Delving deeper into...

In-orbit satellite servicing

Orbital ATK, a pioneering NewSpace company in many ways, has made heavy investments to deliver in-orbit satellite servicing capabilities in the next couple of years. Its subsidiary company, SpaceLogistics LLC, is developing the Mission Extension Vehicle (MEV) as we speak, in order to deliver life extension services that are flexible, scalable, capital-efficient and low-risk. Amy Saunders visited the state-of-the-art Rendezvous, Proximity Operations and Docking (RPOD) facility at Orbital ATK’s headquarters just outside of Washington D.C to learn more about the program.

The satellite business is an expensive game to be in; from design, manufacturing, insurance, launch and operations, bringing a satellite to orbit can easily cost hundreds of millions of dollars. And yet, they only last around 15 years until the onboard fuel is depleted; the satellite can no longer maintain its orbital position, even though the critical components could operate for another 10-15 years. Orbital ATK and its SpaceLogistics subsidiary have found the right solution, at the right time.

A Mission Extension Vehicle

We’ve all heard that SpaceLogistics plans to provide cooperative in-orbit satellite life extension and manoeuvring services to GEO satellite operators using its Mission Extension Vehicle (MEV). It will enable satellite operators to significantly extend satellite mission life, activate new markets, drive asset value and protect their franchises. According to SpaceLogistics, its life extension services are flexible, scalable, capital-efficient and low-risk.

SpaceLogistics isn’t the only entity investing in satellite life extension services, but it is unique in its approach. “Our MEV is doing what I call ‘docked life extension.’ It does both the orbit control, the propulsion, as well as attitude control, and stays docked for the entire duration,” said Joe Anderson, Vice President of Business Development and Operations for SpaceLogistics, LLC. “One of our competitors is taking the refuelling approach; they’ll be docked for a short time, they’ll do surgery on the spacecraft to refuel, and then they’ll leave. That’s the difference.”

The two approaches have very different risk profiles. “Our risk profile is very low. but we’re there for a long period of time, while theirs is very high, I would say, but for a shorter duration,” explained Anderson.

SpaceLogistics’ MEV docks with customers’ existing
satellites to provide the propulsion and attitude control needed to extend their lifetimes. Based on a modified GEOStar 3 bus, the MEV will safely dock with about 80 percent of geosynchronous satellites in orbit today using two key features on the client spacecraft: “We can service any GEO satellite which has a liquid apogee engine and a launch adaptor ring. About 80 percent of all GEO satellites in orbit today have those features,” confirmed Anderson. Most of the 20 percent of satellites that aren’t compatible with the MEV were placed directly into GEO, so while they have launch adaptor rings, they don’t have a liquid apogee engine.

The MEV has three different types of sensors that it uses for the rendezvous and docking with the client satellite: Visible, infrared, and LIDAR. “The MEV will use these sensors to guide itself as it approaches the client satellite, the MEV will circumnavigate it a few times as it spirals in closer. The images from these sensors will also be transmitted to the ground where operators will monitor and control the rendezvous sequence.” explained Anderson.

The MEV utilises a simple mechanical docking system that attaches to existing features on the client satellite, creating a firm connection between the MEV and the client satellite. During the final stage of rendezvous, it approaches the client satellite in stages, pausing at 80m, 20m and 1m away from the client satellite for further instructions from the control centre. “At the 1m waypoint, when everything is ready, and we’re coordinated with the client, we begin the docking. The client will first send a command to their satellite to disable their attitude control, and, moments later, we send the docking command and our capture mechanism enters the liquid apogee engine, fingers deploy inside the nozzle creating a soft capture, and then the mechanism is retracted pulling the two vehicles together causing three stanchions on the MEV, which are like large feet, to press up against the launch adaptor ring. The push-pull tension between the stanchions and the capture mechanism creates the firm connection between the two vehicles. That’s our docking mechanism,” explained Anderson.

How automated is the process? “The operation of the MEV is very similar to the operation of any GEO satellite. The rendezvous and docking operations will last around 20m and 1m away from the client satellite for further instructions from the control centre. “At the 1m waypoint, when everything is ready, and we’re coordinated with the client, we begin the docking. The client will first send a command to their satellite to disable their attitude control, and, moments later, we send the docking command and our capture mechanism enters the liquid apogee engine, fingers deploy inside the nozzle creating a soft capture, and then the mechanism is retracted pulling the two vehicles together causing three stanchions on the MEV, which are like large feet, to press up against the launch adaptor ring. The push-pull tension between the stanchions and the capture mechanism creates the firm connection between the two vehicles. That’s our docking mechanism,” explained Anderson.

Once docked, the MEV will safely dock with about 80 percent of geosynchronous satellites in orbit today using two key features on the client spacecraft: “We can service any GEO satellite which has a liquid apogee engine and a launch adaptor ring. About 80 percent of all GEO satellites in orbit today have those features,” confirmed Anderson. Most of the 20 percent of satellites that aren’t compatible with the MEV were placed directly into GEO, so while they have launch adaptor rings, they don’t have a liquid apogee engine.

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In-orbit satellite servicing has been on the cards for many years, but it’s only now that it’s becoming a reality. The potential applications span all GEO satellite operators: “We’re a commercial business, targeting the operators or anyone who needs our service, including government satellites,” said Anderson.

SpaceLogistics’ MEVs have a 15-year design life and sufficient fuel to enable well in excess of 15 years of station kept life while docked with a typical 2000kg geosynchronous satellite. The rendezvous, proximity and docking systems of the MEV allow for numerous dockings and undockings during the life of the MEV.

Commenting on his expectations of typical contract durations, Anderson said: “I think shorter-term contracts are more likely; our business expects five-year or so life extension contracts.” He continued: “The typical concept is that a satellite is designed for 15 years, and usually it has fuel for 16 years, but a lot of the satellites being de-orbited today are healthy; they’re just out of fuel. Those that have lasted longer with enough fuel have operated satellites for much longer, some 20-25 years. The electronics and other components can survive and work just fine. Our estimate is that the average operator would want to extend the satellite from its 16th year to its 21st year, but we’re open to doing it as long as the satellite is healthy.”

The business case is all about capital deferment. “To buy a replacement satellite, depending on the size and complexity of the communications payload, that replacement satellite could cost anywhere from US$150 to US$400 million,” said Anderson. “Now, the operator can lease a service from us to extend their life for a reasonable cost and shift that huge US$150 to US$400 million into somewhere else. The potential is enormous.”
So far, Intelsat has placed two orders for satellite life extension services from Orbital ATK. MEV-1 will be launched later in 2018 to service the Intelsat-901 satellite in GEO for five years. “After we launch our vehicle, it’ll take us several months to get out to GEO, and as we’re doing that orbital raise, Intelsat will raise the orbit of its satellite to rendezvous together out at the graveyard orbit,” explained Anderson. “Their communications payload will be off during the process. We’ll then move the satellite into its next orbital position, back down in GEO.”

After the five-year contract is complete, MEV-1 will move the Intelsat satellite back to the graveyard orbit and detach before moving on to its next client satellite. MEV-2, meanwhile, will perform the same service for another Intelsat satellite, with services kicking off in the first quarter of 2020. Anderson confirmed that SpaceLogistics is not yet marketing the years following the initial five for either MEV-1 or MEV-2.

There’s more to the MEV’s capabilities than straightforward life extension services as well. “Approximately every year and a half, there’s a launch that doesn’t meet its objectives, and a satellite is delivered into a non-optimal orbit,” said Anderson. “Normally, they can get out to GEO using their own fuel, but then they have no fuel left for operations. Our recommendation is that those satellites use their own fuel to get to GEO, and then they use our life extension services to get the full lifetime out of their satellite.” While SpaceLogistics could launch and rescue those satellites from where they’re dropped into orbit, that would be an inefficient approach.

The MEV can do life extension in GEO, but it can also retrieve a satellite that’s in an inclined orbit, and bring it back to geostationary orbit. “That requires extra fuel, and that’s why we have additional fuel beyond the 15 years,” explained Anderson. “There are actually two propulsion systems on board the MEV: the primary electric propulsion system runs on Xenon for station keeping, there’s also a hydrazine chemical propulsion system, which is used for the rendezvous and docking, when six degrees of freedom is needed to stay in full control and avoid collisions. Hydrazine propulsion systems provide a more robust control authority.”

Moving beyond MEV
In March 2018, Orbital ATK announced the next step in its in-orbit satellite servicing plans: A new robotic servicing system that provides additional options for customers to enhance the value of their satellites.

The new system consists of two products, Mission Robotic Vehicles (MRVs) and Mission Extension Pods (MEPs), which will provide customers with more flexibility to extend the life and effect repairs to satellites in-orbit. The MEP is an external propulsion module that attaches to and provides up to five years of orbital life extension for aging satellites which are running low on fuel but are otherwise healthy. “It’s another way to do the life extension for the client, although the MEP does not do attitude control,” added Anderson.

While the primary application of the MRV is to transport and install MEPs or other payloads on customer satellites, it will also offer space robotic capabilities for in-
easy augmentation. So, instead of trying to do refuelling surgery on a spacecraft, or remove a component and put a new component in, such as a momentum wheel, a new communications system, or a new battery, we can simply replace any of those functionalities through this one interface.

“Through this one interface, you could replace any failed item in orbit. That’s our idea for making satellites more serviceable in the future.” He added: “There are always going to be some elements that we can’t fix through this interface; a transponder within the communications payload, for example, that may be more difficult to fix.”

SpaceLogistics is also working on a significant contract with NASA, namely Commercial Infrastructure for Robotic Assembly and Services (CIRAS), “for in-orbit assembly of large space structures. The contract we have right now is for the ground demonstration of those technologies, which is going to happen this year,” said Anderson. “NASA is expected to issue a proposal very shortly for phase 2 of that, which would try to take it to an in-orbit demonstration, nominally in the early 2020s.”

Outlining SpaceLogistics’ long-term plan, Anderson concluded: “Ultimately, our goal is to have another satellite in orbit, a Mission Assembly and Repair Vehicle (MARV), that could build these large space structures.”

“We look forward to hearing more about MARV in due course...”