

Interfacing the CoDA and CADCON Simulators:

A Multi-Fidelity Simulation Testbed for Autonomous Oceanographic Sampling Networks

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Project Goal

- CoDA
 - Multi-fidelity AOSN simulation testbed
- CADCON
 - High-fidelity Multi-AUV and environment simulator
- CoDA/CADCON

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Project Outline

- CoDA Project
- CoDA Simulator
- CADCON Simulator
- Combined Simulator
- Integration Issues and Solutions
- Conclusion and Future Work

The CoDA Project

- Cooperative Distributed AOSN controller
- Impossible to pre-specify an organization
 - Prediction of agents in AOSN
 - Agents enter/leave AOSN
 - Absence of contact with AOSN
- AOSN must organize and reorganize autonomously

CoDA's Approach

- Treat AOSN as multiagent system
 - Use CDPS to organize/reorganize
 - No agent has complete global view
 - No agent has complete control
- Two-level approach:
 - Meta-level organization
 - Task-level organization
- Cooperation protocols control interaction between agents of the AOSN

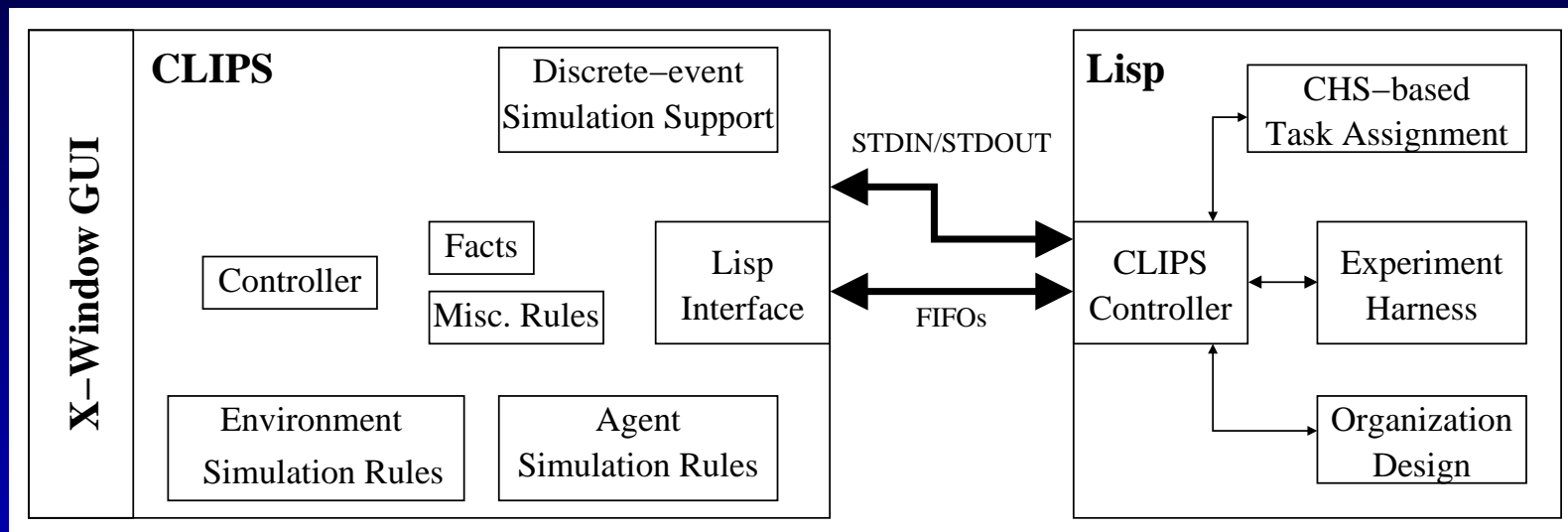
The CoDA Simulator

- Multi-fidelity simulator
 - AOSNs simulated at several different levels
 - High-level behavior
 - Rule-based system
 - Other parts higher-fidelity
 - Possibly by fieldable code
- This method promotes:
 - Rapid prototyping
 - Faster-than-real-time simulation
 - Detailed simulation for accuracy

CoDA Implementation

- Written in
 - Allegro Common Lisp (Franz, Inc)
 - CLIPS (NASA)
- Runs on Linux and other Unix-like systems
- Low-fidelity, high-level behavior written in CLIPS
- High-fidelity portions written in Lisp

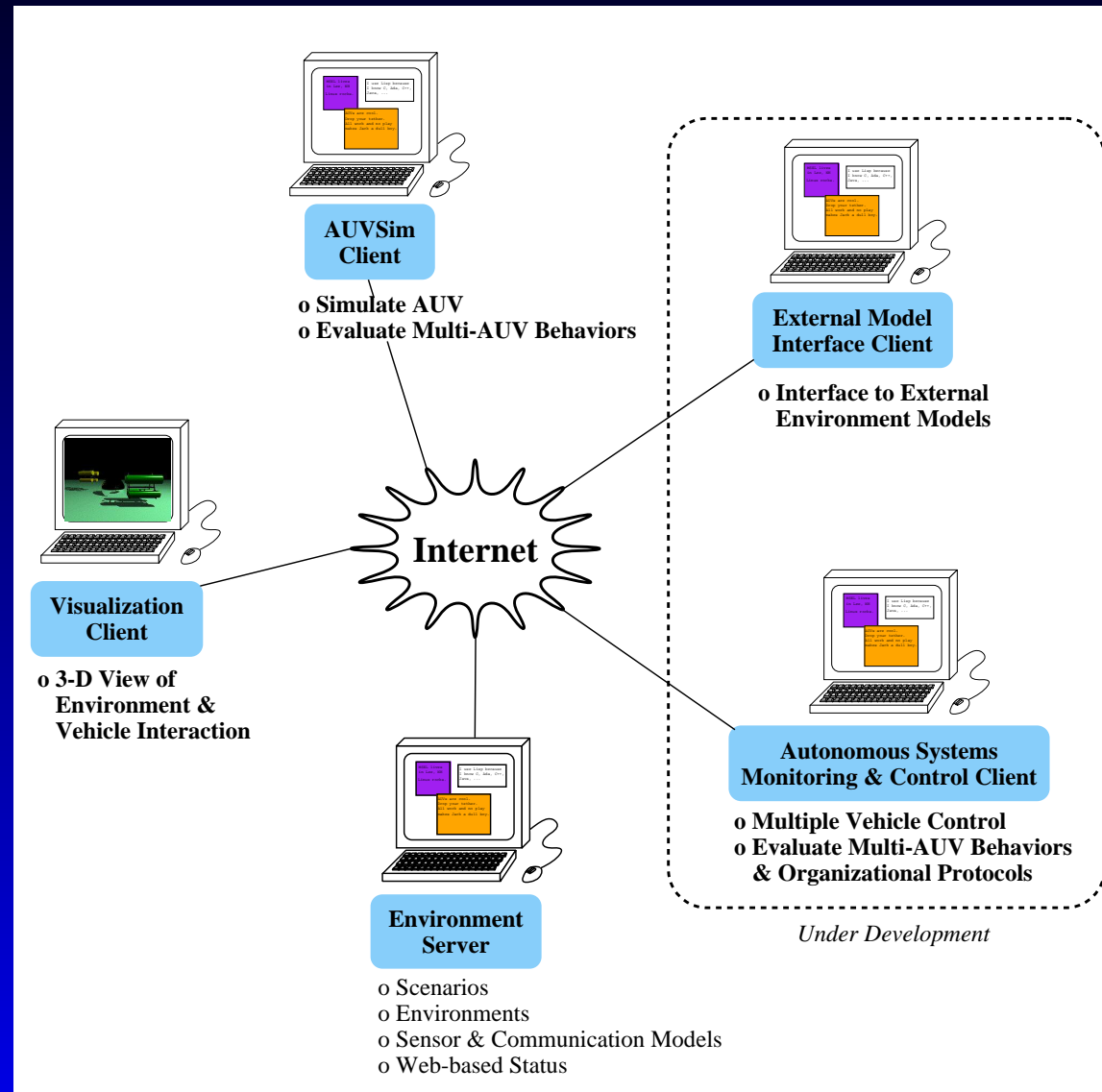
CoDA Structure



The CADCON Simulator

- Cooperative AUV Development Concept
- Autonomous Undersea Systems Institute
- High-fidelity, multi-AUV and environment simulator
- Distributed
- Hardware-in-the-loop simulation
- Current components include:
 - Environment server
 - Visualization client
 - AUVSim Client

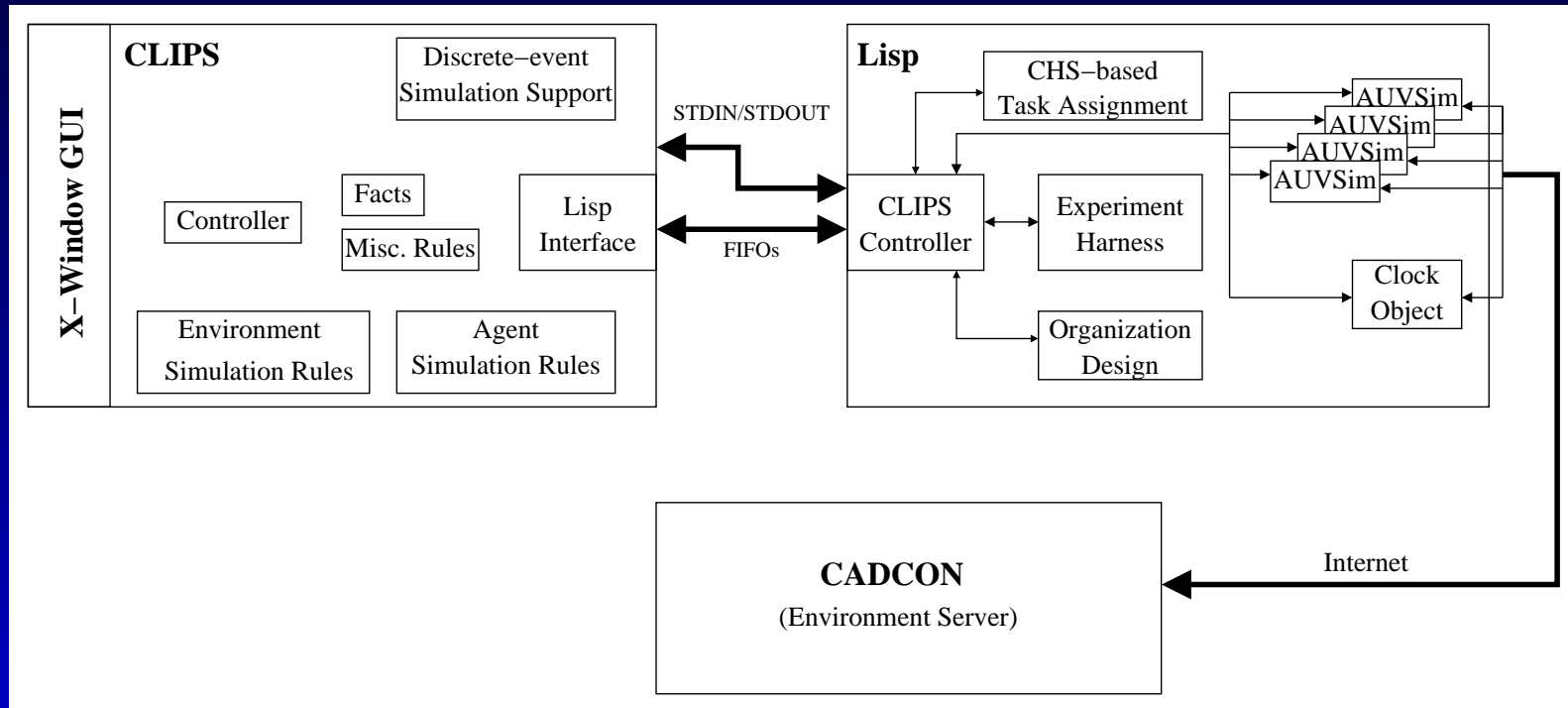
The CADCON Simulator



The Combined Simulator

- High-level simulation provided by CoDA
- Low-level, high-fidelity simulation provided by CADCON
- Visualization provided by CADCON
- General simulation structure:
 - CoDA creates AOSN from file or user input
 - CoDA creates AUVSIM objects to simulate agents
 - CoDA connects agents to CADCON server
 - Simulation executes

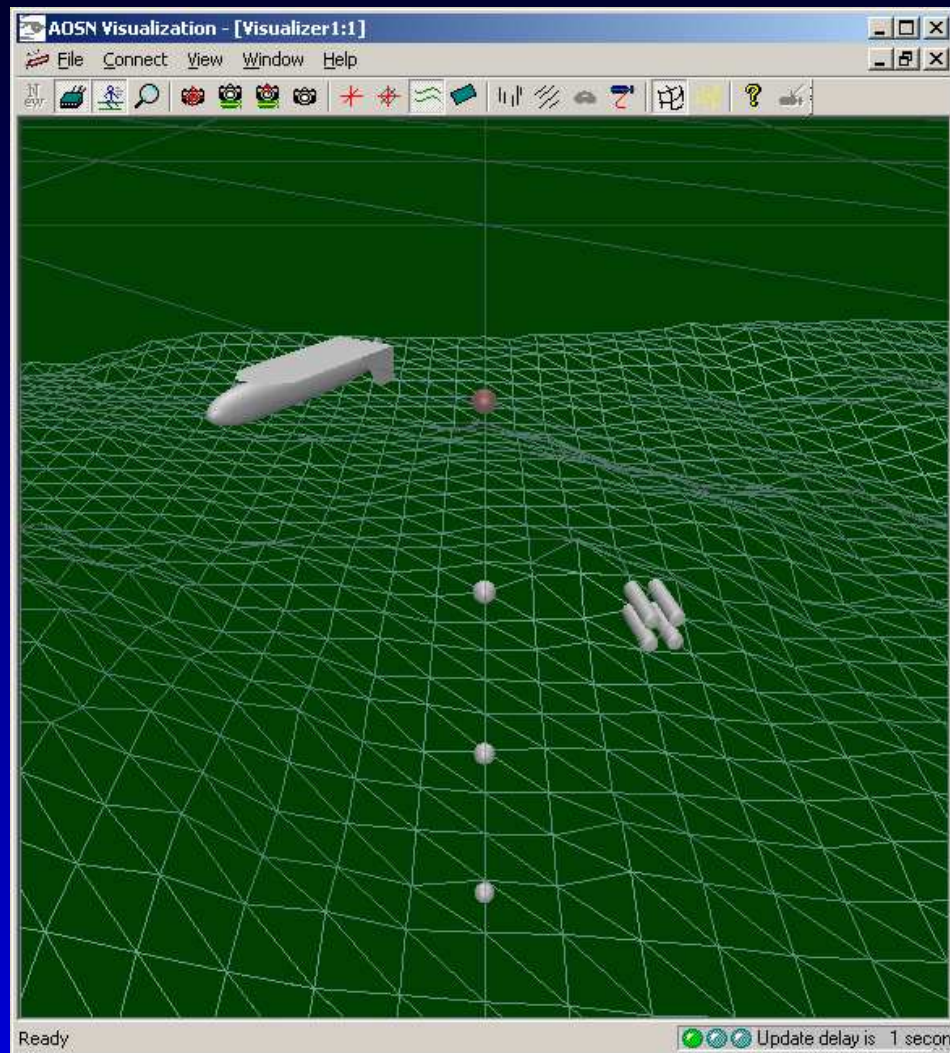
The CoDA/CADCON Simulator



The Lisp-Based AUVSim

- Frame-based knowledge representation language specifications
- Specifications exist for:
 - EAVE vehicles
 - Solar powered AUVs
 - Simple CONVEX mooring
- Benefits:
 - No overhead of translation to CCL
 - Decouples CoDA/CADCON and AUVSim
 - Prevents proliferation of AUVSim processes
 - Provides Lisp-based simple AUVSim for investigators working in Lisp

CoDA/CADCON Visualization



Integration Issues

- Implementation languages
- Keeping CADCON integration optional
- Continuous versus discrete time
- Controlling multiple simulated AUVs simultaneously
- Handling telemetry and sensor data
- Issuing commands
- Complex instrument platforms
- Speed mismatch

Conclusions

- Multi-fidelity simulator facilitates development of complex AOSN systems
- CoDA/CADCON supports high-fidelity simulations of AUVs
- Supports sister project Orca

Future Work

- Further development of AOSN operation
 - Organization/Reorganization
 - Task Assignment
- Method to describe problems, VIPs, capabilities
- Lisp-based AUVSim will become an interface to AUSI's AUVSim
- Shift from aggregate property to agent-based simulation