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eSpace
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SPACE INNOVATION

Transportation to Space

New Space Economy

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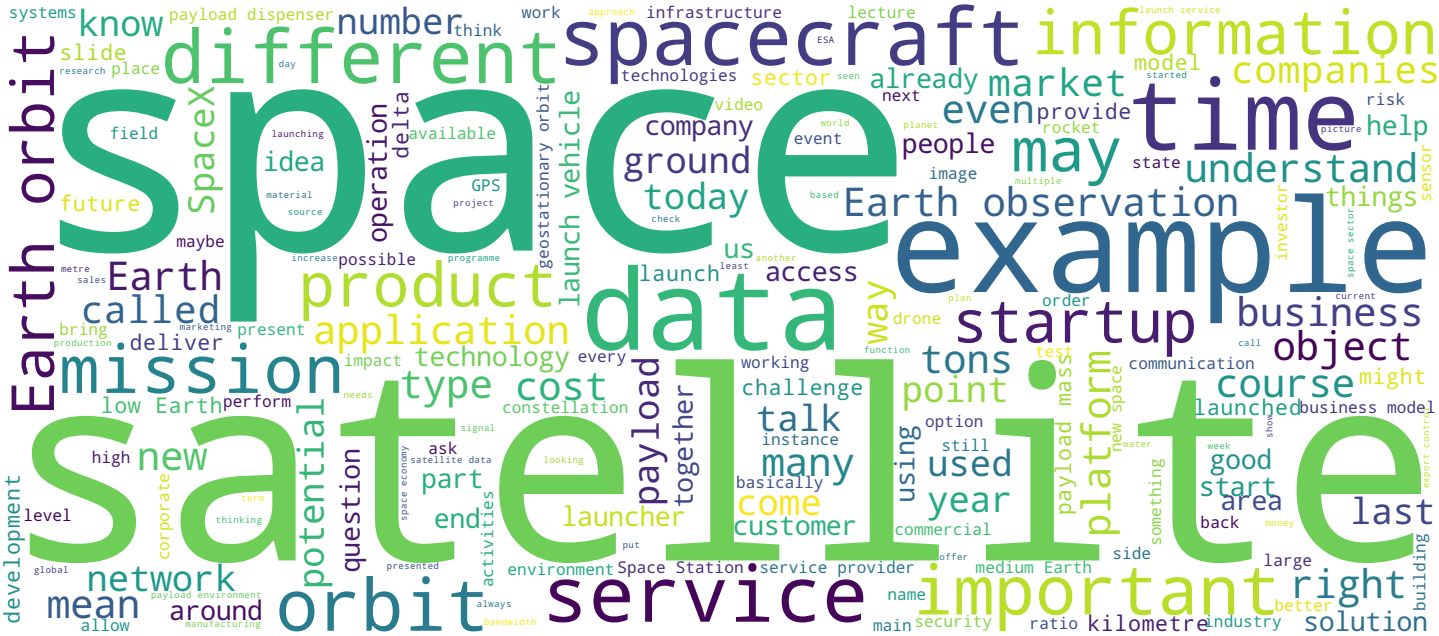
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Welcome

- Where do you want to go?
- How to get into space?
- Who can get you to space?

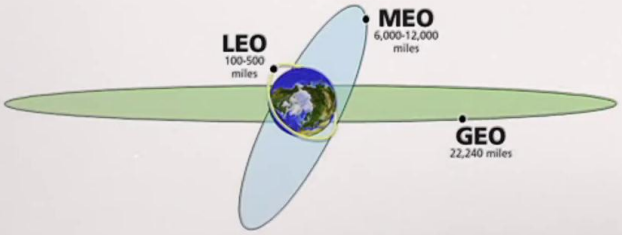
Welcome everyone on this session on space transportation. While thinking about sending an object to space, you may want to consider how you will get your spacecraft into space. Therefore, you need to ask yourself a few questions. Where you want to go? How you're going to get there? And who will get you there? At the end of this lesson, you should have an idea of this main aspect to consider while procuring a space transportation service and where to find the information for that.

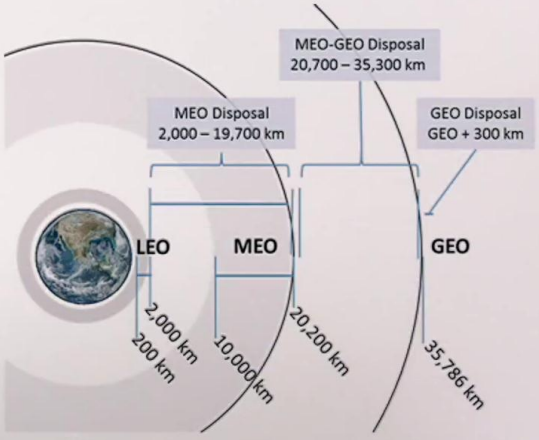
Notes

Summary

0m 05s

Where do you want to go?



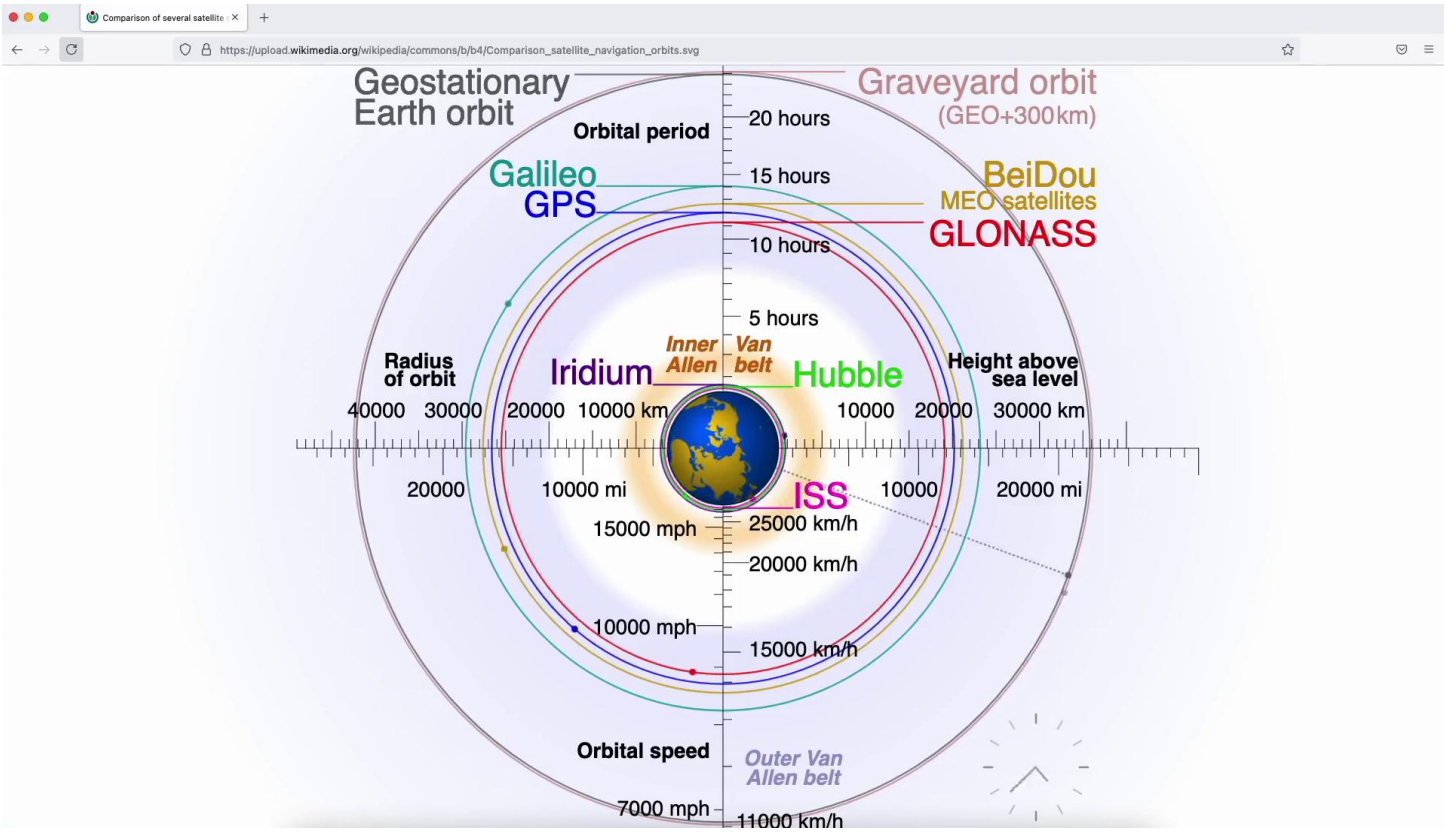


What is important to note is that in space, due to orbital mechanics, your spacecraft will orbit around the Earth. There are three major orbits you need to know. LEO, low Earth orbit, MEO, medium Earth orbit, and geostationary orbit. LEO is from 0-2,000 kilometres. In general, you have Earth's observation satellites in this orbit. For example, for your meteor. Then you have medium Earth orbit from 10,000-20,000 kilometres. Here, you have a few constellations like the GPS, but also Galileo and BeiDou. And finally, you have the geostationary orbit at 36,000 km. This orbit is special as it allows the satellite to be always looking at the same area region on the Earth. This orbit is highly regulated and there are some processes at the ITU, International Telecommunication Union to take into consideration.

Notes

Summary

0m 35s

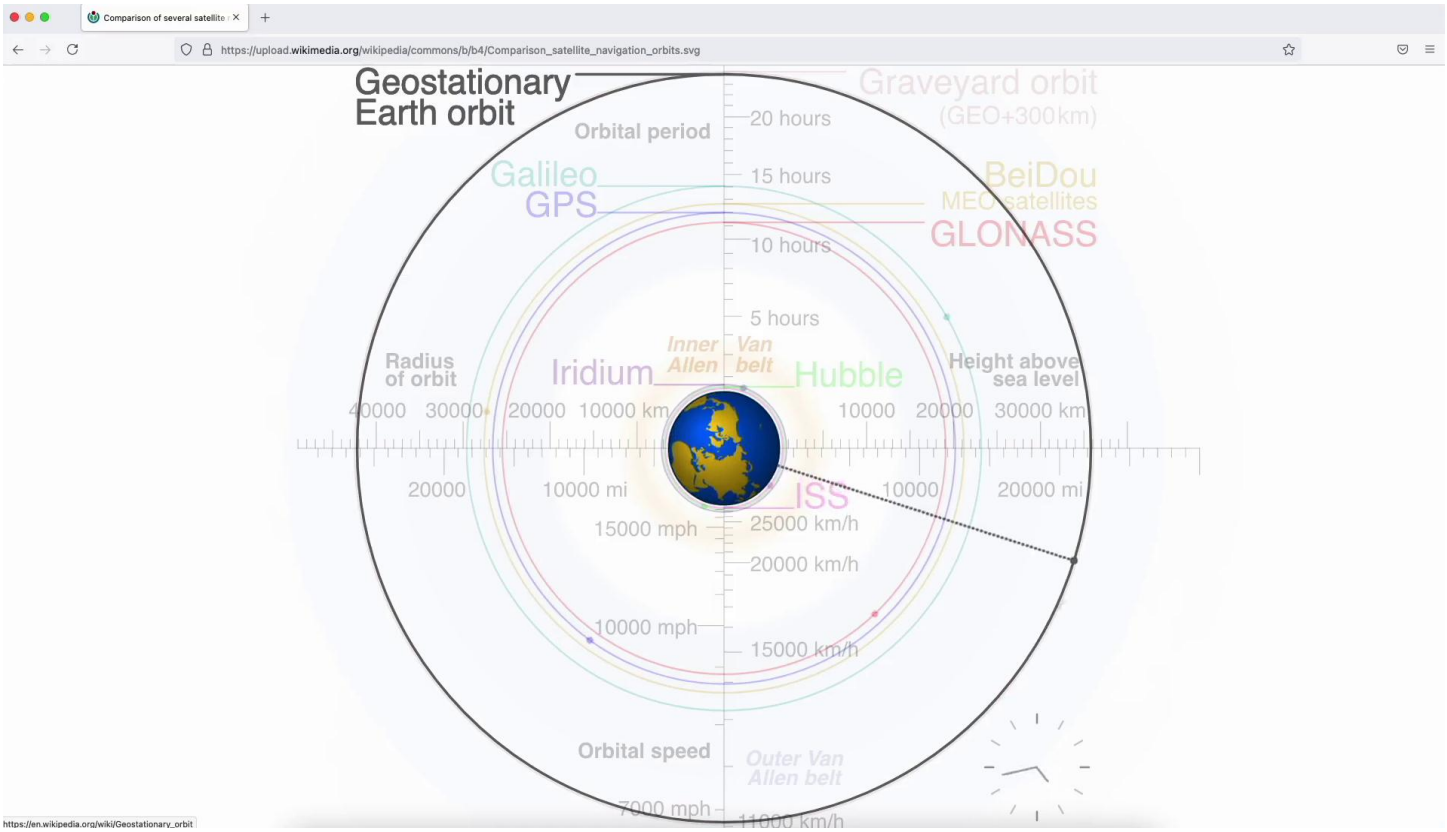


On this animation, you can see the different orbits.

Notes

Summary

1m 42s



Here, you have the low Earth orbit with the ISS Hubble Space Telescope and the Iridium satellites. You have medium Earth orbits with the GPS, the Galileo Constellation, BeiDou and the GLONASS. So these are the four global navigation systems. And then you have the geostationary orbit, as I mentioned, and you can see here that the spacecraft orbiting is always pointing at the same place on Earth.

Notes

Summary

1m 47s

How to get into space?

Rocket Equation

delta V = g I_{sp} ln (M_o/M_f)

where:

delta V = rocket velocity change (m/s)

g = gravitational constant (9.81 m/s^2)

I_{sp} = rocket specific impulse (s)

M_o = initial rocket mass (kg)

M_f = final rocket mass (kg)

Equation is for ideal conditions, with no strong gravity fields, as with near a planet. Corrections can be made by accounting for gravity "losses."

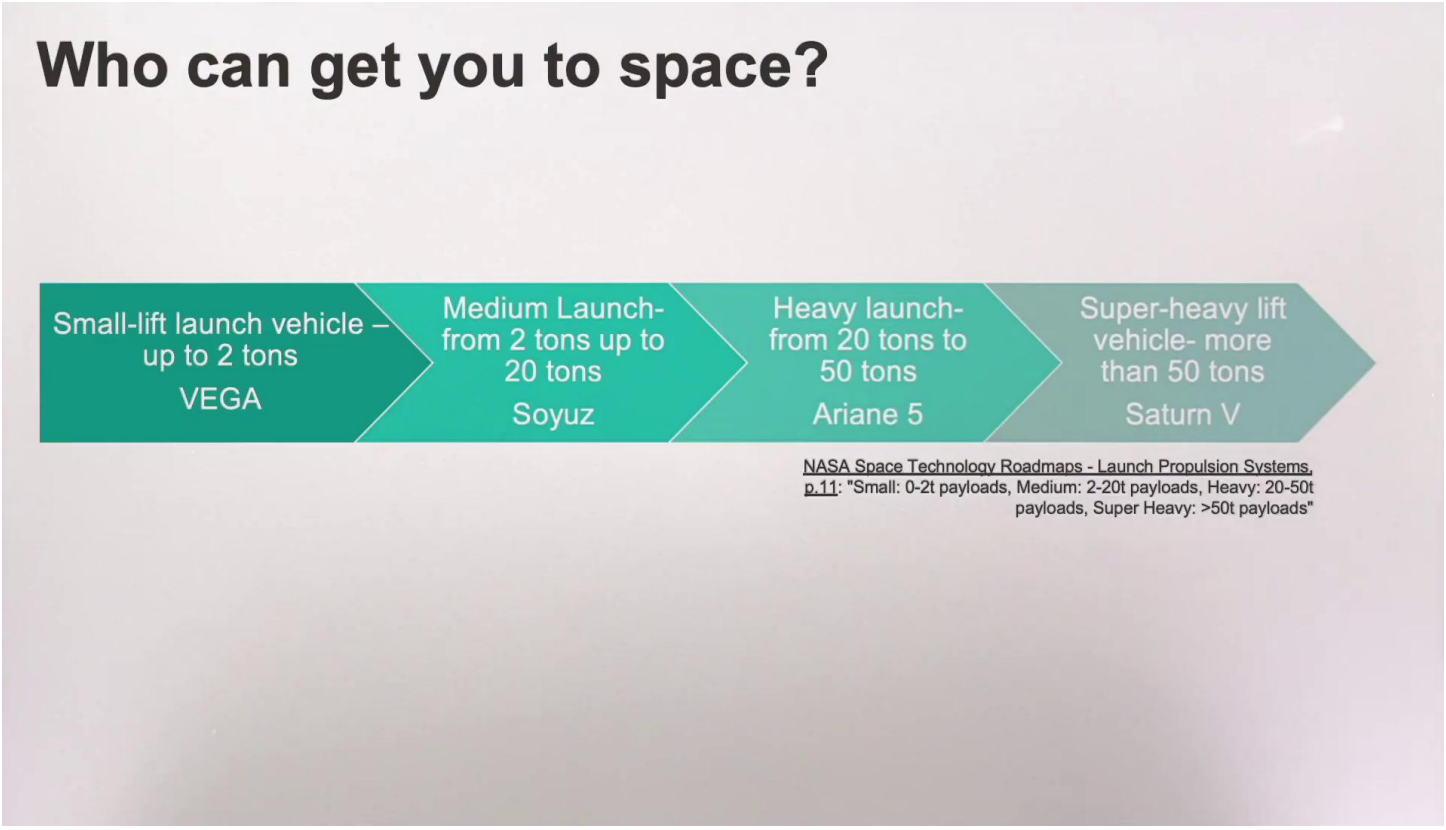
It does not takes into account losses such as aerodynamic, thrust vector misalignment…

Now that you know where you want to go, you need to decide how you want to go there. In rocket science, we talk a lot about the delta-v. Delta-v is the rocket velocity change in metre per second. The delta-v is defined through the rocket equation, which is a function of the gravitational constant, the ISP, rocket specific impulse. This value describes how effective is the engine, and then the function on the ratio of the original mass on the final mass. This ratio is important as the mass of the vehicle is in constant change and you are burning a lot of fuel. This equation is for ideal conditions. It does not take, for example, aerodynamic losses or thrust vector misalignment. So the rocket equation, is that delta-V is equal to the gravitational constant, times the rocket specific impulse, times the logarithm of the ratio of the initial rocket mass on the final rocket mass.

Notes

Summary

2m 16s

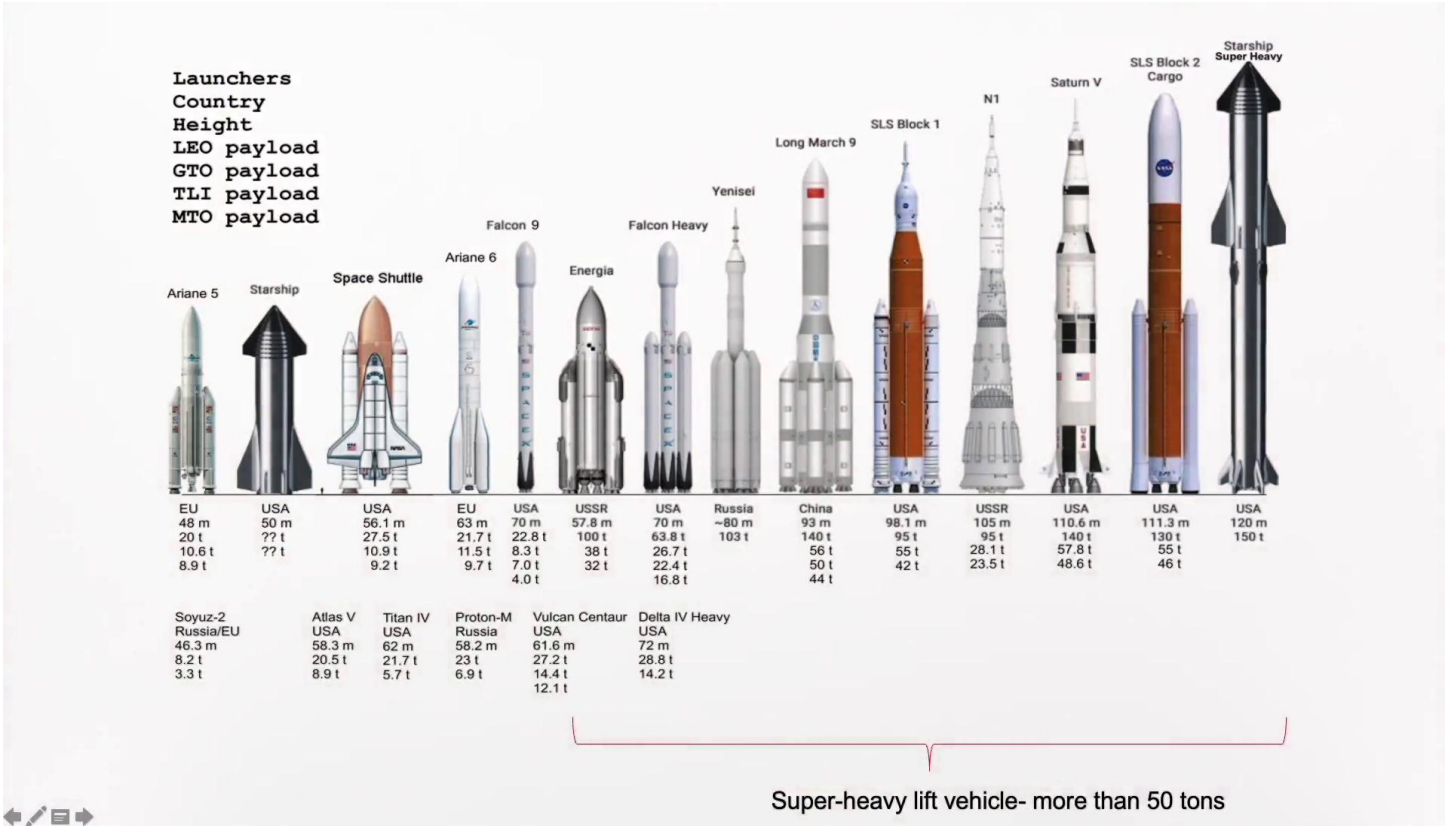


This was the basic physics of the rocket. Now I'd like to introduce to you to the general categories of launchers. You have the small-lift launch vehicle with the payload mass up to two tons. And, for example, you have the VEGA launcher. Then you have the medium launch vehicles with a payload mass from two tons up to 20 tons. An example is the Soyuz launch vehicle. Then you have the heavy launch vehicle from 20 tons to 50 tons, and the super-heavy lift vehicle with a payload mass, more than 50 tons. We will see some examples on the next slide for those two launch categories.

Notes

Summary

3m 32s



On this slide, you have different examples of launchers. For the heavy launch vehicle, you can see, for example, the European Ariane 5 launcher, also the retired Space Shuttle, and also the Falcon 9 from SpaceX. And then you also have the super heavy-lift vehicle with the payload mass of more than 50 tons. You can see, for example, the Falcon Heavy from SpaceX, but also the famous Saturn V, which launched the Apollo missions. And the current launchers in development for exploration missions such as SLS and the Starship.

Notes

Summary

4m 20s

What are the rideshare options?

But at this point you will ask me, how do I do if my spacecraft does not fill the whole payload capacity of the launcher, or if I want to spend several spacecraft at the same time? Then I will answer to you that you can use a payload dispenser or you can use space stocks. This is a new tendency in the space sector and I will present to you now a few options. What are the rideshare options?

Notes

Summary

5m 05s

Payload dispenser

Oneweb dispenser with 34 satellite launched from French Guyana (Feb 20)

A view of Starlink's satellites just before being deployed on May 24. SpaceX

SpaceX launches 60 Starlink sattelite in may 2020- 700 satellite are in space

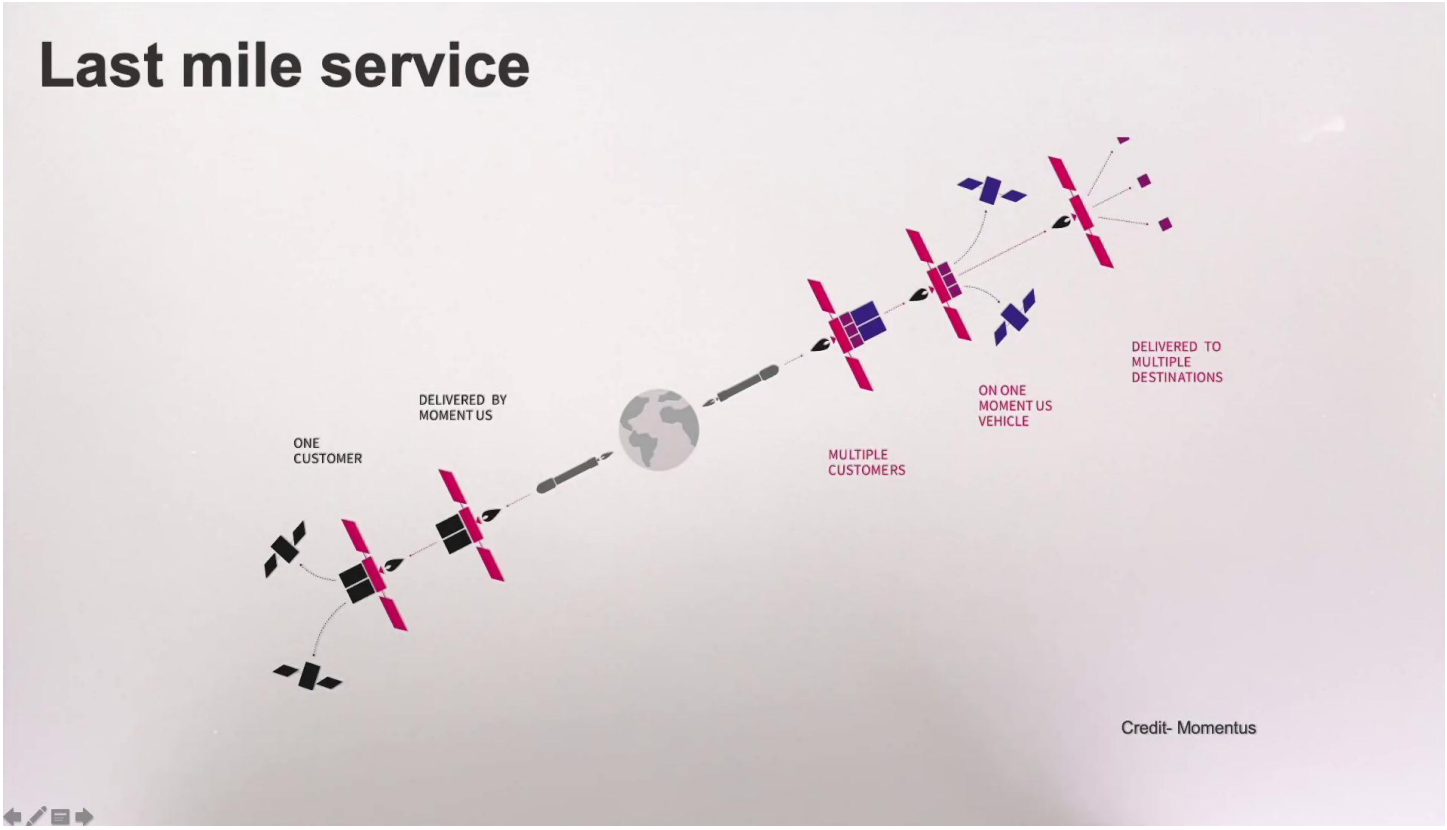
Small Satellite Mission Service (Sept 2020) -53 satellite

On this slide, you can see three examples of payload dispensers. On the left side, you see the payload dispenser or the OneWeb satellite with 34 satellites launched from French Guyana, using the Soyuz launcher developed by OKBs. Here in the middle, you can see the payload dispenser for 60 Starlink satellites that was launched in May 2020. For example, from the Starlink Constellation operated by SpaceX. Then on the right, you can see the SSMS, Small Satellite Mission Service developed by the Italians to be launched with the VEGA launcher. That accommodated 53 satellites. You can see that the three platforms accommodate several satellites.

Notes

Summary

5m 36s



Another option is to use also the last mile services or space tracks. Some companies here, such as, for example, Momentus, are developing a platform that can offer to you two types of services. On one side, they can service several customers and bring them to the specific orbit. And the other time, you can also procure your launch and then they will put, here in this case, your two spacecraft into your wished orbit.

Notes

Summary

6m 29s

Promising actors

Momentus, US

Credit- Momentus

Momentus is a US-based company and is one of the promising actors in the field, as well as D-Orbit, which is also an Italian-based company.

Notes

Summary

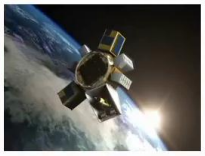
7m 04s

And also

MOOG- Orbital Maneuver Vehicle USA

https://www.moog.com/markets/space/omv.html

Space Flight Sherpa USA



https://spaceflight.com/sherpa/

Skyrora UK

https://www.skyrora.com/space-tug

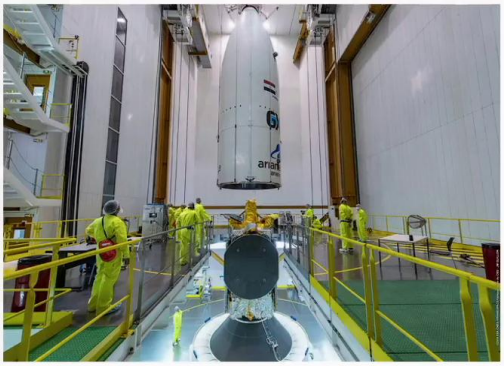
And you have other interesting actors as well, such as MOOG, Space Flight, and Skyrora in the UK. As you can see, the sector is very dynamic and I'm sure that at the time you are watching this recording, there will be new actors.

Notes

Summary

7m 15s

The Payload Environment



https://www.flickr.com/photos/cnes/49084063778/

- Coupled load
- Shock vibration and acoustics
- electromagnetic compatibility
- Thermal Environment
- Ascent venting
- All the information are available in the user manual

Orion's Direct Field Acoustic Testing with concert-like speakers

https://www.nasaspaceflight.com/2019/05/nasa-plum-brook-em-1-orion-testing/2/

Finally, when launching a payload to space, you need also to consider the payload environment at launch. Launch is a rough event and your spacecraft need to survive the coupled load with the launcher or your space tag. The shock vibration and the separation, the acoustic, also to be electromagnetically compatible with the launcher and the other spacecraft. You should also consider the thermal environment in space, but also before the launch, especially if you're launching from a very hot area such as French Guyana. Consider that there will be also some venting around your spacecraft during the launch. All this information are available in the user manual and they are very critical. So I would really strongly recommend you to check as early as possible this information in the launcher users manual and to plan also the Acoustic test for the payload environment.

Notes

Summary

7m 34s

Services around a launch

- Mission analysis
- Tests of your payload (will it sustain the launch environments)
- Payload integration onto adapter
- Infrastructure at launch site:
  - Access to payload
  - Fueling
  - Thermal environment

And finally, you may also want to consider the side services that your launch service provider offers to you, such as the capacity to perform mission analysis, to really understand where you're going to be specifically delivered, who is going to perform the test for the payload environment, and how the launch service provider is going to verify these aspects. Those tests can be very costly. How and when your payload is going to be integrated into the launcher and when is the last moment you will have access to your payload? Also physically, but also remotely, to perform some checks, to do some batteries for charging on your payload. And last but not least, when is your launch service provider able to launch your satellite?

Notes

Summary

8m 37s

Conclusion

- **Where do you want to go?**
  - Main orbits
- **How to get into space?**
  - The physics of a launch
- **Who can get you to space?**
  - Different classes of vehicles
  - P/L Dispenser and Space Tugs
- **What are the services around a launch?**

So to conclude, we've been answered the question where to go and I present to you the main orbits. How to get to space? Who can get your spacecraft to space? And I've presented you the main launcher categories and presented you with a few options. And what are also the services around a launch? This introduction makes you aware of a few technical points you need to take into consideration when planning to send a spacecraft to space.

Notes

Summary

9m 25s