not be longer than 72 hours i.e. a JSE client may not run only the A or only the B feed for longer than 72 hours.

3.3. PRINCIPLE 3 – CLIENT CONNECTIVITY TO REMOTE DR SITE

3.3.1. JSE Equity Market and future ITaC Derivatives Markets

3.3.1.1. JSE Equity Market and ITaC Equity Derivatives and Currency Derivatives Markets Clients are required to have a Primary and Backup connection to the JSE. As all Equity Market Clients are required to connect to the JSE Remote DR Site when it is being used and therefore these are additional considerations.

3.3.1.2. Clients need to consider the following:

a. Whether to have their Primary connection terminate at the Primary Data Centre and their Backup connections terminate at the Remote DR Site. The JSE will allow the Backup connection to be "backhauled" across from the Remote DR Site to the Primary Data Centre on the Customer Access Network (CAN) if the Primary connection fails. This "backhauling" will have up to a maximum of 10ms additional latency. However, the backhauling does not apply to the A and B market data multicast feeds for the Equity Market and future ITaC Equity Derivatives and Currency Derivatives Markets.Trading and Information Systems (refer to Principle 2 above).
b. Whether to have their Primary and Backup connections terminate at the Primary Data Centre and have a separate connection to the Remote DR Site.
c. Whether to use an MPLS Network provider and have their Primary and Backup connections to the MPLS Network provider and then the MPLS Network provider ensures the two connections to the JSE as per the JSE requirements.
d. The "backhauling" will also exclude order routinge management of messages to a customer's colocation environment from the Remote DR Site. Should a client's primary means of connectivity fail, the JSE will only "backhaul" connectivity for a client connecting from the JSE's Remote DR site to a customer's colocation environment for colocation infrastructure technology management i.e. remote management for colocation.

3.3.1.3. Market Data and trading access to the JSE Equity Market and future ITaC Equity Derivatives and Currency Derivatives Markets is made via Serial Multicast (SMUDP). and For trading and post-trade (deal management and clearing) access is via TCP using BGP and PIM routing protocols to provide peering. Clients must use publically registered IP addresses (i.e. not RFC1918).

3.3.1.4. End of Day Dissemination Subscribers who currently connect to the Information Delivery Portal (IDP) via the internet will not be required to change their current connectivity setup to connect to the Remote DR Site as the JSE will facilitate the connectivity via the internet to the Remote DR Site. However, Clients who have a leased line connection will be required to connect to the Remote DR site when this is being used.

3.3.2. Other JSE Market Clients (excl JSE Equity Market ClientsCurrent legacy Equity Derivatives, Commodity Derivatives, Interest Rate Derivatives and Global Markets)

3.3.2.1. Currently Clients need to have connectivity to the JSE. This will still be required however; Clients will be required to connect to the Remote DR Site when it is being used and there are additional considerations.

3.3.2.2. In addition, Clients will need to consider the following:

a. Implementing solutions so that in the event of the JSE failing over to the Remote DR Site that the Client can connect to the Remote DR Site;
b. Whether to commission a separate connection to the Remote DR Site; or
c. Utilising the 'JSEConnect' VPN service (via a broadband connection) currently available through Internet Solutions (IS) (the VPN service does not support the future ITaC derivatives market multicast market data)

3.3.2.3. Information Subscribers of ~~other~~ the legacy JSE Derivatives Markets ~~to~~ must ensure ~~decide whether~~ they ~~want to~~ have connectivity to the Remote DR Site.

3.4. INTERNATIONAL CONNECTIVITY VIA THE JSE LONDON POINT OF PRESENCE (POP)

3.4.1. The JSE London PoP architecture is designed to support the distribution of JSE market data to clients in London and to enable trading and post-trade services on the JSE markets via the normal JSE Client Access Network (CAN) (i.e. trading through current JSE network infrastructure, and NOT via JSE Colocation).

3.4.2. The Equity Market Customer Test Service (CTS) and the new ITaC CTS can also be accessed via the JSE London PoP and are~~is~~ available to assist clients with application development and functional and conformance testing.

3.4.3. The existing (legacy) Equity Derivatives and Commodity Derivatives production and test market data feeds can also be accessed via the JSE London PoP.

3.4.4. The new ITaC Equity Derivatives and Currency Derivatives production and test trading, market data and post-trade services will also be available via the JSE London PoP.

3.4.5. The JSE London PoP operates out of Equinix LD4 in Slough and is managed on behalf of the JSE by an appointed Managed Service Provider (MSP).

3.4.6. Clients in London connecting to the Equity Market, and ~~existing~~ legacy ~~-~~Equity Derivatives or Commodity Derivatives markets to receive market data are required to have a primary and secondary connection (10Mb fibres) from their infrastructure into the JSE London PoP.

3.4.7. Clients in London who wish to connect to Equity CTS, new ITaC CTS and ~~existing~~ legacy Equity Derivatives or Commodity Derivatives test services are required to have an additional and separate connection (10Mb fibre) from their infrastructure into the JSE London PoP.

3.4.8. The following types of connections are supported for the JSE London PoP at LD4:

a. Gigabit Ethernet
b. Fibre: Single Mode with LC Connectors
c. Fibre: Multimode with LC Connectors
d. Copper: Cat6 with RJ45
e. Each Connection will be "rate limited" to the following speeds.
   i. Production PORT: 10 Megabit

ii. UAT PORT: 2 Megabit

f. Connections are Open Systems Interconnections (OSI) Layer 3 based, IP addressing will be assigned as part of the application process.

g. Clients, who already have connectivity in LD4, can leverage off their existing connectivity to connect to the JSE London PoP. The cross connects between client racks at LD4 and the JSE London PoP will be ordered by the JSE. Clients wishing to connect through existing infrastructure will need to supply a letter of authority (LOA) to the JSE to allow the required order to be placed.

h. Clients can provision international connectivity via the JSE London PoP as an additional JSE service to cater for remote management connectivity into Colocation. This will be facilitated on a discrete connectivity platform provided and managed by one of the JSE's network service providers (NSPs). Please contact the JSE on Colocation@jse.co.za for a quote, if required.

i. Alternatively, Clients can provision their own international connectivity to the JSE Markets, for remote management connectivity and/or for order routing into Colocation from any of the telecommunications or network service providers (NSPs) who currently facilitate connectivity into the JSE. Such connectivity will be negotiated between the client and the telecommunications or network service provider (NSP).

3.4.9. The JSE is currently reviewing the London PoP service offering for all JSE services. We will provide further information on the new offering once it is available.

3.5. COLOCATION CONNECTIVITY

3.5.1. The JSE's Colocation data centre is an external data centre to the JSE, and from a client connectivity perspective should be considered a logical extension of the colocation client's own data centre.

3.5.2. Colocation clients will be provided with 6 fibre connections to facilitate their connectivity to the JSE Markets and services and 2 fibre connections to facilitate remote management of the client's Hosting Unit in Colocation from outside the Colocation environment. The fibre connections provided will be:

a. 2 x 10 Gigabit (Gb) multimode fibres for the JSE's Equity, ITaC Equity Derivatives and ITaC Currency Derivatives Market Data Gateways via User Datagram Protocol (UDP) data. One fibre will distribute the ~~Equity~~ Market Data UDP A feed and the second fibre will distribute the ~~Equity~~ Market Data UDP B feed.

b. 2 x 10 Gigabit (Gb) multimode fibres for Transmission Control Protocol (TCP) connectivity to the JSE's Equity, ITaC Equity Derivatives and ITaC Currency Derivatives Trading Gateways. Load balancing across both TCP fibres will not be possible, as the second TCP fibre is provided as a backup to the primary fibre, in the event that the customer's primary fibre or port fails.

c. 2 x 10 Gigabit (Gb) multimode fibres for TCP connectivity to the JSE's legacy Derivatives Market as well as connectivity to the JSE ITaC Post-trade Real-Time Clearing services for the Equity Derivatives and Currency Derivatives markets. Load balancing across both TCP fibres for the legacy Derivatives Market connectivity will not be possible, TCP fibre is provided as a backup to the primary fibre, in the event that the customer's primary fibre or port fails.

d. 2 x 1 Gigabit (Gb) multimode fibres for will be provided to facilitate remote access and management into a client's Hosting Unit (HU) in Colocation to perform infrastructure and operations management of the Hosting Unit. Order routing will not be facilitated via this remote management connection. Load balancing across both remote management fibres will not be possible, as the second remote management fibre is provided to as a backup to the primary fibre, in the event that the customer's primary fibre or port fails.

3.5.3. Fibre connectivity into the Hosting Units is via 2 by pre-installed patch panels; an A patch panel and B patch panel with 4 wired ports per panel. Cross connects to Hosting Units will be delivered into the Hosting Unit as drop fibre connections.

3.5.4. The JSE will only provide physical layer connectivity i.e. cross connects, from the JSE Telecommunications service hub i.e. Meet-Me-Room (MMR) to the Hosting Unit (HU) in Colocation.

3.5.5. It is the Client's responsibility to implement the necessary security controls and procedures within their Hosting Unit in Colocation, to prevent unauthorised network and application access.

3.5.6. Access to the Customer Test Services (both current and ITaC) will ~~only~~ be facilitated via the Client Access Network as well as ~~and therefore access~~ from Colocation ~~is not facilitated~~.

3.5.7. Hosting Unit IP addresses in Colocation will be assigned by the JSE and made available to the client as part of their application for implementation into Colocation.

3.5.8. Latency to JSE services across all hosting units is identical as the cables used are all the ~~– cables~~ same length

3.5.9. A Precision Time Protocol (PTP) offering is available to clients via Colocation ~~details – WIP~~.

4. ADDITIONAL INFORMATION

4.1.1. If a Client uses an MPLS Network provider (it must be an accredited JSE Network Service Provider (NSP)~~SIP~~), the switching of connectivity between the Primary Data Centre and the Remote DR Site can then be facilitated by the MPLS Network provider.

4.1.2. It is important that Clients determine which MPLS Network providers are able to carry UDP Multicast Data.

4.1.3. Connections can be shared across markets (i.e. same connection for a number of JSE services) providing the available bandwidth meets the accumulated bandwidth requirements for all the services being accessed.

4.1.4. Due to the fact that broadband services (ADSL and 3G) are 'best effort shared services', connectivity cannot be guaranteed. The JSE cannot provide technical support for such connections should a Client experience connectivity related issues or performance issues.

4.1.5. Each Client's connectivity is different and Clients will need to engage with the JSE so we can determine the best connectivity option for the Client.

4.1.6. It is important that Clients determine which Network providers are able to route traffic between the Client Access Network (CAN) and the Colocation network so as to ensure adequate network redundancy for them. Clients are to determine whether they can make use of their existing connectivity to the JSE or if they will procure additional connectivity for Colocation.

4.1.7. The JSE Network Service Provider (NSP) policy has been implemented and all telecommunications providers that facilitate connectivity via the telecommunications hub (meet-me-room) at the JSE have been accredited.

4.1.8. Clients should refer to Volume B - Trading and Information Network Configuration Guide for additional information.

4.1.9. The JSE Colocation Network Configuration Guide is available to assist clients.

5. CONNECTIVITY METHODS

The JSE offers flexible connectivity options for Clients to connect to its systems. Minimum requirements in terms of line capacity and service guarantees for the various business services offered are set to ensure that services are delivered in an efficient and timely manner. With these connectivity methods, Clients are given a choice to connect directly to the JSE via Direct Connectivity or fibre optic infrastructure, or via Value Added Network (VAN).

As the JSE is not registered as a VAN, we cannot permit Clients to access services offered by other providers via the Customer Access Network (CAN). Only services that are hosted on behalf of the JSE may be accessed via the CAN.

The JSE supports both Transmission Control and User Datagram Protocols (TCP and UDP) for its various markets and services.

5.1. DIRECT CONNECTIVITY

Direct Fixed Line Connectivity is used by Clients to access services via Leased lines.

Below is a list of known current network providers who have network equipment in the Primary Data Centre and/or Remote DR Site. Please note that these may not be accredited Shared Infrastructure Providers (SIPs).

#	NW Provider	JSE Primary Data Centre	JSE Remote DR Site
1.	Business Connexion (BCX)	Y	N
2.	BT Communication Services SA	Y	N
3.	Dark Fibre	Y	Y
4.	EOH	Y	N
5.	iBurst	Y	N
6.	Internet Solutions	Y	Y
7.	Metro Fibre Networx	Y	N
8.	MTN Business	Y	Y
9.	Neotel	Y	Y
10.	Perseus Telecom Limited	Y	N
11.	Telkom	Y	Y
12.	Viatel France SASU	Y	N
13.	Vodacom SA	Y	N

Clients have the option of installing a primary line directly to the JSE, and have their secondary line connect via a VAN, or vice versa. The lines can be used for both the production and test environments.

Clients will use static routing to route data across the interface between the Customer and Customer Access Network (CAN). Dynamic routing updates will not be forwarded to the CAN from the JSE Network as the JSE's private IP address range might conflict with the Clients IP address range.

Below is a summary of Direct Connectivity options:

#	Line Options	Bandwidth Supported	Load Balancing Support
1.	Leased Line Connectivity (Channel e1 and Serial x21)*	64kbps – 2Mbps	N
2.	Fibre Connectivity (Multi-mode and single-mode)	Up to 1Gbps fibre terminations	N
3.	MetroE	Up to 1Gbps fibre terminations	N

*** Please note** that clients should NOT consider Channel e1 and Serial x21 connectivity ~~as a long term solution for connecting~~ to the JSE as these are legacy connectivity solutions **which are~~will~~ no longer ~~be~~ supported** by the JSE (since ~~**post**~~ **September 2016**).

5.1.1. Leased Line Connectivity

5.1.1.1. A leased line is a symmetric telecommunications line connecting two locations. It is also known as a 'Private Circuit' or 'Data Line'. Unlike traditional telephone lines, it does not have a telephone number as a permanent connection exists between the two ends of the line.

5.1.1.2. The JSE will support leased lines with bandwidth of 64k to 2Mbps (Refer to 'Application and Service Requirements' table in section 6). This will be reviewed from time to time for the various JSE markets as the JSE introduces new services and/or requirement changes.

5.1.1.3. Load balancing between a customer's multiple leased lines is not supported with this type of connection.

5.1.1.4. Please note that clients should NOT consider Channel e1 and Serial x21 connectivity ~~as a long term solution for connecting to the JSE~~ as these are legacy connectivity solutions ~~which will~~ no longer ~~be~~ supported by the JSE ~~post September 2016~~.

5.1.2. Fibre Connectivity

5.1.2.1. JSE Client's fibre connections will terminate on the JSE network equipment.

5.1.2.2. The JSE will support fibre connections up to a maximum bandwidth of 1Gbps. (Refer to 'Application and Service Requirements' table in section 6 to ensure adequate bandwidth is provisioned across the fibre). These bandwidth requirements will be reviewed from time to time for the various JSE markets as the JSE introduces new services and/or requirement changes.

5.1.2.3. Load balancing between a customer's multiple fibre connections is not supported with this type of connection.

5.1.3. MetroE Connectivity

5.1.3.1. JSE Clients MetroE connections will terminate on the Service Providers MetroE equipment.

5.1.3.2. The JSE will support up to a maximum bandwidth of 1Gbps RJ45 Ethernet connections. (Refer to 'Application and Service Requirements' table in Section 6 to ensure adequate bandwidth is provisioned across the fibre). These bandwidth requirements will be reviewed from time to time for various JSE markets as the JSE introduces new service and/or requirement changes.

5.1.3.3. Load balancing between a customer's multiple MetroE connections is not supported with this type of connection.

5.2. CONNECTING VIA A VALUE ADDED NETWORK (VAN)

Clients may connect to the JSE via a JSE authorised VAN available through an accredited SIP - this is the preferred connectivity method. However, the JSE will give Clients flexibility to connect directly to the JSE.

Below is a summary of connectivity options via a VAN:

#	Line Options	Bandwidth Supported	Load Balancing Support
1.	Leased Line	64kbps – 2Mbps	N
2.	Direct Fibre	Rate limited to a maximum of 1Gbps	N
3.	Multi-Protocol Label Switching (MPLS)	64kbps – up to 1Gbps	Y
4	MetroE	Rate limited to a maximum of 1Gbps	N
5.	JSEConnect VPN	VPN connectivity via Internet Solutions' VPN service via a broadband connectivity medium (ADSL or 3G)	N

Clients have the option to install a primary line via a VAN and have their secondary line connect directly to the JSE, or vice versa. The JSE standard is to cap bandwidth at 1Gbps (Refer to 'Application and Service Requirements' table in section 6), and this will be reviewed from time to time.

Clients may use the same access medium to access both the production and test environments/services should they wish, providing the combined minimum bandwidth requirements for both environments are met.

5.2.1. Leased Line

5.2.1.1. A leased line is a point to point connection, connecting the Client directly to the JSE's network infrastructure. These lines range from 64kbps to ~~1Gbps~~2Mbps, and can accommodate for TCP and UDP multicast traffic.

5.2.2. Direct Fibre

5.2.2.1. A direct fibre optic line is a point to point connection, connecting the customer directly to the JSE's network infrastructure. This type of connection can accommodate a 1Gbps connection. (Refer to 'Application and Service Requirements' table in section 6).

5.2.3. MetroE Connectivity

5.2.3.1. JSE Clients MetroE connections will terminate on the Service Providers MetroE equipment.

5.2.3.2. The JSE will support up to a maximum bandwidth of 1Gbps. (Refer to 'Application and Service Requirements' table in Section 6). This will be reviewed from time to time for various JSE markets as the JSE introduces new service and/or requirement changes.

5.2.3.3. Load balancing between a customer's multiple MetroE connections is not supported with this type of connection.

5.2.4. Multi-Protocol Label Switching (MPLS)

5.2.4.1. MPLS is a data-carrying mechanism that belongs to the family of packet-switched networks and a Point of Presence (PoP) providing networks with a more efficient way to manage applications and move information between locations.

5.2.4.2. VANs will support lines with bandwidth of 64kbps to 100Mbps (Refer to 'Application and Service Requirements' table in section 6). This will be reviewed from time to time as the JSE introduces new services and/or requirements change.

5.2.4.3. Load balancing between the customer's MPLS links can be configured by the VAN.

5.2.5. JSEConnect VPN (Internet Based) – for legacy Derivatives Market connectivity only

5.2.5.1. Clients with broadband (ADSL or 3G) connectivity can access the JSE's network by connecting to the JSEConnect VPN service supplied by Internet Solutions. This service must still cater for the minimum bandwidth requirements as per Schedule 1. Please refer to 'Application and Service Requirements' table in section 6, as this connection is only permitted for certain markets.

5.2.5.2. This is not a guaranteed service, as Broadband and 3G connectivity is viewed as 'best effort' and is shared amongst other data users.

~~5.2.5.2.~~5.2.5.3. Clients using this VPN will need alternate connectivity to the JSE Remote disaster recovery site to continue connecting to the JSE services when the JSE invoke DR.

~~5.2.5.3.~~5.2.5.4. This service is solely provided and managed by the service provider.

~~5.2.5.4.~~5.2.5.5. The quality of the service is not guaranteed over a Broadband' connection and no SLA between the client and the JSE can be applied.

5.3. CONNECTIVITY VIA JSE LONDON POP

5.3.1. Clients are able to access the services located at the JSE through the JSE London PoP in Slough in London. Clients wishing to connect to the JSE services via the JSE London PoP are required to procure additional connectivity services to the JSE. Connectivity requirements will be dependent on the services the clients wish to subscribe to.

5.3.2. Connectivity is currently facilitated to the Equity Market production and test services as well as Remote Management connectivity to the Colocation Services. The existing legacy Equity Derivatives and Commodity Derivatives production and test market data feeds can also be accessed via the JSE London PoP. The new ITa~~A~~C Equity Derivatives and Currency Derivatives production and test services will be available via ~~at~~ the JSE London PoP.

6. APPLICATION AND SERVICE REQUIREMENTS

The following table displays the services on offer by the JSE, and provides the JSE's guidelines for corresponding connectivity and minimum bandwidth requirements for each service.

Service description	Protocols	Current Minimum Bandwidth	Primary Connection Options	Backup / DR Connection Options
Broker Deal Accounting (BDA)	TCP/SNA	15kbps per terminal	• Leased line • Direct Fibre • SIP MPLS • SIP 3G APN • SIP ADSL VPN	• Leased line • Direct Fibre • SIP MPLS • SIP 3G APN • SIP ADSL VPN
Commodity Derivatives Market (CDM)	TCP	256kbps per Nutron terminal, per market **	• Leased line • Direct Fibre • SIP MPLS • SIP 3G APN • SIP ADSL VPN	• Leased line • Direct Fibre • SIP MPLS • SIP 3G APN • SIP ADSL VPN
Currencies and Interest Rate Market (IRC)	TCP	360kbps per Nutron terminal, per market **	• Leased line • Direct Fibre • SIP MPLS • SIP 3G APN • SIP ADSL VPN	• Leased line • Direct Fibre • SIP MPLS • SIP 3G APN • SIP ADSL VPN
Derivatives Information Subscriber (EDM / CDM / IRC)	TCP	1Mb per listener per market **	• Leased line • Direct Fibre • MPLS	• Leased line • Direct Fibre • MPLS
Derivatives Dissemination (EDM / CDM / IRC)	TCP	64kbps per connection	• Leased line • Direct Fibre • MPLS	• Leased line • Direct Fibre • MPLS
Equity Derivatives Market (EDM)	TCP	256kbps per Nutron terminal, per market **	• Leased line • Direct Fibre • SIP MPLS • SIP 3G APN • SIP ADSL VPN	• Leased line • Direct Fibre • SIP MPLS • SIP 3G APN • SIP ADSL VPN
Equity End of Day Dissemination	TCP	64kbps	• Leased line • Direct Fibre • MPLS	• Leased line • Direct Fibre • ISDN Router • MPLS
Global Market	TCP	128kbps per terminal, per market **	• Leased line • Direct Fibre • SIP MPLS • SIP 3G APN • SIP ADSL VPN	• Leased line • Direct Fibre • SIP MPLS • SIP 3G APN • SIP ADSL VPN
Equity Market (EQM)				
Equity and Indices Live market data feed subscribers (Equity Market real-time Information Subscribers and Data Vendors)	TCP UDP (Multicast)	To subscribe to all live public Market Data feeds: 2 x 4.5 Mbps to subscribe to: - Level 1 - **throttled** MITCH full depth - Indices and - Regulatory News	• Leased line • Direct Fibre • MPLS	• Leased line • Direct Fibre • MPLS

Service description	Protocols	Current Minimum Bandwidth	Primary Connection Options	Backup / DR Connection Options
		- A+B Feeds combined per Gateway service. ** 2 x 3.4 Mbps to subscribe to: - **un-throttled** MITCH full depth Gateway (A+B feeds) ONLY. - This is over and above the 4.5Mbps for all other real-time market data Gateways above. Replay/Recovery is via TCP		
Equity Market - TSP Host to Host (including JSE Equity Market Trading Private Data only)	TCP	The private trading bandwidth is over and above the bandwidth for public Market Data Gateways above and should be added to it. 2 x 0.750Mbps to subscribe to the **throttled Native Trading** Gateway per connection ** **And/Or** 2 x 1.00 Mbps to subscribe to the **un-throttled Native Trading** Gateway per connection. **And/Or** 2 x 1.049 Mbps to subscribe to the **FIX Trading** Gateway per connection. * Refer to **Section 13 - Schedule 2** for a detailed bandwidth breakdown	• Leased line • Direct Fibre • SIP MPLS	• Leased line • Direct Fibre • SIP MPLS
Future Integrated Trading and Clearing (ITaC) Project 1b (Equity Derivatives) and Project 1c (Currency Derivatives)				
Trading and Market Data				
Equity Derivatives Market (EDM) – public Live market data feed ONLY	TCP UDP (Multicast)	To subscribe to all the live Equity Derivatives Market Data: 2 x 2.2 Mbps to subscribe to: - Level 1 and - **Throttled** MITCH Full market depth public market data feeds (A+B feeds). 2 x 1.25 Mbps to subscribe to: - **Un-throttled** MITCH Full market depth public market data (A+B feed). This is over and above the Mbps for all other market data Gateways above. Refer to **Section 13 - Schedule 2** for the detailed bandwidth break-down Replay/Recovery is via TCP	• Leased line • Direct Fibre • SIP MPLS	• Leased line • Direct Fibre • SIP MPLS

Service description	Protocols	Current Minimum Bandwidth	Primary Connection Options	Backup / DR Connection Options
Equity Derivatives Market (EDM) - TSPs Host to Host (including JSE Equity Derivatives Trading Private Data only)	TCP	The private trading bandwidth is over and above the bandwidth for public Market Data Gateways above and should be added to it. 2 x 0.825 Mbps to subscribe to the **throttled Native Trading** Gateway per connection ** Refer to Section 13 - Schedule 2 for the detailed bandwidth breakdown.	• Leased line • Direct Fibre • SIP MPLS	• Leased line • Direct Fibre • SIP MPLS
Currency Derivatives Market (Curr) – public Live market data feed ONLY	TCP UDP (Multicast)	To subscribe to all the live Equity Derivatives Market Data: 2 x 0.910 Mbps to subscribe to: - Level 1 and - **Throttled** MITCH Full market depth public market data feeds (A+B feeds). 2 x 1.020 Mbps to subscribe to: - **Un-throttled** MITCH Full market depth public market data (A+B feed). This is over and above the Mbps for all other market data Gateways above. Refer to **Section 13 - Schedule 2** for the detailed bandwidth break-down Replay/Recovery is via TCP	• Leased line • Direct Fibre • SIP MPLS	• Leased line • Direct Fibre • SIP MPLS
Currency Derivatives Market (Curr) - TSPs Host to Host (including JSE Equity Derivatives Trading Private Data only)	TCP	The private trading bandwidth is over and above the bandwidth for public Market Data Gateways above and should be added to it. 2 x 0.825 Mbps to subscribe to the **throttled Native Trading** Gateway per connection ** Refer to Section 13 - Schedule 2 for the detailed bandwidth breakdown.	• Leased line • Direct Fibre • SIP MPLS	• Leased line • Direct Fibre • SIP MPLS
~~(~~Post-trade ~~S~~services ~~solution~~ for ITAC Project 1b (Equity Derivatives) and ITaC Project 1c (Currency Derivatives~~ies~~) i.e. Clearing and Deal Management				
Real-time Post-trade e.g Service (for deal management and clearing)	TCP	To subscribe to the ITaC Equity Derivatives or ITaC Currency Derivatives Post-trade service requires: 1 x 1 Mbps per connection to the real-time Post-trade Service per market	• Leased line • Direct Fibre SIP MPLS	• Leased line • Direct Fibre SIP MPLS

Clients must make use of the detailed bandwidth requirements in Section 13 – Schedule 2 to determine their exact bandwidth requirements which will be specific to what they choose to subscribe to and the choice of trading connections they require (if any).

* For the **Equity Market** example

- 2 x 4.5Mbps caters for the A + B Feeds for all public multicast Market data ONLY. (i.e. Level 1, throttled Full market depth, Indices and Regulatory News)
- Clients are required to perform their own calculation to cater for the private trading data requirements, which must be added to this.

Example:

- An **Equity Member** using a 'host to host' to connect directly to the JSE solution currently requires:
  - 2 x 4.5Mbps for the A + B Feeds of public data **PLUS**
  - 1Mbps for each throttled native trading private data, drop copy and post trade service when submitting 100 orders per second.

** Please note that these bandwidth requirements for the legacy Derivatives terminals (Nutron) are based on the current performance volumetrics, and are provided as a recommendation.

- A user connecting to more than one existing legacy Derivatives market at any one time will require additional bandwidth.

Example:

- Two users connecting each to the existing legacy Equity Derivatives (EDM) market concurrently, the total bandwidth consumption will be 512kbps.
- One user connecting to all three existing legacy Derivatives markets concurrently, the total bandwidth consumption will be 872kbps.

Integrated Trading and Clearing (ITaC) Project 1b (Equity Derivatives) and Project 1c (Currency Derivatives) example:

For the **Equity Derivative Market** example

- 2 x 1.25 Mbps caters for the A + B Feeds for all public multicast Market data ONLY. (i.e. throttled Full market depth)
- Clients are required to perform their own calculation to cater for the private trading data requirements, which must be added to this.

Example:

- An **Equity Derivative Member** using a 'host to host' to connect directly to the JSE solution currently requires:
  - 2 x 1.25 Mbps for the A + B Feeds of public data **PLUS**
  - 0.825 Mbps for each throttled native trading private data, drop copy and post trade service when submitting 100 orders per second..

For the **Currency Derivative Market** example

- 2 x 0.910 Mbps caters for the A + B Feeds for all public multicast Market data ONLY. (i.e. throttled Full market depth)
- Clients are required to perform their own calculation to cater for the private trading data requirements, which must be added to this.

Example:

- A **Currency Derivative Member** using a 'host to host' to connect directly to the JSE solution currently requires:
  - 2 x 0.910 Mbps for the A + B Feeds of public data **PLUS**
  - 0.825 Mbps for each throttled native trading private data, drop copy and post trade service when submitting 100 orders per second~~.~~.

7. REMOTE DR SITE LOCATION

Venus 2 Data Centre
The Campus
1st floor Imola Building
57 Sloane Street
Bryanston

8. JSE LONDON POP LOCATION

2 Buckingham Avenue,
Slough Trading Estate
Slough, Berkshire SL1 4NB
United Kingdom

9. SECURITY

To prevent unauthorised access to the Clients' network and their systems, it is the Clients' responsibility to implement security controls between the JSE and Customer Network. However, the JSE will implement additional security controls, listed below, to minimise the risk of unauthorised access to its network.

9.1.1. Incoming access-lists or firewall policies to ensure that Customer Networks can only establish routes to valid Networks at the JSE's Primary Data Centre and Remote Disaster Recovery sites.

9.1.2. Each edge router will maintain an access-list of allowable IP addresses and only packets from addresses in that list will be allowed through the router. Access-lists on the routers will be configured by the JSE.

9.1.3. The JSE will not respond to any Internet Control Message Protocol (ICMP), for example, ping or any requests other than the permitted protocols sent by any customer.

To implement security controls between the JSE and Customer Networks, Clients are advised to use a firewall to secure their environment. Any firewall installed between the JSE and Customer Networks must be enabled for all the relevant protocols and ports to ensure connectivity to the required JSE Services.

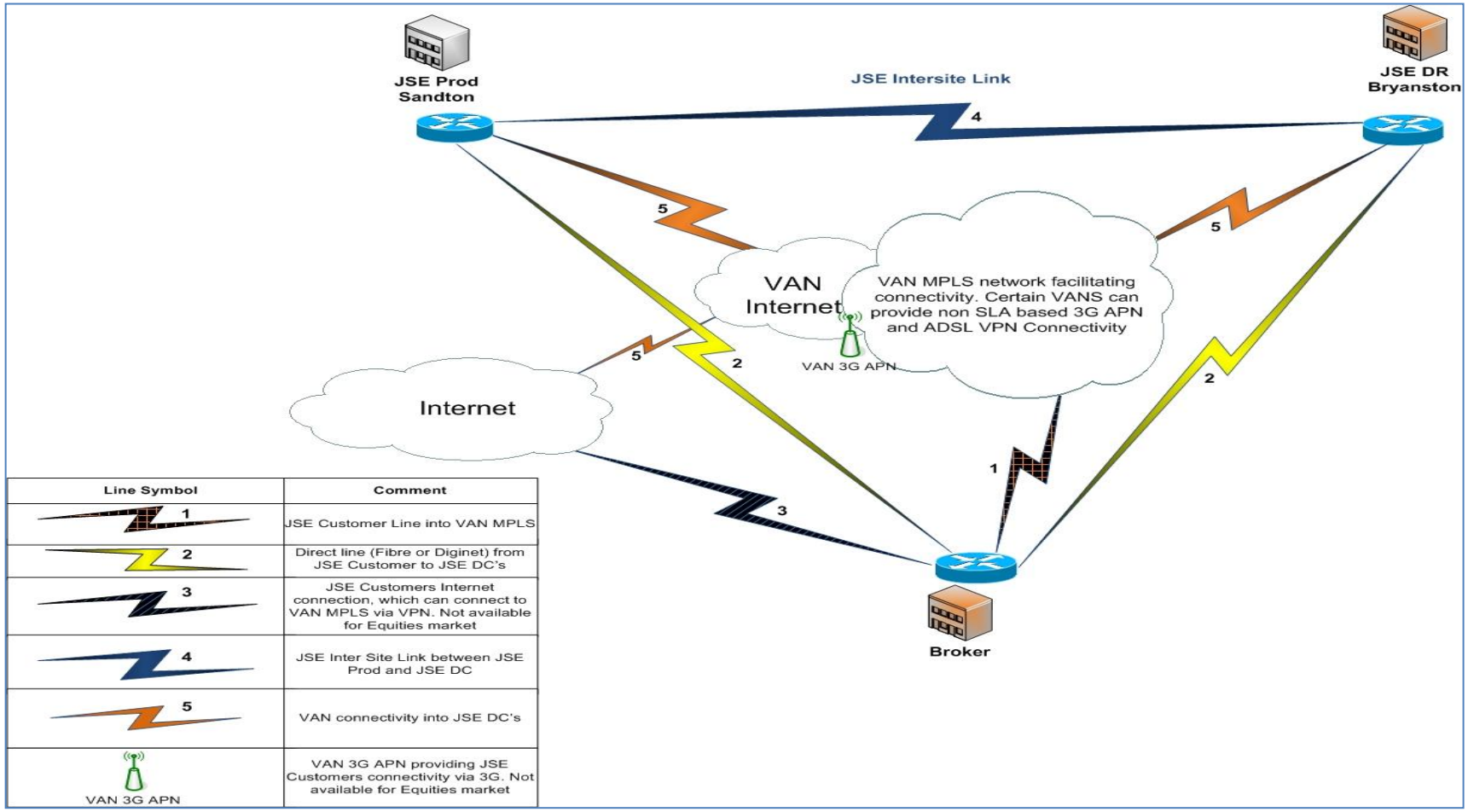
10. GLOSSARY

The terms, abbreviations, and acronyms listed in the table below have been used in this document.

Term	Definition / Description
API	Application Programming Interface (API)
APN	Access Point Name
BACKHAULED	Getting data to a point from which it can be distributed over the network.
BGP	Border Gateway Protocol
BRI	Basic Rate Interface
CAN	Customer Access Network – the network the customers connect to
CDM	Commodities Derivatives Market
FXM	Currency Derivatives Market
DR	Disaster Recovery
EQM	Equity Market
EDM	Equities Derivatives Market
Host to Host	Direct connectivity to the ~~Equity Market~~ JSE services via an API connection e.g. trading engine or post-trade real-time clearing
ICMP	Internet Control Message Protocol
IP	Internet Protocol
IRM	Interest Rate Market
ISDN	Integrated Services Digital Network
LC GBIC	LuxCis Gigabit Interface Connector
Markets	One of the ~~four~~ markets run by the JSE (EQM, EDM, CDM, IRM & FXM)
MPLS	Multi-Protocol Label Switching
NSP	Network Service Provider
PIM	Protocol Independent Multicast
PoP	Point of Presence
SFP	Small form-factor pluggable transceiver
SIP	Shared Infrastructure Provider
TCP	Transport control protocol
TCP	Transmission Control Protocol
TSP	~~Equity Market~~ Trading Service Participants i.e. Trading Member
UDP	User datagram protocol
VAN	Value added networks

11. CONNECTIVITY

The following diagram illustrates the various means of connectivity that clients can use to connect to the JSE Primary Data Centre and Remote DR Site.



Line Symbol	Comment
1	JSE Customer Line into VAN MPLS
2	Direct line (Fibre or Diginet) from JSE Customer to JSE DC's
3	JSE Customers Internet connection, which can connect to VAN MPLS via VPN. Not available for Equities market
4	JSE Inter Site Link between JSE Prod and JSE DC
5	VAN connectivity into JSE DC's
VAN 3G APN	VAN 3G APN providing JSE Customers connectivity via 3G. Not available for Equities market

12. SCHEDULE 1 – SUMMARY CONNECTIVITY AND MINIMUM BANDWIDTH REQUIREMENTS

	Protocols			Primary Connections							DR Connections					
Service description	**TCP**	**UDP Multicast**	**Leased Line**	**MetroE**	**Dark Fibre**	**MPLS**	**SIP MPLS**	**SIP 3G APN**	**SIP ADSL VPN**	**Leased Line**	**MetroE**	**Dark Fibre**	**MPLS**	**SIP MPLS**	**SIP 3G APN**	**SIP ADSL VPN**
Broker Deal Accounting (BDA)	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Commodity Derivatives Market (CDM) (legacy)	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Currencies and Interest Rate Market (IRM) (legacy)	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Derivatives Dissemination (EDM / CDM / IRM) (legacy)	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Equity Derivatives Market (EDM) (legacy)	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Equity End of Day Dissemination	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Equity Market (EQM) - Only JSE Equity and Indices Live market data feed	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	N	N
Equity Market (EQM) - TSPs Host to Host (including JSE Equity Trading and JSE Equity and Indices Live market data feed)	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	N	N
Global Market	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Derivatives markets: Information Subscriber (EDM / CDM / IRM) (legacy)	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	N	N
Future Integrated Trading and Clearing (ITaC)																

	Protocols			Primary Connections							DR Connections					
Service description	**TCP**	**UDP Multicast**	**Leased Line**	**MetroE**	**Dark Fibre**	**MPLS**	**SIP MPLS**	**SIP 3G APN**	**SIP ADSL VPN**	**Leased Line**	**MetroE**	**Dark Fibre**	**MPLS**	**SIP MPLS**	**SIP 3G APN**	**SIP ADSL VPN**
Equity Derivatives Market (EDM) – public live (real-time) market data	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	N	N
Equity Derivatives Market (EDM) – private trading data	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	N	N
Currency Derivatives Market (FXM) – public live (real-time) market data	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	N	N
Currency Derivatives Market (FXM) – private trading data	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	N	N
Post-trade Real-time Clearing (RTC) Service – private clearing data and public market data	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	N	N

13. SCHEDULE 2 – TRADING, POST-TRADE AND INFORMATION MINIMUM BANDWIDTH REQUIREMENTS

JSE Equity Market Bandwidth (Megabits per inter second)

Item	Current Min Bandwidth (effective from 26 Sept 2016)	Unit	Description
Bandwidth for JSE			
Client Bandwidth (100 orders/sec – Native Trading throttled)	0.750	Mbps	Native Trading throttled client bandwidth including order management + drop copy + post trade bandwidth without market data
Client Bandwidth (100 orders/sec – Native Trading un-throttled)	1.000	Mbps	Native Trading un-throttled client bandwidth including order management without market data
Client Bandwidth (100 orders/sec – FIX Trading)	1.049	Mbps	FIX Trading bandwidth including order management + drop copy + post trade bandwidth without market data
FAST bandwidth for a single Multicast feed (e.g. Feed A only)			
Level 1 (incremental for JSE)	1.410	Mbps	FAST multicast feed bandwidth for top of the book service
Indices (JSE)	0.512	Mbps	FAST multicast feed bandwidth for Index service
News (JSE)	0.512	Mbps	FAST multicast feed bandwidth for News service
MITCH bandwidth for a single Multicast feed (e.g. Feed A only)			
MITCH (JSE) – Full Depth	1.370	Mbps	MITCH multicast feed bandwidth for full depth MITCH service
Un-throttled MITCH (JSE) – Full Depth	3.400	Mbps	MITCH multicast feed bandwidth for full depth Un-throttled MITCH service

NSX Equity Market Bandwidth (Megabits per inter second)

Bandwidth for NSX	Current Min Bandwidth (effective from 26 Sept 2016)	Unit	Description
Client Bandwidth (5 orders/sec – Native Trading throttled)	0.035	Mbps	Native trading throttled client bandwidth including order management + drop copy + post trade bandwidth without market data for NSX market
Client Bandwidth (5 orders/sec – FIX Trading)	0.052	Mbps	FIX Trading client bandwidth including order management + drop copy + post trade bandwidth without market data for NSX market
FAST bandwidth for a single Multicast feed(e.g. Feed A only)			
Level 1 (incremental for NSX)	0.024	Mbps	FAST multicast feed bandwidth for top of the book services for NSX
Indices (NSX)	0.067	Mbps	FAST multicast feed bandwidth for Index service for NSX
News (NSX)	0.067	Mbps	FAST multicast feed bandwidth for News service for NSX
MITCH bandwidth for a single Multicast feed (e.g. Feed A only)			
MITCH (NSX)	0.047	Mbps	MITCH multicast feed bandwidth for full depth MITCH service for NSX

Future Integrated Trading and Clearing (ITaC) Bandwidth Requirements

JSE Equity Derivatives Market Bandwidth (Megabits per inter second)

Item	Future ITaC Project 1b Min Bandwidth (effective Q4 2017)	Unit	Description
Client Bandwidth (100 orders/sec – Native Trading throttled)	0.825	Mbps	Native Trading throttled client bandwidth including order management + drop copy + post trade bandwidth without market data for JSE market
MITCH bandwidth for a single Multicast feed (e.g. Feed A only)			
MITCH (JSE) – Full Depth	1.250	Mbps	MITCH multicast feed bandwidth for full depth MITCH service for JSE
Un-throttled MITCH (JSE) – Full Depth	1.880	Mbps	MITCH multicast feed bandwidth for full depth Un-throttled MITCH service for JSE
MITCH – Top of Book (BBO)	0.950	Mbps	MITCH multicast feed bandwidth for top of the book service for JSE

JSE Currency Derivatives Market Bandwidth (Megabits per inter second)

Item	Future ITaC Project 1c Min Bandwidth (effective Q4 2017)	Unit	Description
Client Bandwidth (100 orders/sec – Native Trading throttled)	0.825	Mbps	Native Trading throttled client bandwidth including order management + drop copy + post trade bandwidth without market data for JSE market
MITCH bandwidth for a single Multicast feed (e.g. Feed A only)			
MITCH (JSE) – Full Depth	0.910	Mbps	MITCH multicast feed bandwidth for full depth MITCH service for JSE
Un-throttled MITCH (JSE) – Full Depth	1.020	Mbps	MITCH multicast feed bandwidth for full depth Un-throttled MITCH service for JSE
MITCH – Top of Book (BBO)	0.700	Mbps	MITCH multicast feed bandwidth for top of the book service for JSE

Post-trade Services (i.e. Real-time deal mgmt. & clearing (RTC)) Bandwidth (Megabits per inter second)

Item	Future ITaC Project 1b and 1c Min Bandwidth (effective Q4 2017)	Unit	Description
Post-trade Service (for real-time deal management and clearing interface)	1.000	Mbps	Real-time bandwidth requirements for the Post-Trade services namely, deal management and clearing functions. This is the minimum bandwidth required for Application Programming Interface (API) connection(s) to the JSE real-time Post-trade solution.

A Clearing Member who needs to subscribe to the Post-trade service for Equity Derivatives and Currency Derivatives will require 2 x 1Mbps connections to the service.

A Clearing Member who needs to maintain separate connections to the Post-trade service for more than one client on behalf of who they clear will require:
e.g. 5 (clients) x 1Mbps connections = 5Mbps for the Post-trade service

14. CONTACT INFORMATION

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