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Sub-Orbital Spaceport–A Spaceport in the Orbit for Interplanetary and Interstellar Missions

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Abstract—*Interplanetary missions have been planned right since the 20th century. Since the time the researchers and astronomers started to discover new planets, new comets, new galaxies, and new outer space objects, humans have fantasized going into space and experiencing the ever appealing world of stars and planets. A step forward was taken in the 1950's with the launch of first man-made satellite into the orbit. This development opened the doors for manned space missions and it took the space exploration to a whole new level. With the launch of manned missions to orbit followed by manned mission to Moon, the quest for manned interplanetary missions grew even much higher. Even though the existing missions to Moon have been successful, the interplanetary manned missions are still under development. The success of manned mission will be a giant step towards the future, and to assist and improve its efficiency, the idea of a sub-orbital spaceport comes into play. Rather than launching the rockets from Earth again and again for these missions, if we place a space station cum spaceport right into the orbit, it will not only save huge amount of fuel and money, but it will also assist in saving time between two space missions, storing and providing supplies to the astronauts, as well as acting as a hub. This spaceport will be capable of launching both interplanetary and interstellar manned as well as unmanned missions. This technology will result in reduction of regular launches from Earth, thereby reducing the amount of debris created by the separated rocket boosters. It will also help in regulating the pollution created by the burnt fuel within the Earth's atmosphere. Regular supplies, according to the need can be made from the Earth to this sub-orbital spaceport, which will then further assist these supplies to the further space missions.*

1. INTRODUCTION

Spaceport is the port, from where rockets and spacecraft's are launched into space. It is, in a way, the airport for space missions. The spaceport has traditionally been used for all those sites around the world, which are capable of launching a spacecraft into orbit around Earth or for the interplanetary missions.

The term rocket launch site is used for any facility from which rockets are/can be launched. It may contain one or more launch pads or suitable sites to mount a transportable launch pad. Generally, it is surrounded by a large safety area, often called a rocket range or missile range. The range includes the area over which launched rockets are expected to fly, and within which some components of the rockets may land. Tracking stations are sometimes located in the range to assess the progress of the launches.

Baikonur Cosmodrome in southern Kazakhstan is credited to be the world's first fully developed spaceport for orbital and human launches. It is this spaceport which launched Sputnik 1 into orbit, which was the world's first man made satellite. This spaceport also holds the distinction of being the first spaceport of the world to launch a human into space when in 1961, Yuri Gagarin was launched into space. Since then, many spaceports have been developed world wide as every country has since established its own Space Agency. With the development of space agencies, such as NASA (US), ESA (Europe), ISRO (India), JAXA (Japan), etc, they have built their own space port. The main reason behind this was to become independent of the outer world for satellite launches, and also save money. Each spaceport has since been fully developed, modernized with time to support the launch of heavy rockets, which have come under development with the advancement of technology.

2. SPACEPORT

With the development in science and technology, we have been successful in transforming the way the world see space. From sending first living creature in space in 1957, to exiting our own solar system in search of life somewhere else by Voyager 1 in 2013. In the span of these 56 years, the space exploration has reached new heights with the launch of numerous satellites and space shuttles, and its possible only because of world class, multi-purpose and multi-functional spaceports. It is a very crucial part of a space mission because it is responsible for all the phases of the ground work of a space mission, right from assembling the rocket in the Vehicle Assembly Line to its launch from the launch pad. The spaceport should be the designed and developed in such a way that it should be able to support the launch of wide range of rockets, from light weight to heavy weight rockets, with the purpose of placing a satellite in lower earth orbit to interplanetary and interstellar missions. Moreover the location should be strategic so that the mission is cost efficient. This is

the most important parameter which is taken into consideration when we aim to build a spaceport on Earth.

This is because of the reason that we tend to take advantage of the Earth's rotation while launching a satellite into geostationary orbit. This is the reason it is desired to have the space port near equator, and launch the satellites into easterly direction. Though, this technology is not helpful if we want to place a satellite into polar orbit.

Every spaceport has some basic facility available with it, which is very important for the existence of the spaceport, as well as the success of the complete mission. They are mentioned below.

2.1 Launch Pads

The launch pad is a platform which is designed above the ground to support the vertical launch of rockets or space vehicles into orbit. This is the most basic facility of the spaceport. The launch pad is supported by various other structures at the space port, which includes the method which the agency use to transport the rocket or space vehicle from the assembly line to the launch pad. This technology vary from agency to agency, as NASA uses crawler transporter to transport the rocket atop a mobile launch vehicle, which ISRO uses a mobile assembly line and the launch pad is fixed. There may be a single launch pad at a spaceport, or there may be multiple launch pads. Generally, it is financially more beneficiary to have multiple launch pad as then, the launch window between two consecutive launches can be reduced as the rocket can be launched from the other launch pad, while the first one is undergoing overhaul to be able to support the launch again.

2.2 Vehicle Assembly Building

As the name suggest, this is the heart of any spaceport as it is within the premises of this building that the building blocks are put together to take the shape of space vehicle as we see them. The complete construction of the vehicle, and its assembly takes place inside this building. Its height can vary from 30 m to 80 m, depending on the size of rocket.

2.3 Launch Control Centre

This is the mission control of the space mission. The trajectory analysis as well as telemetry and communication is handled by the scientists from this base. It provides the technology for the in-flight navigation of the spacecraft and all the avionics systems of the craft is monitored from here. Launch Control Centre also house all the warning systems of the spacecraft as it directly receives the signals from the sensors placed on the space craft.

3. SUB-ORBITAL SPACEPORT

Since rocket launches includes a lot ground work, including assembling the satellite to the vehicle, transporting it to the launch pad, pre-launch test, etc., a lot of time, effort and money is consumed in it. The time difference between two subsequent launch for Moon or Mars will range from 1 year to 5 years. But this time frame can be reduced if we place a space station cum spaceport right up there in the orbit. The whole system will be having different module which will have different task. The basic structure of the system will be as follows:

i. Space Station: the spaceport will act as a space station which can home the crew of upto 20 astronauts. It will be on the same model, as that of International Space Station.

ii. Launch Pad: Around the space station will be a space port's launch pad build on 2 circular rings. The launch pads can be multiple, presenting the opportunity to perform multiple launches to save time and money. It will be connect with the help of a passageway to the main space station.

iii. Vehicle Maintenance and Repair: Since the space vehicle will undergo multiple flight, as assumed, there has to be a vehicle maintenance and repair module where the space vehicle will undergo continuous observation and maintenance work for any probable damage or failure caused as a result of previous flight.

iv. Observation Desk: This is another important part of the spaceport which will keep a track of all the important avionics system of the space vehicle. It will run a test on the vehicle's system and keep a track of its functioning.

v. Radio Communication and Telemetry: This module of the spaceport is responsible for establishing the communication with the launched space craft and to monitor all the sensors and performance of the vehicle as it tends to reach either reach its desired orbit or go out on the interplanetary mission.

These are the basic facilities that are required when placing the spaceport into the orbit as with the help of these basic facilities, we will be able to monitor the complete health of the spaceport in addition to the functioning of the space vehicle. This step will be a very important step for the development of human settlement in space and other planets as this technology will not only reduce the cost factor involved in one space mission compared to Earth, but it will also decrease the time difference between two consecutive launches. This will result in increasing the efficiency of the long term interest, as flights can be used on the scale of shuttle service, which will increase the intensity and thus, the efficiency. Spaceports will also help in conducting various researches in the space, and will act as a space laboratories where the results can be preserved and used as per need.

4. CONCLUSION

From this research, we can conclude that Spaceport in space is feasible in the same way, as today International Space Station

exists. This technology will not only reduce our dependency on rocket boosters for launch, it will reduce the cost factor attached with the mission. Reduction in use of boosters will also help us reduce the air pollution caused by the burnt fuel in the atmosphere, keeping the air fresh. It will effectively reduce the debris left by the rocket boosters in the orbit. Spaceport will not only help us conduct research about different phenomenon associated with space, such as microgravity, solar radiation, etc., it will also act as a waypoint for further space missions to outer planets and asteroids. This step will be very vital as it can take the space research to a whole new level. It will give us a new home in space, from where we can fly out for interplanetary missions. And soon a day will come, when our technology would have developed to such an extent that we will be able to take a giant step forward to interstellar missions and this spaceport will act as a launch pad towards future.

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