Stream for Kx
Product Overview
Stream for Kx is a powerful data management and Complex Event Processing (CEP) platform with feature-rich visualisation

Stream for Kx enables users to capture, store, analyse and visualize large volumes of data within a single platform. It provides a framework to develop and deploy customized analytics that quickly perform complex calculations on large volumes of real-time and historical market data. By harnessing the power of Kx technology it offers unparalleled storage and retrieval capabilities.

Sample applications include the development of real time analytic engines (e.g. real time P&L engines, customized VWAP engines), trade cost analysis (TCA), data repository for equity research teams and compliance tools.

Stream for Kx has been engineered with the latest technology and deployed on-premises or hosted by Kx in its data centres in New York, London and Tokyo.

We hope to explain to you why this combination of the technology, the product and the pedigree of our company makes Kx your ideal technology partner in providing the best service to your clients and the greatest return to your shareholders.

Kx provide an accompanying range of services and support for all its products.

We provide a pool of talented and experienced developers with deep domain knowledge to assist clients in developing customised solutions that distinguish them in the market place. We provide services for defining, designing, testing and rolling out new functionality with supporting project management services to ensure control, quality and on-budget delivery. Kx also offers both public and private training services customised to client needs ranging from new system design and implementation guidelines to code optimization and architectural reviews.

Kx has operational bases in Europe, North America, Asia and Australia to service its global client base both locally and on a near-shore basis.
Stream for Kx– Big Data Fast

Stream for Kx is a proven Data Management solution that can be deployed Locally, in the Cloud, or as part of a wider Big Data architecture. Offering unrivalled performance, Stream for Kx allows firms to manage all of their analytics and visualisation needs in a single platform, or form a high performance component of a multi-platform Big Data solution.

Leveraging Kx’s rich SQL-like language and native map reduce features, the system is built to deal with high Volume and Velocity data. This information can then be extracted extremely fast and harnessed to form trading strategies, risk views, business intelligence and compliance answers. With the ability to scale vertically or horizontally using a simple architecture and boasting over 20 storage data types, Stream for Kx has become the data service backbone of some of the world’s most successful financial and investment management companies.

Why is Stream for Kx different?

- **Time to Market** - Customers can quickly build trading, risk and surveillance tools within days.
- **Value for Money** – Stream for Kx processes and monetizes massive amounts of data using a fraction of hardware and resources that traditional systems consume.
- **Rich Visualisations** - deploy business OLAP and BI Dashboards that run in real time rather than hourly.
- **Openness and Extensibility** - add your own feeds, real time pricing engines, analytics, etc.
- **Speed of analysis** - the speed that we can run complex queries on large data sets means business users can do 10x the analysis that they could on slower systems which leads to better insight.
- **Domain Expertise** - We understand your data problems.
As well as quoted market data across various asset classes such as Commodities, FX, fixed income, equity and commodities the application is ideal for generating streaming derived data.

Sample Analytics:
- VWAPs
- Bucketed data
- Level 2 order book profiles
- Real-time positions and aggregations
- Real-time P/L and risk measures
- Implied option volatilities from option prices
- Blended yield curves from money market, swap and treasury data
- Implied default rates from credit market data
- Construction of on-the-fly indices
- Algorithms used in compliance and detecting fraudulent trading patterns
- A high performance CEP engine – subscribing from a Tickerplant and generating derived data such as VWAP a PnL engine consuming opening positions, FX and Equity prices, and Trade reports and recalculating the PnL in real-time
- A pass-through bridge to relay tick data to a sandboxed set of other Real-time Engines

Key features of Stream for Kx

- Single inserts, updates, joins and selects – millions per second per core. Consistent performance with 10s of billions of inserts per day
- Bulk inserts, updates, joins and selects: up to 10s of millions of bulk inserts per second. Trillions per day
- In-memory table scans of unrivalled speed measured in milliseconds across trillions of records
- Supports thousands of concurrent time series queries involving billions of rows of data.
- Publish/subscribe mechanisms which can update hundreds of subscribers or a messaging bus in real-time.
- Historical databases allow users to access terabytes of records in seconds.
- Nanosecond timestamps.
- Size of database is limited only by RAM & disk capacity.
## Use Cases

The combination of high volume data capture, rich analytics and latency processing makes Stream for Kx an ideal solution across many domains within and without the capital markets.

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<tr>
<th>Domain</th>
<th>Specific Requirements</th>
<th>Common Requirement</th>
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<tbody>
<tr>
<td><strong>Banks / Hedge Funds/ Financial Institutions</strong></td>
<td><strong>Analyse price movements, define trading strategies and execute upon trading signals. Run Depth of Order Book analysis and Transaction Cost Analysis (TCA) to assess profitability across asset type, customer and trading strategies. Aggregate risk exposures, consolidate positions and P/L measure to establish a complete and accurate enterprise-wide risk and mark-to-market profile. Define intra-day, pricing, credit, exposure and P&amp;L alerts with visual tools, including heat maps and OLAP drill downs to monitor activity. Connect to major third party data vendors and exchanges to retrieve millions of updates per second. Process incoming data to cleanse and enrich with time series and statistical measures to drive trading strategies and feed downstream systems. View data on dashboard to look for patterns and identify anomalies.</strong></td>
<td><strong>Real-time data capture, storage of large data sets with built-in quantitative analysis and data mining functionality.</strong></td>
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<td><strong>Exchanges Regulators</strong></td>
<td><strong>Use Kx for Surveillance, based on Stream for Kx, to consolidate all exchange data (market, reference and even external client intelligence data) within a high performance database for both real-time and historical analysis providing the ability to monitor, alert and report on High Frequency and Algorithmic trading activity in real-time. Incorporate news, reference and intelligence data (e.g. investor associations) into comprehensive alerts and reports.</strong></td>
<td><strong>Alerts Framework for notification of results and actionable follow-ups – drive activity from analysis.</strong></td>
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<td><strong>Insurance Companies</strong></td>
<td><strong>Consolidation of data for profiling, aggregating and segregating risk factors. Simulation, replay capability to calibrate models and re-run analyses.</strong></td>
<td><strong>Replay and back testing to confirm results and fine tune parameters – confirm accuracy and derive new models.</strong></td>
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<td><strong>Telco</strong></td>
<td><strong>Monitoring network usage, call volumes, routing statistics to assess service levels and measure client profitability. Monitor backbone throughput and capacity levels to dynamically ramp up/ ramp down on resource allocation. Model and back test new pricing bundles and special offers.</strong></td>
<td><strong>Dashboard visibility offering intuitive, user-friendly interface with the ability create new queries and view results as charts, bubble graphs, tables, candlestick graphs.</strong></td>
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<td><strong>Gaming</strong></td>
<td><strong>Using high volume data capture to track usage patterns, player profiles, demography to measure penetration and forecast service capacity. Correlate with social media data to quantify sentiment and stickiness profiles. Model profitability, analysis advertising spend and revenue and model monetising possibilities.</strong></td>
<td><strong>High performance - Queries and functions are executed on commodity hardware at unrivalled speeds.</strong></td>
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<td><strong>Data Centres</strong></td>
<td><strong>Traffic monitoring and analysis: Peak and trough profiles, burst activity, capacity planning, detecting malicious or faulty behavior patterns, detect processing bottlenecks and monitor latency rates. Manage multi-server distributed environments from a single dashboard. Monitor the health of thousands of processes and servers across plants spread throughout multiple regions.</strong></td>
<td><strong>Resilience - Failover and Replication methods for enabling Hot-Hot and Hot-Warm failover capabilities.</strong></td>
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<td><strong>Utilities</strong></td>
<td><strong>Correlate usage patterns and trends with seasonality, demographic and environmental data to and optimize supply and delivery costs. Measure usage patterns to determine bottlenecks and latencies.</strong></td>
<td><strong>Connectivity to data sources and APIs for customized development.</strong></td>
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<td><strong>Retail</strong></td>
<td><strong>Monitor buying profiles and profitability by footfall, location, season, gender and age. Predict trends and cross-sell opportunities. Measure advertising impact and return, correlate with browsing patterns and social media data. Predict stock requirements, location needs. Model promotions, special offers and price points.</strong></td>
<td><strong>Enterprise level entitlement and user permissions for added security.</strong></td>
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Stream for Kx Components

Stream for Kx comprises four powerful components which together make it the most usable, effective and high performing system available. The core elements of all products in the Kx application suite - Control and Dashboards - are built on Kx core technology. Streams for Kx, the application layer, is built on Control for Kx and uses for Dashboards for Kx for visualisation.

APPLICATION LAYER

The Stream for Kx Application Layer comprises a rich set of processes and analytics that perform all the key tasks required from a CEP engine. The Process Library contains a rich set of highly optimized boiler plate processes including:

- **Real-time Engines** - easily configurable engines (CEP processes) consuming data and running analytics in real-time and either storing the raw and derived data in-memory or publishing it out to other engines.
- **Streaming Data Capture and Storage Engines** - enable the high-speed capture and retrieval of intraday in-memory data and the persisting of that data to disk for Historical querying.
- **Query Gateways** - query manager processes that optimize the real-time subscription of data from the platform to the frontend Dashboards and bridge processes which optimize the querying of data across multiple Intra-day and Historic databases.
- **File Loader Engines** - processes that can be easily configured with watch lists of files that should be transformed/cleaned and loaded into the system at different times of the day with built-in alerting functionality if files do not arrive as expected.
- **Alerting Engines** - functionality that enables alerts and notifications to be easily configured and generated by any of the engines and email or Dashboard notifications to be triggered.

The Analytics Library contains a central suite of Analytics that can be injected into the Process Templates or used by Dashboards Apps to access the underlying in-memory or persisted data.

DATABASE

At the heart of Stream for Kx is the high-performance Kx database, specifically designed for time series. It offers a database for both real-time and historical data. The same database is used to capture, store and analyse data. Kx combines the functionality of CEP engines, in-memory databases and analytic databases. It includes q, a general-purpose programming language that can access data directly, avoiding the performance degradation of first reading in data, then sending the data to an external routine. Q is an array oriented, functional language.

Event processing can be done immediately, as data is received.
- Lists, dictionaries and tables are primitive data types, and the core primitives are designed for this - for example to do arithmetic on tables. Operations apply as easily to a million records, as to a single record.
- It has built-in time data types, and queries are highly optimized for time series data.
- Data attributes such as sorted can be applied to columns to optimize performance.
- Q has database queries that are similar to SQL as well as functionality that goes beyond traditional SQL.
- The q interactive environment provides immediate feedback for rapid development.

_ENTERPRISE FEATURES_  
Control for Kx provides the centralized development, configuration and runtime management functionality for Streams for Kx. It also provides comprehensive enterprise functionality which is used by the Application Layer. This includes:

- **Permissions** - Entitlement checking and permissioning at entity levels;
- **Logging and Diagnostics** - Standardized logging and internal stats generation;
- **Messaging** - Topic centric discovery and routing and robust IPC abstraction;
- **Centralized Configuration** and parameter management;
- **Scheduling and Workflow** - Built in scheduler and workflow management;
- **Alerting and Notifications** – A standard alerting framework; **Error Handling**.

_VISUALIZATION_  
Dashboards for Kx is a high performance browser-based user interface application that provides a range of features that support user interaction with the server side components and the underlying KX database. Users of Dashboards for Kx can quickly and easily create Dashboard Apps (GUI forms) that can be used to retrieve data from underlying backend databases or ticker plants and present this data either in formatted data grids or graphs and charts. Polling or streaming options are available. Dashboard Apps can be linked together to provide sophisticated drilldown interaction between data sets and enables powerful views of complex analytics.
The main components of Stream for Kx are as follows:

- **The heart of Stream for Kx lies with the CEP engine**, which operates in a publish & subscribe configuration. The CEP engine is in effect a highly optimized tickerplant.
- **Real-time subscribers/engines** such as the Alerts Engine and the **Real-Time Database (RDB)** are processes that subscribe to the CEP engine and receive updates on the requested data.
- Stream for Kx is highly open and clients can connect to the real-time database (or directly to the CEP engine) through a series of interfaces such as Java, C/C++ and an embedded HTTP server. Stream for Kx also publishes results through a series of APIs.
- The real-time database can be configured to execute an end-of-day process that transfers all the collected data into a **historical database (HDB)**.
- **Dashboards for Kx** (see page 12) are used for visualising data in the HDB and RDB and for interacting with Kx for Stream.
Historical Database

The historical database is a database partitioned by date and composed of a collection of independent segments, any subset of which comprise a valid historical database. The database segments can all be stored within one directory on a disk, or distributed over multiple disks to maximize throughput. The historical database comprises a complete on disk collection of all the data stored so far and operates 24/7.

A query of the historical database is processed one segment at a time, possibly in parallel by multiple processes working on different disks. The historical database layout can easily be customized, as can its stored procedures and specialized analytics.

Similarly to the Real Time Database, any intra-day failure of a historical database will only have the effect that clients will not be able to retrieve information from that particular Historical Database. Any queries will then be directed to the historical databases that are still operating. If the historic database fails it should be re-started. This should be instantaneous at any time of the day. When the crashed historical database comes back online, all of the required data will be on disk so there is no data lost. Regardless of whether or not the HDB was down when the RDB wrote to disk, once the HDB is back up and running it will automatically detect the new data. Therefore no data will be lost.

Stream for Kx

The historical database is merely a replication of all the data in the log file. These updates can be configured to be immediate or polled. At a configured time an end-of-day message is sent to the RDB which causes the real time database to save all the intra-day data to the HDB and reset its tables. This message is also sent to all subscribers which can act on it accordingly.

The effect of this is that Stream for Kx operates seamlessly on a 24/7 basis.

The latency between the feed and the data being written to the log is less than 1 millisecond.

The CEP engine can be queried directly but ensure fail-safe and real-time operation, it is advisable that clients should only have access to it as subscribers.

Chained CEP engines are a useful device to improve performance further – each engine subscribes to a subset of data and in turn publishes to its own set of subscribers.

Stream for Kx users can use the GUI in Kx Analytics Library to develop their own functions. These can be used in the CEP Engine and real-time subscribers such as the Alerts Engine. The main features of the Analytics Library are:

- Single storage location for all analytics, with permissioned update and access.
- Share available functions, description and required parameters with other team members.
- Functions can be injected into processes via an easy-to-use GUI.
- Function backup, change history and version control available.
- Ability to test analytics on an underlying database or process.

CEP Engine

The CEP engine or tickerplant performs the following customisable operations:

- Receives the data as parsed messages and can store the data in memory for a short period of time (this is configurable).
- The parsed messages are immediately logged to disk (for recovery) and updates are published to any subscribers. These updates can be configured to be immediate or polled.
- The clients subscribe to the CEP engines rather than the real-time database. Once subscription has been made, the client will receive all subsequent updates. The real-time database is merely a replication of all the data in the log file. As soon as all the subscribers have been updated in-memory data is discarded.
- At a configured time an end-of-day message is sent to the RDB which causes the real time database to save all the intra-day data to the HDB and reset its tables. This message is also sent to all subscribers which can act on it accordingly.
- The effect of this is that Stream for Kx operates seamlessly on a 24/7 basis.
- The latency between the feed and the data being written to the log is less than 1 millisecond.
- The CEP engine can be queried directly but ensure fail-safe and real-time operation, it is advisable that clients should only have access to it as subscribers.
- Chained CEP engines are a useful device to improve performance further – each engine subscribes to a subset of data and in turn publishes to its own set of subscribers.

Real-Time Subscribers or Engines

Real-time subscribers are processes that subscribe to the CEP engine and receive filtered updates on the requested data. In general these should be started at the same time as the CEP engine. These subscribers perform user defined, real-time (or timer based) functions on all updates it receives. The subscriber publishes either the consumed data or derived data to more user defined subscribers.

Typical real-time subscribers are Kx+ databases that process the data received from the CEP engine and/or store them in local tables. The power of the Real-time Engine lies in the hooks that are exposed that allow runtime configuration. These include schemas, data sources, tables to subscribe to, sym, processes and analytics.

The Stream for Kx Alerts Engine is a special real-time engine designed to generate customized alerts.

The real-time database (RDB) is a specialized real-time subscriber. It contains all the data received for the day so far. When the RDB starts up it makes a synchronous subscription call to the CEP engine for all data from all tables. The synchronous subscription returns the schema of all tables defined in the CEP engine which the RDB initializes itself with. The RDB also retrieves and replays the log of messages and receives all subsequent updates. After this operation is complete the RDB has and maintains a complete history of all data observed on that day. As the RDB subscribes and retrieves the log count in the same call it will not miss or duplicate any updates. When the RDB receives the end-of-day message it saves all data to disk and flushes its tables. It then sends a reload message to the historic database.

In the event of failure, the real-time database automatically resyncs itself with the contents of the ticker-plants log file before receiving further updates. The real-time data base is operational 24/7. Clients who don’t require immediate updates, but need to view the intra-day data will query the real time subscriber.

Multiple real-time databases subscribing to the tickerplant may be used, for example, to off-load queries that employ complex, special-purpose analytics. The update data they receive may simply be used to update special-purpose summary tables. Using one of the many interfaces available including TCP/IP socket programming, custom subscribers can be created using virtually any programming language, running on virtually any platform.
Dashboards for Kx

Dashboards for Kx is a component of the Stream for Kx solution that provides the ability to visualize, analyse and explore large and complex data sets and unlock the value they contain. Users of Dashboards for Kx can quickly and easily create Dashboard Apps (GUI forms) that can be used to retrieve and interact with data from underlying backend databases or ticker plants and present this data either in formatted data grids or graphs and charts.

Key Features at a glance

- Flexible layout and formatting
- Web enabled
- Entitlements framework
- Easy to use Dashboard Builder Wizard
- Real-time OLAP – no need for pre-processed cubes
- Extensibility via plugins
- Kx Excel plugin
- Supports thousands of concurrent users

- Low latency/high volume streaming data
- Supports complex queries
- Real-time and historical data visualisation
- Takes advantage of the unrivalled power of Kx
- Full integration with other Kx applications
- Poll real-time data

Each dashboard comprises what is loosely termed a collection of applications, or “apps”. Apps are the core building blocks of a dashboard. Consisting of all the details required to relay your chosen information in your chosen format, apps allow the user to quickly extend his/her dashboard views, create new dashboards and update existing views all within a fully regulated environment with respect to entitlements. Apps provide a means of bringing together information from across multiple different databases in different locations into one unified visual space. Management of these apps in terms of entitlements, version control and release to production is performed by and maintained within Control for Kx.

Dashboards for Kx is much more than a business intelligence reporting tool. Starting from the highest level strategic view, a Dashboards for Kx user can drill down interactively to bringing greater detail on areas of interest in real time. In addition, Dashboards for Kx offers several ways for users to interact with the dashboard on screen. For example, the query parameters linked to a datagrid view can be populated by selections made on another part of the dashboard.

**Charts**

Charts are highly customizable. Even the most complex overlay chart can be configured in just a few clicks. A large range of graph types are available, including: Line, Area, Plot, Bar, Column, Pie, Candle, Bubble, Heat Map, Tree Map.

A variety of text formatting and conditional highlighting options are available to maximize the impact of the data displayed. Dashboards for Kx automatically discovers the schema of the underlying database tables to build a data dictionary of tables and their relations.

This knowledge of the underlying schema is encoded in the query builder to allow for very complex queries, including joins across multiple tables, via an easy to use drag and drop user interface that hides much of the complexity from the end user. This means that business users with minimal prior knowledge of the structure of the reference data and with no knowledge of SQL or Q can quickly explore the available relational and dimensional datasets, and easily build OLAP views on the data.
Stream for Kx is **totally open**; there has been no technology with which it cannot communicate.

Stream for Kx can interface to a multitude of input and output data sources such as:
- Data warehouses (Oracle, Sybase)
- Metadata repositories
- Statistical analysis tools (MATLAB, SAS, R)
- Access data portals
- BI tools (Delta Excel, Crystal Reports, Informatica)
- C/C++ API
- ODBC and JDBC support
- Connections through SDK, SOA and SaaS
- FIX; 29 West; Tibco
- Greenplum adaptor

**Feed handlers**

Kx offers a library of handlers for common feeds, as well as a service for developing in-house or external feed connections. Many clients have already reaped the benefits of fast, robust and supported access to multiple data sources. All Stream for Kx feedhandlers and bridges support entry and exit timestamps enabling full end to end latency to be measured and analysed. All handler functionality has been developed on a common C++ framework, sharing core capabilities across each adaptor. The feedhandlers also include a FIX engine which provides access to any FIX based market data stream.

Stream for Kx Feedhandlers capture market data and provide order entry capability across multiple asset classes.
- **In market data mode** they capture and can record different data formats to configurable Kx consumer processes.
- **In order entry mode**, the handlers offer a range of order types and reconcile responses.

**Key functionality:**
- Data normalisation
- Built in BBO calculations
- Order book generation
- Configurable schemas
- Statistics & time stamping
- Cross/lock book checking
- Audit Trail and logging
- Record and replay capability
- Depth snapshots and management

**Benefits:**
- Straight forward to deploy, tried and trusted implementations across multiple client sites.
- An accompanying administration console enables centralized management of adaptors, eases capacity planning and reduces configuration management overhead.
- FD provide on-going support including upgrades, schema or protocol changes.

**Sample of supported adaptors:**
- Athena & Athena APS
- CME iLink
- Currenexitch
- FXAll (Accelor API)
- GFX (spot 5 best limit)
- Hotspot FIX
- ReutersNews
- Interactive Data/Comstock
- BBG (Bloomberg TradeBook)
- CME MDP
- EBSLive
- FXALL (FIX)
- GFXFiX
- Integral FIX
- Reuters RFA/Dealing 3000 (& MAPI FIX)
- Ion, Exegy, Spryware, Quanthouse
- BGC (eSpeedFX/BGCFX FIX)
- CurrenexFIX
- FastMatch
- FXCM (FIX)
- Hostpot Itch
- Lmax FIX
- TraFX/ParFX FIX
- Calypso, Murex, Wall Street

**Historic Data Loading**

Stream for Kx has fast loaders for delimited and fixed width text and fixed width binary files of any format.

A File Watcher process is given a list of directories and regular expression based file names that it continually checks for. If it finds the target file it loads it onto the system.
Application Management & Control

Control for Kx offers additional components that complement Monitoring for Kx and provides functionality for configuring, deploying, maintaining Kx and non-Kx applications and processes.

Control for Kx provides centralized development, configuration and runtime management for Kx and non-Kx applications. Runtime management includes scheduling, log message handling, automated corrective action upon failure, hot patch code deployments, query access and end-user notification of environment issues. All user interaction is done via the Control for Kx User Interface, an Eclipse based client side application. The functionality available to each user is controlled by entitlements, meaning each user or user group can have a different view of the system.

A single instance of Control for Kx can manage the processes running across a server farm. It is fully fault tolerant when run in a clustered configuration, replicating its current state across nodes.

Kx Enterprise Edition also provides a comprehensive set of highly optimized enterprise functionality including:

- Process Library – a set of customisable process templates commonly used in enterprise level systems.
- Analytics Library – a set of customisable, modifiable analytics (functions) used to modify and extend system behavior.
- Permissions - Entitlement checking and permissioning for both entities and data.
- Logging and Diagnostics - Standardized logging and internal statistics generation. A central operations subsystem is used to provide a view of system health across the whole environment.
- Messaging - Topic centric discovery and routing.
- Centralized Configuration – Parameter management including parameter overriding and automatic configuration update deployment.
- Scheduling and Workflow - Built in scheduler and workflow management.
- Failover and Replication - Methods for enabling Hot-Hot, Hot-Warm and Hot-Cold failover capabilities.
- Alerting - An alerting framework to allow both system and business focussed alerts and corresponding notifications.
- Error Handling - Error propagation and automated corrective actions.
- Report Generation - A resilient report generation component which allows management reports to be periodically scheduled and distributed.
- Release Management – Tools for building release packages and to enable automated deployments.
# Kx - Power, Performance and Scalability

The Kx database platform is developed by Kx Systems, a subsidiary of FD. It is the world’s leading time series database and is used by some of the world’s largest investment banks, hedge funds and insurance companies. Together have helped many of these organisations develop mission critical systems using Kx technology.

The unrivalled power, performance and scalability of Kx lies at the core of our software solutions. Ongoing enhancements take advantage of the latest advances in hardware, networking, compression and data transport.

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<th><strong>Power</strong></th>
<th><strong>Performance</strong></th>
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| - A columnar structure for the database simplifies indexing and joins and speeds search performance.  
- Publish/subscribe mechanisms: offload processing from the main server onto chained servers, allowing data services to be provided to a virtually unlimited number of clients.  
- Kx includes a general-purpose programming language, q, a superset of SQL that has direct support for databases. The language features provide enormous advantages over traditional SQL systems, or where the supplier provides pre-written queries. With q, the end user can respond quickly to emerging needs.  
- An interactive environment provides immediate feedback for rapid development.  
- Kx is a fully functional relational database, with support for foreign key and ad hoc joins to reference data.  
- A single installation supports multiple distinct feeds and setting up additional feeds from internal sources is easy.  
- A Kx real time database can handle hundreds of thousands of records per second as updates while maintaining sub-millisecond query response times. | - Kx achieves its performance advantage over other databases by its close attention to key performance criteria:  
- Native 64-bit architecture – essential for managing today’s data volumes.  
- Built-in multi-core processing and multi-threading. Performance scales linearly with more CPUs - multiple cores without having to write special thread-aware code.  
- Performance of disk based databases is based on being able to quickly map fixed width columns from disk.  
- Compression is supported. In addition file system based compression (e.g. ZFS) perform well.  
- Kx supports incoming ODBC connections to allow other programs (e.g. Oracle) to extract data using SQL queries.  
- With conventional databases, performance degrades for large tables, and query response times can run to hours. Even with fast storage, random data access is slow. To assist with disk management, Kx supports distributed parallel scalability. CPUs and disks can be dedicated to specific operations, preserving performance for operations that require more power, i.e. real-time analytics. |

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<th><strong>Scalability</strong></th>
<th><strong>Time Series</strong></th>
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| - Support for parallel access to large partitioned historical databases, so queries can be farmed out to multiple cores/machines  
- Kx can handle millions of records per second, billions per day, trillions in a historical database. It copes with data spikes, and it can be used with hardware accelerators.  
- Optimized for bulk inserts/updates, and not just single transactions – bulk operations do not need taken offline.  
- Horizontal scalability is linear and virtually without limit; simply add another CPU or server, increase the memory, or expand your storage. There is almost no discernible effect on the performance, even with hundreds of CPUs.  
- Distributed parallel scalability maintains query speeds.  
- Databases can be spread across machines and queried in parallel using gateway processes.  
- Different machines can access a shared file system which contains the database.  
- Parallel processing is very simple there are built in options for using slaves to retrieve / process subsets of data.  
- Vertical scaling is easy - adding more CPUs to a machine will either allow more processes to be run, or allow the processes running on that machine to use more slaves.  
- Extra RAM / disk can be used to increase the amount of data stored in memory or on-disk. | - Kx has been explicitly designed with the nuances of time series databases in mind.  
- Time series information is stored by default with a resolution of less than a millisecond. Additional temporal types available if more precision is required.  
- Lists, dictionaries and tables are primitive data types, and the core primitives are designed for this - for example to do arithmetic on tables. An operation can apply just as easily to a million records, as to a single record.  
- It has built-in time data types, and queries are highly optimized for time series data.  
- Data attributes such as sorted can be applied to columns to optimize performance.  
- Kx incorporates a SQL dialect that has extensions specifically for time series queries (i.e. concept of first and last records in a series, built in methods for bucketing data into time slices). Many mathematical and statistical functions are built in (averages, weighted averages, deviation etc), and custom functions can be easily written.  
- Kx’s partitioned historical database can scale to tens of terabytes of data with no performance degradation for queries over a single day or a fixed time period.  
- It can operate on data directly, minimising data traffic. There no need to first read data, then export to an external routine for analysis. Event processing can be done as data is received. |
### Case Studies

#### Background:
The sales division in a major European investment bank required a high performance platform to analyse the profitability of the bank / client trading strategies.

#### Drivers:
The client sales team at the bank needed to calculate trading profitability per client down to a granular level, analyse liquidity in electronic versus manual trading and visualize and calculate trade decay over pre and post-trade movements. Stream for Kx was introduced to provide fast and reliable technology for capturing and storing trade quotes and orders, running analytics and providing users with a browser based GUI through which they can interact with and visualize the resulting data.

#### What we did:
- On-site developers implemented Stream for Kx, configuring it to work within the bank’s existing infrastructure.
- Stream for Kx was configured to capture price quote/tick updates for orders, trades and rejections rates from external and internal sources.
- Set-up raw data processing on a tick-by-tick basis to provide value added information to users immediately.
- Analytics and browser based dashboards developed to client specifications.
- Both on-shore and off-shore development and support was provided.

#### Benefits:
- Significantly increased the amount of quote and trade information being captured, resulting in improved client flow analysis and increased sales desk profitability.
- Improved visibility into rate volatilities over time by instrument, currency, time period, underlying and moving averages by various weightings.
- Quantitative reports and analysis on quote rejections and trading rejection rates.
- A user-friendly browser-based to visualize and interact with rich data sets.
- Leveraged FD’s expertise in Kx to enable rapid iteration and deployment of client requirements.

#### Background:
The client, a major south east Asian exchange, wanted to improve its reporting and monitoring capabilities and, for risk and regulatory purposes, implement advanced surveillance techniques to detect anomalous trading patterns.

#### Drivers:
The client was seeking to replace their internal reporting and monitoring capabilities across all the assets traded at the exchange (equities and derivatives) but also wanted to implement surveillance and alerting functionality to detect and notify any anomalous trading behavior. The client was seeking a platform which would fulfil not only their current reporting requirements but would be flexible and easy to extend for future requirements. Through FD’s Stream for Kx solution they wanted to leverage the data captured and stored by the matching engine to meet future needs in terms of reporting, market surveillance or on-selling of data.

#### What we did:
- Implemented Stream for Kx to capture every message generated by the exchange’s matching engines.
- Replicated the current reports but with vastly superior performance.
- Implemented complex, configurable monitoring rules based on market makers contractual obligations.
- Trained exchange staff to become self-sufficient.

#### Benefits:
- Ability to define and distribute new reports as new requirements arise.
- Monitoring the obligations of all market makers against all their securities in real-time against highly complex rules.
- Real-time alerts and daily reports.
- Detailed view of trading activity at a summarized and detailed level in real-time and as also periodic reports.
- Minimal maintenance required from exchange staff.
### Background:
**A large US telco required real-time tracking and analysis of network usage.**

**Drivers:**
The client required real time analytics on its network routing data to determine usage and capacity needs of system resources (servers, bandwidth, routers). For planning and capacity planning purposes it also needed to capture and analyse data to detect non-standard usage patterns.

<table>
<thead>
<tr>
<th>What we did</th>
<th>Benefits</th>
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| • Deployed Stream for Kx to capture call record routing packets which are published in real time off their router infrastructure.  
• Implemented performance analytics and statistical measures on traffic and routing volumes to track utilisation thresholds and monitor system health status.  
• Built an historical repository of data and metrics for subsequent analysis.  
• Defined alerts to highlight anomalous activity that was not in line with existing system profiles.  
• Provided a Dashboard visual layer for both developers and management to monitor and drill down on key measurements.  
• Trained exchange staff to become self-sufficient and develop own analytics and alerts. | • Immediate and informed insight into efficiencies of the network backbone.  
• Improved capacity planning as business expands and traffic grows, which ultimately reduced costs.  
• Improved end-user customer satisfaction over correctly configured infrastructure as well as minimal outages.  
• The ability to quickly measure their service against competing services.  
• Capability to run ad-hoc analysis when there is a system issue or an inquiry into a record irregularity.  
• The ability to minimize costs associated with illegal usage of their network. |

### Background:
**Statutory obligation required the exchange to implement real-time detection and reporting of suspicious trading activity.**

**Drivers:**
The exchange required a high-performance, low latency solution to enable real-time detection of trading anomalies and irregularities in trading patterns across equities and derivatives assets. Both the volume and the velocity of data required a robust, high performance solution.

<table>
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<th>What we did</th>
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| • Implemented a complete tick real-time & historic database.  
• Integrated Stream for Kx across all components and external interfaces.  
• Customized alerts and data sources based on:  
  – Combined market intelligence (C&S Investor data), news, unstructured data, parsed text data (chats, news), sentiment etc.  
  – Tags for analysts to track investor activity across broker accounts.  
• Implemented post trade processing for historic alerts.  
• Configured integrated workflow management to enable tracking of alerts. | • Fulfilling regulatory requirement on Real-time detection an alerts on suspicious trading activity including:  
  – Price/Volume Reporting  
  – Trade-throughs  
  – Marking the Open/Close  
  – Spoofing (Price ramping)  
  – Order Book Alerts (e.g. Layering)  
• Flexible reporting capability enabling independent definition and distribution new reports and parameterized alerts.  
• Ability to back test and fine tune parameters.  
• Hosted Solution.  
• Cross market monitoring.  
• Detailed view of trading activity at a summarized and detailed level in real-time and as periodic reports. |
FD Corporate
FD is a leading provider of software solutions and consulting services to the capital markets industry. Founded in 1996, it occupies a niche market position in terms of deep domain knowledge and technical expertise. Headquartered in Ireland, FD has a global presence with offices across EMEA, the Americas and Asia Pacific.

- Publicly held company on London Stock Exchange (LSE FDP.L)
- Headquartered in Newry, Co. Down, N Ireland
- 1500+ employees worldwide

Consulting Services:
- Multi-Vendor Services – Calypso, Murex, Wall Street, Summit, Opics...
- Legal, Regulatory and Compliance
- Data Management
- Software Development
- Big Data and Data Science

Big Data Solutions:
- Stream for Kx – high-volume data capture, analysis and distribution
- Kx for Flow – Foreign Exchange trading
- Kx for Algos – low-latency trading strategies and execution
- Kx for Surveillance – for regulators, exchanges and brokers
- Kx for AlgoLab – testing, validating and profiling algorithmic trading strategies
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