

Document title

EURONEXT CASH MARKETS – OPTIQ® OEG THROTTLING MECHANISM

Document type or subject

Optiq OEG Throttling Mechanism - Functionality Description

Version number

2.2

Date

23 Nov 2018

Number of pages

28

Author

EURONEXT

This document is for information purposes only. The information and materials contained in this document are provided 'as is' and Euronext does not warrant the accuracy, adequacy or completeness and expressly disclaims liability for any errors or omissions. This document is not intended to be, and shall not constitute in any way a binding or legal agreement, or impose any legal obligation on Euronext. This document and any contents thereof, as well as any prior or subsequent information exchanged with Euronext in relation to the subject matter of this presentation, are confidential and are for the sole attention of the intended recipient. Except as described below, all proprietary rights and interest in or connected with this publication shall vest in Euronext. No part of it may be redistributed or reproduced without the prior written permission of Euronext. Portions of this presentation may contain materials or information copyrighted, trademarked or otherwise owned by a third party. No permission to use these third party materials should be inferred from this presentation.

Euronext refers to Euronext N.V. and its affiliates. Information regarding trademarks and intellectual property rights of Euronext is located at <https://www.euronext.com/terms-use>.

PREFACE

PURPOSE

This document provides details of the throttling mechanism for the Optiq® Order Entry Gateways (OEG).

This document is a supporting document for other technical specifications made available for Optiq, some of which are listed in the section Associated documents.

ASSOCIATED DOCUMENTS

The following list identifies the associated documents, which either should be read in conjunction with this document, or which provide other relevant information to the clients:

- Euronext Cash Markets – Optiq OEG Client Specifications – SBE Interface
- Euronext Cash Markets – Optiq OEG Client Specifications – FIX 5.0 Interface
- Euronext Cash Markets – Optiq Kinematics Specifications
- Euronext Cash Markets – Optiq & TCS Error List
- Euronext Cash Markets – Optiq OEG Connectivity Configuration Specifications
- Euronext Cash and Derivatives Markets – Optiq File Specification
- Euronext Cash Markets - OEG Cancel on Disconnect (CoD) Functional Overview

Clients are advised to also refer to the Euronext Rules and Regulations documents for more details.

For the latest version of documentation please visit <http://www.euronext.com/optiq>

SUPPORT

Optiq Support Desk

Tel: +33 1 70 48 25 55

Email: optiq@euronext.com

DOCUMENT & REVISION HISTORY

For the details of this and previous updates of this document please refer to the [Appendix](#) at the end of this document.

Version	Change Description
2.2	Parameter updates

CONTENTS

- 1. INTRODUCTION4**
- 1.1 Glossary.....4
- 2. OEG THROTTLING MECHANISM IN OPTIQ6**
- 2.1 Main Concepts & Limits6
- 2.1.1 Summary of Formulas.....7
- 2.1.2 Private Messages Used by the OEG Throttling Mechanism7
- 2.1.3 Use of the Bucket Concept7
- 2.1.4 Notes on rounding.....8
- 2.2 OEG Throttling Interaction with Other Mechanisms & Components of Optiq.....8
- 2.3 Details of OEG Throttling8
- 2.3.1 Queue vs. Reject8
- 2.3.2 Communication of Throttling Events.....9
- 2.3.3 Behavior in Case of Queueing.....9
- 2.3.4 Behavior in Case of Rejection10
- 2.3.5 Behavior for Excessive Breach of Rate11
- 2.3.6 Behavior on Intra-session Disconnection11
- 3. ASSOCIATED GUIDELINES FOR CLIENTS12**
- 3.1 Measures to be Adopted Following an OEG Throttling Event12
- 3.1.1 Over the OEG Throttling Limit (Queueing)12
- 3.1.2 Over the Throttling Queue Size (Queueing)12
- 3.1.3 Over the OEG Throttling Limit (Rejection).....13
- 3.1.4 System Busy (Rejection)13
- 3.1.5 Excessive Breaches of Rate.....13
- 3.2 How to Avoid being Throttled & Examples15
- 3.2.1 Flooding, in Queueing Case16
- 3.2.2 Queueing Cases17
- 3.2.3 Rejection Cases.....23

1. INTRODUCTION

The Optiq Order Entry Gateway (OEG) provides high-speed and real-time connection to the Exchange markets. Objectives of OEG throttling are similar to those found in any system that has to manage high amount of message exchange with multiple participants, to

- Regulate message / data traffic by evening out the concentration flow of messages, and distributing the use of available system processing ability and bandwidth across all users of the system
- Help minimize or limit message exchange and processing congestion, which assists in ensuring latency of the trading system remains stable and predicable
- Reduce the risk of disruptive events

Furthermore, for a trading venue OEG throttling mechanism allows to:

- Prevent disorderly trading conditions and detect potential threats to the orderly functioning of the market
- Ensure compliance with the articles in MIFID II supplementing Directive 2014/65/EU of the European Parliament and of the Council with regard to regulatory technical standards specifying organizational requirements of trading venues (*a.k.a. RTS7*)

The Optiq throttling solution is built to provide flexibility and predictability.

- **Flexibility:** clients can choose how many messages they can send (vs. how often) to avoid being throttled
- **Predictability:** in most cases clients can use the concepts and formulas provided to calculate the number of messages and time required, without having to wait for Optiq to send them specific messages

This document provides information about the Throttling mechanisms for the OEG implemented in Optiq and details of:

- throttling mechanism supported by the OEG
- concepts, limits and formulas that support client's ability to manage their message flow in order to:
 - avoid being throttled,
 - be informed of the reason their messages were throttled
- recommended practices in using the OEG in most optimal way

The scope of this version of the document covers OEG throttling mechanism for the Cash markets hosted on Optiq.

1.1 GLOSSARY

This section provides a list of some terms & abbreviations commonly used in this document. Please note that some of these terms are described in more details in the dedicated sections within this document or in the associated Optiq specifications documents.

- **Order Entry Gateway (OEG):** is the software that manages the access for exchanges' clients, and acts as the private interface between the clients and the Optiq matching engine.
- **Market Data Gateway (MDG):** is the software that provides high-speed, real-time market data (public messages) for the Exchange's markets.
- **Matching Engine (ME):** is the software that manages the trading services for the Exchange's markets.

- **Optiq Segment:** defines a universe of instruments habitually sharing common trading properties. An Optiq Segment can contain one or several asset classes. An Optiq Segment access is setup through a Logical Access.
- **Partition:** is a technical subdivision of an Optiq Segment. An Optiq Segment may be comprised of at least one or several partitions, physically independent one from another, but connected to each other within the context of the Optiq Segment. Instruments may move from one partition to another within an Optiq segment.
- **Logical Access:** is an OEG (Order Entry Gateway) entry point, setup for clients to connect to a single Optiq Segment, containing the technical configuration for the client's connectivity. Multiple logical accesses can share the same SFTI line.
- **OE Session:** the individual physical connection, to a single Partition. A single Logical access may have as many OE sessions as there are partitions in the Optiq segment.

2. OEG THROTTLING MECHANISM IN OPTIQ

Sections below provide high level descriptions of the OEG throttling concepts and features in Optiq.



Important note: Clients are strongly encouraged to review the explanations provided in the various OEG and MDG specification, Connectivity specifications and kinematic documents in detail before continuing with this document

2.1 MAIN CONCEPTS & LIMITS

The section below provides details on the concepts and limits used for OEG throttling. Please note that some of the concepts listed below have further explanations in dedicated sections within this document.

- **Overall throughput limit / Per second Rate:** the max number of messages setup as the rate for the Logical Access, and used by its physical connections
Example: 100 messages per second
 - Client connections cannot go over this limit defined as their rate within a second. This is accomplished mechanically, as the more granular size / time management of throttling limit will keep the overall throughput within the rate limit
- **Max burst (or bucket) size:** the max number of messages that a client may send at once before being throttled, in a single “burst” of messages (measured in number of messages).
 - represents a constant figure, calculated as a fraction of the overall throughput limit
- **Time to replenish [a single message]:** time needed for a single token to be added into the bucket
 - This time equals to: 1 divided by the client’s rate (1/throughput)
Example: if client’s rate is 100 messages per second, then Time to replenish will be $1/100 = 0.01$ second
- **Token:** Represents the system’s ability to process 1 message. 1 token gives the right to send 1 message
- **Bucket:** is a measuring mechanism used to calculate how many messages can still be sent and when, in order not to be throttled. The bucket doesn’t store any messages. All messages are stored in the queues
 - Size of the bucket: Bucket is currently 100% of the client rate per second, and is measured in tokens
 - The bucket size is the maximum number of messages that can be sent at once (or a burst)
 - Messages in the bucket start being used upon client sending a single application message to the OEG, as such the bucket use employs the concept of the sliding window
- **Scope of Messages for Throttling:**
 - All **application** messages are in scope of throttling (no exclusion list), including those rejected by the OEG for non-throttling reasons. Each application message uses up an available token. This is the main level of throttling in the mechanism.
 - All **administrative** messages and **technically invalid** messages are out of scope of main throttling mechanism, but do contribute to the anti-flooding mechanism
 - All messages are in scope of the anti-flooding mechanism

2.1.1 Summary of Formulas

Concept / Limit	Formula
Throttling queue – Ts (messages)	For Queuing – 2 x Rate (size) of connection For Rejection - Zero
Size of the Bucket – Sb (messages) This is the allowed burst size, i.e. max number of messages a session can send in a row before the throttling kicks in.	100 % of the rate
Replenish Time (to replenish single token [Tr] (seconds))	1/throughput **
Maximum # of “burst” messages to send at once (messages)	Equal to Sb
Wait time to send 1 (more) message (seconds)	1/throughput
Wait time to send “X” messages	(1/throughput) * X (messages)
Max messages before rejection (messages)	Ts + Sb

** Rounding is clarified in the section below

2.1.2 Private Messages Used by the OEG Throttling Mechanism

Optiq supports the following sub-set of private OEG messages that participate in the process of (i) throttling, (ii) settings of throttling configuration, and (iii) communicating the reasons for throttling event or disconnection.

Message Name	SBE Message Code	FIX Message Code	Details
Logon	100	A	Used to select queue vs. reject behavior for throttling
Technical Reject	108	3	Used to indicate rejection of messages due to throttling, and the reason throttling event occurred This message is not sent to Drop Copy
Logout	103	5	Used to indicate reason for disconnection in case of anti-flooding

For more details about these messages clients are advised to review the OEG client specifications for SBE and FIX protocols.

2.1.3 Use of the Bucket Concept

- Each message sent to the OEG uses up a token
- The maximum size of the bucket is always constant. The size of bucket never goes above the maximum size, even if client does not send any messages for a long period of time
 - Any tokens above the size of the bucket disappear, i.e. fall out of the bucket and are not counted
- On every logon bucket is full, allowing them to immediately start sending messages.
 - i.e. client can send a burst of the full bucket size following logon
- When choosing bursts, clients are free to choose the size of their bursts as long as the bursts don't exceed the bucket size, and wait for replenishment before sending the next burst. Both policies can also be combined, taking into account the same two constraints.
- If the bucket is empty, client messages are either rejected or stored in a throttling queue
- 1 token is put back into the bucket (replenished) after a single period of time equal to “Time to Replenish” has passed

- The number of messages in the bucket is replenished continuously up to the maximum size of the bucket, independently of whether client submitted new messages or has been inactive for a long period of time

2.1.4 Notes on rounding

The replenish time is $1/\text{Throughput}$.

For instance, if Throughput is equal to 375 messages/second, the token will be put back into the bucket every 0.002666666666666666666666666666667 seconds round down to the lower nanosecond, that is 2666666 nanoseconds (2,666666 milliseconds).

2.2 OEG THROTTLING INTERACTION WITH OTHER MECHANISMS & COMPONENTS OF OPTIQ

- **High Availability (HA):** OEG throttling mechanism works in the same manner on the Mirror instance of the OEG, in any HA scenario, as it does on the Primary instance, with identical settings and limits.
In the case of disruptive incident that triggers an HA event, any messages that were in a throttling queue are dropped, without further notification to the client.
- **Business Continuity:** OEG throttling mechanism works in the same manner in the Disaster Recovery environment as it does in Production, with identical settings and limits.
In the case of a Business Continuity event, any messages that were in a throttling queue in Production environment are dropped, without further notification to the client.
- **MDG:** OEG throttling and associated messages are not reflected in any public messages.
- **Drop Copy:** OEG throttling does not apply to Drop Copy gateways.

2.3 DETAILS OF OEG THROTTLING

The sections below provide the details associated to the OEG Throttling mechanism, associated concepts and limits.

2.3.1 Queue vs. Reject

At log on, clients choose whether to queue or to reject messages once the throttling limit is reached.

In the **Logon** (100) / (FIX A) message, the field used is

- SBE: *Queueing Indicator*
- FIX: *QueueingIndicator* (tag: 21020)

Where values used are:

- **0** – False, which indicates clients wish to Reject over the limit messages
- **1** – True, which indicates clients wish to Queue over the limit messages

If client chooses to Reject – any limit breached will result in a rejection message.

If client chooses to Queue – over the limit messages are stored in a limited size Throttling queue.

Please note – any messages rejected due to throttling are not read by the OEG. **The sequence number of rejected messages is not taken into consideration by the OEG.** If clients do not take this into account on the FIX protocol, a gap in the sequence number will occur. When sending messages after being rejected, the OEG will initiate the standard FIX protocol mechanism for reset of sequence / gap fill.

2.3.2 Communication of Throttling Events

In case of any rejection due to OEG throttling, Optiq sends the following rejection messages & codes:

- In SBE, clients receive **TechnicalReject** (108) message, where the field *Error Code* is set with the value indicating the reason throttling event has occurred.
- In FIX, clients receive **Reject** (3) messages, where the field *SessionRejectReason* (tag: 373) is set with the value indicating the reason throttling event has occurred.

Three types of rejection are possible in OEG throttling. The table below provides the correspondence of values used for these three types of rejection in SBE and FIX:

SBE Error Code	FIX SessionRejectReason (373)	Description of the OEG Throttling Rejection
2085 = Rate exceeded	26 = Throttling Rate exceeded	Individual message sent is over the limit allocated to the Logical Access. This rejection occur when client chose to Reject over the limit messages
2087 = Throttling queue full	25 = Throttling queue full	This rejection occurs when client choses to Queue over the limit messages, and after the initial throttling queue limit based on the rate is breached, and the throttled messages are stored in the throttling queue, the limit of the queue has also been breached.
2086 = System busy	27 = System busy	This rejection may occur when client chose to Reject over the limit messages, and the system is overloaded by processing of previously sent messages and can't accept more messages until the processing has finished.

2.3.3 Behavior in Case of Queueing

After a client's OEG throttling limit is breached, and the client chose to queue their messages, over the limit messages are stored (or queued) in a buffer called throttling queue.

From the throttling queue:

- messages are processed one at a time at a pre-defined period of time (replenish time)
- messages being processed from the queue are
 - considered as activity, and during 1 second do not strictly require client sending a heartbeat
 - consume 1 token for each messages processed from the queue

While messages in the throttling queue are processed:

- the client may submit additional messages which will also be stored in the throttling queue, until the queue limits have been reached
- as throttling queue is limited in size to the maximum of the throughput,
 - **any messages over the queue size are rejected**, even if the client chooses to queue their messages
 - as soon as a single message is processed from the throttling queue, and a replenish time has passed, the client's next submitted messages will be added to the throttling queue
 - clients do not receive a specific notification message for messages that were queued, however the acknowledgement messages have a field that indicates that the message in question was queued due to throttling
 - ◆ SBE: **Ack (03)** message contains a field *Ack Qualifiers*, one of the positions of which is used for the Queue Indicator. For messages that were queued due to OEG throttling this position is set to one (1)
 - ◆ FIX: **ExecutionReport (8)** message contains a field *AckQualifiers* (tag: 21014), one of the positions of which is used for the Queue Indicator. For the acknowledgement of new order messages that were queued due to OEG throttling this position is set to one (1)
- even if clients choose to Queue their over the limit messages, if their connections breach their rate, either with a large number of messages, or data, within the allocated time, such messages are not processed.

 **Important note:** In such cases, and especially if the client is disconnected for any reason,

- client messages may not be acknowledged or rejected, and
- the queue is dropped

Clients are strongly urged to send at maximum their rate per second to guarantee no rejections.

2.3.4 Behavior in Case of Rejection

After a client's OEG throttling limit is breached, and the client chose to reject their messages, over the limit messages are rejected.

A rejection message will be sent to identify messages processed by the OEG that are over the throughput limit.

Note that throttling is applied at the individual message level. One message can be throttled at one given time, even though a previous or subsequent message can be accepted.

To provide an indication of which message is rejected due to OEG throttling, the following fields are provided in the rejection messages:

- **SBE: TechnicalReject (108)** message contains the following fields for this purpose:

Field	Short Description
Rejected Client Message Sequence Number	Indicates the Client Message Sequence Number of the rejected message
Rejected Message	Provides the Type of message rejected, by indicating its Template ID
Error Code	Indicates the type of OEG throttling rejection that occurred

- **FIX: Reject (3)** message contains the following fields for this purpose:

Tag	Field	Short Description
45	RefSeqNum	Indicates the reference sequence number of the rejected message
372	RefMsgType	Provides the Type of message rejected, by indicating its MsgType (35)
373	SessionRejectReason	Indicates the type of OEG throttling rejection that occurred

The rejection messages do not contain any of the following identified fields: Client Order ID, Order ID, Quote Request ID or Mass Status Request ID

2.3.5 Behavior for Excessive Breach of Rate

In addition to the queue and rejection in place when the throttling limit is reached, the Exchange sets a limit for excessive breaching (either in number of messages or amount of data sent), of the assigned rate / size of connection.

Excessive breaching means that the client attempted to submit a number of messages, or amount of data in bytes, that is multiple times over their allowed rate.

In case a client's connection breaches their rate limit, either in number of messages or in the amount of data, such connections will be immediately disconnected, and won't be allowed to reconnect for 3 seconds. If a client's connections are breaching limits in this manner multiple times and are continuously disconnected, Market Operations will contact the client and may choose to suspend the client's access.

This case could occur due to various reasons, including a technical issue in the client's system. To assist clients in identifying the issue and correcting it as quickly as possible, the **Logout** (103) / (FIX 5) message sent on disconnection in such a case provides specific values identified below.

Case	How to Identify the Case in Logout message	
	SBE [Log Out Reason Code]	FIX [SessionStatus (tag: 1409)]
Excessive number of message	3 = Excessive Number of Messages	106 = Excessive Number of Messages
Excessive amount of data in bytes	4 = Excessive Amount of Data in Bytes	107 = Excessive Amount of Data in Bytes
Excessive number of messages and amount of data in bytes	5 = Excessive Number of Messages & Amount of Data in Bytes	108 = Excessive Number of Messages & Amount of Data in Bytes

2.3.6 Behavior on Intra-session Disconnection

The OEG throttling behavior in case of intra-session disconnection is independent of (i) whether the disconnection occurred in the Exchange or Client systems, (ii) whether it occurred on the same instance of the OEG continuously available, or (iii) whether a disruptive incident triggered a HA or a Business Continuity event.

- Any messages at the moment of disconnection present in the throttling queue are dropped, as if never received by the Exchange. Such messages do not receive acknowledgement or rejection from the OEG
- On Reconnection, during the usual sequence number processes and resynchronization mechanism, clients could receive throttling rejection messages that serve as an indication of messages that were throttled and as such were never processed prior to the disconnection.

3. ASSOCIATED GUIDELINES FOR CLIENTS

3.1 MEASURES TO BE ADOPTED FOLLOWING AN OEG THROTTLING EVENT

Various cases of OEG throttling may occur and are identified by the fields provided in rejection and logout messages. The section below provides the guidelines on measures clients should adopt following an OEG throttling event.

3.1.1 Over the OEG Throttling Limit (Queueing)

For clients that choose to queue throttled messages over the OEG throttling limit, queued messages are indicated by a flag in the Ack message. Such messages are processed by the Exchange with a delay associated to queuing.

As the maximum size of the OEG throttling queue is equal to the rate of the client's connection for the duration of 1 second, the processing of the queued messages, in normal conditions, is expected to last between 0 and 1 second, depending on the number of messages being queued.

To avoid being queued clients should:

- assess the speed and/or number of messages being sent by their system and either
 - reduce the frequency of sending to be in line with their replenish time, or
 - reduce the number of messages sent to be in line with the rate and associated throttling limits set for their logical access

3.1.2 Over the Throttling Queue Size (Queueing)

A customer can be rejected when they choose to queue messages and they send more messages than the number available in the queue.

If a client receives a rejection indicating that their messages were throttled because their throttling queue is full (flagged as follows):

SBE			FIX		
Message	Feld	Value	Message	Feld	Value
Technical Reject (108)	Error Code	2087 = Throttling queue full	Reject (3)	SessionRejectReason (373)	25 = Throttling queue full

The message rejected is not processed by the Exchange. Clients should:

- take this rejection into consideration in their system, and if required resend an instruction to the exchange,
- wait for at minimum 1 replenish time period before sending any further messages,
- assess the speed and/or number of messages being sent by their system and either
 - reduce the frequency of sending to be in line with their replenish time, or
 - reduce the number of messages sent to be in line with the rate and associated throttling limits set for their logical access

3.1.3 Over the OEG Throttling Limit (Rejection)

For clients who choose to reject messages over the throttling limit. If a client receives a rejection indicating that their messages were throttled because they have exceeded their rate (flagged as follows):

SBE			FIX		
Message	Feld	Value	Message	Feld	Value
Technical Reject (108)	Error Code	2085 = Rate exceeded	Reject (3)	SessionRejectReason (373)	26 = Throttling Rate exceeded

The message rejected is not processed by the Exchange and clients should:

- take this rejection into consideration in their system, and if required resend an instruction to the exchange,
- wait for at minimum 1 replenish time cycle before sending any further messages,
- assess the speed and/or number of messages being sent by their system and either
 - reduce the frequency of sending to be in line with their replenish time, or
 - reduce the number of messages sent to be in line with the rate and associated throttling limits set for their Logical Access

3.1.4 System Busy (Rejection)

If a client receives a rejection indicating that their messages were throttled because System is Busy (flagged as follows):

SBE			FIX		
Message	Feld	Value	Message	Feld	Value
Technical Reject (108)	Error Code	2086 = System busy	Reject (3)	SessionRejectReason (373)	27 = System busy

This rejection may occur when the client chooses to reject messages over the throttling limit, but the system is overloaded by processing of previously sent messages and cannot accept more messages until the processing has finished.

The message rejected is not processed by the Exchange and clients should:

- take this rejection into consideration in their system, and if required resend an instruction to the exchange
- wait for at minimum 1 second before sending any further messages,
- review the Market Status page for information on a possible disruptive incident,
- assess the speed and/or number of messages being sent by their system and either
 - reduce the frequency of sending to be in line with their replenish time, or
 - reduce the number of messages sent to be in line with the rate and associated throttling limits set for their logical access

3.1.5 Excessive Breaches of Rate

In case a client is disconnected with one of the excessive breaches of message or data reasons, the reason for such disconnection is identified in the **Logout (103)** / (FIX 5) message in the fields identified in the table below for each protocol.

Case	How to Identify the Case in Logout message	
	SBE [Log Out Reason Code]	FIX [SessionStatus (tag 1409)]
Excessive number of message	3 = Excessive Number of Messages	106 = Excessive Number of Messages
Excessive amount of data in bytes	4 = Excessive Amount of Data in Bytes	107 = Excessive Amount of Data in Bytes
Excessive number of messages and amount of data in bytes	5 = Excessive Number of Messages & Amount of Data in Bytes	108 = Excessive Number of Messages & Amount of Data in Bytes

In case of such a disconnection clients are urged to review the rate at which they are sending messages to the OEG vs the allowed rate for the logical access, or assess if there is a technical issue in the client's system. For further assistance clients should contact one of the Exchange's support teams.

For more details about the cases of disconnection initiated by exchange, including those for excessive breaches of connection rate, please review the *Euronext Cash Markets – Optiq OEG Connectivity Configuration Specifications* document.

3.2 HOW TO AVOID BEING THROTTLED & EXAMPLES

If the message throughput is linear, clients need to ensure the maximum number of messages sent to the OEG are below the throttling limit.

If the message throughput is split into bursts, clients need to respect the buckets available and monitor their tokens available.

Examples in the section below provide indicative information for different behaviors and chosen methods for management of throttling.

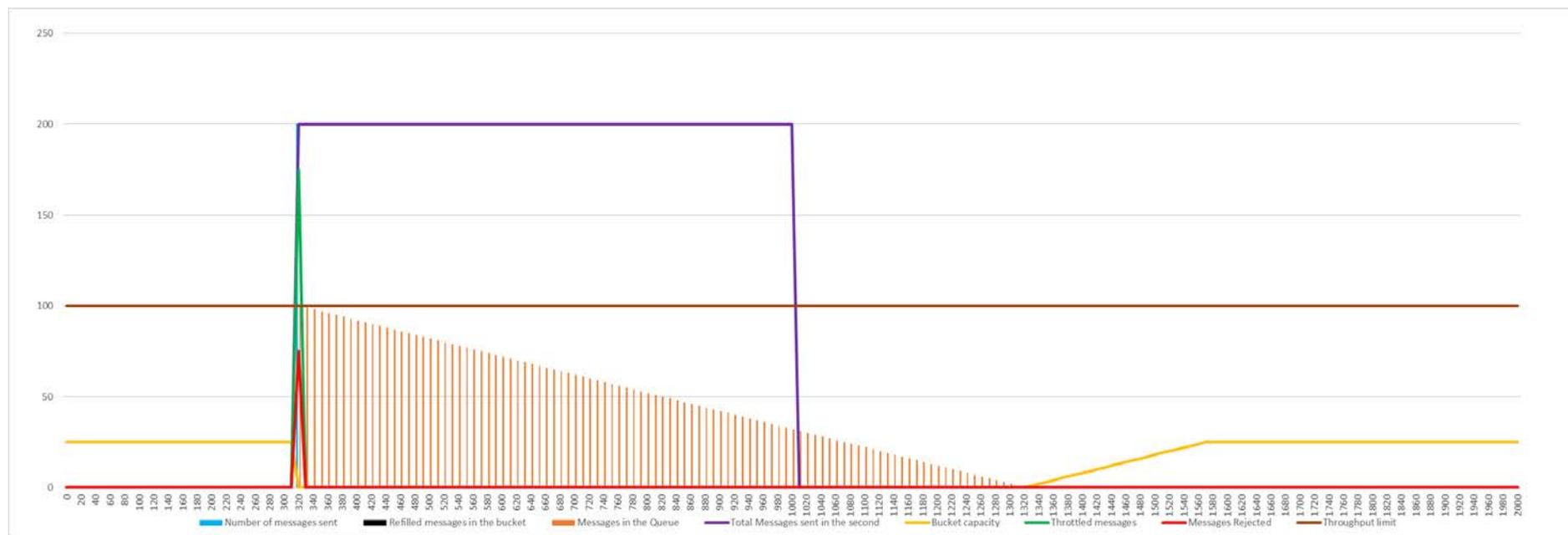


Important note: The values and distribution of messages will be different depending on the throughput of individual connections, client's rate of message injection and examples below should not be used to calculate the actual rates and limits of throttling.

3.2.1 Flooding, in Queuing Case

Assumption: Logical access for 1 session with 1 partition, throughput is 100 msg / second.

Client sends a burst of 350 messages. 50 messages get rejected for excessive breach, 200 are queued, and 100 are immediately processed by the system. For the next 2s, the queue is processed and the bucket is used by the queue.



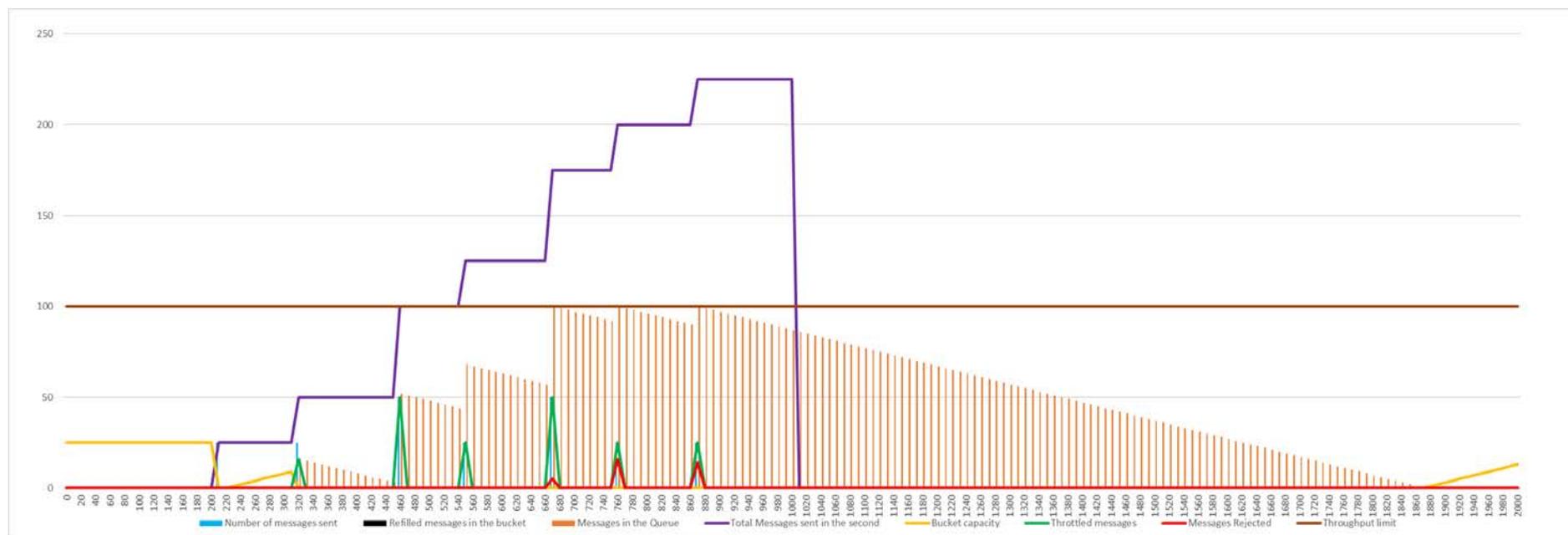
Reason for Throttling: The client sends multiple times their rate. Flooding increases the risk of disruptive incidents and may give rise to disorderly trading conditions, which the Exchange is obligated to avoid.

Recommendation: Distribute messages within the throughput and time allocated to the logical access

3.2.2 Queuing Cases

3.2.2.1 Injection in Bursts, with messages above the limit of the throttling queue

Assumptions are: Logical access for 1 session with 1 partition, throughput is 100 msgs/s.



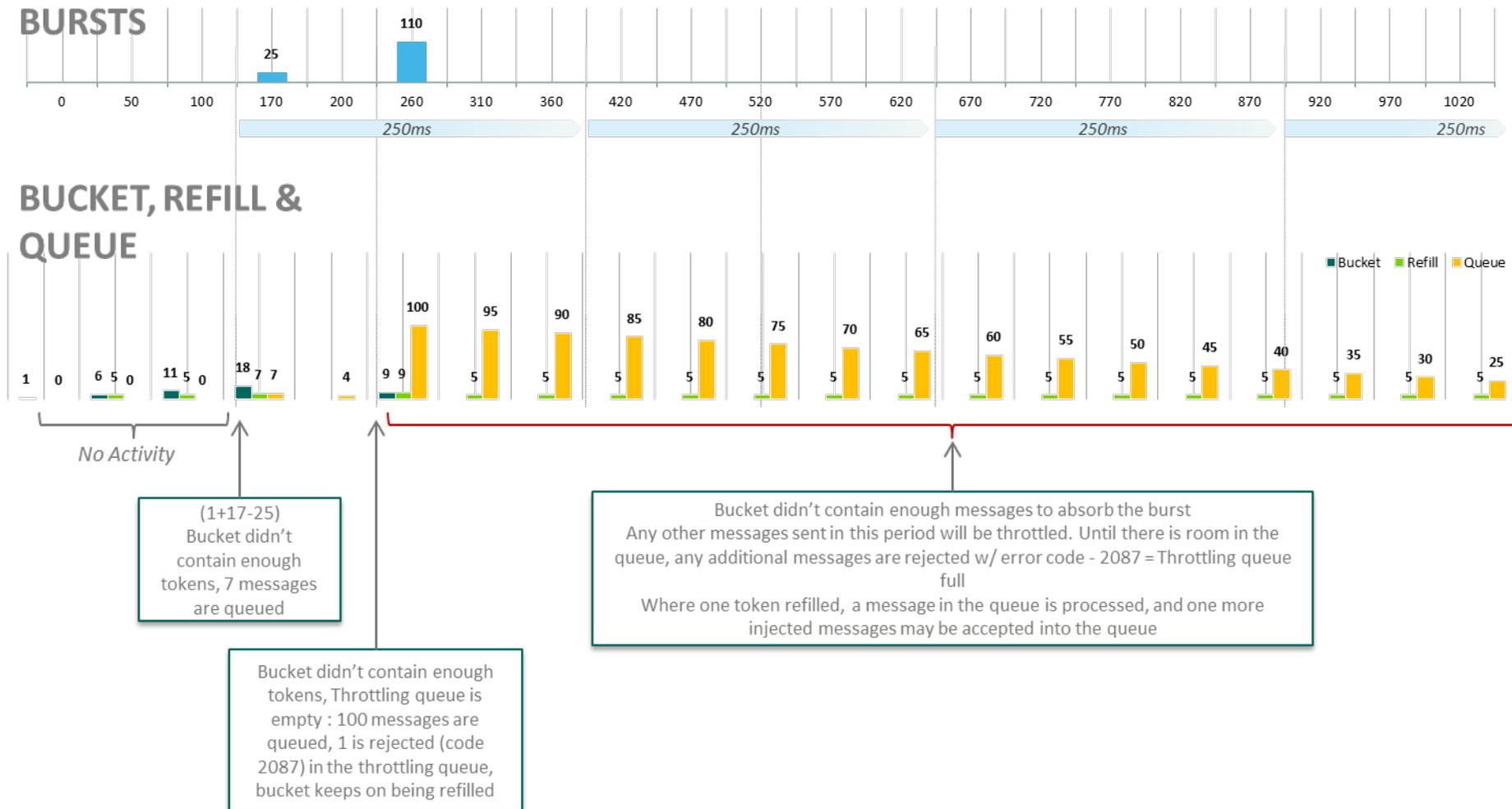
Reason for Throttling: Sum of messages sent within 1 second is more than 1 bucket + 1 second of throughput

Recommendation:

- send fewer messages than the 1 bucket + throttling queue size, within 1 second, to avoid message being rejected over the size of the throttling queue
- split the sending of bursts into fewer messages, which allows for shorter amount of time before the next sending is possible

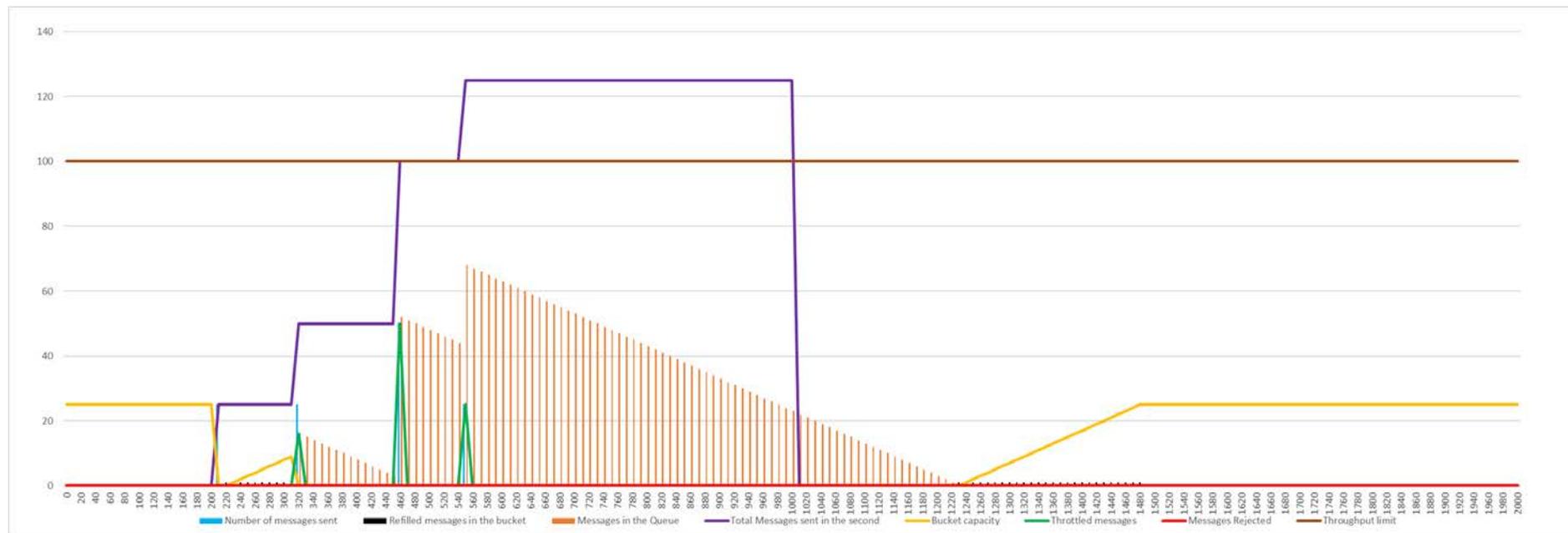
Optiq OEG Throttling Mechanism - Functionality Description

The kinematics of this case are as follows. Assumption: Bucket is initially with 1 message as previously partially used



3.2.2.2 Injection in Bursts, with queuing of messages above the throttling limit

Assumptions are: Logical access for 1 session with 1 partition, throughput is 100 msgs/s.

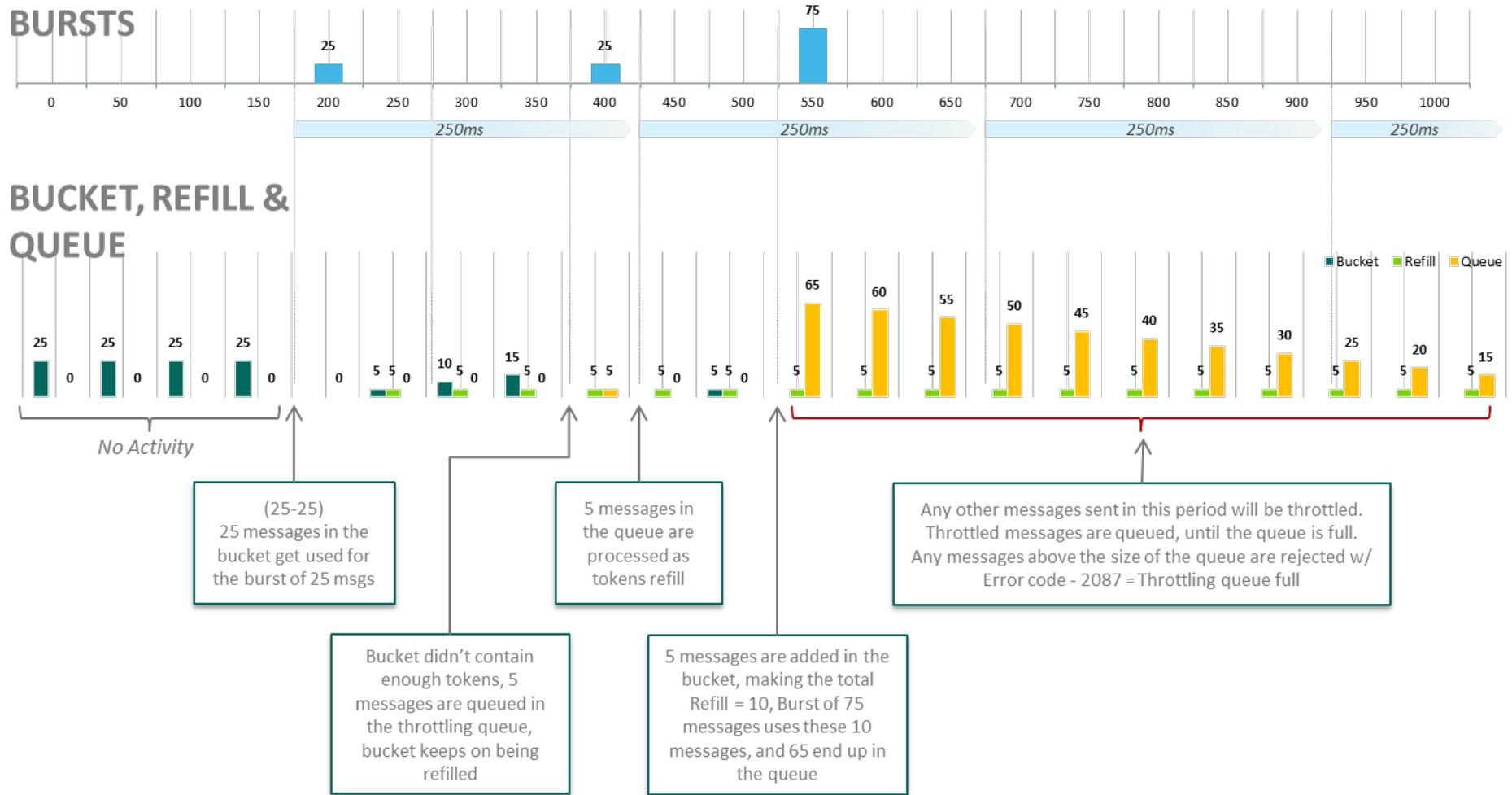


Reason for Throttling: Bursts are larger than the bucket size, or are sent too quickly (more frequently than $1/4^{\text{th}}$ of a second)

Recommendation:

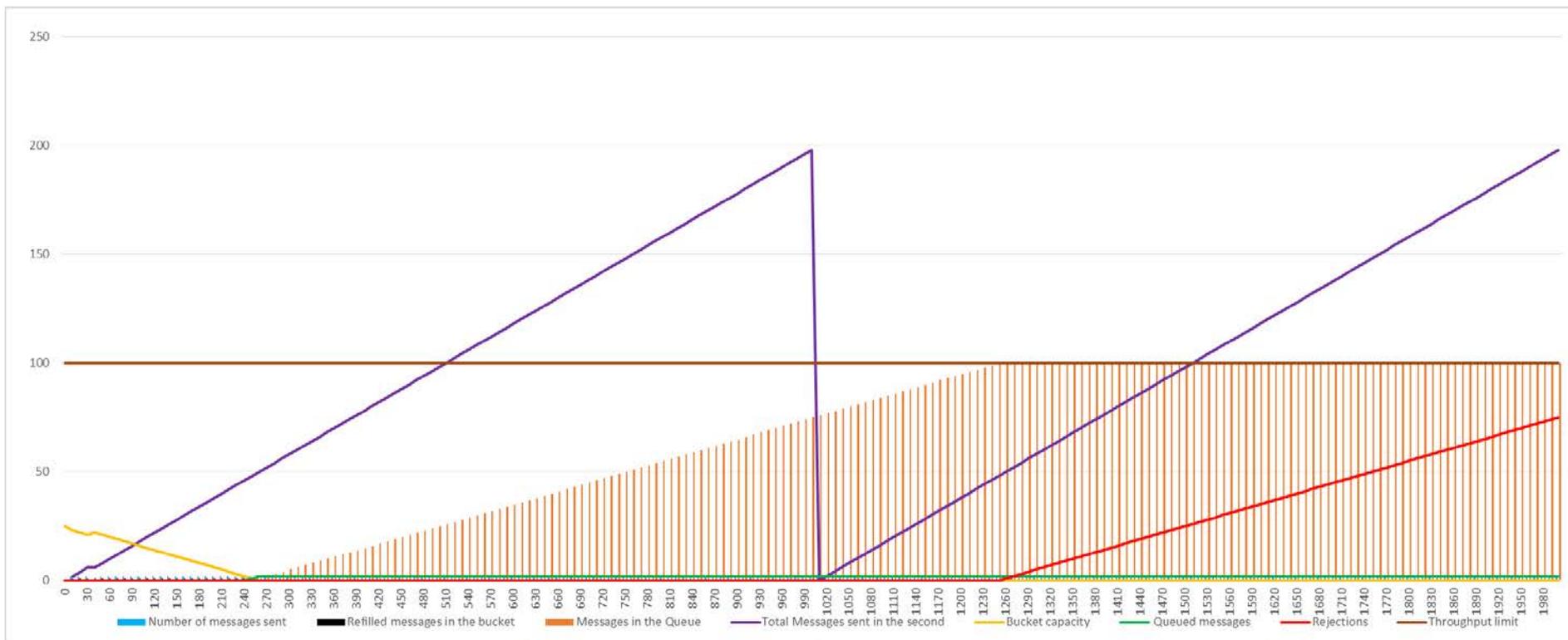
- send at maximum the number of messages equal to the allocated throughput to ensure no rejection over the throttling queue limit. Any messages over the bucket size will be queued until fully processed
- split messages into smaller bursts. This will reduce amount of queued messages
- wait for the period of time required to fully replenish the bucket before sending their full bucket size again

The kinematics of this case are as follows:



3.2.2.3 Linear Injection

Assumptions are: Logical access for 1 session with 1 partition, throughput is 100 msg/s.



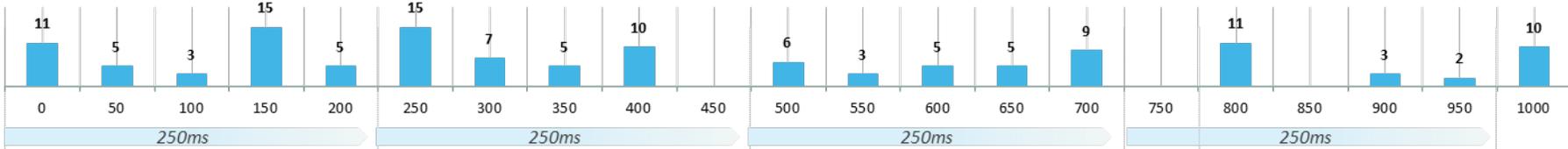
Reason for Throttling: The client sent more messages than the allocated throughput

Recommendation:

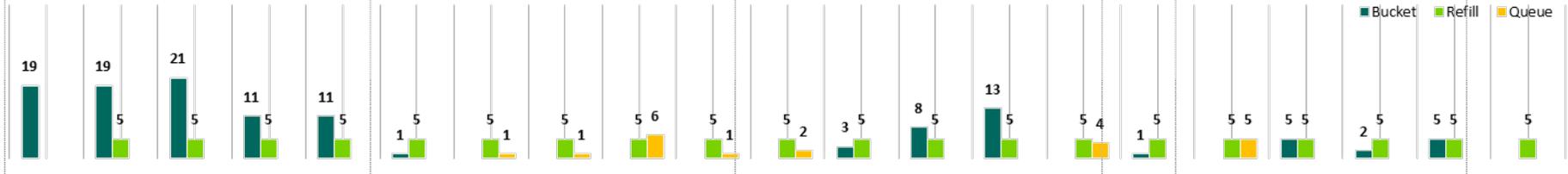
- send fewer messages than the bucket size, no more frequently than the associated replenish time. This avoids queuing of messages

The kinematics of this case are as follows:

MESSAGES IN



BUCKET, REFILL & REJECTS



Bucket didn't contain enough tokens. Messages above the limit are queued, but are quickly absorbed

Bucket didn't contain enough tokens. Messages above the limit are queued, but are quickly absorbed

Bucket didn't contain enough tokens. Messages above the limit are queued, but are quickly absorbed

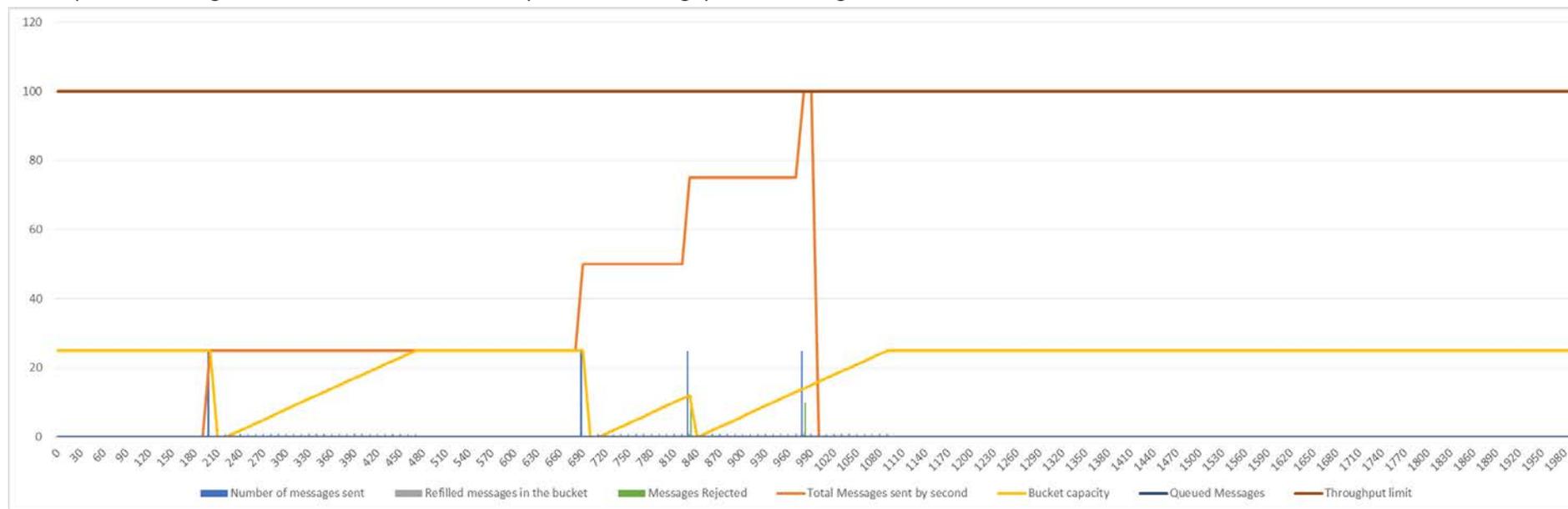
Bucket didn't contain enough tokens. Messages above the limit are queued, but are quickly absorbed

Bucket didn't contain enough tokens. Messages above the limit are queued, but are quickly absorbed

3.2.3 Rejection Cases

3.2.3.1 Injection in Bursts

Assumptions are: Logical access for 1 session with 1 partition, throughput is 100 msgs/s.



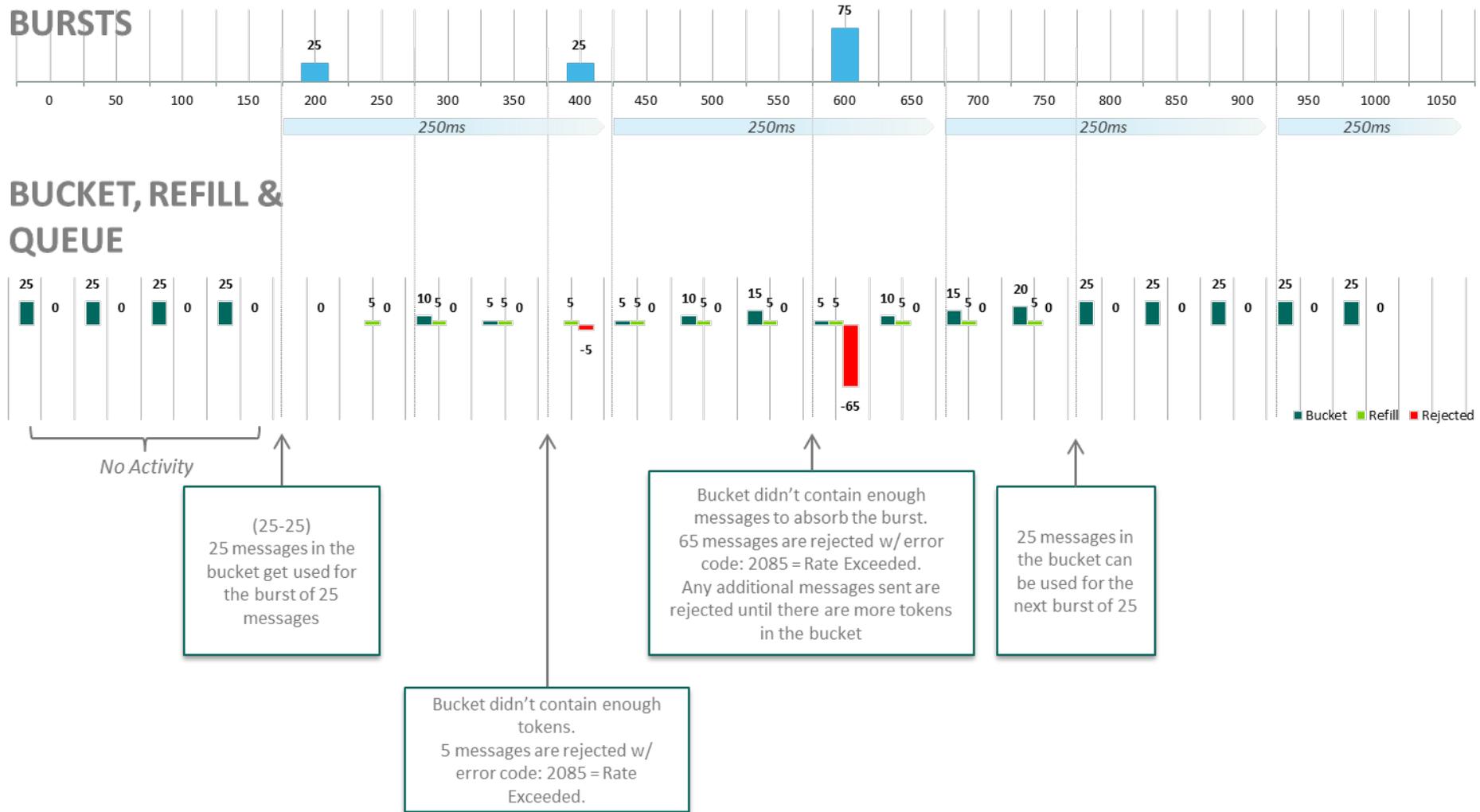
Reason for Throttling: The client sent more messages than the allocated throughput or too quickly (more frequently than 1 second)

Recommendation:

- send at once at maximum the number of messages equal to their bucket size, and wait for the period of time required to fully replenish it, before sending their full bucket size again to avoid being rejected

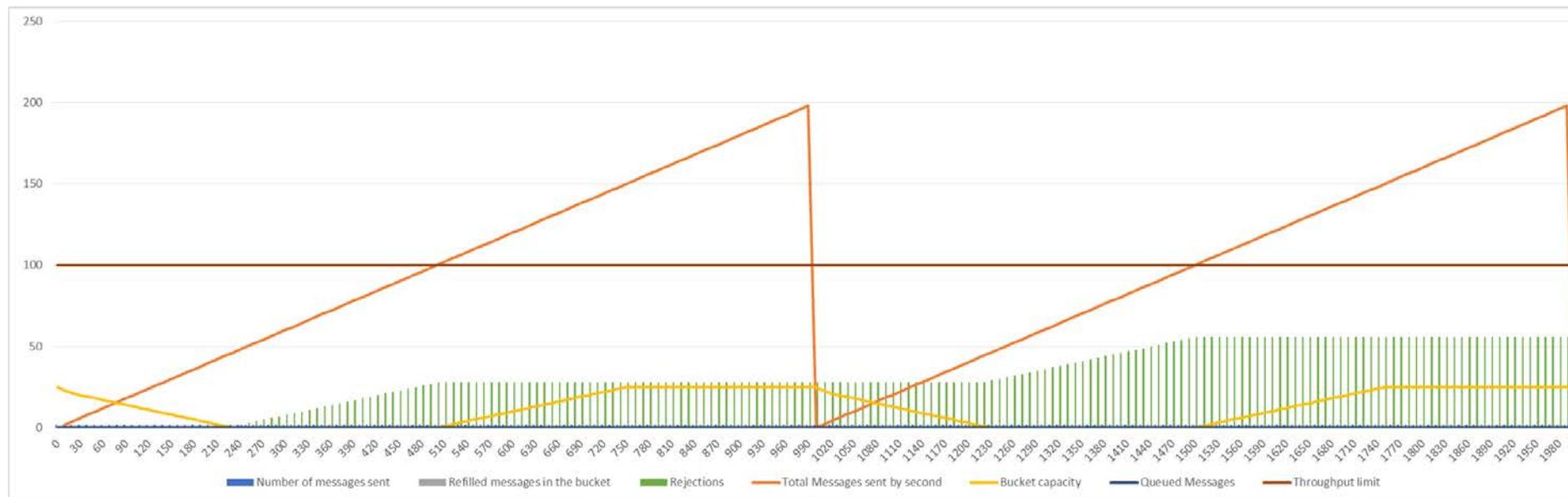
Optiq OEG Throttling Mechanism - Functionality Description

The kinematics of this case are as follows:



3.2.3.2 Linear Injection

Assumptions are: Logical access for 1 session with 1 partition, throughput is 100 msgs/s.



Reason for Throttling: The client sent more messages than the allocated throughput

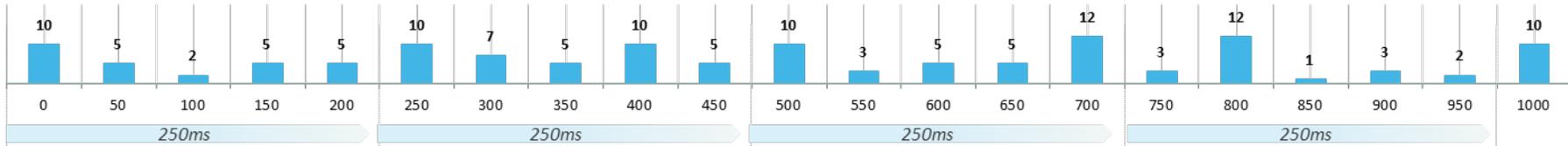
Recommendation:

- As in case of queuing, client should send fewer messages than the bucket size, no more frequently than the associated replenish time. This allows to avoid queuing of messages

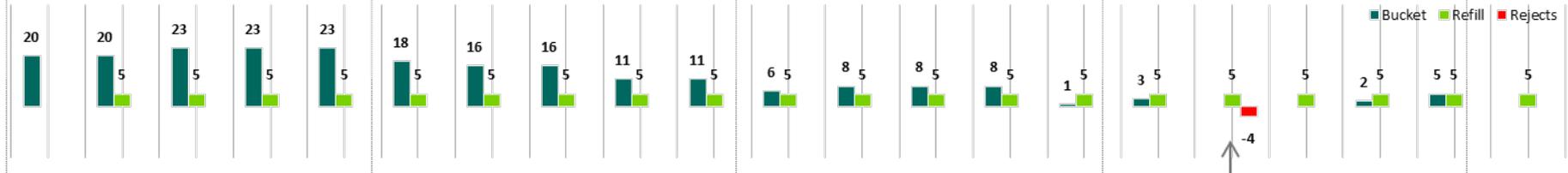
Optiq OEG Throttling Mechanism - Functionality Description

The kinematics of this case are as follows:

MESSAGES IN



BUCKET, REFILL & REJECTS



Bucket didn't contain enough tokens.
4 messages are rejected w/
error code: 2085 = Rate Exceeded

APPENDIX A: REVISION HISTORY

SUMMARY OF CHANGES

Version	Change Description
2.2.0	<p>Parameter updates</p> <p>Update size of the bucket 2.1, , rounding section 2.1.4, example in 3.2.1, reason for throttling in 3.2.3.1, 3.2.2.2</p>
2.1.0	<p>Revisions post go live of Optiq Phase 2 (Cash markets)</p> <ul style="list-style-type: none"> • Modified queueing mechanism & parameters • Added clarification on use of sliding window • Corrected graphs in examples "Flooding, in Queueing Case" (section 3.2.1), "Injection in Bursts, with messages above the limit of the throttling queue" (section 3.2.2.1) & "Injection in Bursts, with messages above the limit of the throttling queue" (section 3.2.2.1)
2.0.0	<p>Second version for Optiq Phase 2 (Cash markets), including the following changes:</p> <ul style="list-style-type: none"> • Descriptions and explanations in the document were adjusted to clarify them and make them more readable. For this sections in the document were adjusted as follows: <ul style="list-style-type: none"> ○ Section 2 - removed duplicate description of throttling (already in Introduction) ○ Main Concepts & Limits moved from 2.3.7 to section 2.1 ○ Summary of Formulas moved from section 2.3.7.1 to section 2.1.1 ○ Notes on Calculation & Minimum Limits moved from 2.3.7.2 to 2.1.3.1 ○ Private Messages Used by the OEG Throttling Mechanism moved from 2.3.8 to 2.1.2 ○ Use of the Bucket Concept moved from 2.3.9 to 2.1.3 ○ ASSOCIATED GUIDELINES FOR CLIENTS and all its subsections were moved to chapter 3 ○ Over the OEG Throttling Limit (Rejection) moved from 2.4.1.1 to 3.1.1 • Section 2.1 HOW OEG THROTTLING WORKS" moved under introduction (now numbered 1.2) and <ul style="list-style-type: none"> ○ Renamed to "MAIN CONCEPTS & LIMITS" ○ Combined content of previous section 2.1 with similar content previously in section 2.3 ○ Added clarification on the throughput assigned per Logical access & partition ○ Clarified inclusion of non-throttling related rejections as being in scope of throttling, and using up a token ○ Adjusted the parameters from 1/10th to 1/4th ○ In section "Summary of Formulas" renamed the Minimum Limit, as the bucket size for Free / Low throughput packages, and adjusted the values ○ Converted notes into a dedicated section with the associated rules and clarifications • Section 2.3.3 <ul style="list-style-type: none"> ○ Title changed from "Behavior if Client Chose Rejection" to "Behavior in case of Rejection" ○ Description simplified and clarified, main concepts remain unchanged • Section 2.3.4 <ul style="list-style-type: none"> ○ Title changed from "Behavior if Client Chose Queueing" to "Behavior in case of Queueing" ○ Clarified that queued messages may not all be acknowledged or rejected, especially in cases when the queue is dropped due to disconnection • Section Use of the Bucket Concept, moved from 2.3.9 to 2.1.3 and description simplified and clarified, main concepts remain unchanged • In section "2.3.5 Behavior for Excessive Breaches of Rate" <ul style="list-style-type: none"> ○ Reduced 15 seconds of disconnection following excessive rate breach to 3 seconds ○ Correction added that disconnection upon any breach of the excessive limits occurs immediately • Section 2.4.2 <ul style="list-style-type: none"> ○ Moved under Chapter 3 ○ Renamed to "How to Avoid being Throttled & Examples" ○ Added details for individual chosen methods of managing throttling ○ Added examples • Removed section "Work in Progress" • Throughout the document, adjustment and clarification of wording and terms used
1.0.0	<p>First Release for Optiq Phase 2 (Cash markets)</p>

DOCUMENT HISTORY

REVISION NO.	DATE	AUTHOR	CHANGE DESCRIPTION
2.2.0	23 November 2018	Euronext	Parameter updates
2.1.0	21 September 2018	Euronext	Revisions post go live of Optiq Phase 2 (Cash markets)
2.0.0	5 July 2018	Euronext	Second version for Optiq Phase 2 (Cash markets)
1.0.0	8 February 2018	Euronext	First Release for Optiq Phase 2 (Cash markets)