Eurex Exchange’s T7

Release 4.0

Incident Handling Guide

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1. Introduction

1.1 Content of this document

This document provides a detailed description of the reaction of Eurex Exchanges's T7 trading system to technical incidents. It describes the reaction of T7 in scenarios either observed in the past (e.g. Matching Engine Failover) or to be expected in case of technical outages (e.g. Market Data failover).

The *Market Status Indicator* on the Eurex website (http://www.eurexchange.com) can serve as an early indicator for any major technical issues in the Eurex T7 system.

1.2 Usage Notes

Even though care has been taken to describe and illustrate known scenarios, the list may not be complete as yet unobserved failure modes might occur in the future

1.3 Further reading

The following Eurex Exchange's T7 documents provide additional information to complement the description given in this document:

- *Functional and Interface Overview*
- *Participant and User Maintenance – Manual*
- *Eurex Trader and Admin GUI – User Manual*
- *Eurex Enhanced Trading Interface – Manual*
- *Eurex Market and Reference Data Interfaces – Manual*
- *Eurex Extended Market Data Service – Manual*
- *Eurex Enhanced Order Book Interface – Manual*
- *Eurex Exchange and Eurex Clearing Network Access - Manual*

Some of the scenarios referred to in this document are also described in the Participant Simulation Guide and the days when they take place is indicated in the Simulation Calendar.

These and other documents providing information on Eurex Exchange's T7 can be found on the web site of Eurex by navigating to the topic *Technology > Eurex Exchange's T7 > System Documentation* and then selecting the relevant release:

http://www.eurexchange.com/exchange-en/technology/t7/system-documentation/release4

2. Concepts

Eurex Exchange's T7 is designed for highest availability and robustness. A guiding principle has been to architect the system in such a way that it can cope with failures of individual components with the minimal effect on the functioning of the market. This is achieved on the one hand by separating the market services into completely independent groups of products (partitions) and on the other hand via technical failover mechanisms.

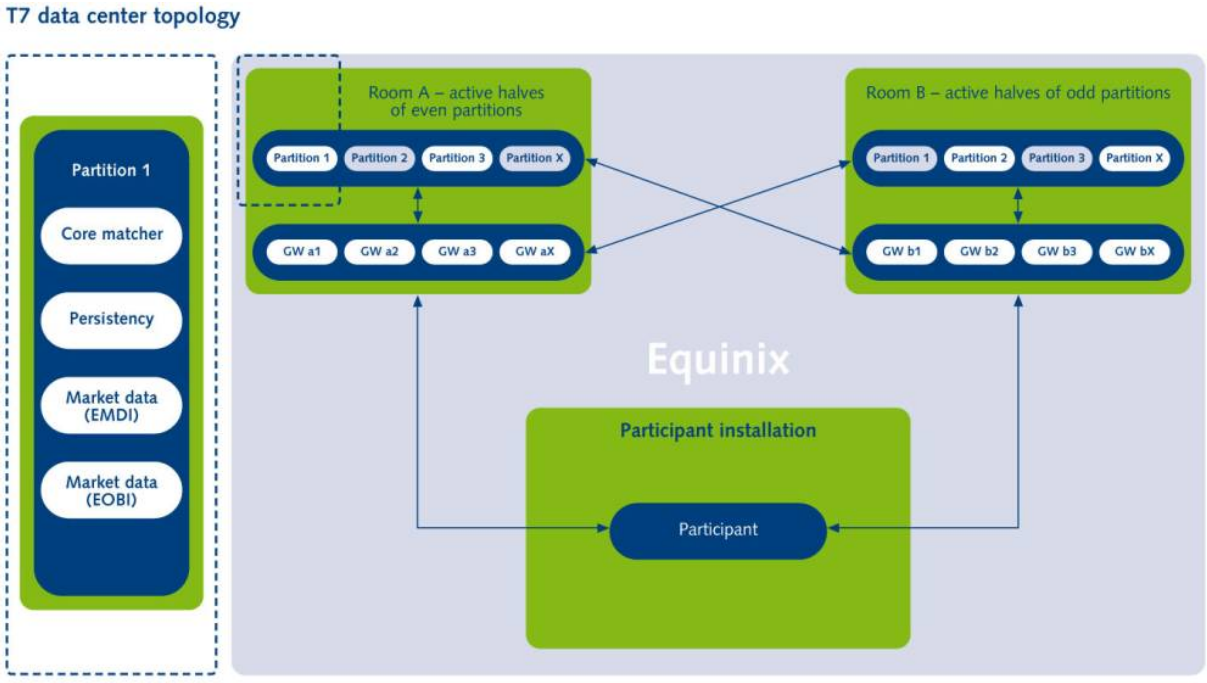
Central components (e.g. Matching Engine, Persistency layer, Trade Entry Service) have a standby partner that takes over immediately when the primary component fails. In most cases this ***failover*** is realized transparently, i.e. without visible impact on any of the T7 interfaces. In case of a non-transparent failover the visible effect on the affected interfaces is described in the following sections.

The T7 system is not prepared to automatically handle the simultaneous failure of primary and standby partner – a double failure of a central component. The component shows then a complete ***failure***. Such incidents are not resolved transparently and require manual interception from T7 operations. The scenarios have a longer impact on interfaces and service availabilities than transparent or non-transparent failover scenarios. In such situations as a general advice members should follow the Eurex exchanges Newsboard messages via ETI News Broadcast, T7 Trading GUI Newsboard or the Newsboard Webpage:

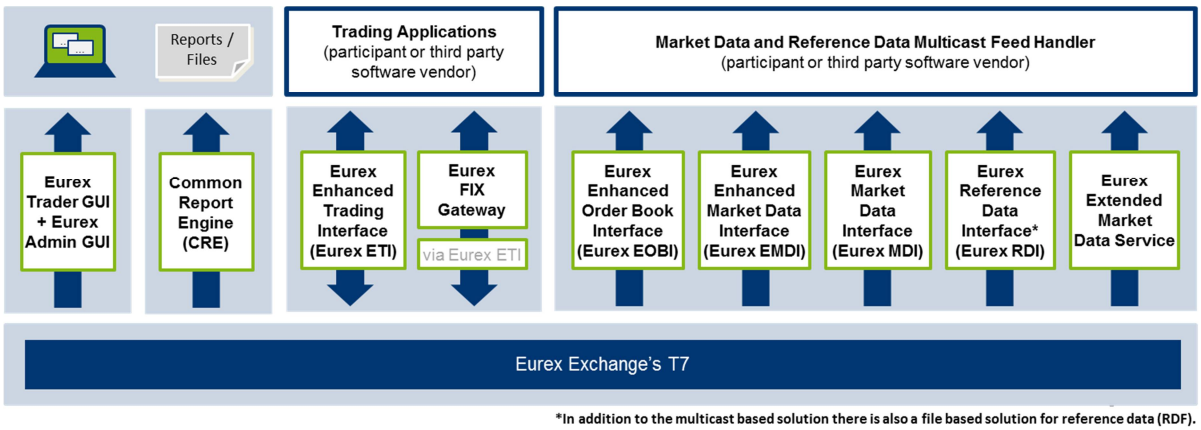
http://www.eurexchange.com/exchange-en/trading/production-newsboard

The standby partner concept is not used for any of the T7 Gateways. A failure of one of these components always requires member interaction, usually reconnecting an affected trading session to a different Gateway. The T7 system provides for all session logins the possibility to use one of two assigned Gateways selected from one of the redundant backend rooms A or B. This ensures exchange connectivity even in the case a member looses one of its network connection to one of the Eurex Exchange's T7 backend rooms.

The concept of two redundant backend rooms also guarantees Eurex service availability in case a complete room in the data center has a major technical outage. The primary and secondary partners of central processing components are always deployed in different rooms to ensure full exchange functionality in case of a room outage. The schematic overview of this principle is shown in the following picture:



The remainder of this document describes now failover and failure scenarios and how they materialize on the T7 Interfaces depicted in the overview below. If not stated otherwise the scenarios describe the behavior of market services for one partition.



From these interfaces the Eurex FIX Gateway and the Eurex Extended Market Data Service interfaces are not yet covered within this document.

The Eurex RDI interface has the same technical interface and behavior as the MDI interface for all described scenarios and is for the remainder of this document not explicitly mentioned.

The Common Report Engine interface is not affected by any of the described scenario and thus not included in any of the descriptions.

3. Scenarios

The following section describes the individual scenarios and the reaction of Eurex Exchange's T7 mainly from an interface point of view.

3.1 Gateway Failure

Eurex Exchange's T7 is currently accessible via a number of High Frequency (HF) and Low Frequency Gateways (LF). A Gateway service might become unavailable for reasons such as hardware failure, network outages or software problems.

In the event of a Eurex ETI Gateway failure, active sessions will be disconnected. The failure of the Gateway component will be detected and all quotes and non-persistent orders of sessions logged in via the failed Gateway will be deleted[1] by the T7 system.

3.1.1 ETI Interface

A failure of a Gateway leads to the termination of the TCP connection. The T7 System will recognize the failure of the Gateway and will not offer its IP address upon next login, i.e. all sessions logging back in will be presented with the IP address of an alternative Gateway IP address from the same backend room, either A or B.

3.1.2 Market Data – Eurex Enhanced Orderbook Interface (EOBI)

There is no special message for a failure of a Gateway. However as all orders from sessions connected via the failed Gateway will be deleted, a lot of *Order Delete* updates are expected.

3.1.3 Market Data – Enhanced Market Data Interface (EMDI)

There is no special message for a failure of a Gateway. However as all orders from sessions connected via the failed Gateway will be deleted, multiple price levels may see a reduction of size.

3.1.4 GUI

A failure of a Gateway is not indicated via the GUI. Secondary effects, i.e. order deletions of non-persistent standard orders will be visible in the order views.

3.1.5 Best Practice

If an active Eurex ETI session is disconnected, for any reason, the participant application should reconnect to the Connection Gateway, send a *GatewayRequest* message, and then connect to the new received Gateway assignments.

In a failover scenario sessions might be directed to Gateways they were not assigned to when the sessions were initially ordered. It is thus strongly recommended to not rely on initial session-to-Gateway assignments.

3.2 Stalled Gateway

Parts of the Gateway might became inaccessible, e.g. a stalled but the TCP connection is not closed or reset. In this case the auto deletion of orders and quotes may be delayed. We therefore recommend taking actions to ensure the status of the orders.

A two-way stalled TCP connection or internally locked up Gateway can be detected by missed ETI heartbeat messages from the Gateway.

[1] For the case a Gateway failure is not (immediately) detected see Section 3.2 Stalled Gateway

A half open TCP connection (only the Gateway receive side does not work anymore) is arguably hard to detect since ETI heartbeats from the Gateway are still received. A Participant's application may detect this stalled connection by lack of responses within a reasonable time while other activity on other sessions or market data indicate a working T7 system for the respective product .

3.2.1 ETI Interface

In case of a two-way stalled TCP connection no ETI heartbeat messages are received from the Gateway but the TCP connection itself is not closed.

3.2.2 Market Data – Eurex Enhanced Orderbook Interface (EOBI)

There is no effect on EOBI data dissemination.

3.2.3 Market Data – Enhanced Market Data Interface (EMDI)

There is no effect on EMDI data dissemination.

3.2.4 GUI

There is no visible effect in the Trader or Admin GUI.

3.2.5 Best Practice

In case a stalled Gateway is suspected the TCP connection to it should be terminated and the according session should try to re-login, An application should not use the stalled Gateway but an alternative Gateway received in the *GatewayResponse* from the Connection Gateway. If the session is still logged in because of the stalled Gateway the re-login might fail, but the login attempt will trigger cancellation of all non-persistent orders (either lean or standard orders) and quotes for that session. If any orders or quotes were to be deleted, this event will be denoted with *MassActionReason (28721): 7 = "Duplicate Session Login"* in *Order/Quote Mass Cancellation Notification* via listener or session data.

If the above logon request is not answered the T7 Trading GUI can be used to delete pending orders and quotes in the *Risk Control* view to delete all orders (per user) or to delete all quotes (per session).

As a last resort call Eurex Market Supervision to delete any pending orders and quotes.

3.3 Matching Engine failover

A matching engine failover is not fully transparent but always implies a market reset. In case the primary matching engine fails, the secondary component will take over by loading the persistent orders from the persistency layer and trading continues after a market reset - all non persistent orders and quotes are deleted. Please also refer to the section 'Matching Engine Failover and Failure' in the Simulation Guide.

3.3.1 ETI Interface

A **ServiceAvailabilityBroadcast** message indicates the MatchingEngineStatus on partition <x> is unavailable. The data below is for partition 1 (FDAX)

```
ServiceAvailabilityBroadcast.PartitionID = 1
ServiceAvailabilityBroadcast.MatchingEngineStatus = 0
```

Incoming messages for this service are from now on rejected directly in the Gateway.
A market reset is issued via a TradingSessionStatusBroadcast message:

```
TradingSessionStatusBroadcast.RBCHeaderME.PartitionID = 1
TradingSessionStatusBroadcast.TradSesEvent = 102
```

All products that are not in state "*continuous trading*" when the primary matching engine fails are set to product state *"Halt"*. Also products in state "*continuous trading*" are set to state "Halt" if the failover process takes longer than a specific (per product) timeframe.

When the secondary matching engine took over this will be signaled by another **ServiceAvailabilityBroadcast** message with availability set to 1 for the partition:

```
ServiceAvailabilityBroadcast.PartitionID = 1
ServiceAvailabilityBroadcast.MatchingEngineStatus = 1
```

Trading then continues..

3.3.2 Market Data– Eurex Enhanced Orderbook Interface (EOBI)

The market reset is communicated via an *Order Mass Delete* message. This is then followed by *Order Add* messages of all persistent (non deleted) orders in the book.

3.3.3 Market Data – Enhanced Market Data Interface (EMDI)

The change in the order book is communicated via a *DepthIncremental* message. Usually there will be changes on multiple price levels because of the market reset.

3.3.4 GUI

Afore mentioned *ServiceAvailability* changes are indicated in the GUI status bar and displayed in detail in the Newsboard window. Submitting orders for the affected partition during the failover time is not possible and requests will be rejected.

The changed order book is displayed in corresponding market overviews and any product state change to "*Halt*" is indicated additionally in the Newsboard view.

3.4 Matching Engine Processing Delay

Large processing delays in the T7 matching engine (caused e.g. by technical problems or unexpected extreme loads) may lead to the built-up of internally queued orders. To avoid processing of old orders and to quickly recover from such a delay situation the affected products change to an internal "not tradeable" state. The incident is automatically detected and for the relevant products the following actions are taken:

- All non-persistent orders and quotes are deleted
- The product is temporarily set to an internal "not tradeable" state and session data and listener broadcasts are sent. The product is not set to *"Halt"*
- For a minimum time frame (currently configured to 10 seconds) and until the delayed processing is resolved all transactions will be rejected except for order deletions
- Once the situation is resolved this is communicated via session data and listener broadcasts

Please also refer to section 'Matching Engine Processing Delay' of the Simulation Guide.

3.4.1 Order Entry (ETI)

Deleted orders and quotes on entering the "not tradeable" state of a product are reported via session data. Additionally product-specific *DeleteAllOrderQuoteEventBroadcast* messages are received for the affected product(s) with *MassActionReason* set to *Product_temporarily_not_tradeable(11)*.

During the delay phase all transactions except deletions are rejected with *SessionRejectReason* set to *Service_Temporarily_Not_Available(102)* and VarText *TRANSACTION REJECTED DUE TO SLOW PARTITION*

When the matching engine will accept transactions again participants will be informed by a *TradingSessionStatus* message (*MsgType (35) = "h"*) specifying *TradSesEvent (1368) = Service Resume (105))*.

3.4.2 Market Data – Eurex Enhanced Orderbook Interface (EOBI)

There is no special message for a matching engine processing delay, but a lot of deleted orders and quotes are expected.

3.4.3 Market Data – Enhanced Market Data Interface (EMDI)

There is no indicator for a currently not tradeable product because of processing delays. Due to the deleted orders changes on multiple price levels are expected.

3.4.4 GUI

Order deletions are visible in the views for the affected products Order submissions for affected products will be rejected with *TRANSACTION REJECTED DUE TO SLOW PARTITION*.

3.4.5 Best Practice

If an ETI trading session receives a *Product_temporarily_not_tradeable* message (see 3.4.1) submission of new orders should be avoided until the *Service Resumed* notification is encountered since new order flow will only exacerbate the solution of the delay problem and the orders will be rejected anyway. Deletion of non persistent orders and quotes already took place so any clean-up can be limited to the deletion of persistent orders if necessary.

3.5 Market Data failover – MDI, EMDI and EOBI

In the event of a failure of a market data disseminator the standby component will take over as soon as the failure is detected. The failover will be completely transparent on all streams other than the failed stream.

Please also refer to section ‘Matching Engine Failover and Failure, EOBI Failure’ of the simulation guide.

3.5.1 Order Entry (ETI)

No reaction to the failed market data components.

3.5.2 Market Data – Eurex Enhanced Orderbook Interface (EOBI)

A change of source IP of the affected multicast streams will happen as the secondary takes over. The *ApplSeqNum* in the packet headers is reset to 1 while the *MsgSeqNum* continues to be incremented, ideally without any gap.

3.5.3 Market Data – Market Data Interface (MDI)

A change of Source IP of the affected multicast streams will happen as the secondary takes over. The *SenderCompID* changes and the *PacketSeqNum* as well as the *MsgSeqNum* for affected products are reset to 1.

3.5.4 Market Data – Enhanced Market Data Interface (EMDI)

A change of Source IP of the affected multicast streams will happen as the secondary takes over. The *SenderCompID* changes and the *PacketSeqNum* in the packet headers is reset to 1. The *MsgSeqNum* remains contiguous.

3.5.5 GUI

There is no visible effect in the Trader or Admin GUI.

3.6 Persistency layer failover

In Eurex Exchange's T7 the persistency layer is running separately from the matching engine to ensure lowest latency and highest throughput. The Services *TradeManager* (trade broadcast recovery) and *ApplSeq* (order status broadcast recovery) are the visible interface parts of the persistency layer and both services are deployed with a standby partner that takes over processing in case the primary component fails.

The failover of these components is completely transparent on all interfaces but sometimes duplicate or missing messages (gaps) might occur on an affected broadcast stream due to the failover. Handling of gaps and duplicates on these streams are already implicitly covered by the ETI application protocol via gap detection plus retransmission and duplicate detection.

Potential message gaps might occur on sequence number based broadcast streams but will not happen for message key based streams.

3.7 Central component failure

The T7 system design caters for an outage of single central component via failing over to a standby process. The complete failure of central component on a trading partition is thus very unlikely.

A central component is the matching engine, EMDI, MDI, EOBI or one of the services form the Persistency Layer (see section 3.6), but not the Trade Entry Service. If any of these components experience a failure, trading on that partition is stopped and the matching engine service becomes unavailable for that partition.

Resolving the situation requires in all cases manual intervention of T7 operations and will take considerably longer than a few seconds because a restart of the matching engine is needed. When the trading services are re-enabled initially all products on the affected partition are in product state *"Halt",* non-persistent orders and quotes are deleted and trading continues with an initial auction.

Though the matching engine service will be disabled when a central component fails it depends on the type of failed component in which order (and when) other services on that partition become unavailable between the incident and the re-start. For example if the *ApplSeqStatus* service from the Persisteny Layer fails the *TradeManagerStatus* might still be available and usable for a while until the manual shutdown is triggered. A market reset from the matching engine (see also section 3.3) is also not triggered until the restart, but since the matching engine service is unavailable no orders can enter the system in the meantime.

3.7.1 Order Entry (ETI)

A central component failure manifests itself in a **ServiceAvailabilityBroadcast** message indicating at least the *MatchingEngineStatus* on partition <x> is unavailable. The data below is for partition 1 (FDAX)

```
ServiceAvailabilityBroadcast.PartitionID = 1
ServiceAvailabilityBroadcast.MatchingEngineStatus = 0
```

Depending on the type and order of failure unavailability indications for *ApplSeqStatus* and *TradeManagerStatus* are received in the same or additional **ServiceAvailabilityBroadcast** messages.

After a successful restart of all services this will be signaled by another **ServiceAvailabilityBroadcast** message with *MatchingEngineStatus* availability set to 1 for the partition (and when available also for the other services):

```
ServiceAvailabilityBroadcast.PartitionID = 1
ServiceAvailabilityBroadcast.MatchingEngineStatus = 1
```

Trading continues always with a market reset, all products set to product state *"Halt"* and an auction afterwards.

3.7.2 Market Data – Eurex Enhanced Orderbook Interface (EOBI)

If the EOBI component is the failed central component no further snapshots will be received for products of the affected partition. In case another component failed just no new data is received.

After the re-start the *ApplSeqNum* and *MsgSeqNum* in EOBI messages are both reset to 1 and the field A*pplSeqResetIndicator* is set to indicate the restart. A *Depth Incremental* message on the incremental feed is sent that contains a full refresh of the Trade Statistics as normally seen only distributed on the snapshot stream. The market reset is communicated via an *Order Mass Delete* message. This is then followed by *Order Add* messages of all persistent orders in the book.

3.7.3 Market Data – Enhanced Market Data Interface (MDI,EMDI)

If the EMDI component is the failed central component no further snapshots will be received for products of the affected partition. In case another component failed no new data is received, but snapshots are still received.

There is no impact on MDI other than no new data is received for affected products.

After the re-start the *SenderCompID* will change and the *PacketSeqNum* and *MsgSeqNum* in the packet headers are reset to 1.

3.7.4 GUI

The Service Availability changes are indicated in the GUI status bar and displayed in detail in the Newsboard. Submitting orders for the respective partition during the failure time is not possible and requests will be rejected.

The changed order book on restart is displayed in corresponding market overviews and the product state change to *"Halt"* on restart is indicated additionally in the Newsboard view.

3.7.5 Best Practice

Recovery from a central component failure requires manual intervention by T7 operations and may take a considerable amount of time. The market situation and reopening of the market may include additional explanations and planning from the Eurex exchange side. Members are strongly advised to follow the Eurex exchanges Newsboard messages via ETI News Broadcast, T7 Trading GUI Newsboard or the Newsboard Webpage:

http://www.eurexchange.com/exchange-en/trading/production-newsboard

3.8 Trade Entry Service failover and failure

When the primary component of the Trade Entry Service fails the standby component takes over in a fully transparent way. The Tarde Entry Service broadcasts streams might reveal missing messages (gaps) or messages received twice. The streams are sequence number based so both effects are already implicitly covered by the application protocol via gap detection plus retransmission and duplicate detection.

In case of a complete failure of the Trade Entry Service the according trade- and retransmission services become unavailable. Re-enabling the service requires manual intervention of T7 operations and will take considerably longer than a few seconds. On re-start of the services after a failure all TES products on that partition are initially in TES product state *OFF*.

3.8.1 Order Entry (ETI)

There is no visible impact at the ETI interface in a failover situation except for possibly duplicated or missing broadcast messages.

In case of a failure a **ServiceAvailabilityBroadcast** message indicates the TradeEntryService and its broadcast retransmission service on partition <x> is unavailable. The data below is for partition 1 (FDAX)

```
ServiceAvailabilityBroadcast.PartitionID = 1
ServiceAvailabilityBroadcast.TradeEntryServiceTradeDate = 0
ServiceAvailabilityBroadcast.TradeEntryServiceRtmTradeDate = 0
```

During the service downtime all request submissions to the TradeEntryService or the according TradeEntryServiceRtm (broadcast retransmission service) are rejected.

Once the service is available again an according **ServiceAvailabilityBroadcast** message is distributed with the availability set to 1.

3.8.2 Market Data – Eurex Enhanced Orderbook Interface (EOBI)

No visible impact on EOBI.

3.8.3 Market Data – Enhanced Market Data Interface (EMDI)

No impact on EMDI on failover.

On re-start after a failure the initial product states for TES products are reported.

3.8.4 GUI

The Service Availability changes are indicated in the GUI status bar and displayed in detail in the News board. Submitting orders for the failed Trade Entry Service during failure time is not possible and such requests will be rejected.

3.8.5 Best Practice

After a complete failure and restart of the Trade Entry Service applications should check the highest available sequence numbers for all affected broadcast streams and close any potential gaps afterwards via retransmission requests.

3.9 GUI unavailability

When the infrastructure of the T7 GUI is not available client sessions will be potentially logged out and presented with the Login View. Until the infrastructure is available again no login attempts will be successful.

3.9.1 Order Entry (ETI)

There will be no effect on ETI sessions.

3.9.2 Market Data – Eurex Enhanced Orderbook Interface (EOBI)

There is no effect on EOBI data dissemination.

3.9.3 Market Data – Enhanced Market Data Interface (EMDI)

There is no effect on EMDI data dissemination.

3.9.4 GUI

Usage of the GUI is not possible and logins will fail.

3.9.5 Best Practice

Members are advised to follow the Eurex exchanges Newsboard messages via ETI News Broadcast or the Newsboard Webpage. Any news about the expected downtime or availability of the T7 GUI will be reported here:

http://www.eurexchange.com/exchange-en/trading/production-newsboard

4. Change log

No	Chapter, page	Date	Change
V1.0	General	25-07-2016	Creation