

Space Resources Utilization Roundtable II

Exploration and Mining Subgroup

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In evaluation of the HEDS HTCI strategy, is it reasonable, what are the missing pieces, and what will it take to attract industry investment?

- 1) HTCI needs a vision statement in order to clearly focus near-term goals and delineate the NASA management agenda versus the planetary science/space resources community agenda.
- 2) Emphasis on missions and de-emphasis of paper studies must be inherent.
- 3) Intellectual property rights need to be explicitly addressed.
- 4) The technological driver must be explicitly stated, which is to identify space resources in support of HEDS.
- 5) Matching funds implicitly excludes small industry involvement
- 6) International cooperation must be explicitly addressed (especially in terms of (3) above).

What are the recent developments in space resources that suggest that near-term investments should be made?

Recent Developments:

- 1) Change in view
 - a) Communication market decreasing. Space as a volume or position is becoming a commodity, and a saturated one at that.
 - b) “Destination” market increasing. Space is becoming a place to go and stay, with material to exploit, not merely a volume to exploit.
- 2) Discovery of lunar hydrogen (H₂O?) “reserves”
- 3) Asteroid detections increasing from LINEAR, LONEOS, SpaceWatch, NEAT, *etc.*
 - a) We know we can rendezvous with an asteroid given experience with NEAR, so close-approach space missions are possible.
 - b) Physical characterization lags behind discovery and must catch up.
- 4) Permanent human presence in space with first permanent crew of ISS
 - a) Launch costs for consumables of human presence in space is becoming an accounting line-item.

Near-term Investments:

- 1) Determining NEO/Lunar resources
 - a) Using NESS in “characterize” mode to characterize difficult asteroids

- b) Ground-based comprehensive remote sensing data will characterize large number of NEO resources
 - c) Physically and chemically characterizing asteroids is relevant to impact hazard assessment and mitigation
- 2) Determining Mars resources
 - a) Sub-surface sampling/characterization
- 3) Developing tools for exploration
 - a) Adapting technology to new frontier
- 4) Developing resources to support permanent human presence in space
 - a) volatiles
 - b) energy
 - c) construction(?)

Exploration & Mining Sub-Group Final Statement

For exploration of space resources, NASA (in this instance, HTCI specifically) needs to initially lead reconnaissance and technology development specifically for space resource utilization. What is needed in the short-term is development of knowledge regarding the presence of space resources, knowledge which is inherently valuable, but not necessarily profitable. [Emphasize HTCI WBS 2.1 (2.1.1)]

Near-term goals in support of statement:

- 1) Determination of resources available by characterizing a large population of NEO's so that knowledge may be used to:
 - a) Decimate this population to focus on a few worthy candidates as sources for specific resources
 - b) Aid in the simulation of conditions for engineering development
- 2) Sample return from a select few asteroids to provide calibration ground truth for the remote sensing effort.
- 3) Land probes on the lunar poles to characterize the nature of the hydrogen found there.
- 4) Land pilot plants on the lunar mare for yield testing of He³ and other volatiles present.
- 5) Put forth the concept of an "Ares Prospector", akin to the mission Lunar Prospector, which can be a separate mission or series of missions to assess, on an acceptable scale, the resources available on Mars. In lieu of actual missions dedicated to such a task, to ensure that spacecraft currently slated to go to Mars will have planned into their experiments the capability to obtain data easily adapted to this goal, which is understood as being different from that of pure exploration.
 - a) Ground-penetrating radar for sub-surface investigation
 - b) Mineralogical/petrologic/morphological assessment of the Martian surface.
- 6) For each long-term HEDS mission (e.g., ISS, Mars base, lunar base), have NASA calculate and publicly announce true costs for replenishment of consumables and provide a guarantee of purchase from any entity capable of providing these consumables at same or less real cost.