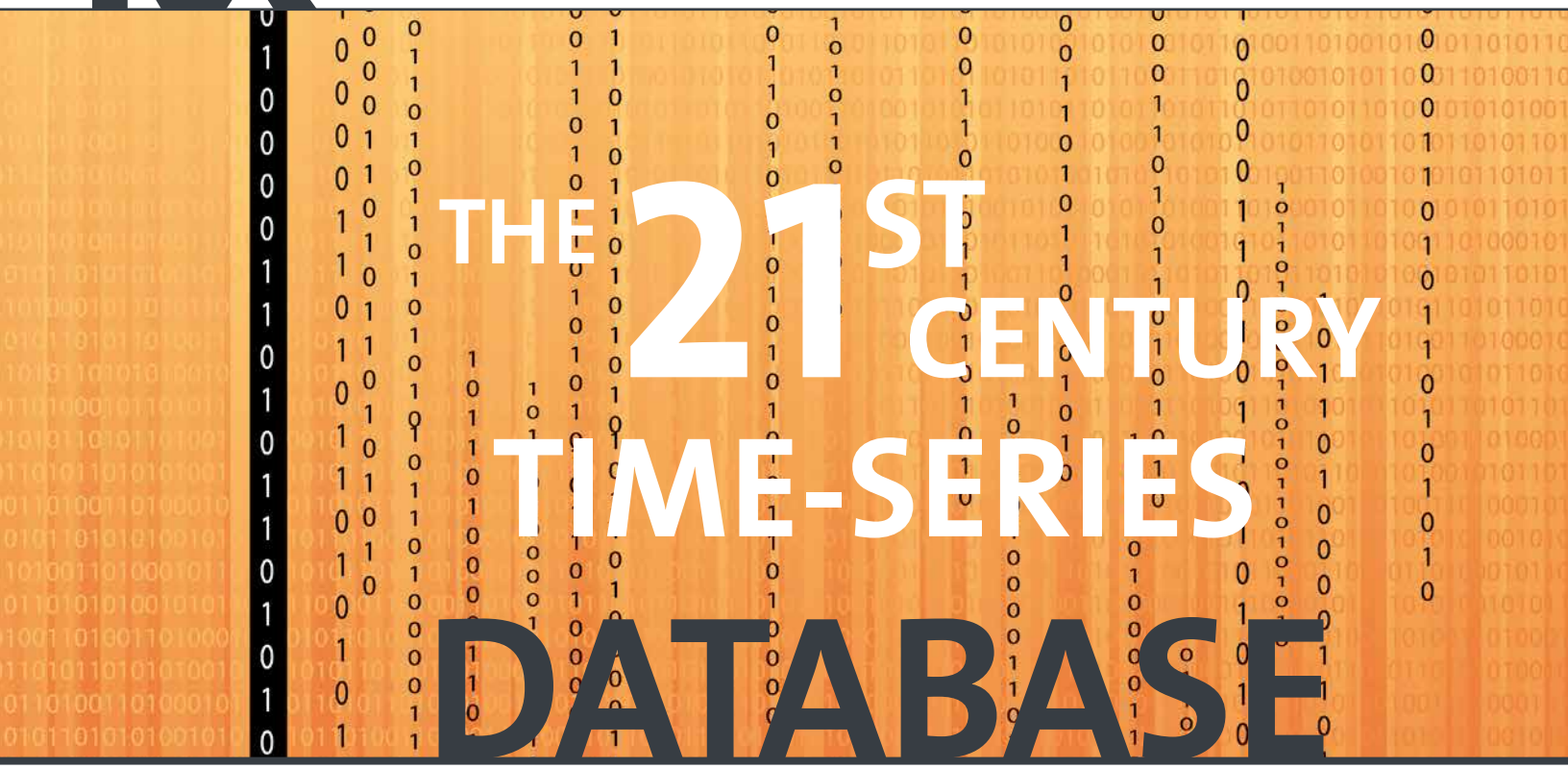
kx



THE 21ST CENTURY TIME-SERIES DATABASE

Making real-time decisions on billions of current data events and trillions of historical records

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Massive data volumes, low-latency, and complex event processing have been recurring themes in recent years.

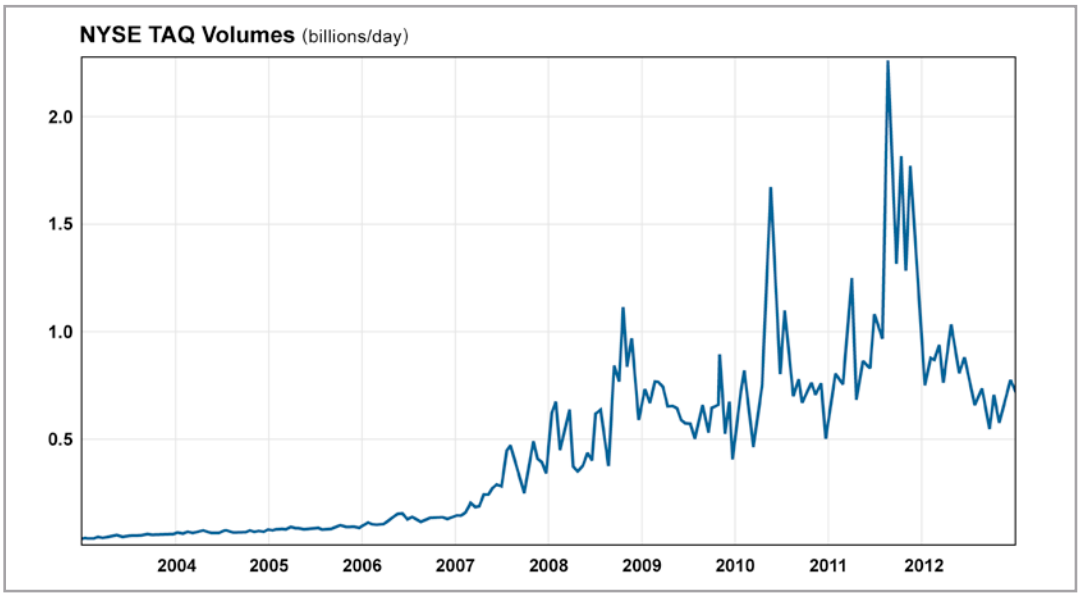
In the mid-1990s, the NYSE produced half a million trades and quotes per day; today this is typically half a billion per day with peaks of over two billion records per day. Options traders now receive over 200 GB of data per day, while stock exchanges have built huge co-location data centers where dealers run algorithms directly on the data feeds, reducing latency to an absolute minimum.

"From the outset, we have designed our products in anticipation of vast increases in data volumes. It has always been our philosophy to make the most efficient use of existing hardware and to build in sufficient redundancy and flexibility going forward. This allows us to make full use of the multi-core systems being brought to market, without having to rewrite our software."

— ARTHUR WHITNEY, CO-FOUNDER AND CHAIRMAN, Kx SYSTEMS

How this data is used also has become more complex. Algorithms are becoming more sophisticated and dark pools of liquidity are adding to the challenges. The available speed and power of equipment is increasing, but so are the demands placed on both software and hardware.

Kx Systems was founded in 1993 to address the inability of traditional relational database technology to keep up with these escalating volumes of data. The company's core product, kdb+, is built on a single architecture for both real-time and historical data. The database incorporates its own powerful query language, q, so that analytics can be run directly on the data. Over the years, Kx has delivered orders-of-magnitude improvements in performance to keep up with the rising data demand.



For many of the company's largest customers, kdb+ is employed as the enterprise-wide market data server, while OEM customers use Kx technology to deliver a wide range of software and services, including data analysis, investment, insurance and business performance monitoring.

kdb+ offers a significant performance advantage over other databases, due to its adherence to a variety of key performance criteria.

- Native 64-bit architecture — this is essential for managing today's data volumes. Legacy 32-bit systems simply cannot keep up.
- Built-in multi-core processing and multi-threading. Performance scales linearly with more CPUs, and applications can take advantage of multiple cores without having to write special thread-aware code.

"It is vital to have software explicitly designed for multiple cores. Because kdb+ was designed from the beginning for parallel execution, it is extraordinarily fast when benchmarking against other traditional applications, as we are able to make full use of all available cores.

Other legacy applications can never be really fast unless programmers go back and rewrite a significant part of their code to take advantage of newer multi-core architectures. It's not enough to naively convert or port existing code and expect to see major performance gains."

— SIMON GARLAND, CHIEF STRATEGIST, Kx SYSTEMS

- Support for parallel access to large partitioned historical databases, so that queries can be farmed out to multiple cores/machines.
- A columnar structure for the database, which simplifies indexing and joins and dramatically speeds search performance.
- Publish and subscribe mechanisms, which offload processing from the main server onto chained servers, allowing data services to be provided to a virtually unlimited number of clients.
- A single solution for real time, historical data and analytics. It is important to minimize the total time elapsed from when data arrives to when analysis is completed — and this in turn depends on minimizing the number of separate steps from one process to another. kdb+ handles everything: data capture, storage, logging, event processing, analytics, real time and historical database.
- Date, time, and timestamp (to nanosecond) as basic data types, making time-ordered analysis extremely fast.
- Record handling of millions per second, billions per day, and tril lions in a historical database. Kdb+'s speed copes with spikes in the data flow, and the database can also be used with hardware accelerators for maximum speed and flexibility.
- Bulk insert and update optimization (not simply one-transaction-at-a time). Exchange data typically comes in blocks, and does not have to be written record by record. Also, the database does not need to be taken offline for bulk transactions.
- Dynamic indices, which allow kdb+ to be able to make efficient use of real-time data.

kdb+ development is driven by customer requirements, and remains significantly ahead of the market. The latest release, 3.0, includes enhancements offering a considerable improvement in processing speeds when running on Intel's recent processors, GUIDs/UUIDs (unique identifiers, which facilitate the design of distributed systems), simplified storage of billions of records, and support for WebSockets.

"The storage improvements in v3.0 allow for a more elegant architecture for very large volumes, while UUIDs simplify the task of managing multiple servers across different regions. These, combined with the speed enhancements in v3.0, enable more efficient systems to be designed."

— SIMON GARLAND, CHIEF STRATEGIST, Kx SYSTEMS

"The increased complexity of the markets and continued race toward automation, across more asset classes and venues, mean that the enormous growth of data will continue. The new version of kdb+ running on the latest Intel processors, such as the Intel® Xeon® Processor server platforms — which are optimized to support AVX instructions, to further increase overall performance — provides market participants and technologists with new capabilities, as well as enhanced levels of performance and flexibility. The result is a powerful tool in the hunt for Alpha, while ensuring maximum stability and reliability."

— DARYAN DEHGHANPISHEH, GLOBAL DIRECTOR, FINANCIAL SERVICES, INTEL

- The optimized code in kdb+ utilizes the processor-specific instructions available at runtime: testing revealed highly significant speed increases when running calculations using Intel's Advanced Vector Extensions (AVX) and SSE instructions, available on Intel's latest generation of Sandy Bridge family of processors.
- The addition of UUIDs as a basic data type is particularly useful for distributed systems. UUIDs can be used to uniquely identify distinct records, and are ideal for transaction IDs such as order and confirmation IDs, making distributed processing more efficient and system design more straightforward.
- The growing volumes of derivatives and trading volumes in FX and equity markets, as well as regulatory requirements, require institutions to store and analyze vast quantities of data. The storage improvements simplify the design and implementation of large systems handling billions of records per day.
- Support for WebSockets allows for a direct, bi-directional, full-duplex connection between a browser and an application. This offers greater scalability and much faster processing than HTTP/AJAX. It is particularly useful for high-performance browser-based applications, such as those visualizing real-time data.

Kdb+ includes a general-purpose programming language, q, that has direct support for databases. This provides an enormous advantage over systems that force the user to rely on rely on traditional SQL for data access, or that must depend on the supplier for pre-written queries. With q, the end user can respond quickly to emerging needs.

"I spent a number of years looking for a language that would provide a high-level 'thinking tool' for complex modeling and the highest possible performance for operations on extremely large structures. When Kx made its language available to the public it was the obvious choice. When I introduced it to my students they loved it, even those who found the more traditional languages hard to learn. The language was easy to use and to teach; it is succinct and efficient and can be used in a wide range of disciplines, from financial markets to engineering and science."

— PAVEL KOCURA, COMPUTER SCIENCE LECTURER, LOUGHBOROUGH UNIVERSITY

- q can operate on data directly, minimizing data traffic. There is no need to first read data, then export to an external routine for analysis. 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 just these kinds of operations; for example, doing arithmetic on tables. An operation can work just as easily on a million records, as on a single record.
- The language 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 counterparts in SQL, as well as functionality that goes beyond traditional SQL.
- The q interactive environment provides immediate feedback for rapid development.

+kdb+tick

kdb+ offers a kdb+tick module for optimum use of kdb+ with tick data (real-time streaming data).

- kdb+tick captures, manages, and analyzes millions of records per second —comfortably keeping up with peak volumes on any exchange — as well as terabytes of historical data.
- There is no need to discard in-memory data at the end of the day; instead, it may be stored it in the historical database.
- With kdb+tick, you have immediate access to data as it comes in, and can run complex queries on both streaming and historical data.
- Built-in feed handlers include Reuters, Tibco, and Bloomberg. Defining new schemas and arranging the feed handlers takes from only a few minutes to a few hours, depending on the complexity of the feed format.

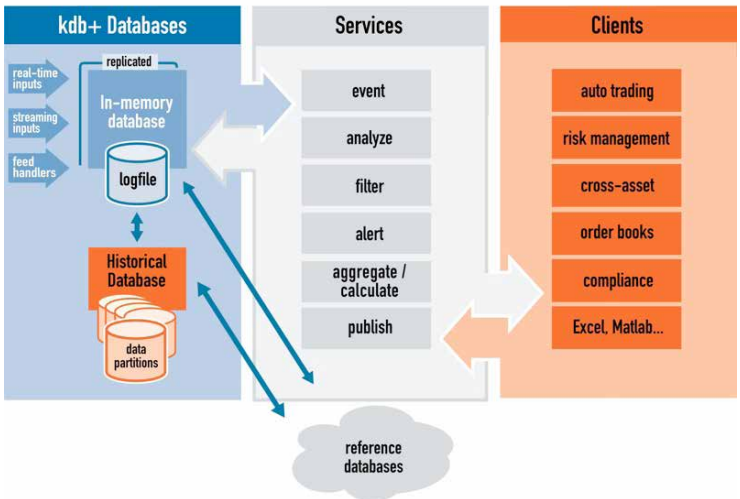
The kdb+ system runs on industry-standard Linux, Solaris, Windows, and Mac OS X 64-bit server platforms. Additionally, the software:

"Kx has always ensured that it made the best use of existing and upcoming hardware and technology, working closely with the R&D divisions of companies such as Intel. While the constantly changing technology can place additional (unwelcome) pressures on clients, Kx always tries to accommodate the new requirements within our software in order to protect and insulate clients from the myriad of technical changes."

— CHARLIE SKELTON, CHIEF TECHNOLOGY OFFICER, Kx SYSTEMS

- has no restrictions on storage architectures — local disks, SANs, and NASs may be used and configured according to any preferences or corporate standards.
- has a small footprint that makes for simple and straightforward install; kdb+ can be set up and running in minutes.
- stores databases as ordinary native files. This means that database administration (for example, backup and recovery) can be done with standard operating system commands and utilities.
- has a very simple API, for easy connectivity to external graphical, reporting, and legacy systems. There are interfaces to C/C++, Java, .Net, R, Matlab, Perl, Python, and others, some contributed by the Kx user community. There is also ODBC and JDBC for interoperability with applications such as Excel.
- allows enterprise-level characteristics such as security, high-availability failover, transaction logging, and capacity planning to be handled at the application level. This enables kdb+ to fit easily with existing operations.
- is supported on clusters, grids, clouds, and other large-scale distributed architectures.
- has a built-in webserver, as well as file operations, communications, and administrative tools.

The kdb+ architecture unifies streaming, in-memory and historical data



- allows virtually unlimited room to grow with short- and long-term profitability requirements, helping to lower total cost of ownership.

Kx is an ISV partner of HP, IBM, Intel, Oracle/Sun and Microsoft, and leverages these relationships in optimizing the product.

Kx is highly attentive to customer needs, and takes pride in its reputation of being one of the most responsive vendors in terms of support; when issues are reported, there is a quick response — typically within minutes, and fuller solutions within the day — from someone who knows the code, vs. a scripted response from an outsourced support center.

"Our goal has always been to provide our clients with the most efficient, fast, and flexible tools for processing real-time and stored data. Our client list speaks for itself and I am very proud that our team has built long-standing relationships with many top institutions around the world. We aim to continue to provide powerful tools for companies to tackle the most complex and data-intensive applications."

— JANET LUSTGARTEN, CO-FOUNDER AND CEO, Kx SYSTEMS

- New development is driven by customer requests. The built-in file compression feature, for example, introduced in the previous version of kdb+, was requested by several of the company's clients.
- There is an active email user forum where clients can post questions and discuss topics of interest to the community; and an active wiki for documentation, cookbooks, tutorials, and software add-ons.
- A 32-bit trial copy is freely available to allow anyone to learn the language. This is supported by the kdb+ personal developers group at http://groups.google.com/group/personal-kdb-plus.

Kx PARTNERS

Kx has long-term partnerships with two established service providers in capital markets technologies. Each partner:

- has vast experience in implementing Kx technology in real-world use.
- offers comprehensive consulting, training, configuration, and installation support.
- provides both off-the-shelf and custom dashboards, feedhandlers, and development and visualization tools.

The Securities Technology Analysis Center employs the STAC-M3 benchmark set for tick databases (www.stacresearch.com/kx).

These benchmarks are run using kdb+ with a year of daily NYSE TAQ-like data — approximately 5 terabytes in total. They use a series of up to 20 complex queries that were defined by financial institutions to reflect real business requirements. These benchmarks enable users and vendors to compare the performance of their database solutions against audited, third party measurements.

"The STAC tests achieved very impressive results. The ability to access and analyze vast quantities of data very quickly has always been important to financial institutions. However, the recent market volatility and record volumes make this an even more pressing requirement. In August 2011 we saw NYSE TAQ daily record volumes break through 2bn a day, and reach a new high of 2.4bn, something the markets were not expecting to see for quite a while yet. The benchmarks demonstrate that financial institutions can test trading strategies, manage their risk, and back-test new trading algorithms very quickly indeed, despite unprecedented volumes."

— SIMON GARLAND, CHIEF STRATEGIST, Kx SYSTEMS

A top-tier U.S. investment bank ...

… uses kdb+ not only as the core technology for many of the company's businesses — such as Foreign Exchange, Electronic Trading, Risk, and Structured Products — but also for enterprise-wide applications that support thousands of users, as well as front-, middle-, and back-office applications.

Because the technology is significantly faster than other data stores evaluated by the firm, data extraction and analytics that previously took hours can now be done in minutes. This allows the bank to do more frequent and more granular analysis — which better supports the company's clients.

A prominent European investment bank ...

… began to recognize the limitations in its existing data capture technology — an infrastructure deficiency that was causing the company to lag behind its competitors. The solutions within the firm at the time ranged from in-house C++ based capture-and-storage mechanisms to fragmented relational solutions that were already at maximum capacity.

After a thorough review, the firm decided to standardize its operations on Kx technology. Current directors attribute much of the power of Kx software to the q programming language, which gives their developers unprecedented control and flexibility. Today, in addition to capturing server performance metrics across the company's IT base, kdb+ is also used as a tick data platform, processing both traditional market data and execution data from trading platforms, as well as metrics from trading engines for quant analysis.

A leading provider of cloud-based analytics ...

… takes advantage of the flexibility and versatility of Kx's vector language to build extremely fast and powerful analytical solutions for clients in finance, retail, manufacturing, and telecommunications.

1010data also uses Kx technology to demonstrate to its clients what can be done with their own data — showing them in real time how their problems can be solved.

Not least, 1010data benefits from the ongoing communication it has with the Kx Systems team, in which improvements to the technology — increasing speed, for example, or creating routines to improve certain functionality — come from both sides, ultimately allowing customers cloud-based solutions of extreme robustness and expressiveness.

A pioneer in the field of Business Process Management ...

… has embedded kdb as a platform to help its clients in telecommunications, government, and financial services rapidly design and execute repeatable processes — where analytic queries and high-speed, real-time reporting are of critical importance.

Specifically, **Appian Corporation** saw kdb as a way to address fundamental problems in scaling out the query performance of large datasets that would allow it to deliver functionality to its customers that they couldn't find anywhere else.

The technical advantages of Kx's software — syntactic elegance, algorithmic performance, and simple, reliable construction — has allowed Appian to create not only business possibilities, but also very real, and distinct, competitive advantages in a wide variety of applications, from real-time analytics to high-performance bulk updates, to virtually every type of query, including time-series, OLAP, and hierarchical.

A leading provider of capital markets software and consulting ...

… made kdb+ the core part of its data management and trading software platform, which its clients have deployed in some of the world's largest banks, exchanges, and hedge funds.

The applications built on **First Derivatives plc**'s platform are designed for "volume and velocity," with low-latency and high-throughput, delivered as a hosted service or deployed locally. These applications include reference and market data management, CEP, exchange management and surveillance, treasury risk management, and algorithmic, FX, and high-frequency trading.

First Derivatives re-engineered its FX trading platform, and witnessed immediate results in terms of the throughput of its execution engines. kdb+ also gave the company the option of extending the post-trade analytics capabilities of the FX platform well beyond its legacy technology.

Kx offers a unified approach to the challenges of managing and analyzing ever-growing volumes of data. Over the years, our software has continually been refined through production use at major corporations worldwide. Through our exclusive focus on high-performance, high-capacity data storage and analytics, Kx has become the world leader in this technology.

For more information visit kx.com. Please contact us with any questions at sales@kx.com.