Egocentric Context-Aware Programming in Ad Hoc Mobile Environments

Christine Julien
Gruia-Catalin Roman

Mobile Computing Laboratory
Department of Computer Science and Engineering
Washington University in St. Louis
Outline

- Motivation
- View Concept
- Declarative View Specification
- View Operations
- EgoSpaces Middleware
- Conclusions
Motivation and Goals

- Environmental adaptation
  - Continuous and rapid reactions
- Novel notion of context
  - Extended in scope beyond the local host
  - Application specific context definition
  - Generalized treatment of context types
- Formal treatment of context-awareness
- Middleware for context management
  - Provide general mechanisms for programming
Computational Model

- Hosts
- Agents
- Tuple spaces
- Tuples
Application Example

- Collision
- Traffic
View Concept

- Egocentric
  - Abstraction of a particular reference agent’s operating context, specific to its needs

- Multiple views

- Projection of all that is available
  - Allow agent to control scope of views
    - Facilitate easy program development
    - Minimize performance penalties
Context-sensitive data structures

- Tuple space provides coordination basis
- Veneers present other interactions
  - Address different agents’ needs
  - Cater to programmer expertise

View Presentation
Coordination Services

- High-level veneers for sophisticated context maintenance
  - Context-sensitive references
  - Context-sensitive bindings
  - Context-sensitive events
Declarative View Specification

- **Specification**
  - Controls scope and size of view

  *All location data owned by collision warning agents on cars within 100 meters of my current location*

- **Implementation**
  - Automatic sensing
  - Transparent maintenance
View Specification:

Network and Host Constraints

- Extend availability of context information
  - Subnet based on abstraction of network topology and its properties
    - ...within 100 meters...
  - Select hosts based on their properties
    - ...cars...
View Specification:
Agent and Data Constraints

- Restrict the set of application agents that contribute to the view
  
  …collision warning agents…

- Allow reference agent to restrict which data items are available in the view
  
  …location data…
Consistency Concerns

- Transactional semantics (e.g., money transfers)
  - Strong application guarantees
  - Can be expensive
- “Best-effort” semantics (e.g., traffic conditions)
  - Variety of possible implementations
  - Application chooses implementation to use based on its particular situation
Access Controls

- Agent specified access control function
  - Limits access of other agents to an agent’s data

- Reference agent provides credentials and intended operations
  - Used by contributing agents’ access control functions
Reactive Programming

- Agents adapt behavior in response to presence of certain tuples
- Associates an application-level reaction to the appearance of a tuple in a view
- Scheduling modality
  - Eager or lazy semantics
Active Views

- Common built-in behaviors on views
  - Transparent data migration
  - Automatic duplication
  - Event capture
  - Extensibility
EgoSpaces Demo Application
Contributions

- General treatment of context
  - Current applications tend to use only basic types of context information in specific ways (e.g., location)
    - Guide tools, field work tools

- Extended scope of context
  - Current frameworks and toolkits provide access only to a single component’s sensors
    - Context Toolkit, Context Fabric

- Scalable and extensible middleware for ad hoc mobile coordination
  - Current middleware provides either only local interactions or symmetric and transitive interactions
    - LIME, MARS
Conclusions and Future Work

- **Novel coordination model**
  - Asymmetric interactions cater to individual agent’s needs
  - As expressive as many other models (e.g., LIME, Linda, JEDI, SIENA)

- **Flexible and general middleware**
  - Simplify programming for ad hoc environment

- **Full implementation to include network abstractions and reactive and active views**

- **Evaluation through application examples**
Thank You

- For more information:
  - http://www.cse.wustl.edu/mobilab