Zombie Satellites and Lessons Learned

As of this writing, Galaxy 15 is staggering through the GEO arc like a loud drunk whose off key singing is not at all appreciated by the peaceful residents. The drunk's family (owner Intelsat and manufacturer Orbital Sciences) are trying hard to get him off the street and back in bed, but so far to no avail. Their yelling is just not getting through that besotted brain. Neighbors are being very understanding as they know they too could be in a similar circumstance, but soon the singing will be seriously disrupting to the community.

An errant satellite like Galaxy 15 is called a "Zombie Satellite" in industry lingo, but zombies are quiet, if deadly. This one is more like a loud drunken satellite…

An errant satellite like Galaxy 15 is called a "Zombie Satellite" in industry lingo, but zombies are quiet, if deadly. This one is more like a loud drunken satellite whose broadcasts threaten to create severe interference to other geostationary satellites in its path. Perhaps drunken is the wrong analogy, as clearly, the satellite was a very respectable orbiting citizen before its recent troubles and probably not to blame for its recent behavior. It is more like Galaxy 15 was drugged without its knowledge. The culprit is suspected to be "unusually violent solar activity that week that damaged the spacecraft's ability to communicate with ground controllers" according to officials at Orbital Sciences.

Orbital Sciences is doing everything humanly possible, but so far has been unable to turn off the satellite. Apparently, they have also not been able to replicate the failure with comparable components in the lab. Thanks to the high degree of autonomy built into state of the art satellites, it looks like Galaxy 15 will continue to drift and interfere for roughly three months until it becomes disoriented and loses power as its solar arrays lose their lock on the sun. Ironically, lack of sunlight may in fact be the only fix for the problem the sun caused in the first place.

LESSON #1 - Black Swans can happen to any industry and can be devastating

So what happened and what lessons are to be learned? Communications satellites like Galaxy 15 are built to withstand the vast majority of expected solar activity and even in rare events where a component is compromised there is generally a work around or a way to reset the system, but not this time. It appears to be a truly Black Swan event for the satellite industry; totally unexpected, but in hindsight probably just a matter of inevitable probability (like an oil rig not being able to restrain a violent

methane bubble, exploding and causing a multi-million gallon oil spill larger than Florida).

LESSON #1 - Black Swans can happen to any industry and can be devastating. Each industry needs to weigh the extra costs of protecting itself from these rare events and acting jointly to make sure the entire industry is protected (be it oil, banking, biotech or satellites).

LESSON #2 - The costs of failure can be devastating.

I suggest the time to take action is now. This unexpected violent solar activity happened at the early stages of what helio-physicists call the Solar Cycle, the periodic increase of sun spot activity that leads to peak solar activity before falling off again. We are now in Solar Cycle 24 and it was a late starter beginning three to three and a half years later than the average solar cycles of the last century. However, in the last few months it has been ramping up rapidly. Still, what is amazing is that we are still relatively far way from the predicted peak in May 2013. What's more, according to NOAA, Solar Cycle 24 is predicted to be the weakest since Solar Cycle 16 in 1928. Even so, NOAA experts say the Earth "could get hit by a devastating solar storm at any time, with potential damages from the most severe level of storm exceeding $1 trillion." If we can lose a satellite at this early stage in the solar cycle, what might happen at the peak in three years and more importantly what might happen at the peak of a far more robust solar cycle?

We may not yet have enough data on the distribution of solar storm intensity to truly predict the risks to the world's satellite assets. Our advanced and highly complex satellites have been operating through only a few solar cycles and our detailed measurement of solar weather in space began in the late 90s. Until we better understand the nature of solar storms, what should the industry be doing to protect its assets and customers?

LESSON #2 - The costs of failure can be devastating. It may be money well spent to increase redundancy and further harden critical components to levels not anticipated before.

LESSON #3 - Replace ACE now!

Another important lesson learned is the importance of accurate and timely warnings for solar storm activity. During periods of high solar activity, satellite operators are frequently warned in advance by NOAA's Space Weather Prediction Center of potentially harmful solar radiation. These warnings allow the operators, if necessary and possible, to configure their spacecraft to minimize the risk of

damage. The satellite used to create these warnings was launched in 1997 by NASA. It is called Advanced Composition Explorer (ACE) and sits at the L1 libration (Lagrange) point between the Earth and the Sun, over a million miles "upwind" in the space weather. At this position, ACE can measure the energetic particles streaming out from the sun up to an hour before they hit our satellites. ACE had a design life of two years and a goal of five years. The "goal" was achieved eight years ago, yet a replacement for ACE has not even been funded despite the fact that it not only helps protect our satellites but also the vastly more expensive terrestrial power and telecomm assets of the world.

LESSON #4 - Maximizing capacity utilization may enhance near term profits, but it does not provide customers with realistic back-up options

LESSON #3 - Replace ACE now! Replace ACE with a more capable system that can provide satellite operators with more accurate and actionable information. Furthermore, given the track record established with NPOESS, the replacement is too important to be trusted to NOAA. NASA or the U.S. Air Force would be better project managers, but perhaps even better would be to privatize this service and allow a commercial entity to offer the data globally. A commercial entity would have the profit motive to make sure the data received maximum distribution.

Perhaps the most immediate and obvious lesson learned was the importance of ready back-up capacity. Luckily, Intelsat was able to efficiently off-load its 24 C-band transponders of media customers from Galaxy 15 at 133º West to Galaxy 12 at 125º West and with little to no service interruptions. Will other operators be able to offer this same service level commitment in such situations? The cost of satellite transmission is a small part of the value chain for media companies, but the loss of transmission is catastrophic. We expect media customers will increasingly insist on very robust back-up capabilities. The Galaxy 15 lesson will not have been lost on these customers. Looks like a huge competitive advantage to us and one worth a nice price premium for capacity.

LESSON #5 - Large fleet operators have a natural advantage over small fleet operators in providing higher service level commitments

LESSON #4 - Maximizing capacity utilization may enhance near term profits, but it does not provide customers with realistic back-up options in the event of anomalies and other emergencies. Losing customers and their long-term contracts is a lot more expensive than losing satellites.

LESSON #5 - Large fleet operators have a natural advantage over small fleet operators in providing higher service level

commitments. Small fleet operators need to create alliances for back-up emergencies and should consider launching two smaller satellites versus one large satellite in markets where customers will pay a price premium for the extra safety.

LESSON #6 - Satellite insurance is a luxury, not a right

Another aspect of this event that bears mentioning is the potential impact to the satellite insurance industry. The satellite insurance industry routinely handles the total loss of one or even a few satellites, but what would happen if a major unprecedented solar storm turned a hundred satellites into zombies? This Stellar Night of the Living Dead may be a low probability event, but it could end satellite insurance as we know it for decades. The space insurance sector of the property and casualty industry is just too small to matter to most underwriters. It is not too big to fail. Whereas the property and casualty insurance companies have to stay in the business after a Katrina or a 9/11, there is no compelling profit motive for them to bother continuing to write in-orbit satellite coverage following a similarly costly and unexpected event in space. The aggregate annual premiums are just not significant enough.

LESSON #6 - Satellite insurance is a luxury, not a right. It can go away quickly. Black Swan events do not appear to be priced into the premiums. Satellite insurance may be a better deal than most operators think. Those operators that self-insure much of their fleet are bearing a hidden level of catastrophic risk.

LESSON #7 - It is time to give non-geostationary orbits like MEOs and elliptical constellations greater consideration

A drifting zombie satellite also highlights another important issue and that is just how crowded the GEO arc has become. Spaced two degrees apart and with many orbital slots holding multiple satellites, the GEO arc is now well populated with hundreds of satellites. That is not to say there is not room for many more satellites. There certainly is and especially for Ka-band, X-band and other as yet developed spectrum. However, for C and Ku-band things are getting a bit cozy. With the developing world developing, HD and soon 3D video proliferating and satellite broadband ramping up quite nicely, we need to find more space in space.

Perhaps it is time to put less of our space segment eggs in this crowded basket and exploit other viable constellation architectures. O3b Networks Ltd plans to put 8 – 16 satellites in a medium Earth orbit (MEO) versus geostationary orbit to provide connectivity to the equatorial region. Sirius XM Radio Inc. broadcasts audio content to

approximately 20 million customers using elliptical orbits. Perhaps even more interesting is the Virtual GEO concept where a specially configured set of elliptical orbits can create what appears to be geostationary satellites at latitudes well above or below the equator, thus greatly expanding the number of available orbital slots for all bands.

LESSON #7 - It is time to give non-geostationary orbits like MEOs and elliptical constellations greater consideration.

Lastly, it occurs to me that the best way to get a drunk of the street is with a policeman walking his beat. For zombie satellites, the best solution might be to finally put into operation an in-orbit satellite servicing and disposal capability. Space tugs and such have been talked about for decades, but we may finally have the robotic technology and tele-presence to actually make it work and affordably too. Two of the commercial initiatives NASA is now studying involve in-orbit servicing and fuel depots in space. These are capabilities that could be important for future NASA and DOD missions, but they also have significant commercial satellite applicability. One application would be to rid the GEO arc of zombie satellites and other space debris to protect operational satellites. It is expected that Galaxy 15 will drift until it comes to rest in one of the libration points in GEO. These are at 75º East and 105º West. There are over 100 dead satellites currently resting in these graveyards. That's a lot of spare parts. Sounds like a good salvage business for the future. Another application would be to repair satellites in orbit to extend their lives or upgrade their capabilities. Fuel depots could similarly extend satellite lives through fuel replenishment, but more importantly could allow satellites to be launched with bigger payloads and less fuel. Finally, having a fuel depot and/or a space tug could allow much greater flexibility in space segment utilization as satellites could more easily and expeditiously be relocated when desired to serve changing market needs.

LESSON #8 - robotic in-orbit servicing, space tugs and fuel depots may soon make economic sense

LESSON #8 - The magnitude of the world's in-orbit assets is reaching a critical mass where developing capabilities such as robotic in-orbit servicing, space tugs and fuel depots may soon make economic sense and allow us to reduce the risks of zombie satellites once and for all.

By Hoyt Davidson
Near Earth LLC

IMPORTANT DISCLOSURES AND INFORMATION ABOUT THE USE OF THIS DOCUMENT:

Near Earth, LLC ("Near Earth") has published this report solely for informational purposes. The report is aimed at institutional investors and investment professionals, and satellite, media and telecom industry professionals. This report is not to be construed as a recommendation or solicitation to buy or sell securities. The report was written without regard for the investment objectives, financial situation, or particular needs of any specific recipient, and it should not be regarded by recipients as a substitute for the exercise of their own judgment. The content contained herein is based on information obtained from sources believed to be reliable, but is not guaranteed as being accurate, nor is it a complete statement or summary of any of the markets or developments mentioned.

The authors of this report are employees of Near Earth, LLC, which is a member of FINRA. The opinions expressed in this report accurately reflect the personal views of the authors but do not necessarily reflect the opinions of Near Earth itself or its other officers, directors, or employees.

The portions of this report produced by non-Near Earth employees are provided simply as an accommodation to readers. Near Earth is under no obligation to confirm the accuracy of statements written by others and reproduced within this report.

Near Earth and/or its directors, officers and employees may have, or have had, interests in the securities or other investment opportunities related to the companies or industries discussed herein. Employees and/or directors of Near Earth may serve or have served as officers or directors of companies mentioned in the report. Near Earth does, and seeks to do, business with companies mentioned in this report. As a result, Near Earth may have conflicts of interest that could affect the objectivity of this report.

This report is subject to change without notice and Near Earth assumes no responsibility to update or keep current the information contained herein.

Near Earth accepts no liability whatsoever for any loss or damage of any kind arising out of the use of all or any part of this report.