inContext: A Pervasive and Collaborative Working Environment for Emerging Team Forms

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SAINT'08, 1 Aug 2008, Turku, Finland
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www.in-context.eu
# inContext Consortium

- **Coordinated by TU Wien (AT)**
- University of Leicester
- West Midlands Local Government Association (LGA)
- DERI GALWAY
- Microsoft Innovation Centre
- Technische Universität Wien
- Vienna University of Technology
- SOFTECO SISMAT
- Electrolux
- COMVERSE

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Talk outline

✓ Motivation
✓ Approach
✓ The inContext Environment
✓ Context Management
✓ Interaction Mining
✓ Service Management
✓ Tools and Experiments
✓ Conclusion and Future Work
The way people collaborate has been changed substantially: Multi-objective and nomadic working style and ad-hoc collaborations

- Working different objectives and projects at the same time
- Moving from places to places during the collaboration
- Using a variety of devices and infrastructures

Many new emerging team forms

- Nimble: short-lived collaboration to solve emerging problems
- Virtual: spanning different geographical place and having diverse professionals
- Nomadic: collaboration with mobility capabilities
Motivation: the problem

- Traditional collaborative working environments
  - Collaboration tools and services are not integrated into a unified system
  - Users have to manually select individual tools/services
  - Context and interaction have not been well utilized
  - See our report for European Space Agency at https://www.vitalab.tuwien.ac.at/autocompwiki/index.php/Current_and_Future_Technologies_for_Collaborative_Working_Environments_study

- Collaboration tools/services are hardly reusable
- Services cannot be adapted according to team context and interaction
- Existing CWEs are not able to support emerging teams in highly dynamic environments
Motivation: questions

✓ How to integrate diverse collaboration tools and services built with different technologies and provided by different organization?
  • To avoid monolithic/proprietary applications and to support the composition

✓ How collaboration services are adapted to the collaboration context of emerging team forms?

✓ How to reduce human intervention in CWEs?

→ The inContext aims at providing solutions for these questions by providing context and interaction based collaboration techniques

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✓ How can we integrate different (free, commercial) collaboration services belonging to different organization?
  • Utilize service computing principle to loosely couple and aggregate diverse types of collaboration services

✓ How do we know the context of teams, their activities and operating environments?
  • Explicitly model context associated with emerging teams
  • Infer and enrich existing context to provide high-level information

✓ How do we monitor and quantify metrics and patterns associated with interactions inherent in collaborations
  • Employ interaction mining techniques to understand metrics and patterns associated with interactions

→ This talk gives you an overview of our approach
The inContext Environment

Providing different types of end user applications for different platforms and devices

Providing context information, metrics and patterns, perform service selection and adaptation

Providing basic operations normally required in collaborations

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A reference implementation of Pervasive Collaboration Service Architecture (PCSA)

PCSA addresses

- Interfaces between diverse types of common collaboration services
- Core services for supporting context- and interaction-based collaboration and their interfaces
- Deployment strategies for different team forms and infrastructures
Context associated with team collaboration is much more complex than HCI or location-based services
- Human, services, teams, activities, and interaction between human and services

Existing context models are not enough
- Reuse existing concepts and develop new ones

inContext relies on RDF+OWL
✓ Context information collected from different sources
✓ Centralized context store is not suitable
✓ Context information is stored in different services
  • Linked through a core model
Context information can be inferred based on rules

- Provide insightful information about context associated with people, teams, services and activities
- Based on SPARQL++

Example: using reasoning techniques to find all civil engineers available at a particular site.

```
PREFIX team:<http://www.in-context.eu/team.owl#>
SELECT ?engineer
WHERE{
    ?engineer :hasProfile ?profile.
    ?profile :hasSkill ?skill.
    ?engineer :locatedAt:"Genoa sea port"
FILTER regex(?sname,"civil engineer","i")
}
```
Context Management: Context Reasoning (cont.)

Reasoning Approach

- **In-Memory Inferencing:**
  Inferred model is created in the memory every time, when query finished, it will be dropped.
  - Flexible, ability to specific reasoning rules for different queries. Lack of efficiency, need to load entire model into memory.

- **Persistent Inferencing:**
  A set of static rules are applied directly on the persistent graph (Database) at all time.
  - Query is more efficient. But reasoning rule set are immutable.
Interaction Mining

✓ Used to understand characteristics of team members, types of communication, performance of services

✓ Provide quantitative information associated with interactions for enriching context and selecting services

✓ Three types of interactions
  • Service-to-service
  • Human-to-service
  • Human-to-human

✓ Three levels of information
  • Individual (human or service), group (a team or a set of services), and the collaboration (all teams and services)
## Interaction Mining: Examples of metrics and patterns

<table>
<thead>
<tr>
<th>Interaction/level</th>
<th>Individual</th>
<th>Group</th>
<th>Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service-to-service</td>
<td>Number of invocations, number of unavailability, number of failures, number of consumers</td>
<td>Usage distribution, usage mode (isolated or composite) patterns, service interactions network</td>
<td>Usage distribution, usage mode (isolated or composite) patterns</td>
</tr>
<tr>
<td>Human-to-service</td>
<td>Number of service invocations, usage mode (isolated or composite) patterns</td>
<td>Usage distribution, constant/-durable/limited duration usage patterns</td>
<td>Usage distribution, constant/-durable/limited duration usage patterns</td>
</tr>
<tr>
<td>Human-to-human</td>
<td>Number of callers/callees, number of interactions, number of assigned activities</td>
<td>Team size, total interactions, average number of callers/callees, interaction networks</td>
<td>Broker, proxy, master/slave, coauthoring patterns, interaction networks</td>
</tr>
</tbody>
</table>
Diverse collaboration services
- Complement or compete
- Are utilized differently, depending on the context
- How to select the right service upon the context?

Traditional service selection approach
- Based on service-meta information, and possibly historical data of service usage
- Not enough for emerging team work due to the lack of context consideration

inContext approach: service selection based on four types of information
- Context information, interaction information, and service meta-information
Service Management and Logging and Interaction Mining Infrastructure

1.0 Select Service

1.1 Lookup

Lookup gets ranked List of Services
Returned List is identified by ListID
ListID is passed through the Access Layer at each invocation
Preferential Service can be determined (Interaction Mining) by correlating selected Service with Lookup Result (ListID)

Access Layer Invocation Proxy

Access Layer Lookup

Collaboration Services

Service Registry & Lookup

MetaData Service

Relevance Engine is composed of different Ranking Services
Use Service MetaData for Ranking

LSP Rank

ServiceRank

Ranking Algorithms

(email)

SubscriptionManager

Logging Service

Notification Broker:
Notification(ServiceInteraction Record) // Contains interaction MetaData and XML Request/Response Messages
Subscription Header // Correlate Notification with Subscription

Persisted Subscriptions

Logging Subscriber

Subscribers:
Context Sensors
Human Interaction Mining
Service Interaction Mining
Complex Event Processing

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✓ Service operations are associated with category
✓ Service-meta information includes a set of criteria of metrics and weighted factors
  • Cost, reliability, availability
  • Criteria can include SPARQL queries
✓ Multiple-steps in selecting a service
  • Using keyword matching to select the right service category
  • Ranking services based on meta-information, interaction information, and context information.
    – Also support a modified LSP algorithm and a service rank algorithm
  • Selecting the best service
✓ Service adaptation at runtime
Example of Service Selections

Standard context queries like retrieving location of a given user

Data about the tents (location, level of support)

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✓ Services are implemented in Java/AXIS/Tomcat and C#/.NET
✓ AJAX-based collaboration tools
  • Using ZK framework
✓ Collaboration services
  • Calendar, Email, Instant Messaging, Document Management, Document Search, Meeting Scheduler, SMS, Activity Management, etc.
✓ Some support for mobile devices
✓ Services deployed in Aachen, Genoa, Leicester, Milan and Vienna
Many collaboration tools can be built
- By utilizing common collaboration services
- By utilizing context-aware supporting services

Electrolux case study: Meeting Scheduling collaboration tool: *support all relevant steps in preparing a meeting*

Event Management Tool – Wolverhampton Fair case study from WMLGA: *support the organization, communication, cooperation and coordination of activities*

Both tools utilize common collaboration services and composite services based on common ones.

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Meeting Scheduling Collaboration Tool

Meeting Details

Title: CP 0 Preparation Meeting
Date: Nov 14, 2007 3:30 PM
Location info: Physical: Conf Room 1 ELX Porcia (Italy)
   Video conf: IP:12.23.34.45 port:7890
   Phone: +39.0123.456789
Participants: Dino, Seth, Alex, John, Seth, Rossi, Neri, Verdi, White, Green
Shared folder: http://sws.elx.com/ice-beer/cp0

Agenda

3:00: Intro
3:15: doc review
3:45: pending issues
4:00: closing

Search documents

Title:
Author:
Keywords (comma separated):
Locally
Network

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Some Videos
Meeting scheduling problem
- Frequently required for team collaboration

It is complex due to emerging team forms
- Many constraints have to be implemented

Three main steps in planning a meeting
- Selecting suitable time and participant
- Preparing document
- Sending notification/changes

Three steps can be fully automated in inContext by utilizing context reasoning, rules, and service selection
Experiment: example of rules for a meeting

Meeting priority and attendance rules

IF meeting priority = High THEN
    ....
ELSE IF meeting priority = Medium THEN
    Attendance type = Any (Physical | Phone | Video)
    Organizer attendance = Physical
    Travel for meeting = False
    Proxy participation = At the same level or one level below
    Attendance Quorum = At least 1 for each L2 type

ELSE IF meeting priority = Low THEN
    ...
ENDIF

Notification rules

Always send MAIL with Full Details
IF present on Instant Messaging (IM) THEN
    send summary as IM message
ELSE
    send summary using SMS
ENDIF

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E.g., Using reasoning techniques to automatically find possible time slots for the meeting

PREFIX iCal: <http://www.w3.org/2002/12/cal/ical#>
SELECT ?T
WHERE {<m1> :possibleTimeSlot ?T ; :priority "low".
   ?T time:hasBeginning ?TB; time:hasEnd ?TE.
FILTER( COUNT{?P : {<m1> :invited ?P }} >=
   2 * COUNT{?P :
   {<m1> :invited ?P .
   ?P :hasCalendar ?C .
GRAPH ?C {?E a iCal:Vevent;
   ical:dtStart ?B
   ical:dtStart ?E. }
})
E.g., automatically find relevant documents

PREFIX res: <http://www.in-context.eu/resource.owl#>
PREFIX act: <http://www.in-context.eu/activity.owl#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?resource ?meeting
{
  ?meeting rdf:type act:Activity.
  ?meeting :shortname "review meeting"^^xsd:string.
  ?meeting :usesResources ?resource.
}
E.g, Check online status of a participant named Rossi

PREFIX ctx: <http://www.in-context.eu/context.owl#>
SELECT ?x ?y
WHERE{
  ?a ctx:connectedBy ?x .
  ?x ctx:hasOnlineStatus ?y .
}

E.g., Send notification

✓ It turns out that we have to send SMS to Rossi
✓ Service Management ranks existing SMS providers
✓ Service Management sends the notification to Rossi through the best ranked one
inContext: a novel pervasive and collaborative working environment

- Support emerging team forms
- Provide techniques for integrating existing collaboration services and for context- and interaction-based collaborations
- Proof the concept with real world applications

Multidisciplinary research: Web services engineering + ontology/semantics + collaborative computing

Future work
- Further development of the Pervasive Collaboration Services Architecture
- Collaboration-aware adaptation and composition
- Distributed users/teams managements, context policy and privacy issues
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