Beyond Rigidity - Lifecycle Management for Dynamic Processes

BPM’07 Tutorial
27 September 2007
Brisbane, Australia

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Abstract

The economic success of an enterprise increasingly depends on its ability to react to changes in its environment in a quick and flexible way. Recently, a new generation of process-aware information systems (PAIS) has emerged to provide this flexibility and to support dynamic processes. Similar to classical information systems development lifecycles, studies on life cycle support for dynamic business processes are often sweeping the issues pertaining to post deployment change management, under the banner of maintenance. However, the pervasiveness of dynamic changes in business processes warrants targeted attention.

This tutorial presents a review of the basic challenges and techniques that exist for life cycle management of dynamic processes. Our approach is to present ideal support for the needs of the various life cycle phases and then to deliberate on various developments from academia and industry in terms of their closeness to these needs, thus identifying open questions where relevant. A case study is presented which forms a motivational backbone for the whole tutorial. A detailed discussion of the process lifecycle structured around the three main phases of design, execution, and monitoring & analysis and proof-of-concept demonstrations are provided.

Outline

The tutorial is split into 3 parts covering the three phases of the process lifecycle:

Part I: Definitional Phase (by Shazia Sadiq):
- We discuss business process definition both from a management strategy perspective and from a means to realize executable processes.

Part II: Execution Phase (by Barbara Weber):
- We discuss challenges and solutions for flexible process execution and particularly motivate the importance of run-time process adaptability.

Part III: Monitoring & Analysis Phase (by Manfred Reichert):
- We discuss challenges and solutions related to the monitoring and analysis of process execution data.
Presenters Background

Shazia Sadiq
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Shazia Sadiq is currently Senior Lecturer in the School of Information Technology and Electrical Engineering at The University of Queensland, Brisbane, Australia. She is part of the Data and Knowledge Engineering (DKE) research group and is involved in teaching and research in databases and information systems. Shazia holds a PhD from The University of Queensland in Information Systems and a Masters degree in Computer Science from the Asian Institute of Technology, Bangkok, Thailand. Her main research interests are innovative solutions for Business Process Management that span several technology areas including workflow systems, service oriented computing, messaging technologies, and deployment of large scale distributed devices. Shazia has contributed widely to the body of knowledge in the field of dynamic workflows and has published several papers on this topic.

Barbara Weber
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Barbara Weber is currently Assistant Professor in the Department of Computer Science at the University of Innsbruck, Austria. Here she also obtained her PhD degree. Barbara is a member of the Quality Engineering research group and is involved in teaching and research in business processes and workflow management. Her main research interests are agile and flexible processes and intelligent user support in flexible systems. This spans several technology areas including workflow management systems, case-based reasoning, process-oriented knowledge management, enterprise information systems, process mining, and agile software development. To allow for the exchange of ideas with practice she is engaged in third-party funded projects with partners from different domains (e.g., healthcare, logistics). In the area of dynamic workflows Barbara has published several papers on topics like integrated process lifecycle support and change patterns. Further, Barbara has been organizer of several international workshops like Proflex’06, ProGility’07 and BPI’07 as well as of a think tank on business agility at AGILE 2007, which are related to dynamic workflows.

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Manfred holds a PhD in Computer Science and a Diploma in Mathematics. Currently, he is working as Associate Professor in the Information Systems Group at the University of Twente (UT). The Netherlands. At UT he is also leader of the strategic research orientation on e-health and member of the Management Board of the Centre for Telematics and Information Technology (CTIT), which is the largest ICT research institute in the Netherlands (with more than 400 researchers). Before Manfred joined UT in October 2004 he was working as Assistant Professor in the Institute for Databases and Information Systems at Ulm University, Germany. Here he also finished his PhD thesis on adaptive process management (with honors). His major research interests are next generation process management technology (e.g., adaptive processes, process lifecycle management, process visualization, data-driven workflows), service-oriented architectures (e.g., service interoperability, service change), and advanced applications for ICT solutions (e.g., e-health, automotive engineering). Together with Peter Dadam he pioneered the work on the ADEPT process management system. Manfred has been participating in numerous research projects in the BPM area and contributed numerous papers. Finally, he has co-organized international and national conferences and workshops.
BPM 2007 Tutorial

Life Cycle Management for Dynamic Processes

Shazia Sadiq, The University of Queensland
Barbara Weber, University of Innsbruck
Manfred Reichert, University of Twente

27 Sep 2007
13.30 – 15.30

Presenters

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## Tutorial Plan

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:30 – 13:40</td>
<td>Challenges of the <em>Dynamic</em> Process</td>
</tr>
<tr>
<td>13:40 – 14:00</td>
<td>Definitional Phase</td>
</tr>
<tr>
<td>14:00 – 14:30</td>
<td>Execution Phase</td>
</tr>
<tr>
<td>14:30 – 15:00</td>
<td>Monitoring Phase</td>
</tr>
<tr>
<td>15.00 – 15.20</td>
<td>Summary, Q &amp; A Session</td>
</tr>
<tr>
<td>15.20 – 15.30</td>
<td>Evaluation and Feedback</td>
</tr>
</tbody>
</table>

## Preaching to the converted!

### The BPM Fever—Hype or Reality

- Business Process Management (BPM) has been identified as the “number one business priority” and a major challenge for senior executives.
- Increasingly, BPM is perceived as a way to align and increase the contribution of information systems to the business.
- Workflow management systems (a core segment in BPM solutions) and related BPM solutions will reach $1.1 billion by 2009 (at $416.4 million in 2003).

### The age of the
- Crafts Worker
- Factory
- Specialist

### Process Orientation

- Re-engineering

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The BPM value proposition

- **Value to shareholders and competitiveness**
  - Transformation
  - Business insight
  - Compliance & consistency
  - IT agility
  - Efficiency
  - Knowledge

- **IT agility**
  - Process execution
  - Process monitoring
  - Process modeling

- **Compliance & consistency**
  - CIO
  - CFO
  - CXO
  - CEO

- **Workers, supervisors, and managers**
  - Lower

- **Customers and partners**
  - Higher

Process Life Cycle

- **STATEGIZE**
- **MODEL**
- **MONITOR**
- **EXECUTE**
Process Life Cycle (variants)

Overview
- Definitional Phase
- Execution Phase
- Monitoring Phase
- Summary

STATEGIZE ➔ MODEL

EXECUTE ➔ MONITOR

IDS Scheer

Microsoft Business Activity Services for BizTalk

Reality Check

- Consider an organization See-the-Bears Pty Ltd that provides services for adventure travellers.
- See-the-Bears has specialized for Alaskan travels and organizes everything which is required for the customer’s personal Alaskan adventure.
- This includes arranging transportation and accommodation as well as activities (e.g., flightseeing, hiking, etc.).
- See-the-Bears has a large network of partners (i.e., service provider) in different places in Alaska on whose services it can rely on.
- For example, it partners with a company offering a boat tour service at Glacier Bay or with a company offering flightseeing to Wrangell St. Elias Mountains).
- This allows See-the-Bears to let their customers choose from a wide variety of services and to consider the particular preferences of their customer when creating a plan for their customers’ personal adventures prior to the journey.
- The payment for the adventure travel is handled by See-the-Bears in cooperation with different credit card service providers.

The competitive advantage of See-the-Bears is its ability to flexibly address customers’ preferences (e.g., service variability) and its high responsiveness to change.
Business (Process Management) as Usual

- See-the-Bears does not offer out of the box travels to their customers, but *flexibly composes a personal Alaskan adventure* for each of its customers.
- Although See-the-Bears creates personal travel adventures for each of their customers taking their preferences into account, *adaptations to the plan* created prior / during the journey often become necessary.
- Depending on the customer the plan for the journey is not entirely fixed in advance. Instead, *many decision are taken during the journey*.
- Some events like a road closure might not only affect a single customer of See-the-Bears, but many customers, and may last for long periods, thus See-the-Bears has to consider this situation when planning for new customers.
Characterizing Dynamic Processes

- Flexibility
  - Customization
  - Knowledge based
  - See-the-Bears does not offer out of the box travels to their customers, but *flexibly composes a personal Alaskan adventure* for each of its customers.

- Adaptation
  - Exceptions
  - Ad-hocism
  - Depending on the customer the plan for the journey is not entirely fixed in advance. Instead, *many decision are taken during the journey*.

- Evolution
  - Improvement
  - Innovation
  - Some events like a road closure might not only affect a single customer of See-the-Bears, but many customers, and may last for long periods, thus See-the-Bears has to consider this situation when *planning for new customers*.

Life Cycle for the *Dynamic Process*

- Overview
- Definitional Phase
- Execution Phase
- Monitoring Phase
- Summary

- STATEGIZE
- MODEL
  - Flexibility
- EXECUTE
  - Adaptation

Evolution
Definitional Phase

Preparing models
Strategy definition/Executable models

Preparing models for dynamic processes

- Flexibility
  - Customization
  - Knowledge based

- Adaptation
  - Exceptions
  - Ad-hocism

- Evolution
  - Improvement
  - Innovation

The Notorious Business-IT Divide

“Management Pull and Technology Push don’t connect”

© Thomas Davenport
http://www.tomdavenport.com/
**The Missing Middle**

- **Management Pull**
  - Process Orientation does not increase over time
  - Process infrastructure does not get built
  - Each process initiative has to start from scratch
  - Process tools not fully exploited
  - Technology push does not yield business value

- **Technology Push**

---

**Stretch the Missing Middle**

- **Management Pull**
  - Senior executives become intensively involved in process/IT change programs
  - BPM tools generate systems that are aligned with processes and strategies

- **Technology Push**
Process Modelling for Strategy Definition

- Six Sigma
  - Bill Smith (1986) Motorola University
- Porter’s value chain
- Rummler’s management theory
- SEI Capability Maturity Model Integration
  - www.sei.cmu.edu/cmmi
- Process Improvement
- Process Handbook
- Reference Models
- Process Templates

→ Mostly contributions from Management Science

Overview
- Definitional Phase
- Execution Phase
- Monitoring Phase
- Summary

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Process Modelling for Process Execution

... Remaining discussion on Modelling for Process Execution

- The modelling landscape
  - Languages
  - Expressability and patterns
  - Discovery and mining
  - Tools
  - Standards

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Example – BPMN

Overview

Definitional Phase

Execution Phase

Monitoring Phase

Summary

Enter Customer Request

Create Offer

Customer Likes Offer

Home Offer

Book Journey

Pay Journey

www.bpmn.org

Example - FlowMake

Overview

Definitional Phase

Execution Phase

Monitoring Phase

Summary

Begin

Enter Customer Request

Create Offer

Choice

Customer likes offer

Revise Offer

Merge

Book Journey

Pay Journey

End

Sadiq & Orłowska (2001)
Example – Petri-nets

Overview

Definitional Phase

Execution Phase

Monitoring Phase

Summary

Example - ADEPT

Enter Customer Request → Create Offer → Revised Offer → Book Journey → Pay Journey → END

Customer likes offer

Reichert (2000)
Example – EPC

Overview
Definitional Phase
Execution Phase
Monitoring Phase
Summary

New Customer Request
Enter Customer Request
Customer Req. Entered
Create Offer
Customer likes offer
Customer does not like offer

Pay journey
Journey booked
Book journey

Offer revised

Usability vs. Expressability Debate

Overview
Definitional Phase
Execution Phase
Monitoring Phase
Summary

complexity & workarounds
revisit Davenport's business-IT divide
controlling the loosely defined process
procedural vs. declarative

formal languages and the business analyst
evidence of process errors
Modelling the Dynamic Process

- See-the-Bears does not offer out of the box travels to their customers, but flexibly composes a personal Alaskan adventure for each of its customers.
- Although See-the-Bears creates personal travel adventures for each of their customers taking their preferences into account, adaptations to the plan created prior to the journey often become necessary.
- Depending on the customer the plan for the journey is not entirely fixed in advance. Instead, many decision are taken during the journey.
- Some events like a road closure might not only affect a single customer of See-the-Bears, but many customers, and may last for long periods, thus See-the-Bears has to consider this situation when planning for new customers.

Selected Approaches

- Granularity Control
- Configuration
- Late Binding
- Late Modelling
Granularity Control

**Make a phone call**

**Meet and decide**

**Complete list**

**Enter data**

Do not control “flexible” activities through process control flow?

---

Configuration

**Parameter driven**

- trip-category = “adv”
- duration < 2 weeks
- total cost <5K

---

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Configuration

Parameter driven

- trip-category = "adv"
- duration < 2 weeks
- total cost <5K

Overview
- Definitional Phase
- Execution Phase
- Monitoring Phase
- Summary

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**Configuration**

- **Trip-category** = "adv"
- **duration** < 2 weeks
- **total cost** <5K

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>On</td>
</tr>
</tbody>
</table>

**Late Binding**

- **Activity Metamodel**
  - `<Id, … Role>`
  - Design time
  - Run time

- **Role: Performer**
  - `<Senior Manager: [Jack, Trevor, Sally Hadden]`
Late Binding

Overview

Definitional Phase

Execution Phase

Monitoring Phase

Summary

Activity Metamodel

WSDL

Service Binding

Process Binding

Adams et al. (2006)
Asynchronous Events

In case of road delay, if customer is premium, inform and change accommodation booking

Casati & Pozzi (1999)

Late Modeling

permit is required for skydiving

A maximum of 3 recreational activities can be selected from the package

Bear viewing trip must be organized by same transport provider

Total cost of stay at Denali not to exceed 3.5K

Lu et al (2006)

Sadiq & Orłowska (2005)
Late Modeling

Overview

Definitional Phase

Execution Phase

Monitoring Phase

Summary

Set of Activities

\[
\begin{align*}
P & \quad Q & \quad R \\
S & \quad T & \quad U \\
X & \quad Y & \quad + \\
P \text{ before } Q \\
S \text{ with } T
\end{align*}
\]

Set of Constraints

Instance Specific

Pocket of Flexibility

Small no. of execution options

Large no. of execution options

DECLARATIVE
Late Modeling

Issues at Build time

Constraint Modeling
  Scheduling
  Selection
  Resource
  ...

Consistency checking
  Conflicts & Redundancies

Permit is required for skydiving

A maximum of 3 recreational activities can be selected from the package

Bear viewing trip must be organized by same transport provider

Total cost of stay at Denali not to exceed US$3.5K
Life Cycle for the *Dynamic Process*

### Overview

- **Definitional Phase**
- **Execution Phase**
- **Monitoring Phase**
- **Summary**

### Definitional Phase

- **STATEGIZE**
- **MODEL**
- **EXECUTE**

### Execution Phase

- **CONCRETIZE**
- **EXECUTE**

#### Concretizing loosely specified models

- Flexibility
  - Customization
  - Knowledge based

#### Handling expected exceptions

- Adaptation
  - Exceptions
  - Ad-hocism

#### Flexibly deviating from the pre-planned process

- Evolution
  - Improvement
  - Innovation
System Perspective

- Process Type Level

Process Schema S1

- Process Instance Level

Process Instance 1

System Perspective

- Process Management System

Process Execution Engine

- Summary
User Perspective

Overview
Definitional Phase
Execution Phase
Monitoring Phase
Summary

Process Instance II

A → B → C → D → E → F

Offered → Allocated → Started → Completed

Joe Peter

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Manfred Reichert
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User Perspective

Overview

Definitional Phase

Execution Phase

Monitoring Phase

Summary

Process Instance 1

A → B

A AND-Split

C → D

C AND-Split

E → F

Offered Allocated Started Completed

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Late Binding

• Process Type Level

• Process Instance Level

Selection based on rules or user decisions

IF … THEN
ELSE IF
ELSE …
Late Binding

- Process Type Level

- Process Instance Level

Late Modeling

Issues at Run time

Dynamic Build

Instance Template Validation

Lu et al (2006)
Sadiq & Orlowska (2005)
Late Modeling

• Process Type Level

[Diagram of Process Type Level]

• Process Instance Level

[Diagram of Process Instance Level]

How to realize step B for process instance I1?
Late Modeling

- Process Type Level

Process Schema S

- Process Instance Level

Set of Activities

P Q R
S T U
X Y

Set of Constraints

P before Q
S with T

Process model correct!

Overview

Definitional Phase

Execution Phase

Monitoring Phase

Summary

Overview

Definitional Phase

Execution Phase

Monitoring Phase

Summary
Dealing with Exceptions

Overview

Definitional Phase

Execution Phase

Monitoring Phase

Summary

Expected Exceptions

Unexpected Exceptions

Exception Handler

Ad-hoc Changes

Expected Exceptions

Work Item Failure

Deadline Expiry

Resource Unavailability

External Trigger

Constraint Violation

Russel et al. (2006)
Expected Exceptions

Overview
Definitional Phase
Execution Phase
Monitoring Phase
Summary

Process Instance II

A
B
AND-Split

C

D

E

F

Offered
Allocated
Started
Completed

Joe

Peter

Expected Exceptions

Overview
Definitional Phase
Execution Phase
Monitoring Phase
Summary

Offered
Allocated
Started

Withdrawn

Failed

Completed
Expected Exceptions

Overview

1. Definitional Phase
2. Execution Phase
3. Monitoring Phase

Expected Exceptions

Joe Peter

Rollback / Compensate

Effect of Exception

Process Instance 11

A offers
B
C
D
E
F

Offered
Allocated
Started
Completed
Expected Exceptions

Overview
- Definitional Phase
- Execution Phase
- Monitoring Phase
- Summary

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Ad-hoc Changes

• Process Type Level
  - Process Schema S

• Process Instance Level
  - Process Instance II

Reichert et al. (1998), Reichert et al. (2003)
Ad-hoc Changes

- Process Type Level

  Process Schema S
  \[ A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \]

- Process Instance Level

  Process Instance II
  \[ A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \]

Insert X before E
Replace F by Z

Overview
- Definitional Phase
- Execution Phase
- Monitoring Phase
- Summary

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Cost of Change

• Change Operations vs. Change Primitives

![Diagram showing change from one process to another](image)

Insert A parallel to B

<table>
<thead>
<tr>
<th>Change Patterns</th>
<th>Change Primitives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 High-Level Change Operation</td>
<td>9 Change Primitives</td>
</tr>
<tr>
<td>parallelInsert (S, A, B)</td>
<td>Add Node (3x)</td>
</tr>
<tr>
<td></td>
<td>Move Edge (2x)</td>
</tr>
<tr>
<td></td>
<td>Add Edge (4x)</td>
</tr>
</tbody>
</table>

Adaptation Patterns

Adding / Deleting Fragments

AP1: Insert Process Fragment
AP2: Delete Process Fragment

Moving / Replacing Fragments

AP3: Replace Process Fragment
AP4: Move Process Fragment
AP5: Swap Process Fragment
AP14: Copy Process Fragment

Adapting Control Dependencies

AP8: Embed Process Fragment in Loop
AP9: Parallelize Activities
AP10: Embed Process Fragment in Conditional Branch
AP11: Add Control Dependency
AP12: Remove Control Dependency

Changing Transition Conditions

AP13: Update Condition

Add / Removing Levels

AP6: Extract Sub Process
AP7: Inline Sub Process

Weber, Rinderle and Reichert (2007)
Change Reuse

- Process Type Level

- Process Instance Level

Case-Base with previously performed changes

Weber et al. (2004)
Weber et al. (2006)

Overview
Definitional Phase
Execution Phase
Monitoring Phase
Summary

Life Cycle for the **Dynamic Process**

- STATEGIZE
- MODEL

Flexibility

- EXECUTE
- MONITOR

Adaptation

Evolution
Monitoring Phase

Ensuring traceability of dynamic processes
- Flexibility
  - Customization
  - Knowledge based

Real-time monitoring and control
- Adaptation
  - Exceptions
  - Ad-hocism

Diagnosing and mining of dynamic processes
- Evolution
  - Improvement
  - Innovation

Managing change policies and process evolution
MONITOR

Overview
Definitional Phase
Execution Phase
Monitoring Phase
Summary

Process Monitoring

Process Modelling
Process Models

Process Execution
Process Instances (and logs)
Instance Adaptations

Process Monitoring, Diagnosis & Mining
Dashboards, Reports, Discovered Flaws

Process Variants

Overview
Definitional Phase
Execution Phase
Monitoring Phase
Summary
Relevant Issues

• Dynamic processes provide significant runtime data
• Promising perspectives with respect to process analyses, process intelligence and process evolution
• But: systems enabling dynamic processes are more vulnerable to misuse
• Relevant issues, e.g.
  – Execution & change traceability
  – Real-time monitoring & control
  – Process diagnosing and mining, process compliance
  – Change policy management and process evolution

Traceability

Weber et al. (2005)
Traceability

### Execution Logs

**Process Instance 4711**

- **Instance 4711**
  - Activity: Event, User, Timestamp
  - A: Started Garry 2007/09/08 15:00
  - A: Completed Garry 2007/09/08 15:45
  - X: Started Fritz 2007/09/11 09:01

**Process Instance 4723**

- **Instance 4723**
  - Activity: Event, User, Timestamp
  - A: Started John 2007/08/02 10:47
  - A: Completed John 2007/08/02 12:44
  - S: Started Helen 2007/08/04 09:11
  - S: Completed Helen 2007/08/04 14:09
  - C: Started Garry 2007/08/07 16:55

---

**Traceability**

### Change Logs + Process Variants

**Original Schema S**

- A
- B
- C

**Change Log**

- **Change Log** Instance 4711 on Schema S
  - Change TX Applied Changes: User:Timestamp

**REPLACE C by Z**

- Helen (2007/09/10 12:02)
- Jim (2007/09/10 09:31)

**ADD X PARALLEL TO B**

- Rinderle, Jurisch, and Reichert (2007)
- Rinderle, Reichert, Jurisch and Kreher (2006)
Traceability

Execution & Change Logs allow to ...

- reconstruct the structure and the state of a particular process instance at any point in time (next slide)
- monitor, analyze and diagnose a collection of completed and/or running instances
- identify those process instances which deviate from the original process schema
- learn from these instance-specific changes and to derive optimized process models
- check for process compliance (i.e., to check whether a particular process instance meets certain control objectives)
- ...

Traceability

Execution & Change Logs: Reproducibility of Variants

Original Schema S

<table>
<thead>
<tr>
<th>Activity Event</th>
<th>User</th>
<th>Timestamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instance Started</td>
<td>Garry</td>
<td>2007/09/08 15:00</td>
</tr>
<tr>
<td>A</td>
<td>Started</td>
<td>Garry</td>
</tr>
<tr>
<td>B</td>
<td>Completed</td>
<td>Garry</td>
</tr>
<tr>
<td>S</td>
<td>Started</td>
<td>Helen</td>
</tr>
<tr>
<td>X</td>
<td>Started</td>
<td>Fritz</td>
</tr>
</tbody>
</table>

Change Log Instance 4711 on Schema S

<table>
<thead>
<tr>
<th>Change TX Applied Changes</th>
<th>User</th>
<th>Timestamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>001 InsertFragment[S;X,A,C]</td>
<td>Helen</td>
<td>2007/09/10 12:02</td>
</tr>
</tbody>
</table>

Process Instance 4711

2007/09/10 11:00

<table>
<thead>
<tr>
<th>Garry</th>
<th>Helen</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
</table>

2007/09/10 13:00

| Garry | Helen | B | X | C |

2007/09/11 10:00

| Garry | Helen | B | X | Z |

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Real-time Monitoring & Control

Workflow dashboard

- operational console for running process instances
- aggregated overview of process instance collections
- monitoring and visualization of single process
- performing administrative and corrective actions on work items and process instances (suspend, reassign, change, etc.)
- connect with alerters and notification services (e.g., to deal with delays in the processing of work items)
Real-time Monitoring & Control

Monitoring and visualizing the progress of single instances

Overview

Definitional Phase

Execution Phase

Monitoring Phase

Summary

Process Diagnosing and Mining

Overview

Definitional Phase

Execution Phase

Monitoring Phase

Summary
Process Diagnosing and Mining

Overview
- Definitional Phase
- Execution Phase
- Monitoring Phase
- Summary

Process Diagnosing and Mining

Overview
- Definitional Phase
- Execution Phase
- Monitoring Phase
- Summary
Process Performance Metrics - Examples:

- **Process perspective**: cycle times, waiting times, processing times, and synchronization time.
  - What average time does See-the-Bear need to process a customer request?
  - What is the maximum waiting time for activity “book boat tour for Glacier Bay”?
  - What percentage of customer requests is handled within 24 hours?
  - What is the minimum processing time of activity “plan transportation”?
  - How many times was a travelling plan dynamically adapted? Which services were most sold? In how many cases was a trip aborted?
  - What are the average transporation costs for customers?
  - How many process instances have been handled last year? How does their distribution look like?

- **Resource perspective**: frequencies, time, utilization, and variability.
  - How many times did Garry complete activity “book boat tour for Glacier Bay”?
  - How many times did Helen withdraw activity “book rental car”?
  - How much time did Garry work on instances of activity “plan transportation”?
  - How much time did people with role Manager work on this process?
  - What is resource usage distributed over a certain period of time?
  - How many times did Helen work for more than 1 hour without interruption?

Process Performance Metrics – Analysis Options:

- **Resource & Organization Analysis**: extract information on resource and organization models

- **Aggregated Analysis**: Based on execution of process activities (average revenue, execution cost, idle cost, allocated resource cost, total cost, and profit)

- **Process Instance Analysis**: Based on individual dynamic process instances (resources allocated per activity instance, allocation duration, shortage, and cost)

- **Comparison Analysis**: Compare the weighted average analysis results for two processes
Process Diagnosing and Mining

Process Performance Characteristics

- Each dynamic process instance has a number of properties:
  - Resource that worked on a specific activity
  - Value of a characteristic data element (e.g., size of order, age of customer, number of flights per adventure trip, etc.)
  - Performance metrics of instance (e.g., processing time)

<table>
<thead>
<tr>
<th>caseid</th>
<th>Act A</th>
<th>Act B</th>
<th>Act Z</th>
<th>Data D1</th>
<th>Data D2</th>
<th>...</th>
<th>Data D9</th>
<th>Proc time</th>
<th>Wait Time</th>
<th>Flow time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>John</td>
<td>Mike</td>
<td>Anne</td>
<td>$50</td>
<td>20y</td>
<td>...</td>
<td>...</td>
<td>60%</td>
<td>12h</td>
<td>3d</td>
</tr>
<tr>
<td>2</td>
<td>Clare</td>
<td>Jim</td>
<td>Ike</td>
<td>$75</td>
<td>15y</td>
<td>...</td>
<td>...</td>
<td>75%</td>
<td>6h</td>
<td>3d</td>
</tr>
<tr>
<td>3</td>
<td>John</td>
<td>Mike</td>
<td>Clare</td>
<td>$55</td>
<td>20y</td>
<td>...</td>
<td>...</td>
<td>80%</td>
<td>18h</td>
<td>4d</td>
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<td>...</td>
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</tr>
</tbody>
</table>

- Using data mining techniques it is possible to find relevant relations between these properties

- Examples:
  - If John and Mike work together, it takes longer.
  - Expensive cases require less processing


Process Mining based on Execution and/or Change Logs

Data from a collection of process instances

Process mining can be used for …

- discovering process models from execution logs (What is the process?)
- performing delta analyses and compliance checks (Are we doing what was specified? Are control objectives met?)
- discovering process optimizations based on execution and/or change logs
Process Diagnosing and Mining

Process Mining based on Execution and/or Change Logs

Execution analysis - Example: Discover a process model (e.g., in terms of a BPMN diagram) based on the execution log and without prior knowledge about the structure of the process.

Execution log (simplified):

I1: A
I2: A
I3: A
I3: B
I4: A
I2: B
I2: D
I3: E
I4: C
I4: C
I3: C
I3: D
I4: B
I5: F
I4: D

I1, I2: ABCD - I2, I4: ACBD - I5: EF

Aalst et al. (2003); Aalst et al (2004)

Process Diagnosing and Mining

Change Analysis - Example: Discover a meta change process which covers all changes applied to dynamic process instances from a given collection.

Discover change process model from change logs


Process Evolution

- Process changes can be realized by adapting the process schema at the type level (process schema evolution).
- Challenge: How to deal with running process instances when adapting their original process schema?
- At least version control and co-existence of process instances running on the old and the new schema is needed.
- For long-running process instances, in addition, their controlled migration to the new schema version is often required.
- Correct behavior of process instances after their migration is a must!
- In the following slides, we sketch selected scenarios on this:
  - Scenario 1: No version control
  - Scenario 2: Co-existence of instances running on the old / new schema
  - Scenario 3: Change propagation and instance migration
Scenario 1 – No Version Control

Type change overwrites schema S

Process Schema S

Process Schema S

Instances I2 and I3 are in inconsistent states

Process Instance I1

Process Instance I2

Process Instance I3

Change is propagated to all running process instances

Process Instance I1

Process Instance I2

Process Instance I3

Instances I2 and I3 are in inconsistent states

Scenario 2 – Co-Existence

Type change results into a new version of schema S

Process Schema S

Process Schema S'

Old instances remain with schema S

Process Instance I1

Process Instance I2

Process Instance I3

Instances created from S

New instances with schema S'

Process Instance I4

Process Instance I5

Instances created from S'
Scenario 3 – Instance Migration

Type change results into a new version of schema S

Process Schema S

Process Schema S'

Migration of compliant process instances to S'

Process Instance I1

Process Instance I2

Process Instance I3

Non-compliant instances

Summary

Revised lifecycle for dynamic processes

Schema S':

Process designer / Process administrator

Execution Log

Change Log

Case Base

Actor

Reuse Changes

Instance-specific Change

Process Execution

Instance, with ad-hoc change
Summary

Current tool support for dynamic processes:

- **Commercial Systems**
  - Late Binding available in most commercial systems
  - Late Modeling and ad-hoc changes are not or only rudimentarily supported

- **Academic Prototypes**
  - Examples: ADEPT, CAKE2, CBRFlow, Pockets of Flexibility, Worklets, etc.
  - Most prototypes either focus on late binding / late modeling or ad-hoc changes

Some open research issues:

- Management of changes and process variants:
  - variant repositories
  - querying variants
  - learning from variants

- Role of dynamic processes for compliance management

- Dynamic processes for smart, ambient systems

- Dynamic processes in cross-organizational settings

- …
Feedback

Please take a few minutes to fill out the feedback form!
References

Sources from Industry and Practitioners


Forester 2007 BPM Market Overview


Menendez, M. (IBM Software Group): WebSphere Business Integration Modeler v 5.1, 2003


S. Sadiq, B. Weber, and M. Reichert  BPM Tutorial
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