Example of essay on launch windows

Life

Abstract

Launch window is the precise time at which a space vehicle must be launched so that a given space mission can be achieved. The launch window is especially important in missions to other planets and when the vehicle has to rendezvous with a satellite already in space. If the launch window is not calculated right, it could lead to spending a lot of time and energy. Space missions are elaborate tasks which use a large number of people working in crews to complete specific tasks, calculating the launch window is an important task completed by a selected crew. There are cases in which whole missions had to be canceled due to errors in calculating the launch window, so accuracy is very critical.

Launch window is the term used in space technology to describe the precise time at which a launch vehicle (a rocket, a space ship etc) must be launched. The importance of the launch window is that if the particular launch vehicle does not get launched at the given specified time, then it is possible that the whole space mission will be jeopardized.

In situations where the rocket is supposed to be launched into an arbitrary earth orbit for example, there need not be any strict time to fire it off. But if the vehicle is meant to get in the orbit of a different planet, or correspond to a space station on the Earth’s orbit, then it is important to accurately calculate the exact time at which the vehicle must be launched so that the objectives will be reached.

For example, you are standing at the center of a race track and there are athletes running around you. If you want to intercept a particular runner, one way to do it is to simply walk to one side of the track. Now there are three

possibilities. If you are lucky you will reach at the same time the runner reaches that point and you can intercept him easily. If you reach after he has left that point, you can chase him and if you run faster than him then you may be able to intercept him. But this is obviously only possible if you can run faster than him, and you will have to spend a lot of energy in the process. If you reach before he reaches, then you will have to wait for him to come and then intercept him.

Now a very time-efficient and energy efficient way is to calculate precisely at what time he will reach the point. This is possible if you know his speed of running, your speed of walking and the respective distances you and the runner have to cover. Using that information it is possible to reach the given point exactly at the same time the runner reaches the point and there you can intercept him. This is exactly the significance of launch window.

So how do we achieve this in real life, for a satellite to get to the orbit of a planet? The major difference between the given example and real life space science is that, in real life the orbits are predominantly elliptical and in rare cases circular. So the calculations are very different. Kepler’s Third Law of Planetary Motion is used to calculate the exact time it will take to reach the point and thereby the launch is timed in such a way that the space vehicle reaches at the given time.

For example let us calculate the time needed to reach Jupiter’s orbit. The mathematical form of Kepler’s Third Law is P2 = a3 where we have to use years for P and AU for a.

The major axis = 5. 2 + 1 = 6. 2 AU

The semi major axis= 6. 2/2= 3. 1 AU

(Substituting in P2 = a3)

P2 =(3. 1)3

P= 5. 5 years (for one total orbit).

This means that the satellite will take 2. 75 years to reach the aphelion (half the time because 5. 5 years is for the total orbit)

And finally to complete the plan, we have to find a date at which Earth and Jupiter are aligned in such a way as to minimize any given difficulty (which part of the orbit we are aiming at, interference of meteorites etc). We will be able to predict where exactly Jupiter will be 2. 75 years from then, and where exactly the space vehicle will be at any given time.

How difficult a job is determining the launch window and synchronizing the space vehicle? How many people work behind this?

Before the space shuttle was invented, the whole job needed only a few people to determine the respective times to launch, rendezvous and to reenter. But the space shuttle being very much more complex, work is divided into phases, in each phase works a team of specialists. Eventually, all the work is coordinated to complete the mission.

How does the rotation of the earth play a factor?

The rotation of the earth plays a very important factor when it comes to calculating the launch window. The earth rotates from west to east at a

speed of 1035 mph, but any satellite’s orbit is kind of fixed in place(it is okay to assume mostly that the earth is not revolving and the revolution of the earth is not usually taken as a factor). Now after the satellite crosses a fixed point on its orbit, it takes 24 hours to go around and reach the same point again. If the space vehicle does not get to the satellite at the precise time, then it will not be able to reach the satellite(you can imagine how much space would be wasted if the vehicle were to ‘ chase’ the satellite around its orbit to get to it).

What are the other factors involved?

Another important factor is calculating the phase window. This is period of time at which launching the space vehicle would plant it in line behind the satellite. This is usually around three days after the vehicle is launched. The window is between 2. 5 minutes and 10 minutes, any more than 10 minutes would deplete the fuel resources on the vehicle.

Other factors include the sleep cycle of the onboard crew(you do not want the satellite to reach when the crew is asleep, this also has to be taken into account), where the rocket’s external tank and solid boosters have to be dropped off, wind characteristics on the launch day, mission-specific factors, any given emergency situation, and the desired reentry times.

How flexible is calculating the launch window?

As said before, everything may depend on 10 minutes either way from the time of launch. But it is possible for the computers to fine-tune to the different factors even in the last seconds before launch. It is also possible for the crew inside the vehicle to steer the vehicle at times to adjust to any possible shift in orbital paths.

References

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