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Quantifying the Cost Reduction Potential of Small Observation Satellites

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ABSTRACT

In the present budget environment, there is a strong need to dramatically drive down the cost of space missions. There is the perception that small satellites are inherently much lower cost than more traditional larger satellites and can play a central role in reducing overall space mission cost, but this effect has been difficult to quantify in the past. Without quantifiable evidence of their value, we believe that small satellites are under-utilized as a method for reducing space mission costs.

The purpose of this study is to quantify the relationship between cost and performance for space systems, by creating a *Performance-Based Cost Model (PBCM)*. Today, most acquisition performance analyses focus on cost overruns, or how much the system costs relative to what it is expected to cost. Instead, *PBCM* allows us to focus on other important questions, such as, how much performance we can achieve for a given cost, or what the cost is for a given level of performance. In this paper, we present the relationship between cost vs. orbit altitude for a fixed resolution and coverage requirement. Traditional cost models for space systems are typically weight-based, primarily because mass allocation is determined early in mission design and has historically correlated well with actual hardware cost. To provide the underlying cost data for this study, we apply three cost models widely used and trusted throughout the aerospace cost modeling community: Unmanned Space Vehicle Cost Model, Small Satellite Cost Model, and the NASA Instrument Cost Model.

Our first application is for Earth observing systems. Past Earth observation systems have used traditional space technology to achieve the best possible performance, but have been very expensive. In addition, low-cost, responsive dedicated launch has not been available for small satellites. Space system mass is proportional to the cube of the linear dimensions – equivalent to saying that most spacecraft have about the same density. This means that by flying at lower altitudes, satellites can reduce their payload size and therefore the entire mass of the satellite, thus reducing the cost of the system dramatically. This paper will show that for an Earth observation system, an increase in performance, reduction in cost, or both, is possible by using multiple small satellites at lower altitudes when compared to traditional systems. By using modern microelectronics and light-weight materials such as composite structures, future small satellite observation systems, operating at a lower altitude than traditional systems, have the potential for:

- Comparable or better performance (resolution and coverage)
- Much lower overall mission cost
- Lower risk (both implementation and operations)
- Shorter schedules

The principal demerits of the approach are the lack of low-cost launch vehicles, the need for a new way of doing business, and changing the way we think about the use of space assets. This paper provides the basis for this assessment, estimate for the level of cost reduction and the quantitative results, and reports on additional results since the 2013 Reinventing Space Conference.