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# Mobile Agents Integrate Astronauts, Rover, & Mission Support in Desert-RATS Mission Simulation



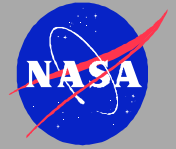
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design - collaborate - integrate - explore

NASA's Desert Research and Technology Studies (D-RATS) Team



Ames Research Center

Johnson Space Center

Maarten Sierhuis (co-PI)

Frank Delgado (SCOUT)

John Dowding (Language)

Susan Torney (ExPOC)

Dan Berrios (Database)

Joe Kosmo (Suits)

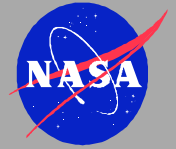
Mike Scott (Agents)

Ron van Hoof (Habcom)

*In collaboration with many others from JSC, KSC,  
GRC, and Hamilton Sundstrand...*



# About Desert-RATS



- NASA-led research “working group”
- Eight annual field trip; Apollo training legacy
- Four NASA centers and external partners (USGS, industry, academia)
- Preparing for human-robotic exploration
- Integrates projects into coordinated field test
- Goal: Develop EVA operational concepts in analog setting through hands-on experience.

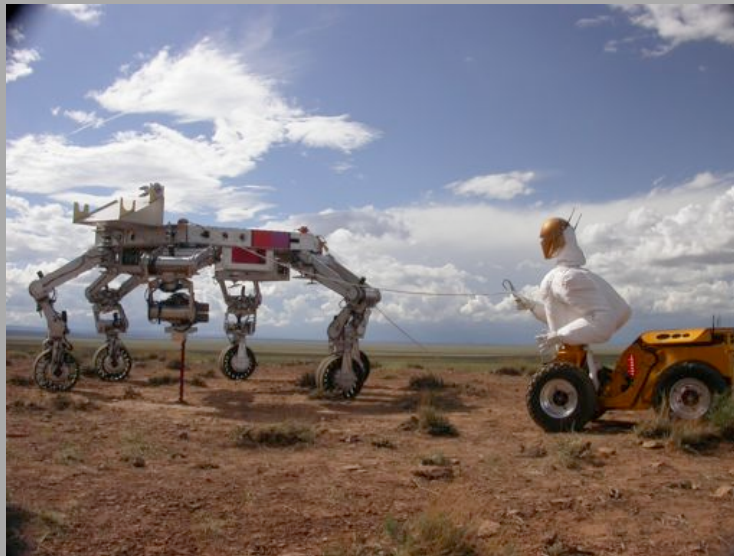
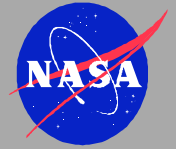


# Field Layout





# Robonaut & Athlete

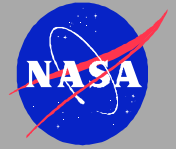




# Mobile Agents @ D-RATS06

## Objectives

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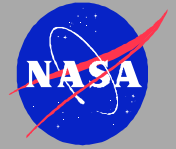


*Test subjects conducting simulated extravehicular activity (EVA) while wearing pressurized space suits and using a prototype rover vehicle*

- Demonstrate first end-to-end systems integration between mission support and people & robotic systems at a remote site
- Show generality of agent-based systems integration
  - Autonomous drives of SCOUT
  - Control of multiple cameras
  - Programmed control of the Planetary Exploration Geophone System (PEGS) hardware
  - Remote access to telemetry & voice commanding
  - Heads-up display



# System Configuration



**Suit & CAI Pack**



**ExPOC@ JSC**



**SCOUT & PEGS**

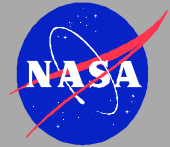


**HabCom @ Meteor Crater**

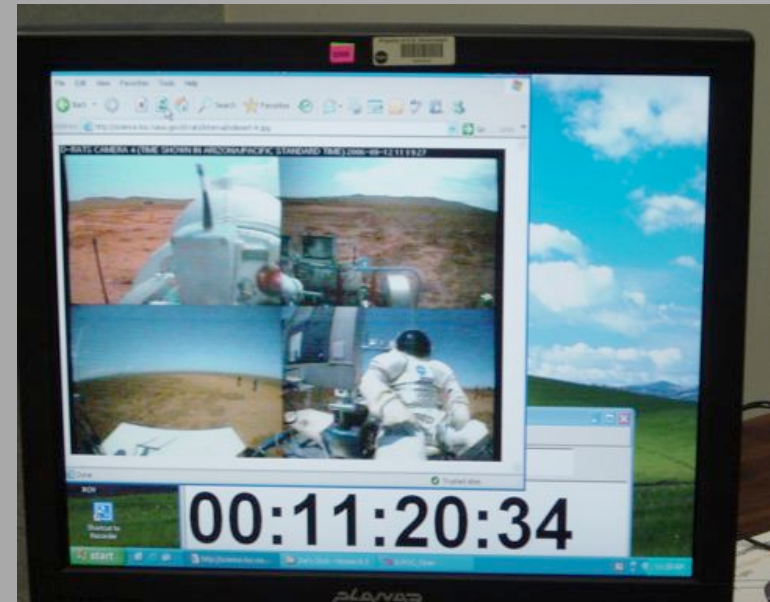




# ExPOC Activities



- Commanded SCOUT to execute an autonomous plan, e.g., move & take pictures.
- Interacted with crew and Habcom via voice mail.
- Observed status of EVA on aerial photographs showing movements of Scout & crew and photographs, samples, and voice notes.
- Received alerts and emails with links to database created by Mobile Agents

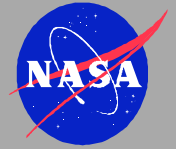


ScienceOrganizer: An Information-Sharing Tool for Mobile Agents NASA Ames

New Item	Search	Home	Go To	Logout	Help
<a href="#">View Links</a>	<a href="#">Edit Links</a>	<a href="#">Modify</a>	<a href="#">Permissions</a>	<a href="#">Delete</a>	<a href="#">Duplicate</a> <a href="#">Put in a Folder</a>
g:\bar_t_bar_eva (open all   close all)					
+ Collected Science Data (2 Science Data\0 Geological P...					
+ /voiceno: 1					
+ /voiceno: 2					
+ Contained By (1 EVA Folders\0 Activities Folders\0 Be...					
+ (Sep 7 2006 EVA Folder					
+ Has Plan (1 Plans\0 ERA Plans)					
+ Bar_T_Bar_EVA_Plan					
+ Shown In (3 Image Files)					
+ 1m Aerial Photo EVA Map (AstroTwo)					
+ 2m Aerial Photo EVA Map (AstroTwo)					
+ 2m Aerial Topo Composite EVA Map (AstroTwo)					
+ EVA: Bar_T_Bar_EVA					
Item ID# 187374 updated 2006/09/07 08:41AM PDT by @ScienceOrganizer.Com Agent (SQCA)					
Send this item's web address via Email					
Description					
Start Time					
End Time					
Start Location					
End Location					
Duration (hh:mm:ss)					
Status					
Starting Date					
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Participants					
Notes					
Write Permission <a href="#">Mobile Agents Architecture (MAA -- Entire)</a>					
Read Permission <a href="#">Mobile Agents Architecture (MAA -- Entire)</a>					

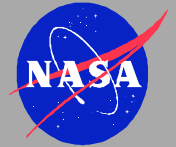


# Video





# Example Scout Protocol



*EV1 is off vehicle, which is nearby:*

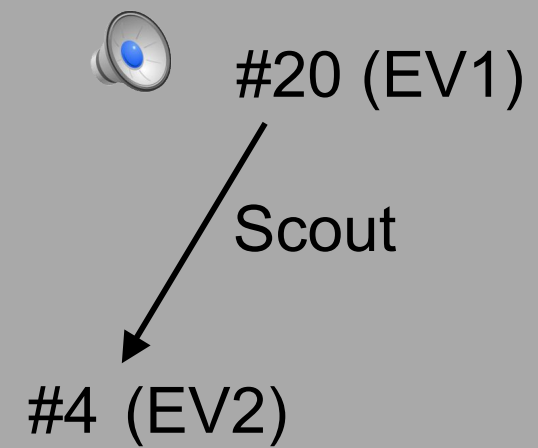
- **Create waypoint 20**
- **Where am I?** (“Waypoint 20”)
- **Where is EV2?** (“Waypoint 4”)
- **Scout, move to Waypoint 4**  
(Autonomous, no riders)

*EV1 works in area of Waypoint 20.*

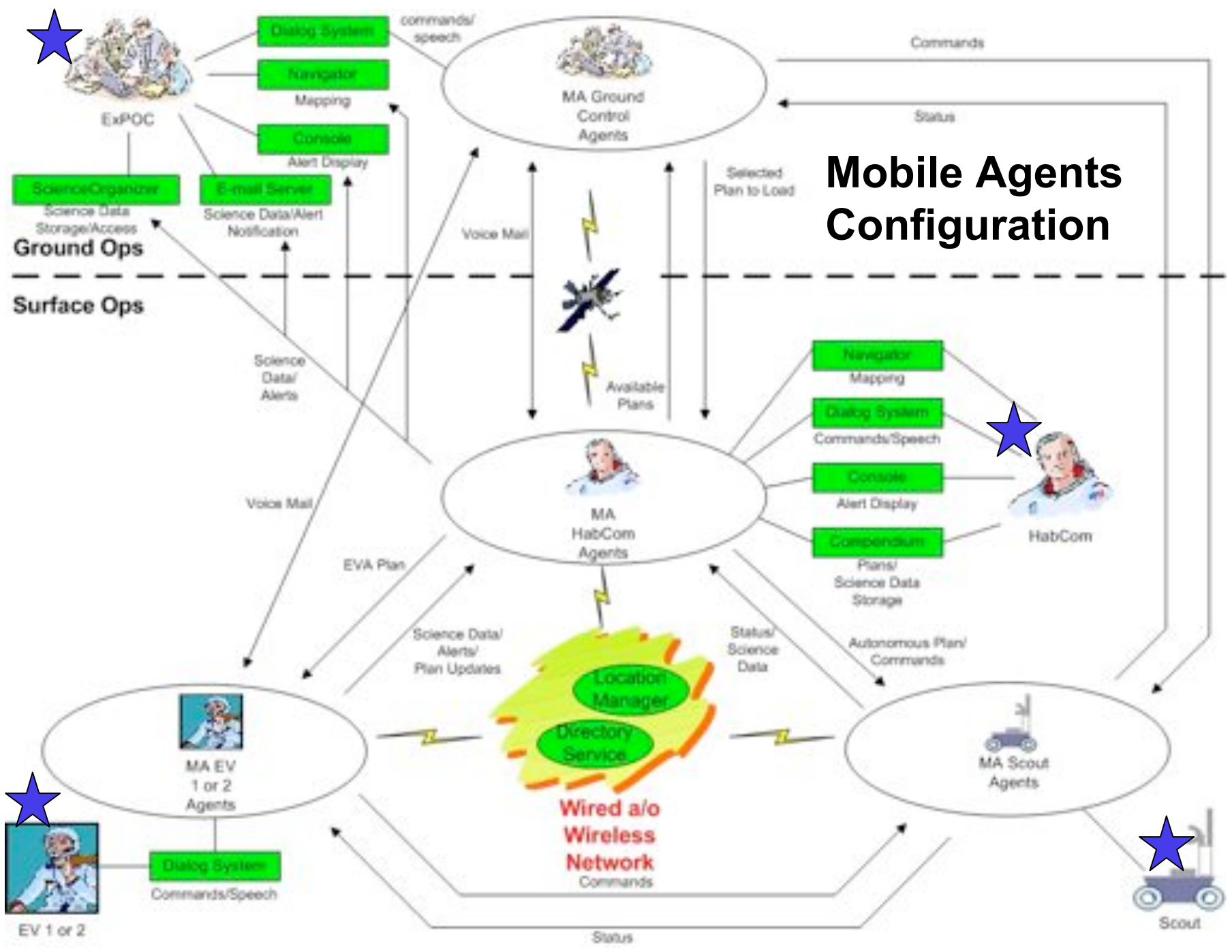
*EV2 gets onboard Scout when it arrives.*

- **Scout drive to Waypoint 20**  
(Autonomous drive back to EV1)

*On arrival, EV1 joins EV2 onboard Scout.*

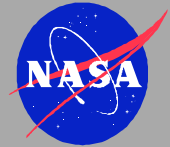


# Mobile Agents Configuration





# D-RATS06 Voice Commands



- **Interaction**

- Hello | Acknowledge
- {INCREASE | DECREASE} volume
- Repeat that
- Please stop talking
- Go to sleep
- Wake up

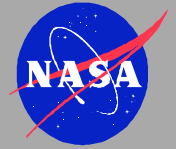


- **Heads-Up Display**

- {DISPLAY | SHOW | HIDE | CLOSE}  
  {POWERPOINT | DOCUMENT | JPEG} <#>
- Page {UP | DOWN}
- Zoom {IN | OUT}
- Pan {LEFT | RIGHT | UP | DOWN}



# Location & Activity Voice Commands



- Location

- Where am I?
- Where is {EV1 | EV2 | SCOUT | WAYPOINT # | WORKSITE #} {relative to {<LOCATION>}}
- {CALL THIS LOCATION | CREATE} {WAYPOINT # | WORKSITE #}

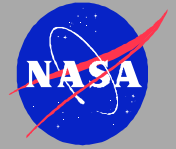
- Activities

- What is {my | EV1 | EV2's} {CURRENT | NEXT} activity?
- {WHAT | WHERE} is my next activity?
- Start {MY} {FIRST | NEXT} activity.
- How much time is left?
- What time is it?
- Extend duration by # minutes.
- Change duration to # minutes.





# Scout Voice Commands

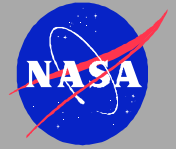



- Scout halt.
- Scout take a picture of <PLACE> = {EV1 | EV2 | ME | WAYPOINT # | WORKSITE #}
- Scout take a panorama.
- Scout plan a path to <PLACE>
- Scout {DRIVE | MOVE} to <PLACE>
- Scout {PREPARE TO | ON MY ORDER} follow {EV1 | EV2 | ME}
- Scout follow {EV1 | EV2 | ME}
- Scout {WATCH | STOP WATCHING} <PLACE>
- Scout who are you watching?
- Scout, execute the plan





# Science Voice Commands

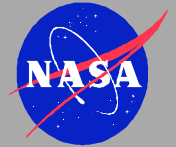





- Record a voice note.
- Continue {LAST} voice note.
- Send {LAST} voice note {# } to {EV1 | EV2 | HABCOM | EXPOC} 
- {RECORD | TAKE} a voice {NOTE | MAIL} for <AGENT>
- List voice notes.
- Create a sample bag.
- List sample bags.



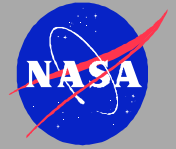


# Speech Recognition Research



- Goal: Replicate MDRS voice commanding quality in actual space suits
- Audio noise is the limiting factor
- Desert Rats '05
  - 13% Word Error; False Accept and False Recognize rates over 20%
  - Unacceptable for practical use
- Desert Rats '06
  - Significantly improved audio
  - Best results with “snoopy cap”
  - Mark III – array mic 
  - Mark III - snoopy cap 
  - I-Suit 



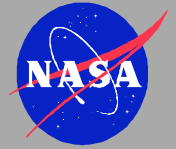


# Some Lessons Learned

- **Voice commands:** Wording, Confirmation, Contextual interpretation (e.g., “yeah”)
- **Parallel work:** Multiple voice channels &/or mute; Don’t interrupt human conversations
- **Protocols:** Should “start my next activity” cause Scout to drive?
- **Training:** Focus on recurrent sequences
- **Information Display**
  - Represent more on dynamic map
  - Diagram communication history (for ExPOC)
  - State of activity plan

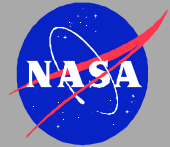


# D-RATS06 Visitor Day

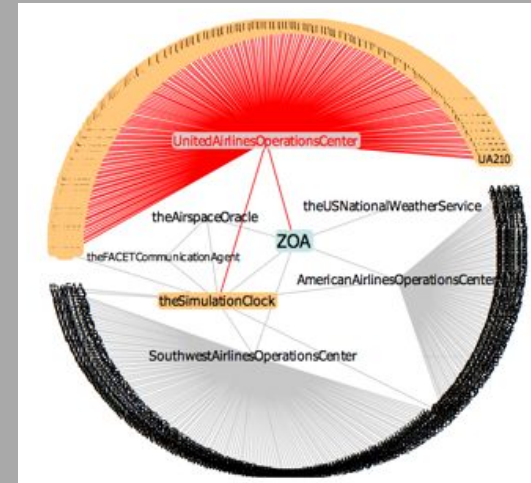




# Other Brahms/MA Projects



Power Agents at MDRS



ATC-Airline Decision Making



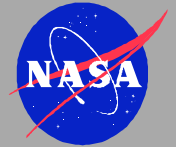
POGO: Metabolic Rate Advisor



OCAMS: ISS File Management



# *For more information...*



- **D-RATS:**  
<http://science.ksc.nasa.gov/d-rats/>
- **Brahms/Mobile Agents:**  
[www.agentisolutions.com](http://www.agentisolutions.com)
- **Publications:**  
<http://bill.clancey.name>



*Joe Kosmo wearing CAIPack assisting Keith Splawn of ILC-Dover in pressurized I-Suit*



*Desert-RATS 2006 Team*