

# **Coordination and Monitoring for Ground Control and Distributed Resources**

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# Motivation

- **Coordination problems are a major obstacle in tasks that are distributed or involve large numbers of people.**
  - 1) **Ground Control staff coordinate with one another, with off-site experts and customers, with satellites and with the ground control systems**
  - 2) **Software Engineering and Computer Supported Cooperative Work techniques are needed to build coordination capabilities into the systems used by Ground Control staff.**
- **Awareness enhances coordination**

# Overview

- 1) Why Awareness Matters**
- 2) Goals for an Awareness Environment**
- 3) CASSIUS Tool Suite**
- 4) Conclusions**

# Why Awareness Matters

- **People and systems are affected by changes to the status, scheduling and decisions of individuals, groups and systems.**
- **Awareness is Informal and Implicit; automatically captures and reports events.**
  - 1) **Awareness of people:**
    - **Individual: location, availability, activity**
    - **Artifacts: Source code, calendars**
    - **Discussions: Emailed discussions, Audio Loops**
  - 2) **Awareness of systems**
    - **Servers: Web, printer, CVS**
    - **Remote hardware: sensors, research labs, satellites**
    - **Software Architecture: bottlenecks, state**

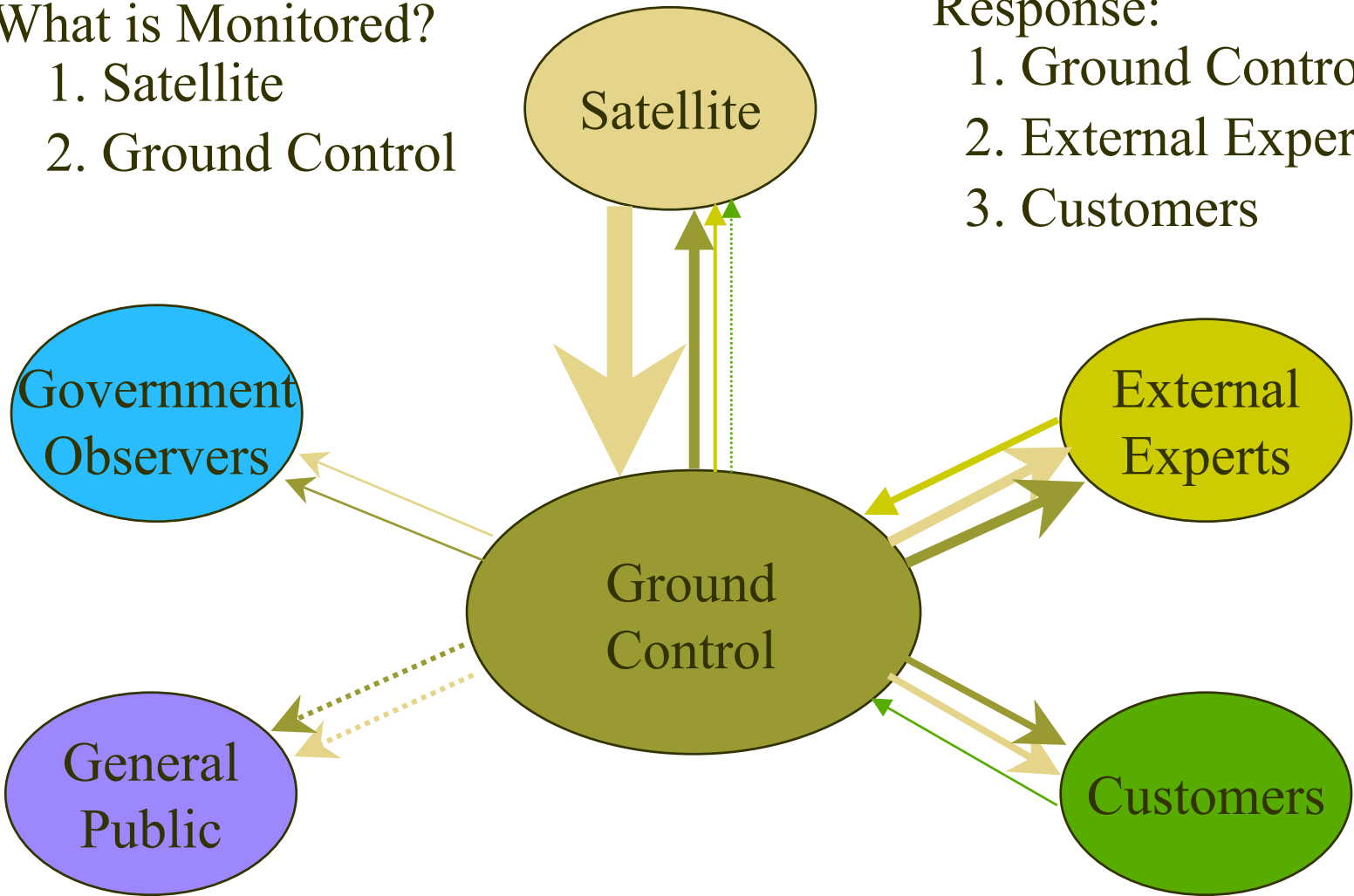
# Awareness for Distributed Expertise

What is Monitored?

- 1. Satellite
- 2. Ground Control

Response:

- 1. Ground Control
- 2. External Experts
- 3. Customers

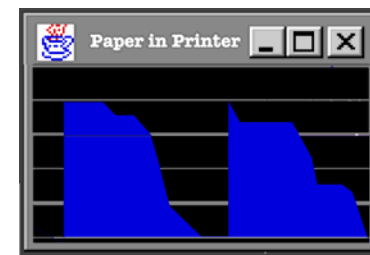


# Goals for an Awareness Environment

- **Ubiquitous Awareness Environment**
  - 1) **Any software, device or component can be a source of “awareness information”**
  - 2) **Any software or device can an “awareness tool” for presenting awareness information**
  
- **Creating Awareness through Subscription Services (CASS) Strategy**
  - 1) **Goals for a usable and useful ubiquitous awareness environment**
  - 2) **Architectural Guidelines**
  - 3) **Design requirements for awareness information and awareness tools**

# Goal 1: Support Awareness Styles

- **Awareness Style describes properties of an awareness tool**
  - 1) **Intrusive vs. peripheral**
  - 2) **Mobility**
  - 3) **Information representation**
- **Users choose style based on**
  - 1) **Work environment**
  - 2) **Personal work practices**
  - 3) **The requirements and impact of each type of awareness information that they receive.**



# Goal 2: Support Diverse Sources

- **Support for diverse awareness sources:**
  - 1) **People, artifacts, on-line discussions, servers, remote hardware/software**
  - 2) **Meet the information needs of a broader range of user**
  
- **An awareness tool must be able to monitor and represent any source of awareness**
  - 1) **Choose awareness style based on work environment/work practices**
  - 2) **Choose information sources based on information dependencies**
  - 3) **One style can monitor many sources**



# Goal 3: Subscription Refinement

- **Meta information describes the capabilities of the awareness environment**
  - 1) **List all sources of awareness information**
  - 2) **List all objects, properties, etc. monitored by sources of awareness information**
    - **Files, sections of documents, cells of spreadsheets, web sites, server load, etc...**
  - 3) **List all events that can target each monitored object**
    - **WebDAV file: Get, Update, Move, Copy, Delete**
  - 4) **UI to communicate validity, usefulness, and range of possibilities for subscriptions**

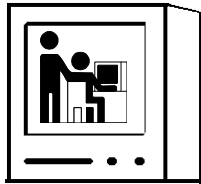
# Information Sources

# Awareness Tools

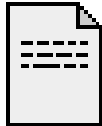
Physical Environments  
(WebCam, Active Badges)



Virtual Environments  
(MUDs, chat rooms)



Shared Artifacts  
(Papers, spreadsheets, databases)



Mobile Workers  
(Customer Rep, Support Staff)



Goal 1: Many awareness styles

Goal 3: A source of meta-information

Notification Server

Goal 2: Many awareness sources

Complex: CASS-Portholes



Writer



Developer

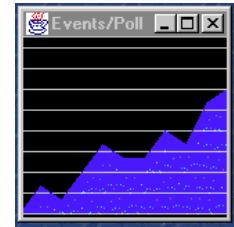


Document

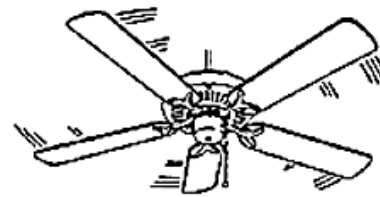


Printer

Simple desktop widgets



Ambient Fixtures

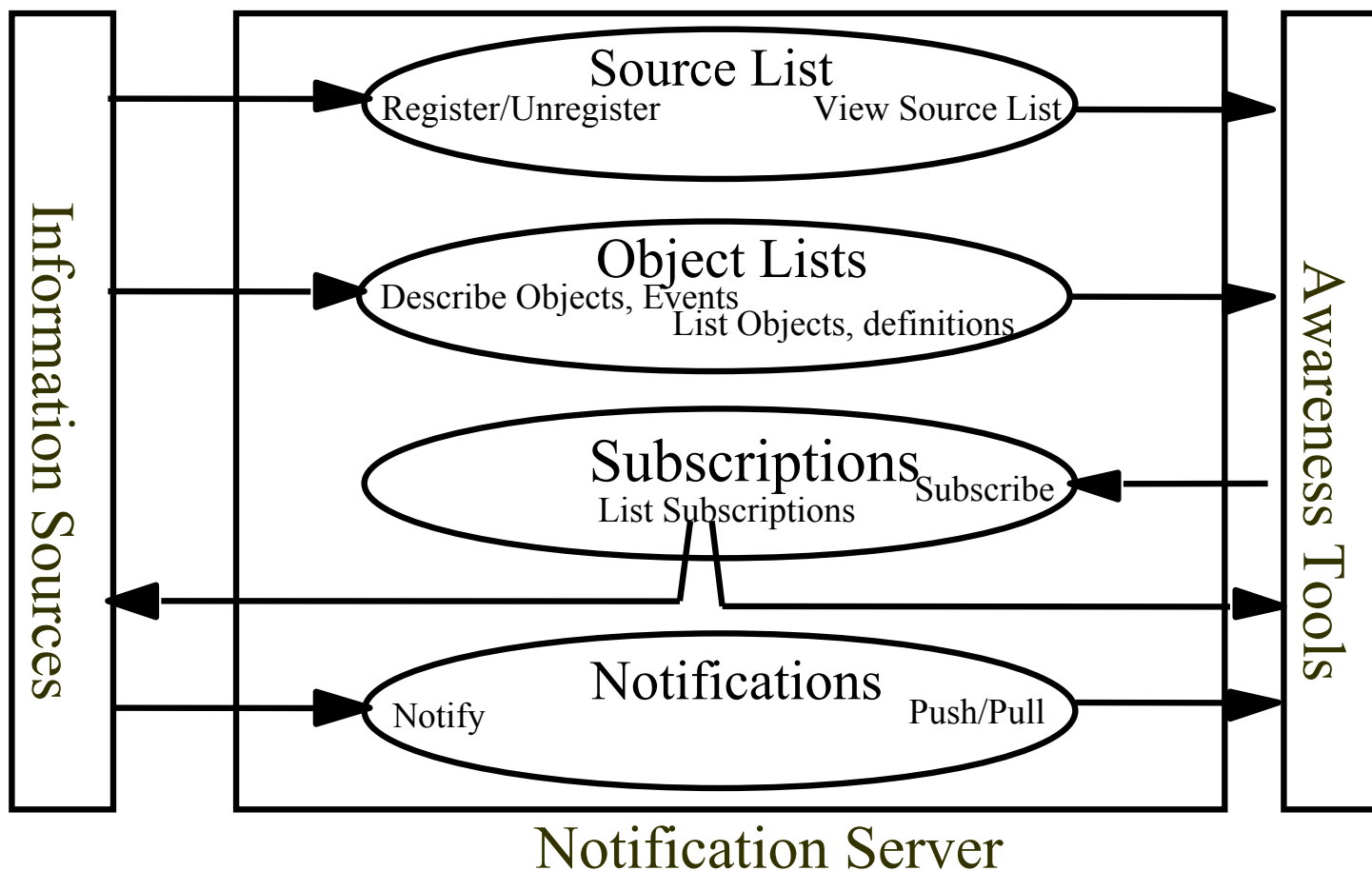


Mobile Awareness

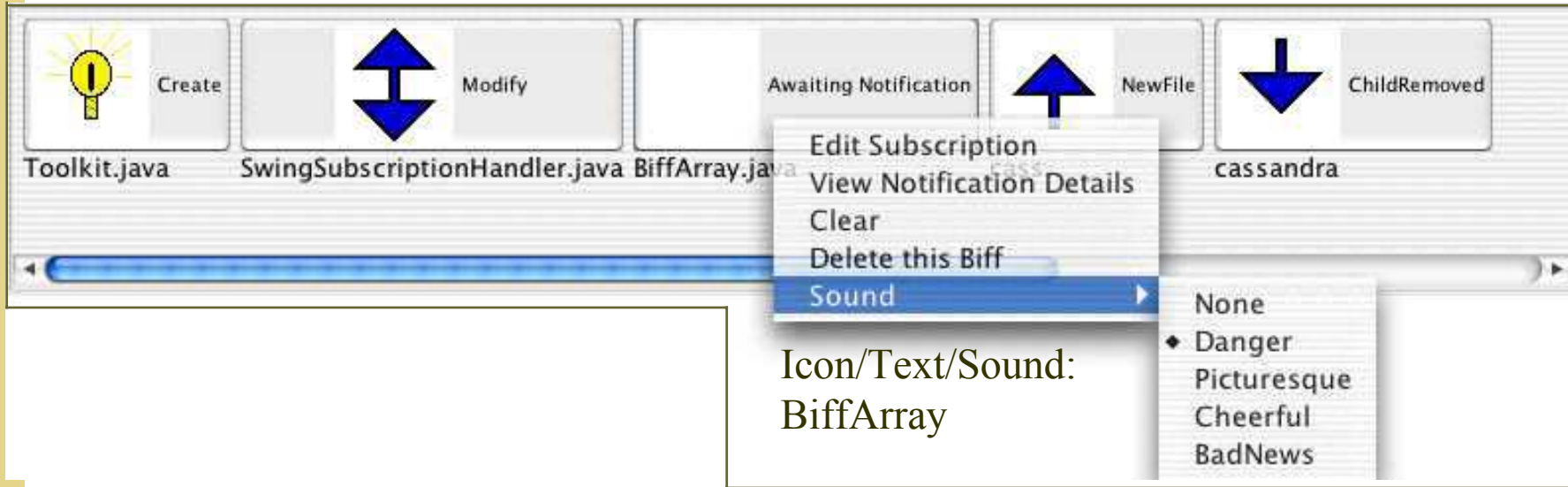


# CASS Information Update Server

- **CASSIUS: Notification server for awareness, not software interoperability.**

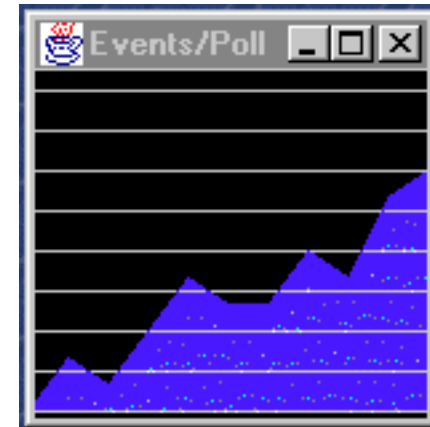


# Example Awareness Tools



Tickertape

Monitor over time



Status Indicator



# More Awareness Tools

Subject	Sent
<b>Subscription 'test as soon as': 2 events rep...</b>	<b>Today 3:02 PM</b>
Subscription 'test as soon as': 1 events reported	11/25/02
Subscription 'test as soon as': 8 events reported	11/25/02
Subscription 'test2': 2 events reported	11/7/02 4
Subscription 'test2': 1 events reported	11/6/02 4

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**From:** Michael Kantor <mkantor@ics.uci.edu>  
**Subject:** Subscription 'test as soon as': 2 events reported

The following are the results of your subscription tit  
'test as soon as'

CASS WebDAV: The object 'src' has received a FileRemov  
Summary:The File /src/CASSIUS For Ground Control.doc h  
removed by mkantor

CASS WebDAV: The object 'src' has received a ChildGet  
Summary:The Folder /src/ has been downloaded by mkanto

Email Notifications

## Mobile Awareness

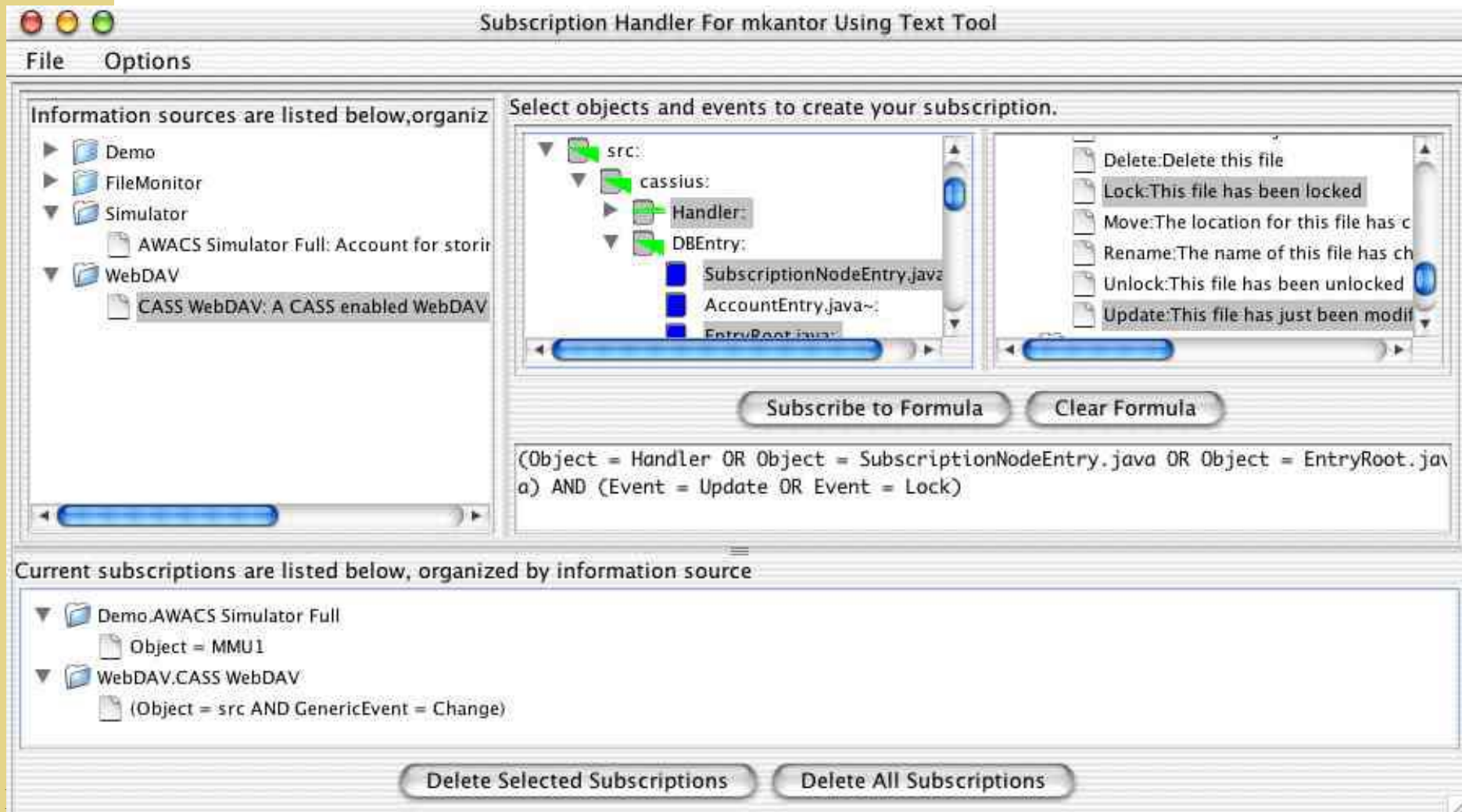
MiniPortholes Demo Displays - Netscape

Close Next

*Emulation Only*

# Default Subscription Editor

Goal 3: communicate validity, usefulness and range of possibilities



# Conclusions

- **Using a CASS awareness infrastructure, enhance coordination:**
  - 1) **Among developers building ground control systems**
  - 2) **Among ground control staff, software and hardware components**
  - 3) **Between ground control and external expertise**
- **Supports diverse work environments of different missions and different external stake-holders.**

# Web Site

**<http://www.isr.uci.edu/projects/cassius>**

**Questions?**



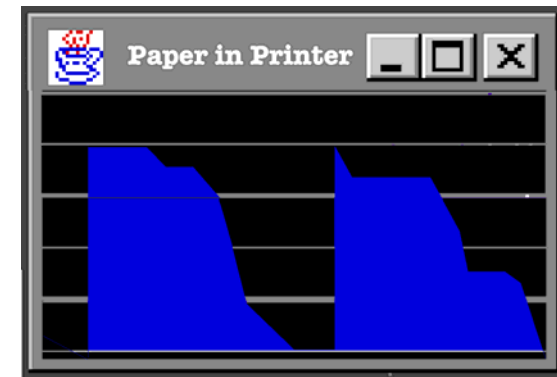
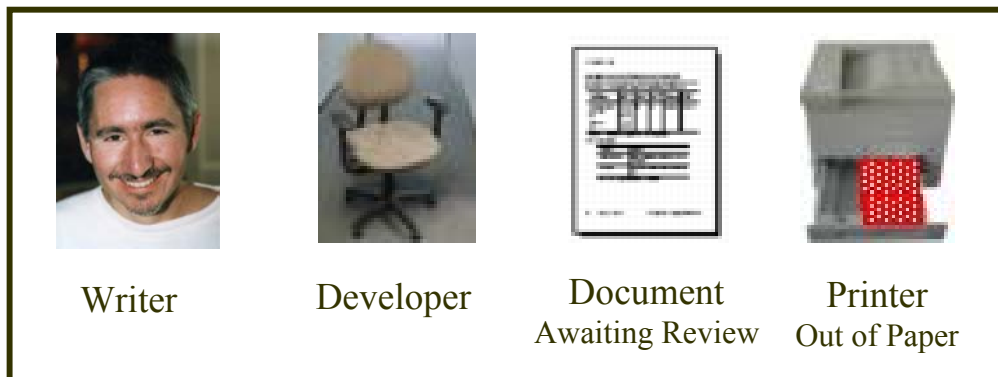
# Extra Slides

# References/Credits

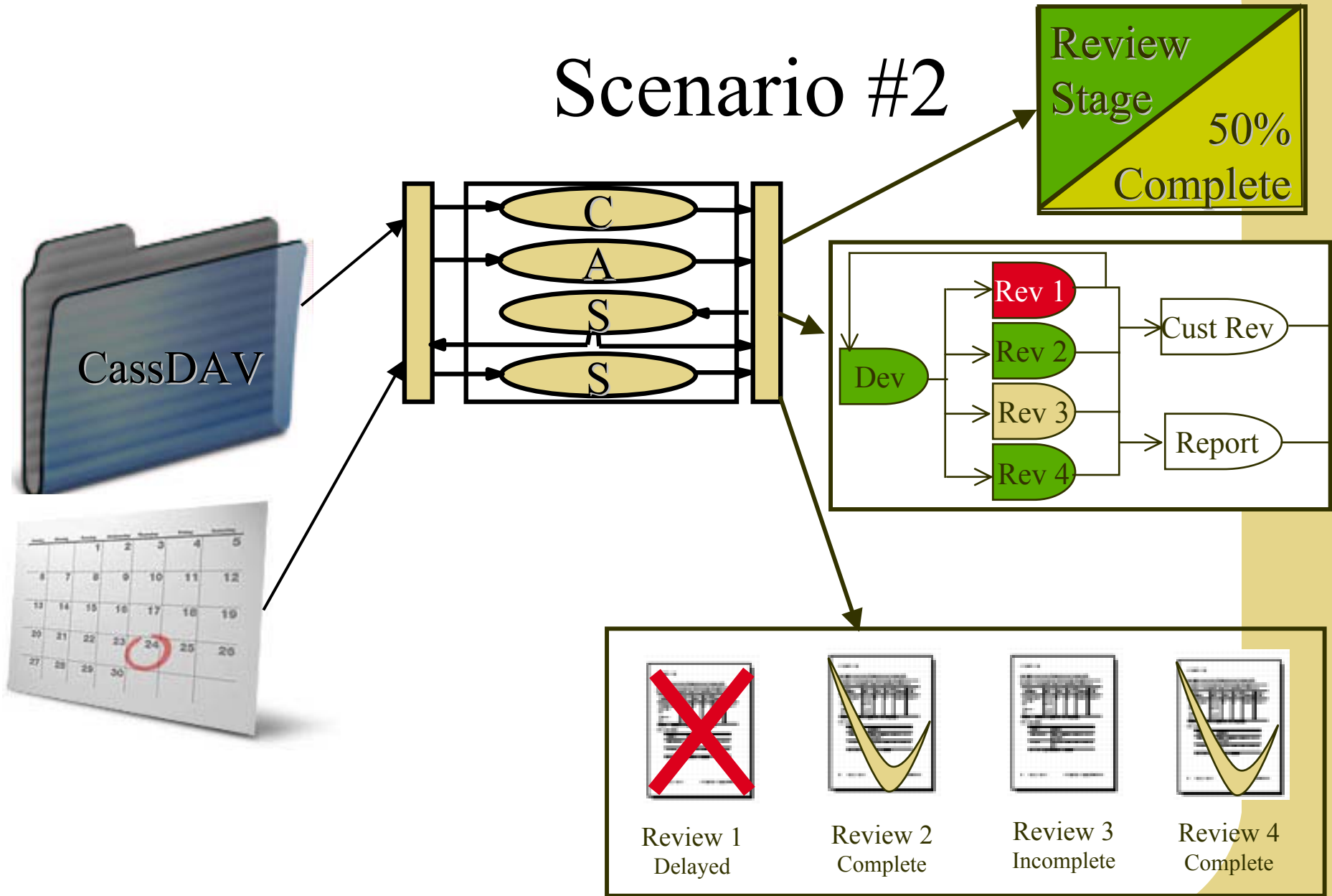
- **Kantor, M., Zimmermann, B., Redmiles, D. From Group Memory to Project Awareness Through Use of the Knowledge Depot, Proceedings of the 1997 California Software Symposium, UCI Irvine Research Unit in Software, Irvine, CA, November 7, 1997, pp. 19-26.**
- **Kantor, M., Redmiles, D. Creating an Infrastructure for Ubiquitous Awareness, Eight IFIP TC 13 Conference on Human-Computer Interaction (INTERACT 2001), July 2001, pp. 431-438.**
- **Girgensohn, A., Lee, A., Turner, T. Being in Public and Reciprocity: Design for Portholes and User Preference, In Human-Computer Interaction INTERACT '99, IOS Press, pp. 458-465, 1999.**
- **Sawhney, N., Schmandt, C (1999) Nomadic Radio: Scaleable and Contextual Notification for Wearable Audio Messaging In Conference on Human-Computer Interaction (CHI'99), pp. 96-103.**
- **SERS: [www.mobileFoundations.com](http://www.mobileFoundations.com)**
- **Elias Sinderson**
- **David Redmiles**

# Scenario #1

- **Reviewing technical document**
  - **Who is around to consult?**
  - **Is the document ready for review?**
  - **Can the document be printed?**
  - **How do others know result of review?**



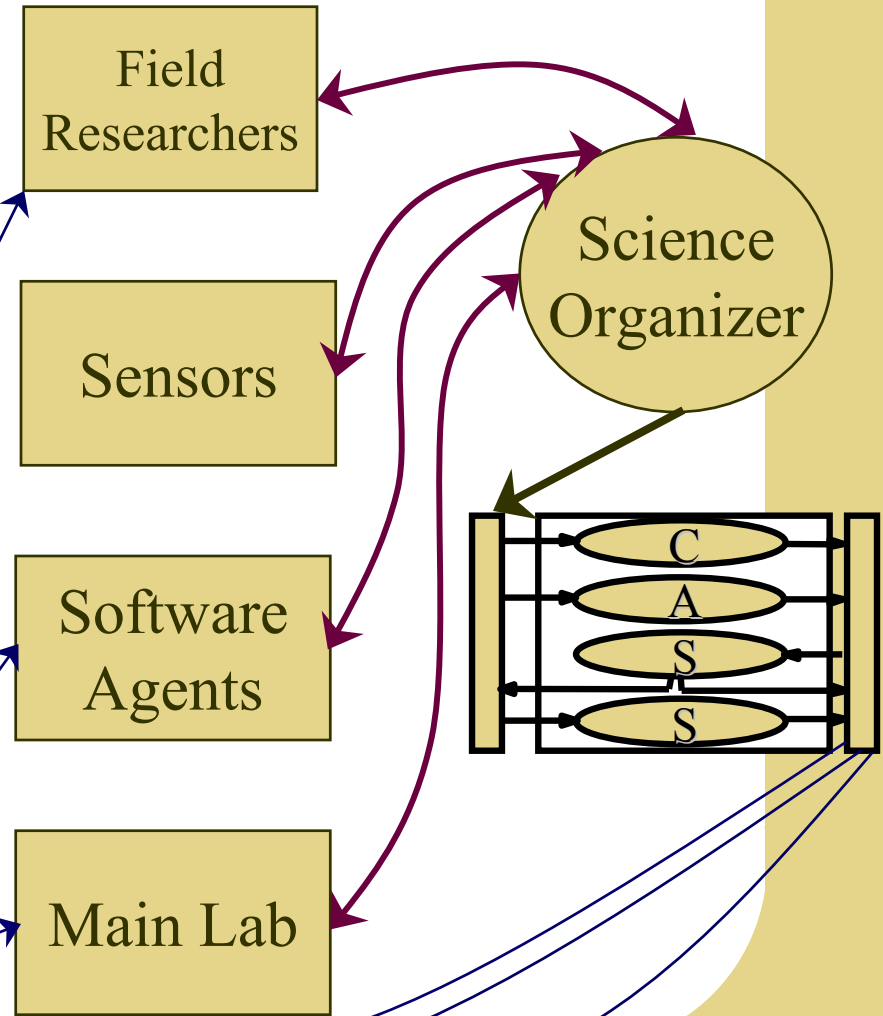
# Scenario #2



# Scenario #3

- **Monitoring Remote Systems**

- **Science Organizer [Keller]**
- **Awareness of/by remote workers**
- **Awareness of physical data**
- **Awareness of/by autonomous agents**
- **Awareness of/by main site**



# Notification Format

## **Fields have preset interpretation**

- **All awareness tools can interpret each field of the notification.**
  - **Summary, Quantification of change, Event type, URL to more data**
- **Selection of fields should cover a large spectrum of awareness tool requirements.**
- **Each tool can choose which fields it will utilize in implementing an awareness style.**

# Notification Format

- **All awareness tools can interpret each field of the notification.**
  - Textual summary
  - Event name
  - Generic event name
  - Numerical value
  - URL to more data
  - Person
  - Place
- **Each tool can choose which fields it will utilize in implementing an awareness style.**

# Information Sources

- **CassDAV (CASSIUS compatible WebDAV server)**
- **AWACS simulator**
- **Upcoming**
  - **Miniportholes (mobile devices)**
  - **Portholes (Webcams for workgroups)**
  - **RiverOne (B2B Server error notification)**
  - **CASSIUS (Registration of new sources)**



# Effort of Instrumenting Information Sources

- **Simple text editor**
  - **2 days to design UI enabling direct subscriptions, communicate with server, parse “diff” to create notifications.**
- **Knowledge Depot**
  - **One hour for event detection**
  - **Three hours for event calculation**
- **WebDav (7-10 days to get oriented)**
  - **Two hours for event detection and object hierarchy maintenance**

# Effort of implementing CASS awareness tools

- **Using CASSandra**
  - **Simple event browser: three hours**
  - **Tickertape: one day**
  - **Main problem: providing awareness style**
    - **Adapt existing (simple) awareness tools: 30 minutes**
- **Using CASS without CASSandra**
  - **Two hours to implement requests and parser for responses**
  - **Longer to implement subscription designer, object hierarchy browser, etc...**

# Avoiding Information Overload

- **Utilize many senses and channels of input**
- **Awareness style affects intrusiveness and quantity of information**
  - Tickertape shows user random events
- **Prioritize information, determine user's accessibility**
- **Provide tools that integrate, summarize and/or visualize large sets of data.**
  - Notifications from different sources often report on different aspects of a single event