



London
Stock Exchange Group

LONDON STOCK EXCHANGE GROUP

GROUP TICKER PLANT

GTP 001 - PRODUCT GUIDE

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One product, **infinite possibilities.**

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Guide Disclaimer

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For further information, please contact your usual London Stock Exchange Group contact.

1. Introduction

Following the successful integration of the Millennium Technology suite in to our service portfolio, the Group has continued to work diligently to review our existing product provision, through rationalising and migrating our services under a common architecture. Under this effort we will be launching a series of new products and services, to better support our clients, our markets and our growing business.

As one of our first priorities within this technological transformation, the Group announced its intention to consolidate all real-time market data services from the current technologies to a single, multi-asset class, low latency market data solution – the Group Ticker Plant. The Ticker Plant delivers exceptional levels of performance, scalability, product resiliency and a rich set of innovative and traditional market data services.

Through a number of phases, market data delivery will be collapsed into a single, bespoke, binary protocol – based on our customer feedback and designed to achieve the best possible performance. Internally, we will also optimise our technologies to ensure our products can evolve in line with our industry, both in the short and long term.

This is an exciting project for the Group and our clients alike – we look forward to working with you, our customers and partners, as we continue to develop our product suite to deliver a better market experience.

2. Documentation

2.1 This Guide

The purpose of this document is to provide an overview of the various services delivered by the Group Ticker Plant.

It will be updated and reissued when appropriate to do so.

2.2 Readership

This document is particularly relevant to trading, market data and technical teams within member firms, information vendors and other market participants who currently receive or are interested in receiving London Stock Exchange Group market data.

When read in conjunction with other Group Ticker Plant documents it is intended to provide all required information to develop to, and interact with, our real-time information systems.

2.3 Document Series

This guide, **GTP001 – Product Guide**, forms part of the documentation library supporting those clients interacting with the Group Ticker Plant. For information, the full series of currently available documentation is outlined below:

- GTP001 – Product Guide (this document);
- GTP002 – Technical Guide;
- GTP003 – Statistics Guide;
- GTP004 – Parameters Guide
- GTP005 – Testing Guide;
- GTP006 – External Sources Guide;
- GTP007 – GTP Lite Guide.

The full library of Group Ticker Plant documentation can be found at:

www.londonstockexchange.com/oneproductinfinitepossibilities

2.4 Document History

This document has been subject to the following iterations:

| Issue | Date | Description |
|-------|----------------|--|
| 1.0 | 27 June 2012 | First issue of this document |
| 2.0 | 24 August 2012 | Second issue of this document with the following iterations: 4.3.3 – inclusion of further information on channel content. |

| | | |
|--------|-------------------|---|
| 3.0 | 15 November 2012 | Third issue of this document with the following iterations: 3.1.2 – Clarification to snapshot building instructions. 3.1.5 – Reference to GTP005 – External Sources Guide included. 4.3.3 – Minor clarifications to Instrument Distribution. |
| 4.0 | 8 February 2013 | 3.1.6 – Inclusion of FTSE Low Latency detail. |
| 4.1 | 6 March 2014 | 3.1.1 – Inclusion of GTP Lite Incremental Service details. |
| 5.0 | 13 August 2013 | Multiple changes to document issued to support Phase 2.0 services. |
| 6.0 | 17 April 2014 | Document baselined following customer feedback on Phase 2.0 services and to support the inclusion of EuroTLX and GTP Lite services. |
| 7.0 | 29 July 2014 | Seventh issue of this document to include minor updates and corrections as highlighted. |
| 8.0 | 19 September 2014 | Additional description added to section 3.1.3 as highlighted. |
| 9.0 | 25 June 2015 | Updated to include Phase 2 product details. |
| 10.0 | 21 October 2015 | Updated to reflect corrections identified. |
| 11.0 | 8 July 2016 | Updated to reflect corrections identified. |
| 12.0 | 10 March 2017 | Updated to include TRADEcho market data channels. |
| 12.1 | 22 May 2017 | Software Release 1.4.0.7: 4.4.2 – Added system event to available recovery requests |
| 13.0 | 22 May 2017 | MiFID Changes: 3.1.3 – Added details for indicative quote information 4.4.2 – Added indicative quote information to available recovery requests |
| 13.1 | 13 December 2017 | Decommission of FTSE Low Latency Service in Production 19 Dec and CDS 18 Dec Removed FTSE Low Latency |
| 13.2 | 03 January 2018 | 4.3.3 – Updated Spanish MIC code from XMCE to X MAD |
| 13.3 | 06 June 2018 | 4.3.3 – Updated MIC code from X MAS to X AMS |
| 13.4 | 22 August 2018 | 3.1.3 – Added Trade Summary |
| 13.5 | 25 October 2018 | 3.1.3 – Added clarification on RFQ quotes publication on Level 2 Incremental service 3.1.7 – Added Section for TRADEcho Service 4, 4.4.1, 4.4.2 – Sections updated 3.1.3 – Added clarification on CPX |
| 13.6.1 | 17 January 2019 | 3.1.3 – Added Turquoise™ market for Trade Summary |
| 13.6 | 11 January 2019 | 3.1.7 – Added TRADEcho hard Brexit APAs category |

In subsequent issues of this document, where amendments have been made, these changes will be indicated through the use of **red text** and sidebars (example left).

2.5 Enquiries

For further information on Group Ticker Plant, please contact either your Technical Account Manager or the Client Technology Services (UK):

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- Email: londontam@lseg.com

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- Telephone: (+39) 02 42 41 13 99
- Telephone (Toll Free): (00800) 26 77 20 00
- Email: clients-services@borsaitaliana.it

Further information can also be found on our project websites:

www.londonstockexchange.com/oneproductinfinitepossibilities

www.borsaitaliana.it/oneproductinfinitepossibilities

3. Service Overview

The Group currently broadcasts real-time data in a number of different protocols. The protocol by which real-time data is broadcast is dependent upon asset class being traded, the core technology underpinning the market, and the nature of the client's interaction with the service.

The Group Ticker Plant supports a number of different asset classes – Cash Equities, Fixed Income (both Bonds and Warrants) and Derivatives – and in an effort to ensure the new protocol is intuitive, performant and generic, some data sets have been removed. All business-critical information remains present and new functional enhancements and data sets have been introduced as a result of customer feedback and market trends.

3.1 Service Lines

The Group Ticker Plant will be introduced in a number of phases. Each phase will be introduced through a parallel run service introduction. Each go-live phase will see either additional service lines or markets introduced to the core product.

Group Ticker Plant delivers the following service lines:

- Level 1 incremental service;
- Level 2 10 depth snapshot service;
- Level 2 incremental service with indicative quotes;
- Reference Data;
- Announcements;
- FTSE Russell Indices;

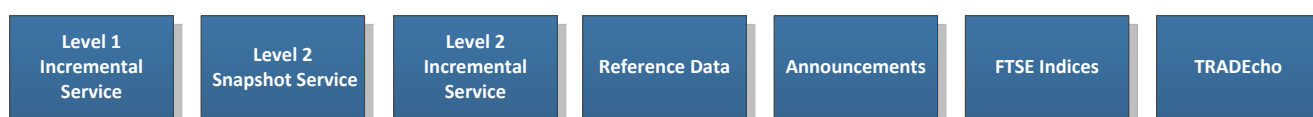


Figure 1: Service lines offered by Group Ticker Plant.

The following markets are currently supported

- London Cash Equity markets (including IOB, EQS and the Order Book for Retail Bonds) (LSE);
- Borsa Italiana Cash Equity markets (MTA, SeDex and ETFs);
- Borsa Italiana Derivatives markets (IDEM);
- Borsa Italiana Fixed Income markets (MOT);
- Borsa Italiana Trading After Hours (TAH);
- EuroTLX markets (ETLX);
- Turquoise Cash Equity markets;
- TRADEcho APA Trade reports and SI quotes.

Customers should note that the Turquoise Cash Equity market introduced at Phase 2 will only be provided as a Level 2 full-depth incremental data service.

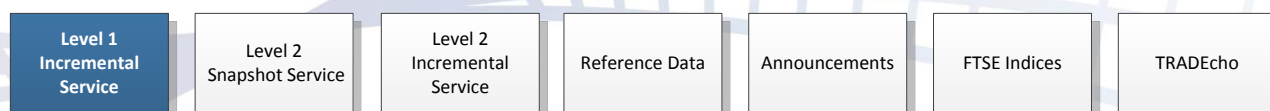
The Group anticipates introduction of the London Stock Exchange Derivatives and MTS markets in due course; an overview of these services is not contained within this documentation iteration.

In a similar design to that of Millennium Exchange today, Group Ticker Plant data services will be disseminated via multicast, broadcast in UDP network packets, and delivered over a number of load balanced IP multicast channels. These IP multicast channels will be supported by TCP/IP replay and recovery services.

In addition, the Milan Group Ticker Plant instance supports the provision of data in TCP/IP delivery mechanic – the GTP Lite service. Further information is contained within GTP007 – GTP Lite Guide, available on the project microsite.

There will be no concept of Prime, Duplicate or Standard data delivery on the new Group Ticker Plant.

3.1.1 Level 1 Incremental Service



The Group Ticker Plant level 1 service is publishing an aggregated Best Bid and Offer, both quantity and price for applicable order types. Market Orders are also aggregated and their total cumulative size will be disseminated. As an incremental service, any change to the consolidated Best Bid and Offer, whether a modify, deletion, addition or execution of a contributing order, will result in the dissemination of the entire Best Bid and Offer details. All values for the level 1 service are contained within a single message type.

In addition to the dissemination of the Best Bid and Offer, the level 1 service delivers all executions, both on and off book, as trade reports. All on book trades (AT and PT trades), auction uncrossing trades (UT trades) and trade breaks are delivered in a single message type. This message includes the executed price (or yield if the instrument is traded in yield), the executed quantity, the transaction time as stamped by the matching engine and the auction type if applicable. Off-book executions reported to supported venues are published in the Off-book Trade message. This message includes the transaction time, traded quantity, traded price and trade date. Further details are included in GTP002 – Technical Guide.

The new level 1 service also broadcasts a rich range of derived information – the Group statistics package. Whilst continuing to broadcast all derived information published across our legacy market data products, the Group Ticker Plant introduces a new set of statistics. Indicative auction information, when applicable, is disseminated as a statistic on the Group Ticker Plant. For information, the statistics supported are detailed below:

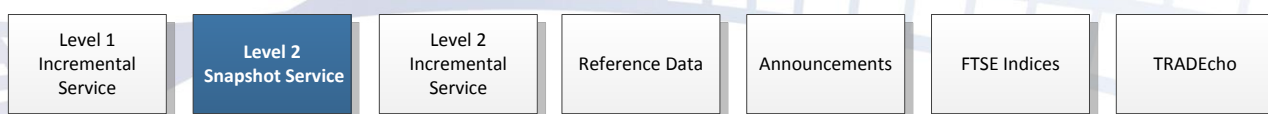
- Volume (on book only and all trades);
- VWAP (on book only and all trades);
- Number of trades (on book only and all trades)
- Turnover (on book only and all trades);
- Trade High and Low (on book only, off book only and all trades);
- 52 week Trade High and Low;
- Closing Best Bid and Best Offer;
- Open interest;
- Volatility.

The level 1 service also publishes the official Opening and Closing price as reported by supported venues. This value is published in real-time and includes the underlying method of calculation.

Further information on our statistics and their derivation method is included in GTP003 – Statistics Guide.

The level 1 service also disseminates the real-time trading status for an instrument and any system event information deemed relevant to market data clients.

3.1.2 Level 2 Snapshot Service



The Group supports a level 2 snapshot service. This snapshot service line provisions clients a 10 depth snapshot of the order book. All markets will broadcast snapshots at 150 millisecond intervals, with the exception of the IDEM market which will broadcast at 900 millisecond intervals. This service is not designed for those clients who require full visibility of the order book or a microsecond latency sensitive service – instead being made available to support users sensitive to the bandwidth requirements of a full book incremental market data product.

The level 2 snapshot service line is made available in two different formats: market by order (MBO) and market by price (MBP). Provisioned over two separate market data channels, the two market data products are provisioned to clients subject to the correct commercial arrangements being in place. Further details on the two snapshot services are included below:

- Market by order – the MBO snapshot product issues clients the top 10 individual orders for both the bid and offer sides of an order book for a given security.
- Market by price – the MBP snapshot product issues clients the top 10 price levels for both the bid and offer sides of an order book for a given security.

Snapshots are issued at the advertised intervals to clients. If no change occurs in the order book for this duration, no new snapshot is provided.

Unlike legacy market data snapshot services, the Group Ticker Plant snapshot services are built by processing a number of individual messages. Clients should process all messages received in chronological order, utilising the message sequence number, to ensure an accurate build of the order book.

The MBO snapshot should be built by processing the first Add Order message which contains the best priced buy order. This message also contains the total number of buy orders to be disseminated (a maximum of ten). The following nine buy orders are provided as a number of Add Order Short messages. If no buy side orders exist on the order book, an Add Order message with Depth of '0' is sent. The buy side snapshot will always be disseminated first. Clients should then expect to receive an Add Order message which contains the best priced sell order. In a similar method to that of the buy side, this message contains the total number of sell orders to be disseminated (maximum of ten). These orders are then disseminated as a number of Add Order Short messages. If no sell side orders exist, an Add Order message with Depth of '0' is disseminated. Both the Add Order and Add Order Short messages contain the Order ID as reported by the execution venue – this allow clients to track their orders on the market data product. If no orders exist on either side of the order book, an Order Book Clear message is disseminated by the server.

The MBP snapshot should be built in a similar way to that of the market by order snapshot. Clients should process the first Add Order MBP message which contains the best available buy price. This first update consolidates the order volume at this price point. It also provides the number of orders collapsed at this first price point and the total number of price points to be disseminated to form the book (a maximum of ten). Clients should process the following Add Order Short MBP messages to build the remaining price points of the buy side MBP order book. If no buy side price points exist on the order book, an Add Order MBP message with Depth of '0' is sent. The buy side snapshot will always be disseminated first. Following the dissemination of these price points, clients will receive an Add Order MBP message for the sell side of the MBP order book. This will, as per the buy side, contain the best price point of the sell side. Also contained in this message will be the number of orders collapsed into the order and the total number of price levels to be communicated (a maximum of ten) to build the sell side of the MBP order book. Clients will then receive the Add Order Short MBP messages. If no sell side price points exist, an Add Order MBP message with Depth of '0' is disseminated. If no price points exist on either side of the order book, an Order Book Clear message is disseminated by the server.

The Group Ticker Plant always disseminates Add Order and Add Order Short messages for both MBO and MBP order books in chronological order, in the aforementioned sequence.

Clients should also note that as the MBO and MBP snapshot services are provisioned by dedicated gateways, these cannot be guaranteed to be aligned at all times. Whilst operating independently, both are configured to the same source feed and both operate with the same time interval between snapshots. Customers should note that no MBP level 2 snapshot channel F (European data sets) is provisioned; all European trading services are currently quote based and cannot therefore be aggregated.

The level 2 snapshot service also includes all statistical, trade, reference data, instrument status and event information as contained in the level 1 service and as described in section 3.1.1 of this document.

3.1.3 Level 2 Incremental Service



The level 2 incremental service publishes all order book updates including order add, modify and delete messages. In contrast to the existing Level 2-MITCH market data service available on Group Cash Equity markets, order book management and post-trade management will be through two distinct message types – the Order Executed with Price/Size message does not feature on the Group Ticker Plant service lines.

The Group Ticker Plant will broadcast an Add Order Incremental message each time a visible order is added to the order book. A unique identifier, the Order ID, is applied and should be used to identify all future actions to be applied to that order. In an enhancement versus that of legacy market data products, the Group Ticker Plant explicitly identifies the public order type to facilitate client order book interaction. Should the order be deleted from the matching engine, as a result of market participant deletion or execution, a Delete Order message will be disseminated. The Group Ticker Plant will disseminate a Modify Order message should any attributes of the order be changed, as a result of partial execution or market participant instruction. If private RFQ book is applicable to a tradable product, RFQ quotes will be published according to the RFQ transparency regime:

1. In presence of Partial Post Trade Transparency:

The average of the bid and ask prices of a private RFQ session, and the RFQ ID identifying the session, are transmitted via a single Indicative Quote Information message when:

- a market maker submits a first quote to the book.
- a market maker submits a quote response that results in a price change.
- an RFQ session is terminated
- a quote sent in response to an RFQ is expired/cancelled However, if multiple quotes get expired due to an RFQ termination, a single Indicative Quote Information with zero will be sent at the end of the termination process to notify the recipients of its termination, but no Indicative Quote Information messages will be sent at each quote update.

This regime is applicable to Borsa venues depending on RFQ thresholds.

2. In case of Full Post Trade Transparency:

Individual RFQ quotes are transmitted via the Add Order Incremental messages attached to the RFQ book. Each message will contain the particular RFQ ID identifying the RFQ session, when multiple RFQ sessions are running concurrently.

This regime is applicable to Borsa venues depending on RFQ thresholds, and to LSE venues.

In a similar regime to that of the level 1 incremental and level 2 snapshot services, all executions on the matching engine will result in dissemination of Trade messages. As described previously, in addition to Trade messages, the level 2 incremental service will also disseminate Order Delete and Order Modify messages to customers which should be applied to ensure order books represent the current state of the matching engine.

On level 2 incremental feed, the Group is also implementing a consolidated message (Trade Summary) which disseminates summary information prior to individual trade.

Trade Summary is published immediately in advance of any individual Trade message or set of Trade messages generated from a single Matching Engine event in Regular trading. Trade Summary will contain a summary of aggregated executed and expired volume, and the furthest price at which volume is depleted as part of the event.

Trades resulting from following order types will not, generate a specific Trade Summary message;

- a) Stop Orders
- b) Stop Limit Orders
- c) Orders with a CPX validity type elected during CPX session transition

Instead, volume executed from these order types that are triggered to aggress in the same direction as the initiating aggressive order will be included within the Trade Summary message following the initiating aggressive order contributing to the volume and price fields as relevant.

Volume executed from these order types that are triggered to aggress in the opposite direction to initiating aggressive order will not be included in the Trade Summary message.

Clients should also note that

1. Trade Summary will not be published for Cancellations and Amendments of trades
2. Trade Summary will only be applicable for trades during Regular Trading and Closing Price Crossing session, and not to Auction trades

The functionality will be initially delivered on LSE and Turquoise™ Trading Venue only, and extended to other venues in due course.

Implied orders, identified by the order type flag, retain the lowest order book priority at a unique price point, irrespective of other orders on the book and their attributes. For example, should a limit order lose its price/time priority due to quantity increase, it would continue to reside above an implied order at the given price point. The OrderID of all implied orders will be equal to zero. Please note, implied orders functionality currently only exists on the Borsa Italiana markets.

The Group's level 2 incremental service will also include all indicative quote, statistical, trade, reference data, instrument status and event information as included as part of the level 1 and level 2 snapshot service lines.

3.1.4 Reference Data



The Group Ticker Plant disseminates an enriched package of reference data. When used in conjunction with the Group’s sFTP/FTP reference data packages, it is intended that all information required to trade and manage securities will be provided to clients. Further information on the Group’s sFTP/FTP reference data packages can be found in

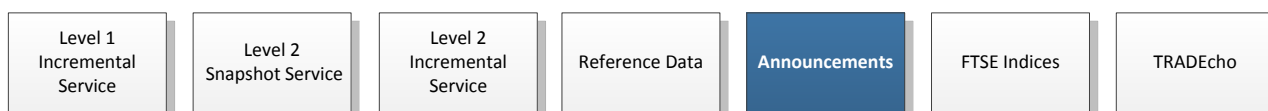
- MIT401 – Guide to Reference Data Services, for LSE venue
- MIT305 – FTP Services Reference Data Specification for Borsa and EuroTLX venues
- MIT501 – Guide to Reference Data Services for Turquoise venue

Each market data service publishes a generic set of reference data, irrespective of the asset class to which a security belongs. This information is contained within the Instrument Directory message and is disseminated each morning. The following information is an example of what will be actively transmitted:

- Instrument;
- ISIN;
- Allowed Book Types;
- Segment;
- Source Venue.

Clients are also able to target the TCP/IP recovery service to request asset specific reference data which is packaged in the Instrument Directory Equities/Derivatives/Fixed Income messages. The content of these messages is available in GTP002 – Technical Guide.

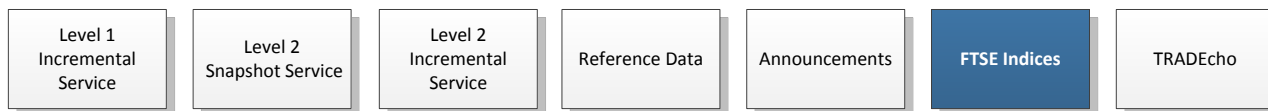
3.1.5 Announcements



The Group Ticker Plant supports the publication of announcements as disseminated by Borsa Italiana markets. Announcements are not currently supported for London Stock Exchange or Turquoise markets. Announcements are packaged in a single message and disseminated on the relevant multicast channel to which the announcement refers.

Please note that the Announcements service line is not the Regulatory News Service (RNS). RNS will continue to be broadcast by our FIX-FAST market data product on the current IP address range.

3.1.6 FTSE Russell Indices



The Group Ticker Plant supports the dissemination of FTSE Russell indices, as received in either snapshot or real-time format, as calculated and broadcast by FTSE Russell. All indices will be broadcast on a single FTSE Russell Indices market data channel. The following values, as reported to the Group Ticker Plant by FTSE, will be published:

- Index Code;
- Index Value;
- Index Status;
- Index Differential;
- Total Return Value;
- Index Timestamp.

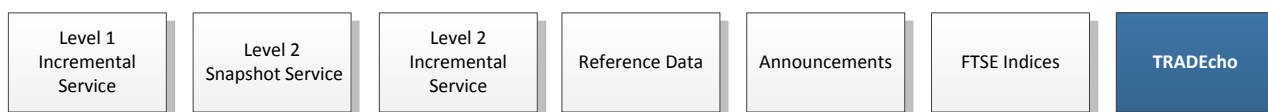
The Group Ticker Plant disseminates all information as received from FTSE Russell. FTSE does not retransmit values in fields when they have not changed versus the previous update, and as such, these fields will be transmitted as blanks by the Group Ticker Plant. Customers should therefore interpret these null values as per the previous update.

Clients should note that only a replay service will be available for message retrieval on the FTSE Russell market data channel – no recovery service will be available for use. Further details on both replay and recovery are contained in section 4.3 of this document.

Whilst the Group Ticker Plant will provision a subset of indices at go-live, clients are encouraged to request additional indices if required. Full details of indices disseminated by the Production Group Ticker Plant are contained within GTP006 – External Sources Guide. Please note that the CDS environment broadcasts only a small subset of indices to facilitate customer development and testing.

Clients should ensure that they have the appropriate commercial license in place with FTSE Russell prior to requesting indices to be provisioned.

3.1.7 TRADEcho SI quotes and Trade Reporting



The Group Ticker Plant supports the dissemination of SI quotes and Trade Reports submitted to TRADEcho APA over dedicated service lines.

The following information is made available over the TRADEcho service lines:

- Reference data, intra-day status updates of off-book trade reporting sessions and trades statistics, limited to products listed on LSE venue.
- Publish SI quotes of equity instruments listed on LSE venue.
- Publish off-book trade reports when eligible for publication, for the global ESMA FIRDS instruments database as reported to TRADEcho APA.
- Publish trade reports segregated for either UK or European TRADEcho APA's following a hard Brexit scenario.

For instruments which are traded both off-book on TRADEcho APA and on electronic book on LSE venue, GTP will provide the same Source Venue identification code.

Further information on off-book statistics and their derivation method is included in GTP003 – Statistics Guide.

4. System Overview

The interfaces, protocols and architecture used by the Group Ticker Plant differ considerably to those currently employed by the Group's Millennium Exchange, SOLA or other Production environments. Whilst taking some key characteristics, formats and behavior of the existing Level 2-MITCH protocol and Millennium Exchange architecture, ultimately the bespoke, binary protocol employed by the Group Ticker Plant are a new set of message formats for clients to develop to.

The Group has invested in designing an intuitive, performant protocol, generic in nature which we hope aids client development and provides a design which can easily evolve as further service lines or markets are introduced. Whilst the protocol is not an industry standard such as FIX-FAST, we believe it is simpler and supports the needs of our clients and markets to a greater degree.

The Group Ticker Plant is deployed to both London and Milan Primary Data Centre (PDC) estates. Both London and Milan Ticker Plants operate with Secondary Data Centre (SDC) estates in their respective geographic locations.

London and Milan Group Ticker Plant PDC/SDC pairs operate independently of each other, London site providing market data for

- London Stock Exchange;
- Turquoise Cash Equity markets;
- TRADEcho APA.

and Milan site providing market data for

- Borsa Italiana MTA, SeDex and ETFs, MOT, TAH);
- EuroTLX;
- IDEM.

FTSE Russel Indices service is provisioned via both London and Milan sites

4.1 Message Formats

The various messages of the Group protocol support publication of all service lines for all supported markets. Some messages may not be broadcast for all supported markets. Where this is the case, it will be clearly identified in GTP002 – Technical Guide.

4.2 System Architecture

The Group Ticker Plant has a number of architecture modules supporting internal market data normalisation and processing, the build of data sets into our message formats and the client-facing modules supporting data dissemination and recovery.

Our market data gateways house the dissemination gateways supporting our real-time channels and the TCP/IP replay and recovery services.

Each multicast channel is supported by two market data gateways – a primary and secondary gateway. The primary gateway is located at our Primary Data Centre and during normal operation will build messages for onward dissemination; the secondary gateway is located at our Secondary Data Centre and during normal service operates as slave to the primary gateway – simply disseminating the already processed market data.

In addition to the primary and secondary gateway pair, the Group Ticker Plant has a single market data gateway operating in warm standby mode, supported by all critical Group Ticker Plant upstream architecture, located at our Secondary Data Centre. In the unlikely event of a Secondary Data Centre invocation, this single market data gateway will begin to publish market data.

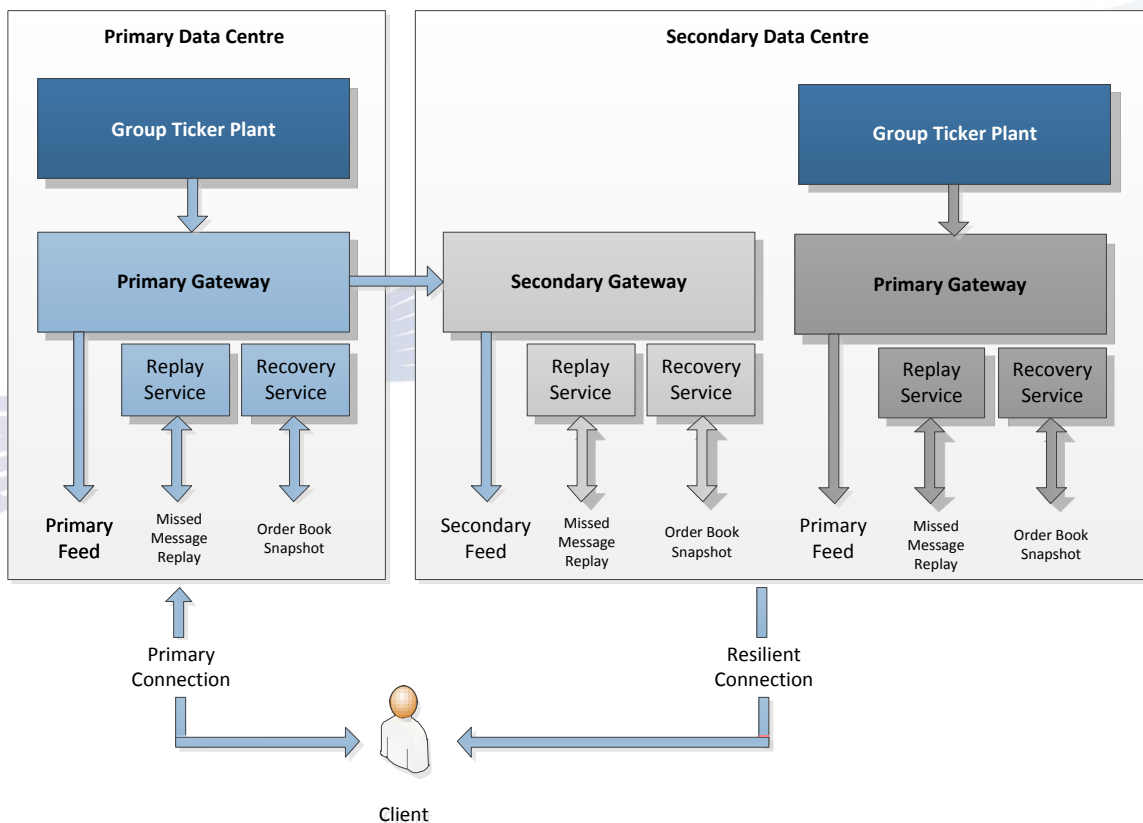


Figure 2: Schematic of Group Ticker Plant architecture during normal operations.

Further details are available in sections 4.4 of this document and in GTP002 – Technical Guide.

4.3 Real-Time Channel

Our real-time channel is the primary mechanism by which market data is published to customers. Market data is published on clients' primary and resilient (secondary) connections to the Group – the data provisioned on primary connections will always be less latent than data provisioned on secondary connections. The market data messages published on client secondary connections are identical to that published on primary connections – this includes consistent sequence numbering which facilitates client arbitration against any message loss. Whilst messages disseminated are identical, the

network transport packing algorithm operates independently on each gateway and UDP packets may therefore contain different message combinations. Clients are strongly advised to ensure all systems are configured to subscribe to both primary and secondary market data feeds.

Each market data feed contains an identifier. This identifier is known as the Market Data Group. During normal operational state the identifier on the primary market data feed will always be in uppercase. In the event of primary market data feed failure, and secondary market data feed resuming service, the identifier on the secondary market data feed will be in lowercase. The Market Data Group on the Secondary Data Centre market data feed will always be in uppercase.

Instruments are configured on only one real-time channel at any one time. Instruments may change channel inter-day but will not change real-time channel intra-day. Clients should identify to which channel an instrument is assigned by using the Instrument Directory messages published each morning.

Each application message disseminated on the real-time channel contains a sequence number. Sequence numbers are reset each trading day to '1' and increment by '1' as each application message is built and subsequently disseminated by the market data gateways.

During periods of inactivity the real-time channels issue Heartbeat messages every 2 seconds. Receipt of Heartbeat messages should assist clients in maintaining connection to the real-time channels during periods of limited message dissemination.

4.3.1 Throttling

In an improvement versus the existing Millennium Exchange market data products, the Group Ticker Plant supports 'Intelligent Throttling' to the real-time data multicast channels. Messages deemed non-latency sensitive are packaged in multi-message per UDP packet format and issued to clients. Those messages deemed to be latency sensitive are either packaged in single message per UDP packet and immediately issued to clients, or packaged alongside non-latency sensitive messages if this is the quickest route to publication. Full details of messages and their classification can be found in GTP002 – Technical Guide.

Intelligent throttling is a further attempt by the Group to ensure efficient data publication during all periods of trading activity.

4.3.2 Instrument Identification

The Group Ticker Plant will introduce a new set of unique instrument identifiers which will exist for the life of the instrument. This identifier, the GTP Instrument identifier, should be used by clients in all interactions with the Group Ticker Plant, including replay and recovery services.

The GTP Instrument identifier is unique to an instrument but will be identical across trading venues. Clients should use the GTP Instrument identifier and Source Venue combination to accurately manage their market data.

Provided in the daily Instrument Directory messages, the GTP Instrument identifier is provided alongside the source market's proprietary identification mechanism thus allowing clients to map to Group information and trading products and to industry standards such as ISIN.

4.3.3 Instrument Distribution

The Group Ticker Plant distributes real-time market data over a number of load balanced IP multicast channels. The channels have been carefully configured to ensure clients can subscribe to the required asset classes cleanly, whilst ensuring Group architecture is managed to ensure performance, scalability and resiliency.

The table below outlines the distribution of instruments across channels:

| Market Data Group (Primary feed) | Market Data Group (Secondary feed) | Source | Content |
|----------------------------------|------------------------------------|-------------------------|--|
| A | a | London Stock Exchange | FTSE 100 |
| B | b | London Stock Exchange | FTSE 100 |
| C | c | London Stock Exchange | FTSE 250 |
| D | d | London Stock Exchange | Structured Products (MOT) |
| E | e | London Stock Exchange | Miscellaneous (AIM, ORB and International Board) |
| F | f | London Stock Exchange | European (EQS) and International Trade Reporting (ITR) |
| G | g | London Stock Exchange | International (IOB) |
| H | h | Borsa Italiana | MTA |
| I | i | Borsa Italiana | MTA, SEDEX, AIM Italia. |
| J | j | Borsa Italiana | Structured Products (ETF) |
| K | k | Borsa Italiana | Miscellaneous (MOT) |
| L | l | Borsa Italiana | IDEM |
| M | m | Borsa Italiana | IDEM |
| Q | q | EuroTLX | EuroTLX |
| R | r | EuroTLX | EuroTLX |
| S | s | EuroTLX | EuroTLX |
| T | t | Turquoise Cash Equities | XLON |
| U | u | Turquoise Cash Equities | XPAR |
| V | v | Turquoise Cash Equities | XETR |
| W | w | Turquoise Cash Equities | XCSE, XHEL, XMAD, XSTO, XSWX and XVTX |
| X | x | Turquoise Cash Equities | MTAA, XOSL, WBAH, |

| | | | |
|---|---|-------------------------|---|
| | | | XDUB, ARCX, XBUD, XNGS, XNMS, XNYS and XPRA |
| Y | y | Turquoise Cash Equities | XAMS, XBRU, XLIS and XLUX |
| Z | z | Borsa Italiana | TAH and MIFID |
| 1 | 5 | TRADEcho | SI Quoting |
| 2 | 6 | TRADEcho | Trades |
| 3 | 7 | TRADEcho | SI Quoting |
| 4 | 8 | TRADEcho | Trades |

| | | | |
|---|---|----------------------|------------------------------|
| O | o | FTSE | FTSE Indices |
| P | p | Borsa Italiana Admin | Borsa Italiana Announcements |

Whilst each service line is supported by a dedicated multicast channel, the market data group is similar across order book service lines i.e. the Level 1 and Level 2 snapshot product supporting the FTSE250 data set both carry the market data group identifier of 'C' and 'c' for Primary and Secondary connections respectively.

Network topology, including multicast source addresses and port details are available in GTP004 – Parameters Guide.

4.4 Recovering from Data Loss

The Group Ticker Plant market data gateways are built to facilitate client recovery from small or large scale data loss through use of either the TCP/IP Replay or Recovery services. Further detail on these services is included in sections 4.4.1 and 4.4.2 of this document.

In an improvement versus the existing Millennium Exchange Level 2-ITCH replay and recovery services, clients will no longer be issued a password for replay or recovery services. Instead validation will be done on CompID and incoming IP address combination.

4.4.1 Replay Service

Each market data gateway will be constructed to include a replay service. In a similar setup to that of Millennium Exchange, the replay service allows clients to request a finite number of missed application messages. The replay service stores the last 65,000 messages disseminated on the real-time channel, available to clients recovering from a small scale data loss.

Replay services is only be available on the primary market data feed unless a component failure occurs.

For a detailed description of message types recoverable from Replay Service, please refer to GTP002 – Technical Guide.

4.4.2 Recovery Service

Each market data gateway (with the exception of FTSE Indices service line) also provisions a recovery service. The recovery channel, in a similar setup to that of the existing Millennium Exchange solution facilitates client recovery from a large scale data loss. The recovery service is also available for clients to request additional information which is not available on the real-time multicast channels.

The recovery service permits the requests of:

- a snapshot of the order book for any active or inactive instrument in the Market Data Group. The snapshot will be of either the level 2 incremental, MBP, MBO or level 1 service line dependent upon the recovery service targeted by the request;
- all trades reported for the trading day (both on and off book), with the exclusion of Trade Summary messages where available;
- a snapshot of an instrument's current statistics;
- the current trading status of an instrument;
- the full set of reference data for an instrument;
- announcements published by a venue on the target recovery service for a trading day (Borsa Italiana and EuroTLX venues only).
- The most recent System Event message
- Indicative Quote Information of private RFQs where partial transparent RFQ model is allowed.

For a detailed description of message types recoverable from Recovery Service, please refer to GTP002 – Technical Guide.

Recovery services are only made available on the primary market data feed unless a component failure occurs.

4.5 Group Ticker Plant Failure

The Group Ticker Plant has been designed and built with ultimate product resiliency as a key prerequisite. In the unlikely event of either a component or catastrophic site failure, the Group Ticker Plant recovery processes shall commence in an effort to restore service lines to normal operations.

During normal operations, clients should subscribe to both primary and secondary market data feeds. Replay and recovery services are only active on the client's primary connection to Group Ticker Plant service lines.

Further information and potential failure scenarios are contained within section 5 of GTP002 – Technical Guide.