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École
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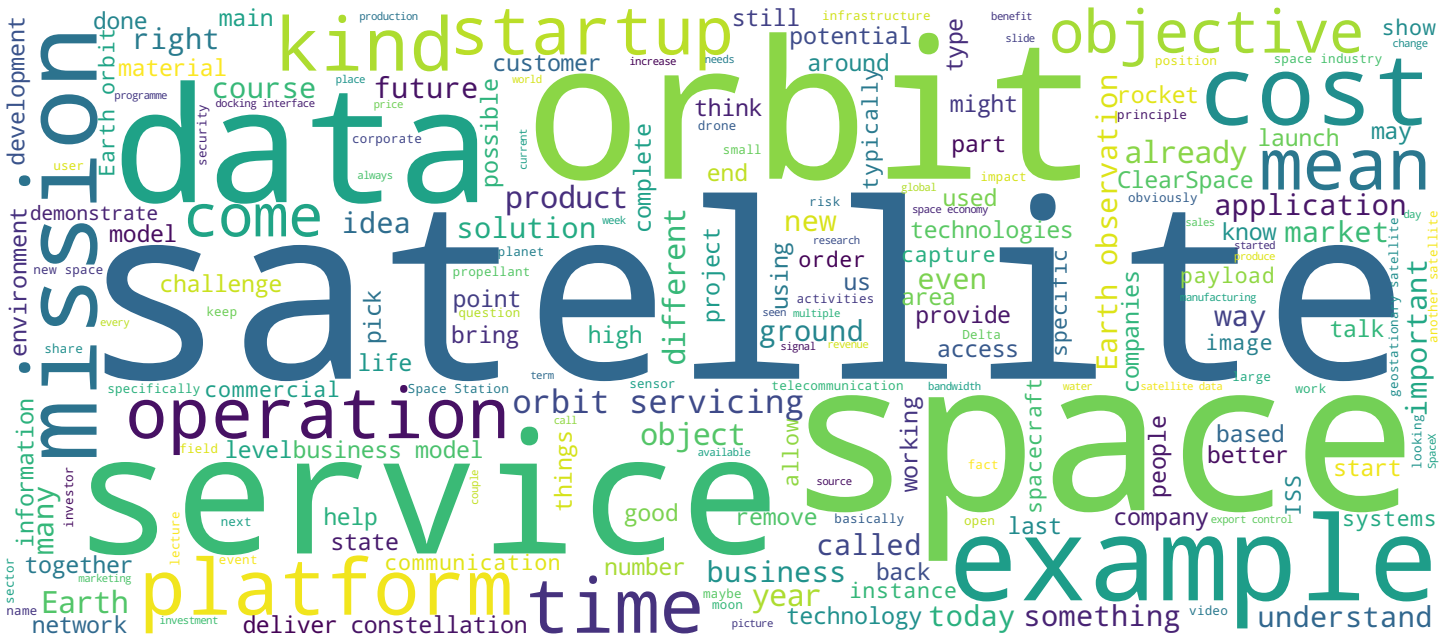
In-Orbit Servicing

New Space Economy

Luc Piguet

ClearSpace SA



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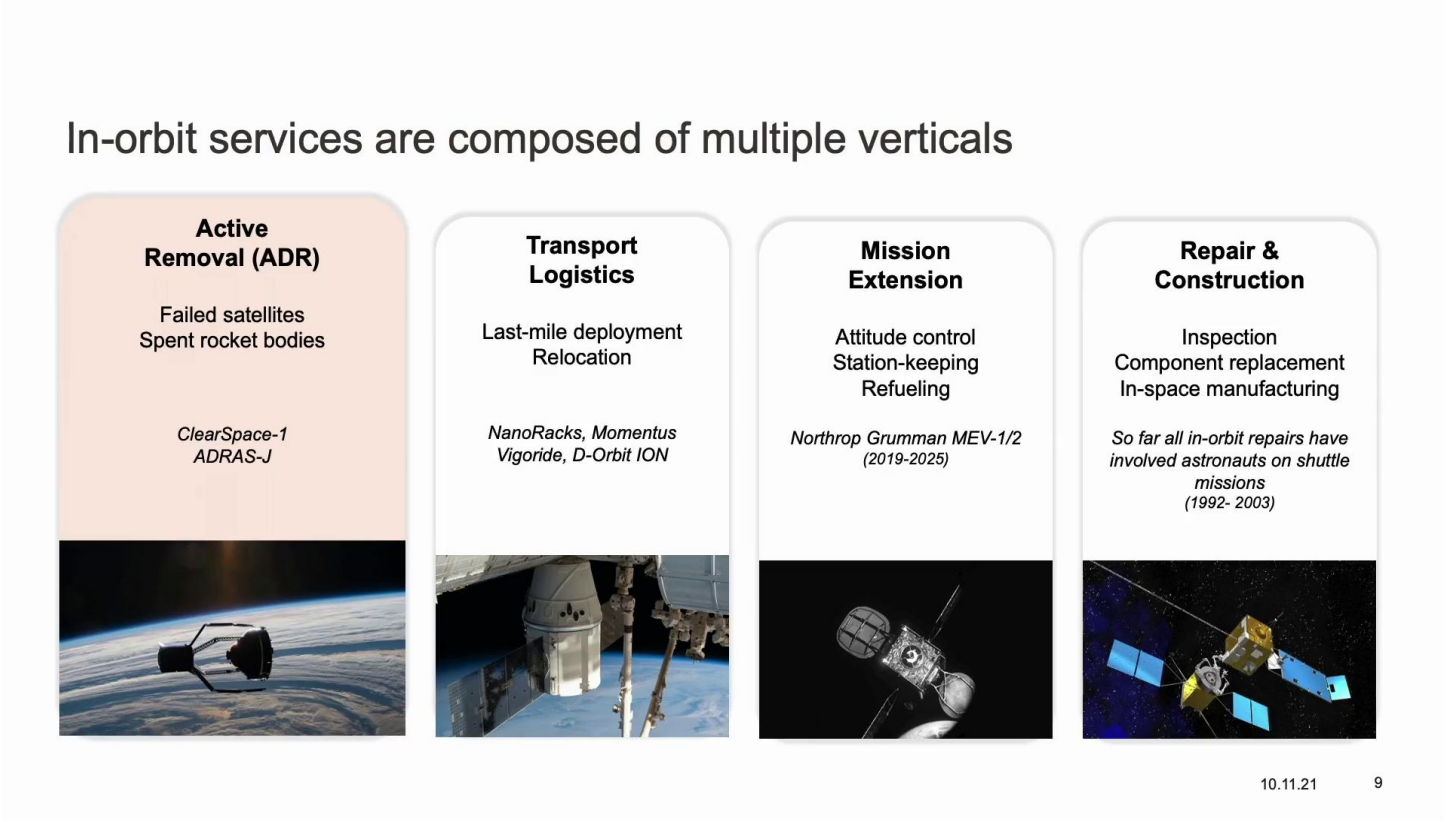
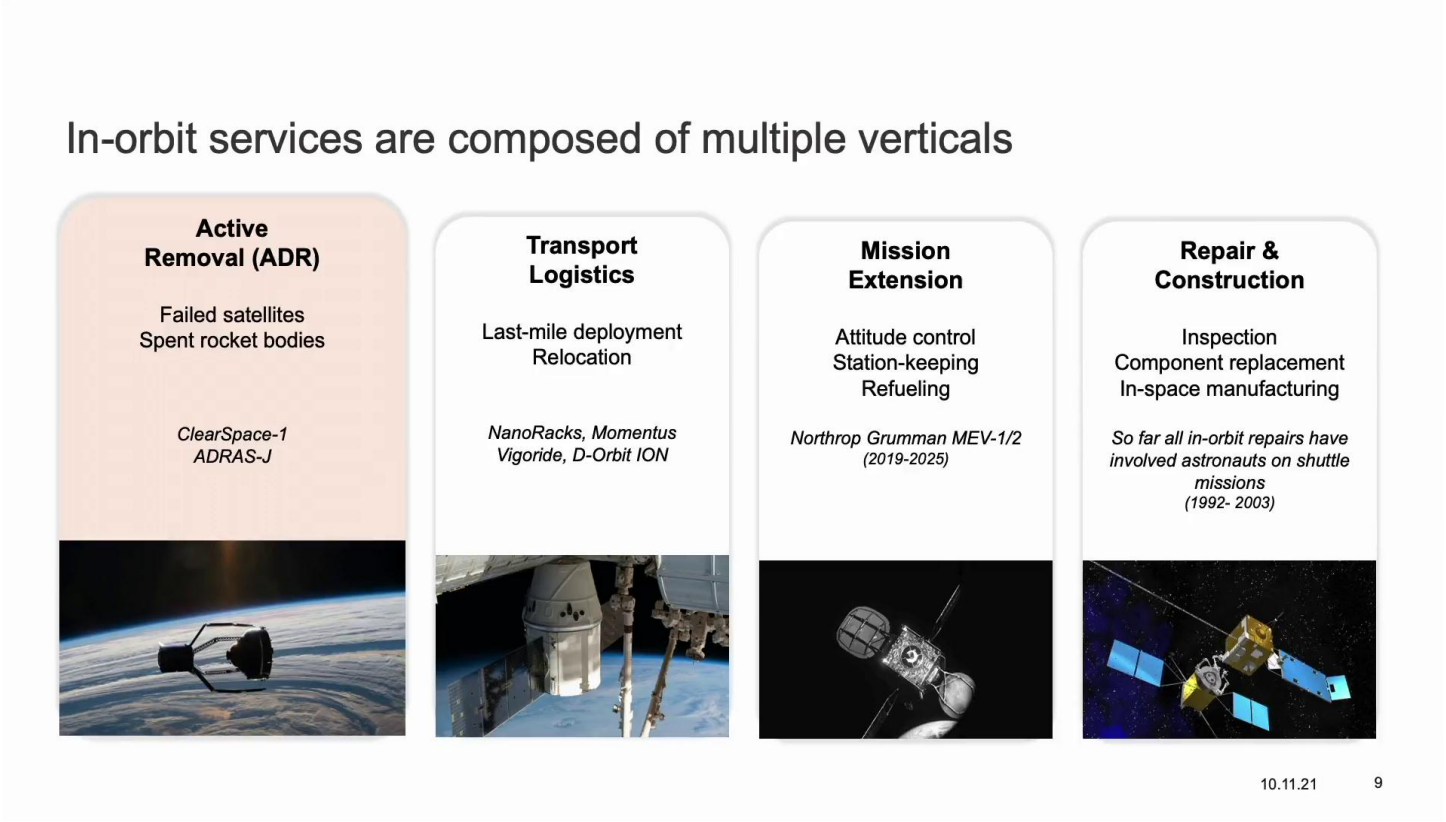


In-orbit servicing has different verticals. There are different ways to present them, but this is a way that helps structuring what kind of services do what. The first one is active debris removal. This means being able to interact with the non-cooperative objects in orbit and go pick it up and remove it, or change its orbit. There are a couple of startups and a couple of missions working on those challenges. The first one is obviously ClearSpace-1, which is an ESA mission, which has an objective to pick up one of the ESA-owned debris and remove it by 2025, 2026. The other mission in progress right now is ADRAS-J by Astroscale, which is a JAXA mission, where the objective first is to go inspect a rocket body, and then later on do a mission to go pick it up and remove it from orbit. There's another vertical, which is transport and logistics. We will have to carry more and more materials and obviously, today, people in-orbit. There's already the Dragon capsule, where we bring all the ATV, or the Soyuz, where we bring either astronauts or materials or consumable up to the ISS. But in the future, as we want to operate on the moon, on other planets, and continue exploring space, we will need more of that kind of services.

Notes

Summary

0m 06s



Beside that, we also need to be able to deliver platforms into the right orbits. And that's typically services provided by actors like Momentous, or D-Orbit in Italy, or Nanoracks, for example, work on that kind of solutions. There's another dimension which is mission extension, which is essentially helping a satellite to provide a few more years of its services. And that can be done by either refueling a satellite. Today, no satellite are pre-equipped with refueling valve, but a lot of people work on that kind of technologies. But what happens today is typically what we do is attitude control takeover, which means that a satellite will pick up another satellite and hold it into position. And the last one, obviously, is repair and construction, which is further away. It is very challenging to do the robotics in-orbit, but a lot of projects have been done in that direction, and we expect that over time, those technologies will come to a level of maturity, making that kind of services possible.

Notes

Summary

1m 32s

Projects roadmap

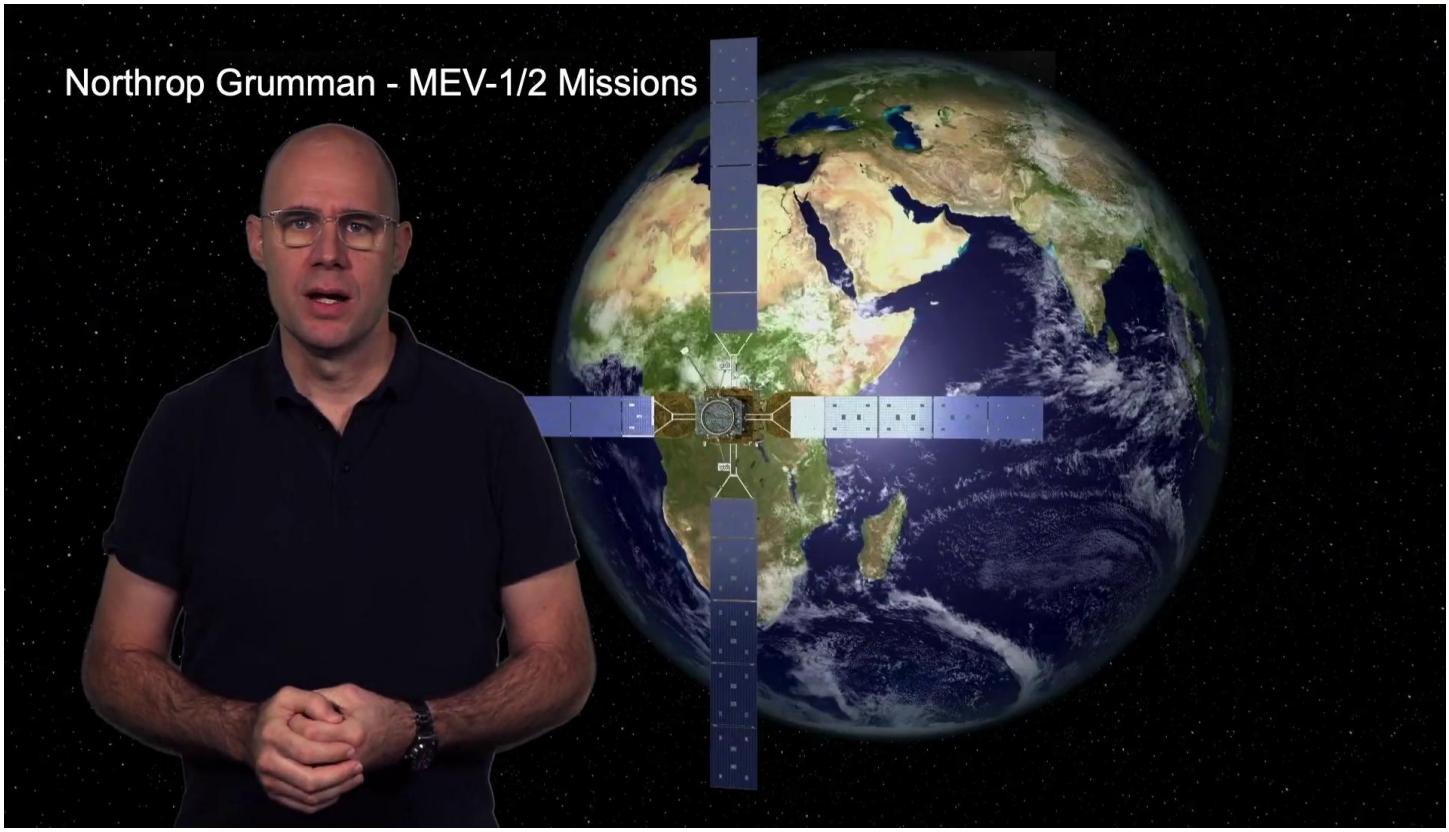
- **Life extension:** NG MEV-1
- **End of Life & ADR:** Astroscale Elsa-d, ClearSpace-1
- **Refueling:** OrbitFab

So here, we're just going to look at a few missions to give you an idea of what kind of close and further away roadmap do we have in space. And typically, we'll be looking at life extension, end of life and ADR, and refueling, which are three of the most mature activities for in-orbit servicing.

Notes

Summary

2m 34s

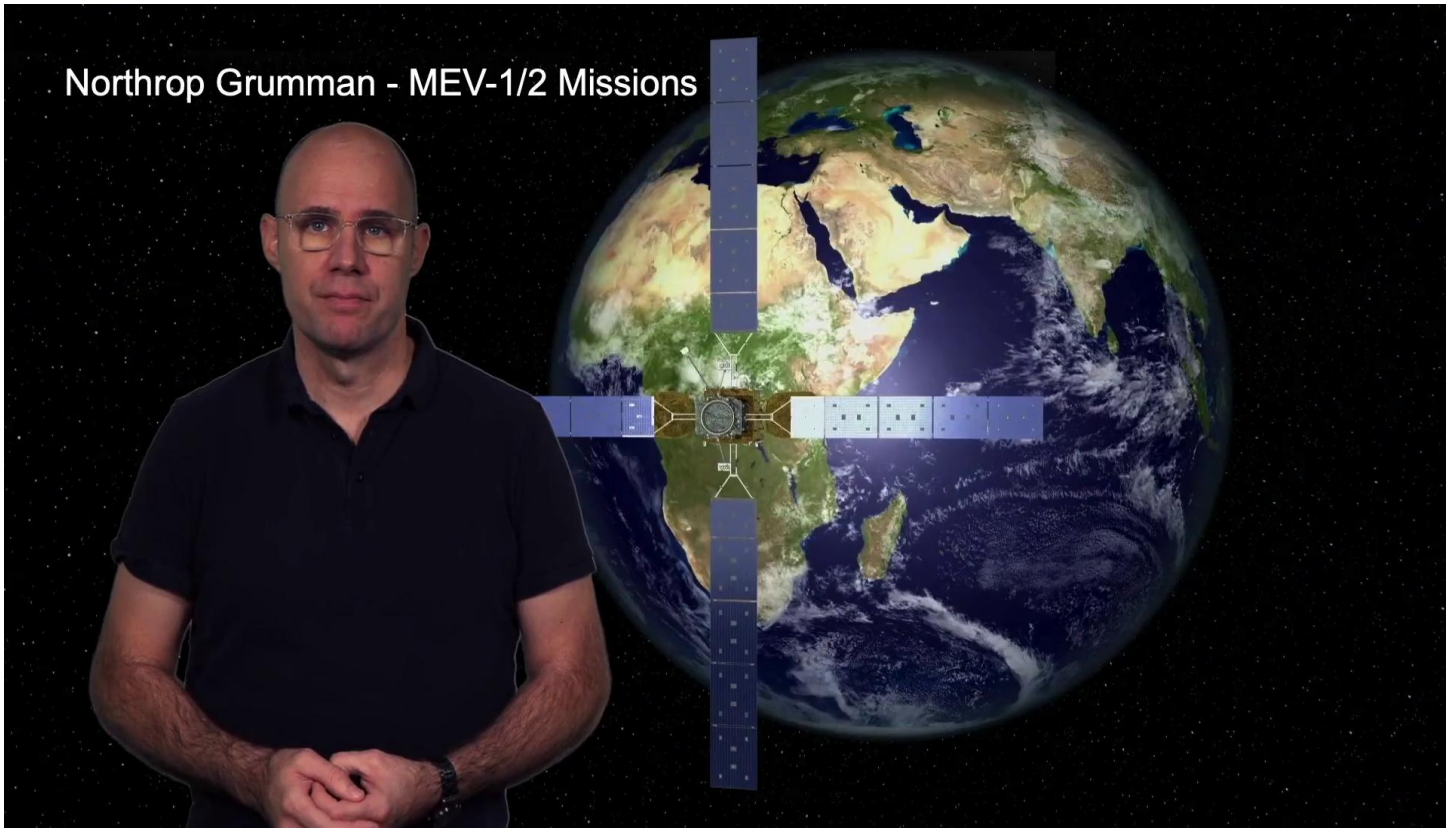


When it comes to life extension, the principle, the idea is to get with a platform to capture another satellite. And this mission you see here is called the MEV by Northrop Grumman, which approached another satellite, introduced a capture system inside of the funnel of the propulsion system, and then pull the platform together to be able to actually hold on to the satellite and keep a geostationary satellite into an operational position in a geostationary slot in-orbit. This principle is relatively simple at first sight. There's several challenges that have to be handled. Obviously, the geostationary satellite that is serviced will not be able to use its propulsion anymore and will have to give over the control of its attitude to the servicing satellite. And that can be done for a period of time of, let's say, for example, five years, which would allow for a satellite to have five more years of life in orbit when it's got no more propellant, and then the servicer can just remove the satellite, place it into a graveyard orbit, and go service somebody else. So this is one example. Northrop Grumman has flown two of those missions.

Notes

Summary

2m 55s



MEV-1 has captured an object that was a satellite that was in graveyard orbit and placed it back into operation. And MEV-2 actually docked with a satellite already in operation and maintained it for a while. And I think that's a very challenging operation, because what you want to do is to be able to capture the geostationary satellite while it's operational, hold it, hand over the AOCS to the servicer without cutting services to the clients on the ground, which is quite challenging to do. So the business model for that kind of services is quite straightforward. It's a cost of service per year. And for the geostationary operator, it's quite easy to calculate. You see how much revenue your platform is doing, how much it costs to replace it, and how many years you can actually use it, continue using it. What is the cost of the service? And you can calculate your return on investment in that kind of operation.

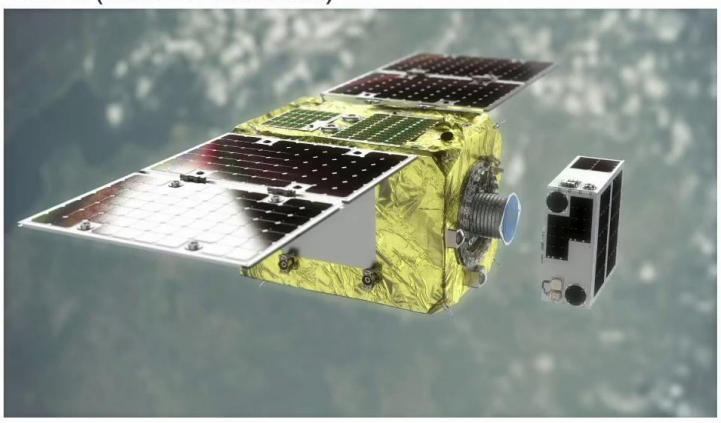
Notes

Summary

4m 09s

End of Life management and ADR

Elsa-d (source: Astroscale)



ClearSpace-1 (source: ClearSpace)

When it comes to End of Life management and ADR, there are two missions today really running for that. There's obviously more startups and companies working on the problem of active debris removal or handling the end of life of satellites when they fail. But today, the main players that actually are either on a mission that is paid or are currently demonstrating orbit is Astroscale in Japan and ClearSpace in Switzerland. Astroscale is currently flying the Elsa-d demonstration mission, where they demonstrate a magnetic docking interface to be able to capture a satellite in-orbit that is pre-equipped with a docking interface for servicing. The case of ClearSpace-1 is a little different. The objective of ClearSpace-1 is to address completely non-coopeerative platforms in orbit, which means any platform that is uncontrollable and that has no docking interface pre-installed. So this is really the worst case possible when it comes to in-orbit servicing. And the objective of the ClearSpace-1 mission is to demonstrate the complete value chain of a complete removal, which means that this mission has this objective to actually pick up a debris that is already in orbit, which is a first.

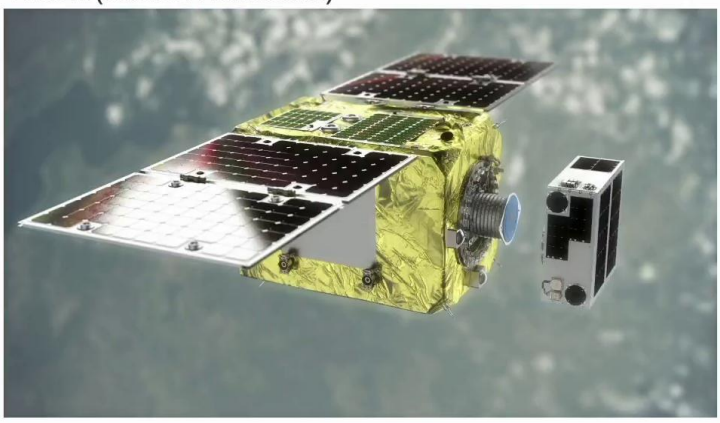
Notes

Summary

5m 07s

End of Life management and ADR

Elsa-d (source: Astroscale)



ClearSpace-1 (source: ClearSpace)

It's something has never been done before. I believe when we look at the mission of the ClearSpace, and specifically the ClearSpace-1 mission, the objective is to demonstrate the complete value chain of a space tow truck, and to make the first removal, to be able to show from now on, this is something that is possible. The other objective is to bring the recurring cost of those operations down to a level where they are affordable for the operators, essentially removing the excuse of doing nothing once their platform fails in-orbit. And today, as we've seen earlier in the class, there's already a lot of objects in-orbit that are failed.

Notes

Summary

6m 20s

The last example I want to share with you today for in-orbit servicing is in-orbit refueling. One of the problems for most satellites, and specifically for in-orbit servicing in general, is the lack of Delta-v, is the fact that you have a limited amount of propellant on your platform in-orbit, which obviously reduces its time frame in-orbit because every single kilogram to send an object in-orbit has a cost. This cost is reducing over time. Today, the cost of launching a kilogram to orbit has been reduced by a factor between 10 and 20 compared to a few years ago. But still, this is very strong limitation on any space platform. Having the capacity to actually refuel a satellite with propellant will open up a lot of avenues of different types of services in-orbit. One of the companies working on that kind of solution is Orbit Fab. Their objective is to create space tankers, which are essentially a propellant tank that can be placed in orbit and service satellites using a standardised interface for refueling. The objective of that, the benefit of that, would be simply that services like in-orbit servicing could even be brought lower simply because a platform that is launched in orbit to provide services can actually have a longer time frame, do more operation, and use more Delta-v, produce more Delta-v, than a platform that is not refueled.

Notes

Summary

7m 03s

This technology has been demonstrated in the ISS, but the commercial market for it and the first in-orbit demonstration mission are being worked on, but is not flown yet. So that gives you a few ideas of what kind of technologies have been or are in development for in-orbit servicing. It is obvious to us that what is produced when it comes to in-orbit servicing is just a missing building block or puzzle piece to the space industry, something that we would have needed already a long time ago, but something that we will definitely need in the future of the space operation. We cannot seriously look at the future, plan the transitions that we are doing right now in the space industry without seriously looking into in-orbit servicing and making sure that we actually build up a complete and sustainable infrastructure with all the services necessary to actually keep it operable for a long period of time. Thank you very much for your attention. It was a pleasure to be able to share a few of the projects we are working on and our vision for the future of the space industry.

Notes

Summary

8m 37s