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View Point

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Adaptive and Intelligent Retailing

Beyond the basics with EDA and CEP

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Abstract

Increasing competition, globalization, market consolidation, the need for better customer service, and a faster pace of business are demanding unprecedented agility from the enterprise. At the same time, enterprise systems are grappling with an information overload. While technology is making it possible for them to get access to more and more relevant information, enterprises are unable to utilize that data to derive the business insight and nimbleness so necessary for a competitive advantage.

The information available needs to be co-related with information generated at the same time elsewhere and future insights to come up with any conclusions that drive responsive decision-making. While BI enables contextual placement of information, it is not effective owing to delayed information processing. Enterprises are in search of solutions that enable them to analyze information, respond in real time and respond proactively, anticipating customer needs, creating opportunities, and avoiding potential problems.

In this point of view, Infosys discusses the criticality of deploying situational awareness to help decision-makers anticipate and respond to threats and capitalize on opportunities before they occur. Made possible through Event-Driven Architecture (EDA) and Complex Event Processing (CEP), this can enable the next step in the evolution of a real-time enterprise: predictive business.

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introduction

The value of any information does not lie in the information itself, but in how the enterprise leverages the knowledge that lies within that information to get ahead of the competition and gain that crucial edge in a changing marketplace. Today's enterprise is weighed down with a deluge of disconnected data, much of it highly relevant to effective decision-making. This data needs to be prioritized and made available into actionable knowledge if it is to provide enterprises with an advantage. However, most enterprises are unable to deal with the exponentially increasing data and integrate it with processes and systems. Information is often not available at the right time and with the right meaning for decision making. The lack of an effective way to gather, analyze, correlate, and apply data, results in information corruption.

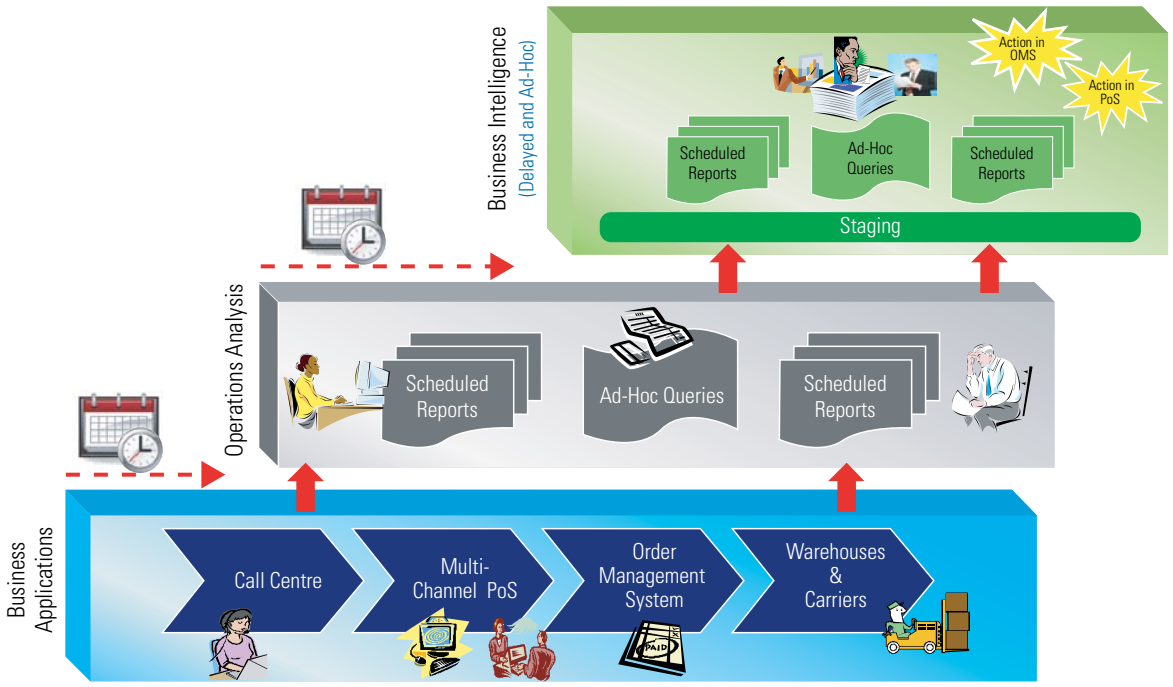
This is a significant issue in the retail environment which has seen the introduction of Commercial Off-the-Shelf (COTS) applications such as ATG for websites, Sterling Commerce for order management, Oracle Finance for sales transactions, and popular third-party systems such as Bazarvoice and Choicestream. These implementations have increased integration challenges and raised the level of difficulty in monitoring and responding to process failures that cut across such systems. Additionally, customer service response-time expectations have shortened dramatically. This adds to the complexity of the situation where data associated with business processes, policies, systems, users, techniques, or strategies and tactics produces unmanageable amounts of information in many different formats.

While enterprises rely on their Business Intelligence (BI) capability to create reports for decision making, such traditional management reports are either time-driven (scheduled) or request-driven i.e., driven by manual queries. Enterprises face several challenges in managing these reports, such as:

- Delayed reports generate stale data or data is misinterpreted owing to dynamic information and processes
- Time delay before a situation is analyzed or reported
- Delay in analyzing a report renders data useless since the situation has passed
- Late reports are analyzed using fixed patterns, which make them useful only for future operations

Such reactive management of business situations hobbles the enterprise, leaving it flat-footed in its response to fluid market dynamics and thus less competitive. To tackle these challenges, many enterprises are in search of solutions that go beyond this basic approach and allow them to analyze information and respond in real time, thus enabling them to move toward predictive business. Such an approach makes it possible to anticipate customer needs, create opportunities, and avoid potential problems.

Figure 1: Traditional BI Reporting



1 The Value of Real-Time Analysis

Real-time information analysis requires immediate notification of 'situations' across business processes and systems such as state changes, transactions and events. In response to this critical requirement, many organizations have started to leverage daily events through Event-Driven Architecture (EDA). Event-driven business processes, workflows, and applications as well as new techniques such as Complex Event Processing (CEP) are now available to ensure increased value from infrastructure and business operations. These systems can identify trends or scenarios that require immediate attention, thereby increasing real-time responsiveness and operational efficiency, allowing businesses to predict customer behaviour/ needs, make timely decisions and take the right action.

EDA and CEP can successfully execute competitive business strategies such as:

Time-Based Competition - Ensures that processes are lean and optimized, thereby completing tasks in less time to remain competitive

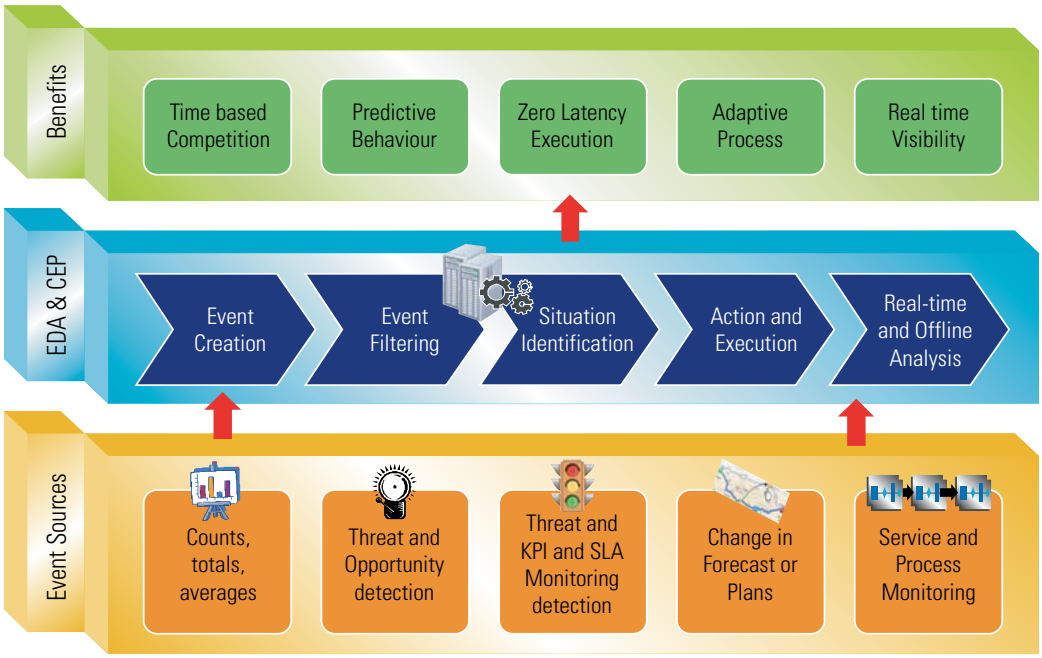
Real-Time Visibility - Detects patterns and trends in real time and provides enterprises with visibility to capitalize on emerging opportunities or mitigate developing risks

Zero-Latency Execution - Removes latency from operations, thereby ensuring that business events occurring anywhere in the organization instantly trigger appropriate actions across the enterprise and beyond

Adaptive Processes - Adjusts operations quickly and smoothly to meet rapid changes in the market, introduction of new technologies and shifting business priorities

Predictive Behavior - Ability to gain insights from real-time analysis to direct, optimize and automate decision making

Figure 2: Real-time analysis



2 How does it help in Practice?

Let us take a look at some examples to gain a practical view of the advantages of experiencing a real-time retail business. The examples mentioned below are drawn from implementations and/or business cases driven by Infosys with its Fortune 500 retail customers.

Product Affinity - Product Affinity Analysis enables the retail enterprise's marketing operations to analyze and target customers based on product-centric purchase histories and patterns. It drives value by providing an improved ability to plan multi-product promotions, evaluating customer response based on products, and measuring customer shifts on promoted products. Such promotions are targeted and customized for valued customers.

With EDA in place, a CEP rule can monitor a customer's real-time purchase orders and check whether the average size of the last few orders is above a certain dollar value, e.g. $1000, after which a decision can be taken for the Point of Sale (PoS) to offer a discount on the current purchase. Such real-time visibility drives business by improving customer experience and increasing customer loyalty.

Out of Stock at Point of Sales - According to a Store Systems study (2008) produced by RIS news and research partner IHL Group, loss of sales to competitors owing to a retailer going out of stock measures $93 billion in the USA - a significant figure that has compromised the financial performance of consumer goods brands. Efforts to address this problem were ineffective since retailers lacked the data and analytic tools to address the prime causes of out-of-stock.

EDA implemented with CEP can monitor any stoppage in regular product sales at a particular store instance, indicating a potential stock-out. CEP enables the system to automatically calculate the estimated on-hand inventory, review recent shipments of that Stock-keeping Unit (SKU), and apply rules to automatically determine that the root

cause is non-availability of the shelf quantities after the endcap. The PoS monitor can visually alert the analyst to the problem and provide a solution to replenish inventory. This process can be further automated by applying selected rules without any manual intervention, thus making it more proactive.

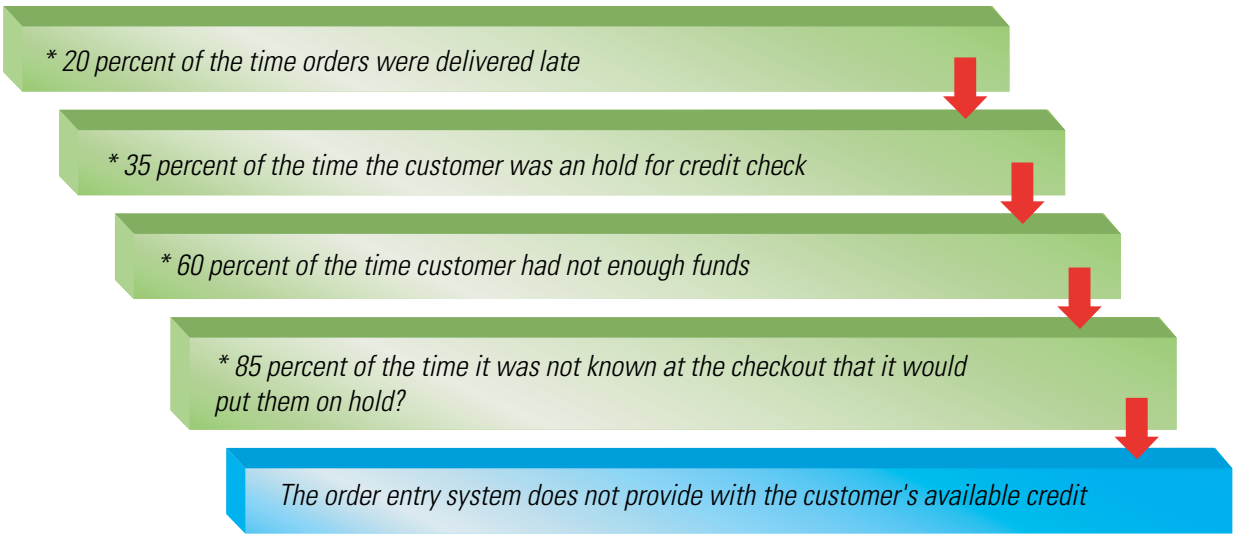
Predictive Monitoring-Order Fulfillment - A core process that directly impacts customer satisfaction and business growth, Predictive Order fulfillment is important for any retailer today. Real time visibility into the order fulfillment process helps detect trends and patterns that may delay or affect an order and proactively correct them.

CEP provides a phased approach to remedy errors in order fulfillment. For instance, the following sequence can be used when an order is delayed due to a hold in credit authorizations.

Pricing Errors - An accurate and consistent pricing structure is important to generate sales and build customer loyalty. Enterprises with poor pricing rules can severely compromise their profitability. For instance, a retailer marking a $199 item $19.90 must apologize to a customer or honor the price leading to a loss. Such a structure is critical for online retailers where pricing errors can be far more costly than in traditional stores. Online forums enable customers to survey product prices across thousands of sites where news of pricing errors can lead to customer attrition.

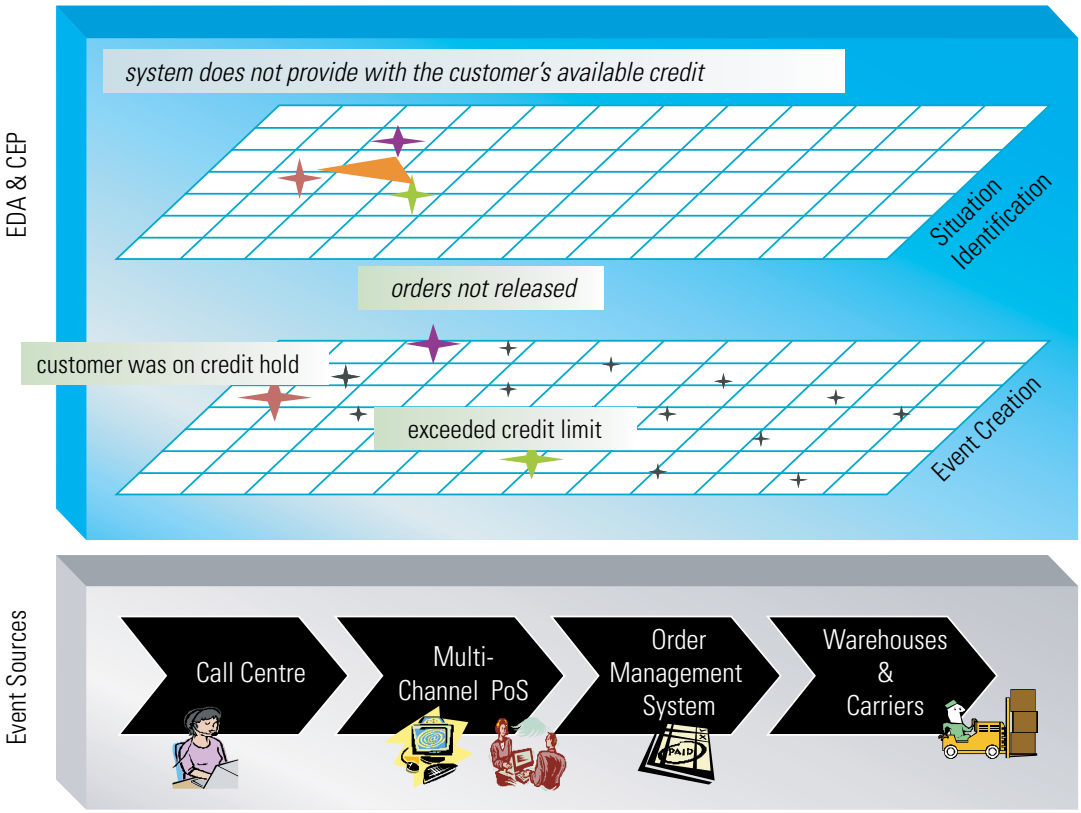
Pricing changes are rule-driven, where any change in price is delivered as an event to a CEP implementation that can then identify the pricing error by comparing another event from a competitor's intelligence system. For example, if the newly applied price is much lower than the competitor price, the commerce back office is alerted or the listing is brought down temporarily. In cases where products are not sold by any competitor, the event of price change is compared against a threshold percentage based on past changes, which triggers another event notifying whether the pricing is accurate or not. This event is then consumed to actually enable the listing.

An alternative method is to identify failed quality checks by first identifying the number of hits for a product page and the number of orders for the same product that are executed in high volume by one customer or in low volume by many. Monitoring such events helps identify possible pricing errors and an immediate alert is raised for automatic action i.e., bringing down the listing temporarily and notifying the appropriate personnel.



*The numbers mentioned in this example is only for sample purpose and has no relation to any identified situation.

Figure 3 - Event Pattern Identification



Customer Insight - Companies often suffer from cancelled customer orders due to poor order fulfillment. Proper identification of the causes for order cancellation can generate valuable customer insight. For example, a PoS submits an order through the system but due to a hardware failure/ loss of network, the order is not forwarded to fulfillment. When the customer calls fulfillment to check the status, they are unable to respond adequately. After a few unsuccessful attempts to track the order, the customer cancels it and orders from a competitor. Another example is when a PoS submits an order through the system that is received by shipping which then assembles it, plans the delivery route and loads the order for delivery. Unfortunately, the driver takes a wrong route and has to be re-routed to the correct airport where he misses the flight. When the order is delayed, the customer cancels it and orders from a competitor.

A CEP implementation can avoid customer dissatisfaction in both scenarios. In the first example, knowledge of the hardware failure and its potential effects on timely delivery, accounts payable, and customer service enables companies to proactively fix the hardware or reroute delivery to avoid any delay in fulfillment. In the second example, the system sends a real-time alert regarding the driver's mistake and the customer is immediately informed of the delay and, further, receives discount vouchers on future orders. By preemptively taking action to solve the outage issue and demonstrating appreciation for the client, organizations can avoid potential revenue loss and retain their customers' loyalty.

3 Implementation of EDA and CEP

Companies looking to implement EDA require a structured, two-phased approach as illustrated in Figure 4. Phase 1 involves Event Modeling, which is a design activity where information from various sources is analyzed to define multiple patterns for situations that need monitoring. This requires sound collaboration between subject matter experts, including the operations and IT teams. Event Monitoring is a process whereby tools and systems are enabled to raise events and are monitored. Here, the events are filtered and matched against defined patterns and when necessary, the system can be alerted to decide on any action whether manual or automated.

Implementing CEP systems can transform traditional business intelligence by enabling real-time reporting and responsiveness to situations. Event-driven alerts are generated from applications and reported and analyzed in seconds, thereby mitigating any unanticipated risks. The post analysis solutions are fed back to in-flight transactions, making the operations more responsive. The event assists analytics by providing a complete and broader view of all applications in one instant rather than one system at a time, which allows for more efficient evaluation and appropriate solutions.

It is also important to consider the relevance of Business Process Management (BPM) in the architecture and its implications for EDA and CEP. As shown in Figure 5, CEP can assist the enterprise in real-time monitoring of low-level events that are translated to business events. Further, CEP can facilitate BPM processes to move ahead as per the modeling by sending events to which the processes react. This provides enterprises the flexibility of monitoring BPM to take proactive actions. Such two-way intelligence makes BPM implementations more robust and operations-driven.

Figure 4 - Implementing EDA

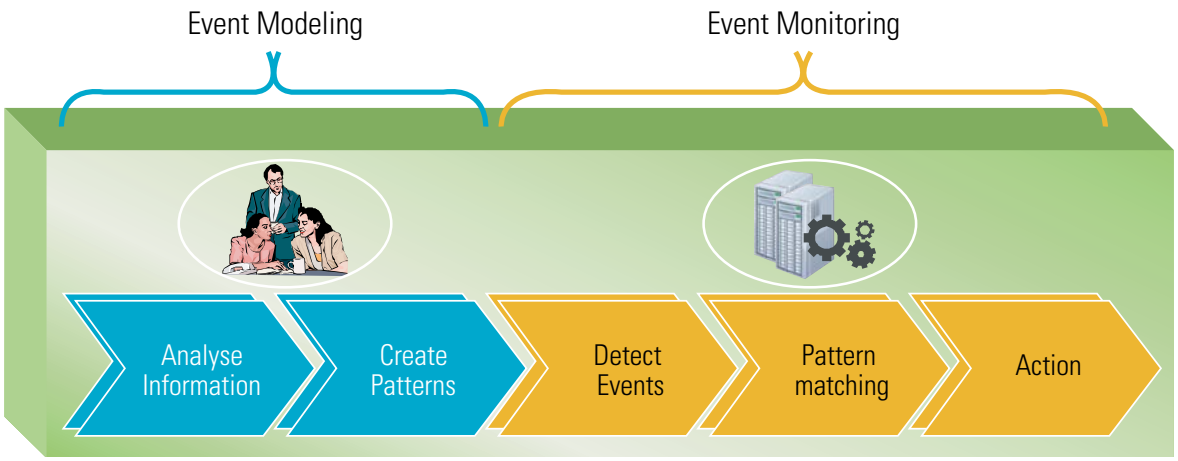
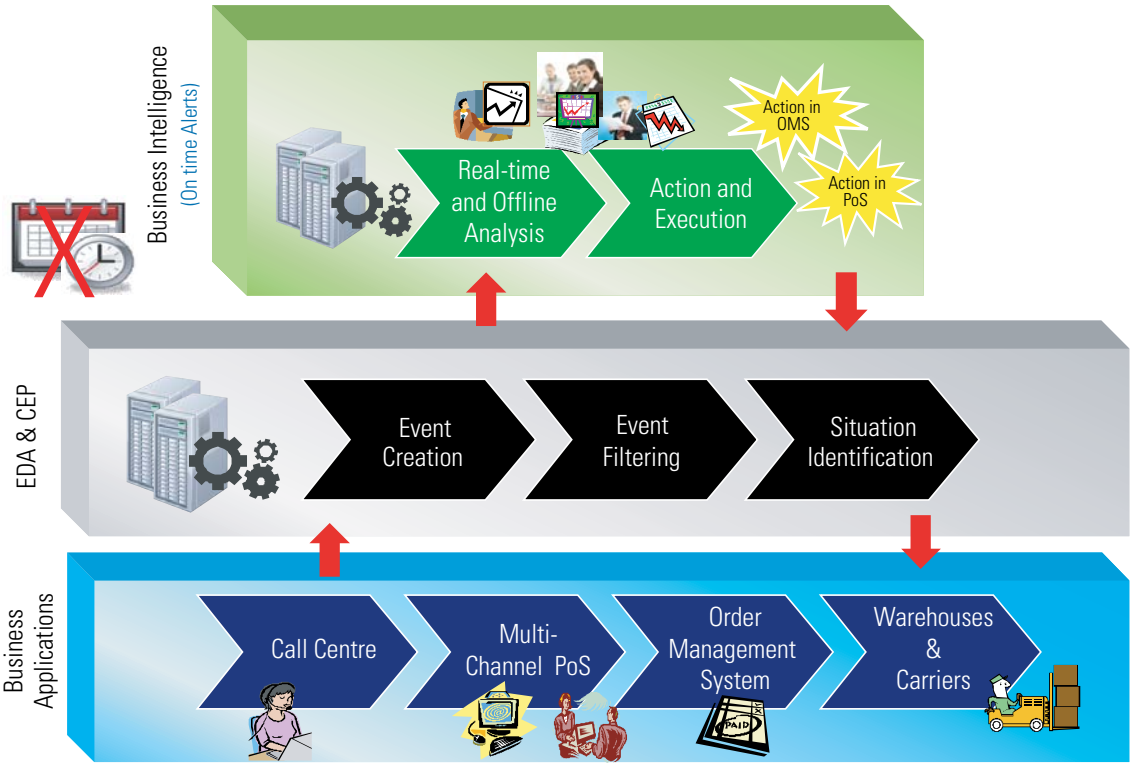


Figure 5 - CEP in use



4 Event Analysis

An event can be defined as a record of any activity that has happened or is in a state of progress within a system. It represents the activity for any analysis and can be related to other events. It is important to understand the mechanics of events, its sources and identification to know how event analysis operates in EDA and CEP.

Events have the following attributes:

Event Identifier - This helps uniquely identify the activity that the event stands for

Event Data - Each event contains data that is carried to signify the activity. This can be more than one data component and structure. Further, event data has several contexts to signify the activity in the system

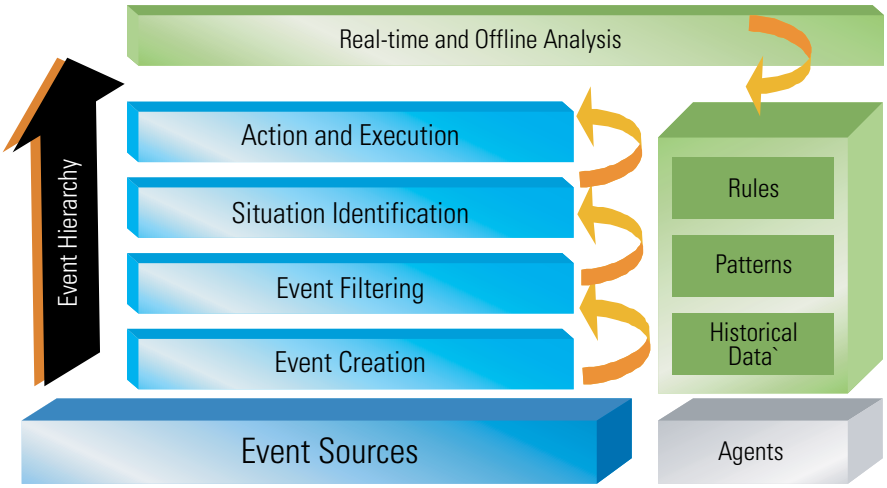
Time Stamp - This is a time factor dimension or a time interval that relates the event to other events and generates time-based patterns

Event Cause - Any event that has a predefined path for its cause has this information. For example, Event EA1 causes event EB1. When EB1 is generated, it has a reason/cause for its creation.

Aggregation - Sometimes an event is a result of aggregation of other events. This information is required by the CEP engine to form patterns and for further processing.

Events are created within the system in the following ways:

Observation - Activities within the system need to be observed in order to capture events. Principally the action



of just observing the activity must not change the system

Adaptation - Processing events can create new events that can either be observed or leveraged to invoke an action

The primary sources for events are as follows:

IT layer - The middleware layer and component to component interactions implemented via Enterprise Application Integration (EAI)/ Service-Oriented Architecture (SOA)/ Messaging layers

Instrumentation - Heartbeats and alerts from network management systems, status of operation system, outage alerts, etc.

CEP - Events are also created by the CEP engine itself to be used for further analysis

It is important to note that not all events captured through various sources can be utilized as-is for decision making. In such cases, the event hierarchy acts as a level of filters to ensure the right situation is analyzed and acted upon.

The hierarchy consists of the following levels:

Event Creation - This step deals with event generation from various sources and primarily deals with downstream applications, systems, and operational logs. It also handles normalizing the information and altering it for further processing within the hierarchy

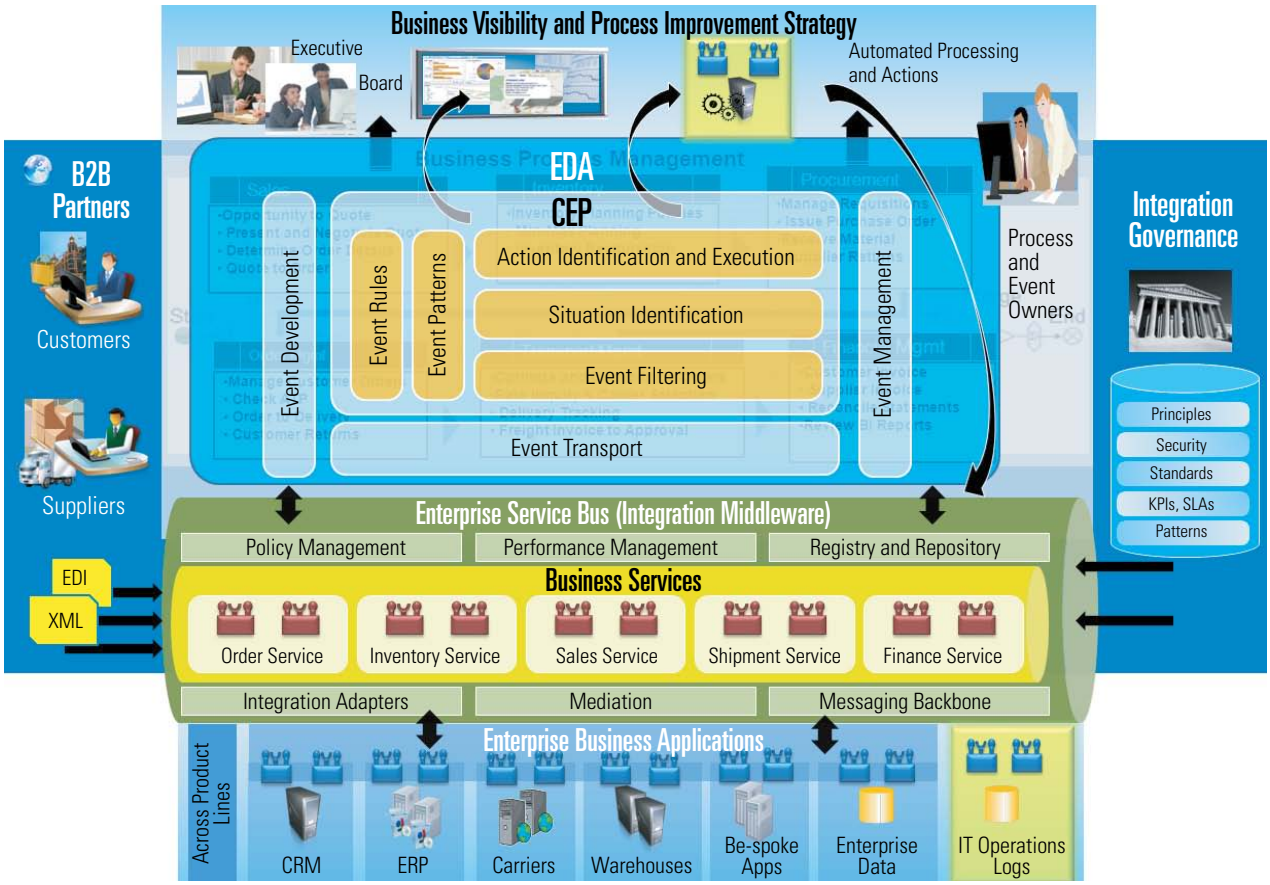
Event Filtering - This step analyzes the information previously altered to check its relevance for further processing. For example, failure of a network router may affect other processes besides order fulfillment

Situation Identification - This step performs aggregation and correlation pattern matching with historical data to find the cause or predict a situation. Rules-driven CEP engines play a major role in executing this step

Action Identification and Execution - This step involves tools that can display situations so that manual and automated intelligence can act upon the event. Dashboard utilities and report generation are used for manual intervention while CEP engines use rules to identify automated actions to be taken and to generate new patterns.

5 Process and Event-Centric Architecture: The End Goal

Figure 6 - Event Analysis



Businesses require a robust methodology to capture granular, real-time events from multiple sources at different organizational layers across the value chain. In a competitive environment, seemingly small errors can easily turn a customer to another organization that promises superior service or enticing benefits. By leveraging the existing data, companies can anticipate errors, predict reactions and proactively act on potential problems or issues caused by an error. EDE provides enterprise visibility and information triggers by integrating CEP into highly responsive, real-time enterprise architecture. This allows companies to identify and anticipate exceptions as well as opportunities represented by seemingly unrelated events across complex, distributed, heterogeneous IT environments.

Note: The above Architecture is a recommendation based on Industry Best Practices and the Infosys experience of delivering large-scale business transformation programs. A detailed study and analysis is recommended to apply the same to the Business and Technology landscape of any interested organization.

Conclusion

Enterprises seeking to retain their competitive edge require responsiveness and business agility. While traditional BI reporting can provide copious information, this needs to be intelligently co-related with historical information, information generated at the same time elsewhere and future insights in order to generate true business value. The current BI systems have severe limitations in information processing and real-time responsiveness.

Adoption of Event-Driven Architecture (EDA) and Complex Event Processing (CEP) can provide a real-time dimension to any enterprise architecture. It enables an enterprise to analyze and respond in real time and to move toward predictive business - an approach that makes it possible to anticipate customer needs, create opportunities, and avoid potential problems. A pragmatic approach to enable CEP can improve predictive monitoring for order fulfillment, pricing errors, out of stocks, etc. Further, the implementation needs to be adopted incrementally with a robust SOA and BPM system.

Such a system enables real time analysis and immediate, informed decision making thereby maintaining the competitive edge in the market where customer experience is the critical key and predictive business becomes a need.

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About the Authors

Bhupesh Naik is a Senior Integration Architect at Infosys Technologies Ltd having more than 11 years of experience in large-scale enterprise integrations. Bhupesh specializes in Service-Oriented Architecture (SOA) and defining real-time integration strategies solutions. He has helped various enterprises choose the right technology and architecture to set up enterprise-wide global integration platforms. He currently assists a large-scale global retailer in defining and implementing their integration solution through a strategic SOA initiative.

Arup Raha is the Industry Head for retail for the BPM and Integration Services practice at Infosys Technologies Ltd. He has over 13 years of experience in helping large enterprises find the right solutions to integrate their information, applications and processes using technologies like BPM, SOA and Enterprise Application Integration (EAI) that enable businesses gain speed and agility. He has consulted extensively on establishing Integration Competency Centers to define and execute enterprise integration strategies and solutions.

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