Improving Space Utilization by Increasing Solar Array Reliability

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Abstract

Reliable power delivery over the mission life is critical to all satellites; therefore solar arrays are one of the most vital links to satellite mission success. However, in the last ten years Airclaims has documented 113 satellite solar array anomalies, 10 resulting in total satellite failure, making solar array reliability a serious issue. Solar array anomalies account for 38% of all power anomalies. In addition, solar array claims are much more costly than any other power system claim, as seen in Figure 1, resulting in almost half of insurance claim payouts. It is no wonder that satellite manufactures have faced criticism resulting in a negative perception and impact on the space industry as a whole, thus affecting the quality and services provided by satellite operators. Although anomalies have decreased in the last few years the consequences of previous failures still affect the industry though high insurance rates, approximately 50% of the cost of the satellite, along with new technology no longer being embraced due to increased fear of failure, and satellites are no longer seen as commodities. For the future of the satellite industry, it is imperative to increase solar array reliability.

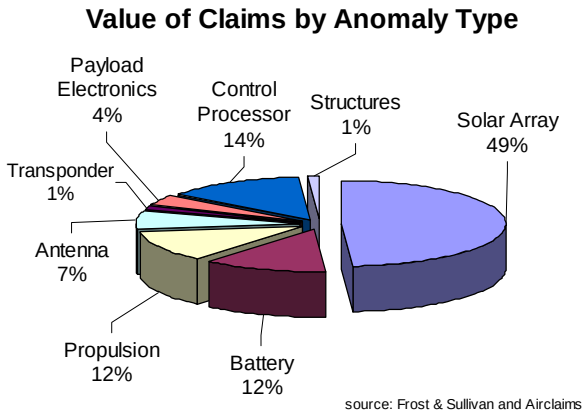
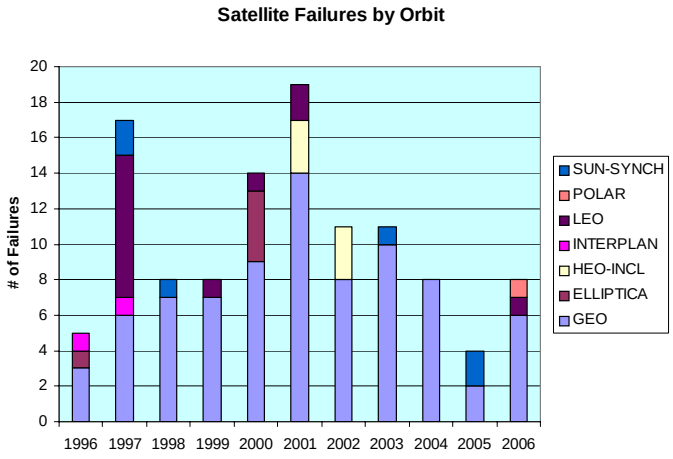


Figure 1: Value of insurance claims by type

To better face the challenge of solar array failures on orbit, more feedback is essential. The types of anomalies seen in satellites in the past ten years need to be examined and trends found. Figure 2 shows one such trend in that the number of satellite failures in GEO is significantly greater than any other orbit for the last ten years. With access to the Ascend SpaceTrak database many factors of satellite reliability have been queried and analyzed to determine which type of anomaly occurs most often, which anomaly has the greatest



insurance loss, what manufacturers are involved in the majority of anomalies, what anomalies are industry wide, what is the average timeframe after launch that an anomaly will occur, and how many of these anomalies prove fatal. In addition, it is possible to determine if the reliability of satellites is getting better or worse.

Another issue associated with satellite failures to be included is failures prior to launch. Over testing is a prime example. Quality testing versus acceptance testing is an emerging issue. There is a need for standardization of testing procedures and a limiting of what tests can be done on the actual flight hardware. Solar array anomalies show the classic infant mortality trend depicted in Figure 3. Infant mortality generally indicates that the design is poor and/or there are defects in construction. This observation raises fundamental questions about solar array designs, construction and testing prior to launch.

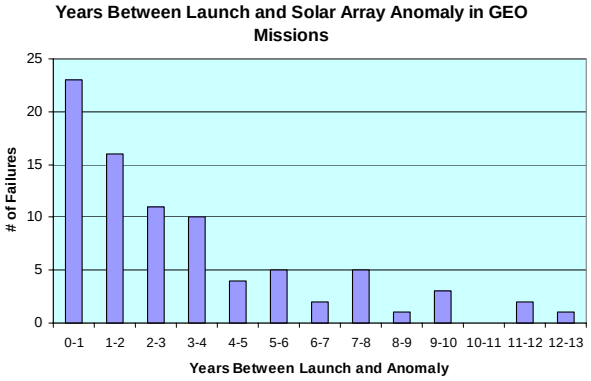


Figure 3: Years between launch and solar array anomaly in GEO

This paper will discuss power system issues with the focus on solar array reliability issues. Suggestions for next steps that could be taken by the satellite industry to improve the reliability of the solar arrays will be included. This includes the creation of an international committee on satellite failures through an underwriters' agency. While there is a legitimate reason to keep some proprietary advances, compiling a common database on orbital issues can become an integral part of overcoming some of the largest causes of on-orbit failures. A certified module and array testing facility (somewhat akin to the Underwriters Laboratory for terrestrial electrical appliances) that would be able to certify in-space reliability is potentially the answer to increasing the reliability of solar arrays while reduce their cost. Ways to improve solar arrays for high power and geosynchronous power will also be discussed in an effort to address some of the main failure trends seen in the satellite anomaly analysis. Solar array reliability is an issue that must be addressed to take space utilization to the next level.