



Human-Robot Collaboration for Remote Surveillance

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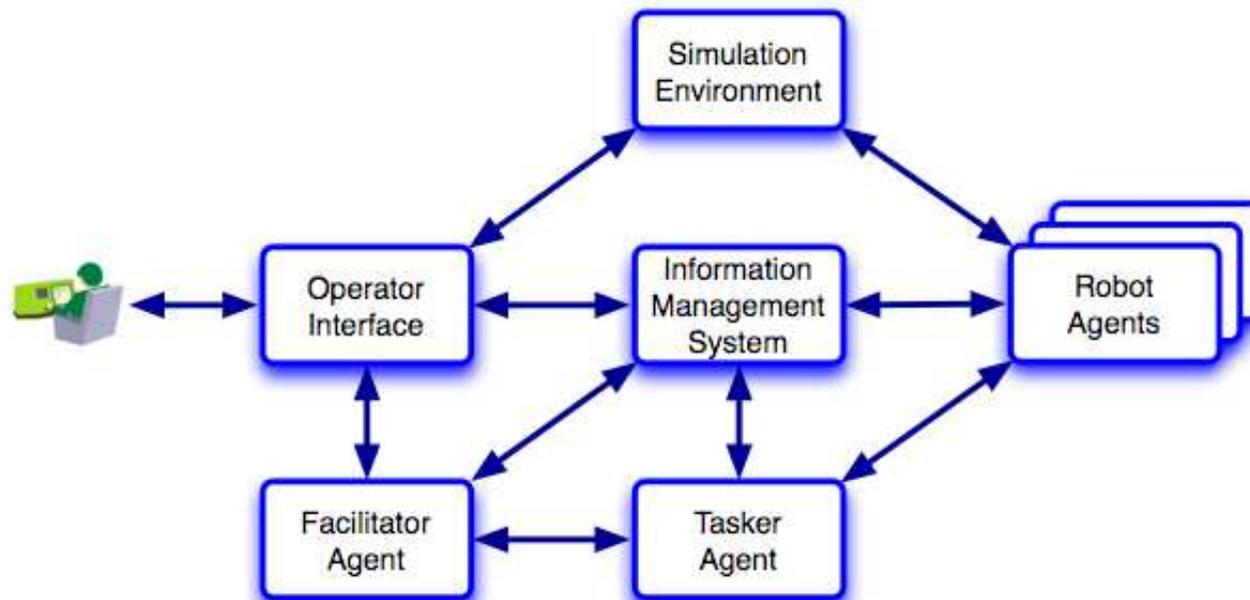
Team

- Soar Technology
 - Alan J. Vayda
 - Sean A. Lisse
 - Steven N. Furtwangler
- Drexel
 - William C. Regli
 - Evan A. Sultanik
 - Ilya Braude
 - Peter Thai
 - Robert N. Lass
 - Duc. N. Nguyen
 - Joseph B. Kopena



Integrated Control Framework (ICF) Testbed

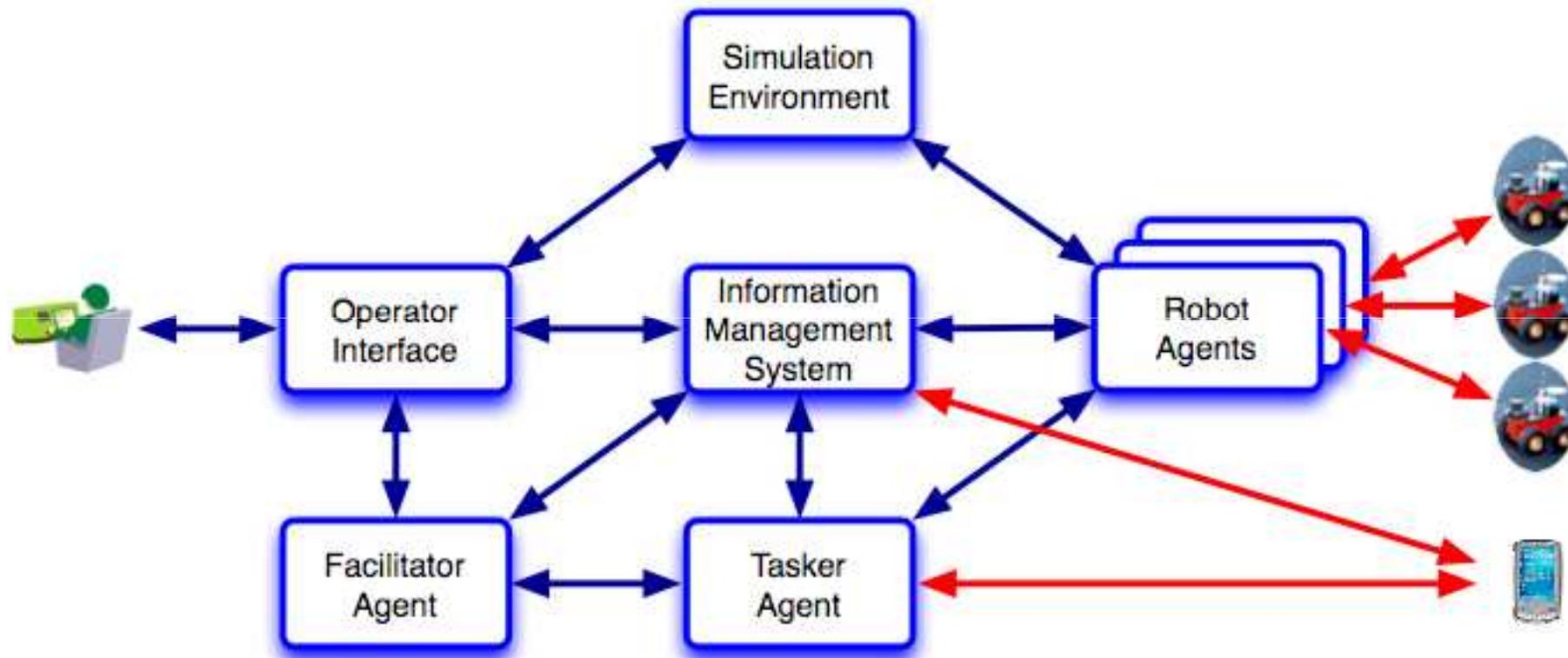
- Designed for multi-robot (UGV and UAV) command and control experimentation in simulation (OTB)
- Emphasis on a team of heterogeneous autonomous robots under the command of a single operator
- Also serves as a toolkit for building applications



Secure Wireless Agent Testbed (SWAT)

- Developed by Drexel under the Applied Communications and Information Networking (ACIN) program sponsored by CERDEC
- Humans use PDAs with GPS to communicate over a mobile ad-hoc network (MANET)
- Robots (Pioneer P3-AT) use similar equipment

ICF Testbed and SWAT Combined for Robotics Demonstration



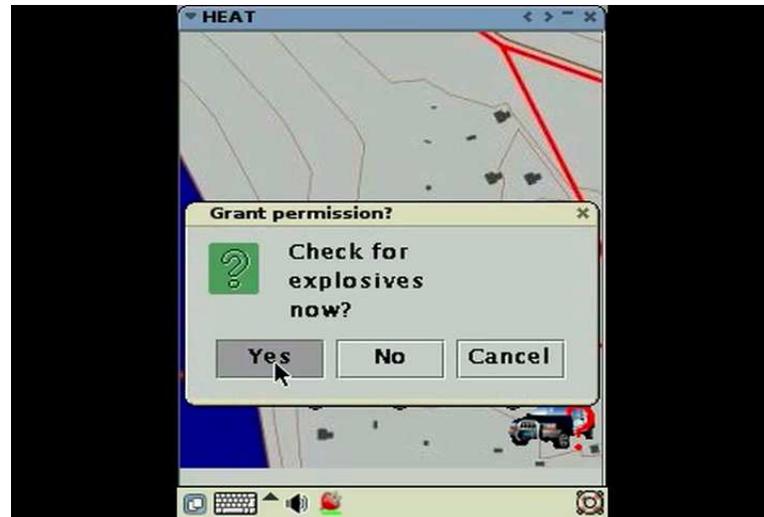
Current Practice

- Robots are tele-operated with no autonomous capabilities
- Robot requires full attention of the operator at all times (while in transit and while sniffing)
- Operator must be close enough to view the robot or have adequate video capability
- Operator may require another human nearby for security
- Humans maintain situational awareness via direct or radio conversation

Demonstration Scenario

- Robot follows one human team member
- A different team member spots a suspicious vehicle and enters the location on his PDA
- The robot asks the commander for permission to inspect the vehicle via a message on his PDA
- The commander grants permission on his PDA
- The robot plans a path to the vehicle and performs the inspection
- The robot reports the results
- The robot returns to its previous task of following a human team member

Demonstration Video



Innovations and Implications

- SWAT devices improve situation awareness for both humans and robots
 - Improves everyone's decisions
- Robot is autonomous part of the team instead of controlled by a single human
 - Reduced workload
 - Flexibility
- Natural interaction between robot and humans
 - Minimized special training required
- Mixed initiative, interruptible tasking
 - Autonomous and semi-autonomous control supported
- Robot utilizes superior human sensory and reasoning capabilities
 - Robot not constrained by limitations of computer vision

Conclusions

- Nuggets
 - ICF Testbed was designed for simulating robots but it has been adapted for use with real robots
- Coal
 - The gap between simulation and reality for robotics is large
 - Experimentation exposed issues not apparent in simulation
 - Uncertainty in location, communication
 - Lower level robot control
 - Even a relatively simple scenario presents many challenges