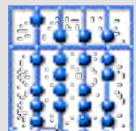


# Herding Sheep: Live System Development for Distributed Augmented Reality

ISMAR 2003, Tokyo, Japan  
10.9.2003

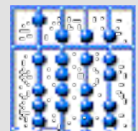
Asa MacWilliams, Christian Sandor, Martin Wagner, Martin Bauer,  
Gudrun Klinker and Bernd Bruegge  
(macwilli | sandor | wagnerm | bauerma | klinker | bruegge)  
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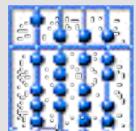
# Introduction

- More and more AR systems are built using frameworks:
  - Repo-3D, Studierstube, Tinmith, MR Platform ...
- DWARF framework is unique regarding:
  - Flexibility at runtime
  - Distribution among different hosts/operating systems
  - Introspection facilities
  - Easy adaption of third-party software
- What is SHEEP?
  - The „Shared Enviroment Entertainment Pasture“
  - Distributed multiplayer game with variety of multimodal interactions
- Why SHEEP?
  - AR games are not new: Cow Painting, ARQuake, AquaGauntlet ...
  - Evaluation and refinement of architectural claims
  - Testdrive for new development process

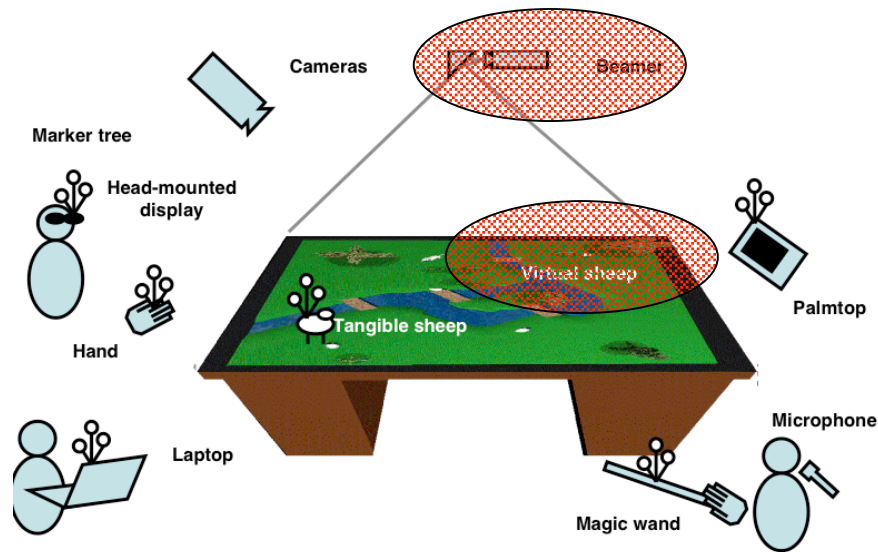


# Outline

- The Game
  - Shows the game from the user's perspective
- Framework Level
  - System Architecture
  - Subsystem Details
- Process Level
  - Methodology
  - Tools
- Conclusion



# The Game

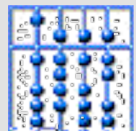


Landscape containing virtual sheep is projected onto a table

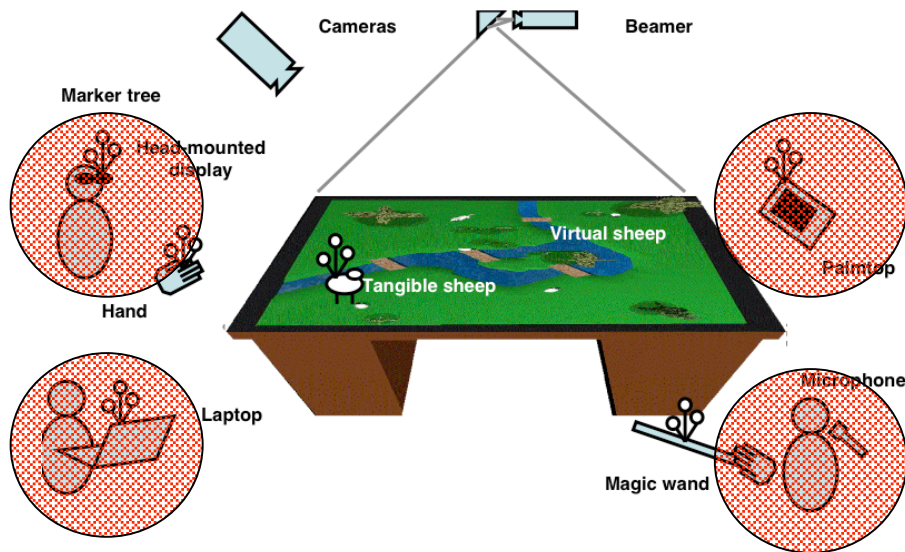


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# The Game

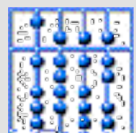


Players have a variety of devices for interaction

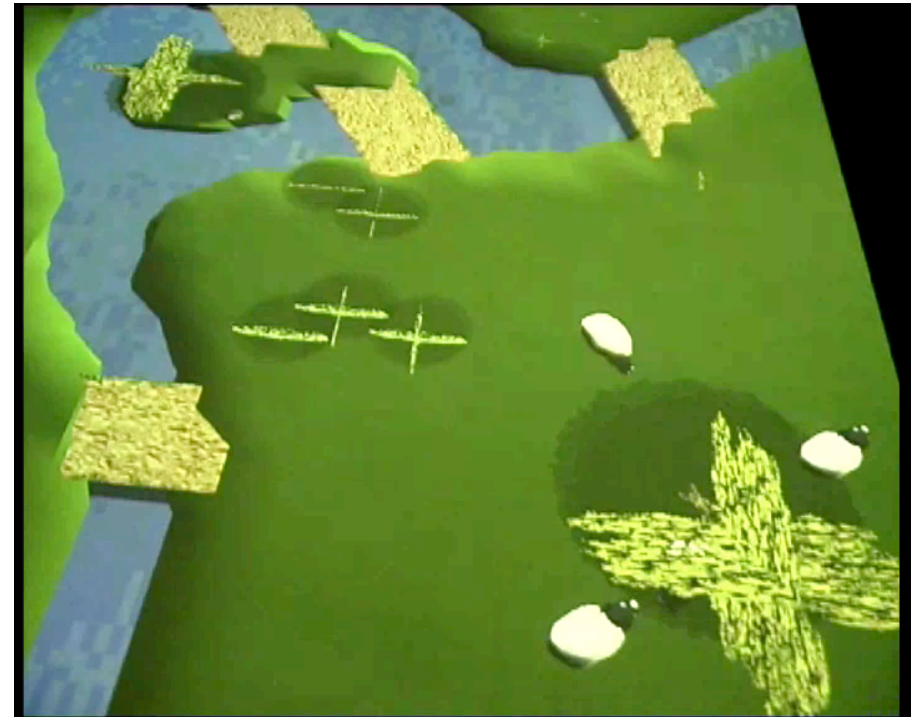
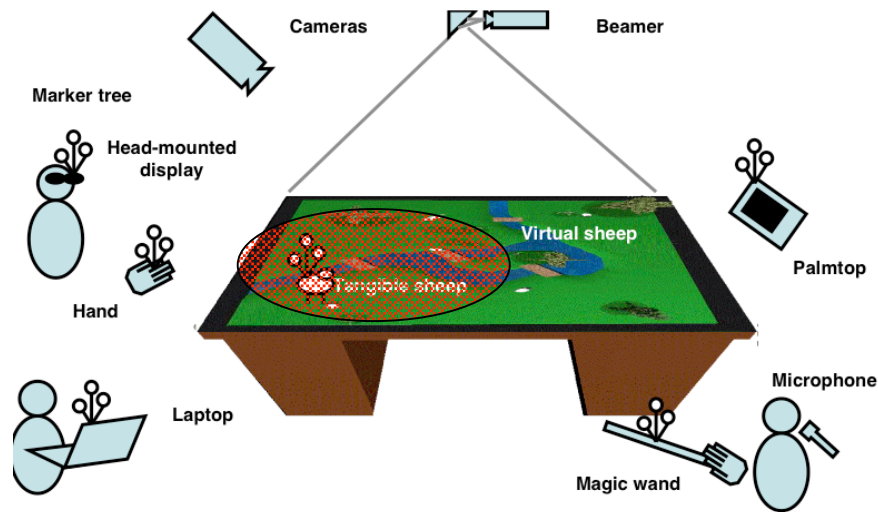


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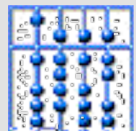


A tangible plastic sheep attracts the virtual sheep

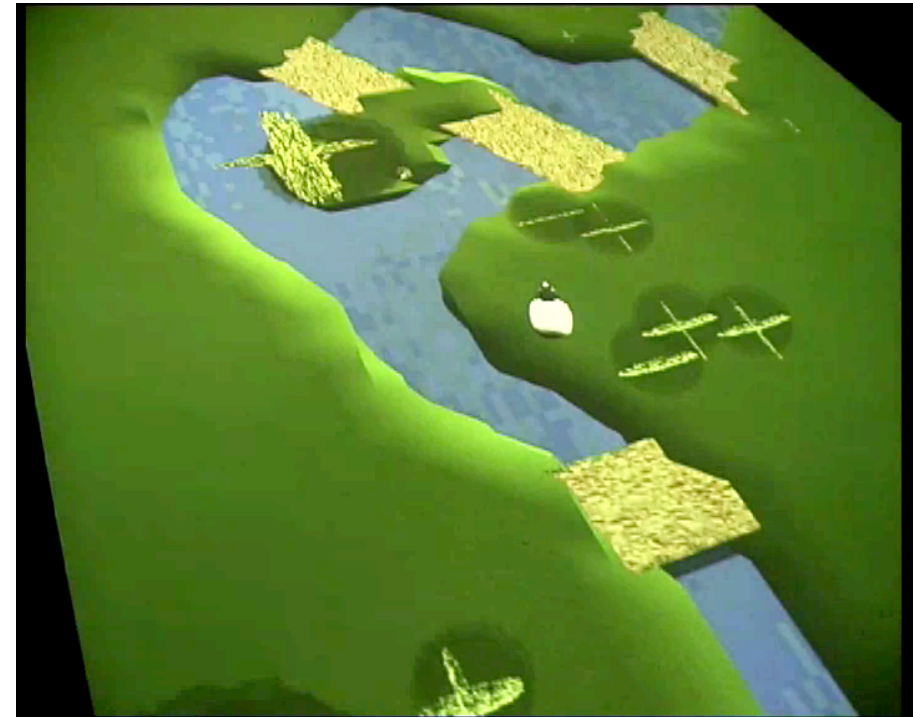
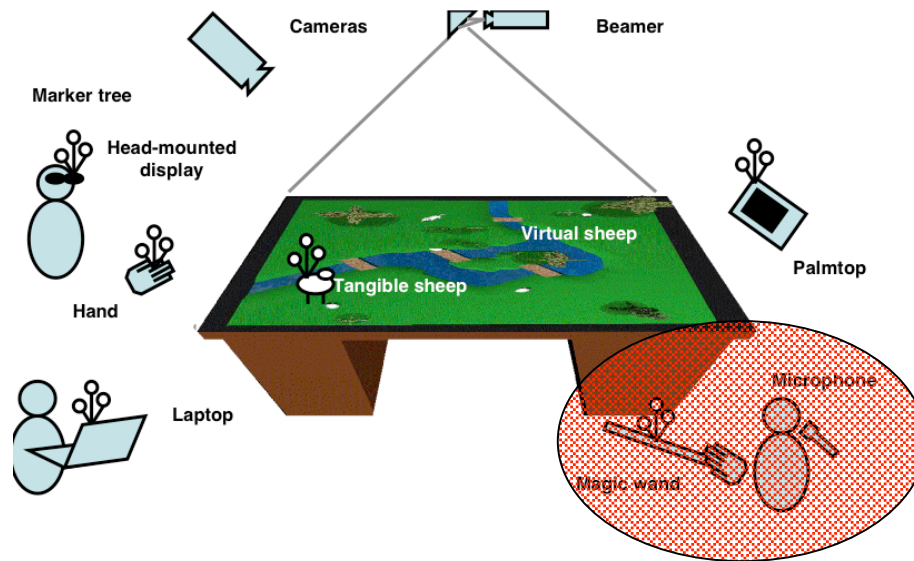


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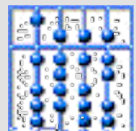


Point-and-Speak is used to create and remove sheep

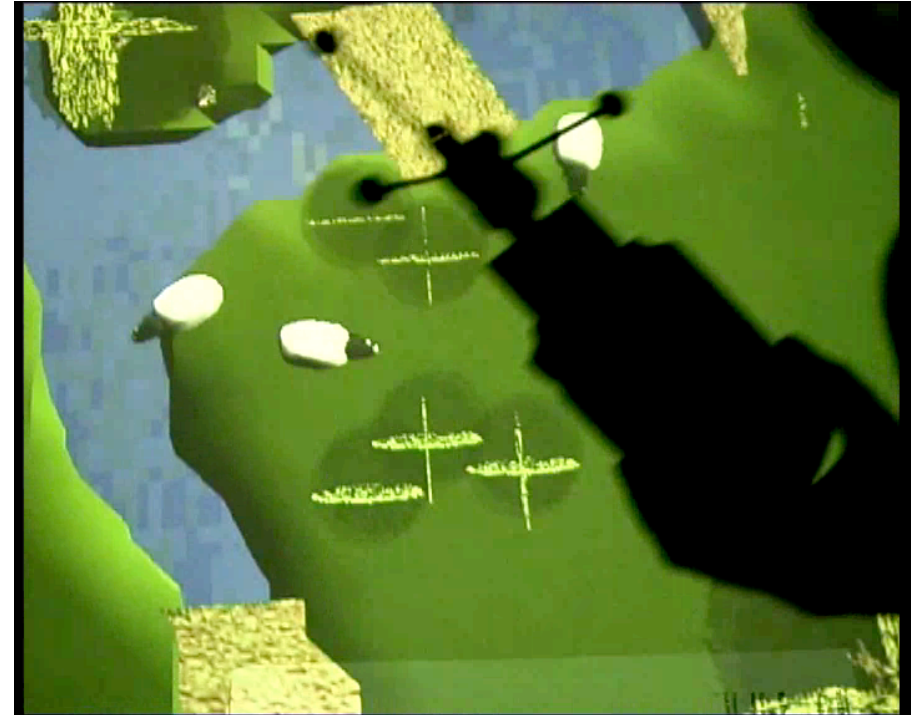
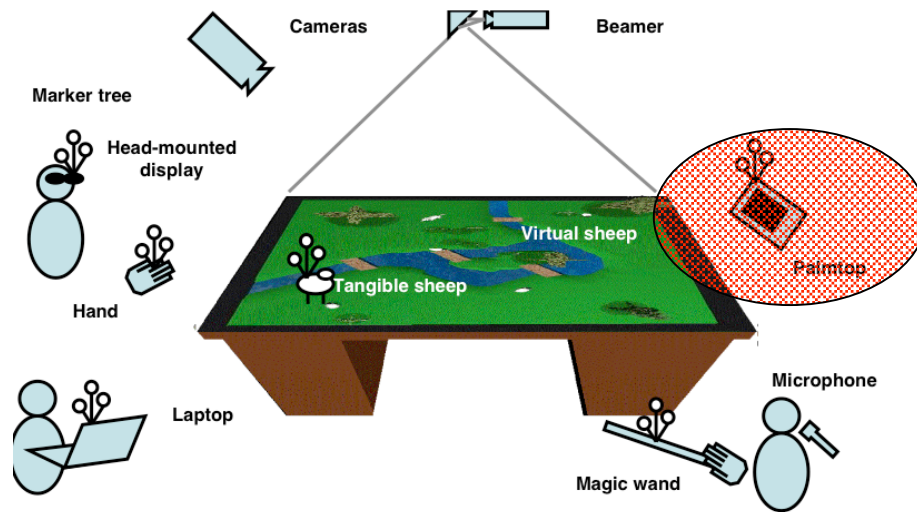


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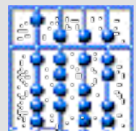


Sheep can be scooped and dropped with an iPAQ



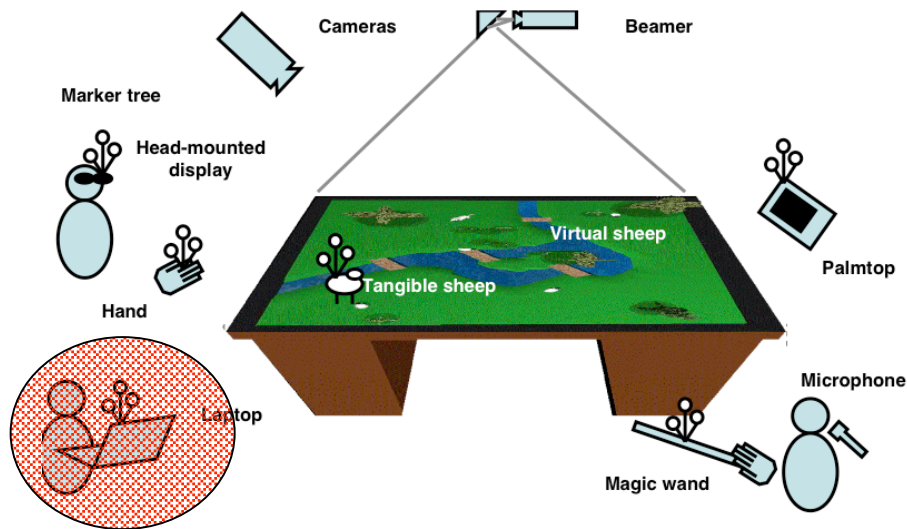
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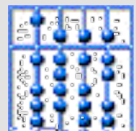


A tracked laptop as window to the virtual world

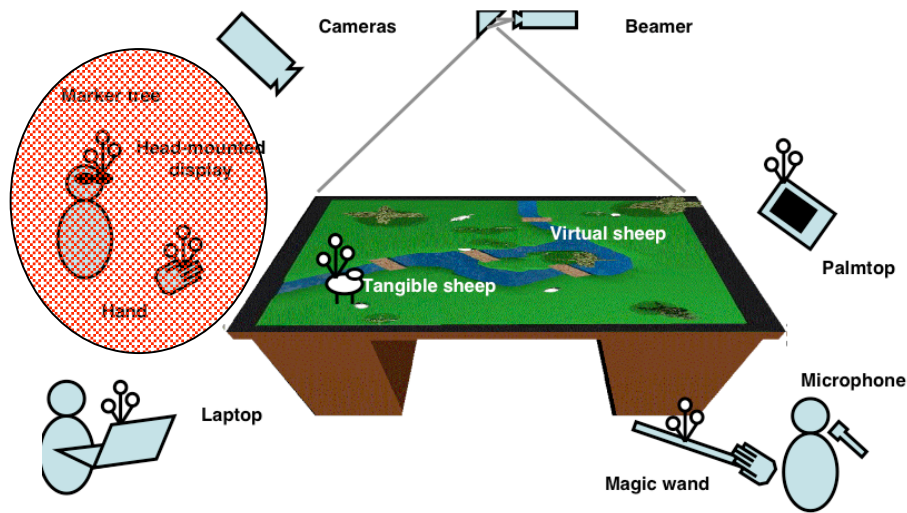


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# The Game

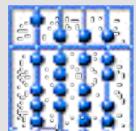


Color of sheep can be changed by user wearing an HMD

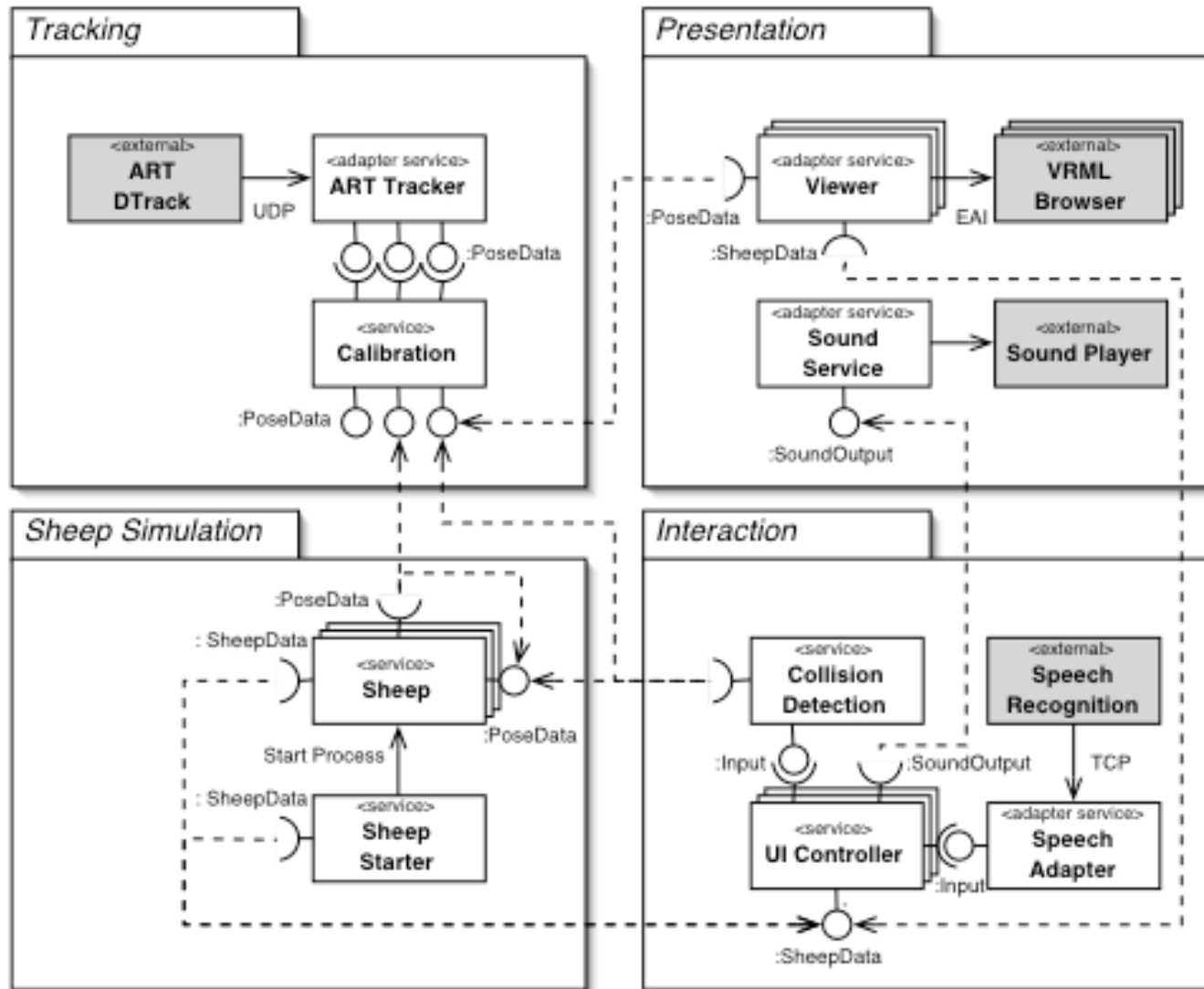


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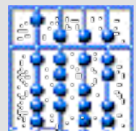
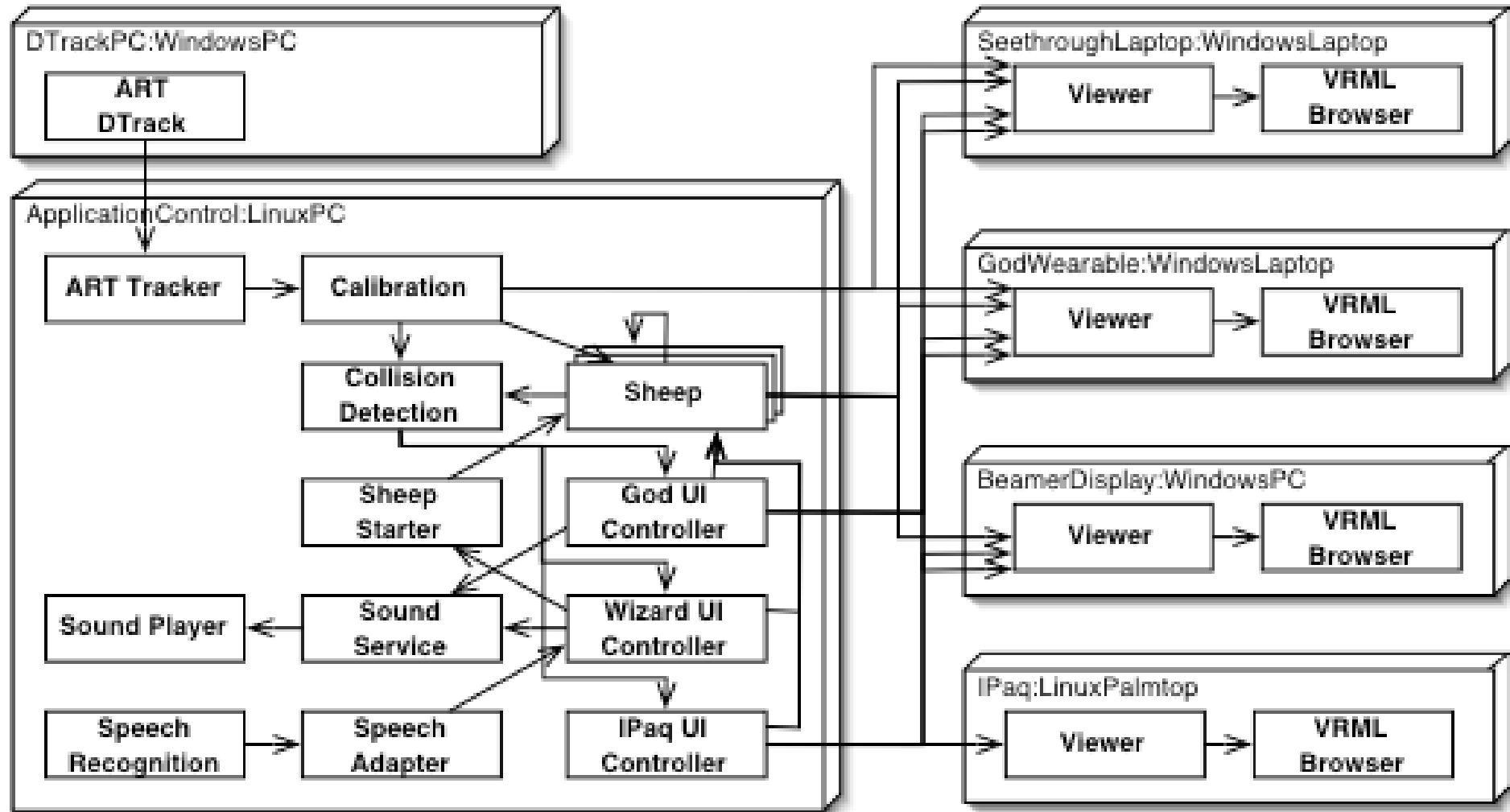
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# System Architecture (1) - Subsystems

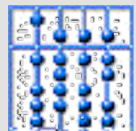
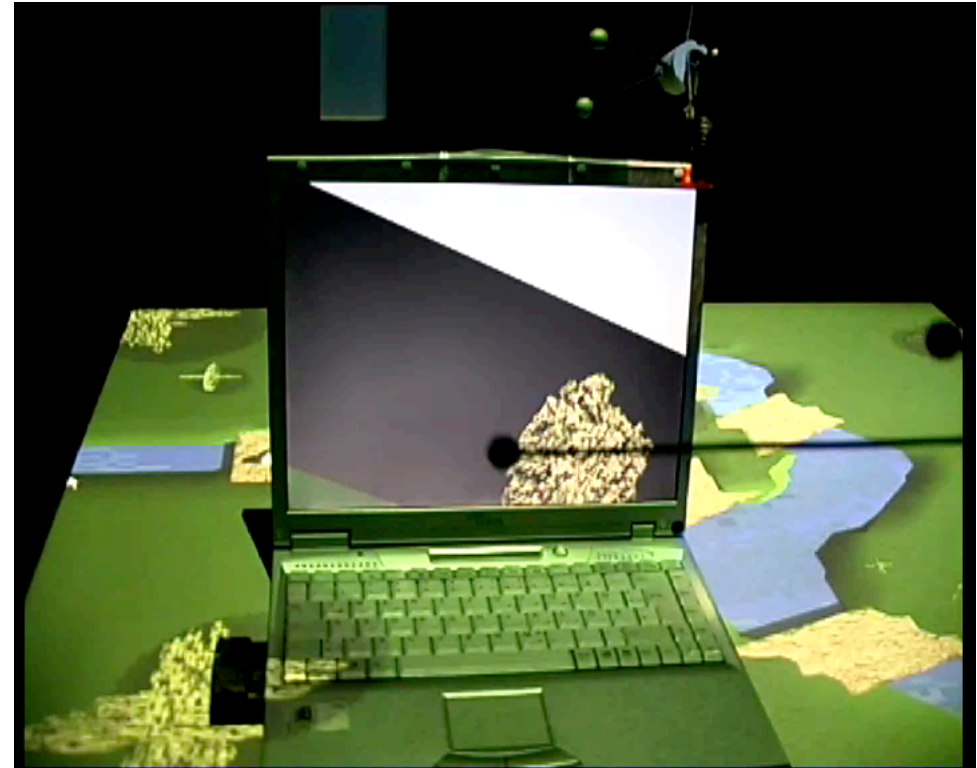


# System Architecture (2) - Deployment



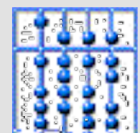
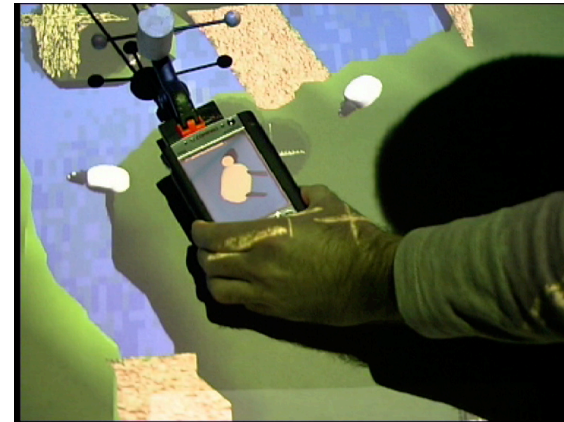
# Subsystem Details (1)

- Sheep Simulation
  - Based on distributed variant of flock of birds algorithm [Reynolds 1987]
- Tracking
  - Dtrack system (ART GmbH) delivers raw pose data
  - Pipe-filter tracking architecture using DWARF event bus
  - Calibration component unifies coordinate systems, one-step calibration using a pointing device



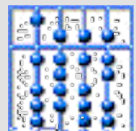
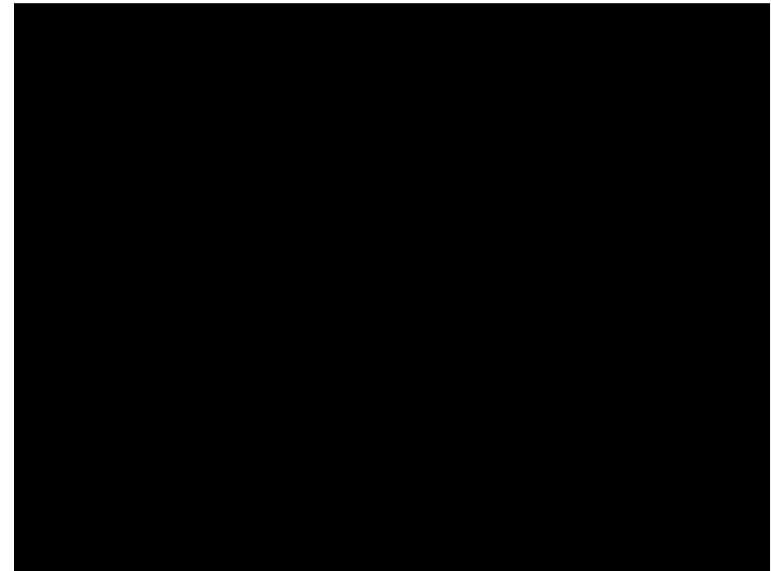
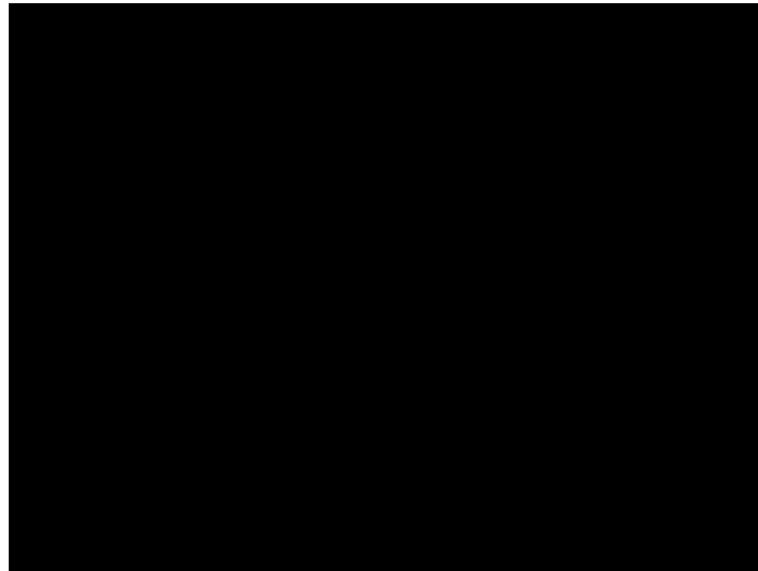
# Subsystem Details (2) - Visualization

- VRML browsers with DWARF/EAI adapter
- Two types of browsers:
  - Windows/Intel: Cortona from Parallelgraphics
  - Linux/StrongARM: FreeWRL
- Distributed Scenegraph realized through manual synchronization
- Problematic limitations of:
  - OpenGL/Java on iPAQ
  - EAI



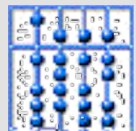
# Subsystem Details (3) - Interactions

- User Interface Controller: Conversion of multimodal input into commands
- Internal structure: Petri-Net
  - Graphical output during runtime
  - Based on Petri-net framework jfern (XML and Java)



# Development Methodology

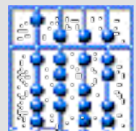
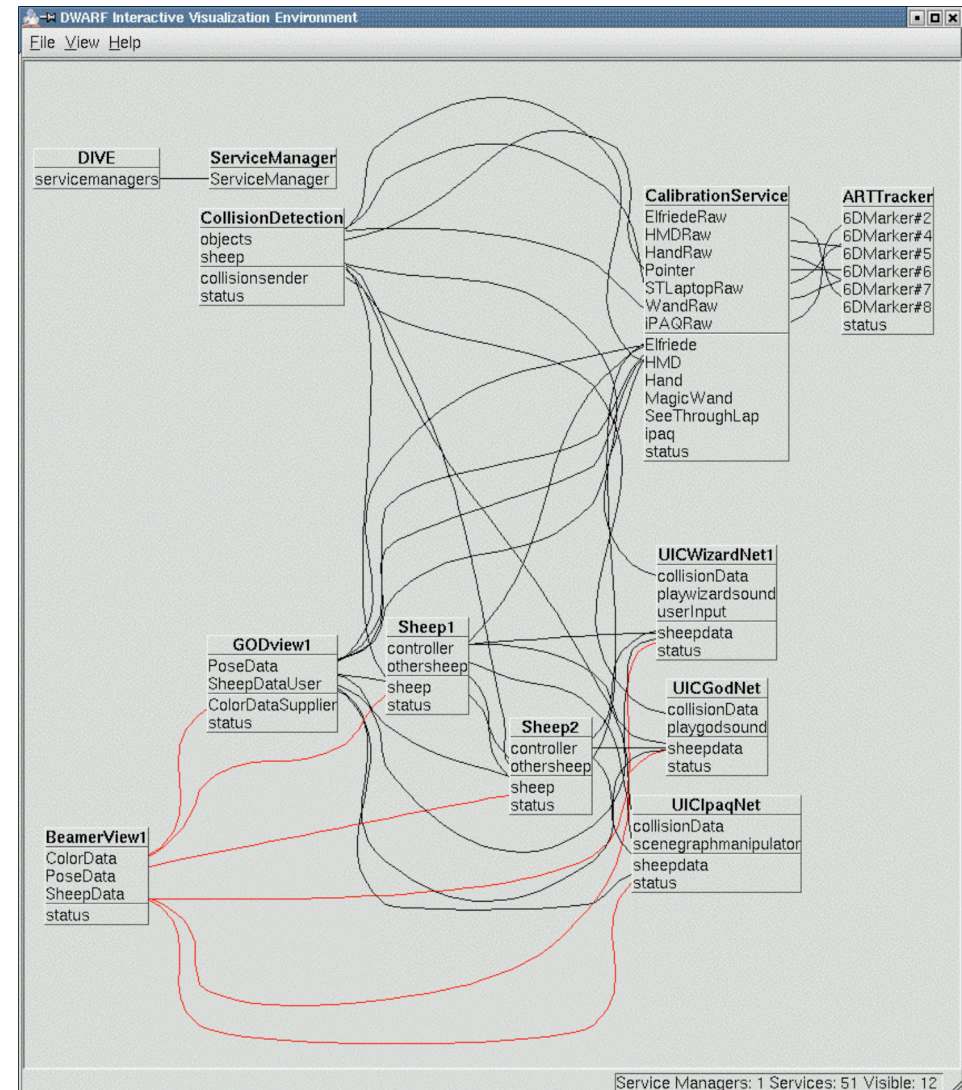
- Incremental development of running system
- Continuous integration of evolving components
- System design during implementation
- Jam Sessions: Interaction design and evaluation during runtime





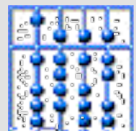
# Supporting Tools

- One-step calibration with magic wand
- Monitoring:
  - UI: User Interface Controller
  - Overall system state
- Testing:
  - Tracker simulation
  - Component simulation



# Results

- The game:
  - Shown publicly at various occasions, first at ISMAR 2002 in Darmstadt.
  - User Feedback
    - Tangible User Interfaces with magical metaphors are easy to use
    - Direct interaction with head-fixed widgets is bad
    - Immediate feedback is important (graphical and acoustical)
- The framework:
  - Overall concepts validated
  - Single components still need improvement
- The process:
  - Still work in progress
  - Jam Sessions are fun and productive
  - Introspection facilities are very useful for debugging



# Future Work

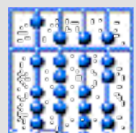
- Game extensions:
  - Saving sheep from wolf and falling off the table
  - Landscape manipulations
- Conduct usability studies:
  - Consolidation of metaphors
  - Runtime usability evaluation tool
  - Interaction library for User Interface Controller
- Process:
  - Formalization and thorough evaluation
  - Further speedup of prototyping with new tools (Python<sup>1</sup>)
- Integrate recent DWARF improvements into SHEEP:
  - OpenInventor-based viewer
  - World model: Consistent data storage
  - Better calibration (SPAAM)
  - Middleware: Automatic component startup
  - Mac OS X/Windows support

<sup>1</sup>Special thanks to Joe Newman (TU Wien)



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# End of Talk

- Why not start with DWARF today?
- Project homepage

<http://www.augmentedreality.de>

- Please ask your questions!  
質問をどうぞ！ただし英語でお願いします。



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