The business case for satellite life extension: running on empty

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Imagine if you had to scrap your car when it ran out of petrol. This, essentially, is the situation that satellite operators find themselves in. Geostationary satellites are usually designed for a working life of around 15 years. A lot of effort goes into the design and testing of their components to ensure high reliability. Consequently, most satellites are retired not because of component failure but because they run out of fuel for their thrusters. This article assesses the viability of using space tugs to extend the working life of satellites.

Space tugs offer a simpler alternative to re-fuelling satellites in orbit

Satellites have solar panels to generate electrical power for their communications payload and operations such as attitude control (that is, keeping their antennas pointing in the right direction). Nevertheless they require thrusters for station-keeping (that is, maintaining a fixed orbital position).[1] Therefore, the idea of being able to re-fuel satellites in orbit is inherently attractive. Unfortunately, it is difficult to achieve because many different types of fuel valve (the equivalent of a car's petrol tank cap) are available and existing valves were not designed to be robotically opened and resealed after many years in space.

An alternative approach is to use a space tug, a separate spacecraft that docks with an existing satellite and takes over station-keeping, and in some cases attitude control as well. The tug approach is technically much simpler because no fuel is transferred. In theory, using a tug is less energy-efficient than re-fuelling because a tanker can detach once re-fuelling is complete, but a tug must station-keep its own mass as well as that of the satellite for the duration of its mission. However, this issue can be mitigated by incorporating recently developed and more fuel-efficient electric thrusters into tug designs, while for now tankers need to carry the chemical fuel that most existing satellites use.[2]

Tug providers intend to charge according to the expected value of their services to individual satellite operators

Two companies, Orbital ATK and Effective Space Solutions, have announced the imminent launch of tug systems for satellite life extension. Orbital ATK's system was originally developed by ViviSat, a joint venture (JV) between ATK Systems and U.S. Space. It is based on a medium-sized (2–3 ton) spacecraft bus using a combination of chemical and electric propulsion, and provides both station-keeping and attitude control for up to 15 years. Effective Space Solutions, a UK-based company, has developed a much smaller all-electric

1 Most of the fuel is required to maintain North–South control, counteracting the gravitational pull of the sun and the moon. Lesser amounts are required to maintain East–West control (that is, control of the orbital period). Consequently, satellites that are low on fuel are often placed in inclined orbit, where East–West control is maintained, but North–South control is allowed to drift. Attitude control is typically maintained using reaction wheels powered by the satellite's solar panels but the wheels build up excess momentum over time and thrusters need to be fired occasionally to slow them down.

2 Electric thrusters still consume chemical propellant but achieve higher efficiency than traditional thrusters by employing electric fields to expel propellant at high velocity as an ionised gas or plasma.

platform weighing around 350kg, allowing the spacecraft to be launched as a rideshare with other satellites. It is designed to provide station-keeping only (with attitude control provided by the satellite to which it is attached) and its expected service life is at least 7 years.

So what about the economics? The upfront cost of a large geostationary satellite including the satellite itself, launch and insurance is typically USD300–350 million. The weighted average cost of capital (WACC) for large satellite operators is around 7.0–9.0% per annum, suggesting that the value to an operator of deferring satellite replacement is USD20–32 million per annum. Ordinarily it would be difficult to find out how much tug providers actually charge, but Orbital ATK is in a legal dispute with U.S. Space and recently filed court papers that show the prices that the now-dissolved ViviSat JV had agreed with prospective customers (see Figure 1).[3]

Figure 1: Expected revenue from ViviSat's satellite life-extension service [Source: U.S. Space papers filed with the Supreme Court of the State of New York, 2016]

Operator	Lease term	Annual lease cost (USD million)	Revenue over lease term (USD million)	Implied average annual price per tug (USD million)
SES	3 years	10–12	33	11
Hispasat	3 years	8–14	35	11.7
Intelsat	5 years (2 tugs)	24	120	12
Asia Broadcast Satellite	3 years	13	39	13
Measat	5 years	13–15	71	14.2

These figures suggest that ViviSat was intending to price based on the expected value of its service to individual operators (that is, taking account of variations in their WACC) and was planning to split the economic benefits roughly 50:50 with its customers, although the margin on these early sales must have been slim once ViviSat's costs were subtracted. Effective Space Solutions also intends to price according to expected value, while relying on its small spacecraft cost structure to improve the business case.

Besides simply extending the life of a station-kept satellite, tugs can also be used to de-orbit satellites that have become stranded in geostationary orbit (freeing up space for new satellites) and bring satellites in inclined orbit back to station-kept orbit (significantly increasing their revenue-earning potential). Perhaps most interestingly of all, tugs can relocate satellites to new geostationary orbital positions. Relocation gives operators the chance to test the market in new geographies at relatively low cost before committing to the expense of a new satellite. At a time when the industry faces many uncertainties from terrestrial competition and the development of high-throughput and low Earth orbit satellites, this flexibility could be a deciding factor in persuading operators to hand over the keys to tug providers.

Analysys Mason works extensively with satellite operators and service providers and their investors on market forecasting, business planning and transaction support projects. For further information please contact Philip Bates at philip.bates@analysysmason.com.

3 Supreme Court of the State of New York case index number 652303/2016, 29 April 2016.

