Microcosm Technologies for Reducing Space Mission Cost

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The goal of cost reduction program should not be reducing cost at some undetermined future time, but instead reducing cost now, in the near-term (24-36 months), and in the long-term (2-8 years). Each technology that is proposed should include an estimate of projected cost savings over time, along with the basis of that estimate so we can judge its reality.

Low Cost Mission Engineering

Most mission cost reduction doesn't come from buying cheaper solar arrays or driving down a supplier's profit, but from the up-front mission engineering—that fuzzy process by which the mission is defined and the requirements determined. Looking broadly at new approaches to meeting mission objectives and learning from the experience of others can pay great dividends. Microcosm is one of the world authorities in both Space Mission Engineering and Reducing Space Mission Cost and can provide assistance in multiple forms:

- **Creating a Proactive Program for Reducing Mission Cost.** Microcosm can help you create a Proactive Program or Plan of Attack for your specific program or organization with multiple options to meet your specific cost and mission objectives (and help defend those options against the inevitable objections of those who want to continue business as usual).
- **Training**. Microcosm provides 3 different 5-day courses, all oriented toward reducing mission cost:
  - Design of Low Cost Space Missions
  - Responsive Space Mission Analysis and Design
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- **Mission Engineering Support.** This includes key areas critical to driving down space mission cost, such as Mission Utility and Figures of Merit, Trading on Requirements, Agile Spacecraft and Responsive Orbits, Space Mission and System Design, and bringing to bear the both the technologies and approaches from 40 years of low-cost, smallsat experiences in space.

Low Cost Missions

There are a number of key missions that are central to the US space effort for which reducing cost could have a major impact on both near-term and long-term US space costs. Microcosm has assessed each of the missions below and believes any or all of them can be implemented in the near-term with a non-recurring development cost of less than $60 M per mission and a recurring cost of less than $25 M per flight. These missions are intended to supplement, not replace, the very large and expensive assets that

are currently flying. However, even a short delay or small reduction in the number of large assets can represent a very substantial near-term savings. In addition, having a mix of large and small assets for critical missions provides greater safety if the Chinese or others choose to attack any of our major assets and gives us future choices that we do not now have on balancing the mix between large traditional satellites and much smaller, lower cost satellites in response to both economic and military needs.

- **Surveillance.** Very low cost small satellites flying at low altitudes can provide results that are as good as, and in some respects better, than those from traditional large satellites at high LEO altitudes. Visual, IR, and SAR payloads are all available.
- **Supplemental Communications.** Low cost satellites in mid-altitude circular orbits (not elliptical orbits) can provide continuous, robust communications both within an area of interest and back to CONUS.
- **Wind Lidar.** In this case, the traditional approach has been so expensive that it has not been flown. This mission can be accomplished at low cost with low altitude SmallSats. Here the cost savings are with respect to largely ground-based processes by the AF, Navy, and Army. Substantial additional savings come about from far more accurate hurricane prediction.
- **Detection of Nuclear Weapons.** This technology is not as far advanced as those above and, therefore, the cost, performance, and timeframe are less certain, although the mission can most likely be done by a low altitude smallsat. Nonetheless, being able to track both our own and other nuclear weapons from space would be a capability that could reduce errors and save both lives and money in helping to reduce nuclear threats. While the ultimate system may or may not be buildable at low cost, it is at least worth initial investigation, which can be done at very low cost.

Enabling Technologies

Microcosm has worked for many years on several key technologies that either reduce cost directly or enable very much lower cost missions.

- **Integrated Spacecraft All-Composite Pressure Structure.** Microcosm and Scorpius Space Launch Company have jointly developed a number of all composite tanks and unibody structures that can dramatically reduce the mass and cost and increase the strength of spacecraft structures.
- **Autonomous on-board orbit control and spacecraft agility.** These technologies directly reduce operations cost by automating a process that is operator-intensive. It also makes spacecraft more responsive to changing needs and conditions, thereby allowing one spacecraft to meet the needs of multiple missions.
- **Plug-and-Play.** Microcosm has played a central role in the development of smallsat plug-and-play technologies that can significantly reduce spacecraft integration and test time and cost. In addition, this can allow multiple payloads

to work on a single spacecraft bus and allow technology upgrades while a spacecraft is in storage awaiting launch.

- **Reduced Drag Spacecraft.** Flying at low altitude is a much lower cost substitute for large aperture. An 0.6 meter instrument at 200 km and costing mllions or 10's of millions has the same resolution as a 2.4 meter aperture instrument (i.e., Space Telescope looking down) flying at 800 km that costs several billion dollars. The key enabling technology to allow this is the Reduced Drag Spacecraft. With ground tests costing less then $1 M, a low-cost flight demonstration could be done in less than 2 years.
- **Scorpius Low-Cost Launch System.** Scorpius is a family of low-cost responsive launch vehicles capable of reducing near-term launch costs by a factor of 5 to 10 and of providing economical launch for small and very small spacecraft. (Payload capability to orbit ranges from 100 lbs to well over 20,000 lbs.) These vehicles are based on a number of new, yet simple and now proven technologies, including low-cost, all composite propellant tanks and engines. This is a critical technology for enabling low-cost small satellites and, in the longer term, can greatly reduce the cost of our large space systems as well.

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