Johannesburg Stock Exchange

New Equity Market Trading and Information Solution

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1.1 Table of Contents

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1.4   References

None

1.5   Contact Details

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2 OVERVIEW

This document is intended to give required information to JSE Clients on the behaviour of the services when there is a failure and the recovery guidelines to resume to normal operations.

Software components, machines and network hardware can fail while the JSE System is in operation. The System deployed for the JSE will have fault resilience built into it which prevents a "single point of failure". This ensures that if a server, software component or network equipment fails, the JSE System will be able to continue operating without service degradation. Note that there may be degradation in the performance (increase of latency, reduction of throughput) depending on the type of failure.

High Availability is achieved through each component having a Mirror component which can take over from a Primary component failure. Details of both Primary and Mirror services for the software components of the JSE System for, the Gateways used by JSE Clients are outlined in this document. JSE Clients are requested to use the guidelines given in this document in conjunction with the respective interface specification documentation for each service.

In the event of a catastrophic failure of the JSE's Primary Data Centre, the JSE System will also have the capability to fail over to the JSE's Remote DR Site. In case of a total failure in the entire System in the JSE's Primary Data Centre site, the System will be started in the JSE's Remote DR Site. This document also details guidelines for JSE Client Recovery following a site failover.

3 TRADING, POST TRADE AND DROP COPY GATEWAY FAILURE

Each Interface User (identified by the Interface User (CompID)) will be enabled for access to the JSE System via one or more Primary and Mirror Gateways for each trading interface i.e. Native Trading, FIX Trading, Post Trade and Drop Copy. Equity Market CompIDs can connect to Native Trading or to FIX Trading gateways for order entry activity. Derivative Markets CompIDs can only connect to the Native Trading gateways.

3.1 Loss of the Primary Gateway

In the case of an unexpected disconnection from the Primary Gateway, JSE Clients should attempt to re-connect to the Primary Gateway a total of 3 times, with 3 seconds between each attempt before attempting to connect to the Mirror Gateway.

Likewise, if there are issues in connecting to the Mirror Gateway, after a total of three connection attempts, with 3 seconds between them should be repeated, the JSE Client should then immediately contact the JSE Client Service Centre (CSC).

Derivative Market clients have a further Tertiary Gateway to which they can attempt to connect. Once this connection fails JSE CSC should be contacted.

3.2 Loss of both Primary and Mirror Gateways

After six failed connection attempts (three on each gateway) for Equity Market Clients and 9 failed attempts (three on each gateway) this may indicate an issue and the JSE CSC should be contacted for guidance. If both all Gateways fail then no connection will be possible to the JSE System via either the Primary or the Mirror Gateways. Whilst the cause of the issue is being resolved by the JSE, JSE Clients will receive communication updates through the regular crisis communication channels.

3.3 Recovery after both Primary and Mirror Gateway failure

The JSE will generally recover the Primary Gateway first. Dependent on the nature of the recovery the FIX sequence numbers will either be maintained from the previous session or be re-set to 1. It is re-set to 1 in situations where the Gateway cannot be restarted maintaining the current state. This will be communicated to JSE Clients prior to re-connection.

Once JSE Clients have re-connected then recovery actions should be identical to that for the loss of a single Gateway. In addition, it is recommended that all JSE Clients should perform the following actions:

- Submit an Own Trade Download via the Trade Capture Report Request message for the Interface User ID (CompID) through the Post Trade Gateway to confirm which trades have been confirmed and committed in the JSE System.

- Submit an Own Order Book Download via the Open Order DownloadOrder Mass Status Request message through the Drop Copy Gateway to reconcile the JSE Client view of the open orders with that of the JSE System. It should be noted that should the JSE switch over to the Remote DR site all orders will be deleted i.e. the JSE system will start with a clean order book.

3.4 FIX Gateway Specifics (FIX Trading, Drop Copy and Post Trade)

On re-connection the FIX Gateways will increment the outbound (to JSE Clients) message sequence numbers by 5000 to ensure that any messages in-flight at the time of failure can be recovered by JSE Clients.

Following log-on to the Gateway all messages, including any Execution Reports or Trade Capture Reports generated by the System whilst clients were disconnected (including deletions due to Cancel on Disconnect) will automatically be re-sent. After the messages are sent to the client following the re-connection, if the client re-requests, then only 2000 messages will be sent.

The FIX Gateways have two unique ports that can be connected to on both instances of the gateway. When connecting to a Primary FIX Gateway on port A during a failover, the port that should be utilised on the Secondary FIX Gateway should also be port A. the same applies if port B is connected to.

3.5 Native Trading Gateway

JSE Clients should first connect to the Real-Time channel before connecting to the Recovery Channel. Following this any missed messages or Execution Reports generated by the system whilst participants were disconnected can be recovered via a Missed Message Request.

3.6 Other functionality related to Trading Gateways (FIX Trading and Native Gateways)

JSE Clients with the "Cancel on Disconnect" flag enabled should be aware that any orders submitted by Interface Users (CompIDs) through a Primary Native Trading or Primary FIX Trading Gateway that has failed, will be deleted depending on the configuration adopted by the JSE Client.

4 MARKET DATA GATEWAY FAILURE

This section is applicable for both the FAST and MITCH Market Data Gateway services. All multicast channels will have 2 identical feeds (known as the A and B feed). The Primary Market Data Gateway disseminates the primary (A) feed and the Mirror Market Data Gateway disseminates the identical Mirror (B) feed. The sequence numbers across both feeds are consistent, allowing clients to subscribe to both feeds and arbitrage any potential loss of multicast messages.

The following TCP channels are available to recover missed multicast messages.

- The TCP Replay Channel can be used by the JSE Clients who missed messages on multicast feeds can get the last 250000 messages (REPLAY_CACHE_SIZE).

- The TCP Recovery Channel can be used by the JSE Clients who connect late to the system or have recovered from a problem experienced to receive the market data snapshot. JSE Clients need to listen to the multicast feed for online updates and synchronise messages based on sequence numbers.

4.1 Loss of Primary Gateway

Following the failure of the Primary Gateway, the Primary multicast feed will automatically stop. In such a situation, JSE Clients have to stop arbitration and only expect the Mirror (B Feed) multicast feed.

Any TCP connection attempts to the Primary Gateway for either the Replay or Recovery services will get disconnected. In the case of an unexpected disconnection from the Primary Gateway, JSE Clients should attempt to re-connect to the Primary Gateway a total of 3 times, with 3 seconds in between each attempt before attempting to connect to the Mirror Gateway.

Likewise, if there are issues connecting to the Mirror Gateway a total of three connection attempts, with 3 seconds between them, the JSE Client should then immediately contact the JSE CSC.

When the Mirror Market Data Gateway takes over from the failed Primary, the following should be expected by the JSE Clients:

- The Real-time Multicast UDP sequence number will automatically be reset to 1 in the Mirror feed.

- The Replay and Recovery services will be activated on the Mirror Gateway and JSE Clients should use the Mirror IP and port configuration to access these services.

- It will be necessary for the Market Data Gateway to resynchronize it's order book in this situation and therefore all existing order books will be cleared down using an MDEntryType (269) = J (Empty Order Book) for FAST services and an 'Order Book Clear' message on the MITCH service.

- For FAST services the Snapshots will resume as per usual services for Snapshot channels and for update services a series of Market Data Incremental Refresh messages will be sent. For the MITCH channels all active orders on the book will be disseminated via 'Add Order' message.

- The market data statistics disseminated on FAST will also be refreshed. Initially a Market Data Incremental Refresh message will be sent with MDEntryType (269) = z (No Statistics) followed by a series of Market Data Incremental Refresh messages with the most recent values for each type of added value data.

4.2   Loss of Mirror Gateway

In the event of a Mirror feed (Feed B) failing the Primary feed (Feed A) will continue to disseminate market data updates without any interruption to the service. However JSE Clients will not be able to arbitrate between the Primary and Mirror feeds until the entire service is reinstated.

4.3   Loss of both Primary and Mirror Gateways

If both the Primary and Mirror Gateways fail, both multicast feeds (A and B) will be stopped. This will be detected by JSE Clients with continuous missed heartbeats or any other messages in the multicast feed until the heartbeat expiry time. In such a situation, the JSE CSC should be contacted for guidance.

Regarding the TCP recovery and replay services, after six failed connection attempts (three on each gateway) if both Gateways are unreachable, the JSE CSC should be contacted for guidance.

Whilst the cause of the issue is being resolved by the JSE, JSE Clients will receive communication updates through the regular channels

4.4   Recovery after both Primary and Mirror Gateway failure

On recovering the gateways generally the Primary Gateway is recovered first. The behavior seen by the JSE Client is similar to when the Mirror gateway takes over after the failure of the Primary Gateway.

4.5   Other functionality related to Market Data Gateways

There are a maximum number of requests supported per Interface User (CompID) during a day for the Replay and Recovery services. JSE Clients may request the JSE to reset its login and request counts if the JSE Client exhausts the maximum allowed count. This feature is intended to help manage an emergency situation and should not be relied upon as a normal practice.

5 INDICES GATEWAY FAILURE

5.1 Loss of Primary Gateway

Following the failure of the Primary Gateway, the Primary multicast feed (A Feed) will be stopped automatically. In such a situation, JSE Clients have to stop arbitration of the multicast data and only expect the Mirror (B Feed) multicast feed.

Any TCP connection attempts to the Primary Gateway for Replay service will fail as it is not possible to connect to the service. In the case of an unexpected disconnection from the Primary Gateway, JSE Clients should attempt to re-connect to the Primary Gateway a total of 3 times, with 3 seconds in between each attempt before attempting to connect to the Mirror Gateway.

Likewise, if there are issues connecting to the Mirror Gateway a total of three connection attempts, with 3 seconds between them, the JSE Client should then immediately contact the JSE Customer CSC.

When the Mirror Index Gateway takes over from the failed Primary Gateway, the following should be expected by the JSE Clients:

- The Real-time Multicast UDP sequence number will be taken from the last sent message and incremented.

- The Replay service will be activated on the Mirror Gateway and JSE Clients should use the Mirror IP and port configuration to access this service

5.2 Loss of Mirror Gateway

In the event of a Mirror feed (Feed B) failing the Primary feed (Feed A) will continue to disseminate Index data updates without any interruption to the service. However JSE Clients will not be able to arbitrate between the Primary and Mirror feeds until the entire service is reinstated.

5.3 Loss of both Primary and Mirror Gateways

If both the Primary (Feed A) and Mirror (Feed B) Gateways fail, both multicast feeds (A and B) will be stopped. This will be detected by JSE Clients with continuous missed heartbeats or any other messages in the multicast feed until the heartbeat expiry time. In such a situation, the JSE Customer CSC should be contacted for guidance.

Regarding the TCP replay service, after six failed connection attempts (three on each Gateway) if both Gateways are unreachable, the JSE Customer CSC should be contacted for guidance.

Whilst the cause of the issue is being resolved by the JSE, JSE Clients will receive communication updates through the regular communication channels.

5.4 Recovery after both Primary and Mirror Gateway failure

On recovering the Gateways generally the Primary Gateway is recovered first. The behavior seen by the JSE Client is similar to when the Mirror Gateway takes over after the failure of the Primary Gateway.

5.5 Other functionality related to Indices Gateways

There are a maximum number of requests supported per Interface User (CompID) during a day for the Replay service. Recipients may request JSE to reset its login and request counts. This feature is intended to help manage an emergency situation and should not be relied upon as a normal practice.

6 NEWS GATEWAY FAILURE

6.1 Loss of Primary Gateway

Following the failure of the Primary Gateway, the Primary multicast feed (Feed A) will be stopped automatically. In such a situation, JSE Clients have to stop arbitration of the multicast data and only expect the Mirror (B Feed) multicast feed.

Any TCP connection attempts to the Primary Gateway for Replay service will get disconnected. In the case of an unexpected disconnection from the Primary Gateway, JSE Clients should attempt to re-connect to the Primary Gateway a total of 3 times, with 3 seconds in between each attempt before attempting to connect to the Mirror Gateway.

Likewise, if there are issues connecting to the Mirror Gateway a total of three connection attempts, with 3 seconds between them, the JSE Client should then immediately contact the JSE Customer CSC.

When the Mirror News Gateway takes over from the failed Primary Gateway, the following should be expected by the JSE Clients:

- The Real-time Multicast UDP sequence number will automatically be reset to 1.
- The Replay service will be activated on the Mirror Gateway and JSE Clients should use the Mirror IP and port configuration to access this service

6.2 Loss of Mirror Gateway

In the event of a Mirror feed (Feed B) failing the Primary feed (Feed A) will continue to disseminate News data updates without any interruption to the service. However JSE Clients will not be able to arbitrate between the Primary and Mirror feeds until the entire service is reinstated.

6.3 Loss of both Primary and Mirror Gateways

If both the Primary and Mirror Gateways fail, both multicast feeds (A and B) will be stopped. This will be detected by JSE Clients with continuous missed heartbeats or any other messages in the multicast feed until the heartbeat expiry time. In such a situation, the JSE Customer CSC should be contacted for guidance.

Regarding the TCP replay service, after six failed connection attempts (three on each gateway) if both gateways are unreachable, the JSE Customer CSC should be contacted for guidance.

Whilst the cause of the issue is being resolved by the JSE, JSE Clients will receive communication updates through the regular communication channels.

6.4 Recovery after both Primary and Mirror Gateway failure

On recovering the Gateways generally the Primary Gateway is recovered first. The behavior seen by the JSE Client is similar to when the Mirror gateway takes over after the failure of the Primary Gateway.

6.5 Other functionality related to News Gateways

There is a maximum number of requests i.e. 1000 < USER_MAX_REQUESTS_FOR_ REPLAY_CHANNEL > supported per Interface User (CompID) during a day for the Replay service. JSE Clients may request the JSE to reset its login and request counts if the JSE Client exhausts the maximum allowed count. This feature is intended to help manage an emergency situation and should not be relied upon as a normal practice.

7 INTERNAL COMPONENT FAILURE

The JSE System is made up of a number of software components, with the exact system response to failure varying from component to component. This section details the JSE system behaviour and the required action from JSE Clients in case of an internal component failure.

7.1 Loss of internal components

JSE Clients should be able to handle the following situations that may occur in the event of a failure.

- Temporary increase in message latency as a Primary component fails over to its Mirror component.

- Temporary reduction in system throughput as a Primary component fails over to its Mirror component.

- Complete loss of both Primary and Mirror in major components (e.g. Matching Engine) resulting in an automatic Session Halt for impacted instruments i.e. all JSE/NSX Instruments and any inbound messages for these instruments will be rejected at the Trading Gateways.

7.2 Recovery after loss of internal components

The recovery procedures and market control actions will vary according to the nature of the failure. Guidance with regard to these will be communicated to the market. JSE Clients will receive communication updates through the regular channels. JSE Clients should be prepared to carry out the following in the case of such situation.

- Carry out an Own Trade Download via a Trade Capture Report Request Message for the Interface User (CompID) through the Post Trade Gateway to confirm which trades have been confirmed and committed in the JSE System.

- Carry out an Own Order Book Download via an Open Order Download Message through the Drop Copy Gateway to reconcile their view of the open orders with that of the JSE System.

8   PRIMARY SITE FAILURE

8.1   Loss of Primary site

The JSE System will operate in cold standby mode in the JSE Remote DR site and in the event of total loss of the Primary site; the JSE will switch over to the JSE Remote DR site. The JSE is still confirming the length of time the switch over will take and will confirm this when the JSE has completed all its failover testing. Any market control actions and regular updates will be communicated to JSE Clients through the regular communication channels.

8.2   Recovery after Primary site failure

Once the JSE Remote DR site is active the JSE System will be re-started. The system will not have any previously published order or market data generated for the day after the restart. Following this, JSE Clients will be asked to connect to the JSE Remote DR Gateways. JSE will decide the session to start from following the recovery after a Primary site failure.

In the event of a disaster only trades that have been sent to JSE clients via a Trade Capture Report (TCR) from the Post Trade Gateway can be guaranteed to have been sent to the JSE System. JSE Clients should disregard any trades for which only an Execution Report has been sent prior to the disaster.

JSE Clients should re-connect to the designated Primary gateways using the Backup site IP addresses and ports given. All FIX message sequence numbers will automatically be re-set to 1 on the FIX gateways. JSE Clients must also reset their outgoing sequence numbers to 1 before reconnecting. Sequence numbers are not maintained for Client Initiated messages on the Native Gateways. The System cannot guarantee that any messages sent prior to the disaster will not be processed if the client outgoing sequence numbers are not re-set.

JSE Clients should note that no updated Execution Reports will be sent identifying those orders that have been deleted due to either 'Cancel on Disconnect' or the System clearing down order books as part of the recovery procedure. JSE Clients should cancel any open orders on their systems. Any requests for missed messages on the Native Gateway Recovery channel will not return any messages from the trading system. (A Message Request Ack and a Transmission Complete will be received without any messages being transmitted; this is the normal response on such a scenario.)

Once re-connected, it is recommended that all participants should do the following.

- Carry out an Own Trade Download via the Trade Capture Report Request (message for the Interface User (CompID) through the Post Trade Gateway to confirm which trades have been confirmed and committed in the JSE System.

- Carry out an Own Order Download via the Open Order Download Message through the Drop Copy Gateway to reconcile their view of the open orders with that of the JSE System.