1 Introduction

When people talk about the 3V’s of Big Data they could equally be talking about the volume, velocity and variety of trade monitoring and reporting regulations facing banks. It is estimated there are over 1,000 initiatives worldwide with each imposing heavy burdens on meeting their regulatory demands. They are onerous, far-reaching and complex.

The survivalist tendency to resort to spreadsheets, bespoke code changes and one-off interfaces has yielded pyrrhic victories - providing solutions for today but problems for tomorrow. Too many projects have run over schedule or remain open-ended because, while the original requirements may have changed, the solution’s capability to support them hasn’t. What banks need is a solution that accommodates change rather than recoils from it, that factors it as a reality rather than a risk and builds the flexibility to incorporate it. That solution is Kx for Surveillance. This document outlines some of the functionality in its alerts library.

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### 2 Alerts Management Screens

#### 2.1 Alerts Summary

The Alerts Summary dashboard provides managers, analysts and auditors with an overview of current and historical alerts status. It itemizes how many alerts are active and their investigation status (New, Unassigned, Assigned, ...) and provides the ability to launch support screens for more detailed investigation, configuration and backtesting.

- Alerts can be filtered by alert type, by particular security/instrument or by assignee.
- Each alert enters initially in an ‘Open’ status and from here it can be progressed to a variety of different queues for example ‘Investigating’ or ‘Escalated’.
- All action items can be edited to include comments or documents/emails attached on the workflow.
- Alternatively alerts can be reassigned to a better suited user if necessary.
- Each alert item when selected includes a button linking to the relevant investigation dashboard and to launch the Order Book replay.
- This screen can be used as a case management system over the lifecycle of each alert item.
2.2 Action Tracker

The Action tracker provides a filterable list of all system generated surveillance alerts shown at the top of the screen. On selecting an alert the historical audit trail and details of the alert appear in supporting panels.

- The top panel presents alerts based on user role. Users can filter and sort by alert type.
- A detailed description of the alert is presented on the bottom right panel – alert type, when it was fired and why, its source, asset classes and further details to assist follow-up investigation and possible reassignment.
- The bottom left section display an audit trail, notifications and other information for the selected alert. It also facilitates adding comments, including attachments and reassignment to other users.
2.3 Market Replay

Market Replay screens enable users to select an instrument and view its price/volume chart over a chosen period. Users can select any point on the timeline to reconstruct the order book at that time with the ability to view the book graphically or in tabular form along with incoming orders, trades and other events as they were generated.

- The top section presents average buy and sell prices over the selected time period and traded amounts
- The left panel display market events with filters and sorting option and the ability to highlight specific events
- Order book events, volumes, quoted and trade prices are presented in the bottom right hand panel
2.4 Alert Configuration

Customers can independently amend alert definitions, threshold, and parameters using the screen below. This gives flexibility to recalibrate alerts and reduce false positives.
3 Sample Alerts

3.1 Abusive Squeeze

This alert identifies where traders having large positions in both the market of the underlying asset and derivative contract and will be fired if they cause a significant price change in the underlying market (all with respect to a pre-defined thresholds).

The alert can be analyzed using the generic trade Investigation screen below:

An illustration of the definition logic is presented below:
Kx for Surveillance – Sample Alerts

3.2 Bait and Switch

This alert identifies entities who submit a number of orders at different price levels on one side (layered side) and subsequently switch to the other side and trade at a particular price range and finally cancel the majority of the orders on the layered side (all with respect to pre-defined thresholds).

The top left grid provides data on the selected trade including the layering start and layering time end time. Other important displayed information include trader name, symbol, order count, max and min price. The adjacent graph represents the rising entity trade price level during the switch order time window for the selected order. The y-axis represents the price of the sym, and the x-axis represents the different time periods throughout the order time window. The dashed red line is the price level threshold. Whenever the entity trade price level exceeds the price level threshold it triggers an alert. The bottom graph provides a more granular presentation of the same information.

The alert can also be analyzed using the generic trade Investigation screen below.
This alert detects unusual price movements between pre-benchmark to benchmark prices. The Benchmark Manipulation scenario is addressed by several sub-scenarios that look at pre-benchmark and in-benchmark period transactions. Post-benchmark manipulation is addressed in other scenarios.

User can select the instrument of interest and the reference periods to monitor against in the top sections. The graph underneath plots the price and trading profile against the left hand axis while the quantities traded are plotted against the right hand axis. The green bar indicates the trade quantity and alert is fired where trade quantity, value and price movement breach pre-defined thresholds.

The alert can also be analyzed using the generic trade Investigation screen below.
3.4 Breaking the Market

A Breaking the Market Order (BMO) is an aggressive strategy that lifts the entire Best Bid or Best Offer from the Order Book. This alert examines aggressive trading activities that “cross the spreads” as well as those lifting the entire best Bid/Offer from the order book, causing actual directional price movements.

The alert can be analyzed using the generic trade Investigation screen below.

An illustration of the definition logic is presented below. The logic constructs a Breaking the Market Time Window of configurable. Across this window, the logic investigates all of the entity’s orders on the same side. The logic only considers orders that have been partially filled + filled at a number of distinct prices greater than a user configurable threshold. Of these orders, the logic only considers orders that have been partially filled at a price range greater than a configurable multiple of the minimum tick size (parameter called Multiple of min tick size breached Threshold). Finally, the logic checks if up to the current fill being investigated, and within the BTM Time Window, the entity has entered orders that satisfy the above conditions greater than BTM Order Count Threshold times.

An illustration of the definition logic is presented below:
The extreme trade range alert identifies trading at unexpected and extreme price levels which may negatively impact market integrity. A transaction will trigger this alert if the price move is greater than an absolute value or percentage from the reference price for the instrument. The reference price is the price of the first print on the primary listing exchange for a security on that day. The thresholds are set for price bands and are expressed as absolute price movements or percentage moves.

The alert can be analyzed using the generic trade Investigation screen below:

An illustration of the definition logic is presented below:
3.6  Fictitious Quotes

This alert detects entities that intend to overload quotation system, which includes activities like submitting or cancelling bids/offers, or submitting non-actionable messages like RFQs (request for quotes). It is triggered by ‘Remove’ or ‘Update’ transactions that have been executed rapidly in a configured time interval.

The investigation screen displays the current stock price for the instrument of interest, RFQ history for the trader of interest and a display of RFQ status held by the trader (quote received, empty or cancelled). Two more bar charts (top right) are included to compare the trader’s RFQ statistics to pre-defined alert thresholds. This particular trader looks to have breached both thresholds, contributing to an alert.

The alert can also be analyzed using the generic trade Investigation screen below...
3.7 Front Running

This alert is designed to identify traders who are executing principal trades ahead of agency trades. This situation occurs when a trader is executing orders on a security for its own account taking advantage of advanced knowledge of pending client orders. Previously submitted client orders may predictably affect the price of the security, therefore the trader purchasing first for its own account has the opportunity to make exploitative gains.

Data input forms at the top of the dashboard enable the user to specify start and end time of the trade window under investigation, the instrument (in this case EUR/USD) and asset class (FX).

In the chart underneath bid price is represented by the green line and the ask price in red. The volume weighted average price for agency trades is depicted by the dashed orange lines and the volume weighted average price for principal trades is the dashed purple line. The purple and orange bubbles represent principal and agency orders respectively while the blue and yellow arrows represent agency and trade orders. Instances where the principal trading prices are consistently outperforming the corresponding agency VWAPs are highlighted for investigation.

The alert can also be analyzed using the generic trade Investigation screen below.
3.8 Inappropriate Barrier Running

This alert is designed to identify instances when Client-underwritten knock-out options are knocked out close to their expiry (in European case) following significant price movement in the underlying market (overall, not entity-caused) over a predefined window up to the knock-out time.

The investigation screen displays current stock prices (selected by dropdown widgets), the trading history of the entity of interest (trades on instrument of interest highlighted in white, ABC in this case), the current options held by the entity of interest and the ability for a user to define the ‘Knockout Barrier’ threshold (shown by the red line on top chart).

The alert can also be analyzed using the generic trade Investigation screen below.
Kx for Surveillance – Sample Alerts

3.9 Inappropriate Stop Loss

The logic detects traders that excessively “pre-hedge” against client stop loss, by comparing the client’s stop loss volume against the firm’s pre-hedge volume. The greater the price impact of the pre-hedging, the larger the firm’s profit at the client’s expense, as the firm can offset the worst price to the client.

The alert can be analyzed using the generic trade Investigation screen below:

An illustration of the definition logic is presented below:
This alert looks for indication of insider trading by comparing the levels of trade reversal activity in a particular security against a benchmark, particularly in cases where significant profits are accrued in the absence of, or just prior to, relevant price sensitive news announcements.

The table at the top of the dashboard presents transaction details such as time, order status, price, quantity, key window and when an entity buys/sells. The adjacent pie charts provide a more simplified image of the entity's activity in the reference window (blue chart) and the comparison window (purple chart). A central chart highlights additional timeline events:

- The y-axis represents the price while the x-axis shows the timeline of events;
- The x-axis logic occurs across the timeline of a day (24 hours) and divided into the key areas being reference window (blue), comparison window (purple) and the reverse window (green);
- The blue line chart is the price at a particular moment in time;
- Various points highlighted are when an entity buys (green dots) and when an entity sells (red dots).

The alert can also be analyzed using the generic trade Investigation screen below.
3.11 Large Order

This alert identifies unusual large orders where both quantity and value for new orders exceed benchmarks set on historical data and pre-defined thresholds. Order quantity is the total order quantity that includes visible and undisclosed quantities but excludes all marking on close orders. For futures, there are no benchmarks and the thresholds are set by contract type, either as number of contracts or value. This alert considers new and amended orders.

The table to the left provides details on entity value, transaction time, orders ID etc and grid below details the specific selected alert description. The timeline structured as follows:

- The y-axis (left) represents the value while the x-axis represents the timeline of events;
- Grey bars are public order value/qty plotted along the X axis representing the time throughout the day;
- Yellow line is the system generated benchmark threshold for this instrument;
- Green bubbles are the broker orders under the threshold;
- Blue bubbles are broker orders over the threshold;
- Red cross is the alert triggering order.

An illustration of the definition logic is presented below:
3.12 Layering

This alert highlights potential instances of the misleading act known as layering, where a broker enters several orders to improve the price of a security which shows false and/or misleading volume so that the broker can potentially trade the other side of the book at a favourable price.

The right side of the screen shows a summed count of each trade on a certain side of the book for the last 3 days.

The left side of the screen in the results section contains two tables, one which shows the entire set of data being investigated and the other showing the traders that have triggered the alert on a certain sym.

The configure tab at the top allows the user to change the parameters the alert works on, such as upping the number of buys/sells needed to trigger the alert or the number of days to look back over etc.

An illustration of the definition logic is presented below:
3.13 Marking the Close

Marking the close is a form of market manipulation. This alert is designed to detect traders or other entities executing trades near to the market close of the trading day for a high proportion of days over the specified period of time.

The top part of the dashboard allows the user to define parameters such as the start and end date of the investigation period, the start and end time of that time period, the stock being investigated, the trader ID and the bucket size (how large or small a window to use).

The multi chart underneath displays a plot of all the relevant data. The red and the green trend lines represent the bid and the ask price while the yellow trend line represents the market quantity. The white filled circles represent the broker quantity. The pink crosses in the trend represent the broker trading last while the yellow crosses representing the market trading last. So from the screenshot above it can be seen that on four occasions the broker traded last on a particular stock but the market also traded last on four occasions.

The alert can also be analyzed using the generic trade Investigation screen below.
Momentum ignition refers to a strategy that attempts to trigger a number of other participants to trade quickly and cause a rapid price movement. Generally, the instigator takes a pre-position, which instigates other market participants to trade aggressively in response, causing a price move; the instigator then trades out as the price reverts slowly to previous levels after the initial rapid price move. Momentum ignition is not exclusive to HFT environments but low latency assists in execution of this abuse.

The investigation screen above give further details into a triggered alert. The top chart displays market trade data (trade price and value), selected by the two dropdowns on the top left. The chart below it displays information about trades made by the trader selected in the dropdown to the left. The bottom left table is a display of all alerts that have been captured. Selecting an alert shows further trade data in the bottom right charts, comparing the market price movement and estimated profits to the pre-defined thresholds. In this case, trader 1 looks to have caused a sharp rise in the price of the selected stock by trading aggressively previously, profiting at around three times the threshold specified by the user.

The alert can also be analyzed using the generic trade Investigation screen below.
3.15 Order to Trade Ratio

This alert detects entities which submitted a high number of orders but had a low number of trades. If the measures of order count, order quantity, order trade count percentage and order trade quantity percentage all exceed their thresholds an alert is triggered.

The dashboard provides a top down view of recent activity across the market. The market overview tool in the top left allows users to pivot between asset classes comparing Instruments or trader/client. In the top right, the top widget contrasts the selected entity for the chosen metric (count, quantity ETC..) over a number of entities while the bottom screen provide further details on the selected entity.

The alert can also be analyzed using the generic trade Investigation screen below
Painting the Tape

Painting the Tape is informally known as "window dressing" in financial circles. This alert is designed to detect trades that cause unusual trade price movement within last 5 business days of the end of month followed by trade reversal within % of position within first 5 business days of new month.

The alert can be analyzed using the generic trade Investigation screen below:

An entity’s buy trade quantity for the last five days of the previous month (Pre Painting Window) is plotted along with the entity’s sell trade quantity for the first five of the next month (Post Painting Window). During the Post Painting Window, the entity reversed their position and breached the pre-defined threshold for the total buy trade quantity in the Pre Painting Window.

An illustration of the definition logic is presented below:
3.17 Parking

This alert detects participant syndicates which trade contracts and related instruments frequently between members without significant change in beneficial ownership, particularly where no individual member has a position that exceeds the regulated reporting threshold but the average member position exceeds a separate defined threshold.

The graph on top portrays several trades including bid, ask, trade, market volume and the fired alert. In this case the market seems to run as would be expected throughout the day, however when the market volume exceeds the bid, ask and trade variables the price suddenly jumps – at which point the alert is fired (and is marked with the purple line).

The data table on the bottom left provides a tabular view of the data with the information highlighted in orange identifying the trade and order that caused the alert. The graph on the bottom right displays the aggregated trade volume by counterparty and by side for the time period in the graph with the bars themselves representing the buy and the sell orders.

The alert can also be analyzed using the generic trade Investigation screen below.
3.18 Phishing

This alert is designed to identify traders or other entities who engage in the submission of a number of small orders, some of which may be filled, followed by the submission and filling of a large order in the opposite direction that benefits from the price movement the action had caused.

The alert can be analyzed using the generic trade Investigation screen below.

An illustration of the definition logic is presented below:

The green bars represent order lifetime. The start of each order bar indicates order entry time when viewed against the Time axis. The position of each order when viewed against the price axis indicates what price they have been entered and filled at. The width of each bar represents order value. Those ending in circles represent orders that have been filled and indicate the end of that orders lifetime. Those ending in fadeouts indicate that their remaining lifetime after entry is not monitored in the logic. For example, the only large order in the illustration was entered shortly before 10:04:19 and completely filled shortly before 10:05:46.
3.19 Ping Order

The alert identifies where a series of small orders is submitted in an attempt to ascertain the level of hidden orders and particularly to assess what may be resting on a dark platform.

The top section provides a tabular view of the relevant trades and cancellations. The bottom section illustrates order amounts and frequencies graphically. Orange dots in the left screen indicate ping orders and the red dots in the right hand graph indicate their high frequency.

An illustration of the definition logic is presented below:
3.20  Pump and Dump

This alert is designed to detect traders or other entities who accumulate a position over a long term, contributing to price movement and subsequently reversing their position substantially, all with respect to user-defined thresholds.

The alert can be analyzed using the generic trade Investigation screen below.

An illustration of the definition logic is presented below: The market trade price is plotted against date and time. The time and price of an entity sell trade is circled in red. This time marks the end of a Pump/Trash Time window and the beginning of a Dump/Cash Reversal Time Window. Entity Buy trades in the Pump Time Window are marked with green circles. Entity Sell Trades in the Dump Reversal Time Window are marked with red triangles. An overlaid zoom-in of a particular section of the graph is included. In this zoom in, some jumps in market trade prices are indicated in black and a price jumps caused by the entity is indicated in green. These measurements are used to calculate the entities contribution to overall market price movement in the alert logic.
3.21 Short Sell Violation

The short sell rule violation alert and report is for each order sent to the exchange. It does not apply to options. The firm-wide position is calculated based on existing positions at the start of the day, trades that occurred earlier in the day and open orders at the point in time the new order is marked. If that total is short (long), the logic confirms that the order sent is marked sell short (buy long). Orders may also be marked short if the total quantity of the sell order is greater than the total long position at the time of the order. The purpose of the alert is identify when the firm marks orders incorrectly.

The alert can be analyzed using the generic trade Investigation screen below.

An illustration of the definition logic is presented below:

![Diagram of alert logic](image-url)
3.22 Spoofing

This alert identifies instances where a large quantity of orders are entered and cancelled shortly thereafter in an attempt to inflate the interest in a contract by entering false and misleading volumes.

In the investigation screen above bid prices are plotted in green and ask prices in red. Market trades are illustrated by blue circles with cancelled orders highlighted in yellow; the size of the circles reflect associated trade and order volumes. The top chart displays the frequency of new and cancelled orders being submitted over the chosen time period while lower charts show split out broker order and traded volumes. The alert is fired after a concentrated sequence of such events attempting to deflate the market price.

The alert can also be analyzed using the generic trade Investigation screen below.
3.23 Unusual Trade Volume

This alert identifies where there is an unusual volume traded in an instrument in a trading day, based on comparison to threshold values or benchmarks for all trades. These thresholds vary through the day and are determined using parameters such as price level, sampling period (number of trading days to include), time bucket, min # of samples and percentile of sample data to use in the calculation. Thresholds are defined on individual trader and instrument.

The top chart displays the volume daily traded average (pink bars) quantified on the left axis and total number of trades (orange bubbles) quantified by the right axis for each trader trading on a specific instrument. The bottom chart displays the bid price (green line), ask price (red line), market price (yellow line) and broker price (orange bubbles) quantified by the left axis. Broker quantity (pink bars) and market quantity (grey bars) are quantified by the right axis. These values are displayed for a specific trader trading on a specific instrument over a given time period.

The alert can also be analyzed using the generic trade investigation screen below.
3.24 Wash Trade

This alert is designed to identify instances where sufficiently large positions are entered into and subsequently closed out, partially or fully, at similar prices leaving a close-to-zero net position (with respect to pre-defined thresholds) suggesting the motivation for the trade may have been to manipulate price by artificially increasing trading volume or facilitating corrupt brokerage payments.

In the case where viewer is the selling counterparty, the alert will flag the other counterparty. In the case where viewer is the buying counterparty, the alert will flag the broker.

The screenshot above display a list of Wash Trade alerts with description and accompany graphs for the illustrating total quantities, VWAP difference and quantity difference percentages for the selected instance.

An illustration of the definition logic is presented below:
4 Alerts Engine

The Kx alerts engine enables alerts to be grouped and triggered by common “events” (e.g. one alert engine might subscribe to trade changes, one to order changes, and yet another to news feed changes). There can be several instances of each type of alert engine, so there could be multiple trade alert engines (each subscribing to trades) allowing hundreds or thousands of different alerts to run in parallel in engines so the system may scale. The design and technology that enable this is based on Kx for Surveillance’s origin in the Algo trading world. Each alert engine can receive any required subset of market data and has access to any available static or configuration data. Given that the basis of the design comes from the algorithmic trading world, the alerts that are possible can be simple or arbitrarily complex. Below is a sample of the range of alerts that can be configured.

Coverage by Asset Class for ESMA MAR Regulations

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