Service-based Integration of Human Users in Workflow-driven Scientific Workflows

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The Topics for Today

- The Context:
  - Simulation Workflows
  - The Workflow Technology
- Communication with Human Users
- Human Communication Flows
- Human Communication Manager
- Using Human Communication Flows in Simulation Workflows
- Summary
Bone Growth Simulation

- Simulate bone growth depending on load, exercise, etc.
  - Understand diseases, e.g. fractures
- Based on the Finite Element Method (FEM)
- Typically manual steps
- Use workflows for automation
Multi-Scale Human Skeleton Simulation

- Choreography of simulations of skeleton, bone, tissue, and cell scale

Service Oriented Approach for Integration

- **Services:**
  - Are units of functionality
  - Described using a unified IDL
  - Independent of implementation technology
  - Self-contained stable service interfaces
  - Virtualization of components
  - Always up and running

- **SBAs** comprise services
- And follow the principles of the Service Oriented Architecture (SOA) style
- The SOA roles and operations:
  - SBAs comprise services
  - And follow the principles of the Service Oriented Architecture (SOA) style
  - The SOA roles and operations:
    - **Technology for implementing SBAs is workflows**
WfMS for Scientific Simulations

Scientific Workflow Modeling Environment

Scientific Workflow Execution Environment

Human Interaction Activity Execution

Task List

Human Task Manager

Applications

Simulation Data

Service Bus (Middleware)

Services

- Chemshell Service
- Dune Service
- Gnuplot Service
- Opal Service
- Pandas Service

Chemical Services

Simulation Data Services

Chemical Applications

Scientific Applications

Scientific Workflow Applications

Simulation Data Applications

Human Interaction Applications

Activity Execution Applications
The Problem: Automation vs. Human Users

- **Use of IT for automation:**
  - Workflows: Flexible composition of componentized functions
  - Scientific workflows: Composing scientific computation functions
  - Service-oriented computing and virtualization

- **Not all tasks can be automated**
  - Notifications to scientists in exceptional situations
  - Decisions on how to react to certain circumstances
  - Parameters that need to be provided by a domain expert
  - Approvals to be made by an executive
  - …

- **Challenges** of communication with humans
  - Human users have multiple communication devices
  - Communication devices offer different channels
  - Digital presence changes often
  - Responses from human users are not always valid
Human Integration Scenarios

- **Heavyweight**
  - Tight integration of the workflow and human task management
  - Collaborative problem-solving through task forwarding
  - Repair of workflows in case of failure in model-as-you-go fashion

- **Lightweight**
  - Pluggable integration of the workflow (engine), (the HCM,) and communication services
  - Human user registers communication devices and sets communication preferences
  - Advanced configurations for communication through presence models and probabilistic information

Available in Related Work

How???
Classification of Human Communication Types

- Different basic classes of communication with humans
  - Notification
  - Response required
  - Response optional

- Notification includes
  - status reports, fault reports, processing completeness updates, information hyperlinks, ...

- Response includes
  - Decisions such as approval, multiple choice, parameter selection, data checking, fault handling directive selection
  - Provisioning of parameters such as simple or complex values, parameter ranges, data correction, data selection
  - Control commands such as pause, resume, abort, retry, iterate, skip, jump, modify variable
Human Communication Flows

- The logic of interaction with a human
- Captured as a pattern and a workflow

**Notification**

**Request and Required Response**
Integration Architecture

- **Human Interaction Activity**
  - A complex process structure that is pre-modeled as process fragment, configurable to enable interaction with a human user
Human Interaction Activity Execution

- The information required for the interaction is sent to the human communication manager
Integration Architecture

- Human Communication Manager (HCM)
  - It manages all human tasks and
  - Enacts communication flows to route the task to users
  - Communication flows exploit presence information
Integration Architecture

- **Integrated Task List**
  - A list of human-related tasks that guide the human user through tasks to be performed
  - E.g. generated Web-forms for specifying complex parameters
Integration Architecture

- Communication services
  - Services enable communication between an application and human users’ devices and channels
Three major message types

- Communication request message
- Communication message
- Channel-specific message
Messages in the Communication Architecture

- Communication request message
  - Contains communication parameters interpreted by the HCM
  - Parameters indicate the type of communication, details on user and communication channel selection, the message, and requirements on the human user’s response
Messages in the Communication Architecture

- **Communication Message**
  - Contains communication parameters interpreted by the service
  - Parameters indicate the message subject, body, the recipient’s address, attachments, importance level, and classification
Messages in the Communication Architecture

- Service-specific Message, e.g. E-Mail Message
  - Represents the actual message sent to the human user
  - Rendering of properties of the communication message to the service-specific format depends on the used channel
Human Communication Flows in Scientific Workflows

- Model the logic of interaction in the workflow models
- Use the concept of workflow fragments for reuse
  - Store Fragments in a Fragment Library
  - Retrieve them during modeling
  - Insert them in the process logic
- Asynchronous communication possible
Prototype: SW4H

- SW4H = Scientific Workflows for Humans
  - SimTech Workflow Engine
  - HCM: message broker Apache ActiveMQ, routing engine Apache Camel, Spring Framework (transactionality, security)
  - Human Task Manager: Project Bangkok
  - 2 communication services: for e-mail (SMTP) and GoogleTalk (XMPP).
  - Communication Service Template
SW4H: Modeling and Frontend

- Integrated in Eclipse
- Stand-alone in a Web browser
Summary

- Using workflows for Simulations modeling and execution

- Interaction of human participants with the simulation workflows:
  - Standards used. No change in the workflow language
  - Allow for communication via different channels
  - Service-based integration of different types of communication services – Web Service focus
  - Asynchronous communication enabled
  - Can be used for other types of applications as communication initiator

- Future work:
  - Other communication services (ftp, twitter, skype)
  - Use workflows to execute the Human Communication Flows
  - Possible use in human-supported computing and integration of social media and BPM systems