



Note: This file can not replace watching the video lecture. Because the video lecture contains more explanation through graphical elaboration.

Certified Junior Astronaut Training Course

Components of the Space System (Part 3)





This lecture will answer the following inquiry:



How can satellites be launched?





How can satellites be launched?

✚ Launching operations are classified into two types as follows:

- ✚ Launching to near orbits.
- ✚ Launching to far orbits.

✚ The launching operations of the first type, to the near orbits, is conducted as follows:

GEO (36000)km

Geostationary Earth Orbit

MEO

Medium Earth Orbit

(2000)km

LEO

Low Earth Orbit

(160)km





Cont.. How can satellites be launched?



- ✚ The satellite is fixed on the launching rocket where the final rocket tests are conducted, they are named "Pre-launching tests". Then the launching countdown begins.
- ✚ The Boosters start working. The rocket launches until it reaches a specific distance. They are then separated and fall on the ground.
- ✚ The next propulsion stage begins until the rocket reaches another distance. After the rocket fuel finished in this stage, it is then separated and falls on the ground. Then the next propulsion stage begins.
- ✚ This is repeated according to the count of stages which can be four stages in some types of rockets.
- ✚ In the final stage, the Fairings are now open and the satellite is launched from the rocket towards its working orbit by a pre-defined inclination angle and an accurately calculated propulsion force that shapes the orbit according to the orbit design and gives it the ability to rotate in its orbit around Earth. This stage is called "Kick-off Stage".
- ✚ Finally, the satellite starts the attitude control, communication with the control station, opening the solar arrays and starting the post-launching tests.



Source: NPP Satellite Launch, Joint work of NASA/NOAA/DOD





Cont.. How can satellites be launched?



Regarding the second launching type "Launching to far Orbits" such as the Geostationary Orbit; which has an elevation of 36000 Km and is used by Communication Satellites, the rocket separates from the satellite at the highest reachable elevation which is about 1500Km only. This happens during a period of 30 to 40 minutes from the start of launching.

Then the satellite moves alone in an elliptical orbit or several sequential elliptical orbits named "Transfer Orbit"; depending on the thrusters located in the satellite to reach the final working orbit. This process takes about 3 to 4 weeks from the start of launching.



Source: Eutelsat



Cont.. How can satellites be launched?

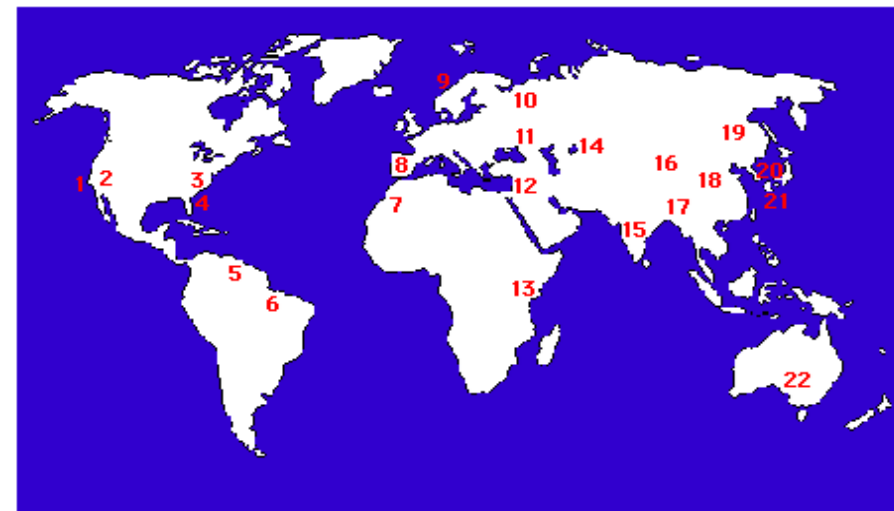


There are about 22 stationary space rockets launching sites worldwide. They are shown in numbers on the map.

Launching from these sites requires the rocket launching angle to be in the direction of the sea or at least towards a vast uninhabited desert to protect humans against the impacts of rocket explosion; in case of an unsuccessful launching attempt.

Additionally, the orbit inclination angle of the satellite that is required to be launched depends on the launching angle of the rocket. Accordingly; there are several orbits that satellites can be launched to from some sites; while from others it can't.

Space Rocket Launch Sites Around the World



1 - Vandenberg
2 - Edwards
3 - Wallops Island
4 - Cape Canaveral
5 - Kourou
6 - Alcantara

7 - Hammaguir
8 - Torrejon
9 - Andoya
10 - Plesetsk
11 - Kapustin Yar

12 - Palmachim
13 - San Marco
14 - Baikonur
15 - Sriharikota
16 - Jiuquan

17 - Xichang
18 - Taiyuan
19 - Svobodny
20 - Kagoshima
21 - Tanegashima
22 - Woomera

Source: spacetoday.org





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In order to overcome all the previous problems, mobile launcher platforms are used and transferred to the appropriate locations that satisfy the launching capability towards the required orbit. Examples include:

- Sea Launch: The image shows a marine mobile launching pad while passing through the Suez Canal.

- Air Launch: The image shows the US Bomber B52 while being used as a mobile launcher platform; carrying the X34 Unmanned Aerial Vehicle (UAV) that carries the satellite to be launched.

- Sometimes, a Space shuttle is also used as a mean of launching satellites.





Cont.. How can satellites be launched?

- ✚ **Regarding the Sea Launch:** The project is composed of an oil drill that has been converted to a floating launching pad and a large vessel that accompanies the launching pad; used as a command center for launching operations.
- ✚ The project is used to perform commercial launching operations of Communication and TV Broadcasting Satellites; which weigh around six tons each.
- ✚ Launching is performed at a site near the equator in the Pacific Ocean and towards the Transfer Orbit. Then the satellite completes the travel distance to reach the Geostationary Earth Orbit by using its own thrusters.
- ✚ The project is owned by Russia, Ukraine, Norway and USA. It is managed by the US Boeing Corporation.



Sources: Sea Launch, National Geographic



Cont.. How can satellites be launched?

- **Regarding the Air Launch:** The US Air-Launched Rocket "Pegasus" is a mean of launching satellites from anywhere; without being restricted by ground stationary launch pads.
- The rocket is composed of three propulsion stages. It separates from the Mother Ship at an elevation of 12000 meters. The Mother Ship is a Lockheed L-1011 Air Bus that is able to carry a satellite of weight up to 443Kg towards the Low Earth Orbit.

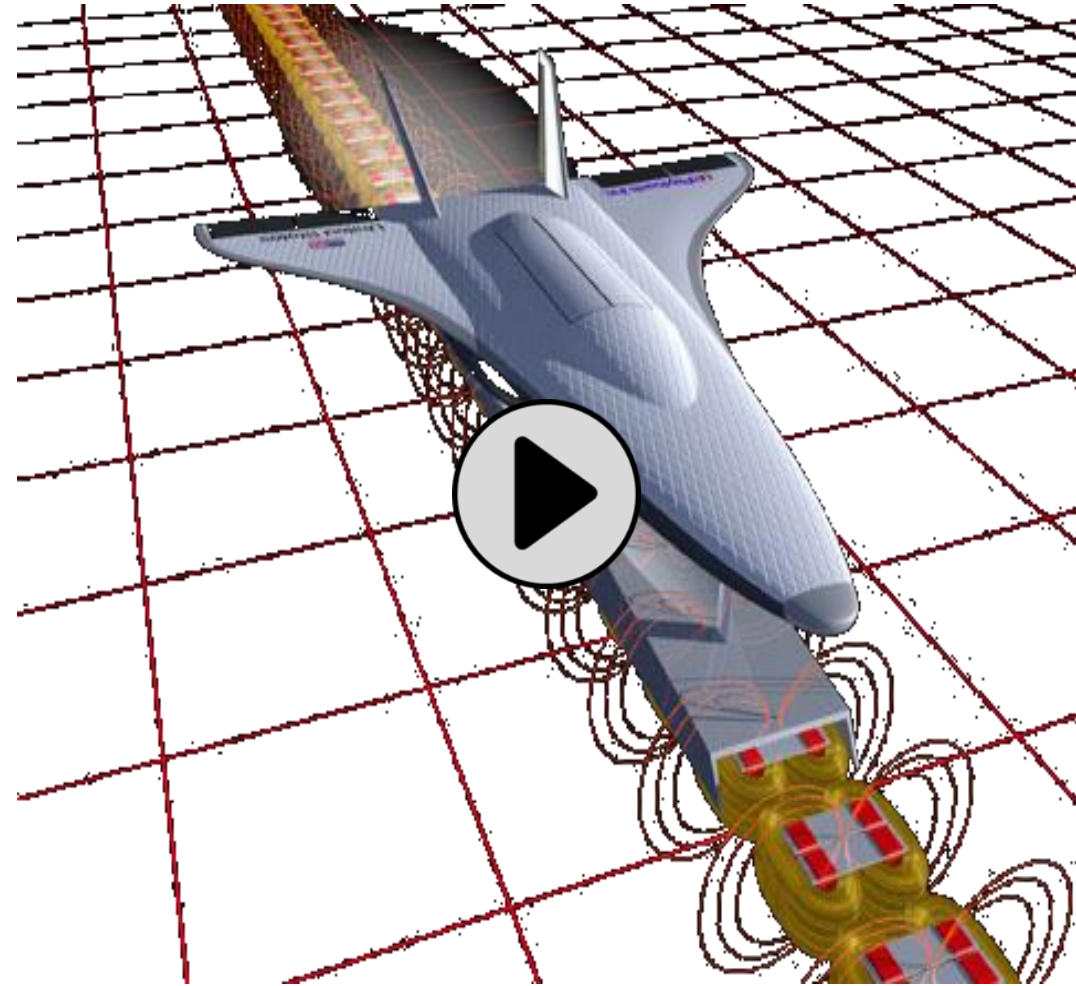


Source: Orbital Science Corporation



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- Due to the high cost of launching satellites, which ranges between 10,000 to 25,000 USD for each Kilogram of a satellite's weight (the weight of some satellites reach several tons), there are ongoing scientific researches to reduce the launching cost. One of most significant researches is the Non-rocket Space Launch research. It is a launching method where one stage of the launching process does not depend on the consumption of the costly chemical propellant. Since, the launch will depend on other means to provide initial speed and elevation; then the rocket resumes the rest of the launching stages.
- This method relies on sliding the rocket to a certain distance on magnetic field rails that provide it with a very high speed which enables it to reach high elevation where it starts to undergo other propellant stages.



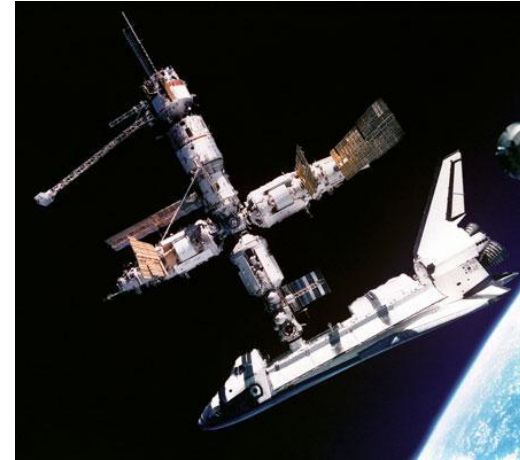
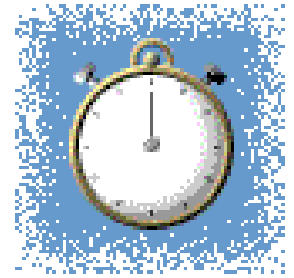
Source: www.msfc.nasa.gov/news



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Launching operations to some orbit types require starting the launch at a specific local timing and within a limited range of minutes named the "Launch Window". If launching did not start at this range of time, the launching should be postponed to the next launch window.

This occurs in some special launch operations when a meeting between two space aircraft is required in space at a specific time, such as the meeting of a space shuttle with the International Space Station to replace astronauts or to transport some items to it, or the meeting of a space shuttle with an important satellite for recovering, repairing and relaunching it in its orbit, or in case of a satellite interception using another satellite with the purpose of destroying it. This meeting process is named "Rendezvous".





Thanks for your undivided attention

