Methods and Technologies for Business Process Monitoring

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Agenda

» Motivation/Introduction
» Real-World Examples
» Technology Perspective
» Web-Service Based Business Process Monitoring
» Adaptive Business Process Monitoring with Sense & Respond
» Modeling Sense & Respond
» Business Process Monitoring with Senactive
» “Diplomarbeitsthemen” in the area of business process management & monitoring
» Q&A
Motivation
Motivation

"What one can measure, shall be measured; what cannot be measured, shall be made measurable."
Schmalenbach (1963)

"If you cannot measure it, you cannot control it. And if you cannot control it, you cannot manage it."
Harrington (1991)

"Large scale production workflow systems with thousands of interactive tasks per day will generate megabytes of audit trail data for analysis."

What do you do with this information?
McLellan (1996)
Why Business Process Monitoring?

» Automatically **extracts and generates performance data** from enterprise processes

» Uncovers **weaknesses in process handling**

» Optimize throughput times, resource assignments

» **Warning system** by monitoring business processes

» **Benchmarking** based on measurable process indicators -> identification of best practices

» **Process-driven analysis** of business data (e.g. break down metrics by business activities)

» **Past activities** can be used to drive prospective interactions with the customer

» Continuous process improvement, closed loop analysis
Introduction
How well is Performing a Business Process?

**Executive Objectives**
- Fully exploit customer potential
- Improve profitability
- Customer satisfaction

**Vice Pres./Director Objectives**
- Shorten delivery and supply time
- Increase Return on Investment
- Increase delivery performance

**Manager Objectives**
- Reduce service costs
- Reduce order processing time
- Improve service quality
- Optimize resource assignments

**Workgroup Objectives**
- Reduce defects/waste/delays
- Improve customer rating
- Automate processing steps
- Early error detection
Process Related Business Questions

Customer Request Processing 1/3

Sample Process

Business Questions

Analysis of the process (time, quality, costs...) and its activities:

- How many customer requests result in a contract?
- Which activities are the bottlenecks in the customer request processing?
- How satisfied are customers with the current process?
- Show the customer requests with the longest processing time?
- Show the average processing time of customer requests for the company XY?
- How did the processing time and process cycle time change compared to the last quarter / last year?
- How did an introduction of an CRM software package impact the processing of the customer requests?
Process Related Business Questions

Customer Request Processing 2/3

Business Questions

Analysis of the control flow and the events:

- How many customer contracts originate from customer contacts and how many are direct customer queries?
- Which customer requests couldn't be processed because of export restrictions?
- Which customer requests were turned back because of less profitability?
- Which customer requests were canceled? Why were they canceled?
- Which customer requests were not processed because the items or services could not be delivered?
- Which customer requests were canceled during the contract processing?
### Process Related Business Questions

#### Analysis of the process context (organization, customer, channel...)

- Which sales teams initiated and processed the most customer requests? Which sales teams are initiating customer contract with a contract volume of more than 100,000$?
- What are the Top/Bottom 10 contract volumes by channels which were used for the customer contacts.
- Which sales teams do the most profitable customer request processing?
- Which customer requests result in long-term contracts?
- Which customer requests cannot be fulfilled and why?
- How long is the average customer request processing per sales team?
- How much time does the contract processing take with a contract volume of more than 100,000$ compared with last quarter / year?
Real-World Examples
Example: Ordering a Book from Amazon

Shopping

Checkout Process

Post-Checkout Processing

Events from Website

User Session Started
Book Search
Add Book to Shopping Cart
Remove Book from Shopping Cart
Checkout
Identify User
Shipping Information Captured
Payment Information Captured
Order Placed
Payment Cleared
Order Confirmation Sent
Example: Ordering a Book from Amazon

Business Process Monitoring

Events from Website

Shopping

- User Session Started
- Book Search
- Add Book to Shopping Cart
- Remove Book from Shopping Cart
- Checkout
- Identify User
- Shipping Information Captured
- Payment Information Captured
- Order Placed
- Payment Cleared
- Order Confirmation Sent

Checkout Process

Post-Checkout Processing

Customer Interest Analysis

- Update Customer Interests
- Update “Customers Who Bought This Book Also Bought” List

Book Demand Analysis

- Order Books from Publisher (Large Quantities)

Publisher: Availability of Books, Terms & Conditions

Sales History

Book Demand Forecasting
Management Portal for Supply Chains
Management Portal for Supply Chains – Detailed Exception View

[Image of a software interface showing a detailed exception view in a management portal for supply chains.]
Technology Perspective of Business Process Monitoring
Technology Evolution for Gaining Insight into the Business

Approaches for Insight into Business Data

- Data Warehousing
- Business Process Warehousing
- Real-Time Business Monitoring
- Adaptive Monitoring Environment
Business Process Monitoring – Technology Landscape

Business Process Monitoring Technology Mix

- **Business Process & Workflow Management**
  - IDS-Scheer, CaseWISE, Popkin
  - Lombardi, IBM, FileNet, Staffware (Tibco)
  - SAP, Oracle, Microsoft

- **Business Software**
  - ERP, CRM, SCM...
  - Business Objects, Cognos, Hyperion

- **Business Process Modeling & Analysis**

- **Network Systems Management**
  - BMC, CA, HP

- **Integration Broker Suites, EAI**
  - Tibco, Vitria, IBM, SeeBeyond

- **Data Integration Suites, ETL**
  - Informatica, Ascential, Data Mirror
  - Oracle, IBM, Microsoft

- **Data Warehouse, Databases**
Web-Service Based Business Process Monitoring
Monitoring of a Distributed Supply Chain Process

- Monitoring of intra-organizational business processes
- Shared monitoring infrastructure for business partners
- Monitoring of business processes as on demand service
<table>
<thead>
<tr>
<th>Define Web Service</th>
<th>Log Web Service</th>
<th>Analyze Web Service</th>
<th>Monitor Web Service</th>
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</thead>
</table>
| • Setup of monitoring infrastructure  
• Identifies web services for monitoring and their owners  
• Defines the web services states and state transition rules  
• Defines performance objectives  
• Defines security policies | • Captures audit trail data from various source systems  
• Logs state changes of a business process  
• Calculates business process metrics and stores them in a database  
• Correlation of process events | • Query interfaces for retrieving performance data  
• The performance data includes  
  • web service enactments  
  • process metrics  
  • service level violations  
• Access to analytical agents  
• Dependent on policies defined by the web service owner | • Senses performance data for exceptional business situations  
• Responds to exceptional business situations (e.g. by calling another web-service)  
• Manages service level agreements |
Monitoring BPEL4WS Processes

Business Partner Business Processes

<receive>
<reply>
... BPEL4WS Process

<receive>
<reply>
... BPEL4WS Process

Organisation with Monitored Business Processes by SMWS

<invoke>
<receive>
<invoke> audit
<invoke>
<receive>
<invoke> audit
<invoke>
<receive>
<invoke>
...

Port Type

BPEL4WS Process

BPEL4WS Process

Monitoring Infrastructure

Log Web Service

Event Stream Processor

Real-time Data Store

Data Warehouse
Monitoring Process Managed By Workflow Management Systems

IBM Websphere Process Choreographer

- **Navigator**
  - State Machine (Process, Activity)

- **Work Item Management**
  - Staff Plug-in LDAP
  - Data Plug-in Java, XML, ...
  - Invocation Plug-in WSDL/ WSIF

- **Tracing Logging**
  - Observer Plug-in Audit Trail
  - Observer Plug-in Proxy
  - Invocation Plug-in WSBI Dashboard

Factory:
- Uses either persistent storage (DBMS) or transient storage (RAM)

Monitoring Infrastructure

- Log Web Service
- Event Stream Processor
- Real-time Data Store
- Data Warehouse

log item
Monitoring with Probes in Operational Systems

Observed Business Process

System 1

System 2

System 3

System 4

Logging Daemon/SMWS Proxy

Monitoring Infrastructure

Log Web Service

Log Files, Log Tables

Audit Data Flows

Real-time Data Store

Data Warehouse

Business Operations

Observable Business Operations

Probes

Event Stream Processor

log item
Event Stream Processor

Log Web Services
- BPEL4WS Process
  - Log Web Service 1
  - Log Web Service 2
  - Log Web Service 3
  - Log Web Service 4
- Raw Logging Items

Event Stream Processor
- Receive/Unify Events
- Event Processing
- Evaluation/Alerting

Services for Event Processing
- Event Standization
- Event Correlation
- Event Condensation
- Event Stream Querying
- Metric Calculation
- Event and Metric Persistence
- Event Flow Management
- Metric Evaluation
- Notifications & Alerting
Adaptive Business Process Monitoring with Sense & Respond
Sense & Respond adds intelligence when the execution of a business operation depends on:

- State of a business process (e.g. delays of process activities)
- Complex event pattern (e.g. a fraud event patterns)
- Assessment of opportunities, risks, capacity utilization, quality of service
- Real-time key performance indicators, which can be highly aggregated business metrics (e.g. cycle times, processing costs, response time to customer)
- Predictable indicators (e.g. demand forecasts, production plans)
### Sense & Respond Loops

<table>
<thead>
<tr>
<th>Sense</th>
<th>Respond</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extracts and collects relevant event data from the business environment</td>
<td>Communicating the decision as a command or suggestion</td>
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<tr>
<td></td>
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</tr>
<tr>
<td>Interpret</td>
<td>Decide</td>
</tr>
<tr>
<td>Giving the event data a meaning</td>
<td>Determines most appropriate action for a response to the business environment</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Analyze</td>
<td></td>
</tr>
<tr>
<td>Determines root causes of identified business situations</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Decide</td>
<td></td>
</tr>
<tr>
<td>Selects the best option for improving the business situations</td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Respond</td>
<td></td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>
Business Activity Monitoring with Senactive InTime

Real-time Business Performance Data

- Sense Events of order process
- Sense Events of production processes
- Interpret
- Analyze
- Decide
- Respond

Production Management

- Notifications eMail for order confirmations
- Response Trigger re-ordering of products and materials
- Updates of production plan

E-Commerce System
Production System
ERP System
Sense & Respond and Data Warehousing

Traditional approach for integrating data into the data warehouse

Enterprise Data Warehouse

Batch Data Integration
- Loading
- Transformation
- Extraction

Real-time Data Store

Business Activity Monitoring

Process Metrics

Notifications

Sense (Business Process Events)

Response

E-Commerce System
Groupware System
CRM System
Production System
ERP System
Sense & Respond – Logistics & Transportation Management

Sense (Shipment Events)

Interpret

Analyze

Decide

Respond

Response & Notifications
(Change route, transportation mode, priorities, ...)

32
Modeling
Sense & Respond
Event Driven Process Chains and Sense & Respond Processes

Outside View of a Sense & Respond Process

Goal of the Business Intelligence Process
Inside View of a Sense & Respond Process

Event Driven Process Chains and Sense & Respond Processes

Data Analysis 1

Situation Event 1

Data Analysis 2

Situation Event 2

Situation Discovery 1

Situation Discovery 2

Analysis Result Event 1

Analysis Result Event 2

Decide on Analytical Results

Decision Result Event

Respond Delegate

Sense Delegate
Event Driven Process Chains and Sense & Respond Processes

Example for Inside View of a Sense & Respond Process

- Select Orders that should be examined
  - Order Event
  - Filtered Order Event
- Analyze Customer Payment History
  - Customer Payment History Accepted
- External Credit Check
  - Credit Rating Accepted
- New Customer Rating
- Update Customer Rating
- Decide on Discount
  - Customer Discount Applicable
  - Deny Order Event
- Deny Order
- Give Discount

Order Request
Web-Service Based & Adaptive Business Process Monitoring
Senactive InTime Sense & Respond Loops

1. Probing / Sensing
2. Transmit Events
3. Unify Events
4. Transform Events into Business Indicators
5. Detect Situations or Exceptions
6. Analyze Situations or Exceptions
7. Make Decisions
8. Put Response into Action
Supply Chain Monitoring of BPEL4WS Processes
Monitoring of BPEL4WS Processes with Senactive

Service Provider Type

BPEL4WS Process

Port Type

Service Provider Type

BPEL4WS Process

Log Web Service

Log item

Sense & Respond System

Process Warehouse

<invoke>

<receive>

<reply>

<invoke>

<receive>

<reply>

<invoke>

<receive>
Monitoring of Non-BPEL4WS Processes with Senactive

Observed Business Process

Web Service Proxy

Response

Monitoring Service

Log Web Service

log item

Sense & Respond System

Process Warehouse
Sense & Respond System

Log Web Services

- BPEL4WS Process
- Log Web Service 1
- Log Web Service 2
- Log Web Service 3
- Log Web Service 4
- Raw Logging Items

Sense & Respond System

- Receive/Unify Events
- Event Processing
- Evaluation/Alerting

Event Adapters
- Event Service
- Evaluators

S&R Services
- Event Standization
- Event Correlation
- Event Condensation
- Event Stream Querying
- Metric Calculation
- Event and Metric Persistence
- Event Flow Management
- Metric Evaluation
- Notifications & Alerting
Sense & Respond Monitoring with Senactive *InTime*

**Sense & Respond Model**

**Senactive InTime Key Features**

- **Visualization** of Sense & Respond Processing
- **Modular and Service-Oriented Architecture**
- **Generation of Real-Time Key Performance Indicators**
- **Real-Time Data Analysis** for Controlling Business Processes
- **Instant Response** on Business Situations and Exceptions
Research Topics for “Bakk.-Arbeiten”, “Diplomarbeiten” etc.
Research Topics (see also http://www.ifs.tuwien.ac.at/~js)

Business Process Management
- Web Service Based Auditing of BPEL4WS Processes
  (Web Services, BPEL4WS, Messaging)
- Scalable Messaging Infrastructure for Monitoring Business Processes
  (Messaging, MSMQ, MQSeries, JMS, …)
- Analysis Services with XMLA for Business Process Monitoring
  (OLAP, Data Mining, SQL Server 2005)

Event Management
- Event Models for Monitoring Business Processes
  (XML Schema for events)
- Event Simulation Model for Business Processes
  (Generating consistent XML events)
- Discovering Patterns in Event Streams, Event-Driven ECA Rules
  (Rule Engines, XML Rules)
- Correlation and Synchronization of Event Streams
  (XPath, Concurrency, Distributed Computing)

Data Management
- Data Management for Event Streams
  (Star Schemas, Data Warehousing, SQL Server 2005)
- Real-time Analytics & Data Stream Analysis with OLAP,
  Neuronal Network, Decision Trees, Clustering Techniques,
  Association Rules
  (Data Warehousing, Business Intelligence, SQL Server 2005)

User Interfaces
- Visualization/Modeling of Sense & Respond Processes
  (data flows, control flows, dependencies)
  (Visualization and manipulation of Graphs, GUI design, Visual Studio 2005, C#)
Q&A
Methods and Technologies for Business Process Monitoring

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