Utilizing Resource Brokering Within Virtual Environments to Support Distributed Collaboration and Rapid Team Configuration

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APL
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APPLIED PHYSICS LABORATORY

Outline

- Background
  - Dynamic Collaborative Action Teams (DCAT)
  - Resource Brokers (RB)
- Virtual Environments
- Prototype
- Issues
- Next Steps

Background

- **Dynamic Collaborative Action Teams (DCAT)**
  - **Framework for rapidly creating teams of experts**
  - **Use of predefined requirements – "patterns"**
  - **Procedure to match and solicit appropriate personnel**

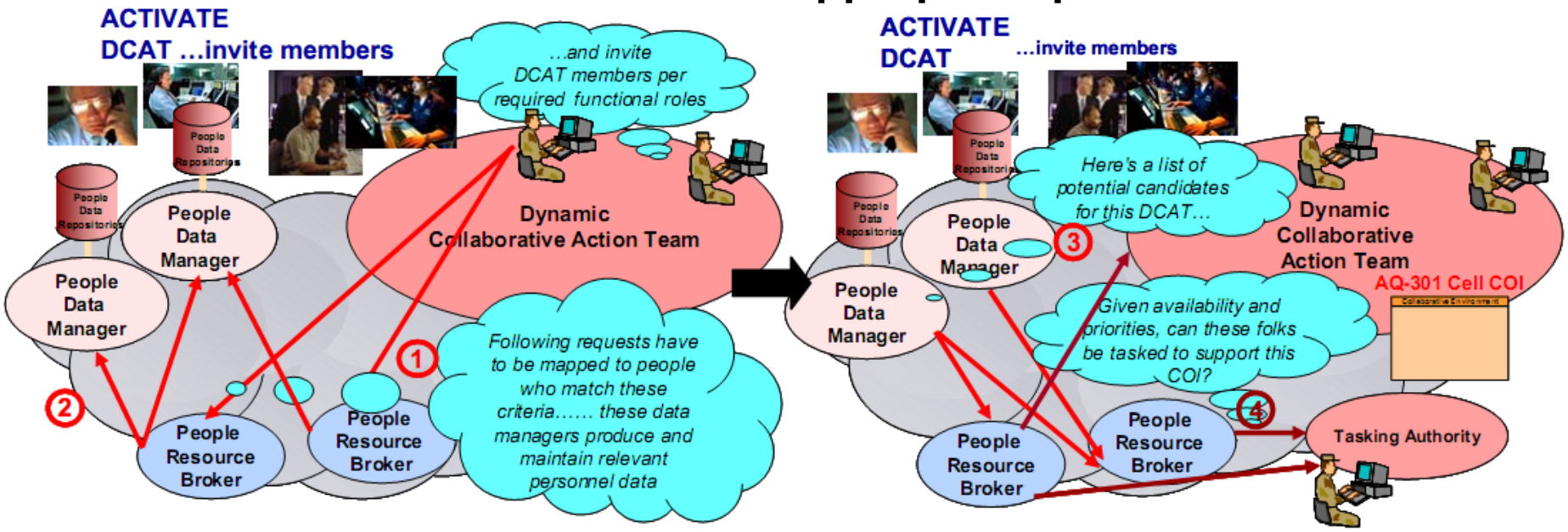
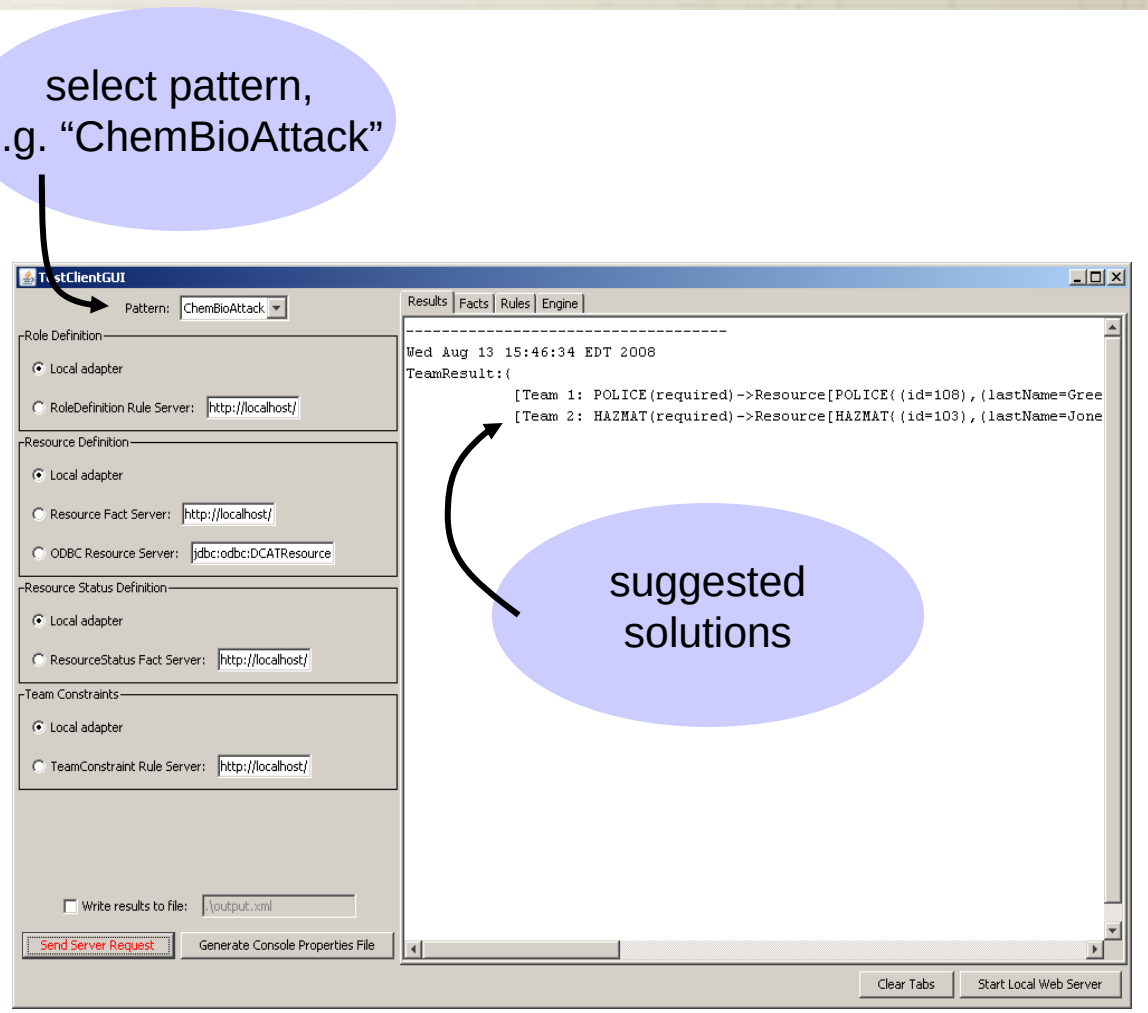


Image courtesy of Salamacha et. al. (2005)

Background (2)

- **Resource Broker**
  - **Component of DCAT framework**
  - **Determines feasible team given pattern and resource metadata**



Real-World DCAT Challenges

- Collaboration
  - Coordination of time and space
- Visualization
  - Limited dimensionality
    - 2D display, 3D physical model
  - Limits due to physics of real world
    - no “zoom” capability
    - difficult to see “inside” model
- Training & Simulation
  - Time and expense to set up scenarios
  - Limited ability to replay performance

Overview of Virtual Environments

sophisticated meeting spaces

features beyond physical world

Images coutesy of Michael Pafford, JHU/APL

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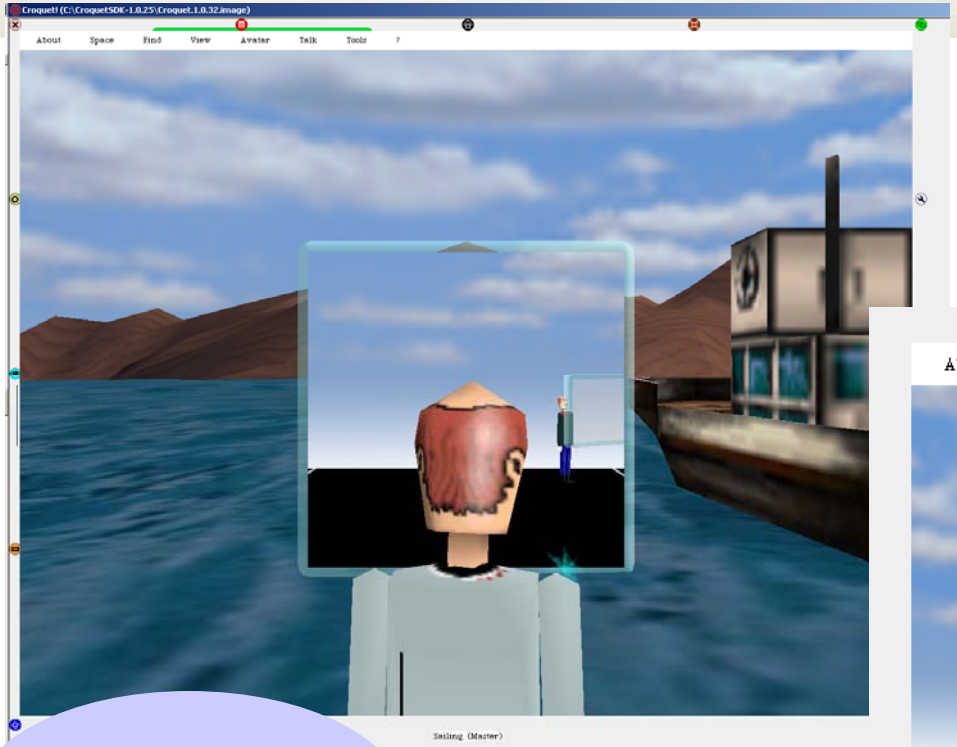
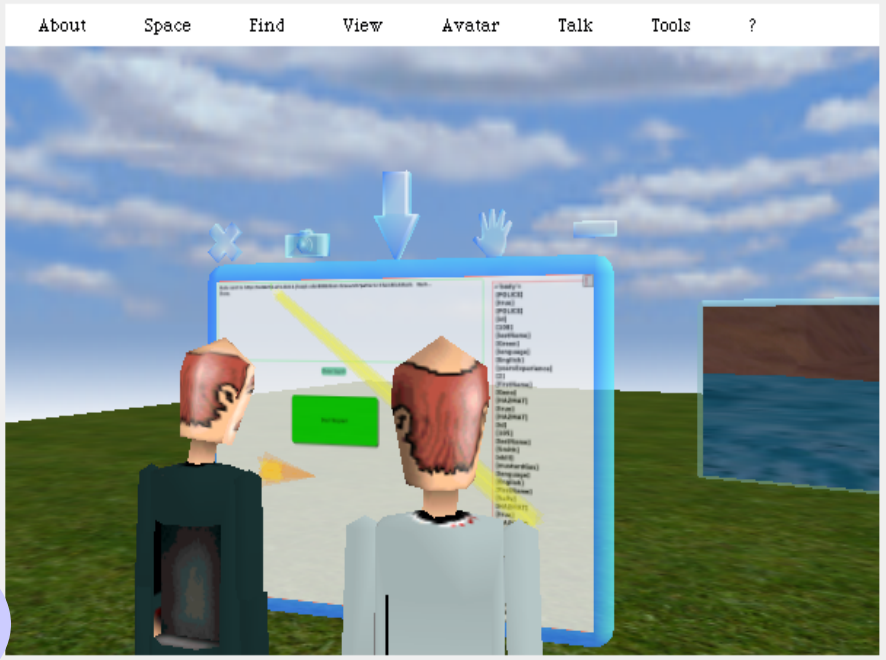
Overview of Virtual Environments (2)

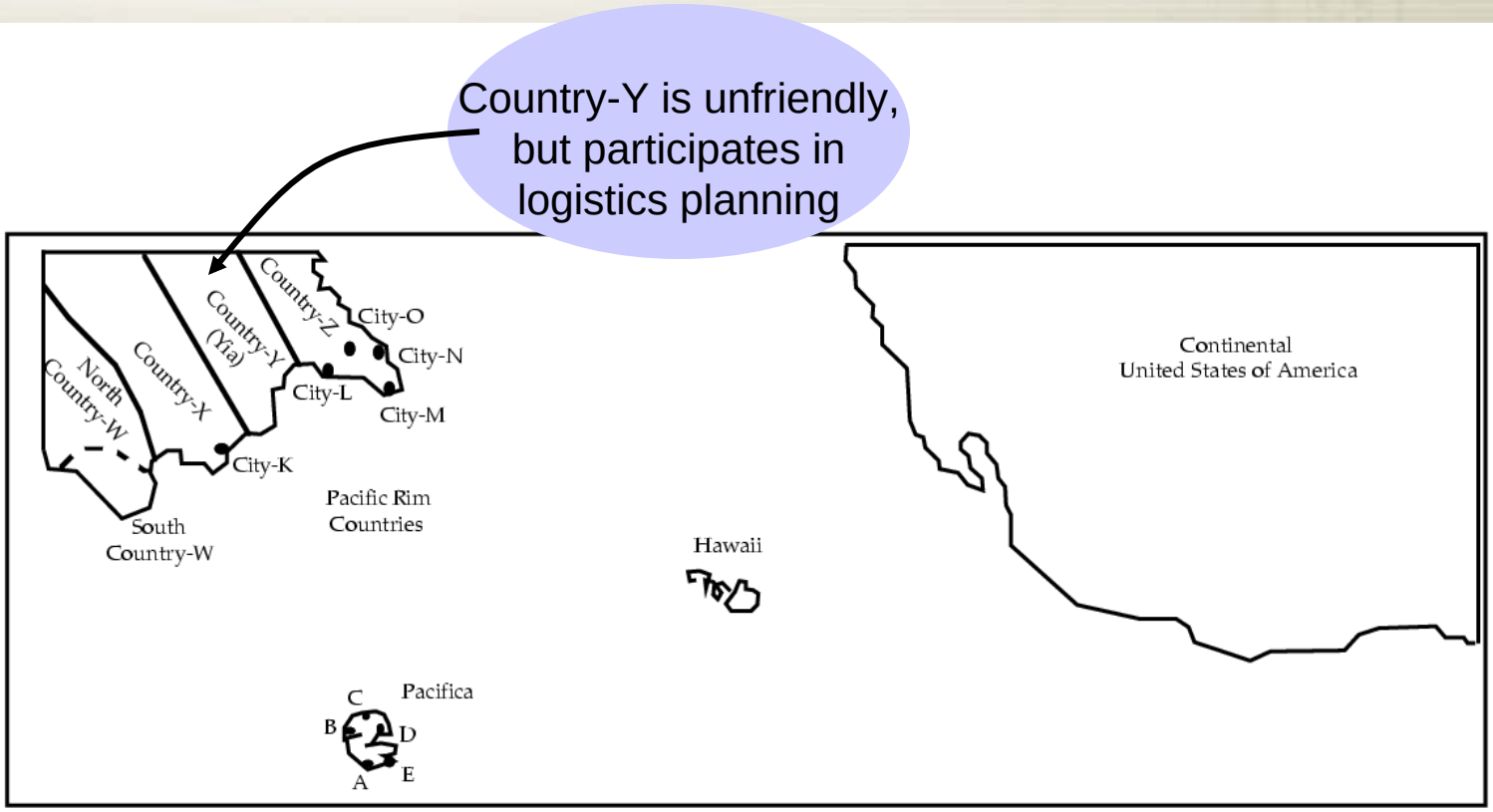




links between environments

virtual collaborations

Resource Brokering in Virtual Environments: Motivating Scenario



G. Reece, A. Tate, D. Brown, and M. Hoffman. The PRECiS Environment. In Proceedings of National Conference on Artificial Intelligence (AAAI-93) DARPA-RL Planning Initiative Workshop, 1993.

Image courtesy of Reece et. al. (2003)

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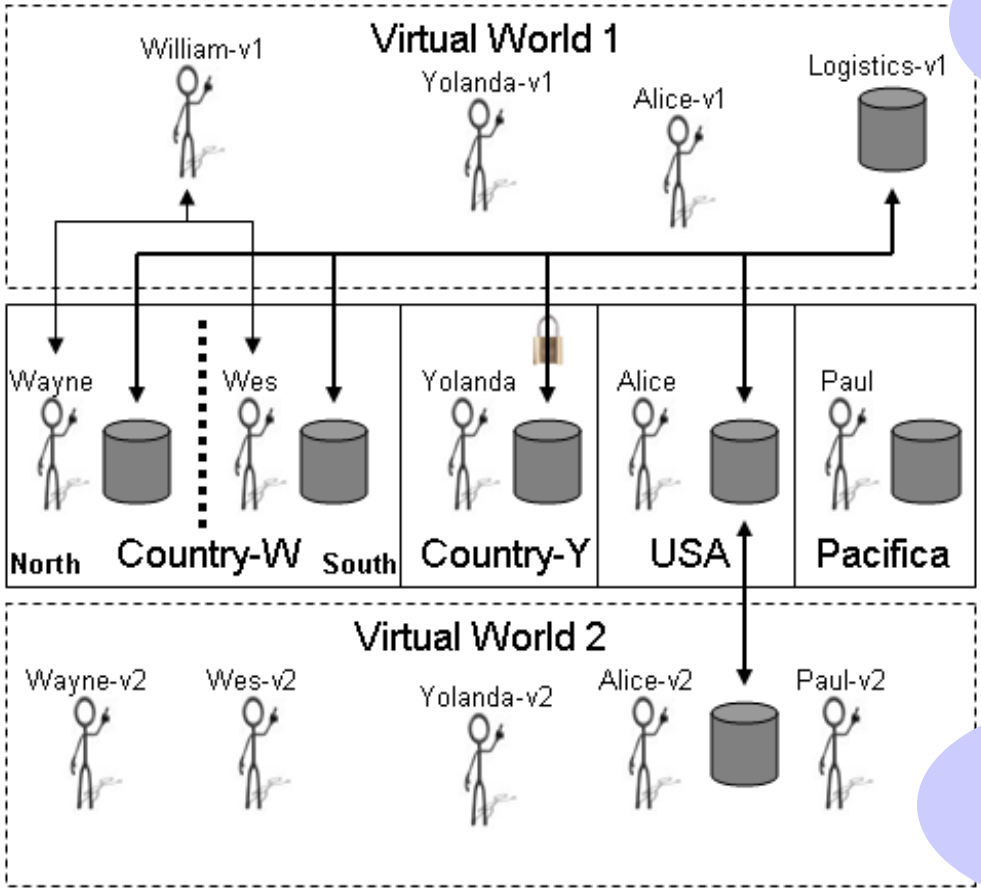
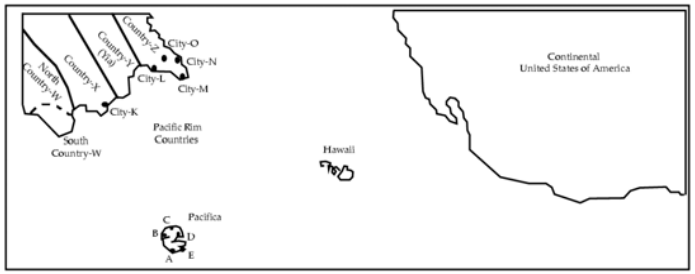
Motivating Scenario (2)



disaster recovery logistics



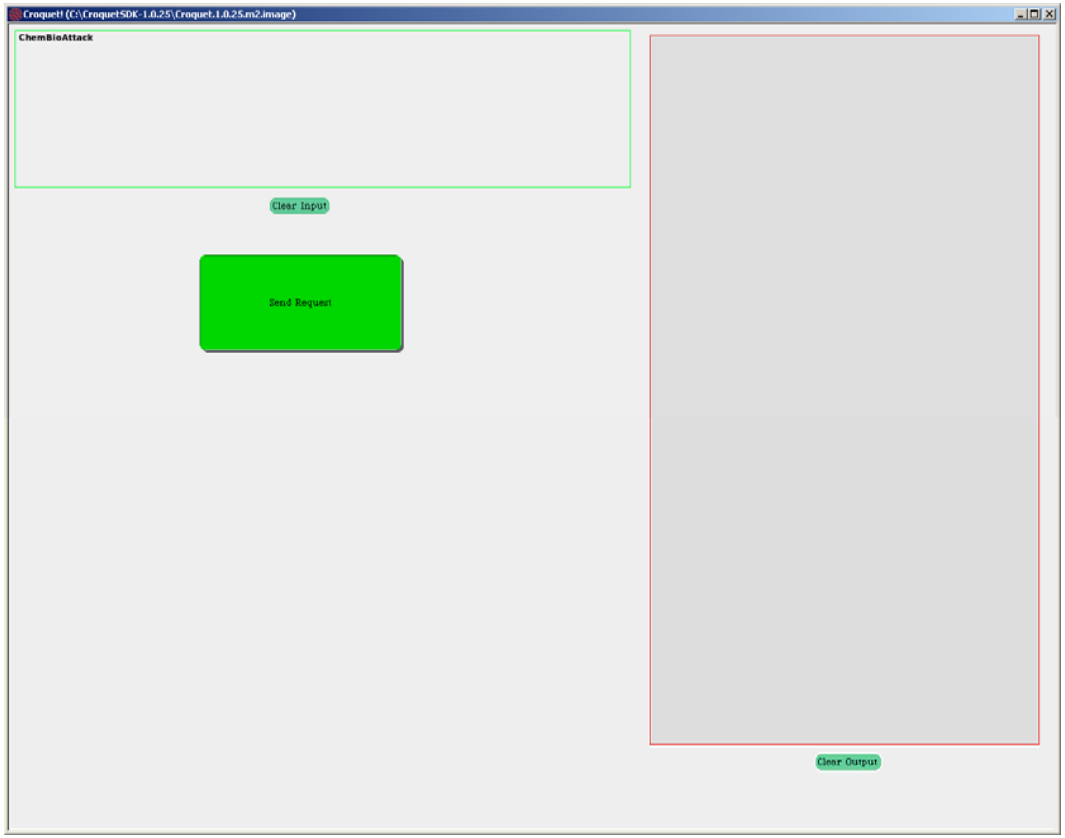
political negotiations

Prototype

- Proof-of-concept implementation
  - Croquet environment
    - Open source freeware
    - Peer-to-peer
    - Based on Smalltalk and Squeak
  - Import of real world resources into virtual environment
  - Ability to collaborate by moving between worlds
  - Shows resource broker ability to access and make choices based on environment state

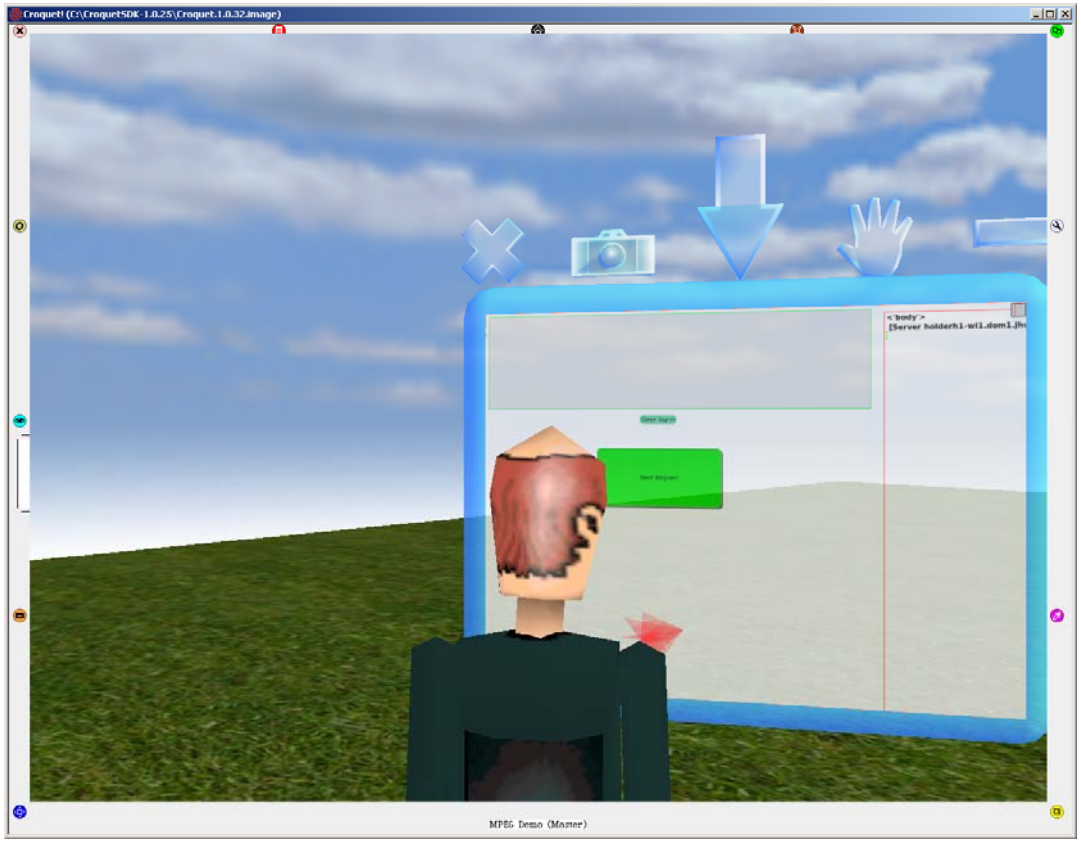
Prototype (2)

- **Alice (USA) has a Resource Broker**



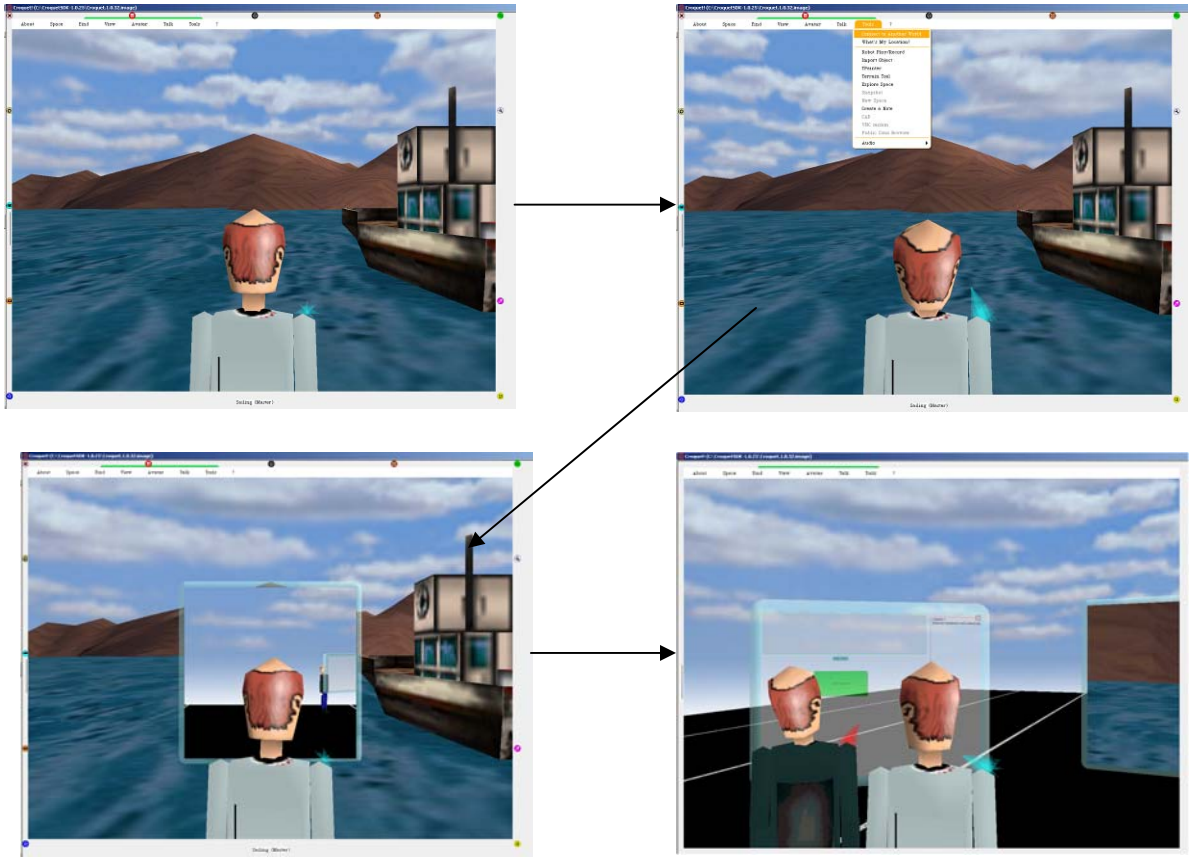
Prototype (3)

- **Alice imports Resource Broker interface into virtual environment**



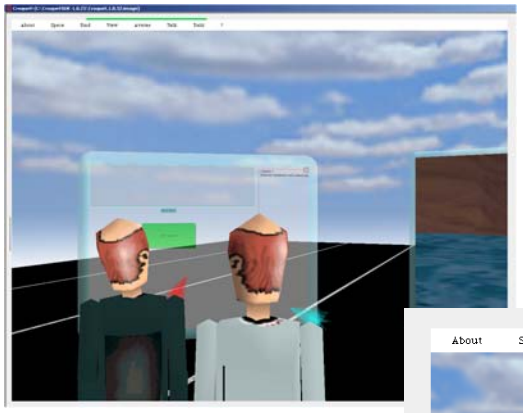
Prototype (4)

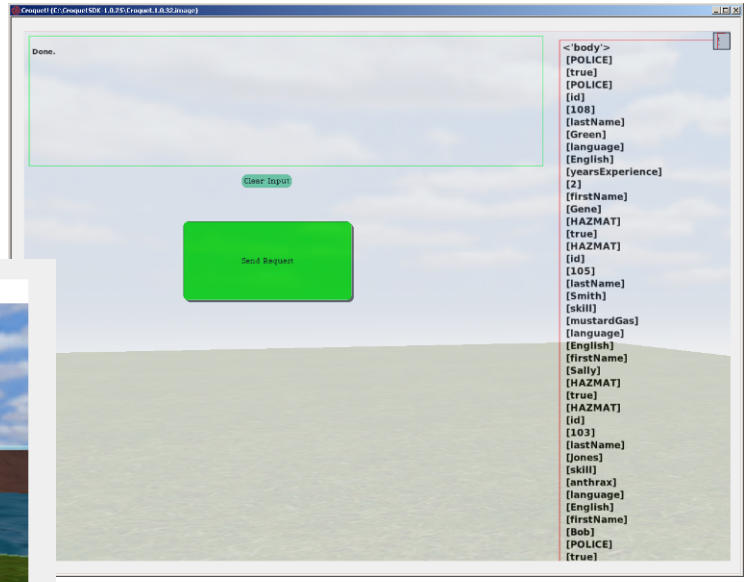
- **Paul (Pacifica) transitions to Alice's virtual world**



Prototype (5)

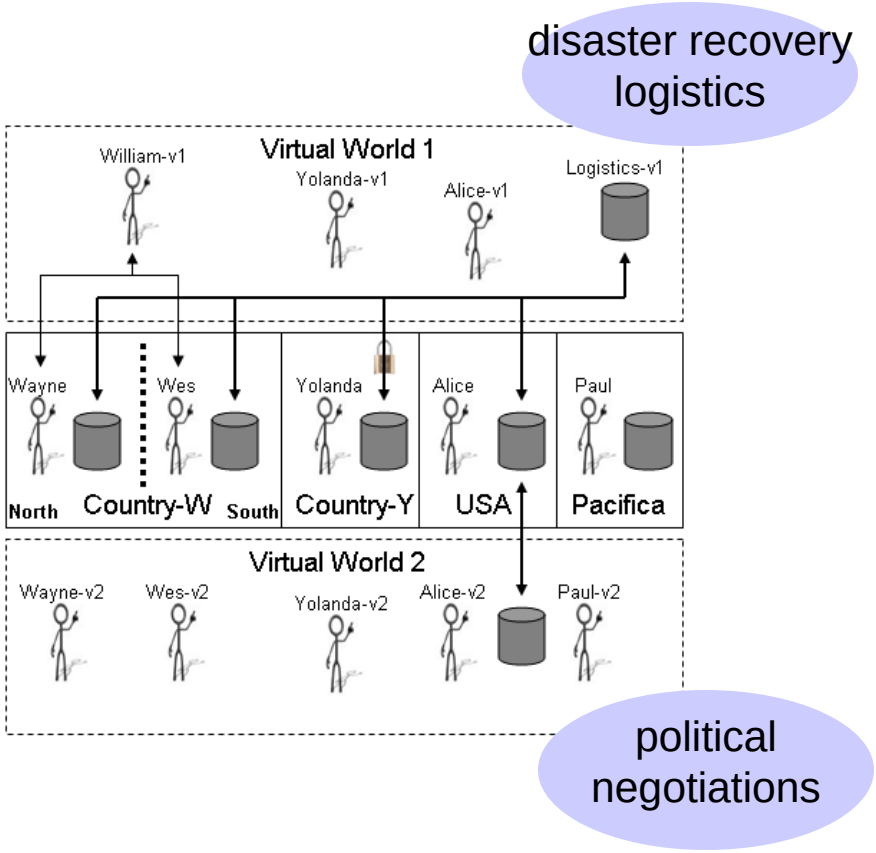
- Alice and Paul use the Resource Broker
- Resource Broker generates team based on awareness of current participants in virtual world





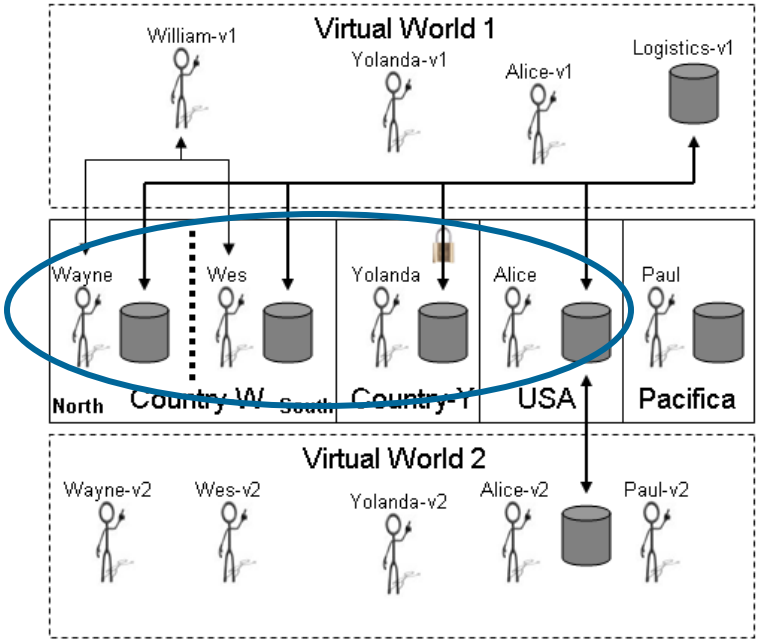
Challenges Moving Forward

- **Diverse environments**
- **Unexpected constraints**
- **Security and privacy**
- **Interoperability between virtual environments**
- **Communication between physical and virtual environments**
- **Connectivity**
- **Collaboration stability**



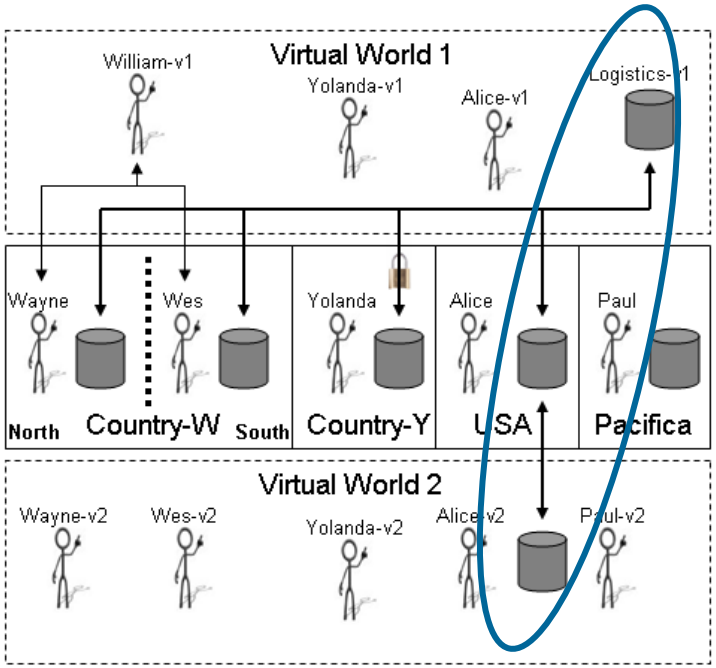
Diverse Environments

- **Virtual environments can facilitate collaboration between disparate individuals and resources.**
- **The consequence of this is a wider range of differences that must be accounted for.**
- **In terms of individuals, we may have to consider differences in terminology and culture.**
- **In terms of resources, we may have to consider data formats and platform assumptions.**



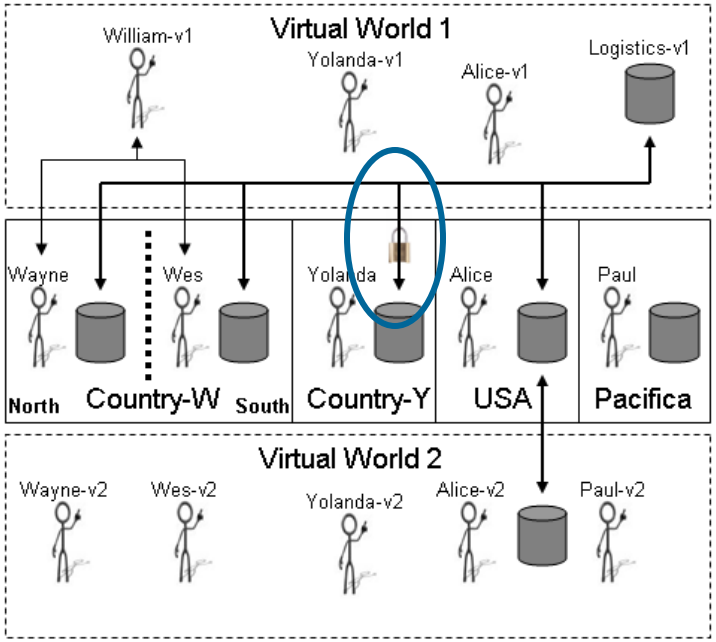
Unexpected Constraints

- In software engineering, when the behavior of an element is unexplainable given the published interface, it is called a “leaky abstraction.”
- Virtual environments promise the ability to collaborate in a manner that hides the underlying physical representation.
- However, these physical implementations have constraints that can lead to unexpected behavior in the virtual world.
- Consider two virtual entities supported by one physical server.



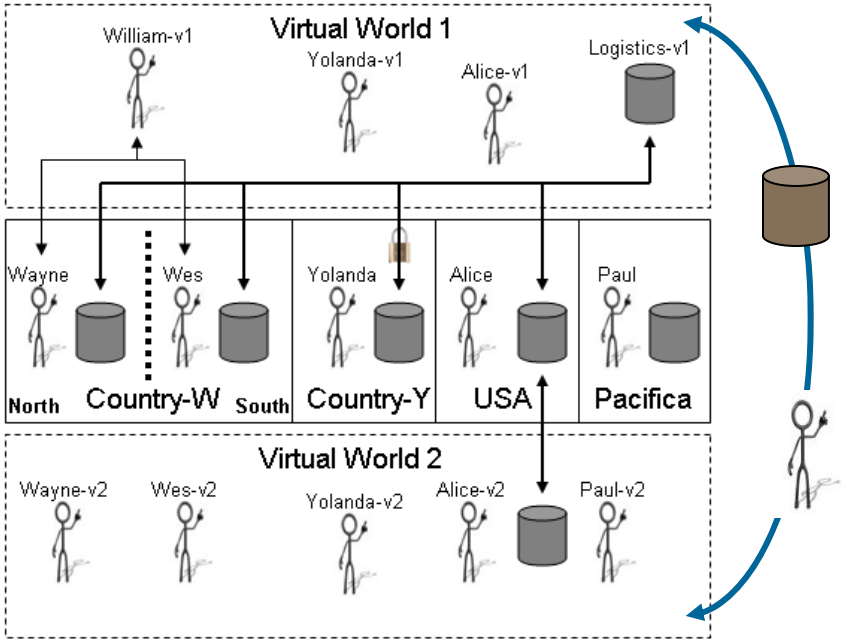
Security and Privacy

- In physical environments, we rely on established physically-based artifacts such as walls, doors, and locks.
- Such protocols in virtual environments have less meaning, as they are enforced not by laws of nature, but code in computers which may be flawed or compromised.
- Privacy in virtual environments has a different meaning as well because all information to render a virtual entities ultimately must be transported from a server and interpreted by a client.



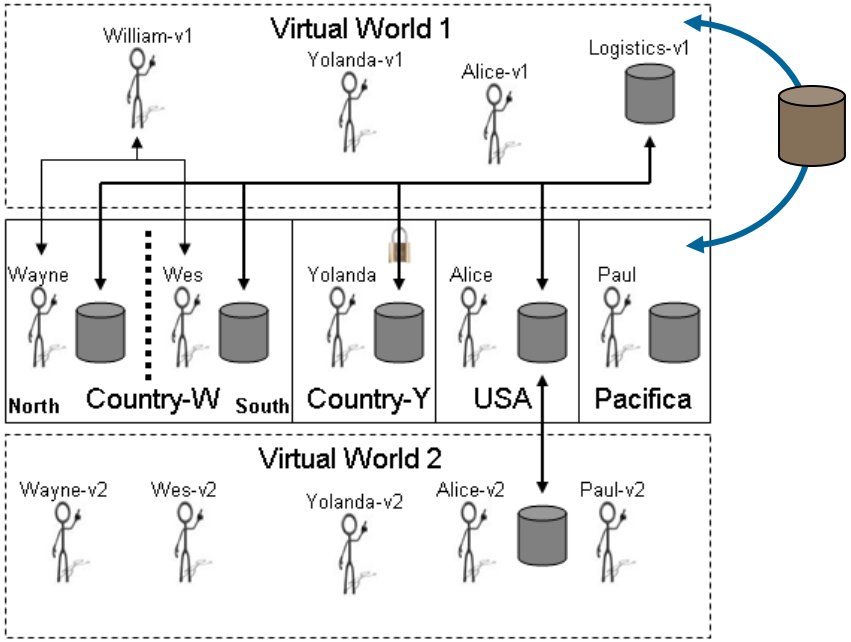
Virtual Environment Interoperability

- **The current state of virtual environments is immature enough that many are being developed for specialized purposes.**
- **We are starting to see efforts towards standardization and interoperability between virtual environments.**
- **Currently, a sophisticated widget that works in one virtual environment will likely have reduced capability, and, more likely, be useless.**



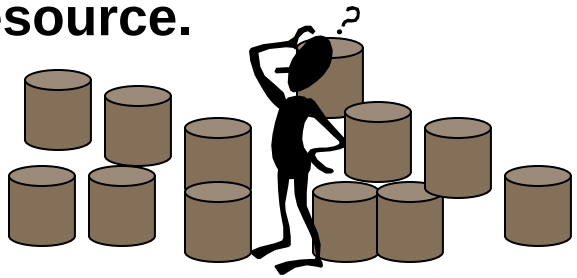
Communication Between Virtual and Physical Environments

- **Transitioning resources between virtual and physical environments can be a nontrivial exercise.**
- **In particular, a resource that is useful in a virtual environment may not be easily represented in a physical environment.**

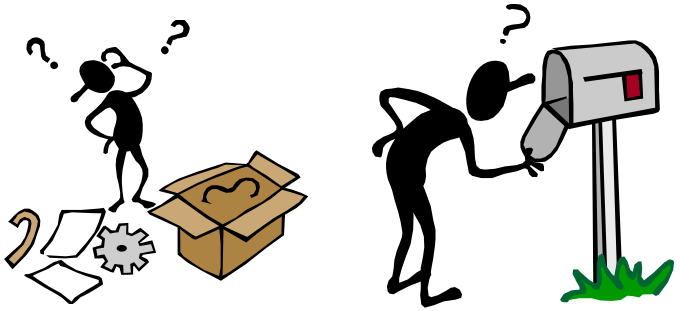


Connectivity

- **Both lack of connectivity and overabundance of connectivity makes for difficulty in finding and choosing appropriate resources to suit collaboration needs.**
- **High connectivity results in difficulty in choosing the most appropriate resource.**

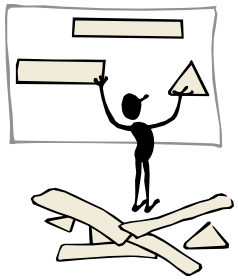


- **Less than expected connectivity leads to too few results.**



Collaboration Stability

- **Ease of changing business partners and the increase pace of business leads shorter-lived collaborations**
- **Similar effects lead to collaborations in which needs and requirements change.**
- **Virtual environments are both affected by and contribute to this effect.**
- **A good Resource Broker will take these possibilities into account, suggesting solutions that are versatile or easily adapted, or allow a user to easily change specifications.**

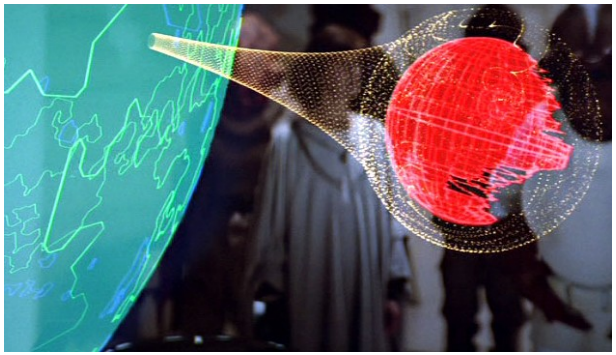


Next Steps

- Advance government and DoD awareness of virtual environments
  - Some current use, e.g. military training
- Understand how to best utilize virtual environments to address specific real world needs, e.g.
  - Usability
  - Data manipulation
  - Collaboration over shared information
- Develop requirements that determine platform selection

Next Steps (2)

- Integration across virtual environments
- Integration of virtual environments with real world
  - Sharing resources across virtual world / real world boundaries



Images courtesy of http://starwars.wikia.com/

Summary

- **Virtual environments have potential to be a powerful tool in collaborative work.**
- **Resource Brokering automates resource acquisition for collaborations.**
- **APL has implemented a proof-of-concept demonstration of a resource broker operating in a virtual environment.**
- **Full utilization of this concept requires addressing several key challenges.**

- **References**

  - **R. Scott Cost, Markus E. Dale, David P. Glock, James Mayfield, Christine O. Salamacha, and David P. Silberberg. Support for dynamic collaborative action teams. In *Proceedings of the Command and Control Research and Technology Symposium (CCRTS 06),* 2006.**
  - **G. Reece, A. Tate, D. Brown, and M. Hoffman. The PRECiS Environment. In *Proceedings of National Conference on Artificial Intelligence (AAAI-93) DARPA-RL Planning Initiative Workshop*, 1993.**
  - **Christine O. Salamacha, N.R. Briscoe, and Steven L. Forsythe. Managing Dynamic Collaborative Action Teams in a Net-Centric Environment. In *Proceedings of 10th International Command and Control Research and Technology Symposium (ICCRTS): The Future of C2,* 2005.**
  - **Christine O. Salamacha, R. Scott Cost, Michael Cramer, Timothy Frey, and David P. Glock. Dynamic collaborative action teams: Implementing a transformational concept. *In Proceedings of Command and Control Research and Technology Symposium (CCRTS 06),* 2006.**