Overview

TIBCO Streaming software is a fully distributed, cloud-ready, in-memory transactional streaming application platform that is currently used at telecommunications, financial services, and other companies to handle several billion transactions annually. The software's powerful visual programming paradigm dramatically reduces implementation complexity and lets programmers develop, share, and revise highly complex streaming applications in a fraction of the time of traditional implementation methods.

With its hardened application platform and fully visual programming environment, TIBCO Streaming software helps companies accelerate business and technology operations by managing streaming events, decisions, processes, and applications in real time on a massive scale. Companies can build extremely robust streaming applications that can evolve and easily change. In a single platform, it combines visual programming, data persistence, business logic, transactions, fault tolerance, and easy integration. Together, these features reduce development and operational complexity, greatly improve performance and availability, minimize integration costs, and simplify testing. The result is on-time delivery of robust and highly available systems and services.

To achieve the highest performance, TIBCO Streaming software uses a memory-resident persistent store to execute the fastest possible transactional reads and modifications. The in-memory store can act as the operational system of record because it can be optionally replicated and distributed to machines. The TIBCO Streaming system can achieve throughput of tens
of thousands of transactions per second per node with the reliability normally associated with expensive, specialized, high-availability hardware.

Living in a Real-time World

High-performance transaction processing (such as high-frequency trading) used to be a rare phenomenon employed only in extreme environments by the largest companies. But in recent years, software as a service (SaaS) and the Internet of Things (IoT) have created the need for applications that serve internet-scale customers and volumes of devices and handle real-time expectations and requirements.

These real-world drivers are making global real-time transaction processing the norm. And that new normal is driving enterprises to seek products with architectures that can handle skyrocketing transaction volumes at the lowest possible cost per transaction, while maintaining flexibility and agility of services. On the other hand, demand for flexibility, agility, high performance, continuous availability, and low cost confounds solutions and architectures designed on proprietary systems.

For example:

- Proprietary high-availability hardware systems can handle high volumes, but are not low cost or flexible.
- Specialized transaction processing systems are medium-volume, cheaper than high-availability systems, but are not flexible.

Application servers such as J2EE/JTS may be less expensive than high-availability hardware systems and specialized transaction processing systems, and they are flexible. However, they are not high-performance, nor are they highly available without adding additional technologies and carefully crafted code and configurations, such as databases, caching, etc.

TIBCO Streaming software was designed to meet the operational needs of today’s most demanding streaming applications, while providing a development paradigm that meets time-to-market requirements.

Architecture

The runtime architecture of TIBCO Streaming software provides a fundamental set of capabilities and services that can be reused and combined in various ways to create flexible, high-performance solutions.
Core transactional, persistence, and high availability services have been proven and hardened in the most demanding industry environments for over a decade. TIBCO Streaming software integrates these services with an equally hardened and proven streaming application environment.

The software’s persistence store can be thought of as a real-time distributed operational data store. When thousands of transactions per second are streaming into system nodes, shared memory acts as a database.

Keeping the data consistent across a distributed, multi-threaded environment requires strict data access control to ensure consistency and to maintain concurrency to support real-time and scalable processing. These services are provided using transactional locking and deadlock detection. In addition, data replication and synchronization mechanisms provide the level of reliability required to turn shared memory into a high-speed repository for transaction processing.

**Transactions**

Perhaps the most fundamental part of TIBCO Streaming software is appreciating the meaning of the word transaction. To sales staff, transactions signify a stream of orders. To a CFO, they could mean credit card transactions or accounting journal entries. To software professionals, the word frequently brings to mind database transactions of the sort that keeps information in a consistent form.

The concept of transaction supported by TIBCO Streaming software is general enough to encompass transactions in the broadest sense:

- Financial transactions, credit card payments, cell phone text messages, accounting journal entries, database transactions, and many other ways of accepting information.
- Very fast processing and recording of huge volumes of information as it comes in and messages going out to elicit the proper response.
TIBCO Streaming software provides real-time transaction management in a distributed environment. To fully take advantage of modern hardware that supports executing many simultaneous threads, concurrent transaction flows must be analyzed in real time to determine which parts of the process are parallel, which serial. TIBCO Streaming software performs this analysis and then orchestrates parallel execution when possible, depending on data locking and concurrent access. The TIBCO Streaming software concurrency model provides both lock-free and serialized access to data using configurable transaction isolation levels. Using transaction isolation as the data consistency mechanism allows optimization in platform locking primitives that are not possible in non-transactional systems, thereby improving overall system concurrency. Transparent deadlock detection is provided to ensure that streaming applications never have an undetected deadlock that would cause an application to hang, another advantage of a transactional locking model over a non-transactional locking model. When a deadlock is detected, the transaction that would deadlock is rolled back, releasing all transactional locks and restoring all transactional resources to their original state. The transaction is then replayed without any application participation.

Scaling

The extreme transaction processing that characterizes digital enterprises today demands the ability to scale as transaction complexity and numbers of users grow. TIBCO Streaming software permits massive and seamless scaling as business needs increase, and supports both single machine and distributed scaling mechanisms. This capability provides application designers with the flexibility to make trade-offs between cost, manageability, and redundancy, as required. The distributed scaling mechanism is fully elastic and can operate while an application is running without impacting service availability.

Vertical Scaling

TIBCO Streaming software is designed to take advantage of the CPU, memory, and disk resources available on its host platform. As CPUs, threads, real memory, and disk space increase, the runtime will scale transparently to the application. CPU scaling is achieved through the use of operating system-level threading. The total number of threads used by the runtime is optimized to minimize empty CPU cycles caused by excessive thread context switching. This feature ensures that CPUs are kept busy performing application work, not on operating system housekeeping. The architecture does not just throw threads at the problem to simplify the implementation.
In addition, TIBCO Streaming software does not perform global locking. All locking of shared resources is designed to minimize lock contention. This is accomplished by eliminating global resources that must be locked by all threads before any work can be performed.

This vertical scalability power derives from the streaming platform’s unique consolidation of data, event and logic processing into the 64-bit shared memory, and its kernel-threaded event execution architecture. These features provide the runtime power to take maximum advantage of the computers on which the system runs. A TIBCO Streaming software solution can utilize as much memory as will ever be available on a computer. Placing all of the data in memory enables incredibly fast processing. TIBCO’s unique linear vertical scalability allows applications to scale from proof-of-concept to full-scale production without performance re-engineering.

**Horizontal Scaling**

Introducing additional servers allows scaling out horizontally. TIBCO Streaming software’s node architecture allows as many nodes as needed to run on as many computers as desired to support the application load. The message traffic and data is spread across the nodes using built-in routing.

Routing and data partitioning allow work to be spread across other nodes that are running on various computers in many different ways. For example, for a given stock-trading application, all of the symbols from A to K could be on one node and the symbols from L to Z could be on another. When a message shows up, it is transparently routed to the node that is handling the processing for that symbol.

In addition, if a particular stock is trading heavily, it is possible to route traffic just for that symbol to another node to better balance the load. This sort of load rebalancing can take place on the fly with no downtime.

**High Availability**

Data replication and recovery logic are inherent in every application built on TIBCO Streaming software, providing transparent application recovery support and saving costly IT resources and time because programmers need not write HA-aware code into each application.

TIBCO Streaming software’s memory-resident transactions and processing ensure memory-speed recovery from failure. Moreover, high-speed rollback and recovery occurs not only for all data associated with an application, but also the current processing state at time of failure; thus, applications restart from the last successful processing step.
High-availability support provides five nines (99.999%) availability without reliance on redundant cluster-ware, transaction monitors, or databases. Five nines availability is a mainframe-class, high-speed, high-traffic system that has no more than five minutes of downtime per year. TIBCO Streaming software high availability provides a low-latency system, where failovers are transparent to users. There is no interruption of work, no transactions lost, and backup and recovery functions occur with no degradation in performance.

However, unlike almost all other solutions, TIBCO implements high availability completely in software without using specialized hardware, shared or clustered disks, or redundant hardware lying idle in standby mode. Transaction routing ensures that business applications are always available, even if there is a hardware, operating system, or application failure.

A first requirement for highly available systems is that all data must be stored elsewhere. Traditional highly available systems like storage area networks and RAID storage devices that spread data out over several disks, make sure that all data is available on at least two physical drives at all times. TIBCO Streaming utilizes transactional replication to accomplish this.

The runtime guarantees data integrity by routing each transaction to an active copy of the data. Key stateful objects can be tagged to be highly available so that, in the event of a transaction failure, the runtime forces a switchover to a designated backup server, which then becomes active and assumes responsibility for completing all transactions until the primary server is restored. The system continues to process every transaction in real time, and failover is transparent to users.

The transactional part of the replication ensures that the write on the primary system is not considered complete until the replication is complete. Any node can play the role of a primary node, a backup node, or both at the same time.

These same services are available without additional hardware or software across geographic regions, providing out-of-the-box disaster recovery that is managed and configured identically to within region high availability.

Continuous Availability

Uncontrolled system changes are a frequent cause of system outages. A company must be able to build, test, and deploy new versions of mission-critical applications as often as necessary—while relying on continuous systems and transaction operations.

TIBCO Streaming software’s change management functions ensure system stability during major system changes, including during system configuration changes and when adding or deleting hardware devices from the running system.
number of reconfiguration tasks can also be controlled at the application level to maintain, repair, or upgrade elements of a system without needing to shutdown or restart.

**Continuous Integration (CI) / Continuous Delivery (CD)**

To allow rapid and safe changes to operational systems, a mature development process is required that supports full development and deployment lifecycle automation—from initial change, through automated testing, to deployment into the production system.

TIBCO Streaming software provides full support for industry standard CI/CD toolchains, allowing applications to fully participate in modern CI/CD pipelines.

**Use Cases**

These use cases provide examples and proof points of TIBCO Streaming software’s ability to solve the most demanding business requirements.

**Best Connectivity and Network Reliability**

**Customer Experience**

**Challenge**

One of the top mobile operators in the UK with 10+ million customers and the majority of all UK mobile data, needed a billing and rating system that would scale and support high volumes of network chargeable events. The company incurred significant revenue loss from billing system outages and maintenance periods and was unable to enforce access control. The requirement was to enforce business and network policy rules to support VoLTE and VToW launches.

**Solution**

The TIBCO Streaming solution’s high availability platform was used to implement a subscriber aware service layer supporting configurable business rules at network scale. The result was >10,000 transactions/second with millisecond latencies.

**Benefits**

The system integrated subscriber-aware IT and subscriber-unaware networks, enables innovation, differentiation, improved customer experience, and immediate business value. Solutions built on TIBCO Streaming platform ensure service continuity and no revenue loss. And at the same time, the highly available systems with ubiquitous coverage and essential connectivity, helped improve customer satisfaction. Reduced cost and happier customers? A double win.
The new billing system allows charging based on service and content, not just volume. It supports charging for data in real time. Flexible billing options for customers is possible now, and the company has a better understanding of customers’ mobile web and services usage.

This mobile carrier was able to enforce access control with criteria such as service eligibility, age, and worthiness. Enforcing the policy for data-fair usage, speed tiering, tethering detection, SIM swap, and policies for voice-default and bearer bandwidth for VoLTE, allows the company to serve a larger user base at significantly reduced costs. It is able to leverage network events at low latency and high volume with a real-time billing and charging system that enables business decisions at network speed.

**5G Migration**

**Challenge**

One of the largest mobile operators in the world needed a platform to support migration of 4G network functions to 5G network functions. Network functions had to be 3GPP compliant and were required to support 5G operational and business models. For example, the network functions had to integrate and decouple the network layer and the BSS IT systems. They needed to deliver event logic that could route, correlate, and effect rules and machine learning algorithms. In addition, they had to manage virtual network function (VNF) state for industry standard and bespoke behaviors particular to the customer environment and use cases, while providing carrier-class availability. These capabilities were critical to the successful monetization of 5G.

**Solution**

TIBCO Streaming for 3GPP software with visual programming was used to deliver both 4G and 5G virtual network functions (VNF). Supporting CI/CD (DevOps) in cloud-native environments, it provided full support for elastic scaling and low latency execution. VNFs were delivered into the telco’s preferred environments, leveraged the capabilities of those environments, and facilitated both 4G to 5G transition services and full 5G services.

**Benefits**

With TIBCO Streaming for 3GPP software, the company delivers a growing set of tested network function templates. Combining the templates with the TIBCO Streaming for 3GPP software EventFlow visual programming language provides the telco, SI, and OEM customers with a working application that can be used as is or rapidly extended.
TIBCO Streaming for 3GPP software is a cloud-native application platform, independent of VNF deployment environments. It provides shared state data models, componentization, microservices techniques, decoupled integration, and local and geo-distributed deployments. Flexible packaging and deployment options allows TIBCO Streaming for 3GPP software to support multiple network generations and evolving 5G core architectures supporting diameter as well as service based architectures (SBA) leveraging the OpenAPI Specification (OAS). Having a single, agile, independent VNF technology provides the ability to select the deployment environments, platforms, and infrastructures of choice. These capabilities bring cost savings, agility, performance, and required availability to support the many possible options faced when migrating to a 5G core.

A unique benefit of TIBCO Streaming for 3GPP software is its ability to execute analytic machine learning algorithms in a network function event stream. These algorithms are the output from advanced analytics, of which TIBCO is the global leader. The importable algorithms are the outcome of descriptive, diagnostic, predictive, and prescriptive analyses. Executing inline with the event stream enables a differentiated way of applying detection and decisioning.

Cost is always a critical factor when performing technology migration. If the cost is too high, it limits a telco’s ability to react and respond to competitive demands. TIBCO Streaming for 3GPP software helps manage the cost of service migration, change, and infrastructure, by providing:

- Rapid and safe implementation of change using a low-code visual development environment
- Choice of deployment environments
- A common technology and skill set for all virtual network functions, avoiding any additional third-party product dependencies
- A leading, low-latency event processing platform for efficient use of infrastructure
- Collaboration among multiple roles for more rapid innovation
- Industry standard DevOps support for no-impact deployment

Driving Value with a Next Generation Mobile Payments Platform

Challenge
One of the largest mobile operators in the world with 50+ million subscribers wanted to augment and accelerate revenue capture by increasing the number and accessibility of payment channels. It wanted the flexibility to rapidly launch, deploy, and charge for new services in a very highly competitive market.
The company’s payment system had reached its technological limitations and could not further support growth in transactions or introduction of new services.

Solution
For the global upgrade of its payment system to provide cost-effective management of subscriber growth, the company opted for high transaction throughput able to support its current level of several hundred transactions per second, and the ability to scale.

Benefits
The company significantly reduced its “zero balance” period while offering multiple new payments and card types. The system performs at an average rate of approximately 500 business requests per second, and 6,000 transactions per second. System availability has been running at 99.996%.

After deployment of the TIBCO Streaming platform, the company experienced significant capability improvement and a substantial positive impact on margin. For example, the system reduced cost of revenue for top-up at local convenience stores from 28% to 3%. This cost reduction was accomplished with only a modest investment in infrastructure hardware, thereby accelerating the pace of the company’s ROI for their new mobile payment-transactions platform.

The new platform supports payments through multiple channels (cash, ATM, credit card, mobile device), card management, many partner payment points, and multiple charging systems. It also facilitates the launch of value-added payment services, such as balance transfer.

Conclusion
TIBCO Streaming software is proven technology that powers high-performance systems for some of the largest companies in the world. The mechanisms and architectural strategies explained in this whitepaper show how the system is constructed from top to bottom to eliminate traditional trade-offs in transaction processing software.

The TIBCO Streaming system fulfills the business imperative of the digital age at the lowest total cost of ownership. It combines an extremely high performance, eminently flexible, highly scalable, ultra-fast processing environment on the lowest cost platforms to create the fastest processing solutions in the world.

Contact your TIBCO representative to begin a conversation about how your company can improve IT performance and revenues and reduce the total cost of deploying software solutions.