BRAHMS: a multiagent modeling and simulation language for work system analysis and design

HCC:From Simulation to Implementation

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The Rocket Science of HCC

HUMAN

COMPUTER

What's the Delta?

Coordinate multimodal concepts, values, practice

Measure, classify, infer, depict, process

Research Question

- **How can we model an organization's work practice in such a way that we include people's collaboration, "off-task" behaviors, multi-tasking, interrupted and resumed activities, informal interaction and geography?**

- Objective is to find representations and techniques for analyzing and designing work systems (socio-technical systems) holistically and human-centered

Work Practice

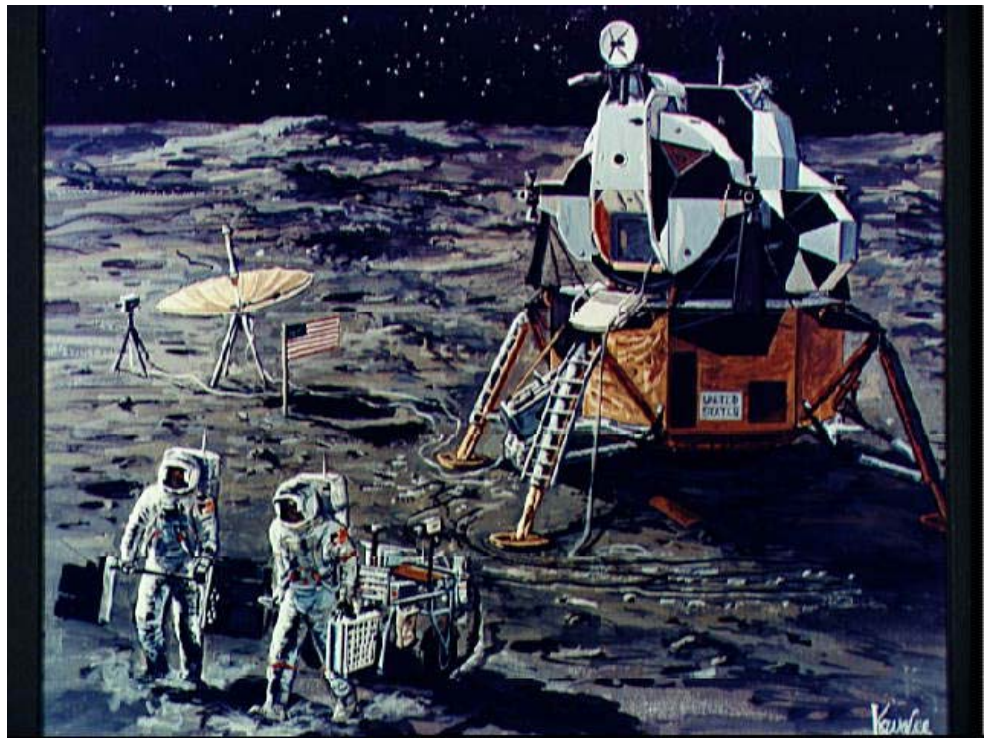
Definition

*The performance of collective situated **activities** of a group of people, collaborating, communicating, and gaining experience while performing these activities synchronously or asynchronously.*

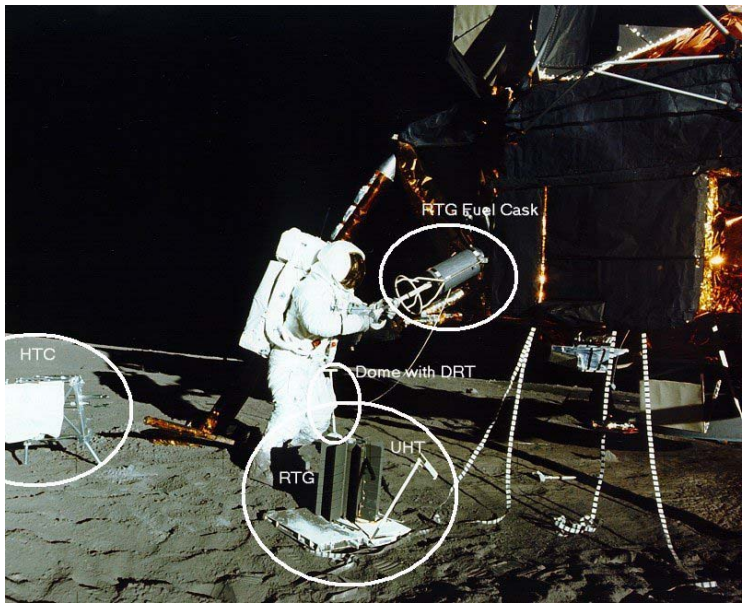
Work Practice Modeling

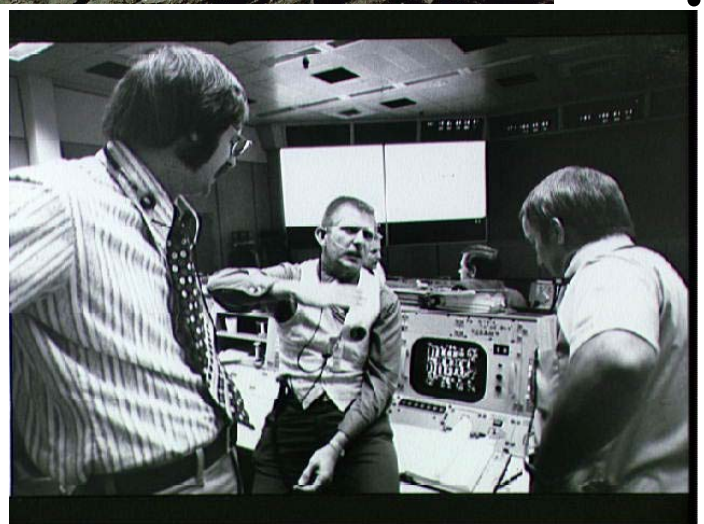
- **Groups & Agents**
  - work as activities
  - beliefs trigger work
  - bounded rationality is socially and culturally defined

- **Collaboration between Agents**
  - agents react to and interact with other agents
  - same time/same place
  - same time/different place
  - different time/same place
  - different time/different place



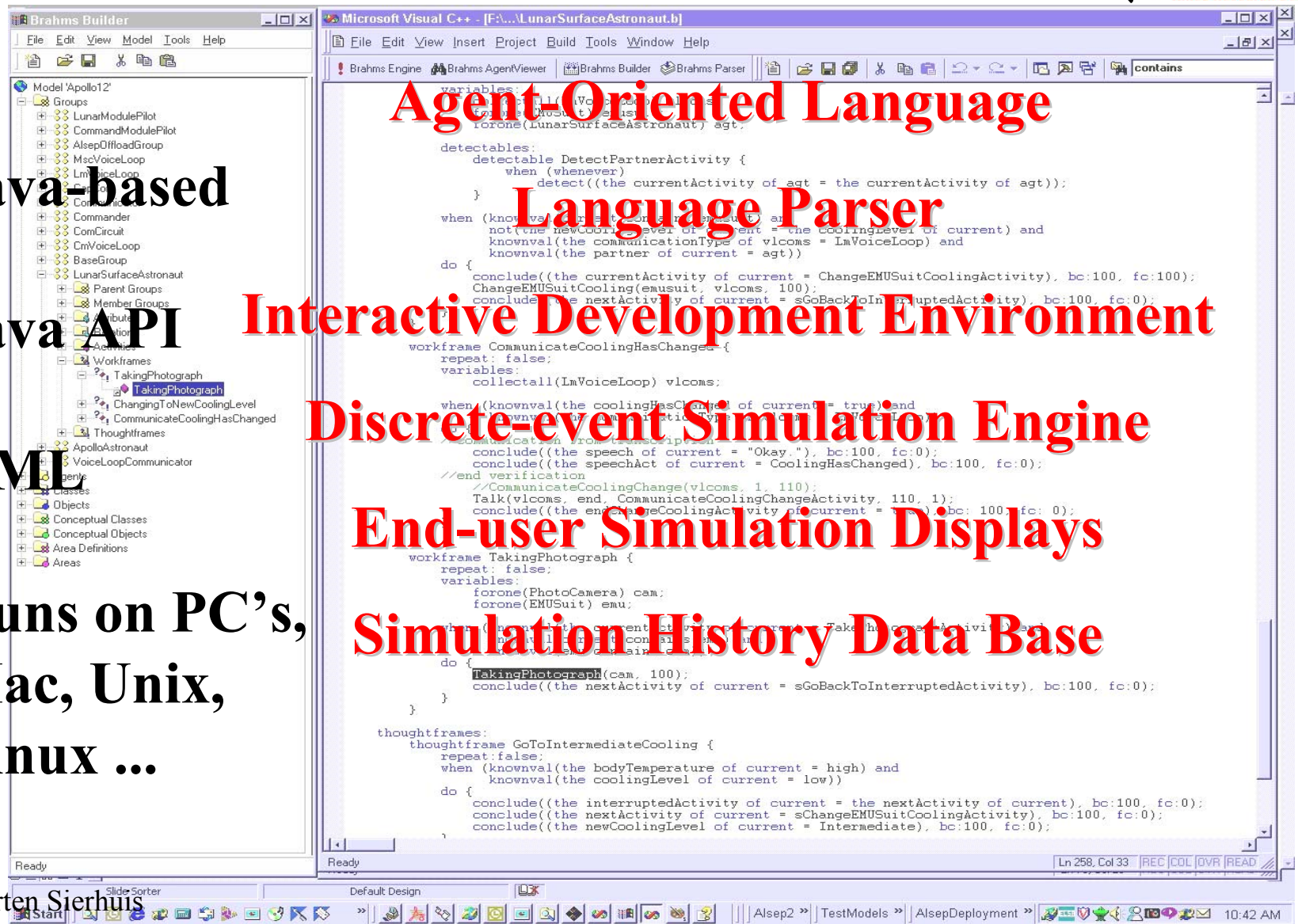
WPM cont'd





- **Tools & Artifacts**
  - tools used in activities
  - artifacts created in activities
- **Environment/Geography**
  - agents have a location
  - artifacts have a location
  - detecting real-world facts
- **Communication**
  - is situated
  - the means of communication depends on the situation (e.g. voice loop, f2f communication, telephone, faxing, e-mail)
  - impacts efficiency of work

Brahms



Agent Oriented Language

Java-based

Language Parser

Java API

Interactive Development Environment

XML

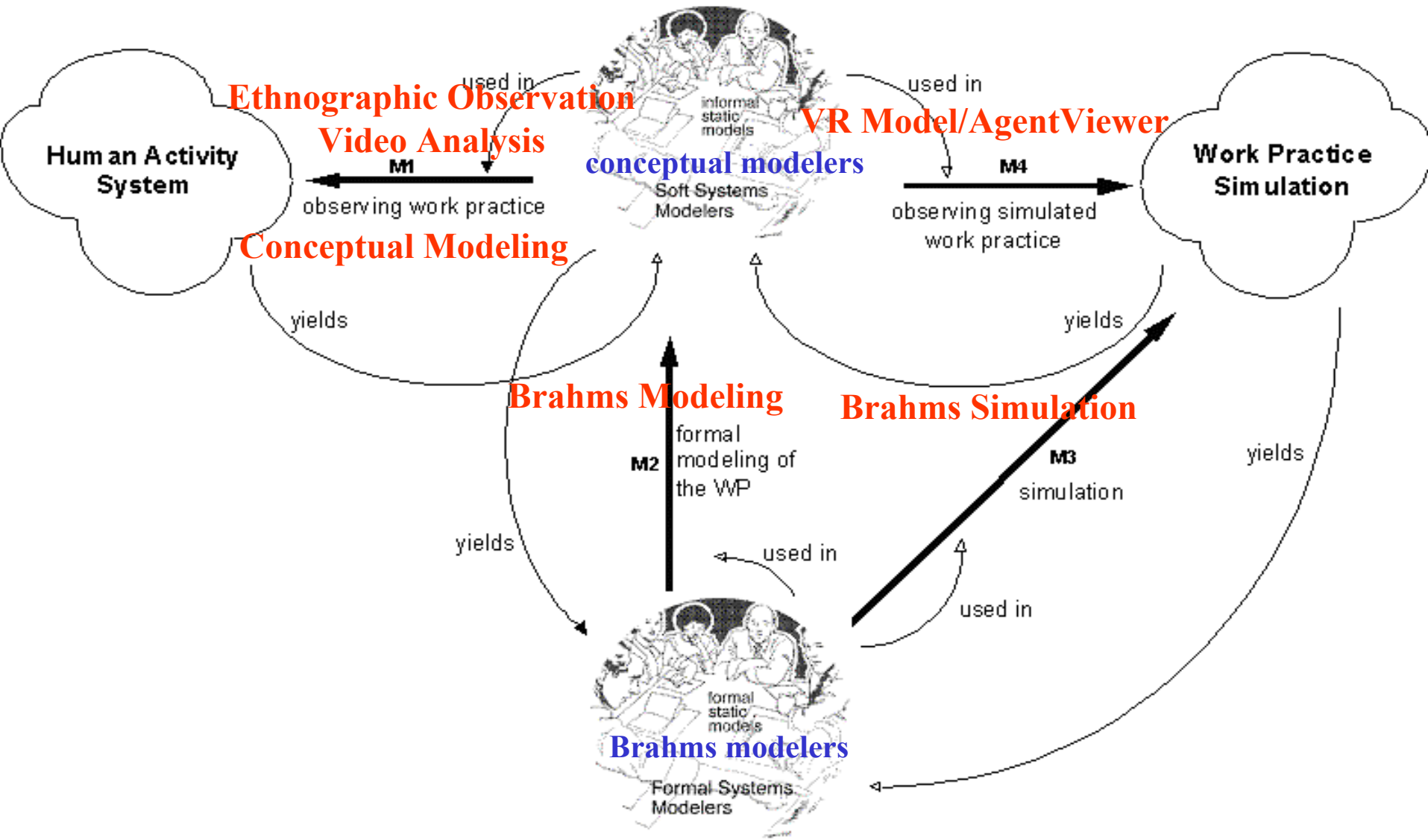
Discrete-event Simulation Engine

End-user Simulation Displays

Runs on PC's, Mac, Unix, Linux ...

Simulation History Data Base

Collaborative Modeling

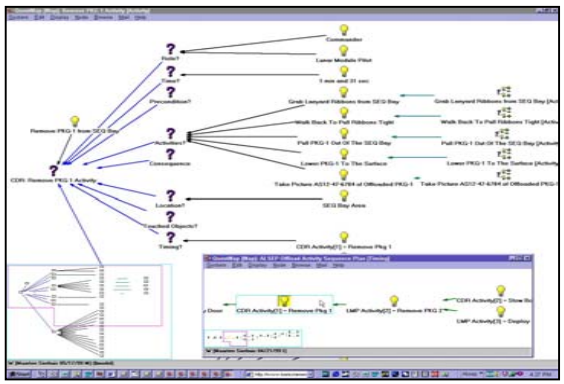


Design, Generate and Simulate

Brahms

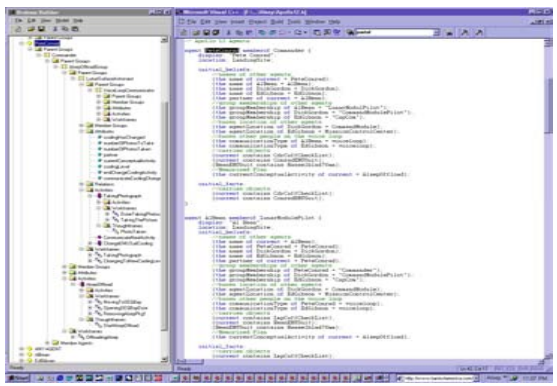
Ames Research Center

M1



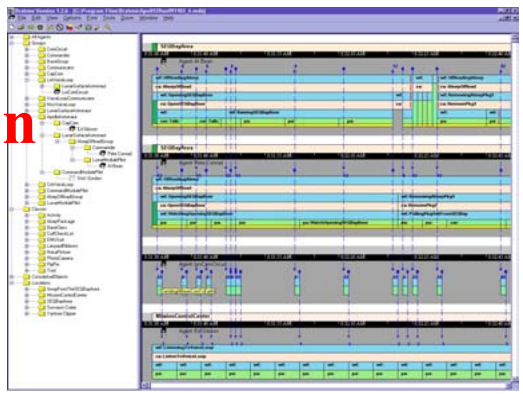
Conceptual Model

M2



Brahms Code Generation

M3/M4



Simulation/Visualization

Brahms Research Projects at NASA

- Human-Robotic Teamwork
  - Teamwork & Work Practice onboard the ISS
  - Mobile Agents supporting of Mars Exploration
- Mars Habitat
  - Living and working on Mars
- ’03 Mars Exploration Rover
  - Use Brahms to model Mission Operations Work System at JPL

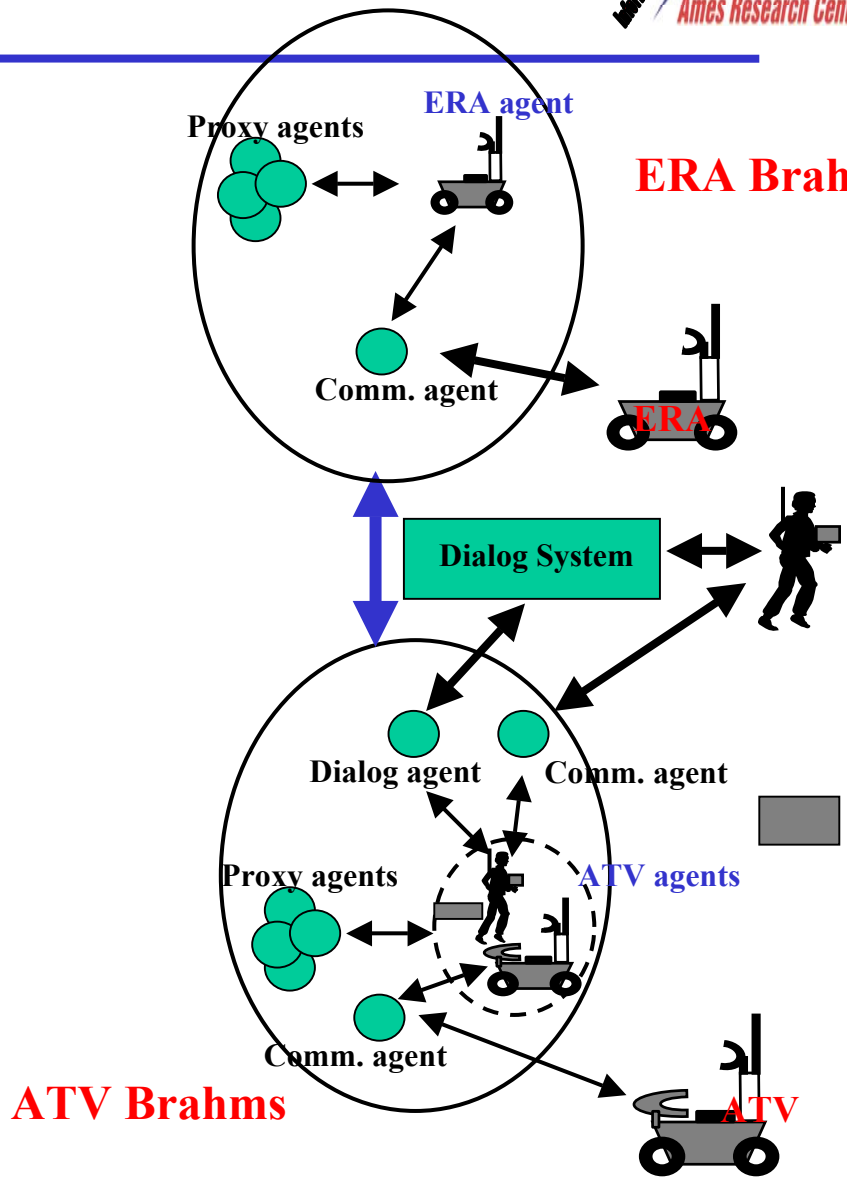
Mobile Agents

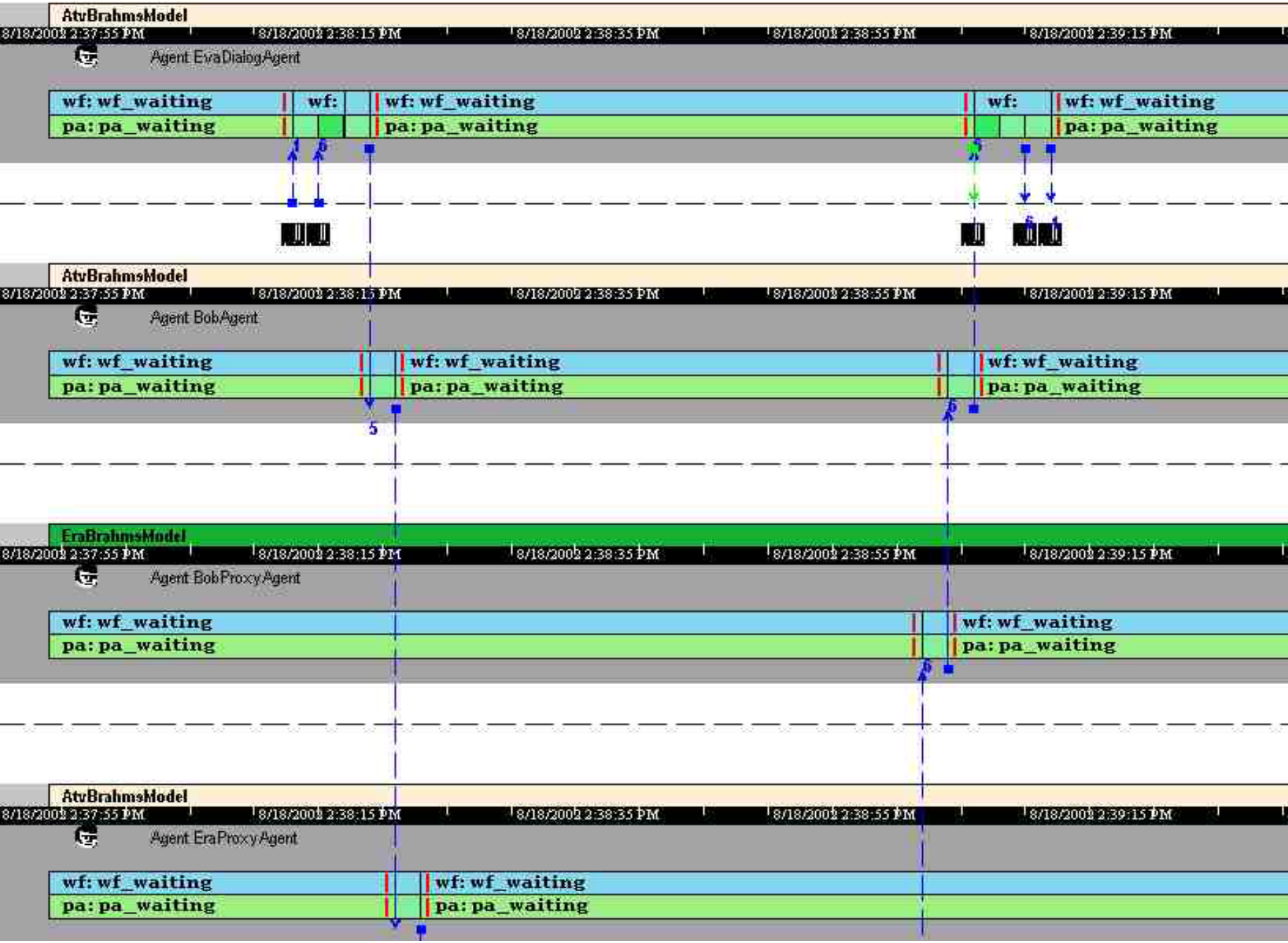
Runtime

- Models of People & Robots
- Intelligent Assistants
  - Agents for people & robots
- Software Agents
  - Dialog agent
  - Communication Agent
  - Proxy agent

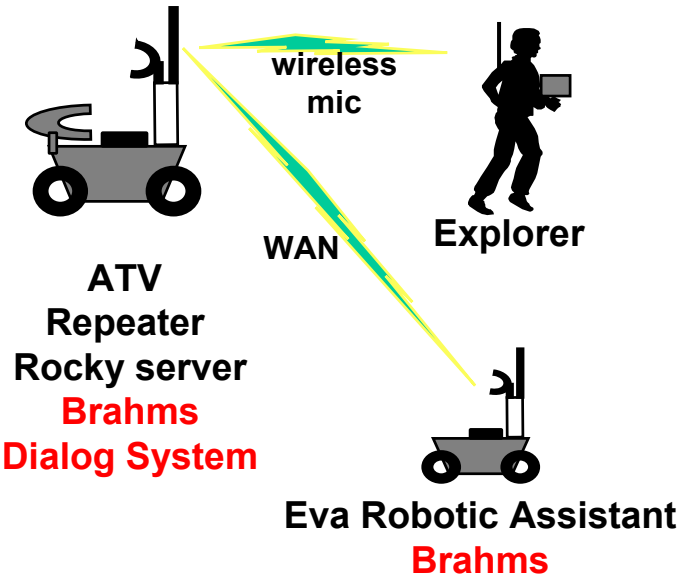
Design Phase

- Simulated People & Robots
- Intelligent Assistants
- Software Agents (simulated)
- Software Systems (simulated)

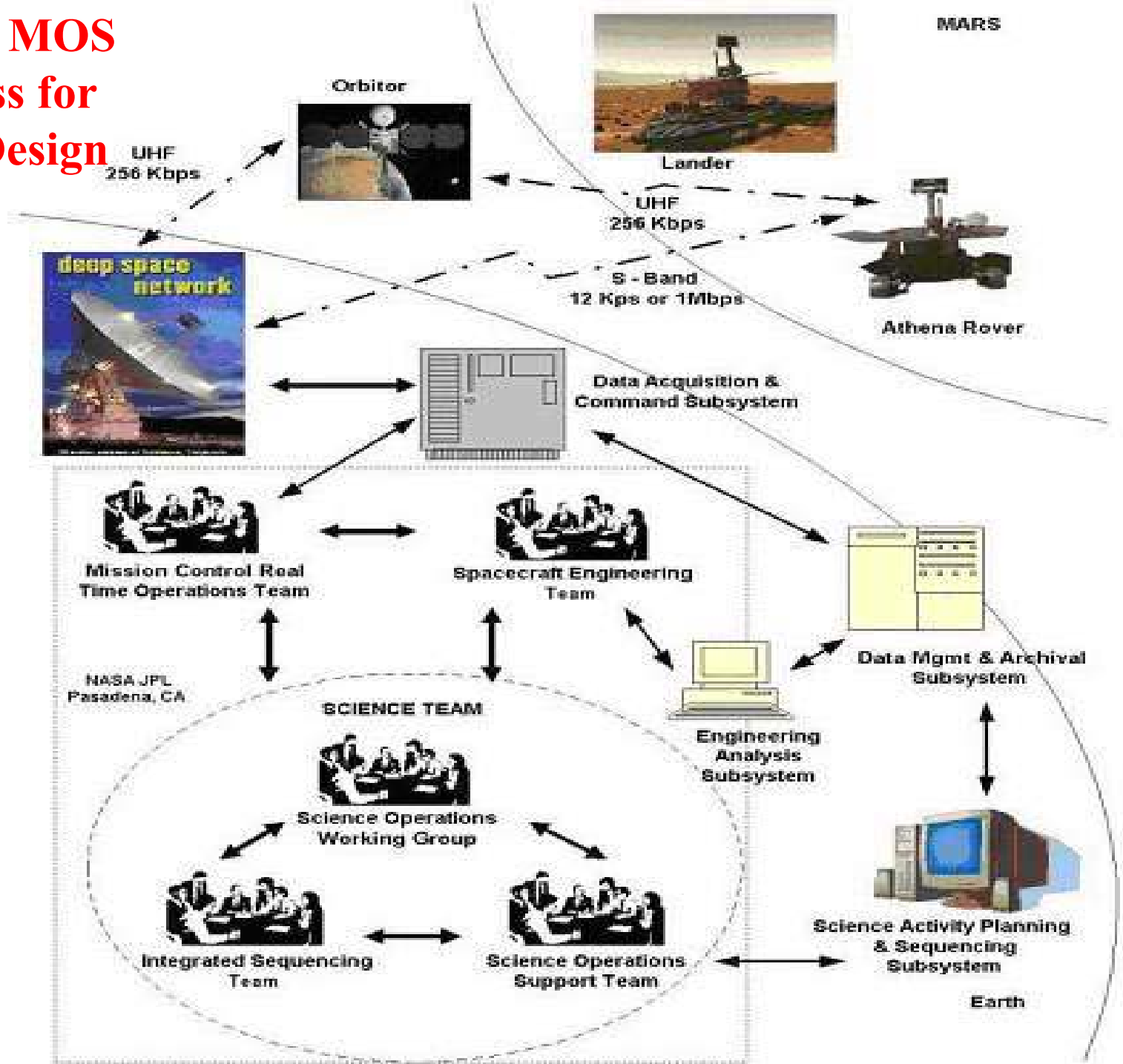



AtvBrahmsModel
8/18/2002 2:37:55 PM
8/18/2002 2:38:15 PM
8/18/2002 2:38:35 PM
8/18/2002 2:38:55 PM
8/18/2002 2:39:15 PM
Agent EvaDialogAgent
wf: wf_waiting
pa: pa_waiting
wf:
wf: wf_waiting
pa: pa_waiting
wf:
wf: wf_waiting
pa: pa_waiting
1
6
2
6
1
AtvBrahmsModel
8/18/2002 2:37:55 PM
8/18/2002 2:38:15 PM
8/18/2002 2:38:35 PM
8/18/2002 2:38:55 PM
8/18/2002 2:39:15 PM
Agent BobAgent
wf: wf_waiting
pa: pa_waiting
wf: wf_waiting
pa: pa_waiting
wf: wf_waiting
pa: pa_waiting
5
6
EraBrahmsModel
8/18/2002 2:37:55 PM
8/18/2002 2:38:15 PM
8/18/2002 2:38:35 PM
8/18/2002 2:38:55 PM
8/18/2002 2:39:15 PM
Agent BobProxyAgent
wf: wf_waiting
pa: pa_waiting
wf: wf_waiting
pa: pa_waiting
6
AtvBrahmsModel
8/18/2002 2:37:55 PM
8/18/2002 2:38:15 PM
8/18/2002 2:38:35 PM
8/18/2002 2:38:55 PM
8/18/2002 2:39:15 PM
Agent EraProxyAgent
wf: wf_waiting
pa: pa_waiting
wf: wf_waiting
pa: pa_waiting

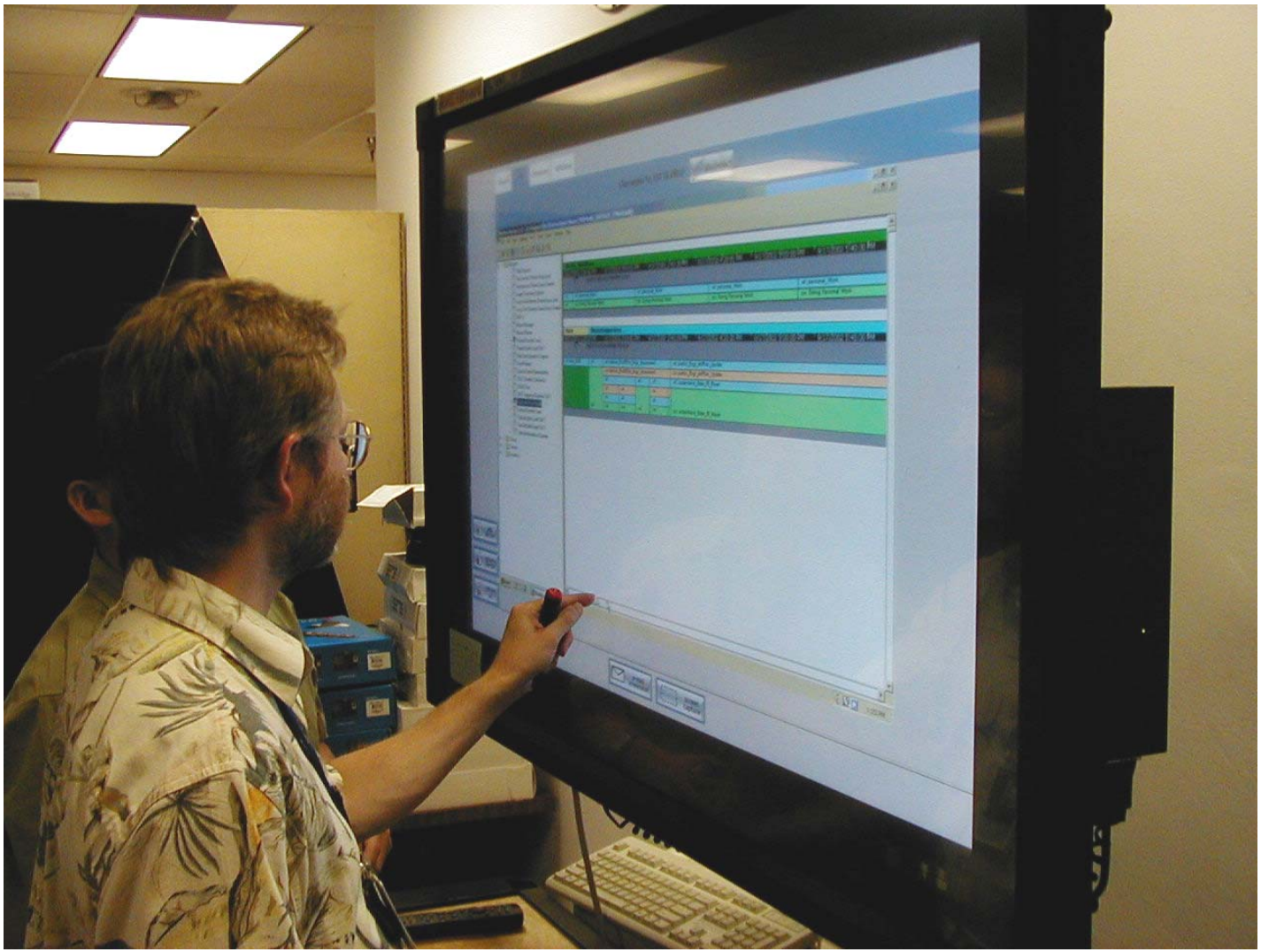
Mobile Agents Architecture

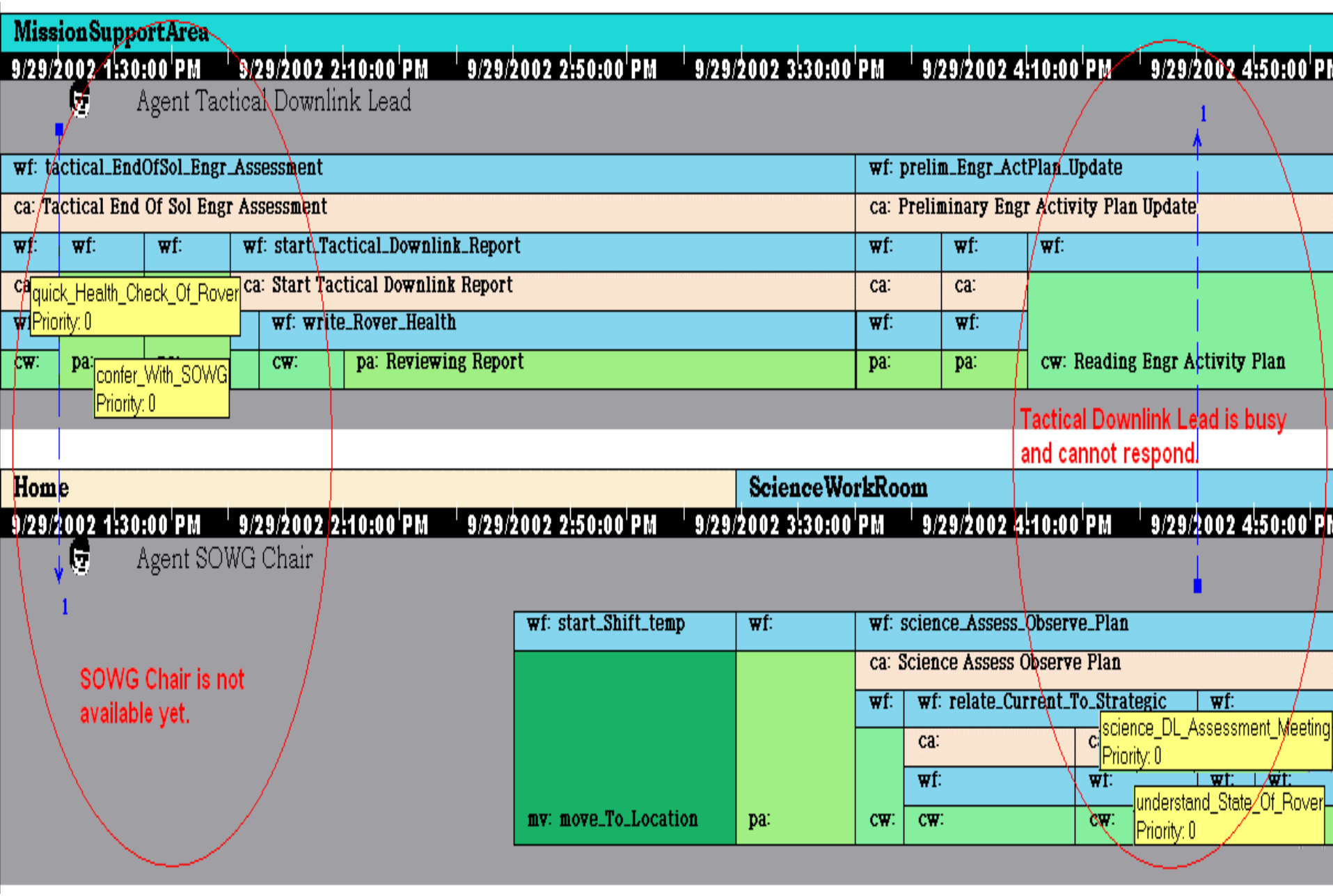


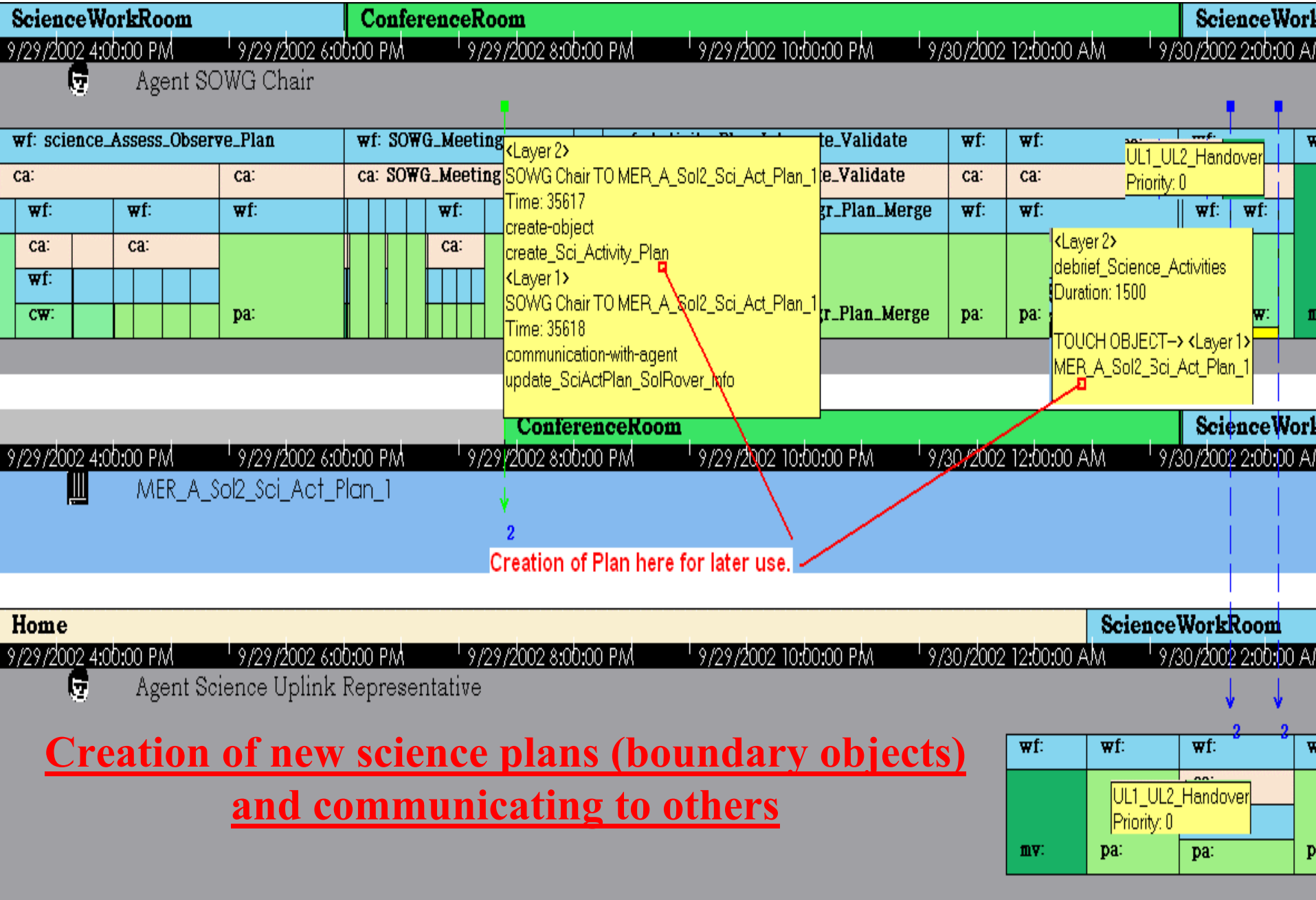
Simulation of MOS Work Process for MER MOS Design



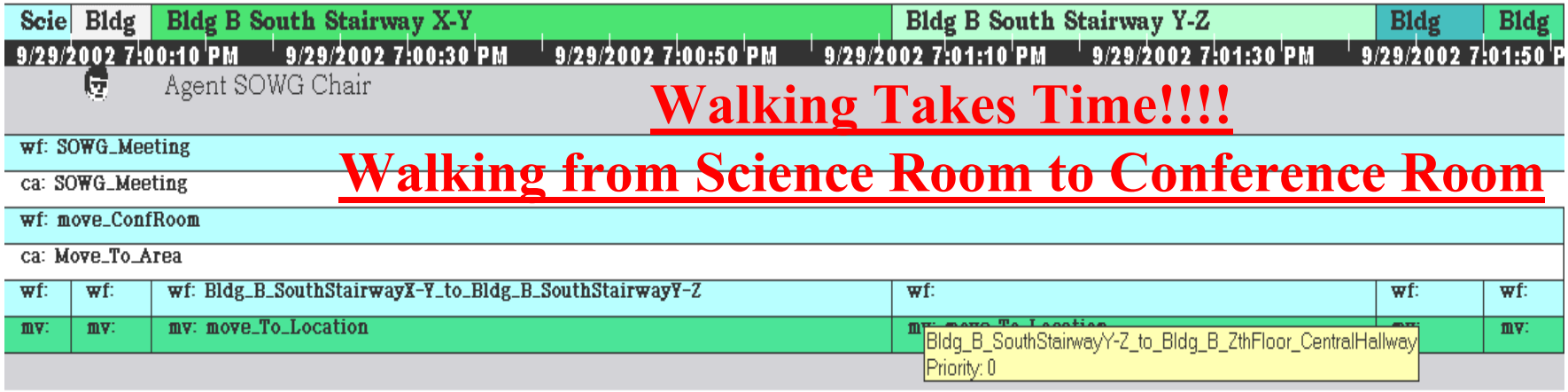
Collaborative Design with MER MOS DT




MissionSupportArea
9/29/2002 1:30:00 PM
9/29/2002 2:10:00 PM
9/29/2002 2:50:00 PM
9/29/2002 3:30:00 PM
9/29/2002 4:10:00 PM
9/29/2002 4:50:00 PM
Agent Tactical Downlink Lead
wf: tactical_EndOfSol_Engr_Assessment
ca: Tactical End Of Sol Engr Assessment
wf: start_Tactical_Downlink_Report
ca: Start Tactical Downlink Report
wf: write_Rover_Health
cw:
pa:
pa: Reviewing Report
quick_Health_Check_Of_Rover
Priority: 0
confer_With_SOWG
Priority: 0
wf: prelim_Engr_ActPlan_Update
ca: Preliminary Engr Activity Plan Update
ca:
wf:
cw: Reading Engr Activity Plan
1
Tactical Downlink Lead is busy
and cannot respond.
Home
ScienceWorkRoom
9/29/2002 1:30:00 PM
9/29/2002 2:10:00 PM
9/29/2002 2:50:00 PM
9/29/2002 3:30:00 PM
9/29/2002 4:10:00 PM
9/29/2002 4:50:00 PM
Agent SOWG Chair
1
SOWG Chair is not
available yet.
wf: start_Shift_temp
mv: move_To_Location
pa:
wf: science_Assess_Observe_Plan
ca: Science Assess Observe Plan
wf: relate_Current_To_Strategic
ca:
wf:
cw:
science_DL_Assessment_Meeting
Priority: 0
understand_State_Of_Rover
Priority: 0

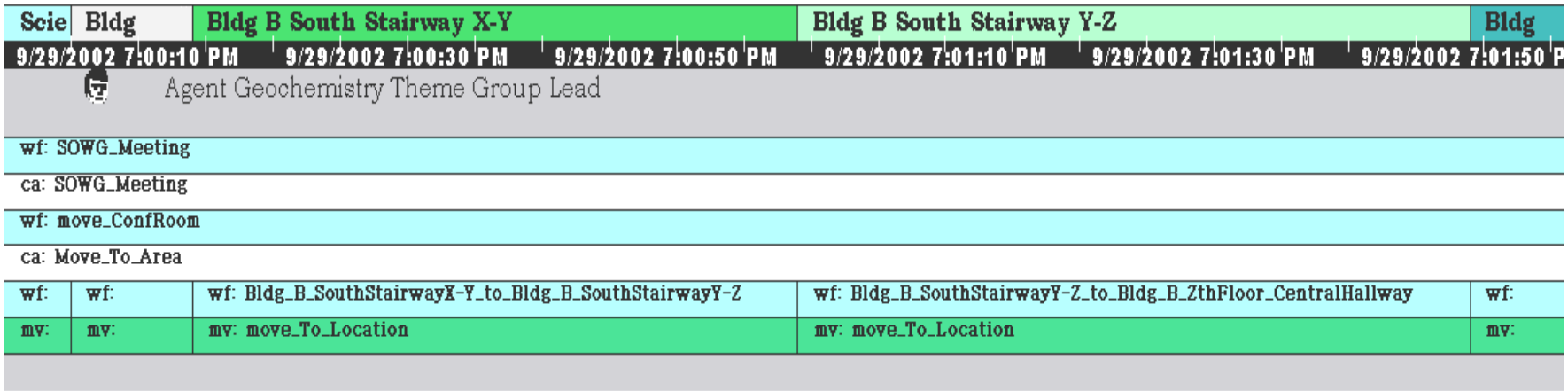


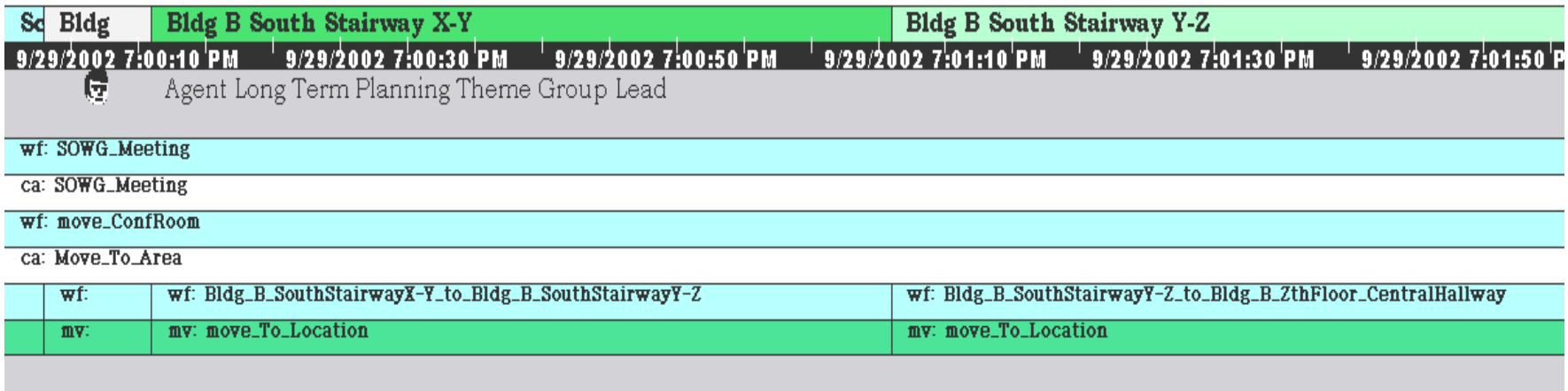
Creation of new science plans (boundary objects) and communicating to others



Walking Takes Time!!!!

Walking from Science Room to Conference Room



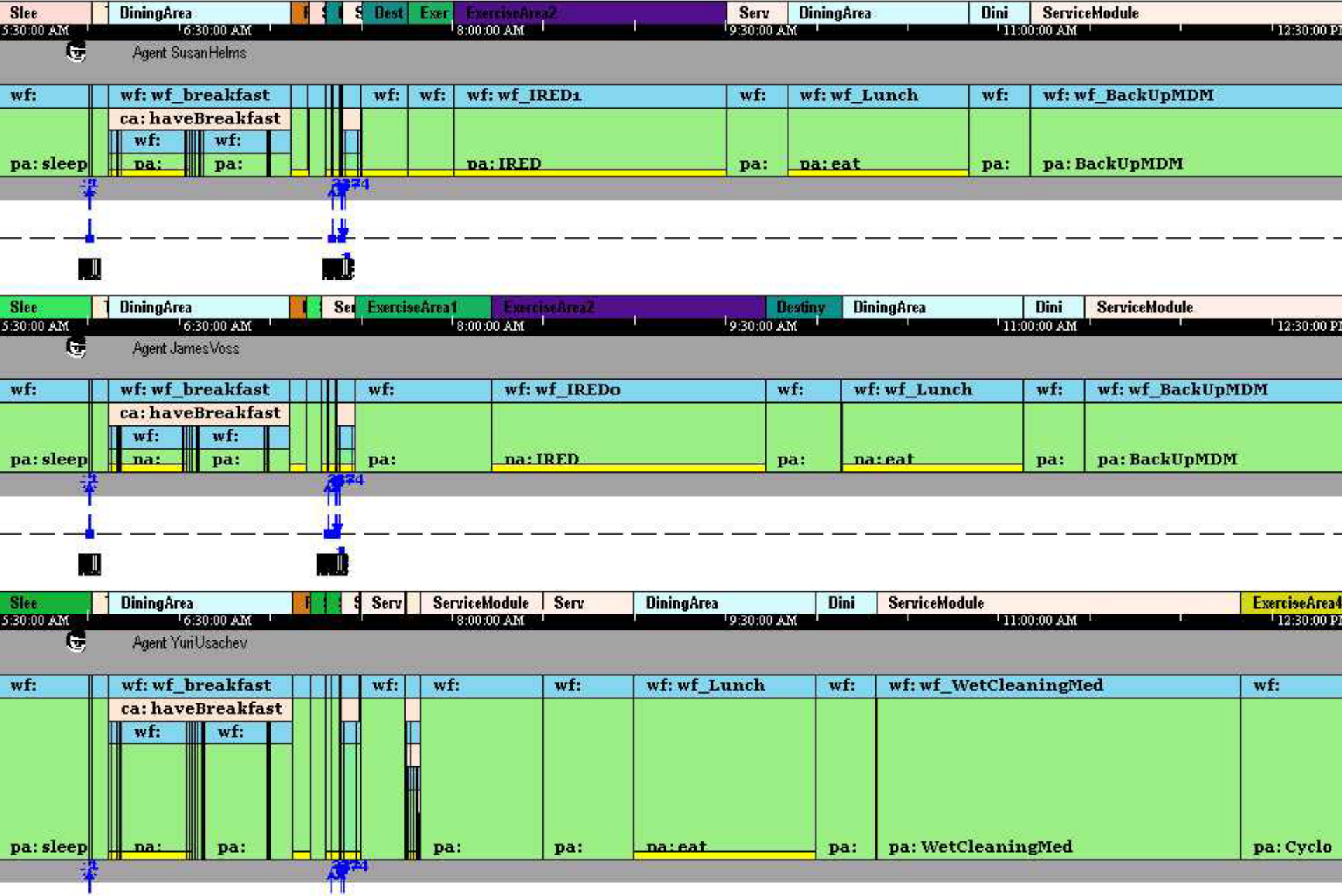


ISS Project Goals

- *External goals*
  - *artifact* to study and understand work practices and teamwork onboard ISS
  - *model* to be used in:
    - *planning.* ISS Mission planning and procedure development
    - *execution.* HCI: Autonomous Intelligent Software or Robotic Agents (e.g. PSA, Robonaut) in support of teamwork .
- *Internal goals*
  - Explore use of Brahms in representing manned space missions
  - Study Brahms as an *ABSS* (Davidsson, 2002)

Modeling the ISS crew with Brahms

- Data
  - Videos, pictures, interviews
  - JSC manuals, procedures
  - Timelines, schedules
  - On-orbit and post-orbit debriefs
  - MOD servers
- Work practice data analysis
- Conceptual modeling
- Brahms model and simulation



Morning Activities ISS Exp 2, May 7, 2001