Data-centric Approaches to Business Process Management: Fundamental Concepts, Tool Support, Open Challenges

Manfred Reichert
BPM Research at Ulm University

Research Topics

Adaptive & Flexible Processes
Human-Centric Processes
Data- and Object-Aware Processes
Process Variability Support
Mobile Process & Task Support
Smart Processes

Methods, Concepts and Technologies for Next Generation Process Management Technology

Application Areas

Healthcare & Psychology
Automotive Engineering
Transport & Logistics
Industry 4.0
Sustainable Data

Research Methods

Design Science
Formal Methods
Innovative Prototypes
Empirical Research
A Review of Previous BPM Research Projects
Scenario 1: Cross-Departmental Business Processes
Scenario 2: 
Process-Centric Resource and Application Integration

- **Registration**
  - HIS
  - patient information

- **Orders Placed**
  - RIS
  - examination orders

- **Orders Filled**
  - modality worklist

- **Report Repository**
  - report

- **Diagnostic Workstation**
  - images retrieved

- **Image Manager & Archive**
  - images stored
  - acquisition completed
  - images printed

- **Film Lightbox**

- **Film Folder**

- **Film**

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Scenario 1: Process-Centric Resource and Application Integration

Scenario 3: Large Collective Process Structures

Large Collective Process Structures

Release Management Process for E/E Car Components

Scenario 4: Cross-Organizational Processes with Real-World Assets

Scenario 4: Cross-Organizational Processes with Real-World Assets

Scenario 5: Mobile Processes

Scenario 6: Processes in a Cyber-Physical World

Tablet production and line with packing machines

Specific machines, Integrated in one line:

- Blister packing
- Box packing
- Patient information leaflet
- Carton packaging
- …
SeaFlows: Process Compliance

Process model to be checked

Generated counterexample:
Execution path and corresponding process context violating the constraint

Prior to an examination of a patient aged beyond 75, an additional tolerance test must be performed.
C³Pro: Multi-Perspective Compliance Monitoring

Non-deterministic processing of start-events

Initial marking

Waiting for next request

Multiple processing of events

Resource conflict

Time conflict

Control-flow conflict

Data conflict

Processing of data-events

Processing of end-events

Processing an update


**C³Pro: Compliance in Cross-Organizational Processes**


ATAPIS: Time-Aware Processes


ATAPIS: Time-Aware Processes

ENPROSO: Aligning Business and Executable Process Models

Business Level

Model created by domain expert

Model created by IT expert

IT Level

ProView: Process Model Abstractions

Example of an Automotive Engineering Process

Product Change Management
ProView: Process Model Abstractions


ProView: Process Model Abstractions


Enforcement: Guardrails (on a road) prevent deviation, but also prevent anything not predicted.

Guidance: Guidelines (on a road) show people where to go, but do not prevent deviations if they are necessary.


AristaFlow: BPM Suite & Process Flexibility

AristaFlow: BPM Suite & Process Flexibility

Clinical Pathway Support with the AristaFlow BPM Suite
AristaFlow: BPM Suite & Process Flexibility

Process-aware, Cooperative Emergency Management for Water Infrastructures

Limitations of the Activity-Centric Modeling Paradigm
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Limitations of the Activity-Centric Modeling Paradigm

- No inherent process flexibility
- Improper asynchronous execution of sub-processes
- No optional activities
- Access on data only during the activity execution
- Isolated execution of process instance

**generic functions**

**comprehensive lifecycle support**

**missing data-oriented view**
Limitations of the Activity-Centric Modeling Paradigm

Contemporary ERP and Application Software

- Managing and accessing data at any point in time!
- Executing the right tasks at the right point in time!

- hard-coded processes and hard-coded configuration facilities
- no (or hard coded) monitoring
- integrated access on data & processes
- no generic functions
- processes depend on the underlying datastructure of the specific domain
- no comprehensive lifecycle support
- high maintenance costs
- long development cycles
Data-Driven Process Structure: The Corepro Approach
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Data Model

Object Life Cycles / Life Cycle Coordination Model

Data Structure

Data-driven Process Structure
Data-Driven Process Structure: The Corepro Approach

Data-Driven Process Structure: The Corepro Approach

Object Life Cycles / Life Cycle Coordination Model

Data-driven Process Structure
Data-Driven Process Structure: The Corepro Approach
Data-Driven Process Structure: The Corepro Approach
Data-Driven Process Changes in Corepro

Change Operation (Data Structure)
1) removeRelation(Telematik High V2.2, TV Tuner V1.83, nutztKomp); 
2) removeObject(TV Tuner V1.83);

Change Operation (Process Structure)
1) removeExtTrans(Telematik High V2.2, Muster Aufgebaut, Installieren, TV Tuner V1.83, E); 
2) removeOLC(Tuner V1.83);
Executing a Process Structure in Corepro


© M. Reichert, University of Ulm, 2012
Corepro: Case Study
Corepro: Proof-of-Concept Prototype

Object-Aware Processes: Characteristic Features


Object-Aware Processes: Characteristic Features

**Data Model**
- Job Offer
  - identifier
  - description
  - vacant from
  - vacant until
- Application
  - name
  - e-mail
  - appl. letter
  - decision
  - evaluation
- Review
  - priority
  - return date
  - remark
  - proposal
  - evaluation
  - reason
  - comment
  - committed
- Interview
  - date
  - time
  - location

**Process Model**
- Job Offer
  - create
  - publish
  - analyze
  - fill
- Application
  - fill in
  - send
  - check
  - accept
  - reject
- Review
  - initiate
  - fill in
  - complete
- Interview
  - initiate
  - perform
Object-Aware Processes: Characteristic Features

User Integration

Form Logic

Object Instance

Process Instance

Review

- remark
- return date
- priority
- proposal
- evaluation
- reason
- comment
- committed

Proposal

- priority
- return date
- remark
- proposal
- evaluation
- reason
- comment

Process instance

- initiate
- fill in
- complete

Object-Aware Processes: Characteristic Features
Object-Aware Processes: Characteristic Features
# Object-Aware Processes: Characteristic Features

## User Integration

### Staff Member

- Department: [department]

### Context-Sensitive Activity

#### Job Offer
- Identifier: salesman
- Description:
- Vacant from: 10.09.2011
- Vacant until: 01.01.2012

#### Application
- Batch Activity
- Decision: reject

#### Review
- Priority: high
- Return date: 12.12.2011
- Remark: complete soon
- Proposal: invite
- Evaluation: very good
- Reason:
- Comment: many competencies

## Process Model

### Job Offer
- Create → Publish → Analyze → Fill

### Application
- Fill in → Send → Check → Accept → Reject

### Review
- Initiate → Fill in → Complete

### Interview
- Initiate → Perform
Object-Aware Processes: Characteristic Features

- integrated access
- object interactions
- data-driven execution
- flexible activity granularity
- object behavior
Künzle, Vera and Reichert, Manfred
Striving for Object-aware Process Supplocation: How Existing Approaches Fit Together.
In: 1st Int. Symposium on Data-driven Process Discovery and Analysis (SIMPDA'11)
# Object-Aware Processes: Characteristic Features

**Existing Approaches**

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(3) Bhattacharya, K., Hull, R., Su, J. In: A Data-Centric Design Methodology for Business Processes. IGI Global (2009) 503-531
Object-Aware Processes: The PHILharmonicFlows Approach
Object-Aware Processes: PHILharmonicFlows

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[1] Künzle, Vera and Reichert, Manfred
*PHILharmonicFlows: towards a framework for object-aware process management*
Journal of Software Maintenance and Evolution: Research and Practice

*Object-Aware Process Management*
PhD thesis, University of Ulm.
Object-Aware Processes: PHILharmonicFlows

Vacation Request

Initialized

Decision Pending

Approved

Rejected

Lifecycle Attributes:
- From: Date
- Until: Date
- Approved: Bool
- Comment: String

Vacation Request – Init
- From: 28.05.2017
- Until: 03.06.2017
- Submit

Vacation Request – Decision
- From: 28.05.2017
- Until: 03.06.2017
- Approved: true
- Comment: Ok. Fine with me.
- Submit
Object-Aware Processes: PHILharmonicFlows
Object-Aware Processes: PHILharmonicFlows
Object-Aware Processes: PHILharmonicFlows


Object-Aware Processes: PHILharmonicFlows
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<td>6/11/2017</td>
</tr>
</tbody>
</table>

### Qualifications
- VFMRLD
- HHDXOW
- Immediate Availability: True
- Job Offer: False
- Name: AQRV
- Proficiencies: JDIIP
Object-Aware Processes: PHILharmonicFlows

Automated Creation of User Forms
Object-Aware Processes in the Large Scale
Object-Aware Processes in the Large Scale

• Can object-aware process support tools scale up horizontally, i.e. over multiple servers? (→ Hyperscale Process Management)

• Which coordination patterns are required to cover all potential relations between objects? (→ The Relational Process Structure)

• How to integrate real-world objects and resources into the approach?

• How to utilize object-aware processes to fully implement object- and process-aware information systems? (→ Development Frameworks)

• How to support engineers in designing object-aware processes? Are there any comprehensibility issues? (→ The Process of Modeling and Understanding Object-aware Processes)
Towards Scalable Object-Aware Process Support

What is scalability?

“Scalability is the capability of a system to handle larger workloads when hardware resources are added.”

Vertical Scalability:

Horizontal Scalability:
Towards Scalable Object-Aware Process Support
What is scalability?

Workload (8 Work Items, 1x Speed):

Vertical Scalability:

Workload (8 Work Items, 4x Speed):

Horizontal Scalability:

Workload A (2 Work Items, 1x Speed):

Workload B (2 Work Items, 1x Speed):

Workload C (2 Work Items, 1x Speed):

Workload D (2 Work Items, 1x Speed):
Towards Scalable Object-Aware Process Support

What is scalability?

**Vertical Scalability:**
- More Downtime
- More Costly
- Applicable to any workload
- Simple
- No communication

**Horizontal Scalability:**
- Less downtime
- Less costly
- Workload has to be executable in parallel
- Complex
- Requires communication
Towards Scalable Object-Aware Process Support

How scalable are activity-centric processes?

The degree of parallelism is determined by process model structure!
Horizontal scalability for a single process instance is limited!
The amount if clients that can interact with the process at the same time is limited!
Towards Scalable Object-Aware Process Support
Are object-aware processes more scalable?
Towards Scalable Object-Aware Process Support
Are scalable object-aware processes technically feasible?
Towards Scalable Object-Aware Process Support
Are scalable object-aware processes technically feasible?

Actor Model!

Actors: A Model of Concurrent Computation in Distributed Systems
PhD thesis, MIT.
Towards Scalable Object-Aware Process Support
First Results
Towards Scalable Object-Aware Process Support
First Results
Outlook
Thank you!