
Manfred Reichert | 4 July 2011 | Bled, Slovenia
Overview

Motivation

Process-aware Information Systems (PAIS)

Adaptive PAIS
- Ad-hoc Deviations
- Process Evolution
- User Assistance
- Mining Process Logs
- Process Configuration

Summary & Outlook
Motivation: The Clinical Workday

hospitalization
pre-/postoperative diagnostics
introduction to the anaesthetist
admission
in-patient treatment
discharge
recording of services
administration
Operation
intensive care
Motivation: Some Problems

Who is responsible?

Wasting all my time with making appointments!

This is the 3rd time today!

Which Menu?
Why to enter the same data once again

What happened to my medical orders?

How to recover in this chaos?
Motivation: Fundamental Goals

Fundamental Goals:

- Continuity of care
- Patient-centered treatment
- Integrated care
- Process-awareness

Urgent need for IT support:

- Frequent cause of medical errors ⇒ Missing information or knowledge
- Example: Medication errors
  - 29% due to missing patient-related information
  - 19% due to missing medical knowledge

Motivation: Fundamental Goals

Fundamental Goals:
- Continuity of care
- Patient-centered treatment
- Integrated care
- Process-awareness

There is a discrepancy between the potential and actual usage of IT!

Why?

Committee on Quality of Healthcare in America (IoM)
Crossing the Quality Chasm: A New Health System for the 21st Century. IOM, 2001
Motivation: Levels of Process Support

- **Organizational processes**
  - Interdisciplinary cooperation among different people and organizational units
  - Example: Order entry and result reporting

- **Patient treatment processes**
  - Guided by available patient information
  - Dependent on medical knowledge

Motivation: Example of an Organizational Process

- **HIS** (Hospital Information System): patient information
- **Orders Placed**: examination orders
- **Orders Filled**: orders placed
- **RIS** (Radiology Information System)
- **PACS** (Picture Archiving and Communication System)
- **Diagnostic Workstation**: images retrieved
- **Film Lightbox**: images printed
- **Image Manager & Archive**: images stored
- **Film Folder**: images completed
- **Film**: acquisition completed

Prefetch any relevant prior studies

Procedure scheduled

Acquisition completed

Modality worklist

Report Repository

Registration

Report
Motivation: Example of a Treatment Process

prehospital phase

poststationary treatment

patient admission

anamnesis and clinical examination

discharge & documentation

clarification of osteoporosis

ward / ICU and operative treatment

Yes

imaging diagnostics

operative treatment depending on diagnosis / symptom

IT support in routine use

no

therapy depending on diagnosis / symptom

initial treatment (emergency area) and operation planning

Yes

proximal femoral fracture & operation indicated?

no

clinical suspicion of proximal femoral fracture?
Motivation: Another Application Example

- Example: Release management for E/E-systems in a car
- 200 - 300 control devices to be systematically tested and released
- Requires the execution of hundreds up to thousands of processes
- Concurrent engineering ➔ complex dependencies have to be considered
- The overall process is long-running


Motivation: Challenges

- Processes can become very large and complex
- Thousands of concurrently executed process instances
- High need for flexibility in all phases of the process lifecycle
- Support for application integration is fundamental
- Correctness and robustness are crucial features of any process-aware inf. systems
- Integrated support of all phases of the process lifecycle required
Overview

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Summary & Outlook


Activity Specification:
- Automated or manual activity?
- Actor / Role assignment?
- Form / service to be invoked?
- Input / output parameters
- ...

Soundness
Business Compliance
Process Patterns
Model Quality
Process Modeling: Ensuring Business Compliance (Semantic Constraints)

After a surgery, an aftercare or an appointment is necessary, before the patient is discharged.

Prior to a CT, the patient has to be informed and after the CT the results have to be reported to the patient.

Prior to an examination of a patient aged beyond 75, an additional tolerance test must be performed.
The activities CT and Inform patient are on different branches of an XOR-Block.
Process Modeling: Ensuring Business Compliance (Semantic Constraints)

Prior to an examination of a patient aged beyond 75, an additional tolerance test must be performed.

Generated counterexample:
Execution path and corresponding process context violating the constraint
PAIS: Process Execution (End User Perspective)

User Worklists

Automatic Invocation of the Corresponding Application Program (incl. Provision of Input Parameters)
<table>
<thead>
<tr>
<th>Patientin stationär aufnehmen</th>
<th>Aufnehmen</th>
<th>Unterbrechen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Förster</td>
<td></td>
</tr>
<tr>
<td>Vorname</td>
<td>Irene</td>
<td></td>
</tr>
<tr>
<td>Komorbidität</td>
<td>keine</td>
<td></td>
</tr>
<tr>
<td>Schwangerschaft</td>
<td>ja</td>
<td></td>
</tr>
<tr>
<td>Eingriff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OP-Termin</td>
<td>21.07.1997, 00.00 Uhr</td>
<td></td>
</tr>
<tr>
<td>Diagnose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bemerkungen</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Einbestellungsplan GYN IV

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Patientin</td>
</tr>
<tr>
<td>Diagnose-OP</td>
</tr>
<tr>
<td>Tel. Nr.</td>
</tr>
<tr>
<td>Fr. Hansen</td>
</tr>
<tr>
<td>(Stationäre Aufnahme)</td>
</tr>
<tr>
<td>07321/45577</td>
</tr>
<tr>
<td>Fr. Förster</td>
</tr>
<tr>
<td>(Überprüfung der Befunde)</td>
</tr>
<tr>
<td>07304 - 657788</td>
</tr>
<tr>
<td>Fr. Breitinger</td>
</tr>
<tr>
<td>(Abruf)</td>
</tr>
<tr>
<td>dg/op Hysteroskopie</td>
</tr>
</tbody>
</table>

<< Info >>
PAIS: Process Execution (End User Perspective)

Actor A

Admissions
Maier, Frida
Schmied, Udo
Müller, Heinz
Peters, Franz

Actor B

Scheduling
Kramer, Gerd
Marx, Fred
Müller, Inge
Peters, Franz

Actor C

Medical Orders
Weber, Heinz
Schmidt, Ingo
Kramer, Ralf
Peters, Franz

…

End User View
PAIS: Process Execution (System Perspective)

... and beneath the surface

- Includes automated steps
- Important: application integration
PAIS: The Process Lifecycle

Overview

Motivation

Process-aware Information Systems (PAIS)

Adaptive PAIS
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- User Assistance
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- Process Configuration

Summary & Outlook
Adaptive PAIS: Need for Flexibility Support

Adaptive PAIS: Enabling Ad-hoc Changes

1. Create Process Schema
2. Create Instances
3. Process Execution
4. Execution Log
5. Evolve Process Schema

Need for Ad-hoc Deviations

Process engineer / Process administrator

Process Monitoring
Adaptive PAIS: Enabling Ad-hoc Changes

Examinations
- U Wallace, Edgar
- **U Miller, Anne**
- U Smith, Karl
- U Jones, Isabelle

The Users' View

Exceptional case – we need an additional lab test!

Adaptive PAIS: Enabling Ad-hoc Changes

Process Type Level

Process Schema S

- Patient Admission
- Anamnesis & Clinical Examination
- X-ray
- MRT
- Sonography
- Non Operative Therapy
- Non Operative Therapy 1
- Initial Treatment & Operation Planning
- Operative Treatment
- Discharge & Documentation

- clinicalSuspicionOfCruciateRupture = "Yes"
- cruciateRupture = "Yes" and operationIndicated = "Yes"

Activity

- XOR-Split/Join
- AND-Split/Join

Process Instance Level

Process Instance I1

- Execution Trace:
  - \(\sigma_1 = \langle \text{Patient Admission}, \text{Anamnesis & Clinical Examination}, \text{X-ray} \rangle\)

Process Instance I2

- Execution Trace:
  - \(\sigma_2 = \langle \text{Patient Admission} \rangle\)
Adaptive PAIS: Enabling Ad-hoc Changes

For patient Mozart the MRT activity needs to be skipped due to his cardiac pacemaker.

Execution Trace:
\[ \sigma_1 = \langle \text{Patient Admission}, \text{Anamnesis & Clinical Examination}, \text{X-ray} \rangle \]

Execution Trace:
\[ \sigma_2 = \langle \text{Patient Admission} \rangle \]
Adaptive PAIS: Enabling Ad-hoc Changes

System’s View

**Process Type Level**

**Process Schema S**

- **Patient Admission** → **Anamnesis & Clinical Examination**
- **X-ray** → **Non Operative Therapy**
- **MRT** → **Non Operative Therapy 1**
- **Sonography** → **Initial Treatment & Operation Planning**
- **Operative Treatment** → **Discharge & Documentation**

**Process Instance Level**

**Process Instance I1**

- Execution Trace: \( \sigma_1 = <\text{"Patient Admission"}, \text{"Anamnesis & Clinical Examination"}, \text{"X-ray"}> \)

**Process Instance I2**

- Execution Trace: \( \sigma_2 = <\text{"Patient Admission"}> \)
Adaptive PAIS: Enabling Ad-hoc Changes

**Pattern AP5: SWAP Process Fragment**

**Description**: Two existing process fragments are swapped in process schema $S$.

**Example**: Regarding a particular delivery process the order in which requested items are delivered to two customers has to be exchanged.

**Problem**: In a real world process a task has to be accomplished which has not been modeled in the process schema so far.

**Design Choices** (in addition to those described in Fig.6):
1. How is the new process fragment $X$ embedded in the process schema?
   a) Without additional condition (parallel insert)
   b) With additional condition (conditional insert)

**Related Patterns**

**Pattern PP3: Late Composition of Process Fragments**

**Description**: At build-time a set of process fragments is defined from which the schema of a concrete process instance can be composed during run-time. This can be achieved by dynamically specifying the control dependencies between them on the fly.

**Example**: Consider a process that consists of several optional activities. The exact order and the activities that are performed are determined dynamically, e.g., based on the specific requirements of the customer.

**Diagram**

Adaptive PAIS: Enabling Ad-hoc Changes

### Process Type Level

**Process Schema S**

- **Patient Admission** → **Anamnesis & Clinical Examination**
- **X-ray** → **Non Operative Therapy**
- **MRT** → **Sonography** → **Non Operative Therapy 1**
- **XOR-Split/Join** on **cruicateRupture = „Yes”**
- **AND-Split/Join** on **cruicateRupture = „Yes” and operationIndicated = „Yes”**

**Correctness Constraints**

**Process Instance Level**

**Process Instance I3**

- **Initial Treatment & Operation Planning**
- **Operative Treatment**

**Execution Trace:**

\[ \sigma_3 = \langle \text{Patient Admission}, \text{Anamnesis & Clinical Examination}, \text{MRT}, \text{X-ray}, \text{Sonography} \rangle \]

I3 is not state compliant with change Delete (I3, MRT)

---

Adaptive PAIS: Enabling Ad-hoc Changes

**a)**

```latex
\text{jumpForward} (\text{CFS}_{\text{instance}}, G, J, \ldots)
```

**b)**

Solution for many fundamental research issues!

**c)**

Formal foundation of the ADEPT technology!

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Adaptive PAIS: Enabling Process Evolution

1. Process engineer / Process administrator needs to evolve the process.
2. Create instances of the new process schema.
4. Execution log is maintained to monitor process execution.
5. Process monitoring and adaptation occur based on the execution log.
Adaptive PAIS: Enabling Process Evolution

ADEPT Process Management System

- Std Client API
- Web Client API
- Modeling API
- Dynamic Change API
- Admin. API
- Role Mgmt
- Authorization Time Mgmt
- Message Queuing Recovery
- Audit Trail

Process Engine

- Process 1
- Process 2
- Process 3
- Process 4
- Process 5
- Process 6
- Process 7
- Process 8
- Process 9
- Process 10
- Process 11
- Process 12
- Process 13
- Process 14

ADEPT Process Composer

- Create Process Template
- Modify Process Template
- Check Process Template

Repository

Users

- Process Designer / Process Administrator

Check Instance Status

4,377 instances can be automatically migrated
1,117 instances have proceeded too far
123 instances cannot be automatically migrated
Adaptive PAIS: Enabling Process Evolution

Fundamental Question: Under Which Conditions is a Migration Possible?

Schema S:

- confirm order
- pack goods
- deliver goods
- get order
- collect data
- compose order

S':

- make invoice
- send invoice
- confirm order
- pack goods
- deliver goods

I_1:

- migrate

I_2:

- migrate

I_n:

- migrate

Process instance not state compliant with S' (remains being executed according to S)

Adaptive PAIS: Enabling Process Evolution

Increased Complexity: Interplay with Ad-hoc Changes

Schema S:

S':

Indispensable: General, Formal Correctness Criterion

Process instance not compliant with S'

Adaptive PAIS: Extended Lifecycle Support

Adaptive PAIS: The ADEPT Approach

(Direct) Process Meta Model

Process Fragment Composition

Process Type Changes

Architecture and Implementation

Ad-hoc Changes

Response Times

Propagation of Process Type Changes

User Interface / API

Transactional Support / Semantic Rollback

Support of Temporal Constraints

Efficient Execution

Component-oriented Software Development

Scalability / Distributed Process Mgmt

Adaptive PAIS: The ADEPT Approach

Adaptive PAIS: The ADEPT Approach

Adaptive PAIS: The ADEPT Approach

ADEPT:
Individually adaptable Process Instances
->
Process Instance = (individual) "Process Program"

Adaptive PAIS: The ADEPT Approach

**ADEPT:**
Individually adaptable Process Instances

Process Instance = (individual) "Process Program"

**Achievements:**
- Formal process meta model (expressive + restricted enough)
- Formal Criteria for Change Correctness (incl. „Theorems & Proofs“)
- Efficient, build-in consistency checks („no bad surprise“)
- Support of a high number of change patterns
- API for accomplishing ad-hoc changes

www.aristaflow-forum.de
IT Support for Clinical Pathways

- **Domain specific knowledge**
  - Clinical guidelines
  - Require consensus among medical experts (and scientific evidence)

- **Site specific knowledge**
  - Clinical pathways
  - Require consensus among cooperating healthcare professionals

- **Individual patient treatment plan**
  - May deviate from medical pathway

- **Actual patient treatment process**
  - May deviate from individual treatment plan
Adaptive PAIS: User Assistance

Process engineer / Process administrator

1. Create Process Schema
2. Create Instances
3. Process Execution
4. Change Log
5. Change Propagation
6. Process-specific
7. Change Log

Exception: Delete \( I_1, E \)

How to Assist End Users?
Adaptive PAIS: User Assistance

The ProCycle (= ADEPT + CBRFlow) Approach for Assisting Users in Defining and Reusing Changes:

- Annotate ad-hoc changes with information about their reasons
- Support users in retrieving past ad-hoc changes applied in similar problem context
- Assist users in reusing (i.e., re-applying) a past ad-hoc change for a particular process instance when coping with an exceptional situation

Adaptive PAIS: User Assistance

Memorizing ad-hoc deviations including their application context

Process Instance $I_1$

Case $c_1$

$pd_{c_1} =$ The treatment of cruciate ruptures routinely includes a magnetic resonance tomography (MRT), an X-ray and a sonography. However, for a particular patient the MRT may have to be skipped as the respective patient has a cardiac pacemaker.

$sol_{c_1} =$ $<\text{Delete}(S_1, \text{MRT})>$

$qasSet_{c_1} = \{(\text{Does the patient have a cardiac pacemaker?}, \text{patient.problemList.hasPacemaker} = \text{'Yes'})\}$

Application Context Model

<table>
<thead>
<tr>
<th>Object</th>
<th>Type</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis</td>
<td>Diagnoses</td>
<td>0</td>
<td>1000</td>
</tr>
<tr>
<td>Patient</td>
<td>Patient</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>age</td>
<td>Integer</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>problemList</td>
<td>ProblemList</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>weight</td>
<td>Integer</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>ProblemList</td>
<td>Diagnoses</td>
<td>0</td>
<td>1000</td>
</tr>
<tr>
<td>hasPacemaker</td>
<td>Boolean</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>therapies</td>
<td>Therapy</td>
<td>0</td>
<td>1000</td>
</tr>
</tbody>
</table>
Adaptive PAIS: User Assistance

Semi-automated retrieval of similar *instance deviations* using conversational case-based reasoning (CCBR)

**CCBR Component**

1. Initiate Case Retrieval
2. Create List of Questions with Possible Answers
3. Answer Questions with Answer Expressions
4. Add answered questions to query qu
5. Calculate Similarity and Rank Cases
6. Show Ranked Cases + List of Questions with Possible Answers
7. Answer Question

Exception for Instance I

Process participant
Adaptive PAIS: User Assistance

Retrieving similar instance deviations based on the actual context

\[ \text{qaSet}_{c_1} = \{(\text{Does the patient have a cardiac pacemaker?}, \text{Patient}.\text{problemList}.\text{hasPacemaker} = \text{Yes})\} \]

\[ \text{qaSet}_{c_2} = \{(\text{Does the patient have fluid in the knee?}, \text{A significant amount}), (\text{Does the patient have an acute effusion of the knee?}, \text{Yes})\} \]

List of Questions with Possible Answers

<table>
<thead>
<tr>
<th>Question</th>
<th>Possible Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the patient have a cardiac pacemaker?</td>
<td>(Patient\text{.problemList}.\text{hasPacemaker} = \text{Yes'}, \text{OTHERANSWER})</td>
</tr>
<tr>
<td>Does the patient have fluid in the knee?</td>
<td>{\text{A significant amount'}, \text{OTHERANSWER}}</td>
</tr>
<tr>
<td>Does the patient have an acute effusion of the knee?</td>
<td>{\text{Yes'}, \text{OTHERANSWER}}</td>
</tr>
</tbody>
</table>

Query \( qu' \)

<table>
<thead>
<tr>
<th>Question</th>
<th>Given Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the patient have a cardiac pacemaker?</td>
<td>\text{OTHERANSWER}</td>
</tr>
<tr>
<td>Does the patient have fluid in the knee?</td>
<td>\text{A significant amount'}</td>
</tr>
</tbody>
</table>

List of Retrieved Cases for Query \( qu' \)

<table>
<thead>
<tr>
<th>Case</th>
<th>Appl. Context Similarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>( c_2 )</td>
<td>50%</td>
</tr>
<tr>
<td>( c_1 )</td>
<td>0%</td>
</tr>
</tbody>
</table>

\[
\text{sim}(qu, c) = \frac{1}{2} \frac{\text{same}(qu, qaSet_c) - \text{diff}(qu, qaSet_c)}{|qaSet_c|} + 1
\]
Adaptive PAIS: User Assistance

Adaptive PAIS: User Assistance

Proof-of-Concept Implementation

Developed as part of the ProCycle project funded by Tiroler Wissenschaftsfond
Adaptive PAIS: Analyzing Process Logs

1. Create Process Schema
2. Create Instanices
3. Process Execution
4. Need for Monitoring and Analyzing Dynamic Processes
5. Evolve Process Schema
6. Process participant
7. Change Propagation

Exception: Delete (I₁, E)

Process engineer / Process administrator

Need for Monitoring and Analyzing Dynamic Processes

Execution Log

Change Log

Schema S:

Schema S‘:

Instance I₁

Figure 1: Adaptive PAIS: Analyzing Process Logs
Adaptive PAIS: Analyzing Process Logs

Original Schema S

Instance 4711
Activity Event User Timestamp
Instance Started Garry 2007/09/08 15:00
A Started Garry 2007/09/08 15:30
A Completed Garry 2007/09/08 15:45
B Started Helen 2007/09/10 11:00
X Started Fritz 2007/09/11 09:01

Change Log Instance 4711 on Schema S

Change TX Applied Changes : User:Timestamp
001 InsertFragment[S;X,A,C]:Helen:2007/09/10 12:02
002 ReplaceFragment(S;C,Z):Jim:2007/09/11 09:31

Process Instance 4711
2007/09/10 11:00
A \( \checkmark \) → B → C
Garry

Helen

2007/09/10 13:00
A \( \checkmark \) → B \( \checkmark \) → C
Garry

Helen

2007/09/11 10:00
A \( \checkmark \) → C
Garry

X

Fritz

Z
Process Mining
Mirrors Reality!
Analyzing Process Logs: Focussing on Execution Logs

2712 patients
29258 events
264 different activities

Source: www.processmining.org
Analyzing Process Logs:
Applying Process Mining Techniques to Change Logs

Phase I

Change Logs
Analyzing Process Logs: Applying Process Mining Techniques to Change Logs

The discovered meta change process covers all changes applied to at least one of the given fluid process instances.

Analyzing Process Logs:
Applying Process Mining Techniques to Change Logs

Change Mining Plugin in ProM

Change Logs Imported from ADEPT
Analyzing Process Logs: Process Variants Mining

1. Configurations are very costly
2. Variants are difficult to maintain

Derive a new reference process model from the variants such that less adaptations are needed in future!

Analyzing Process Logs: Process Variants Mining (Scenarios)

**Scenario 1:** No original reference process model available

- Discovered reference process model $S'$
- Mining & learning

**Scenario 2:** Original reference process model known
- Original reference process model $S$
- Process improvement
- Customization & adaptation
- Mining & learning
- Discovered reference process model $S'$

**Process Repository**

$S_1$, $S_2$, $S_3$, $S_4$, $S_n$

**Goal:** Discover a (new) reference process model which requires less configuration efforts
Analyzing Process Logs: Process Variants Mining (A Heuristics Mining Technique)

Analyzing Process Logs: Process Variants Mining (Healthcare Case Study)
Adaptive PAIS: Configuring Process Models

1. Create Process Schema
2. Create Instances
3. Process Execution
4. Change Log
5. Evolve Process Schema
6. Process participant
7. Change Propagation

Need for Process Variant Configuration

Exception: Delete (I₁, E)

Instance-specific Change
Adaptive PAIS: Configuring Process Models

Reuse of a particular process model requires adaptation to the respective context

Large process variant collections!

Example: Vehicle Repair
Adaptive PAIS: Configuring Process Models

Multi-Model Solution

- Variant 1: Fast Run
- Variant 2: Security-critical Repair
- Variant 3: Fast Run and security-critical Repair

Single-Model Solution

- Standard or Variant 2
- Variant 1 or Variant 3

- Standard or Variant 2
- Variant 1 or Variant 3

- Standard or Variant 1
- Variant 2 or Variant 3

Final Check

Hand Over
Adaptive PAIS: Configuring Process Models

**General observation:**
*Process variants can be created by adapting a common reference model*

Reference process (Base Process)

Variant specific adjustments

Derived process variant
Adaptive PAIS: Configuring Process Models

The Provop Approach

Configuring Process Models: The Provop Approach
Configuring Process Models: The Provop Approach
Configuring Process Models: The Provop Approach

Patient is pregnant; process variant “pregnancy” is chosen

New process fragments are inserted in parallel!

Increased blood sugar level; process variant “Diabetes” is chosen
The Process Structure Tree - Providing abstraction to end users
The Process Structure Tree representing the patient-specific pathway!
Overview

Motivation

Process-aware Information Systems (PAIS)

Adaptive PAIS
- Ad-hoc Deviations
- Process Evolution
- User Assistance
- Mining Process Logs
- Process Configuration

Summary & Outlook
Summary

We are confronted with ...

- Cross-departmental & -organizational Processes
- Changing Processes
  New Evidence
- Organization-specific Processes
- Increasing Mobility & Emergence of Smart Devices

We need ...

- Integrated PAIS
- Evolutionary & Adaptive PAIS
- Configurable & Adaptive PAIS
- Mobile Services & Processes

High potential for Process Management Technology when being adapted to the socio-technical context of HC organizations
Outlook: Integrating PAIS with Mobile Devices
Outlook: Integrating PAIS with Mobile Devices

Outlook: Integrated View on Processes and Data

Managing and accessing data at any point in time!

Executing the right tasks at the right point in time!

Is this a better application than the one I evaluated yesterday?

Which are the submitted applications?

Integrated view on business information and business processes!
References to DBIS Projects

ADEPT2/AristaFlow  Next Generation Prozess Management Technology
SeaFlows      Semantic Constraints in Prozess Management Systems
MinAdept     Mining Prozess Variants & Prozess Changes
Provop       Prozess Variants by Options
MARPLE       Managing Robust Mobile Prozesses in a Complex World
ENPROSO      Enhanced Prozess Management through Service Orientation
MoDe4SLA     Monitoring Dependencies for SLAs
Proviado     Prozess Visualization in the Automotive Domain
niPRO        Personalized and Intelligent Prozess Portals
Corepro      Data-driven Prozess Structures
PHILharmonic Flows Linking Prozesses, Humans and Information
Q-Advice     Quality ADVisory Infrastructure for Collaborative Engineering

Visit www.uni-ulm.de/dbis for more details!