A blueprint of an International Lunar Robotic Village

Leon Alkalai
Jet Propulsion Laboratory
California Institute of Technology
Lunar Robotics Exploration Office
June 19th 2012, EACS 2012, Genoa, Italy
Solar System Science Mission Formulation
Robotic Capabilities

**GRAIL – 9/10/2011:**
precision formation flying

**MoonRise – Proposed Sample Return**

**Lunette: Proposed Network of Small Landers**

**InSight: Proposed Robotic Payload Deployment**

L. Alkalai
Motivation and Vision

MOTIVATION:
• Human civilization is destined to look, find and develop a second habitable destination in our Solar System, besides Earth:
  – Moon and Mars are the two most likely and credible places based on proximity, available local resources and economics
• Recent international missions have brought back valuable information on both Moon and Mars:
  – Moon: GRAIL (USA) LRO/LCROSS (USA), Kaguya (Japan), Chandrayaan-1 (India), Chang’e (China)
  – Mars: MER (USA), Phoenix (USA) and upcoming MAVEN (USA), MSL (USA)

VISION:
• A permanent presence on the Moon using advanced robotic systems as precursors to the future human settlement of the Moon is possible in the near-term. An international effort should be initiated to create a permanent robotic village to demonstrate and validate advanced technologies and systems across international boundaries, conduct broad science, explore new regions of the Moon and Mars, develop infrastructure, human habitats and shelters, facilitate development of commerce and stimulate public involvement and education.
A Proposed Vision of a Permanent Robotic Village on the Moon
Robotic Assembly of Human Habitats, Infrastructure on the Moon
ATHLETE Transportation of Human Habitat Modules

6/19/2012 L. Alkalai
ATHLETE example of scale
Large Scale Landers can deliver 1-10 MT of payload
Medium Scale Landers
~ 1000 kg payload delivery to the Moon
Low –Cost Small Landers for Environmental Monitoring and Geophysical package deployment
Collaborative Assembly of Large Systems and Repair

- Collaborative precision assembly
- Collaborative lifting
- Robot repair tools
Exploring Cold Traps on the Moon using AXEL

- Cold Trap Exploration mission concept
Other Potential Exciting Robotic Projects as Precursors to Human Presence

- In Situ Resource Utilization
- Digging, sieving, movement of regolith on a small and large scale
- Studies of regolith properties, deep excavation and mining
- Pavement of roads
- Establishment of power supply stations
- Telecommunications infrastructure
- Establishment of human/robotic shelters
- Assembly of human habitat modules
- Public engagement and Education
- Mission operations studies, tele-operations, autonomous operations.
An International Robotic Village ... requires

- A common vision and leadership
- International agreements for collaboration
- Establishments of standards and procedures of interoperability
- Development of infrastructure and utility services such as:
  - power, tele-communications, storage, waste management, shelters, repair shops
Recent References and further reading

- The ISECG Reference Architecture for Human Lunar Exploration, Summary Report, ISECG Architecture Working Group, July 2010


- National Space Policy of the United States of America, June 28, 2010