A Preliminary Outline for a Ubiquitous Computing Software Infrastructure

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Outline

- An appraisal of Ubiquitous Computing
- Ubiquitous Computing Challenges
- A Comprehensive Architectural Model
- Project ISAM
- Current Research
- Overview of Continuum Software Infrastructure
- Conclusion and Future Work

Ubiquitous Computing

also referred as *Ubicomp*

"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."

"A new way of thinking about computers."

(Mark Weiser, 1991)

Ubicomp Challenges

Issue	Alias	Focus Area	Motive
Heterogeneity		Distributed systems	- Variety and difference - Different types of devices, networks, systems, and environments
Scalability	Localized Scalability	Distributed systems	- Large scale - Increase in the number of resources and users
Dependability and Security	Fault Tolerance	Mission-critical and Distributed Systems	- Avoiding failures that are more frequent and more severe than acceptable - Providing availability, confidentiality, reliability, safety, integrity, and maintainability
Privacy and Trust		Internet and Mobile computing	- Protecting against bad use of personal data - Defining the trustworthiness of interacting components
Spontaneous Interoperation	Volatility	Mobile computing	- Allowing interaction with a set of components that can change both identity and functionality - Permitting association and interaction
Mobility	Follow-me applications	Mobile computing	- Application and data access anywhere and anytime - The user environment goes along
Context awareness	Perception	Mobile computing	- Perceiving user's state and surroundings - Inferring context information
Context management	Smartness, Masking uneven condition, Adaptability	Mobile and Ubiquitous computing	- Modifying the behavior of the system based on the perceived context information - Adapting
Transparent User Interaction	Human-computer interaction	Ubiquitous computing	- Merging user interface with the real world - Allowing user focus on tasks with minimal distraction
Invisibility	Ubiquity, Pervasively	Ubiquitous computing	- Allowing users focus on task, not tools - Making computers disappear in the background

A Comprehensive Architectural Model

- Based on the previous challenges
- Presents the requirements for Ubicomp
- Proposes the use of **Middleware** and a **Framework**

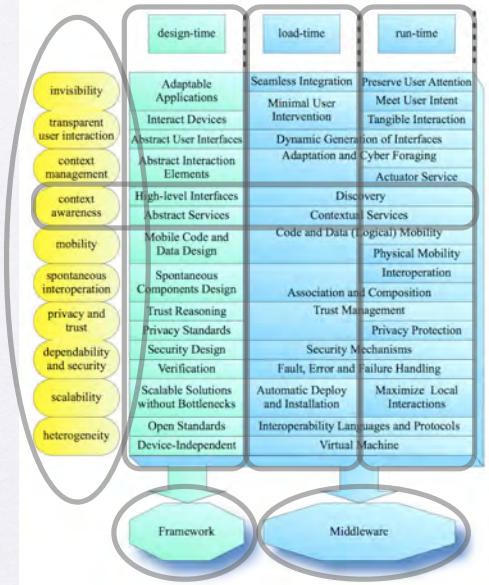
"A software that support mediation between other software components, fostering interoperability across heterogeneous platforms and varying resource levels."

(Adelstein et al., 2005)

"An environment, composed of APIs, user interfaces, and tools, which simplifies software development and management in a specific domain."

(Bernstein, 1996)

The model



Project ISAM

- Mobile Applications Support Infrastructure (*Infra-estrutura de Suporte às Aplicações Móveis*)
- integrates concepts of context awareness, **grid**, and **mobile computing**
- consists of a pervasive computing infrastructure, integrating a **programming language** and **middleware**
- includes **ISAMadapt**, a programming language that provides some means for expressing dynamic adaptation and context-awareness. Based on **Holoparadigm**

(Augustin et al., 2005)

Current Research

Defended Thesis

- Follow-me semantics can reduce the distance between Weiser's vision of ubiquitous computing and the current distributed computing scenario

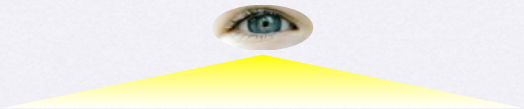
What is follow-me semantics?

- Applications and data go along with the user
- The user executes her applications and data regardless of location, even on the go

Current Research

The Big Picture (general goal)

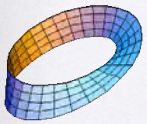
- Developing a software infrastructure applying follow-me semantics in the field of ubiquitous computing and addressing issues of context awareness and context management.



Current Research

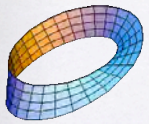
The Bottom Line (specific goals)

- Addressing context awareness issues, more specifically:
  - Representing context information
  - Storing context data
  - Distributing and placing context information
  - Supporting context awareness without excessively burdening programmers nor software development
  - Mixing user preferences and context information
  - Using up-to-date technology for dealing with context



Continuum Infrastructure

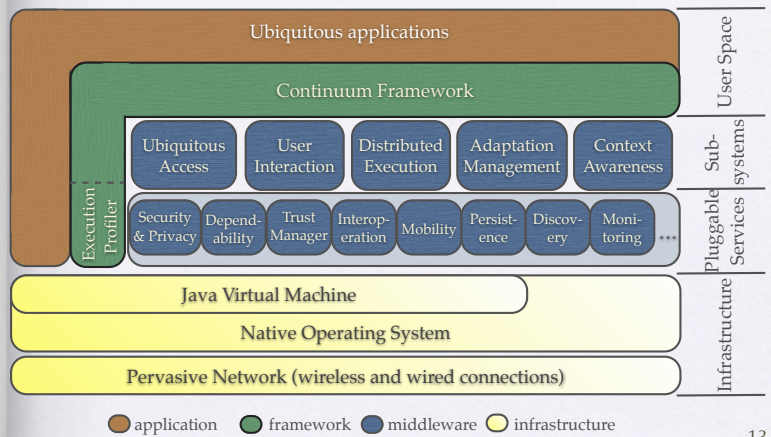
- Redesigns Project ISAM
- Reflects our Comprehensive Architectural Model
- Focuses on better support for:
  - Follow-me semantics
  - Context awareness
  - Context management



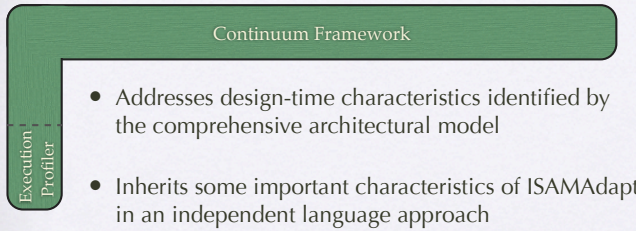
Continuum & ISAM

- Main differences between Continuum and ISAM:
  - ISAMAdapt has been discontinued; Continuum will at first support Java only
  - Continuum makes use of frameworks, instead of a language
  - Continuum focuses on context awareness
  - ISAM addresses awareness issues only partially
    Issues addressed included the acquisition of raw information, its distribution, and the conversion of raw information into abstract context elements, guided by an XML description.

Continuum Architecture



Continuum Framework



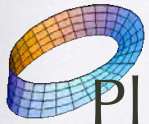
- Addresses design-time characteristics identified by the comprehensive architectural model
- Inherits some important characteristics of ISAMAdapt, in an independent language approach
- Execution Profiler helps the user choose the best implementation for each service
  The Execution Profiler parameterizes the deployment process during load-time.

Continuum Subsystems

- **Ubiquitous Access** — Reinforces follow-me semantics and tackles the issues of user attention and intent
- **User Interaction** — Treats tangible interfaces and transparent interaction
- **Distributed Execution** — Controls the management of applications and of the infrastructure
- **Adaptation Management** — Deals with the adaptation process, including agility aspects and the maintenance of system stability
- **Context Awareness** — Addresses the specific goals of our thesis; context awareness is a *real* subsystem

Continuum Pluggable Services

- Loads services on-demand, according to necessary functionalities (adaptive behavior)
- Uses concepts of Service-oriented architecture (SOA) and web services
- Makes interaction easier, enabling services to be effortlessly used in many applications, in a more *ad hoc* approach



Continuum Pluggable Services

Security & Privacy	Responsible for security mechanisms and privacy protection
Depend-ability	Aimed at fault, error, and failure handling
Trust Manager	Accountable for the establishment of trust
Interop-eration	Targeting at communication
Mobility	To support logical and physical mobility
Persist-ence	Intended to store data
Discov-ery	Used to dynamically locate resources
Moni-toring	For the purpose of interacting with sensors

Conclusion

- It is still difficult to find a software infrastructure that has all the characteristics proposed by the comprehensive model
- The architectural model could be used as a standard for assessing proposals and suggesting needed features
- The software infrastructure of Continuum is based on Project ISAM and also on the comprehensive architectural model
- Continuum applies follow-me semantics in ubicomp
- The current work is detailing the infrastructure of Continuum and factoring ISAM in this process

Future Work

- Model Continuum subsystems and create UML class diagrams for each one of them
- Detail Continuum framework and pluggable services
- Investigate and propose innovative solutions to deal with context (deal with specific goals)
- Defend the Thesis Proposal (until the end of 2007)
- Implement some Continuum subsystems
- Create case-studies (context-aware applications) to show the functioning of Continuum, especially of context awareness

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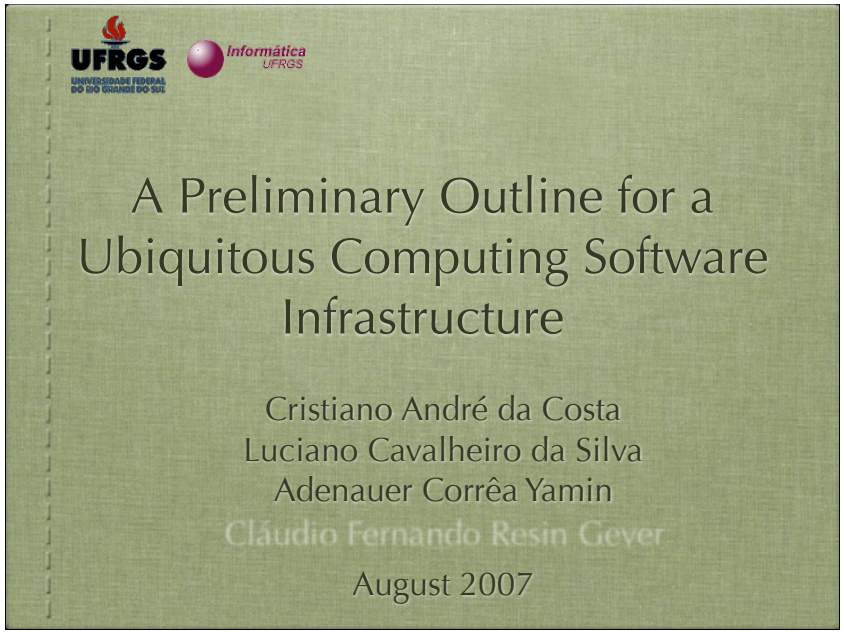
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