



# MOVE:

## Component Groupware Foundations for Collaborative Virtual Environments

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# Outline

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- Motivation
- Related work
- System Architecture
- The ANTS CSCW Framework
- MOVE Architecture
  - Session and Zone Management
  - Shared Artefacts and State Propagation
  - Coordination and Consistency
  - Awareness
- MOVE Performance Issues
- Conclusion and Future Work

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# Motivation

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- **Current situation**

- Advances in networking technologies and protocols, DBs, Computer Graphics and Display Technologies
- Consequence: Many 3D CVEs have emerged

- **What is MOVE ?**

- 3D CVE. Interaction with other users or with shared artefacts
- Tested in the Catalonian Internet2 project
- Deemed for educational purposes
- Developed using open technologies: VRML, H-Anim, Java, ...

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# Motivation

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- **Problems in existing 3D CVEs:**
  - High complexity in development. Should be scalable and support many concurrent users. Addition of new components: **Component Reusability**
  - **Data Extraction:** Were not thought for retrieving data in an easy way
- **MOVE** uses the **ANTS CSCW Framework:**
  - Facilitates development of collaborative components
  - Smooth transition from local to distributed apps

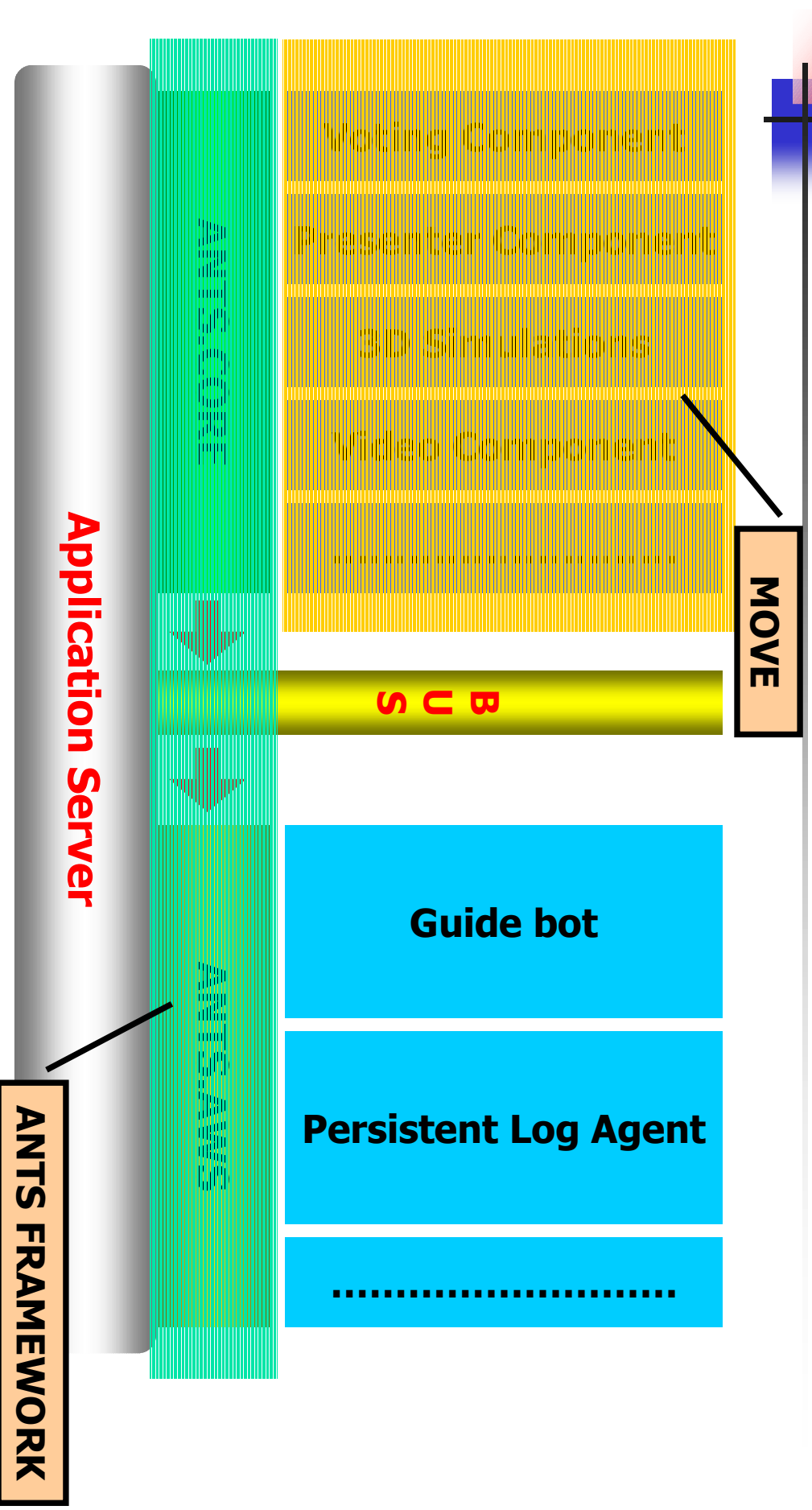


# Motivation

- **How have we solved the previous problems?**
  - Definition of a **Component Model** based on the standard *JavaBeans* specification
    - Hides complexity to users, providing
      - Transparently Remote Persistence
      - Distributed Events
      - XML Component Descriptors & Packaging
  - Definition of a dedicated **Awareness (AWS)** and **Event Monitoring** service
    - Also, an agent system that reacts to events triggered in the bus has been implemented
    - Any kind of information can be obtained!



# System Architecture





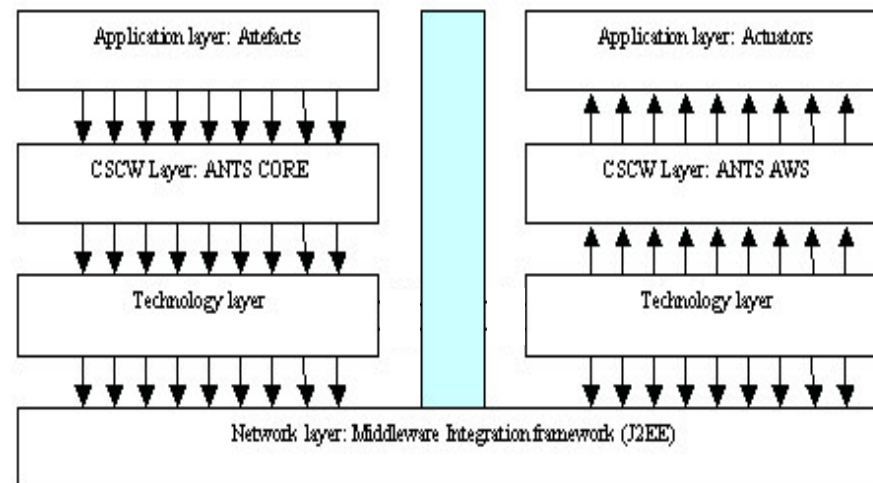
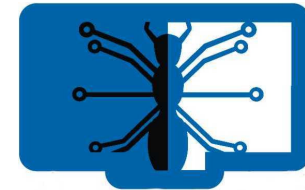
# Related Work

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- **Component Architecture Approaches:**
  - NPSNET-V: Components loaded at runtime
  - NPSNET Bamboo: Code modules operate in X-platform and X-language manner
- **Awareness Services Approaches:**
  - TOWER: Event analysis visualized with Blaxxun
  - MASSIVE-3: Record & Replay mechanisms
- **Declarative Component Approaches:**
  - CONTIGRA and Jamal: Both define XML-based mark-up languages for 3D component description & assembly

# The ANTS CSCW Framework

- Provides a Generic Multi-User Collaborative Framework
- Key piece: The Collaboration Bus







# The ANTS CSCW Framework

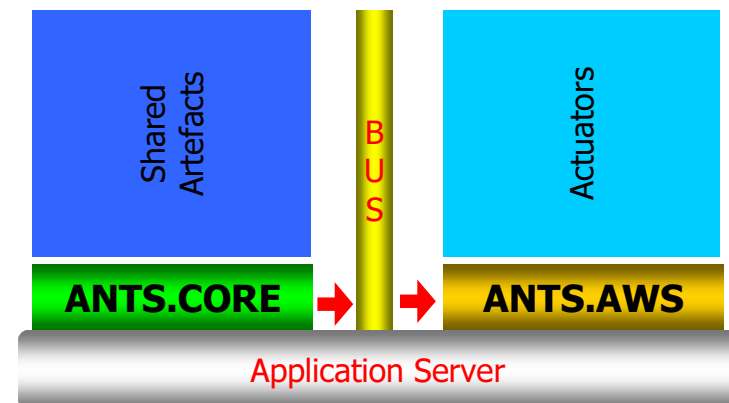
- The collaboration bus
  - Is not only an event dispatcher
  - Is a higher level abstraction constructed on top of publish/subscribe middleware.
    - Creates a state propagation system for shared components transparent to developers.
    - Also creates a mediator system. 3rd-party actuators can react to environment events

- 3-layered architecture

Application Layer

CSCW Layer

Technology Layer



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# The ANTS CSCW Framework

- **Application layer** (2 extension hooks)
  - Provides development of new collaborative components using the *JavaBean* specification
  - Provides awareness actuators that react to information events produced in the Framework
  - We have created a **Component Model** comprising
    - Persistence & Events
    - Coordination
    - Customization, Introspection & Packaging

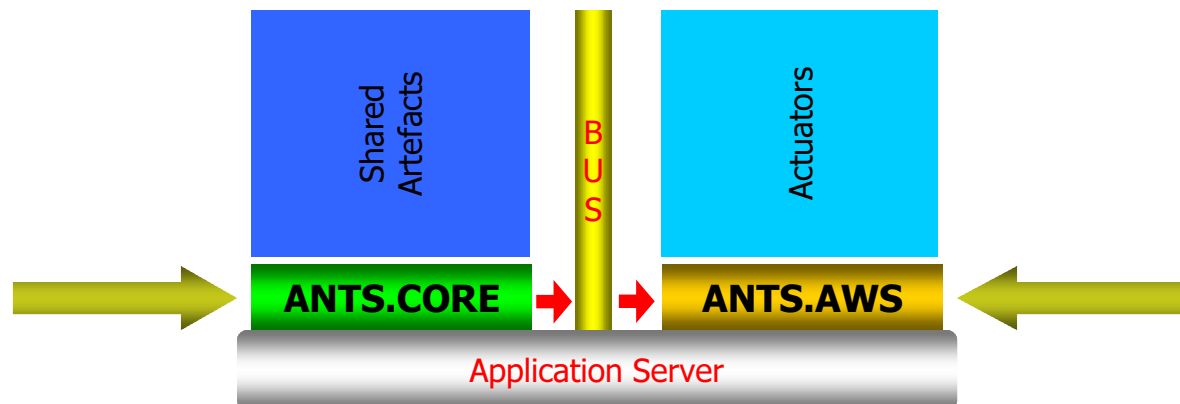
# The ANTS CSCW Framework

## ■ CSCW Layer

- Set of Collaborative Services offered to the Application Layer.

## ■ Modules

- Container Runtime Module (**ANTS.CORE**)
- Awareness Services Module (**ANTS.AWS**)





# The ANTS CSCW Framework

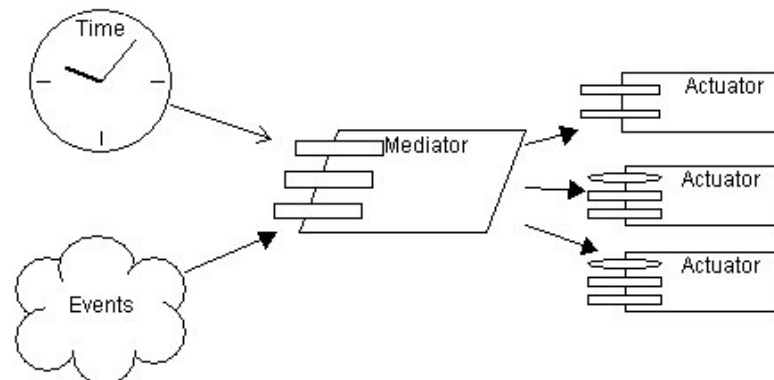
## ■ ANTS.CORE

- Support for **Sessions, Shared Artefacts, Coordination Control, Security** and a **Seamless Security Model**
- MOO Influence
  - Session = *Place*
  - Artefacts = *Things*
- **Place**
  - Represents the shared session. Contains users, components and links
  - Provides several methods: send/subscribe events, get connected users, get links, ...
  - Dynamically loading of *JavaBean* components to the shared context.

# The ANTS CSCW Framework

## ■ ANTS.AWS

- Enables triggering of a **set of actuators** in response to **events** produced in the system
- Integrated with the CM through Component's XML descriptors
- AWS follows a **Mediator design pattern**
  - Sensors, Mediator and Actuators





# The ANTS CSCW Framework

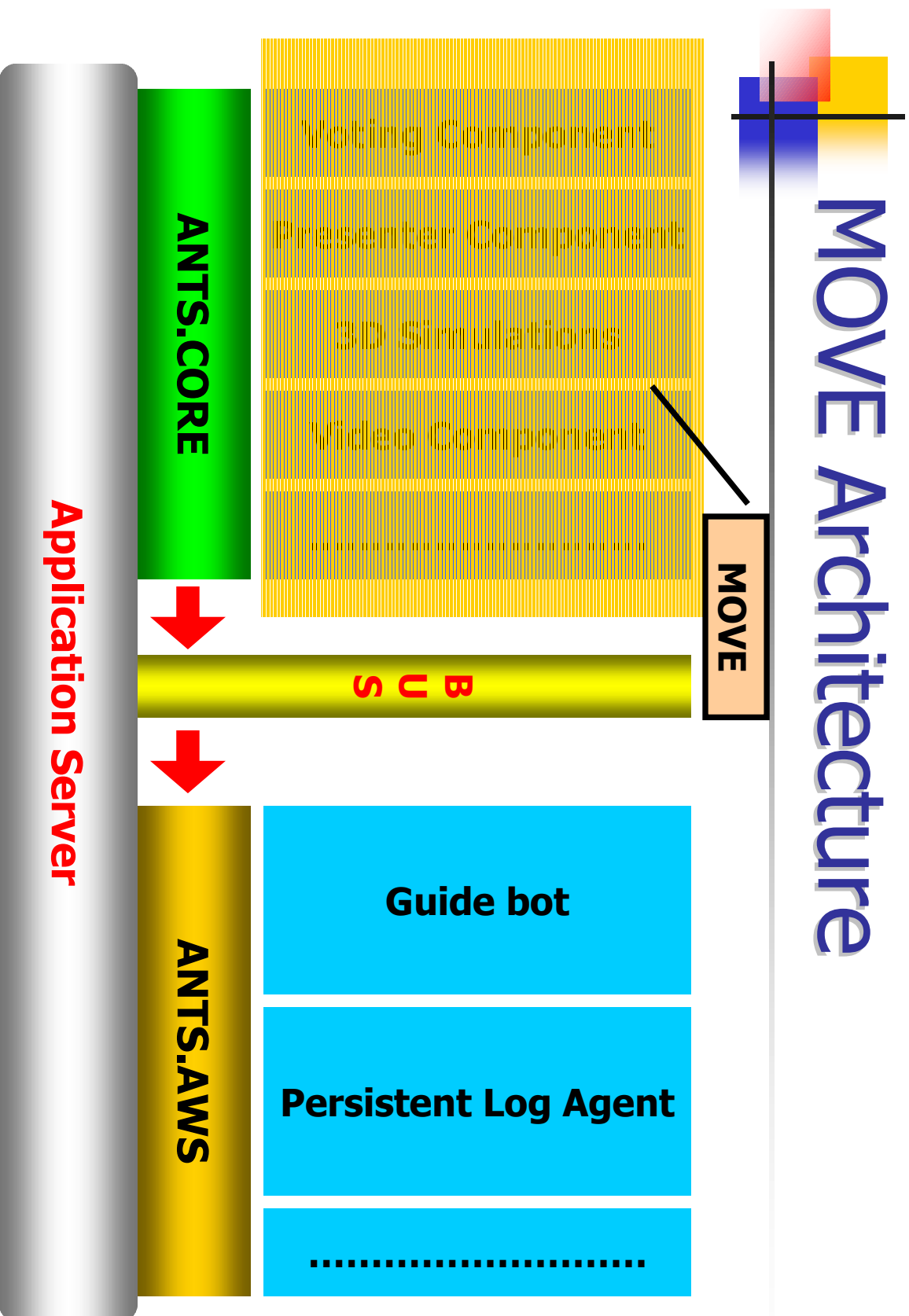
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- **Technology Layer**

- Solid infrastructure providing security, scalability, transactions and performance needed
- **J2EE** Platform was chosen as technology infrastructure
  - Infrastructure and System independent code
  - Lets us base on open specifications and components
  - Vendor independent
- Concerning MOM
  - **DSTC's Elvin Notification Service**
  - Façade API that lets us choose between **JMS** and **Elvin**

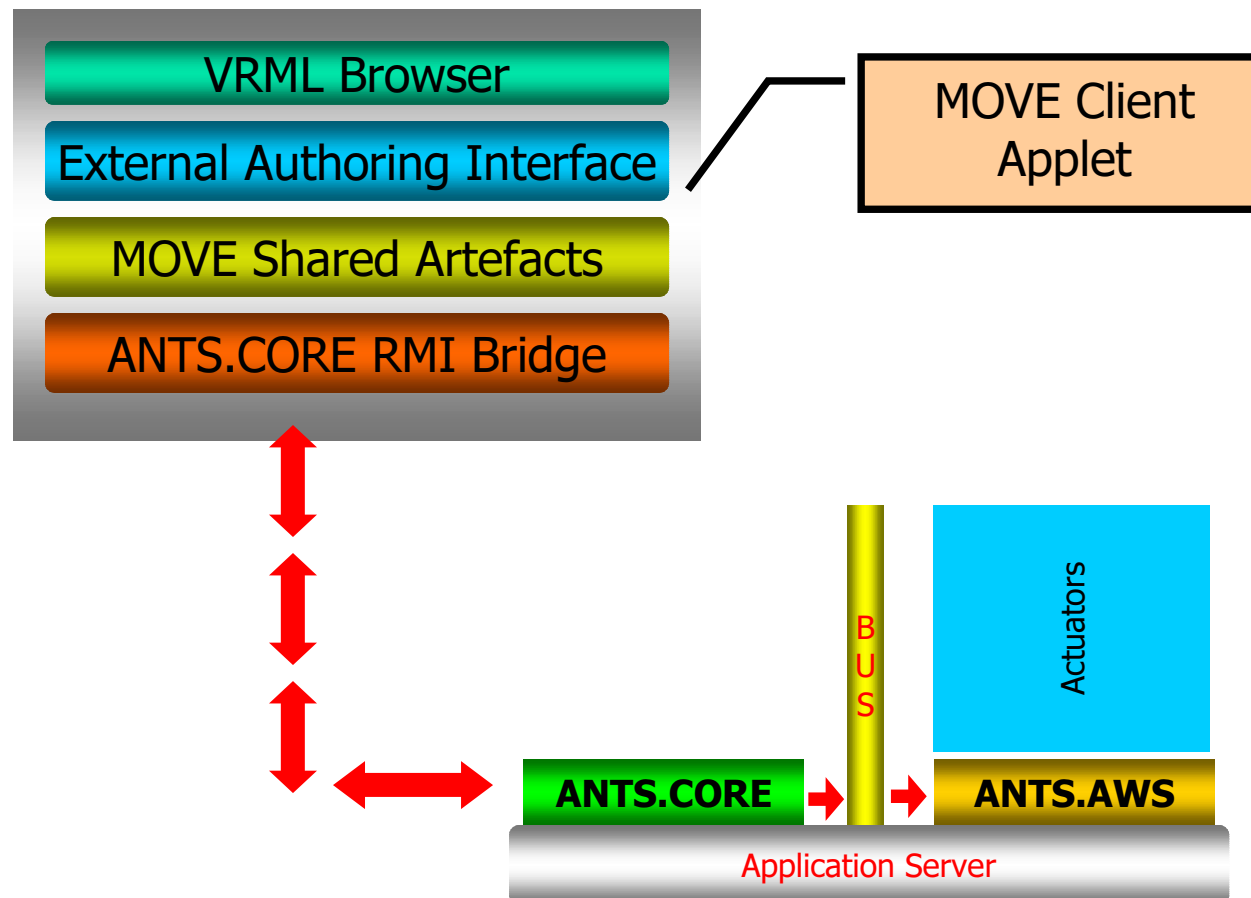


# MOVE Architecture





# MOVE Architecture





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# MOVE Architecture

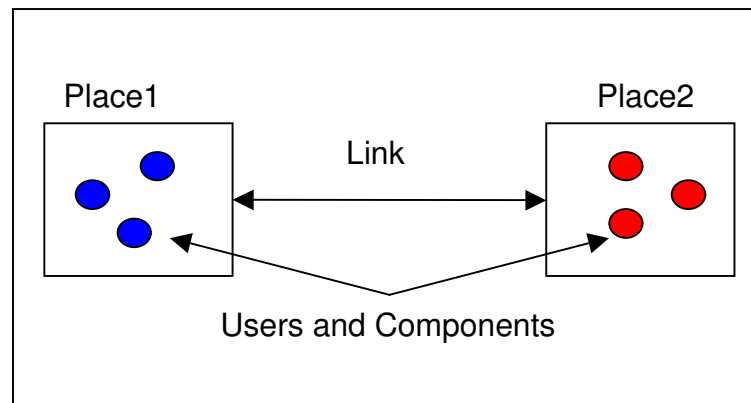
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- **Essential Collaborative Services**
  - Session and Zone Management
  - Shared Artefacts and State Propagation
  - Coordination and Consistency
  - Awareness

# MOVE Architecture

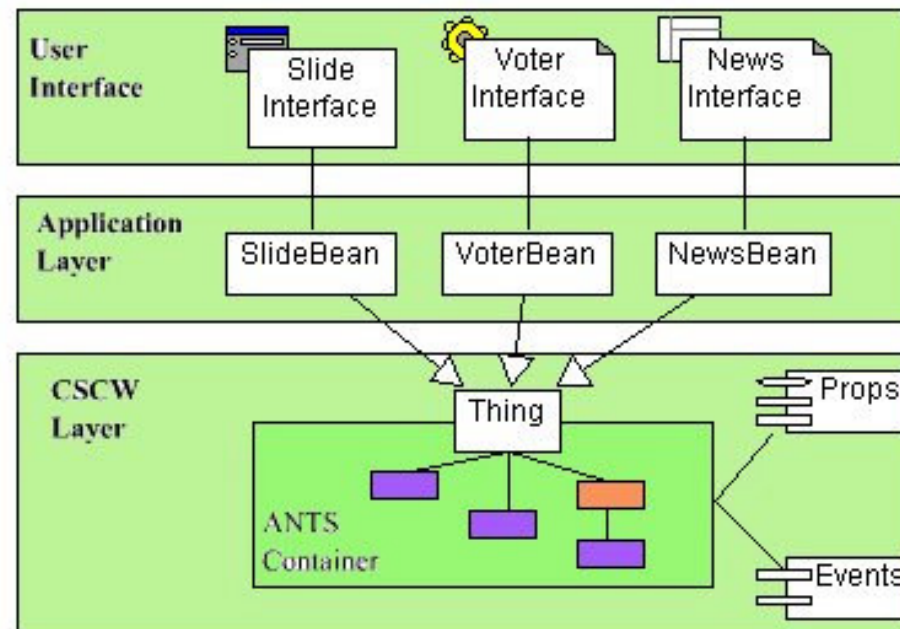
## ■ Session and Zone Management

- Use of the *Place* concept to determine the environment structure
- Session is identified with *place*
- *Places* are similar to *Locales* in SPLINE
- Portals are used for linking places



# MOVE Architecture

- **Shared Artefacts and State Propagation**
  - MOVE is based on a modular architecture for every component, following the MVC paradigm



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# MOVE Architecture

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- **Shared Artefacts and State Propagation (continued)**
  - **Main aim:** design a system so as it is easily extensible and reusable
  - New components contain an XML descriptor with all required information
  - New components are JAR-packaged and deployed on the ANTS Server











# MOVE Architecture

- **Shared Artefacts and State Propagation (continued)**

- We have not taken care of state propagation, nor persistence: **ANTS CSCW does it for us!**

- We have developed a set of artefacts:

- |  |  |
|--|--|
|  Voting tool     |  Banner tool           |
|  Presenter tool |  3D Simulation tool   |
|  Files tool     |  Video streaming tool |
|  Jukebox tool   |  URL tool             |

Hook and Camera tools



# MOVE Architecture



- Model: Hook
- Model: Camera

```
Adding user: guest
Adding existing user: gojiita
VRML Views: Audio URL Votation Hook Slides Video
Document Simulation3D Banner Camera
Teacher Views: Hook Camera
MOVE! Initialized OK.
```

gojiita  
guest



# MOVE Architecture

Presenter tool

Voting tool

Avatar

Video tool



|  |         |
|--|---------|
| <input type="checkbox"/> Model: Hook   | gojiita |
| <input type="checkbox"/> Model: Camera | guest   |

```
Adding user: guest
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# MOVE Architecture

Fase de Disseny  
El mòdul **Move-Core (I)**

SHOWERS  
MOVE CORE  
MOVE BUILDING SLIDES  
ELVIN SERVER  
MOVE SERVER  
MOVE E2E  
JOS EDUCATION SERVER

Slides: slides.v05\_0 ...

Slides Sets:  
projecte\_Move Load  
<< < > >>  
Current Set: projecte\_Move

Attention : fenêtre d'applet

```
User teacher has joined this place.
User teacher has left this place.
Removing user: teacher
User teacher has joined this place.
Removing user: teacher
User teacher has left this place.
User teacher has joined this place.
```

gojiita  
guest  
teacher

User 1

MOVE CORE  
MOVE BUILDING SLIDES  
ELVIN SERVER  
MOVE SERVER  
MOVE E2E  
JOS EDUCATION SERVER

Model: Hook  
Model: Camera

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Adding existing user: gojiita
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MOVE! Initialized OK.
```

gojiita  
guest  
teacher

User 2



# MOVE Architecture

Fase de Disseny  
El mòdul **Move-Core (I)**

SHOWERS  
MOVE CORE  
MOVE SERVER  
MOVE GUI  
ELVIN SERVER

Slides: slides.v05\_0 ...

Slides Sets:  
projecte\_Move Load  
<< < > >>

Current Set: projecte\_Move

Attention : fenètra de ...

gojiita  
guest  
teacher

User teacher has joined this place.  
User teacher has left this place.  
Removing user: teacher  
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Removing user: teacher  
User teacher has left this place.  
User teacher has joined this place.

User 1

MOVE CORE  
MOVE SERVER  
MOVE GUI

Model:  
 Model: Hook  
 Model: Camera

gojiita  
guest  
teacher

Adding existing user: gojiita  
Adding existing user: guest  
Adding existing user: guest  
VRML Views: URL Slides Hook Video Camera Audio  
Document Votation Banner Simulation3D  
Teacher Views: Hook Camera  
MOVE! Initialized OK.

User 2

# MOVE Architecture

Slides Changed



Slides: slides.v05\_0 ...

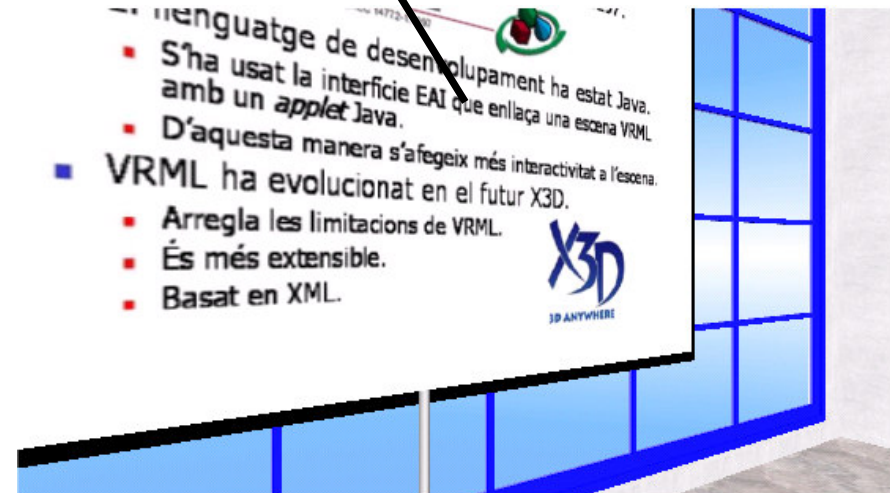
Slides Sets:  
 projecte\_Move Load  
 << < > >>  
 Current Set: projecte\_Move  
 Attention : fenêtre d'applet

```

User teacher has joined this place.
User teacher has left this place.
Removing user: teacher
User teacher has joined this place.
Removing user: teacher
User teacher has left this place.
User teacher has joined this place.
  
```

gojita  
guest  
teacher

User 1



Model: Hook  
 Model: Camera

```

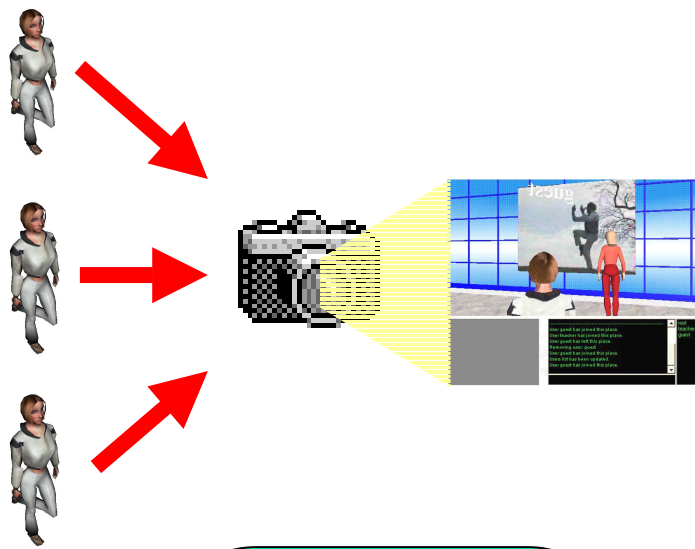
Adding existing user: gojita
Adding existing user: guest
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VRML Views: URL Slides Hook Video Camera Audio
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```

gojita  
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teacher

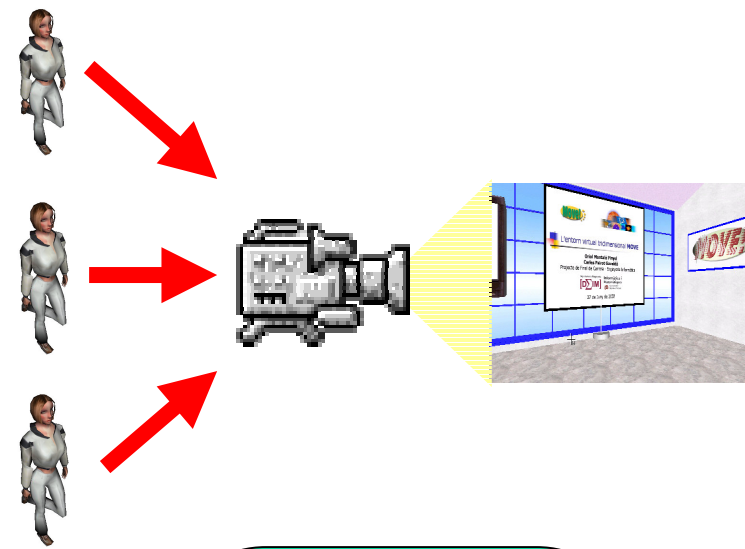
User 2

# MOVE Architecture

- **Shared Artefacts and State Propagation (continued)**
  - Educational Environment
  - User's attention grabbing tools designed



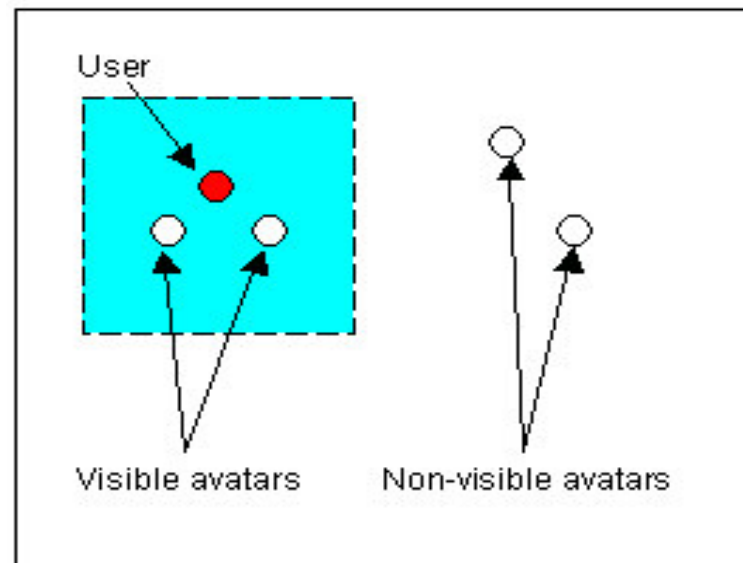
Camera tool



Hook tool

# MOVE Architecture

- **Shared Artefacts and State Propagation (continued)**
  - However, not all components can use state propagation mechanisms of ANTS CSCW
  - Example: **Avatar Movement Component**





# MOVE Architecture

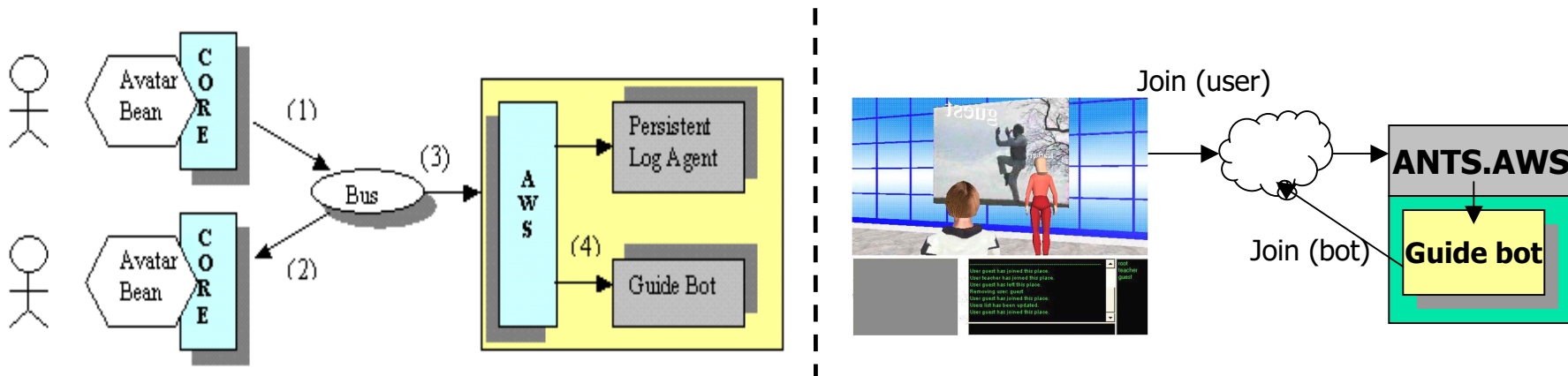
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- **Coordination and Consistency**
  - **Coordination policies** must be supported by software
  - Can be categorized in roles for access control and concurrency control
  - MOVE's authorization is based on a role model
  - Future work: Concurrency control mechanism.  
**Token-based lock component** → Transport artefacts from 1 place to another

# MOVE Architecture

## ■ Awareness

- An awareness platform should provide data acquisition from the running environment
- MOVE uses ANTS CSCW awareness and monitoring services (ANTS.AWS)
- Example: **guide bot**



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# MOVE Performance Issues

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- After performing massive tests:
  - Critical point: **Client** and not the ANTS platform or server-side middleware
  - Implementation of distance-based algorithm. Event discarding
  - Future work: implementation of dead-reckoning algorithms
  - Even though, MOVE scales up smoothly with 200 users in a shared session

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# Conclusion & Future Work

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- Major Features
  - **MOVE**: CVE constructed on top of a Component Groupware Framework
  - Provide consistent Groupware Foundations to the development of VEs
  - Provide **Extensibility** to all framework levels



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# Conclusion & Future Work

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- Future Work

- Improve coordination & consistency control mechanisms
- Improve performance
- Apply data analysis techniques to better understand collaboration flows
- Extension of the agent system
  - Prototype developed using *Python*
  - A Capture & Replay agent has been developed



# Thank you for your attention!

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- If you wish to contact us:
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- MOVE Website:  
<http://ants.etse.urv.es/move>

