Process-Aware Information System Development for the Healthcare Domain – Consistency, Reliability, and Effectiveness

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Motivation

• Healthcare processes
  • Need for:
    – Technological support
    – Monitoring

Out-of-the-box PAIS not sufficient
Motivation

PAIS technology:
- Identification of required functionality
- Satisfies needs

- patient-centric critical processes
- integration with running processes
- user expectations
Approach

MODEL

- Conceptual model
- Operational system
  - Formal
  - Executable

Design phase → Implementation phase → Testing phase → Simulation phase
Overview

- Schedule-Aware WfMS
- Testing
- Simulation
- Conclusions
Overview

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Schedule-Aware WfMS (Concepts)

Flow tasks
- register patient
- physical examination
- consultation
- give information

Schedule tasks

Jane
- assistant

Marc
- doctor

Sue
- nurse

Nick

Start
- d:15
- r:nurse

p1

p3

p5

End
- d:15
- r:nurse
Schedule-Aware WfMS (Concepts)

- **Register patient**: duration d:15, role nurse.
- **Physical examination**: duration d:0, roles assistant, nurse.
- **Consultation**: duration d:45, role doctor.
- **Give information**: duration d:15, role nurse.

Roles (1 or more)

Involvement of patient
CPN Tools

- 30 nets
- 634 places
- 250 transitions
- 1000+ lines of ML
Schedule-Aware WfMS (Architecture)

- Routing of cases
  - Execution of tasks

- Communicating workitems
  - Worktray
  - Calendar

- Manipulation of appointments
  - reschedule
  - reassign
  - reschedule to specific time

- Scheduling service
  - (re)scheduling of appointments
  - generate warning(s)

- view on calendars
- manipulation of contents

- Scheduling service
  - user request
    - reschedule
    - reject
    - move appointment
    - response user request

- scheduling problem
  - start case, cancel case
  - check in workitem
  - check out workitem
  - etc

- scheduling problem
  - cancel case

- scheduling problem
  - create/delete appointment
  - block calendars

- scheduling problem
  - create/delete appointment
  - calendars

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Schedule-Aware WfMS (Architecture)

Microsoft Exchange Server 2007

Microsoft Outlook 2003 client

YAWL

AXIS-2 service

- user request
  - reschedule
  - reject
  - move appointment
  - response user request

- create/delete appointment
  - first available appointment
  - check availability specific slot
  - allocated appointments resource
  - allocated resources appointment
    - meeting time
    - cancel case
    - block calendars

- create/delete appointment calendars

GUI

Workflow client application

Worklist management

Calendar

Worktray
Overview

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Testing

How to test components?

- Workflow engine
- YAWL
- AXIS2 service
- Scheduling service
- workflow client application

1.352 lines of code
4.959 lines of code
7.381 lines of code
Testing

Specification of system

AXIS2 service
Testing

- Black-box, functional testing
- Test environment build using Java

- Test: single execution run of conceptual model
- Completed:
  - Error
  - Specified number of steps executed
Testing

• Replacement of
  • Scheduling service (Component testing)
  • Scheduling service + Workflow engine (Integration testing)

• Initialization
  • Simple process definition
  • Some users together with calendar
Testing

Errors found:

- Integration layer: 15, conversion
- Components: 12, coding, design flaws
- Integration: 1, integration
- Conceptual model: 25, coding, design flaws
- Many concurrency related issues
Overview

- Schedule-Aware WfMS
- Testing
- Simulation
- Conclusions
Simulation

• WfMS augmented with scheduling facilities:
  • What is the operational performance of the system when applied in practice?
  • How efficiently are the calendars filled?
  • How long do patients have to wait for an appointment?
Simulation

- Gynecological oncology healthcare process
- Operational performance
- Short-term simulation
Simulation

- **Gynecological Oncology**
  
  - Week 0
    - Contact telephone
    - Administrative tasks
  
  - Week 1
    - First visit
    - X-ray
  
  - Week 2 and Week 3
    - Diagnosis (MDO)

  - **42 flow tasks**
  - **5 schedule tasks**
Simulation

Workflow engine

Based on AMC calendar system

Workflow client application

Scheduling service

Scheduling algorithm

Simulation:
02-07-2007 to 19-03-2008

Replay

Process definition:
gynecological oncology
healthcare processes

Patients:
- start case
- realized appointments
duration
- rescheduling
appointments

Resources:
- behavior

Conceptual model

Waiting time for first appointment
Waiting time for diagnostic tests
from the time the first visit took place

Output:
- average waiting time for first appointment
- average waiting time for diagnostic tests measured from the time the first visit took place

Source calendars:
- scheduled hours for seeing patients
- non availability resources
- appointments non GO patients
Simulation (Experiment 1)

Only 47% of patients meet service level.

120 minutes added.

- GO
- MRI
- CT
- ANS
- SU
Simulation (Experiment 2)

Schedule MRI, CT, pre-assessment together

• CT
• Pre-assessment

Schedule appointments on one day
Overview

• Conceptual model
• Testing strategies
• Conclusions
Conclusions

• Schedule-aware WfMS

• Re(use) of conceptual model
  • Specification (customer requirements)
  • Development
  • Testing (reliability)
  • Validation (correct operation)
Questions???

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