Kx for Monitoring
Product Overview
Prevention is better than cure, almost everyone would agree. Where it’s not possible, however, early detection must at minimum be achieved to minimize the damage. And in the middle should be early warning – knowing from past experience that a set of events or indicators suggests a failure is imminent and that taking action now will forestall its negative impact. All three come into play in the best monitoring practices: regular maintenance to avoid errors, visibility to detect them and early intervention to minimize them. Kx for Monitoring helps in each of these areas.

**Visibility:** Dashboards enable users to see instantly what is running, not running or running at sub-optimal levels. Alerts and notifications ensure that the right people know where, why and when something is wrong.

**Insight:** A complete database of results, alerts and processing statistics enable analysis into the causes, frequency and precedents of system failures. Historical data provides insight into what regular maintenance should be performed to avoid errors. Analysis of past performance helps identify thresholds and warning levels that indicate where failure may be imminent.

**Control:** Drilldown to detailed information on the causes and location of errors to enable swift remediation. Support staff can see instantly what process is in error, what server, what network card etc. requires attention in order to restore service quickly and effectively.

Kx for Monitoring helps clients ensure their day-to-day operations run smoothly and to schedule. It provides a set of monitoring dashboards that display high-level information on the current status of primary indicators with accompanying drilldown to underlying details. It provides real-time alerts and notifications to those who need to know immediately what is wrong and where and, almost as importantly, it retains historical data for follow-up investigation and subsequent analysis to ensure it is not repeated.

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.
Solution Overview

Kx for Monitoring is an enterprise solution for real-time monitoring, investigation and analysis of system stability and performance. It is specifically designed for platforms where system performance and efficiency is critical to provide real-time visibility into the performance and stability of servers, applications, processes and infrastructure.

- **Control** – Centralized environment for monitoring infrastructure, applications, and processes.
- **Visibility** – Dashboard summary with drilldown functionality to view detailed results.
- **Real-time** display of performance data and processing status.
- **Alerts** – Detection and notification of errors, threshold breeches and bottlenecks.
- **Speed of deployment** – End-to-end solution that can be swiftly deployed to monitor enterprise applications.

Data can be analyzed in real time to trigger alerts and display critical information via powerful dashboards in a versatile and meaningful way. An Integration API provides an interface for publishing signals from in-house systems and applications into Kx for Monitoring enabling cross-enterprise visibility and analysis of processing status. Using the power of Kx, it can incorporate previously stored data, results and signal information to further enrich its analysis and monitoring capabilities. The storage of large amounts of historical data allows the user to analyze different time periods and trends in order to make future predictions.

- **Reactively**:
  - Quickly identify performance bottlenecks and avoid backlogs
  - Latency Signals: internal, point to point and roundtrip latencies
  - Collate data from multiple servers into one central location for investigation, analysis and warehousing
  - Stabilize poorly performing applications

- **Proactively**:
  - Investigate and pinpoint latency points across systems, messages & order types
  - Identify server memory usage/workload patterns per daily/weekly/monthly basis
  - Customize key performance indicators (KPIs) used to provide assurance and visibility of activity and performance
  - Improve and streamline capacity planning and maximize uptime of key applications

### Flexible and Extendible

Kx for Monitoring can be extended and customized as required to areas ranging from scheduling and distribution of management reports to scraping important log files for configured messages and implementing log growth detection.
Why Kx for Monitoring

Kx for Monitoring helps address the question and practical challenges organizations face on a daily basis:

- Are all your systems currently running? Show me.
- Are you confident they will continue to run efficiently? On what basis?
- Can I look at the status of individual applications as well? How?
- Is there a history of performance data I can compare this against and do some analysis on?
- Is there a pattern to the peak and troughs we have been seeing?
- Can we justify to procurement why we need this additional hardware? Do we have supporting stats?

<table>
<thead>
<tr>
<th>Key Feature</th>
<th>Details</th>
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<tbody>
<tr>
<td>Real-time Customizable Alerts</td>
<td>High-performance analysis of monitoring data allowing the user to customize the built-in alerts via parameters or define custom alerts using a built-in Alerts Framework. <strong>Multiple alert notification options</strong> including UI notifications with built-in sound alerts and/or email notification which can be targeted at different users/user groups based on the underlying data. <strong>Users can also extend the notification framework to push alerts to other applications.</strong></td>
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<tr>
<td>Rich Visualization</td>
<td>Interactive analysis capabilities on <strong>aggregated monitoring data</strong> and rich graphical display enabling users to <strong>drill down</strong> to explore trends. The varying priorities of different user groups can be met through a single solution with a completely customizable user perspective - interactive analysis capabilities enabling users to slice and dice the signal information to <strong>identify root causes.</strong></td>
</tr>
<tr>
<td>Integration API</td>
<td>Includes an interface for publishing signals from other in-house systems and applications into Kx for Monitoring enabling cross-enterprise visibility and analysis of processing status. <strong>External applications can interface using java, c, c++, or c#.</strong></td>
</tr>
<tr>
<td>Data Warehousing</td>
<td>Storage of monitoring data using the power of <strong>Kx technology</strong> augments real-time data and enables comparison of current signal information against <strong>historical data</strong> and performance metrics. The storage of large amounts of historical data allows the user to analyze different time periods and trends in order to make future predictions. Since users can quickly access critical data from a number of sources—all in one place—they can rapidly make informed decisions on key initiatives.</td>
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<tr>
<td>Kx Platform</td>
<td><strong>Entitlements</strong>, access control, monitoring, audit and failover capabilities. <strong>Connectivity framework</strong> that greatly simplifies interfaces to read data from market feeds and internal systems and publish them to internal consumers. <strong>Workflow framework</strong> for assigning trading alerts to surveillance analysts, and to manage alerts through analysis, investigation and case creation.</td>
</tr>
</tbody>
</table>

Kx for Monitoring can be extended and customized as required. Customization can be done by the customer directly or with help from Kx. Examples include the ability to scrape important log files for configured messages, implementing log growth detection and scheduling and distributing management reports. The high-performance data processing architecture, built on Kx, ensures that from day one no compromises have to be made on what signals to capture.
Solution Overview

The diagram below illustrates how Kx for Monitoring operates. It ingests system data from servers, server farms and applications via its data capture layer, stores the data in a Kx database, calculates system level and application level statistics and communicates results and overall status via dashboards, reports and alerts.

Visualization of Results

Kx for Monitoring includes Dashboard functionality for highly customizable displays where even most complex views on data can be configured in just a number of clicks. Once created they enable further user interaction including:

- Drilldown into results by double clicking in a row of data
- Slice and dice the underlying data by dragging the column names across the breadcrumb trail and pivoting on key dimensions
- Support for complex parameterized queries making it easier to explore and analyze data sets
- Quick access to aggregated and summary information for strategic analysis

Visualization features include:

- Overlaid Charts Line, Area, Plot, Column, Candle and Bubble charts can be overlaid to view different chart types along the x-axis and up to two y-axis ranges.
- Display Options Various label, legend and axis rendering options allow the graph display to be customized in a large amount of ways.
- Clickable data points Data points can be selected and used to populate parameters on other applications much in the same manner as clicking on row/rows in a data grid.
- Zooming is available in charts when increased resolution is required on the data.
- Parameterization Charts can be parameter-driven to give extra flexibility and ease of user to users.

Monitoring can also extend to

1) Temperature at server & card level and network device & interface level
2) Power - load available & used, input voltage, number of power supplies in active / passive mode etc.
3) Cooling (number of total fans, active vs passive, current loading...).

A collection agent runs on each machine

Statistics are periodically published back to central database. Statistics collected include:

- Server memory, CPU, swap, load, file system and NIC usage
- Per process memory, CPU, TCP/IP queue sizes

Standard alerts based on thresholds provided on

- Server availability, CPU, load, file system usage
- Process availability and memory usage

A generic alert framework is provided – any statistic within the system can easily be converted into an alert.

Kx for Monitoring includes enterprise features for application development, system management, access control, audit, logging and failover.
Kx for Monitoring provides support teams with metrics and statistics on individual servers at an infrastructure level and offers configurable alerts to highlight when key indicators have been breached. Early detection in this manner enables swift, targeted remedial action by support teams armed with the knowledge of what is wrong, where and why.

Dashboards provide summary status views on servers, processes and engines with drilldown to view errors and their causes and enable managers and support staff to view machine status, processing bottlenecks and overdue tasks. Kx for Monitoring provides the tools necessary for the investigation of a problem with system resources in areas such as CPU usage, memory usage or network connection issues. Screens do not provide just static data – they also provide an interaction that enables users view a wide range of data but with the ability to focus in on specific areas that need investigation.

The screen above provides a “Process Details Selector” tab and a range of selectors including users, process types and groupings to filter for specific processes of interest. Similarly, the “Network Connections Summary” tab can be used to find processes which have busy network connections.

Additional information presented includes:
- A graphical view of process details – a historical, time-bucketed view of the process memory and CPU usage;
- Network connection details – a historic, time-bucketed view of the number and aggregate queue size of the network connection details over time;
- Server details – a historical, time-bucketed view of the total CPU, memory, load and individual CPU usage figures for the given server;
- NIC details – a historical, time-bucketed view of the sent and received data for each network card on the given server; and
- Connection details – for each open connection the process has, the total send and receive queue sizes, the duration the connection has been open, and the end points of the connection (if available).

Now and Then: While real-time updates are critical for early detection and minimizing disruption of processing errors it is sometimes almost as important to be able to view historical data, reviewing a previous incident for comparison with a recent one, identifying trends, looking for factors that may have been overlooked or not previously considered. Kx for Monitoring maintains a full historical database of results that can be quickly and flexibly investigated.
Application Monitoring

In addition to infrastructure and resource monitoring, Kx for Monitoring also provides application-level monitoring that enables users to view details on individual engine status, processing backlogs, scheduled tasks and information on long running queries such as when started and by whom.

- All Kx processes publish application monitoring information
- This includes log messages, queries being run, access requests and latency measurements
- Dashboards to view and analyze these are provided
- Other applications can similarly publish data to existing schemas
- Alternatively schemas and analysis can be extended as required
- Alerts can be derived from any and all application data
- Application can interface using Java, C, C++, or C#

Sample Use Cases

<table>
<thead>
<tr>
<th>Kx Applications</th>
<th>Non-Kx Applications</th>
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<tbody>
<tr>
<td>In the Kx for Flow FX trading platform, Kx for Monitoring is used for analysis such as</td>
<td>In Calypso environments, Kx for Monitoring can be used to monitor the processing time of messages within the Calypso engines to pinpoint bottlenecks</td>
</tr>
<tr>
<td>- Latency measurements within and between processes</td>
<td>- Measuring and quoteack/nack trends and ratios</td>
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<tr>
<td>- Measuring and quoteack/nack trends and ratios</td>
<td></td>
</tr>
</tbody>
</table>

- CPU and memory usage, disk and network I/O, pings...
- Latency Signals: internal, point-to-point and roundtrip latencies.
- Quickly identify performance bottlenecks and avoid backlogs.
- Data cached to identify server memory usage/workload patterns per daily/weekly/monthly basis etc...
- Data integrity signals: non-tick symbols, order book validation.
- Temperature, power load and other physical statistics
Multi System Monitoring

Applications and servers may individually provide information on their status but what support teams need is a consolidated view across multiple systems – a dashboard that summarizes the overall enterprise-wide status. To do this Kx for Monitoring does the following:

- Collects data from multiple servers to gather a complete picture of network communications and interfaces.
- Collates data from multiple servers into one central location for investigation, analysis and warehousing.
- Provides an Integration API to simplify data collection.
- Enables servers to be grouped into different logical environments such as Production, UAT and analyzed at that level.

It then presents the results in a consolidated dashboard that instantly gives users a “Top” overview.

Alternative graphical displays can be easily created.

Drilldown information enables users to view underlying data on selected servers and across selected days and dates. In this example, the alert history is displayed to view causes, recurring trends and individual occurrences. This information enables users to not only identify where remedial action is required (for example, there is a recurring instance of queue depth build on a particular server) but also to verify if the remedial action taken actually addressed the problem (for example, did the added memory and disk space address the high memory utilization rates experienced over the last week?).

“Top” Views
- Process CPU memory league table – which processes are using the most CPU and memory
- Network Connections league table – which processes have busy network connections to other processes
- Server Memory league table – which servers are using most memory
- CPU Core league table – which CPU cores are being used most actively
- File System league table – the used space on each file system
- CPU and memory graph – a historical time-bucketed view of the process memory and CPU usage
- Server details graph – a historical, time-bucketed view of the total CPU, memory, load and individual CPU usage figures a selected server
- Alerts Monitor – a view on all alerts being generated by the system
Warehousing and Profiling

One of the major advantages of Kx for Monitoring is that it stores all results in a Kx database that makes it easy for clients to retrieve and analyze historical results. In its most intuitive form, it provides a Dashboard “State at time” that largely emulates the “Top” Dashboard outlined earlier but on any historical date or time selected by the user. This can be especially useful for investigating environments at or around the time of a system or process failures and for looking for recurring patterns or trends that may inform capacity planning or suggest configuration changes.

The Monitoring Dashboard provides the tools necessary for the investigation of server problems specifically with regard to statistics like CPU usage, memory usage and network cards or physical measures like temperature or power usage.

1. The following server detail parameters: host, start date, end date, start time, end time, CPU and bucket seconds must be selected and submitted to return the required statistics for the graphical displays on the GUI.
2. Once submitted, the Server Details Graph and the NIC Details Graph are populated.
3. Statistics which make up the graphs can be displayed by holding the mouse over the graphs at different time periods.
4. More descriptive statistics can be found by selecting the Server Details tab and the NIC details tab above both graphs.

The dashboard on the right queries entries in an audit table. From this information a user can determine if there were any configuration or analytic updates over a specific time frame, view previous amend dates and compare the changes from one version to the next. Double clicking on an audit event, the app to the top right-hand side will show the versions and dates of alterations.
Dashboards can monitor data from multiple sources and of multiple types - the dashboard above summarizes queries on the Latency, Log, Query Log and CPU processes tables.

**Performance Monitoring and Stress Testing**

Kx for Monitoring can also be used to track key performance metrics that give developers, testers, technical analysts and system administrators insight into system dynamics and enables them to test how coding and configuration changes may affect performance.

- Waiting and Consumed processes.
- Totals, averages, spike and drop statistics
- Incoming database figure and throughput processing statistics.

It also provides a real-time engine monitoring component to monitor live queues and provide alerts.

**Process Statistics**

Dashboards can be created to focus on specific process information and statistics such as:

<table>
<thead>
<tr>
<th>Process name</th>
<th>Current process memory used in MB</th>
<th>Current process CPU usage</th>
<th>Number of log errors on processes today</th>
<th>Number of log warnings on processes today</th>
<th>Number of queries hitting process today</th>
<th>Average query time in Query Log table</th>
<th>Max and median latency stats</th>
</tr>
</thead>
</table>

- Investigate and pinpoint latency points across systems, messages & order types
- Stabilize poorly performing applications
- Improve and streamline capacity planning
- Customize key performance indicators (KPIs) used to provide assurance and visibility of activity and performance
- Proactively identify where the problems reside
- Maximize uptime of key applications

**Metrics on application performance**

- Analysis of coding and configuration changes

**Identifying degradation levels**

- Pin-pointing throughput peaks and troughs
- Identification of performance bottlenecks
Business Process Monitoring

Kx for Monitoring can be used to service not only technical and infrastructure support teams, but also business users who wish to monitor statistics on business processes such as the number of alerts being raised, performance measures and trading profiles.

Alerts Profiles

This Alert Summary dashboard provides functionality to view, filter and analyze all alerts raised. Bar charts enable users to view the status of alerts by symbol, by user and by alert type. These can be further filtered by time period with an accompanying drilldown to the content of each alert. This enables the user to view patterns and detect trends in the alert profile. The visibility from overview to detail enables organizations to better manage and assess alerts and their underlying causes.

Monitoring Quote Acceptance and Rejection Levels

In the screens below the viewer is analyzing the filled / unfilled order statistics (Acks/Nacks) in a trading solution.

The first tab “Ack Nack Total” looks at results per client by various user parameters: dates, duration, currency pairs, quotation pools and participant type. This enables users to scan the full data set swiftly and drill into particular areas of interest or concern. The relatively large proportion of red in the middle column would indicate a client with a particularly high rejection rate that warrants further investigation.

The “Ack Nack by Freq” tab then provides the ability to view recurring peaks and troughs in throughput or rejections within user specified time interval. This enables operators to identify trends and aids capacity planning. In this case we see the volumes of Acks and Nacks in 15 minute intervals over the last 5 days and can immediately identify high Nack rates (red column) in early morning, midday and late afternoon periods. As with all dashboards the data under analysis can be readily amended by users and all results can be exported to Excel for further analysis and reporting if required.
Analysing Trading Patterns

Dashboard tabs enable users to combine lots of views into a single display and provide the ability to assimilate a range of different measures when assessing data. In the example below, five tabs provide different insights into trading activity enabling regulators and trading desks to quickly form an overall impression of counterparty trading profiles.

The first two tabs use heat maps to rank participants by an order-to-trade ratio and by trade aggressor figures - profiles that may suggest High Frequency Trading activity. Hover-over callouts and drilldowns provide further detail.

The Cancellation Rate tab displays the number of times an order was cancelled within a configurabe threshold time - clicking on the individual counts provides further detail to assist investigation into the appropriateness or not of such potentially manipulative activity.

The Daily Turnover Ratio graph detects traders who are closing out positions above a configurable percentage (in this case 95% is selected) - the number of trades within such close outs is illustrated by the bubble size and the color indicates the traders profit or loss profile.
Management and Control

Control for Kx offers additional components that complement Kx for Monitoring 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.

Control for Kx also provides a comprehensive set of highly optimized enterprise functionality including:

- Process Library – A set of customizable process templates commonly used in enterprise level systems.
- Analytics Library – A set of customizable analytics (functions) used to modify and extend system behaviour.
- 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 focused 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.
Other Services

Kx works with many of the world’s leading investment banks and hedge funds, helping them achieve success in an ever changing business environment. We capitalize on our experience as a provider of technological services and also as a dedicated product supplier. Kx can find the right solution for you and has the expertise to get the job done.

Kx has a number of specialist practices headed by subject matter experts each with between 10-25 years of experience in the capital markets industry. Kx provides expertise across a number of areas:

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<th>Regulatory and Compliance</th>
<th>Software and Services</th>
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<tbody>
<tr>
<td>• Staff Augmentation</td>
<td>• Kx</td>
<td>• Dodd-Frank</td>
<td>• Streams for Kx</td>
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<td>• Kx for Algos</td>
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<td>• Commodities and Energy Trading</td>
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<td>• Summit</td>
<td>• Non-Core Asset Disposal</td>
<td>• Kx Development and Training</td>
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**Financial Services Practice:**
Kx offers in-depth knowledge of capital markets combined with extensive technical expertise. We work with clients to gain an understanding of their individual and unique needs and offer a variety of services at competitive fees. We believe in investing in our people and endeavour to employ the brightest graduates along with proven winners from across the capital markets sector. Our Capital Markets Training Programme provides continued professional development for our consultants.

**Third-Party Vendor Products:**
We have over 15 years’ experience of supplying implementation and support services to the world’s leading financial institutions on the choice and usage of vendor applications. We are not only experts in our field, but we have an expert methodology in place to ensure that our clients get the best advice. Our Vendor Services team is dedicated to giving you the best possible service in line with your expectations and requirements.

**Regulatory and Compliance:**
Kx has a unique capability and proven track record in providing consultants who can add value from day one. Each possesses deep capital markets knowledge as well as legal and technical expertise. As a result Kx is ideally placed to assist organizations in interpreting regulations and implementing the necessary changes. Our typical consultant will have a legal qualification (many are qualified lawyers), experience in searching and extracting data from multiple systems as well as the ability to categorize and interpret vast amounts of documentation.

**Software and Services:**
Kx offers a range of applications providing capabilities in reference data management, market data management, CEP, algorithmic and high-frequency trading, FX trading, treasury risk management and exchange management surveillance. Kx has been adopted by the vast majority of the world’s leading financial institutions.

Kx services offering can help you to achieve a number of business goals including faster speed-to-market, accelerated by industry and technical experience while avoiding the cost and time required for internal training and skill development. Kx services provide skilled personnel to work under your direction to help you develop, maintain, manage and support your applications. Our skilled professionals can help you manage fluctuating skill needs, skills gaps and changing staffing needs to meet your aggressive project timelines.
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.

- Publically 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:
- Streams 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
<table>
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<tr>
<th>Region</th>
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<tr>
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