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Satellites Recycle System

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System Architecture

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Contents

Satellites Recycle System

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1. Background: It is a meaningful project

1) Satellites cost are expensive

Satellites are usually expensive. They cost a lot of money to design, construct, launch and monitor. Just how much money? If you have at least $290 million in your bank account, that money can go into making a satellite that can track and monitor hurricanes. Add about $100 million dollars more if you want a satellite that carries a missile-warning device. What makes satellites so expensive?

Fig-1 Satellite

Some of the factors that drive the cost of satellites are the equipment and materials used to build them. Transponders alone hundreds of thousands of dollars a year to maintain, while bandwidth cost per MHz is priced at a minimum of about $3,500 a month. Running a satellite at a 36MHz bandwidth will cost over $1.5 million a year. There are also the other gadgets and equipment that have to be built into the satellite in order for it to perform its intended function. These can include computers, computer software and cameras.

Another factor that contributes to the expense associated with satellites is the cost of putting one into orbit. It is estimated that a single satellite launch can range in cost from a low of about $50 million to a high of about $400 million. Launching a space shuttle mission can easily cost $500 million dollars, although one mission is capable of carrying multiple satellites and send them into orbit.

Also to be considered in the cost of satellites is its maintenance. After getting one into orbit, it has to be monitored from a ground facility, which will require manpower. Satellites are also not impervious to damage or down times. Furthermore, if things don't go too well during a launch, a multi-million endeavor can either end up in pieces or sustain damages that will cost more money to repair. Some of the top satellite firms in the U.S. are Hughes, Boeing, Ball Aerospace & Technologies Corp. and Lockheed Martin. [1]

2) Space Debris

About 6,600 satellites have been launched. The latest estimates are that 3,600 remain in orbit. Of those, about 1,000 are operational; the rest have lived out their useful lives and are part of the space debris. Approximately 500 operational satellites are in low-Earth orbit, 50 are in medium-Earth orbit (at 20,000 km), the rest are in geostationary orbit (at 36,000 km). [2]

Fig-2 Space Debris

Earth's orbit is littered with decommissioned satellites but also with debris from tools, rocket boosters, debris from the testing of anti-satellite weapons and unmanned spacecraft. Space debris is not biodegradable and it will stay in orbit for decades, or even centuries, before it eventually falls to earth and burns up. [3]

- 29,000 pieces of debris for sizes larger than 10 cm;
- 670,000 pieces of debris for sizes larger than 1 cm; and
- More than 170 million pieces of debris for sizes larger than 1 mm

2. Conceptual Model

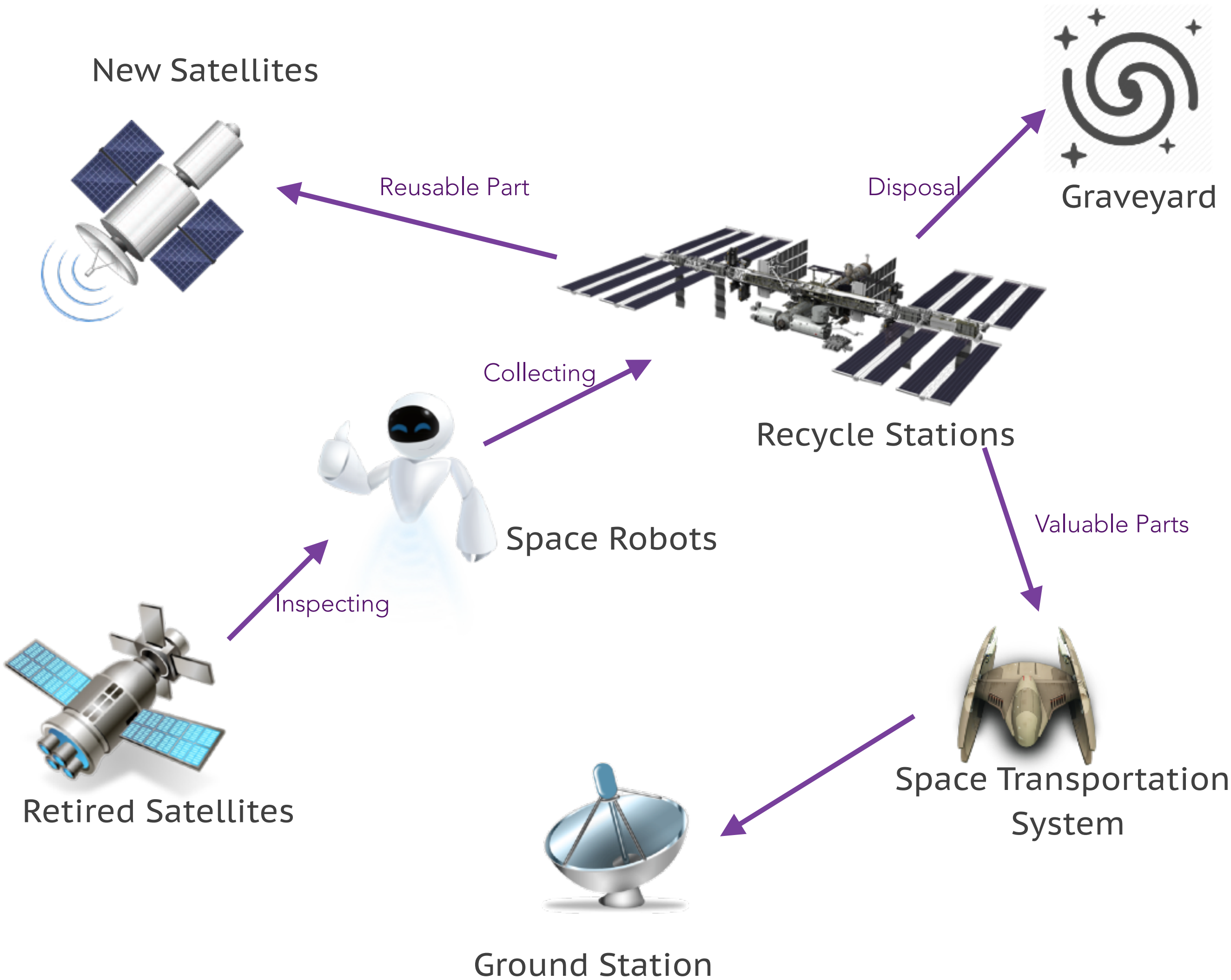


Diagram -1 Conceptual Model

Conceptual Model: 1) Space robots inspect and find the retired satellites. 2) Space robots collect the retired satellites and drag them to the recycle stations. 3) Dismantling the satellites in the recycle stations. 4) Using the reusable parts to new satellites 5) Transporting the rest valuable parts back to earth 6) Disposal the waste into graveyard and storage the valuable parts

3. Operational Node Connectivity

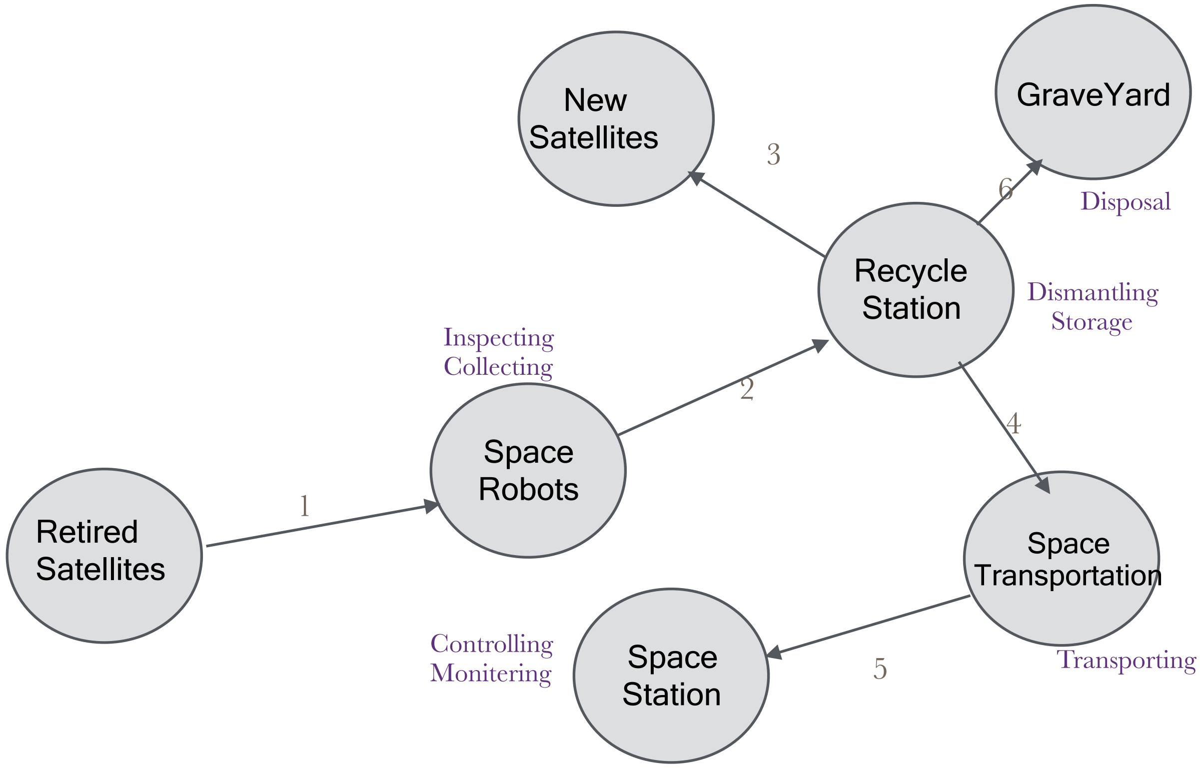


Diagram -2 Operational Node Connectivity

4. Challenge : Space Robots

Space robotics is the development of general purpose machines that are capable of surviving (for a time, at least) the rigors of the space environment, and performing exploration, assembly, construction, maintenance, servicing or other tasks that may or may not have been fully understood at the time of the design of the robot. Humans control space robots from either a “local” control console (e.g. with essentially zero speed-of-light delay, as in the case of the Space Shuttle robot arm (Figure 3.1) controlled by astronauts inside the pressurized cabin) or “remotely” (e.g. with

Fig-3 Space Robot

non-negligible speed-of-light delays, as in the case of the Mars Exploration Rovers (Figure 3.2) controlled from human operators on Earth). Space robots are generally designed to do multiple tasks, including unanticipated tasks, within a broad sphere of competence (e.g.payload deployment, retrieval, or inspection; planetary exploration).[20]

Figure 3.1. Space Shuttle robot arm developed by Canadian Space Agency.

Figure 3.2. Mars Exploration Rover.

Figure 3.3. Artist's conception of Robot Blimp on Titan.

Phoenix Satellite-Recycling Project

“Use robotic tools and assembly techniques, but also validated the concept that we could build new satellites on orbit by physically aggregating satlets in space” [4]

DARPA hopes Phoenix develops tools and capabilities that will allow satellites to be inspected, serviced, upgraded and assembled on orbit, extending the lifespan of existing space assets and significantly reducing the cost of future satellites.

Flight Telerobotic Servicer (FTS) - 1987

The flight telerobotic servicer, or FTS, was conceived as a means of incorporating U.S. robotics technology on Space Station Freedom. The U.S. Congress was interested in advancing both robotics and automation technology for the benefit of the Station, as well as directing spin-offs to the U.S. economy. In addition to ensuring technology transfer between various U.S. industries, the FTS would also serve to provide telerobotic assistance to early Station assembly tasks, service attached scientific payloads, and serve as a telerobotic assistant to EVA crew members. [5]

Fig-4 FTS

NASA decided to develop a $288-million Flight Telerobotics Servicer (FTS) in 1987 to help astronauts assemble the Space Station, which was growing bigger and more complex with each redesign. Shown here is the winning robot design by Martin Marietta, who received a $297-million contract in May 1989 to develop a vehicle by 1993.

About the best thing that can be said for the FTS project was that it generated a lot of lessons learned. The robot never flew and never will fly because it was never completed. This project demonstrated that fault-tolerance gone wild will doom a robot. The robot had so many redundant systems that there was just too much to go wrong. [6]

Heuristic: Keep it simple and stupid.

Heuristic: The simplest solution always the best solution.

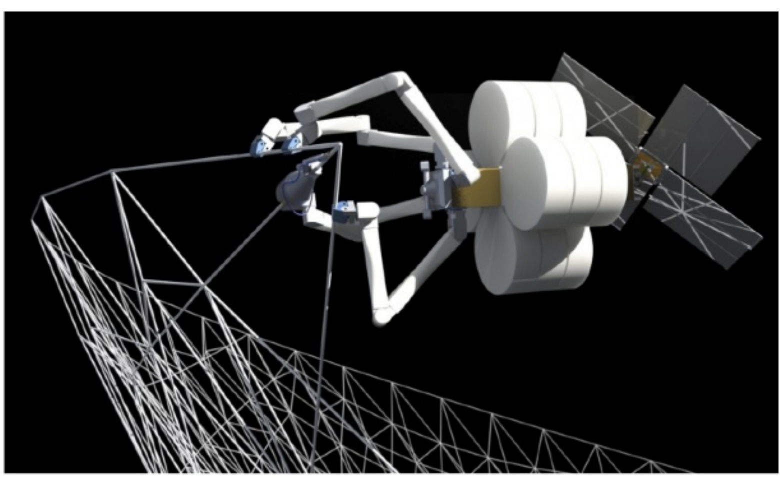


Fig-5 Robotic Spacecraft

Solutions: No need intelligent Robot, but Collecting Device

Alterative Solution: Robotic Spacecraft

Robotic Spacecraft on Earth Orbit

A robotic spacecraft is an unmanned spacecraft, usually under telerobotic control. A robotic spacecraft designed to make scientific research measurements is often called a space probe. Many space missions are more suited to telerobotic rather than crewed operation, due to lower cost and lower risk factors. [7]

The space robotic will detect the target satellites, and drag them to the recycle station.

5. Challenge: Recycle Station

Solution: Space Station

The International Space Station (ISS) is a space station, or a habitable artificial satellite, in low Earth orbit. The ISS serves as a microgravity and space environment research laboratory in which crew members conduct experiments in biology, human biology, physics, astronomy, meteorology, and other fields. [9]

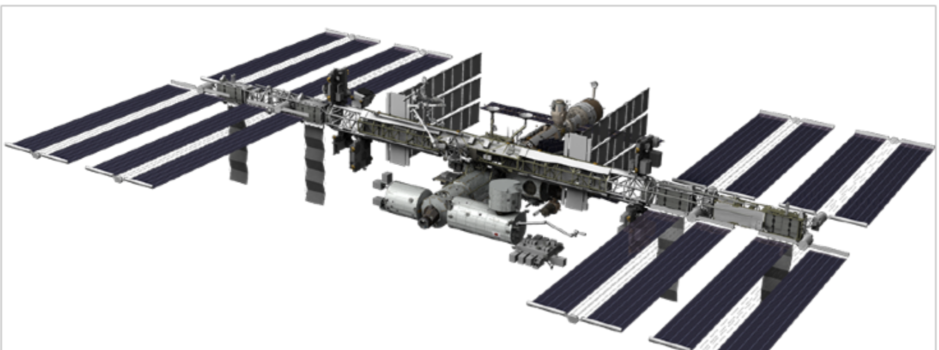


Fig-6 International Space Station

How big is the International Space Station?

The space station, including its large solar arrays, spans the area of a U.S. football field, including the end zones, and weighs 861,804 lb. (391,000 kilograms), not including visiting vehicles. The complex now has more livable room than a conventional five-bedroom house, and has two bathrooms, gym facilities and a 360-degree bay window. Astronauts have also compared the space station's living space to the cabin of a Boeing 747 jumbo jet. [8]

International Space Station is expandable.

The ISS is a third generation modular space station. Modular stations can allow the mission to be changed over time and new modules can be added or removed from the existing structure, allowing greater flexibility. [9]

The International Space Station (ISS) could be used as the satellites recycle station. In future, the ISS will expand and have more room for research

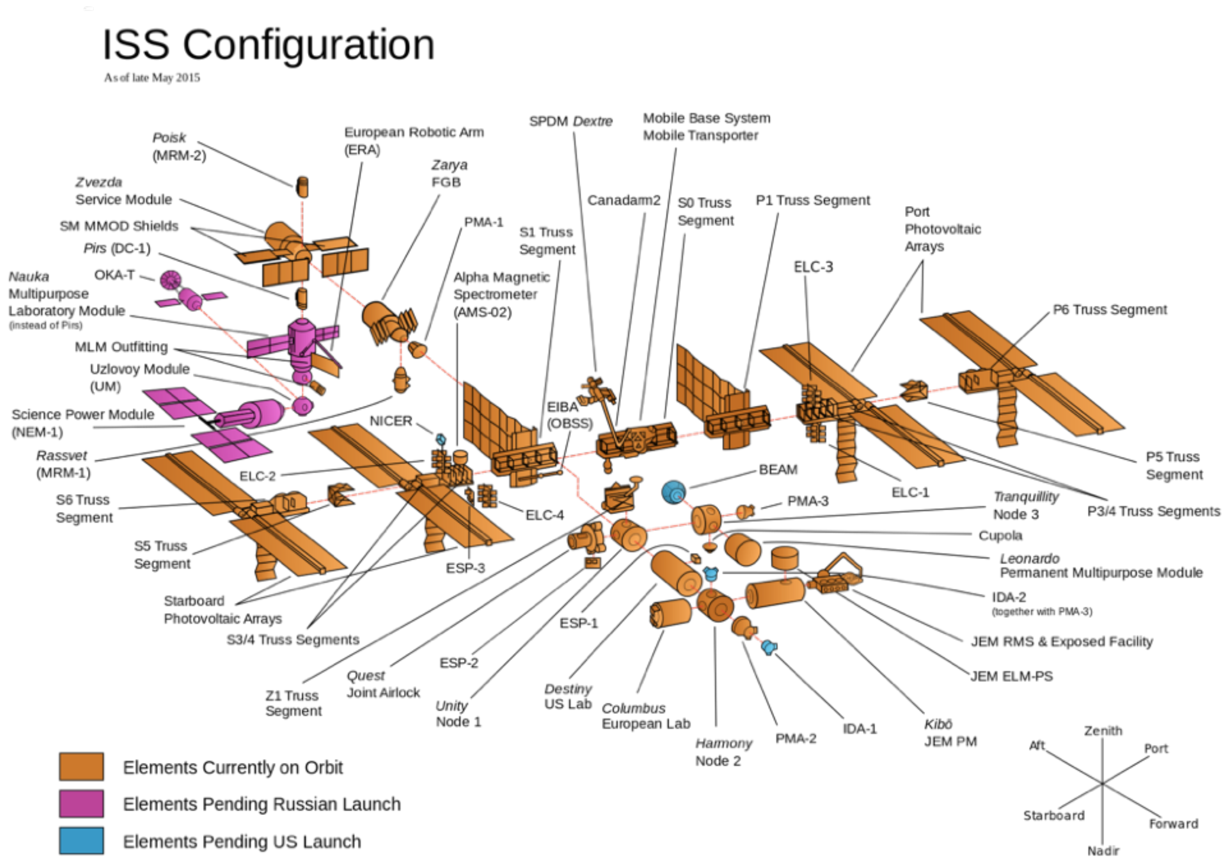


Fig-7 International Space Station Configuration

6. Space Transportation System:

Space Capsule/ SpaceCraft / Space Shuttle

1) Space Transportation System: The Space Transportation System (STS) was a proposed system of reusable manned space vehicles envisioned by NASA in 1969 to support extended operations beyond the Apollo program. (NASA appropriated the name for its Space Shuttle Program, the only component of the proposal to survive Congressional funding approval.) The purpose of the system was twofold: to reduce the cost of spaceflight by replacing the current method of launching "capsules" on expendable rockets with reusable spacecraft; and to support ambi-

tious follow-on programs including permanent orbiting space stations around the Earth and Moon, and a human landing mission to Mars. [10]

2) Space Shuttle: The Space Shuttle was a partially reusable low Earth orbital spacecraft system operated by the U.S. National Aeronautics and Space Administration (NASA), as part of the Space Shuttle program. Its official program name was Space Transportation System (STS), taken from a 1969 plan for a system of reusable spacecraft of which it was the only item funded for development. The first of four orbital test flights occurred in 1981, leading to operational flights beginning in 1982. They were used on a total of 135 missions from 1981 to 2011, launched from the Kennedy Space Center (KSC) in Florida. Operational missions launched numerous satellites, interplanetary probes, and the Hubble Space Telescope (HST); conducted science experiments in orbit; and participated in construction and servicing of the International Space Station. The Shuttle fleet's total mission time was 1322 days, 19 hours, 21 minutes and 23 seconds. [11]

Fig-8 Space Shuttle Discovery

Space Shuttle Cost: The total cost of the actual 30-year service life of the shuttle program through 2011, adjusted for inflation, was $196 billion. The exact breakdown into non-recurring and recurring costs is not available, but, according to NASA, the average cost to launch a Space Shuttle as of 2011 was about $450 million per mission. [12]

Space shuttle is too expensive!!

Private transportation company: **SpaceX Dragon**

Dragon is a spacecraft developed by SpaceX, an American private space transportation company based in Hawthorne, California. Dragon is launched into space by the SpaceX Falcon 9 two-stage-to-orbit launch vehicle, and SpaceX is developing a crewed version called the Dragon V2. During its maiden flight in December 2010, Dragon became the first commercially built and operated spacecraft to be recovered successfully from orbit. On 25 May 2012, a cargo variant of Dragon became the first commercial spacecraft to successfully rendezvous with and attach to the International Space Station (ISS). SpaceX is contracted to deliver cargo to the ISS under NASA's

Fig-9 SpaceX Dragon

Commercial Resupply Services program, and Dragon began regular cargo flights in October 2012. The Dragon spacecraft consists of a nose-cone cap that jettisons after launch, a conventional blunt-cone ballistic capsule, and an unpressurized cargo-carrier trunk equipped with two solar arrays. The capsule uses a PICA-X heat shield, based on a proprietary variant of NASA's Phenolic impregnated carbon ablator (PICA) material, designed to protect the capsule during Earth atmospheric entry, even at high return velocities from Lunar and Martian missions. The

Dragon capsule is re-usable, and can fly multiple missions. The trunk is not recoverable; it separates from the capsule before re-entry and burns up in Earth's atmosphere. [13]

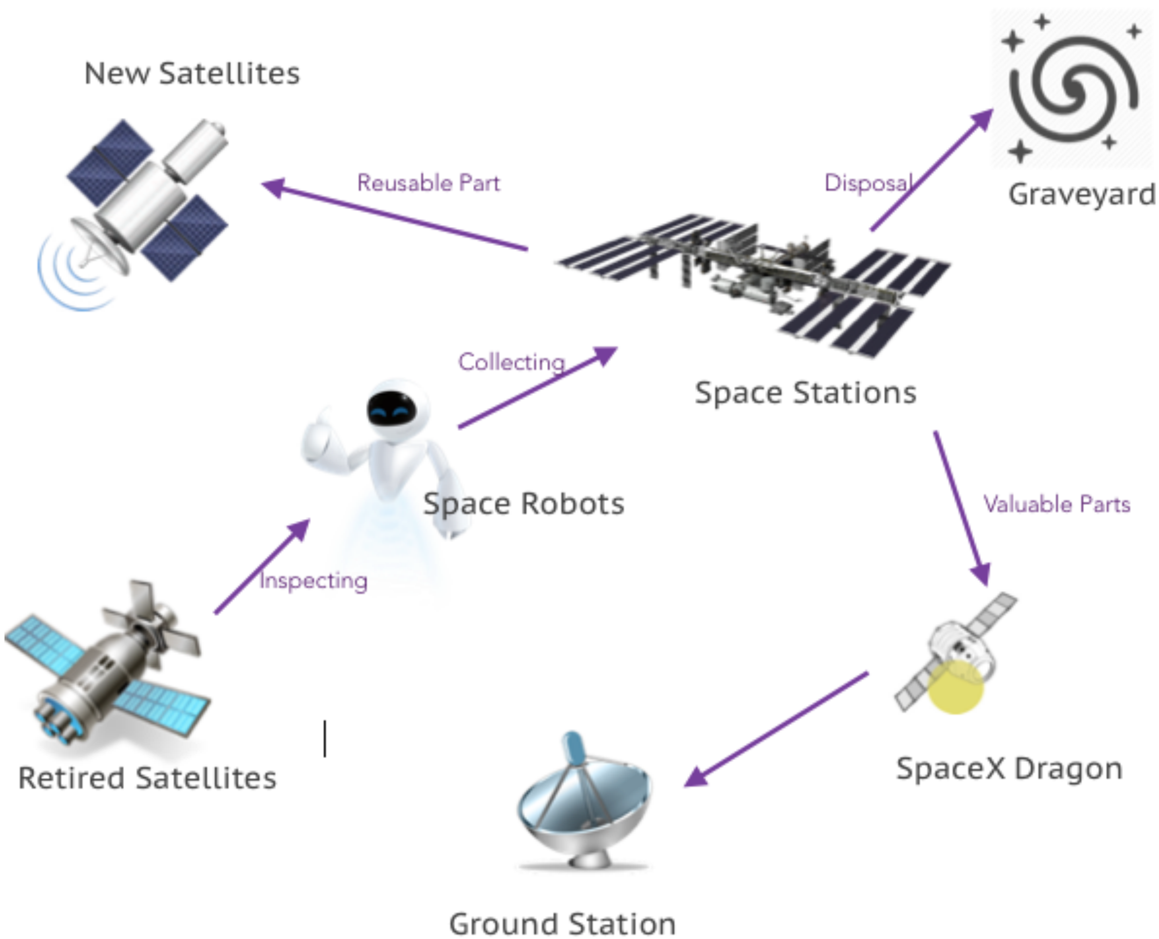
Fig-10 SpaceX Falcon 9

Reusable technology in Dragon V2: Dragon V2 (also Dragon 2, Crew Dragon, or formerly DragonRider) is the second version of the SpaceX Dragon spacecraft which will be a human-rated vehicle able to make a terrestrial soft landing. It partly reusable; can be flown multiple times, resulting in a significant cut in the cost of access to space. SpaceX anticipates that about ten flights are possible before significant vehicle refurbishing is needed. [14]

SpaceX Dragon Cost: NASA currently pays Russia $63 million for a seat in a Soyuz capsule; a seat on the Dragon V2 would cost just $20 million. [15]

Reusable Rocket Falcon 9: SpaceX has been attempting autonomous landing of the first stage of some of their rockets. On December 21, 2015, SpaceX successfully landed the first stage for the first time for an orbital launch, landing the first stage booster from their second mission partnered with Orbcomm at Landing Zone 1 at Kennedy Space Center (a Return To Launch Site landing). [16]

Solution for Transportation System: The reusable technology make the transportation from ground to earth orbit easy and affordable. During the Dragon's return flight from ISS, It could be used to transport the recycled satellites parts back to earth.



Conclusion: Conceptual Model

1) Space Robots: collecting target satellites

2) SpaceX Dragon: transportation system

3) Space Station: as recycle station

Dia -1-1 Conceptual Model

7. Information Exchange Matrix

Information Exchange Matrix defines data or information needs between operational elements

Needlines	Information Descripiton	Information Attributes		Information Source	Information Destination
		Details	Media		
1	Retried Satellites Information	Location, Model, Size	Message, Data	Retired Satellites	Space Robots
2	Retired Satellites	Retried Satellites	Satellite	Space Robots	Space Station
3	Reusable Parts	Reusable Satellite Parts	Satellites Parts	Space Station	New Satellites
4	Valuable Parts	Valuable Satellites Parts	Satellites Parts	Space Station	SpaceX Dragon
5	Valuable Parts	Valuable Satellites Parts	Satellites Parts	SpaceX Dragon	Ground Station
6	Waste	Waste Parts	Waste	Space Station	Graveyard

(nodes) from Operational Node Connectivity. Information exchanges and identifies *"who* exchanges *what* information, with *whom*, *why* the information is necessary, and *how* the information exchange must occur."

From Diagram-2 Operational Node Connectivity, six needline applied. The consumer and provide as Diagram-3 Information Exchange Matrix.

8. Operational Activities

describes the operations that are normally conducted in the course of achieving a mission or a business capability. It describes capabilities, operational activities (or tasks), input and output (I/O) flows between activities, and I/O flows to/from activities that are outside the scope of the architecture. High-level operational activities should trace to (and are decompositions of) a Busi-

Diagram -3 Information Exchange Matrix

ness Area, an Internal Line of Business, and/or a Business Sub-Function as published in OMB's Business Reference Model

Key Elements

1) Space Robots Operational Activities: the space robots will locate, collect, and transport the target satellites to recycle station or space station, graveyard. The same time, robot has communication system that could response the commands from control center and report the task process to control center.

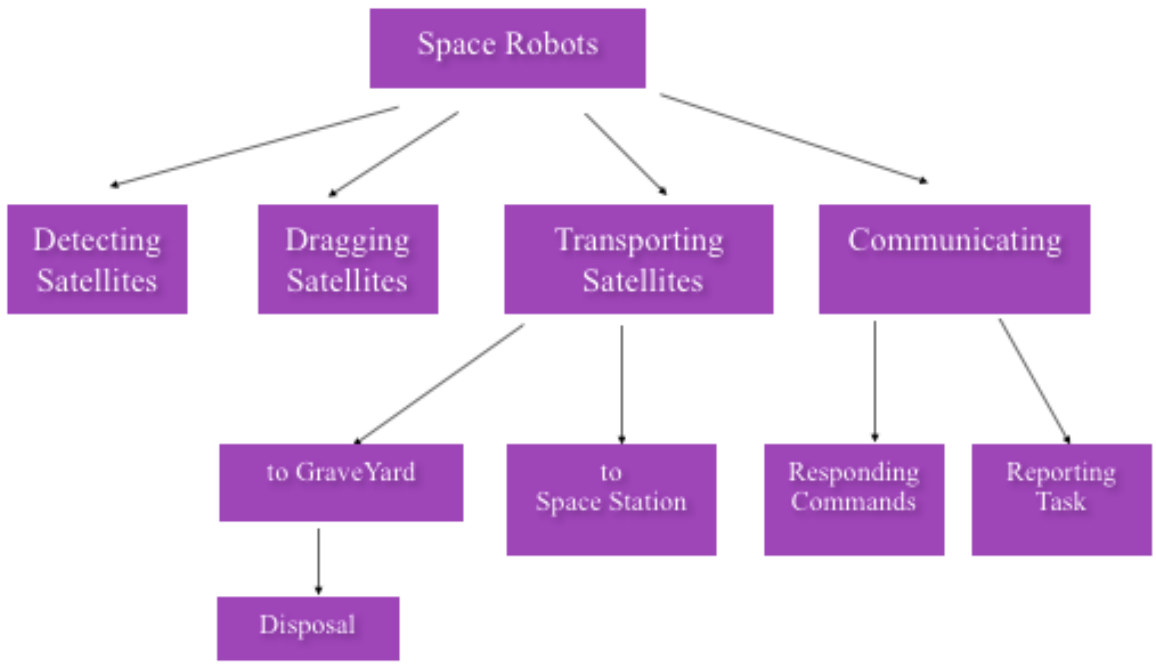


Diagram - 4-1 Space Robots Activities

2) Space Station Operational Activities: International Space Station is used as the recycle station. It is big enough and expandable. The Space Station center is the place for space robots to parking, and also the control center of Space Robots. What's more, space center is the place for crews to live in and work at. After the space robots bringing back the target satellites, crew will dismantling satellites at work section, and store the reusable and valuable part to storage space. Space Station also has docks for spacecraft to load the valuable parts.

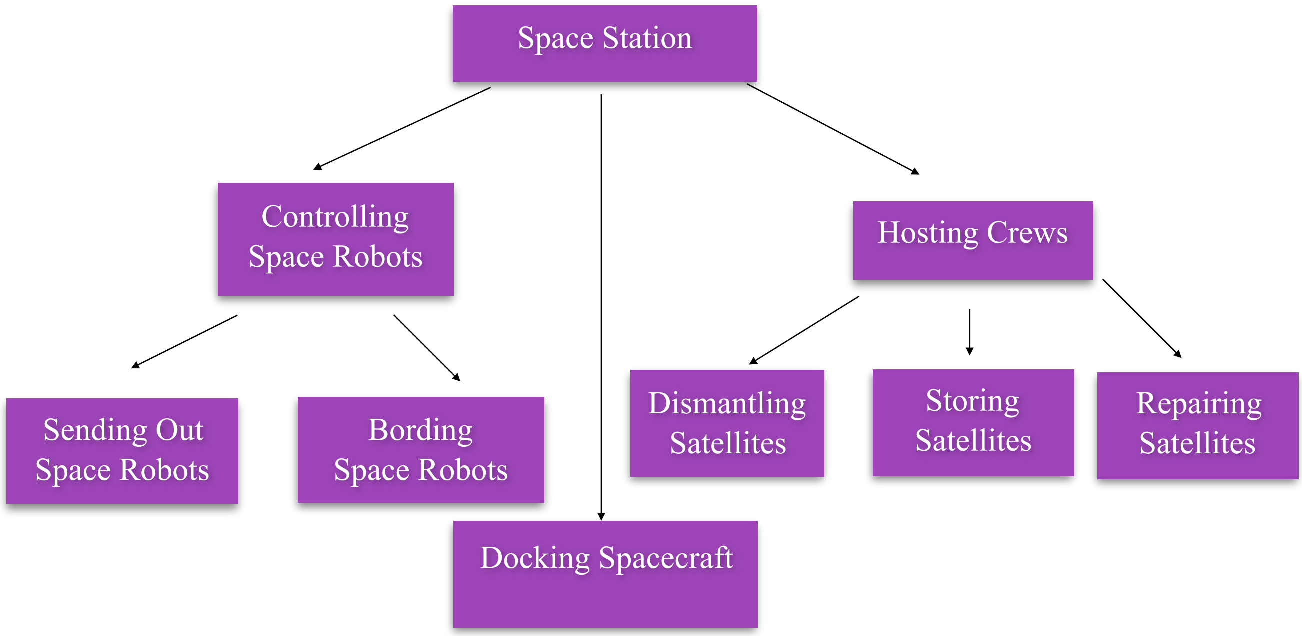


Diagram - 4-2 Space Station Activities

3) Transportation System Operational Activities: The transport the valuable parts from space station to ground station. The spacecraft also carry crew member to repair the new satellite if in need.

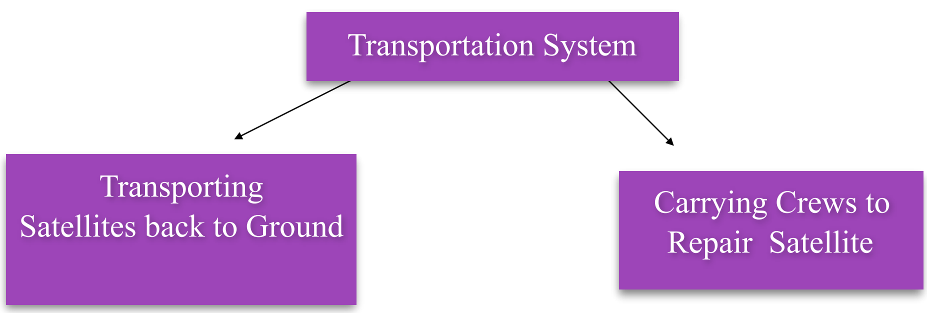


Diagram - 4-3 Transportation System

Activities Summary: Space Robots collect the target satellite, send it back to Space Station. At the Space Station, crews dismantling the satellite, store the reusable parts and valuable parts. Space robots dispose the waste to graveyard. Spacecraft send out the crew and the reusable parts to other the satellite that need repair. Spacecraft send valuable parts back to grounds.

9. System Functional Description

The SV-4a documents system functional hierarchies and system functions, and the system data flows between them. It develops a clear description of the necessary system data flows that are input (consumed) by and output (produced) by each system, 2) ensure that the functional connectivity is complete (i.e., that a system's required inputs are all satisfied), and 3) ensure that the functional decomposition reaches an appropriate level of detail.

Heuristic: Except for good and sufficient reasons, functional and physical structuring should match.

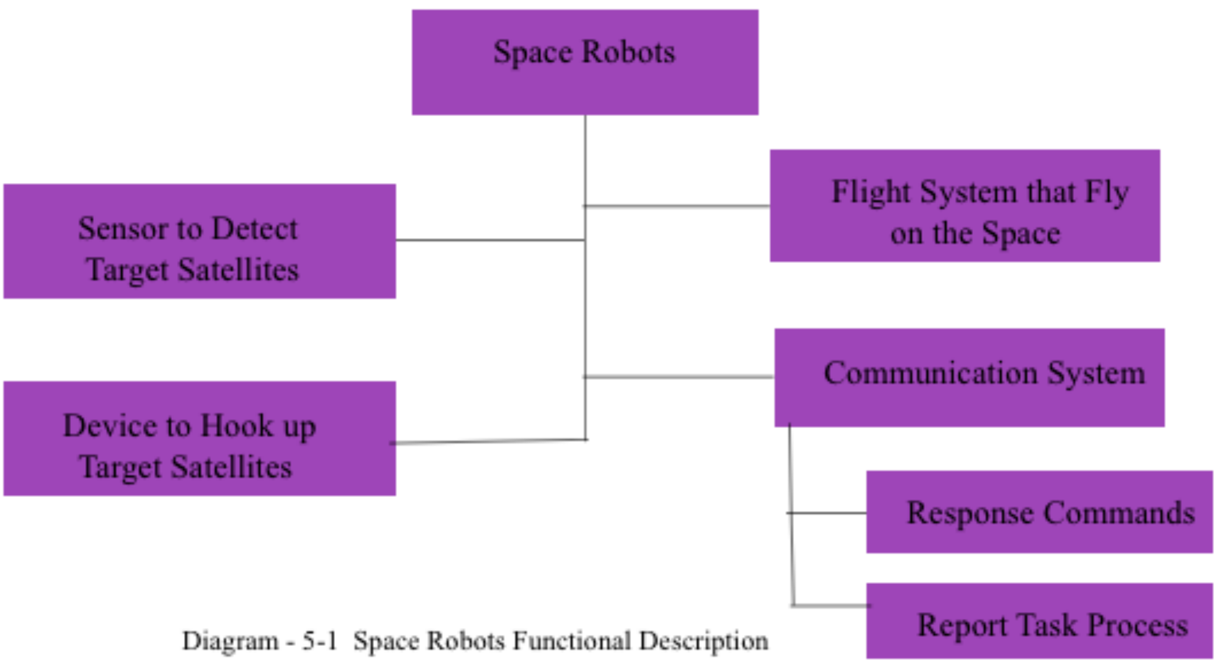


Diagram - 5-1 Space Robots Functional Description

During design the function of the system. It suppose to match the operational activity purpose. The same time, physical structure should match the functional structure.

1) Space Robots Functional Description: It should have sensor that could detect the target satellite; It should have hook device to connect target satellite; It could fly on the space; It has communication system that could respond the commands from space station and could report the task process to control center.

2) Space Station Functional Description (1) It has space robots section: Space Robots control center, Space Robots parking place to store the Space Robots, and the Dock for Space Robots landing and unload satellites. (2) It has space for crew to live and work. In the work space, crew will dismantling, classify, and store the satellites. (3) It has dock for spacecraft to load the cargo. The last function is control center that could communicate the spacecraft.

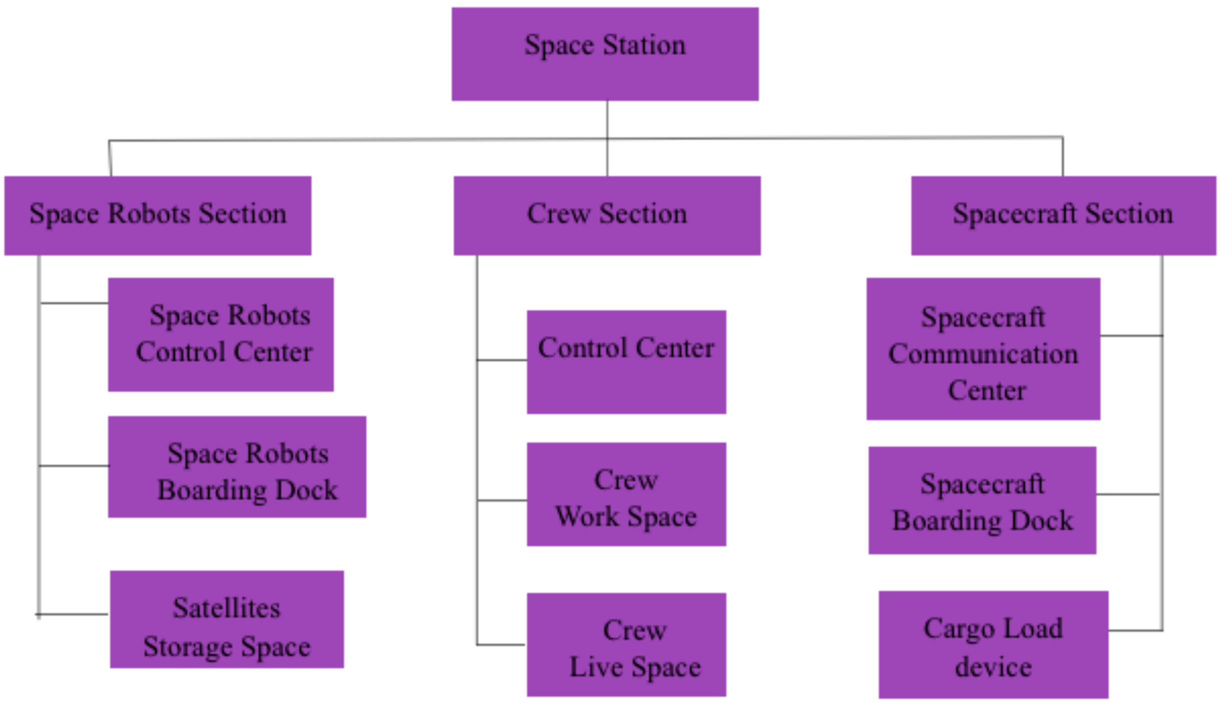


Diagram - 5-2 Space Station Functional Description

10. System Interface

System Interface identifies systems nodes and systems that support operational nodes. Interfaces that cross organizational boundaries (key interfaces) can also be identified in this product. Some systems can have numerous interfaces. Initial versions of this product may only show key interfaces. Detailed versions may also be developed, as needed, for use in system acquisition, as part of requirements specifications, and for determining system inter operabilities at a finer level of technical detail.

1) Satellites Components: Command Antenna, Communication Antenna, Solar Cells, Batteries, Radio Receivers and Transmitters, Rocket Fuel, Main pocket motor, Rocket Thrusters.

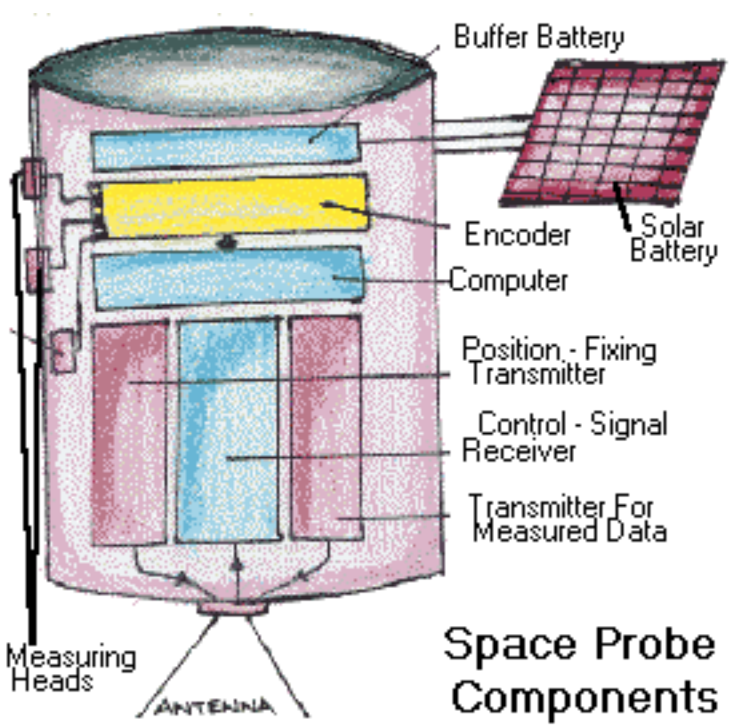
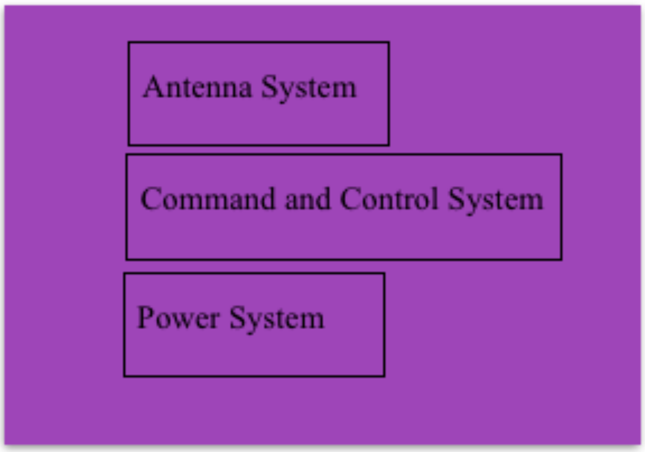


Fig-11 Satellites Components

Subsystems: command and data handling subsystems consist of computers that gather and process data from the instruments and execute commands from Earth. A power subsystem generates, stores, and distributes a satellite's electric power. This can include panels of solar cells that gather energy from the sun. Some things that help satellites work are a power supply and distribution system, telemetry, communications, and navigation system, on-board intelligence, and thermal management equipment.

There are also different kinds of satellites which require different components to launch it. Some components needed in a multi spectoral satellite are a scanner rotator, spherical focal point, focusing mirror, radiation gathering mirror, and a beam of radiation. [17]

Antenna System: A satellite's antennas have two basic missions. One is to receive and transmit the telecommunications signals to provide services to its users. The second is to provide Tracking, Telemetry, and Command (TT&C) functions to maintain the operation of the satellite in orbit. Of the two functions, TT&C must be considered the most vital. If telecommunications services are disrupted, users may experience a delay in services until the problem is repaired. However, if the TT&C function is disrupted, there is great danger that the satellite could be permanently lost drifting out of control with no means of commanding it. [18]



Satellites Subsystems

Command and Control System: This control system includes tracking, telemetry & control (TT&C) systems for monitoring all the vital operating parameters of the satellite, telemetry circuits for relaying this information to the earth station, a system for receiving and interpreting commands sent to the satellite, and a command system for controlling the operation of the satellite.

2) Space Station Components:

The components of the ISS include shapes like canisters, spheres, triangles, beams, and wide, flat panels. The modules are shaped like canisters and spheres. These are areas where the astronauts live and work. On Earth, carbonated drinks come packaged in small canisters to hold the pressurized liquids efficiently. Similarly, the U.S. Laboratory Destiny holds a pressurized atmosphere. Russian modules like Zvezda (which means "star") and Zarya (which means "sunrise") consist of a combination of spheres and canisters.

Triangles and beams are used for strength on Earth in structures like bridges. The truss that forms the backbone of the Station is made up of many triangular structures and beams.

Panels are wide, flat surfaces used to cover large areas. On the ISS, the solar panels are used to collect sunlight and convert this energy into electricity. Likewise, radiators are waffle-shaped panels used to get rid of extra heat that builds up in the Station.

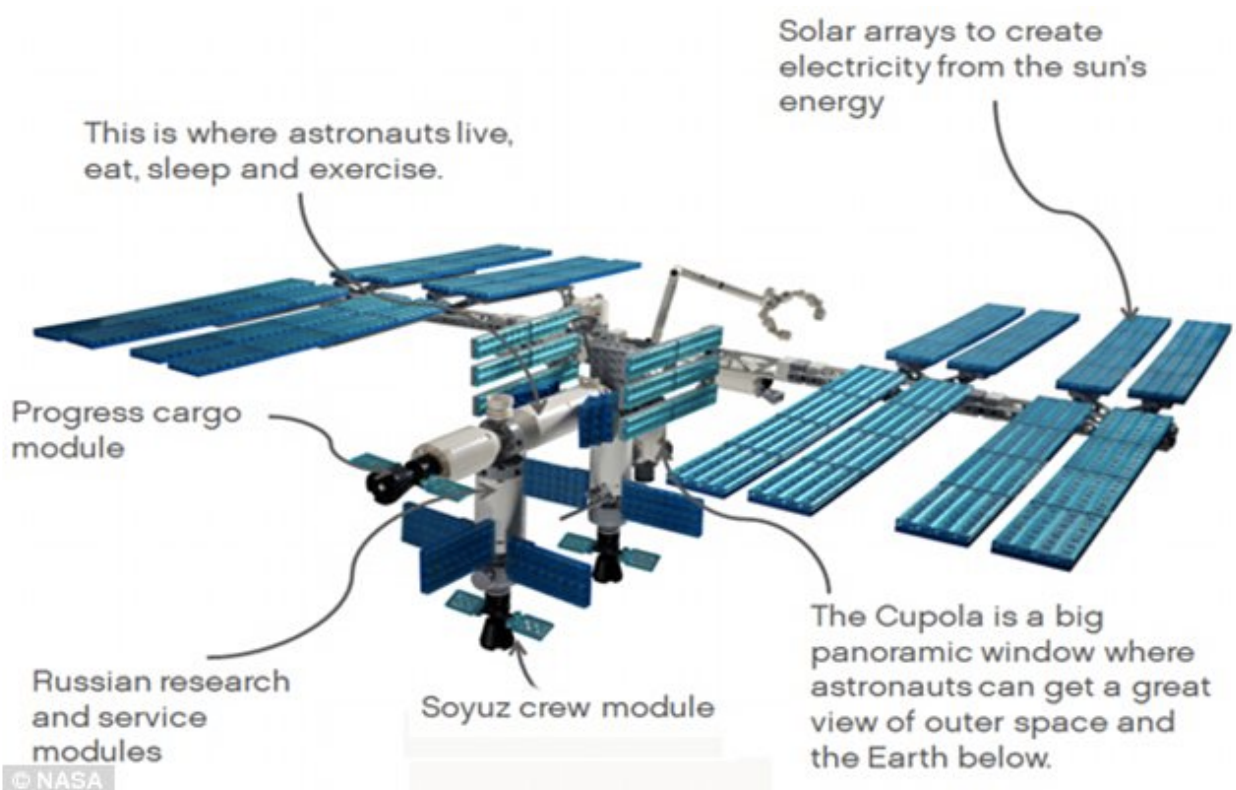


Fig-12 International Space Station Components

The ISS also has a robotic arm known as the Remote Manipulator System. It is used to help construct the Station by grappling and moving modules or by moving astronauts into position to work on the Station. The robotic arm was built by Canada and is called Canadarm 2. The first Canadarm is on the Space Shuttle and is used to retrieve cargo from the Shuttle bay. [19]

To achieve Space Station Functional Description, we need satellites storage section and satellites work space.

Alternative Solution: 1) diverted from original Space Station.

2) expands the Space Station for Satellites Storage use.

Space Station Subsystems including satellites section. The System Interface Diagram as following:

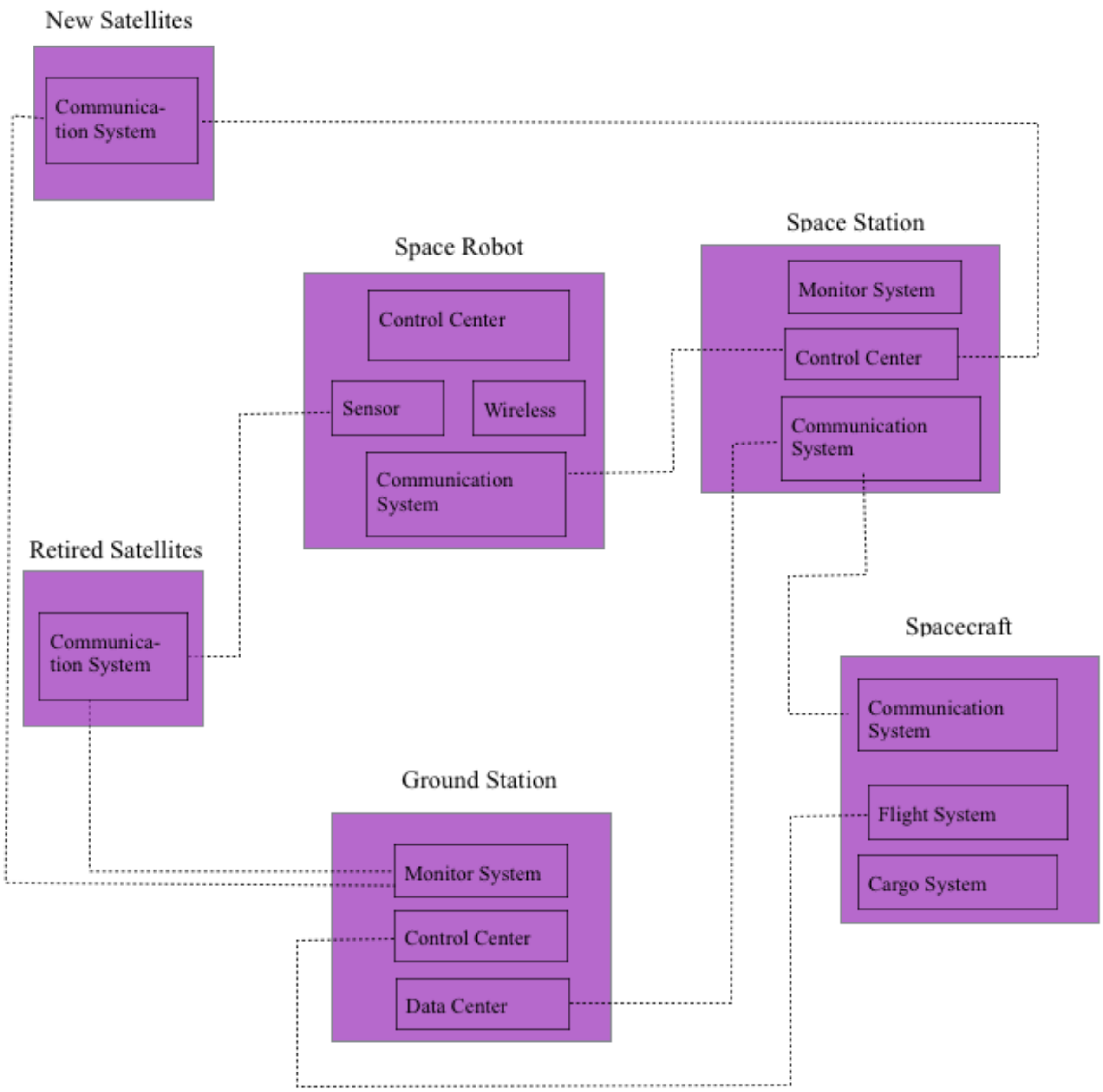


Diagram - 6 System Interface

Task 1 Recycle Retired Satellites: Ground Station monitors the satellites and obtains the location data of target satellite —> Ground Station Data Center sends the data information to Space Station —> Space Station accepts the task and sends out Space Robot—> Space Robot searches for satellites and locates the target satellite, drags the satellites back to Space Station, report the task process to Space Station Control center.

Task 2 Repair New Satellites in need: Ground Station monitors the satellites and obtains the location data of target satellite —> Ground Station Data Center sends the data information to Space Station —> Space Station accepts the task, sends out reusable satellites parts and repair crew member—> Crew member and spacecraft searches for satellites and locates the target satellite; crew repair the satellite; crew member report the task process to Space Station Control center.

11. Operational Activities to System Functionality Matrix

Operational Activity to SV-5a and SV-5b is a specification of the relationships between the set of operational activities applicable to an architecture and the set of system functions applicable to that architecture.

Product Purpose. SV-5a depicts the mapping of operational activities to system functions and thus identifies the transformation of an operational need into a purposeful action performed by a system.

SV-5a can be extended (SV-5b) to depict the mapping of capabilities to operational activities, operational activities to system functions, system functions to systems, and thus relates the capabilities to the systems that support them. Such a matrix allows decision makers and planners to quickly identify stove piped systems, redundant/duplicative systems, gaps in capability, and possible future investment strategies all in accordance with the time stamp given to the architecture. SV-5b correlates capability requirements that would *not* be satisfied if a specific system is *not* fielded to a specific DoD unit.

The relationship between operational activities and system functions can also be expected to be many-to-many (i.e., one operational activity may be supported by multiple system functions, and one system function may support multiple operational activities)

From the diagram, operational activities and system functions performance is clear and no redundancies. All the activities have related system functions.

Diagram - 7 Operational Activities to System Functionality Matrix

12. Risk Management

Space Robots Risk

ISSUES IN SPACE ROBOTICS

How are Space Robots created and used? What technology for space robotics needs to be developed? There are four key issues in Space Robotics. These are Mobility—moving quickly and accurately between two points without collisions and without putting the robots, astronauts, or any part of the worksite at risk,

1) Manipulation—using arms and hands to contact worksite elements safely, quickly, and accurately without accidentally contacting unintended objects or imparting excessive forces beyond those needed for the task.

Fig-13 Special Purpose Dexterous Manipulator on the end of the Space Station Remote Manipulator

2) Time Delay—allowing a distant human to effectively command the robot to do useful work, and Extreme Environments—operating despite intense heat or cold, ionizing radiation, hard vacuum, corrosive atmospheres, very fine dust, etc.

3) Cost risk. All space robots share a need to operate in extreme environments. Generally this includes increased levels of ionizing radiation, requiring non-commercial electronics that have been specially designed and/or qualified for use in such environments. The thermal environment is also generally much different from terrestrial systems, requiring at a minimum systems that are cooled not by air or convection, but by conduction. Many space environments routinely get significantly hotter or colder than the design limits for normal commercial or military components. In such cases, the space robot designer faces a choice of whether to put those components into a special thermal enclosure to maintain a more moderate environment, or to attempt to qualify components outside their recommended operating conditions. Both approaches have been used with success, but at significant cost. [21]

Space Station Risks

1) Cosmic rays pose a hazard to space station crews. Cosmic rays are a form of natural background radiation that travels from space to the Earth. Cosmic rays primarily consist of protons, but also contain other charged particles such as electrons or nuclei, high-energy photons such as gamma rays, and neutrinos. Cosmic rays, which are produced at various points in the universe, propagate through interstellar space. Before they reach the Earth, they occasionally interact with interstellar media or are reflected by interstellar magnetic, solar, or geomagnetic fields.

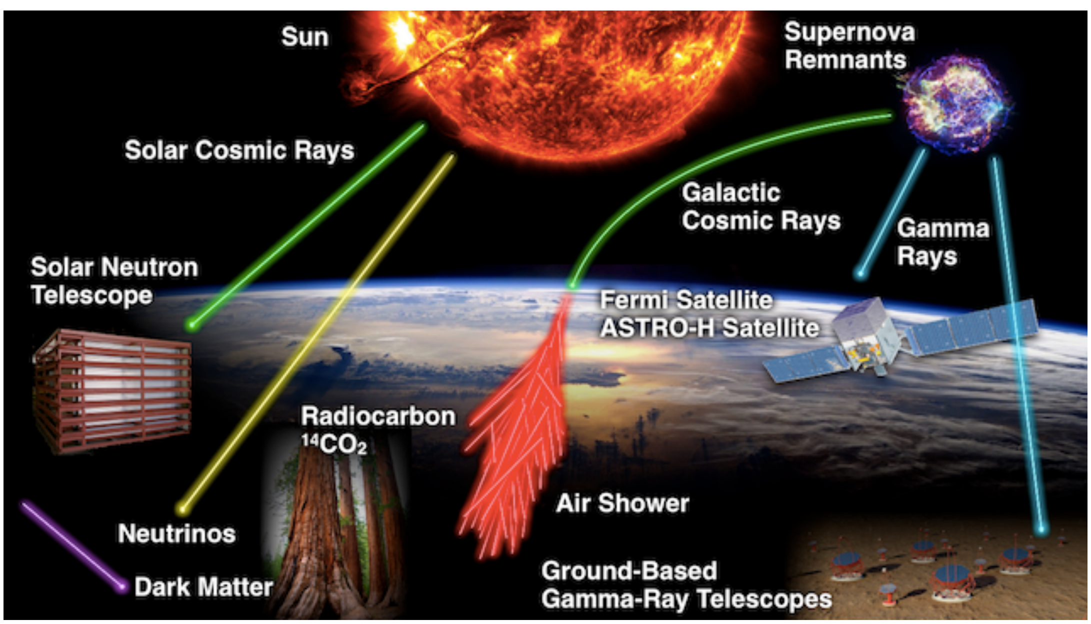


Fig-14 Cosmic Rays

Radiation levels on the International Space Station are as high as they were on the antiquated Russian space station Mir, in spite of NASA's attempts to clad the ISS with better shielding. If NASA can't protect astronauts, its vision of sending a crew into deep space may come to nothing.

2) Space debris threaten. More than 500,000 pieces of debris, or “space junk,” are tracked as they orbit the Earth. They all travel at speeds up to 17,500 mph, fast enough for a relatively small piece of orbital debris to damage a satellite or a spacecraft. The rising population of space debris increases the potential danger to all space vehicles, but especially to the International Space Station, space shuttles and other spacecraft with humans aboard.

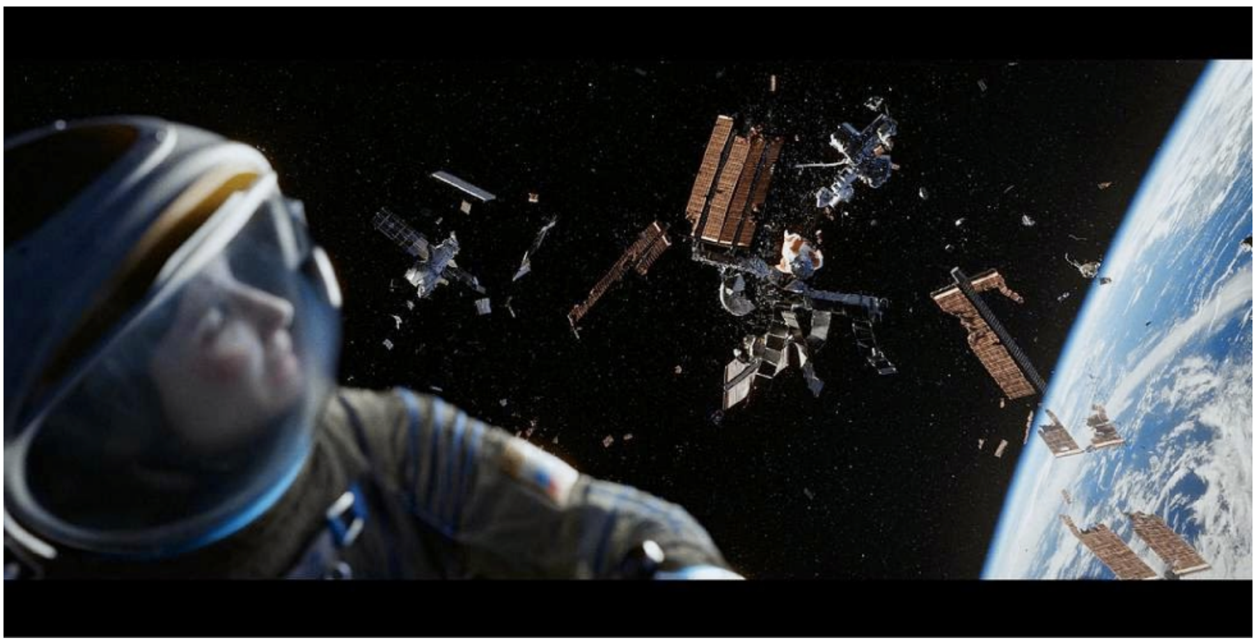


Fig-15 Space Debris

Management Risk: Maneuvering Spacecraft to Avoid Orbital Debris

NASA has a set of long-standing guidelines that are used to assess whether the threat of a close approach of orbital debris to a spacecraft is sufficient to warrant evasive action or precautions to ensure the safety of the crew. [22]

Debris avoidance maneuvers are planned when the probability of collision from a conjunction reaches limits set in the space shuttle and space station flight rules. If the probability of collision is greater than 1 in 100,000, a maneuver will be conducted if it will not result in significant impact to mission objectives. If it is greater than 1 in 10,000, a maneuver will be conducted unless it will result in additional risk to the crew.

3) Cost overrun risk.

The ISS is arguably the most expensive single item ever constructed. In 2010 the cost was expected to be $150 billion. It includes NASA's budget of $58.7 billion (inflation unadjusted) for the station from 1985 to 2015 ($72.4 billion in 2010 dollars), Russia's $12 billion, Europe's $5 billion, Japan's $5 billion, Canada's $2 billion, and the cost of 36 shuttle flights to build the station; estimated at $1.4 billion each, or $50.4 billion total. Assuming 20,000 person-days of use from 2000 to 2015 by two to six-person crews, each person-day would cost $7.5 million, less than half the inflation adjusted $19.6 million ($5.5 million before inflation) per person-day of Skylab.

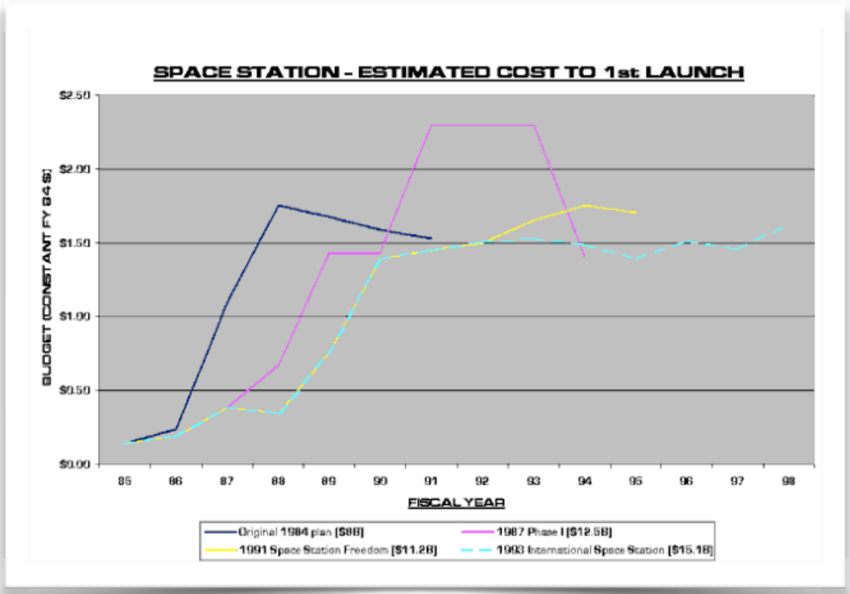


Fig-16 Space Station Cost

13. Stakeholders Interaction

It is a big and complex project and involves in different stakeholders.The architect balances the needs of all stakeholders. The major stakeholder of this project is NASA. Another important role is SpaceX.

SpaceX's Falcon 9 rockets and Dragon spacecraft are initially expected to be unmanned vehicles to serve NASA's cargo needs for the International Space Station. Dragon could be ready to launch astronauts within three years of receiving a contract from NASA to do so. The company currently has a $1.6 billion contract to provide 12 unmanned cargo deliveries to the station

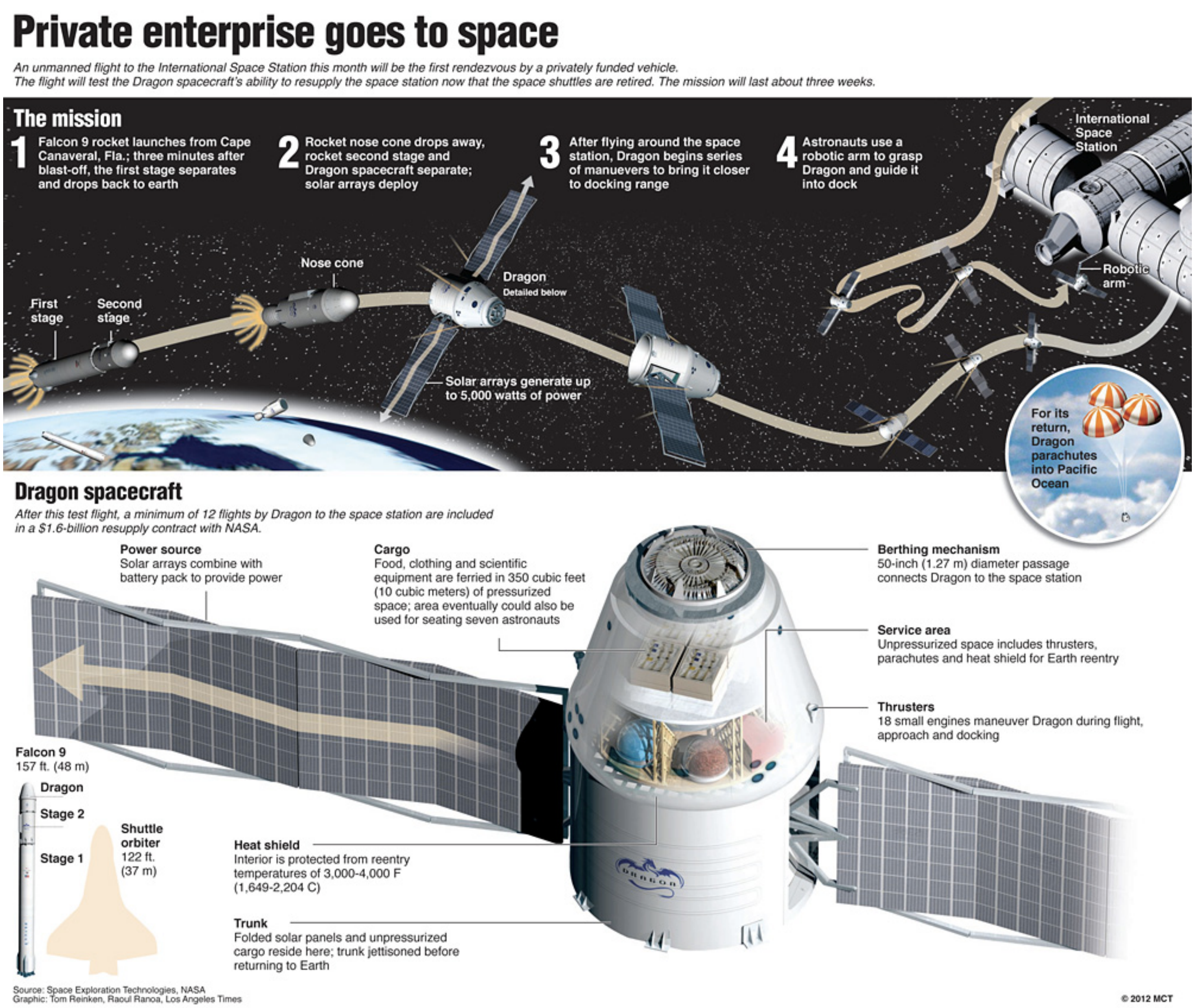


Fig-17 SpaceX Dragon

through 2016. The Falcon 9 rocket is about 180 feet (57 meters) tall and is a two-stage booster. The Dragon capsule is a solar-powered spacecraft designed to be grappled by the space station's robotic arm and installed on a docking port.

Some other private company could involve in this business in future.

Orbital Sciences: Orbital Sciences has a $1.9 billion contract with NASA to provide eight cargo missions for the International Space Station using its unmanned Cygnus spacecraft and the new Taurus 2 rocket.

Fig-18 Orbital Sciences' Cygnus Spacecraft Aborts First Attempt At Docking With ISS

Blue Origin: Blue Origin has tested a prototype of its New Shepard spacecraft at the company's proving grounds in Texas. New Shepard is expected to be a vertical launch and landing vehicle capable of reaching an altitude of about 75 miles (120 km) . [23]

Bigelow Aerospace: Bigelow Aerospace has been paving new ground in inflatable spacecraft and already launched two mini-space station prototypes, called Genesis 1 and Genesis 2. The company's larger Sundancer and BA-330 vehicles are expected to serve as space stations, not capsules. Additionally, company founder Robert Bigelow has set his sights on developing a private moon base using the inflatable technology. [23]

Fig-19 Boeing CST-100 capsule docks at Bigelow Aerospace space station

SpaceDev/Sierra Nevada Corp. : California-based SpaceDev is a wholly owned subsidiary of Sierra Nevada Corp. (which acquired it in 2008) and has been developing the reusable Dream Chaser space plane to launch crew and cargo into space at an Atlas 5 rocket. In February, Sierra Nevada won $20 million in NASA funds to continue the Dream Chaser's development. The spacecraft's design is based on the HL-20 lifting body tested by NASA and aims to launch on a rocket and land on a conventional runway, for quick turnaround and reuse. [23]

Fig-20 Dream Chaser

Virgin Galactic: The only air-launched vehicle in the group, Virgin Galactic's SpaceShipTwo

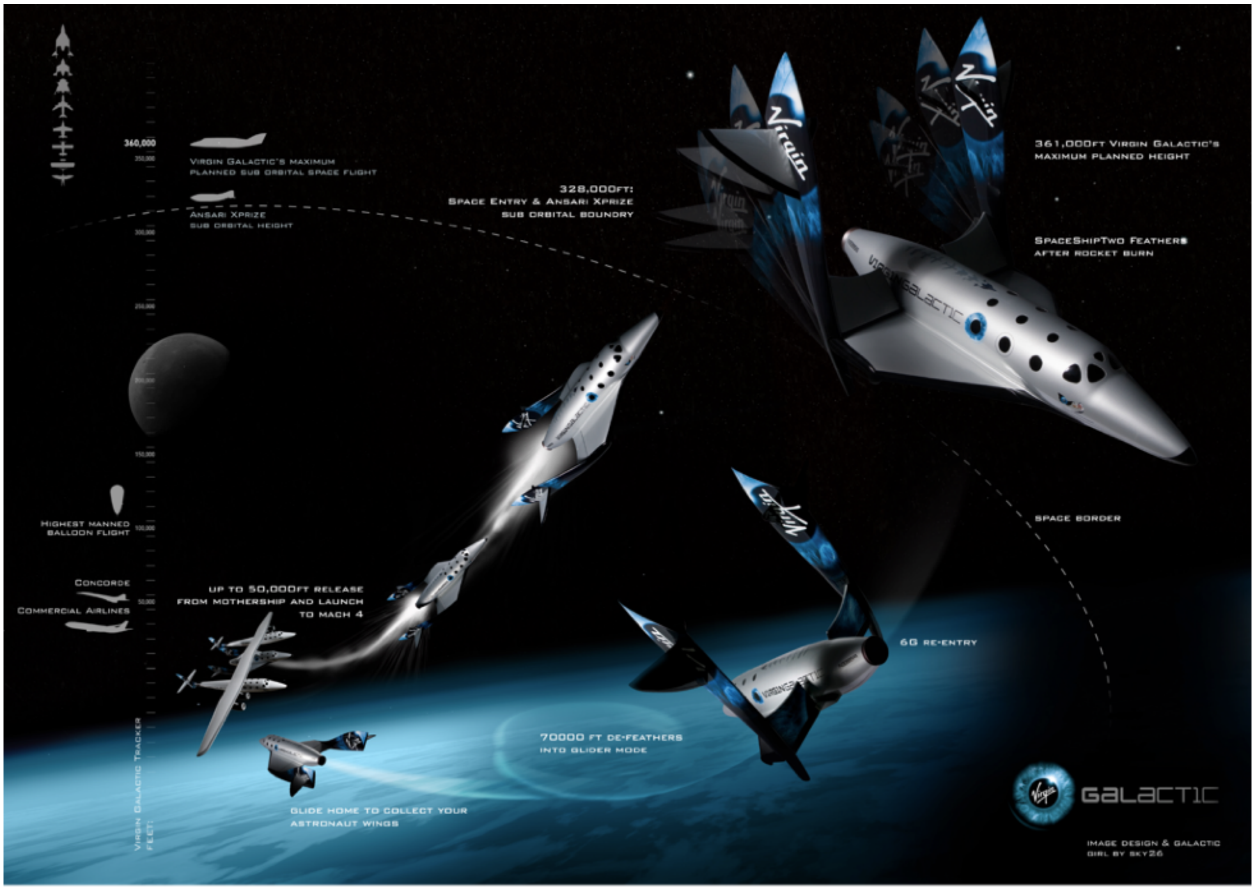


Fig-21 Virgin Galactic

vehicle is still just a suborbital vehicle designed for space tourism jaunts into space. The company envisions launching paying passengers on suborbital thrill rides for about $200,000 per seat. However, the spacecraft's mother ship the huge WhiteKnightTwo aircraft could be modified to launch small rockets or satellites for NASA or other users. [23]

About the Future:

There are still lots of details and processes on this project…

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