WHY EVENT PROCESSING
Event processing actively tracks and processes streams of events entering an enterprise so that opportunities and risks can be proactively identified and business outcomes optimized. The traditional data processing approach of store-analyze-act introduces the fundamental challenge of decision latency. Information is often the most relevant as soon as it is captured, and event processing helps organizations process this information in a more timely and contextual manner. It helps solve numerous problems: identifying fraud as it happens, delivering a contextual offer while the customer is still in the store, or predicting disruptions to minimize delays. With the advent of big data and the need to handle it in real time, event processing is becoming increasingly important.

Fierce competition and an increasingly complex business environment are forcing many organizations to spot and respond to opportunities and threats in real time. By investing in enterprise service bus (ESB) technology, many have taken the right first step towards collecting events from regular business applications and making them available to other applications on the ESB. For this information to be truly meaningful, you need to identify opportunities and threats hidden in these events by processing them in real time to derive insight and take appropriate action.

This paper provides an overview of event processing functions and key features provided by TIBCO BusinessEvents®.
HOW BUSINESSES ARE DERIVING COMPETITIVE ADVANTAGE
The ability to process events in real time and generate actionable insights can provide competitive advantage to organizations. Many are successfully using event processing capabilities to outsmart their competitors with:

SUPERIOR CUSTOMER SERVICE
Organizations in various industries are using better event processing to provide significantly improved customer service.
- Retail organizations are creating instant offers enabling cross-selling and up-selling based on customer status, location, inventory, and other factors.
- Logistics and transportation organizations are providing real-time visibility into order/consignment/package status.
- Airlines are proactively notifying customers of problems, changes, and delays.
- Service organizations are monitoring service level agreements (SLAs) and promptly taking corrective actions to avoid unmet agreements.
- Banking and credit card companies are preventing and detecting fraud.

REDUCTION OF COSTS AND MORE EFFICIENT USE OF RESOURCES
Superior event processing is also allowing organizations to reduce operational costs and improve operational efficiencies.
- In retail, real-time inventory tracking and management with the ability to define and change product promotions dynamically based on trends and surplus
- In government, cyber intrusion detection and prevention
- In airlines, optimization of crew scheduling and efficient baggage tracking
- In logistics and transportation, optimization of shipping movements in-transit and in-port
- In manufacturing, proactive maintenance of key shop-floor equipment
- In the energy sector, predictive outage and fault management of the grid
- In hospitals, optimization of scheduling of expensive procedures such as MRIs in response to disruptions and no-shows

BETTER OPERATIONAL VISIBILITY AND DECISION-MAKING
Real-time event processing capabilities also significantly enhance the organization’s visibility into its operations, enabling faster and better decisions. For example:
- In telecommunications, identification of under-performing business systems to help ensure SLAs can be met
- In hospitals, visibility into patient numbers and bed availability to ensure optimal decision-making
- In financial services, visualization of market data, order executions, trades, deals, settlements, and pre-post trade exceptions
- In retail and services industries, real-time visibility into order status
- In insurance, real-time visibility into status of processing new customer applications
- In factories, visibility into the status of machines and other shop-floor assets
- In the logistics and transportation industries, visibility into the current location of trucks and packages
A COMPREHENSIVE VIEW OF EVENT PROCESSING

Event processing must use different approaches to solve different types of problems. TIBCO BusinessEvents uses several:

**INFERENCE RULES**

Inference rules provide a mechanism for relating events that represent point-in-time data with other events or concepts that represent historical data residing in diverse sources/databases. Inference rules can be written declaratively and forward-chained during execution by a high performance inference engine to generate meaningful actions. Inference rules are used, for example, to relate a customer’s purchase history with perishable inventory and provide real-time offers that are relevant to the customer and yet profitable for the organization.

**STATE MACHINES**

State machines provide an event-driven and rules-based mechanism for tracking and tracing entity lifecycles. Missing events can be detected through timeouts. For example, they can be used to track and trace orders that go through a number of steps before being fulfilled, to better monitor SLAs at every step by alerting responsible staff in case of a time-out, and to provide real-time status updates to customers.

**DECISION TABLES**

Decision tables are business-user defined rules that provide a spreadsheet-like interface. They are ideal for creating rules with conditions that are combinations of possible values or ranges of values for a set of parameters, for example: “If the applicant is female, in the age group 30-40, has 10 years of driving history, resides in the state of California, has never had an accident, has a Master’s degree, owns a regular sedan in the price range of $15K-25K, then the premium is USD 400 per annum.” The actions for each combination can be specified inside cells of the spreadsheet.

**BUSINESS RULES**

Business rules are parameterized rules implemented by business users based on templates defined by technical users. Within TIBCO BusinessEvents, business users have a web-based interface for implementing rule templates. Business rules can be used to, for example, compute loyalty-related discounts based on customer category and total purchases over a period of time, where the discounts change frequently based on the time of the year, what competitors are offering, and other factors. Rules are controlled by the business through a business friendly interface and a flexible hot deployment framework that supports modifying rules as needed.

**PROCESS ORCHESTRATION**

Event-driven complex straight-through processing can be achieved using BPMN 2.0-compliant processes that provide inference and decision paradigms within the processes. Event-driven process orchestration can be used to, for example, orchestrate the order fulfillment process for selling telecom bundles online where the processes involve computation of a number of rules or decision tables based on the availability of products and services in the area where the customer lives, the product and service combinations selected by the customer, and regulatory requirements in the area where the customer lives.

**EVENT PATTERN MATCHING**

Temporal relations across event streams can often be expressed through patterns such as sequencing, duplicate detection, store and forward, and others. A simple pattern-matching language can be used to define and enforce patterns. Positive or negative callback functions can be triggered when the pattern is met or not met. Event pattern matching can be used, for example, by a shipping company to collect a minimum number of containers for a particular destination port or wait for a maximum period of time, whichever comes earlier, before ordering shipment.
Both snapshot and continuous queries are supported by TIBCO BusinessEvents. Snapshot queries provide information on the state of objects stored in the in-memory data grid, while continuous queries execute continuous aggregations on event streams and trigger actions through callbacks. Snapshot queries can be used to, for example, reschedule flights that were supposed to land at a particular airport that is being closed due to bad weather. Continuous queries can be used to aggregate faulty power line signals by location code, determine if a fault is likely to affect households, dispatch a technician, and proactively notify customers before they start calling to report the problem.

**KEY FEATURES**

TIBCO BusinessEvents has several important features that make it a high performance, enterprise-class, event-processing platform:

**MULTIPLE TRANSPORTS**

- TIBCO Rendezvous
- TIBCO Enterprise Message Service
- HTTP, SSL
- SOAP over HTTP, SOAP over SSL
- TCP
- TIBCO ActiveSpaces
- TIBCO Hawk

**ECLIPSE-BASED DEVELOPMENT STUDIO**

TIBCO BusinessEvents Studio enables model-driven development through an Eclipse development environment with built-in debugging and testing and UML modeling of data and state. Graphical editors are provided for all artifacts. Project libraries facilitate teamwork through the creation of re-usable components. Users can drag-and-drop a rich set of out-of-the-box catalog functions or user-defined functions into the rules editor. The tool also provides the ability to map from one artifact to another and to apply XPATH formulae on mappings.

**TIBCO BUSINESSEVENTS STATE MACHINE.** The State Machine uses the UML-standard definition for state models, a directed graph in which states are represented by nodes and state transitions are represented by connectors. A state model lets you model the lifecycle of a concept instance. For each instance of a given concept, you can define what states the instance passes through, and how it will transition from state to state.
TIBCO BUSINESSEVENTS PROCESS ORCHESTRATION. Within a business process, you can see the event processing function and segregate rule sets within the flow.

TIBCO BUSINESSEVENTS STUDIO. Application designers can model events and stateful data structures; provide implementations of rules, state machines, queries and processes; map data from one structure to another; provide template implementations of decision tables and business rules; debug and test projects; and create and build deployable TIBCO BusinessEvents artifacts.
STATEFUL RULES ENGINE

- High performance, highly scalable
- Horizontally scalable and elastic distributed in-memory data grid for state
- Built-in in-memory replication for fault-tolerance
- Shared-nothing persistence to distributed local file systems or shared-all persistence to databases
- Transport-level or smart-key load-balancing

HIGH PERFORMANCE STATEFUL RULES ENGINE

TIBCO BusinessEvents provides a high performance, highly scalable, fault-tolerant, and load-balanced stateful rules engine that uses patented inference techniques to relate events with other events or with stateful data. The state of the data is stored in a distributed, horizontally scalable, and elastic in-memory data grid with built-in replication of data in-memory for fault-tolerance. Optional shared-nothing persistence onto distributed local file systems, or shared-all persistence onto a database, is also supported. Default transport-level load balancing or content-based smart load balancing is supported.

BUSINESSEVENTS WEBSTUDIO AND RULES MANAGEMENT SERVER

Business users employ a web-based tool, TIBCO BusinessEvents’ WebStudio, to implement decision tables and build business rules and process flows. From within the WebStudio interface, users can hot-deploy artifacts into a running TIBCO BusinessEvents environment. It connects to the Rules Management Server (RMS), which acts as a content repository for TIBCO BusinessEvents projects, as well as a provider of user authentication and authorization services using JAAS configuration files, LDAP, or Active Directory. RMS also supplies workflow management for business-rule and decision-table approvals.

APIs

APIs available out-of-the-box can be used to customize and create business user interfaces (UIs). Custom web UIs can be built to match the look and feel of existing applications, to allow users to define rules in their own language. They can also be embedded in other systems.

REAL-TIME DASHBOARD

- Aggregation and real-time computation of user-defined metrics
- Charting library for visualization of metrics with drill-down capabilities
- Real-time visual alerts
- State Machine Visualizer
- Concepts relationship viewer
- Query Manager to execute queries on concepts and metrics

TIBCO BUSINESSEVENTS WEBSTUDIO. Using this online tool, business users can create and manage business rules based on rule templates defined by developers using TIBCO BusinessEvents Studio.

REAL-TIME DASHBOARD

TIBCO BusinessEvents’ Views provides a real-time dashboard that allows aggregation and real-time computation of user-defined metrics, charting of metrics with drill-down capabilities, and real-time visual alerts. It also provides a State Machine Visualizer, a Concept Viewer for seeing relationships between stateful data elements, and a Query Manager to execute queries on stateful data and metrics.
TIBCO BusinessEvents Studio provides the ability to generate all required deployable artifacts directly from the project editor. This includes creating the necessary deployment topology and generating the cluster deployment descriptor (CDD) file that contains the overall deployment configuration. The BusinessEvents monitoring and management tool deploys and monitors BusinessEvents applications. TIBCO Hawk and JMX based monitoring are also supported.

ANALYTICS

TIBCO BusinessEvents is closely integrated with TIBCO® Enterprise Runtime for R (TERR). In addition to running rules, R models can be applied to results from the TIBCO BusinessEvents engine, allowing statisticians to analyze datasets and enable smarter analytics.

TIBCO BUSINESSEVENTS VIEWS. The dashboard provides real-time representations of business operations to facilitate proactive decision-making.

TIBCO BusinessEvents monitoring and management can be used to deploy TIBCO BusinessEvents applications on a single engine or on a cluster spanning multiple machines. It can also be used to monitor and manage the applications.
CONCLUSIONS
To gain competitive advantage from day-to-day business transactions, you can transform your organization into an event-enabled enterprise. Using an event-processing application, you can identify opportunities and threats hidden in your business events and take action proactively and predictively.

TIBCO BusinessEvents is a comprehensive event-processing platform with a powerful, high-performance stateful engine that provides multiple options for different classes of event processing problems.