Chandrayaan 2 all information pdf

THE CHANDRAYAAN-2 LUNAR MISSION ISRO Spacecraft Launch Mode Sensor Completes Ground Segment REFERENCES ISRO began India's planetary exploration program with the successful launch of the Chandrayaan-1 spacecraft mission to the moon in 2008. The 11 remotely sensory scientific instruments from ISRO, Nasa and ESA aboard Chandrayaan-1 (launched in October 2008) have reached significant findings, including the discovery of water signatures, spinal minerals, lunar lava tubes, evidence of recent volcanism, rock movements triggered by injury and the discovery of bubbling atomic oxygen and helium smeared on the lunar surface. 1) The Chandrian-2 spacecraft to the moon is a complex module mission consisting of Orbiter, Lander and Rover. Chandrayaan-2 is scheduled to be launched aboard a Geosynchronous satellite launch vehicle (GSLV) in summer 2019. The spacecraft will carry the combined stack up to the moon until the lunar orbiter (LOI) enters. The combined pile is inserted into orbit around the moon of 100 km by 100 km. The lying with the rover is then designed to be separated from the Orbiter for a soft landing at a site near the surface of the south polar moon. Chandrayaan-2's overall goal is to build on the successes of the Chandrayaan-1 mission, testing new technologies and conducting experiments on the moon. The rover will collect samples from the moon's surface and analyze them at the site, transferring data to Earth through the spacecraft. The spacecraft will map the contents of the surface to a depth of several dozen meters and conduct a detailed study of the lunar exosphere. India's maiden lunar voyage was a significant achievement for its space program, but ended prematurely when ISRO lost contact with the spacecraft ten months into its planned two-year mission. However, a device on a probe that reached the moon's surface gathered enough data for scientists to confirm the presence of water traces. Chandrian-2 will attempt more ambitious technical maneuvers that will put Indian space technology to the test. For the first time, ISRO will try to give a controlled, or soft, landing spacecraft. The agency was forced to develop advanced systems that could guide the thrulid to contact and successfully deploy the rover. Chandrayaan-2:2) goals • Expand technologies from Chandrayaan-1 and demonstrate newer technologies for future planetary missions. • Deploy a moon-rover lying capable of soft landing at a specified lunar site and deploying a rover to perform in-situ analysis of chemicals. • Carry cargo in an Orbiter spacecraft to enhance chandrayaan-1's scientific goals with improved resolution. Spacecraft: Chandrayaan-2 is the ISRO (Indian Space Exploration Organization) mission that includes the 'Orbiter Spacecraft' and the 'Lander Spacecraft'. Chandrayaan-2's main goal is to demonstrate the ability to land soft on the lunar surface and activate a robotic rover on the surface. Scientific goals include studies on lunar topography, mineraugia, Abundance, lunar exosphere, and signatures of hydroxyl and water ice. The Orbiter Craft Module structure is a three-ton category bus structure made of central complex cylinder, gia and deck panels. It was developed by Hindustan Aeronautics Ltd(HAL) and delivered in June 2015 to the ISAC (ISRO Satellite Center) where additional subsystands and payloads of the spacecraft were built on the structure. 3) Chandrayaan-2, India's second lunar mission, has three modules namely Orbiter, Lander (Vikram) & Rover (Fargian). Orbiter and Lander modules will interface mechanically and stack together as integrated modeling and will be hosted inside the GSLV MK-III launch vehicle. The rover is sings inside the lying. After launch into Earth orbit by GSLV MK-III, the integrated module will reach lunar orbit using an Orbiter propulsion module. Lander will then separate from orbit and soft ground at the pre-laid site close to the lunar south pole. 4) Figure 1: An image of Chandrayaan-2's 'Orbiter Spacecraft Module Structure' delivered by HAL to ISAC (ISRO Satellite Center), Image Credit: ISRO Moreover, the rover will reel in for performing scientific experiments on the lunar surface. Instruments are also mounted on Lander and Orbiter to conduct scientific experiments. Chandrayaan-2 Spacecraft Architecture Chandrayaan-2 Orbiter Craft is built around cuboidal structure houses propulsion tanks and the launch vehicle's separation mechanism at one end and lands at the other. The ship's decks include the spacecraft's various household systems. The solar array consists of two solar panels that are stored in the launch configuration and deployed on separation to provide the necessary power for the Orbiter spacecraft at various stages around the Earth and moon. The lithium-ion battery provides the power support during an eclipse and the spacecraft's peak power requirements. The Orbiter is a three-axis body-positioned spacecraft with reaction wheels that provide a stable imaging platform. Thrusters are present for throwing momentum and repairing access. A bi-propaneal liquid engine is used to elevate the vehicle's orbit from earth's parking orbit to a 100-km orbit around the moon. The access and control in electronics orbit to receive the access data from the star sensors and body lessons from Gyro's to S/C. 5 control) The other sensors used to control the spacecraft are solar and outline sensors. The telemetry system provides health information about the spacecraft while the communications system handles command and distribution. The various charges in the Orbiter interface with the system design for handling the base bar data and recording a solid state recorder for later operation. The RF system consists of a TTC transmitter and an X-band transmitter for transmitting cargo data to the Indian Deep Space Network (IDSN) station. Cargo data is transmitted via X-band A gimbal antenna that will be sharpened to the ground station. The Chandrayaan-2 Lander structure is a severed pyramid around a cylinder that has an impulse tank and the interface for orbiter's separation mechanism. Vertical panels have solar cells while rigid panels house all electronic systems. The lying foot mechanism (four nos.) provides stability when landing on different areas. The body mounted solar panels to provide the power for the various systems during the mission at all stages. In addition, a lithium-ion battery supports power consumption requirements during an eclipse and lying down. Control electronics provide the interface to all sensors and serving drives. The sensors are set for inertial navigation from separation to the end of rough braking and the absolute sensors determine the location and speed relative to the landing site to guide the lying beyond the rough braking phase to the detected site. Guided navigation and control landing will be autonomous from separation onwards and must ensure accurate, safe and soft landing on the lunar surface. The braking thrust for lying down is provided by four nos. Of liquid motors. The lying's approach is maintained with eight No. Of propellers. The lying foot mechanism ensures that the energy on landing is absorbed and all lying systems are integral and stable for the continued conduct of cargo deployments and science on the moon. Each leg consists of a telescopic leg assembly with crush material in the leg and leg amputate. Extensive analysis and testing is done for the lying foot mechanism to ensure stability in extreme terrain conditions and terminal speed. TTC communication between the lyst – IDSN is in the S-band and the payload data is transmitted by a high-torque double gimbal antenna. Lander has a TM-TC data handling system with built-in storage. The Chandrian-2 rover is stored at the lying during launch and the ramp landing has been deployed and a cable car begins its journey across the lunar surface. The lying device will be deployed on landing. Chandrayaan-2 Rover is a six-wheel mobility system designed to perform mobility on the low gravity & vacuum of the moon and also conduct science for understanding lunar resources. The rover's design is based on the well-proven Sojourner rover deployed by Nasa for Mars exploration in July 1997. The rover chassis houses all electronics and has two navigation cameras to create stereo images for lane planning. The deployed solar panel provides the power during the mission. The boogie mechanism of the swing along with the six wheels ensures a rugged mobility system over obstacles and slopes along the path identified for exploring the area. The rover communicates with the A.D.C.N. through the lying. Both rover charges conduct science on the lunar surface. Figure 2: The spacecraft and landed in a stacked configuration On top) with a rover inside the lying down (Image credit: ISRO) Figure 3: Chandrayaan-2 Mission Elements (Image credit: ISRO) Figure 4: Image of a MkIII-M1 GSLV vehicle at the second launch pad (Image credit: ISRO) Launch: Chandrayaan-2 mission launched on 22 July 2019 (09:13 GMT, GMT, with an expected moon landing on September 6, 2019) using a GLSV (geosynchronous satellite launch vehicle) Marcus III in a launch vehicle from SDSC (Satish Dhawan Space Center) on Sriharikota Island. 6) Orbit: The lying-spacecraft pair will enter an initial elliptical (170 x 45,475 km high) Earth orbit, followed by trans-lunar injection. Both spacecraft enter an initial elliptical orbit of the moon. After inserting a runway, the lying and the spacecraft separated. - The spacecraft develops into a 100 km circular polar orbit and brakes land from orbit and land on the surface in high latitude areas near the South Pole. The spacecraft portion of the mission is scheduled to last a year. The rover will be deployed via ramp shortly after landing and is scheduled for 14-15 days, one period of moonlight. The Chandrayaan-2 mission profile begins with the GSLV MKIII launch vehicle injecting the lunar spacecraft's combined stack and lying modules (wet mass ~3320 kg) into a transfer orbit. The spacecraft and lander are injected into a transfer orbit of 170 x 45,75 km or EPO (Earth's parking orbit) by the launch vehicle. A series of mid-orbit lift maneuvers and final entry maneuvers are performed to place the spacecraft in orbit 100 x 100 km around the moon. Based on mission planning, after achieving the desired initial conditions, the lying is separated from the spacecraft and a short burn boost is performed to reduce the risk to 6 km. After a long beach phase, the lying will reach the shed. Near 1000, a second longer de-nudge burn is performed for horizontal containment. The purpose of the braking phase is to effectively kill the horizontal speed to 0 at the desired height. The lyst will then track a vertical descent, during which periodic firing will be done to reduce the vertical speed and achieve a speed of 0m/s, at 4m at which the impulse will break. The final stage is a free fall from 4m to the point of impact with a touch-down speed < 5 m/s (Ref. 1). Figure 5: The Chandrayaan-2 mission profile (image credit: ISRO) lying module operations from separation to landing will be performed by a closed loop NGC system (navigation, training and control). InS (inertial navigation system) alone will not be able to meet the stringent touchdown requirement of < 5 m/s at vertical and horizontal speed. The growth of the unbound error in INS over time is corrected with other absolute external dimensions. An integrated navigation system consisting of INS, star tracker (2), ID (2), and Lucimeter (2) and image sensor (2) will be exploited. IMU's initial approach in de-boost is determined by a star tracker. You're the... And Jiro erosion is also updated before the first burn. State vectors are created through the Deep Space Network (DSN), setting orbit and linking land and being transferred to the INS system. INS after updating the status vector is used for the first burn. During the long coastal phase as well, the access and gyro erosion are updated using a star tracker. The tilt of the accellation gauge is also updated during the long coastal phase. The INS mode vector is used during the second burn. During the vertical descent phase, the height of the height is used for the altitude information. The Doppler speed sensor is primarily used to measure horizontal velocity during the terminal landing phase to ensure a safe landing with a downward contact speed of < 5 m/s. Vision aid or space sensor using a CCD camera is used to get the image of the lunar surface to avoid the obstacles and re-focus the landing pad. 8) The Chandrayaan-2 thrust will activate a grouped configuration of four 800 N engines along with 50 N access control thrusters placed at the bottom of the spacecraft, to slow the spacecraft for braking and soft landing on the lunar surface. The spacecraft will be released from lunar orbit, which will go through even more different moon-related phases like de-reinforcement, rough braking, precise braking and vertical descent. The engines will be powered together at various stages to reduce the spacecraft's speed to move from 100 km north pole to 6 km south pole lunar altitude position. The lyst will be aboard a radio sea gauge, a pattern recognition camera and a reference inertial laser and accelerometer package (LIRAP). The thermal protection system was designed to keep the temperature of the craft-lying systems within the safe limits at this time. 9) A proportional flow control valve (PFCV) is the heart of the system that uses a mobile pintal-based design as a valving element, which moves in and out of the valve flow zone thus closing and opening the valve in the process. This movement is controlled by a step motor-based operator which will provide a proportional line to the command and thus provide smooth and continuous flow control. 10) The Lander-Rover module with a mass of about 1250 kg will be soft and has landed at the specific Lunar South Pole site. The lyst will deploy a lunar rover (~20kg mass) to perform in-situ analysis. The rover consists of six independently driven wheels attached to the rover's body through a swing-bogie mechanism with 10 degrees of freedom (DOF). The rover chassis houses each electronics and has two cameras for creating stereo images for lane planning. The deployed solar panel provides all the power during the mission. The rover is a combination of motion, navigation system, communication system, manipulator and scientific equipment. Software on board will allow the rover to roam the lunar surface semi-autonomously. ISRO will Partial command and control instructions from the ground. According to the memorandum of understanding signed with ISRO, IIT Kanpur designed, developed and verified two software algorithms (a) kinematic control algorithm for the rover's movement on uneven terrain and (b) algorithms for a computer vision-based autonomous navigation system for mobile robots for the Lunar Rover mission. The vision-based system will provide the 3D map of the area based on which the traction control algorithm will give the safest path for the rover. Path Tracking Control (PTC) is based on the kinematics and dynamics model of the rover undergoing 3-mith-paired motion with notes. A slip evaluator for the rover will be used in feedback for the route tracking controller. 11) All six wheels of the rover are powered by DC brushless servo engines. The front and rear wheels also have steering wheel engines. The rover has two rocking arms attached to the rover's body through differential. Each swing has a rear wheel attached to one end, and a bogey attached to the other. The boogie is hooked up to a swing with a joint on the loose. The wheels are spherical in shape and this ensures that the normal force in the contact of the terrain passes through the center of the wheel to reduce the wheel torque requirement. The maximum slope allowed because the rover can climb safely is 35', and can travel in an area with a maximum side slope of '35. 12) The inertial navigation of the throes is carried out by LIRAP (gyro laser-based inertial reference unit and accelerometer package). The LIRAP consists of four ILG (ISRO Laser Gyro) sensors and four CSA sensors (servo ceramic accelerometer). This sensor provides an access reference for the thym after it separates from the runway until landing. The acclutometers provide a speed seam for a detached liquid motor during orbital maneuvers. It also provides inertial navigation information (location, speed and quaternions) from separating the lying lying for a touchdown. One of the key elements essential for a safe landing is a hazardous detection and avoidance system (HDA). The HDA system consists of several sensors like high-resolution Orbiter Camera (OHRC) for landing site characterization, cameras for horizontal speed calculation, camera for pattern adjustment and position assessment, laser microwave to time, laser doppler velocimeter. All of these sensors provide information like the horizontal velocity of the thyme, vertical velocity, altitude above the moon's surface, relative position of the moon's surface of the W.R.T. lying, a risk/safe zone around the landing site. The HDA system aboard the lying processes the inputs from the various sensors, compares the data collected with the information already stored at the lying and provides the required real-time navigation and guidance system inputs to correct the runway at the end of a rough braking to enable a safe and soft landing (Ref. 5). Figure 6: Chandrian-2 Moon landing (with rover) Soft landing (Image credit: ISRO) Chandrayaan-2 India's Operations Mission Chandrayaan-2 spacecraft consisting of the Orbiter module and the Lander module (with rover) is expected to be launched on 6 September. The MKII GSLV rocket will place the Chandrayaan-2 spacecraft in a highly elliptical EPO (Earth's parking orbit) of 170 km by 45,475 km. The Chandrian-2 spacecraft's Orbiter propulsion system raises orbit around the Earth through several maneuvers of Earth burns and shakes the composites into a lunar transfer orbit. Furthermore, the spacecraft is captured into lunar orbit through precise maneuvering by the spacecraft's propulsion system. Furthermore, maneuvers around the moon are designed so that the orbit of the rider in the circular polar orbit of 100 km will be above the landing site on the day identified (R). Launch day/day and lunar orbit entry location will be timed to maximize the life of lying and cable car missions. This constraint will be met by proper planning of launch vehicle insertion parameters, orbit raising maneuvers and geometry to capture the moon in relation to the sun and Earth. The Orbital parameter of the Chandrayaan-2 spacecraft is composed when around the moon will need to be precisely determined and repairs made to ensure that the composite is at the point of separation at a predetermined time. As soon as this time, the Orbiter/Lynx separation system will separate the two modules. The Chandrian-2 spacecraft will continue to orbit the moon and perform science over the moon. In separation, a de-nudge maneuver at an altitude of 100 km causes a free fall of Lander to an altitude of 11 miles. The activated descent to the intended landing site begins with a closed-loop NGC (navigation, training and control) system to ensure a precise soft landing on landing. The lying, which will travel at 1.7 km per hour at 100 km, by separation, will be satisfied with it (by moving Homan) by firing its braking engines to reach 11 miles. The lying module will navigate precisely according to plan with the insizent INS (inertial navigation system). As soon as priapsis begins the rough braking phase. During this activated descent phase the approach of the thrust will be accurately controlled and the NGC system with the help of the inerviol sensors will provide the closed loop feedback for the operating systems. At the end of the rough braking phase [about 7 km], the hazard avoidance sensors will sense the location and speed of the lying lying with reference to the landing site. Based on the relative position and speed relative to the predetermined lunar landing site, the additional runway is planned on board and the sensors along with the factories will direct the throid to a position above the landing site [about 100m]. At this point, the lander hovering over the site and a risk avoidance sensor will determine the safest landing point in the immediate vicinity and the lander will Maneuver up to this point. At an altitude of 2m, having ensured that the relative speed with reference to the lunar surface is nil, the braking engines are cut off. The lying falls freely to the surface and the landing leg mechanism will absorb the impact loads and ensure the integrity of the lynth for further operations. The entire operation from separation to touch is fully autonomous and must be performed by the computers on board the blender without any interference from the ground. The onboard guidance algorithm takes the current navigation position and speed (in each training cycle) and produces a real-time steering profile by considering the final target modes. The steering profile determines the impulse size for each engine and the access required for the lyst. The access controller tracks the lead approach while ensuring closed loop stability. Inertial navigation is prone to errors because of factors such as error in initial situations, distribution errors, and inherent inaccuracies. This must be corrected with updates from absolute navigation sensors. When the lying is at an altitude of 7 km from the moon's surface, the absolute position of the lyder relative to the landing site is determined by a lying position detection camera. In addition, in this case the horizontal and vertical speed, absolute height relative to the surface of the moon is derived from the instruments on the board and are subjected to a closed loop NGC system for further refineation of the orbit. Given the absence of atmosphere on the moon, an active slowdown by pushing utilization of a bi-propaneal system with four 800 N engines will be performed. Eight 50 N engines are used to ensure the direction required during each descent phase. The separation error ellipse (100 km) generated by complex situation uncertainty increases over time against the inerviolable navigation errors. To fix the same thing, at 7 km it is required to have engine thrust control and the same is obtained by providing throttlability in all four engines. This variance in the engine ensures a safe and soft landing at the detected site regardless of the errors accumulated at the end of the rough braking phase. The lyst follows the landing strip and after a 100m short hover stage to re-locate the safe landing site lands at the identified site. Once the lander has landed on the surface, the rover is deployed, and the rover begins its journey across the moon. The rover's semi-autonomous navigation is powered by a pair of navigation cameras mounted on the rover that are able to take pictures of the moon's surface in front of the rover. These images are sent to the ground control center where the digital height model of these images was created. Based on this data, the path on which the rover can move is determined and the same is linked to the rover (using Lander). The slope the car can The size of the rock that the rover can climb, the sinking/smoothing are basic inputs that are considered when planning the path for rover movement. A telemeter mounted on the rover's chassis calculates the slope navigating the lunar surface and the same is used for safety reasons to end traffic in case the safe limits are exceeded. Other similar autonomous safety parameters like engine wheel current, feasibility of communication with a trope and power generation from a solar panel in front of monitored shadows to ensure the safety of the rover during mobility. Mission mode • January 6, 2020: India announces plans to land an unmanned space vehicle on the moon in 2020. The plans mark a continuation of India's drive to expand its space program. 13) - The head of India's Space Exploration Organization (ISRO), Kailasavadivoo Sivan, announced it on January 1. The planned mission, called Chandrian-3, is designed to land a research vehicle on the lunar surface. Chandrian is the sanskrit word for lunar vehicle. Sivan recently told reporters that mission planning had progressed smoothly so far. According to Sivan, we're aiming for a launch for this year, but it could spill over into next year. Indian sources told Agence France-Presse that officials had set November as a deadline. India seeks to become only the fourth nation to land on the lunar surface after the U.S., Russia and China. Israel unsuccessfully attempted to land a spacecraft on the moon last April. India worked to establish itself as a low-cost satellite launcher. It seeks to become a global space force. However, the country's space program suffered a failed lunar landing attempt last September. That mission, Chandrian-2, ended in the spacecraft crash landing on the lunar surface. Chandrian-2 was aiming to land at the moon's south pole, where no other lunar mission had been before. The area is believed to contain water that is largely unaffected by the sun's high temperatures. Chandrian-3's investigative vehicle hopes to confirm the presence of water in lunar ice form, which he first discovered during a mission in 2008. Sivan said the new pilotless mission is expected to cost about $35 million, with additional launch costs. - Sivan also announced that India has selected four astronaut candidates to take part in the country's first scheduled flight-to-orbit mission. This mission is set for the end of 2021 at the earliest. The four candidates are expected to start training in Russia later this month. Up to three astronauts are scheduled to take part in the flight. The flying mission is one of India's main projects to mark the 75th anniversary of India's independence from British rule. • November 13, 2019: Space Mapping Camera-2 (TMC-2) is a follow-up of TMC on board Chandrayaan-1. TMC-2 provides images (0.4 µm to 0.85 µm) at 5m spatial resolution and stereo threesomes (before, and astle display) from a 100 km orbit to prepare a digital booster model (DEM) of the full moon's surface. The mission's lying was unsuccessful in its planned landing on the South Pole, but the rover continues to orbit the moon with all its payloads fully functional. 14) 15) - Triplet images from TMC-2 when processed into digital height models, allow mapping of landform surface morphology. These include: a) craters (created by influencers) in) lava tubes (potential sites for future habitation) c) Rilles (stitches created by collapsed lava channels or lava tubes) d) dorsa or wrinkle ridges (formed Mainly in the Mara regions depicting cooling and contraction of basaltic lava) e) graben structures (depicting structural dislocations on the lunar surface) and) moon domes/cones (the local pricing of past volcanism on the moon). - The derivative information facilitates the dimensional assessment of the above features and its comparison to create regional framework reconstruction, crater characterization to produce impact geometries, determining the age of the surface using CSFD (crater size – frequency distribution) methods, rheological analysis based on derivative morphometric parameters, lunar reflection assessment etc. Figure 7: Generation DEM from TMC-2 (Image credit: ISRO) Figure 8: TMC-2 3D View of a crater near Lindbergh (Image credit: ISRO) Figure 9: TMC-2 Three-dimensional image of a wrinkle ridge near Dorsa Geiki (Image credit: ISRO) • October 31, 2019: Planetary scientists prefer to call the thin gas envelope around the moon as the lunar exosphere because it is so faint that gas atoms rarely collide with each other. While earth's atmosphere near sea level average contains ~1019 atoms at 1m3 of volume, the lunar exosphere contains ~104 to 106 atoms at 1 cm3. 16) - Argon-40 (40Ar), which is one of the isotopes of the noble gas organization, is an important component of the lunar exosphere. It originates from the radioactive disintegration of potassium-40 (40K), which has a half-life of ~1.2 x 109 years. The 40K radioactive nokd, which lies deep beneath the lunar surface, disintegrates to 40Ar, which, in turn, is scattered through intergranspire space and makes way to the lunar exosphere through seeps and flaws. Figure 10: Schematic of the origin and dynamics of the 40Ar in the Lunar Exosphere (Image credit: ISRO) - CHACE-2 (Chandra Explorer-2's atmospheric composition) Cargo aboard the Chandrayaan-2 spacecraft, is a neutral mass spectrometer-based payload which can detect lunar neutral exosphere components in the range of 1-300 amu (atomic mass unit). As part of its early operation, it detected a 40Ar in the lunar exosphere from an altitude of ~100 km, capturing the day-night concentration variations. 40Ar being a condensable gas concentrated in temperatures and pressures prevailing on the lunar surface, digested during the lunar night. After lunar dawn, the 40Ar begins to be released into the lunar atmosphere. Shaded area with letter 11). Figure 11: A variation of Organization-40 observed in orbit one of Chandrayaan-2 during the day and night of the moon. The partial pressure observed should be refined for the background and other effects to infer the density of the lunar exospheric organization. The observations when Chandrayaan-2 was on overnight marked by a solid black rectangle at the top of the board and the two dashed vertical dashed lines. Being in polar orbit, Chandrayaan-2 enters the lunar day crossing the Arctic, crossing the day and entering the night after crossing the South Pole (Image credit: ISRO) • October 24, 2019: Chandrayaan-2 is the second Indian lunar mission to continue studies on the origin and evolution of the moon. Today, the spacecraft is in a polar orbit of 100 km around the moon and all science charges are operational. The data is analyzed by the appropriate cargo teams and preliminary results have been published on the ISRO website. 17) - Lunar science sessions are organized to maximize scientific outcome from this mission and increase the user base, especially from non-ISRO institutions such as national institutions, universities and colleges. - About 70 participants attended this meeting, of which 38 were faculties and research students from non-ISRO institutions (14 from IITs, 9 from national institutions and 15 were from universities and colleges). The meeting focused on users who presented their ideas and approach to data analysis and the outstanding scientific issue they plan to tackle using Chandrayaan-2 cargo data. - Lead researchers science cargo teams of Chandrayaan-2 displayed the performance of IEDs and provided the necessary clarifications. A data user guide for Chandrian-2 Orbiter cargoes has already been compiled and distributed to the lunar science community. Figure 12: 'Chandrayaan-2's Data Users Meet', which is the third in a series of lunar science sessions, held on October 22, 2019 at the DOS (Space Department) Secretariat Branch, New Delhi (Image credit: ISRO) • October 22, 2019: Preliminary Imaging and Observations by Chandrian-2 of you synthetic aperture at double frequency (DF-SAR). 18) - The moon has been continually bombarded by meteorites, asteroids and comets since its inception. This resulted in the formation of countless impact craters that form the clearest geographical features on its surface. Impact craters are live circular depressions on the lunar surface, from small depression, simple bowl-shaped to large, complex, multi-ringed impact basins. Unlike volcanic craters, which result from an explosion or internal collapse, impact craters typically raised hoops and floors lower than the surrounding area. The study of nature, size, distribution and composition of impact craters and emitted properties associated with them provide valuable information about the origin and evolution of Wear processes cause many of the physical properties crater material emit to get covered by layers of regolith, making some of them undetectable through optical cameras. A synthetic aperture (SAR) is a powerful remote syringe device for the study of planetary and underground surfaces due to the ability of the thy own sign to penetrate the surface. It is also sensitive to the roughness, structure and composition of surface material and burial ground. Previous SAR systems surrounding the moon, such as the HYBRID SAR-Polari-Band in ISRO's Chandrayaan-1 and NASA's S&X-band Hybrid-Polari SAR on Nasa's Lunar Reconnaissance Orbiter mission, provided valuable data on the dispersed characterization of impact crater plate materials on the moon. However, L & The S band SAR in Chandrayaan-2 is designed to produce greater details about the morphology and emitted materials of impact craters due to its higher resolution imaging capability (slope range of 2-75 m) and full polarimic modes in standalone states, as well as common S and L-band modes with a wide range of common angle coverage (9.5° - 35°). In addition, the larger penetration depth of the L-band (3-5 meters) allows you to look at the area buried at greater depths. The band's SAR charger L&S helps identify and unequivocally quantify lunar polar water ice in permanently shaded areas. - Easy access to discerning your information is to prepare images using two derivative parameters, 'm' the degree of polarization and the relative 'β' phase between the polarized signals receiving transmission. These parameters are used to create composite color images with Double Jump, Volume, or Strange Jump image scatters of a pixel represented in red (R), green(G), and blue (B) of image planes, respectively. The beginning of the dispersion mechanism is illustrated with the letter 13. Figure 13: A conceptual diagram explaining different types of dispersion mechanisms from you on the lunar surface and sub-surface (image credit: ISRO) - Figure 14 is one of the first data-veering images acquired over the lunar South Pole regions in low-resolution L-band (2 m) polar mode. It is important to note that the resolution achieved is in one series better than the best by you lunar. This image presents many interesting facts about the secondary craters of different ages and origins in the lunar south polar region. The yellowish hue around crater hoops pictured shows palette fields. The distribution of braces fields, whether uniformly distributed in all directions or in the direction of a particular side of a crater, indicates the nature of the impact. The image shows craters of vertical impact and diagonal impact on the upper right and upper- bottom right, respectively. Similarly, the roughness of the braces associated with the impact craters indicates the extent to which the crater is weathered Three similarly sized craters along a row in the lower right corner of the image show examples of a young crater, a crater in fair weather and a degraded old crater. Many of the fields emitted in the image are not visible in a high-resolution optical image above the same area, suggesting that the braces fields are buried beneath regulatory layers. Figure 14: M-η Decay Image The first data shifts acquired over the high-resolution lunar south pole regions of L-band (2 m at slope range resolution) Hybrid polarity mode (image credit: ISRO) Figure 15: Chandrayaan-2 Orbiter's DF-SAR has been activated in full polarimetry mode- a gold standard at SARIMETRY, and is the first ever by any planetary device. This figure shows a completely polar L-band resolution image, within 20m of the Pitiscus-T crater. The image is a color combination of various polarization responses of transmission-to-receive of the imaging area (Image credit: ISRO) • October 18, 2019: Despite the delay in India's second lunar mission - Chandrayaan-2, the satellite's rover continues to go around the moon with all its payloads and is fully functional. The lyst failed to land softly on the lunar surface and lost contact with the Earth Station of the Indian Space Exploration Organization (ISRO). 19) - The rover has now begun collecting data on the lunar surface and atmosphere. The IIRS (Imaging Infrared Spectrometer) aboard the lunar probe is designed to measure reflected sunlight and emitted part of moonlight from the moon's surface in continuous narrow spectral channels (bands) ranging from 0.8-5.0 µm. Figure 16: An IIRS instrument on board Chandrayaan-2 measures reflected sunlight and emitted part of the moon's light from the moon's surface at narrow spectral frequencies ranging from 0.8 to 5.0 µm (image credit: ISRO) - the main purpose of IIRS is to understand the origin and evolution of the moon in a geological context by mapping minerals to the lunar surface and the composition is volatile through signatures on the reflected solar spectrum. IIRS has now sent the first illuminated image of the lunar surface. The image covers part of the far side of the moon in the northern hemisphere. Several prominent craters are visible in the image (Somerfield, Stebbins and Kirkwood), ISRO said in a statement on October 17. - Earlier, ISRO shared high-resolution sharpest ever images of the moon, taken by its high-resolution camera (OHRC) aboard the Orbiter. - The images are an important new tool for lunar topographical studies of selected regions, according to ISRO. It was obtained from an altitude of 100 km and covered part of the Bogoslavsky E crater and its surroundings, located in the moon's south polar region. The crater is named after German astronomer Fallon Ludwig von Bogoslavsky. The spacecraft's life was initially planned to last one year, but during its journey to the moon, ISRO was able to conserve fuel, which could extend its life for a longer period. Able to communicate with the Indian Deep Space Network (IDSN) in Byalalu, near India's southern city of Bengaluru. • September 27, 2019: Nasa on Friday released high-resolution images taken by its Lunar Reconnaissance Orbiter (LROC) camera during its flight of the lunar region where India's ambitious Chandrayaan-2 mission attempted a soft landing near the moon's uncharted south pole and found Vikram had a hard landing. 20) - The module attempted a soft landing on a small patch of smooth moon mountain plains between Simplus N and Manzinus C craters before losing communication with ISRO on 7 September. The site was about 600 km from the south pole in relatively ancient territory, according to the ESA. Figure 17: The Chandrian-2 Vikram module attempted to land softly on a small patch of smooth plains of Moon Mountain between Simplus N and Menzinos C craters before losing communication with ISRO on September 7, 2019. Vikram had a hard landing and the spacecraft's exact position at lunar levels has not yet been determined, according to Nasa (image credit: Nasa) - After Vikram lost contact with ground stations, just 1.3 miles above the touchdown site, the possibility of contacting the lying lander had a deadline of September 21 because then the area entered a lunar night. Figure 18: Looking down on Vikram's landing site, this image was acquired before the landing attempt (Image credit: Nasa/Goddard/University of Arizona) - LRO will next fly over the landing site on October 14 when lighting conditions are more favorable, according to John Keller, deputy project scientist for the Lunar Reconnaissance mission at NASA/GSFC (Goddard Space Flight Center). It was dusk when the landing zone was pictured so large shadows covered most of the area; You may have landed Vikram hiding in the shade. The lighting will be positive when the LRO passes over the site in October and again tries to locate and image the lying down, Nasa said. • September 7, 2019: The Chandrayaan-2 mission was a very complex mission, representing a significant technological leap compared to isRO's previous missions, which consisted of an Orbiter, a Lander rover to study the moon's unexplored south pole. Since the launch of Chandrayaan-2 on July 22, 2019, not only India but the whole world has watched its progress from one stage to another with great expectations and excitement. It was a unique mission aimed at studying not just one area of the moon, but all the areas that combine the exosphere, the surface, as well as the moon's sub-surface in one mission. The Orbiter has already been placed in its intended orbit around the moon and will enrich our understanding of the evolution of the moon and the mapping of minerals and water in the polar regions, using its eight newest scientific instruments. Orbiter camera is the highest resolution (0.3 m) on any lunar mission so far and will provide high-resolution images that will be very useful to the global scientific community. The precise launch and mission management ensured a long life of nearly 7 years instead of the planned year. The Vikram Lander tracked the planned runway from a course of 35 km to below 2 km above the surface. All of the lyst's systems and sensors have performed fine up to this point and have demonstrated many new technologies such as variable impulse propulsion technology used in the lying. The success criteria have been defined for each stage of the mission and until this date, 90-95% of the mission's objectives have been achieved and will continue to contribute to lunar science, despite the loss of communication with the lying. 21) Figure 19: The Artist's View of the Spacecraft deployed by Orbiter in lunar orbit (Image credit: ISRO) 22) • September 7, 2019: The Chandrayaan-2 lyst failed to land on the lunar surface not enough. And that's all thanks to chandrian-2 track. 23) All is not lost. And so approved by many experts. Only 5% of the mission was lost to Vikram, the lying, and Pergin, the rover. The remaining 95%, namely the Chandrayaan 2 spacecraft, successfully orbits the moon, said a senior ISRO official. The former ISRO shooter, G. Medhavn Nair, noted that the spacecraft was healthy and functioning normally in lunar orbit, and Chandrayaan-2 had multiple targets, including a soft landing. The Chandrian-2 spacecraft consisted of three segments of the Orbiter (a mass of 2,379 kg, eight payloads), Vikram (1,471 kg, four payloads) and a Farjian (27 kg, two payloads). The spacecraft, with a planned one-year mission life, carries eight scientific charges for mapping the lunar surface and studying the moon's exosphere (outer atmosphere). The spacecraft's charges will make remote sensory observations from a 100-km orbit. According to ISRO, the lying carried three scientific charges to conduct scientific experiments on the surface and surface, while the rover carried two payloads to improve our understanding of the lunar region. - The Chandrayaan-2 spacecraft, going around the moon, is able to communicate with the Indian Deep Space Network (IDSN) and the orbiter's mission life is one year. With a one-year mission life, orbiter can take many pictures of the moon and send them to ISRO. The Orbiter could also photograph the lying to know its status, a space agency official said. Figure 20: An illustration of the Chandrayaan-2 spacecraft orbiting the moon before the separation of Vikram (Image credit: ISRO) • September 7, 2019: ISRO lost contact with its unmanned spacecraft just before it was scheduled to land on the moon on Saturday, in a blow to the country's ambitious low-cost lunar program. 24) - India hoped to become only fourth country after Countries, Russia and China will successfully land on the moon. - But as Prime Minister Narendra Modi looked on, the mood at the control center in the southern city of Bangalore soon deteriorated when it became clear that everything was not going according to plan. - After a few tense minutes when the expected landing time arrived and went, ISRO shooter Kailasavadivoo Sivan announced that communication with the lying had been lost. - The descent of the 'Vikram' lyst was (going) as planned and normal performance was observed, until the spacecraft dropped 2.1 km above the south polar region, Sivan said. Communication from the lander was subsequently lost to the ground station. The data is analyzed, he said, surrounded by gloomy-faced engineers and technicians in the control room. - Moody told them after Sivan's announcement that what you've done (already) is no small feat. • September 5, 2019: The Chandrayaan-2 spacecraft's second tracking maneuver was successfully performed early Wednesday, according to ISRO, en route to achieving a historic soft landing on the lunar surface. A 9-second de-orbit or retro-orbit maneuver was performed at 3:42 a.m. using the onboard propulsion system, the space agency said. 25) - With this maneuver, the trajectory required for the Vikram lying to begin it lying towards the moon's surface is achieved, ISRO said in a statement. - On Tuesday, the first de-orbit maneuver for the spacecraft was performed, a day after the Vikram lying was separated from orbit. - While the Chandrayaan-2 spacecraft continued to orbit the moon in a frigi of 96 km and an apogee of 125 km, Vikram Lander is orbiting 35 km from Perigee and 101 km apogee. Both the spacecraft and Lander are healthy, the space agency said. - It also said that the Vikram moon lying was planned for a preventive descent between 01:00 and 02:00 on 7 September, followed by a touch of the lying between 01:30 and 02:30 am. - Yur ISRO K Sivan said the proposed soft landing on the moon was going to be a scary moment as ISRO had not done it before, while the Moon Orbit Insertion (LOI) maneuver was successfully performed during the Chandrayaan-1 mission. - After the landing, the 'Farjian' rover will roll from 'Vikram' between 5.30am and 6.30am on September 7, conducting experiments on the lunar surface for a period of one lunar day, equivalent to 14 Earth days. The lying mission life is also one lunar day, while the spacecraft will continue its mission for a year. • August 27, 2019: Chandrian-2 took the first image of the moon, two days after entering lunar orbit. The image was taken by Vikram, the spacecraft's lying and shows the Mara Orientala Basin and the Apollo craters. The image was taken at an altitude of about 1,650 miles from the moon's surface on August 21. 26) - Take a look at the first image taken by #Chandrayaan2 #VikramLander at an altitude of about 2650 From the moon's surface on August 21, 2019. The Mara Orientala Basin and the Apollo craters are pictured, tweeted by the Indian Space Research Organization (ISRO) on Thursday (August 22). Figure 21: Chandrayaan-2 will explore an area of the moon where no mission has ever set foot. The spacecraft consists of a spacecraft, a lying ring, and an SUV together known as a composite hull (image credit: ISRO) - ISRO chief K. Sivan announced chandrian-2's successful completion of the lunar orbital insertion while stating that the mission will make a soft landing on the moon on September 7. Sivan also said an invitation had been extended to Prime Minister Narendra Modi to witness Chandrian-2's landing, but were awaiting confirmation. - Sivan elaborated that the next major event will take place on September 2, when the lying will be separated from orbit. • On August 20, 2019, the Indian Chandrian-2 spacecraft entered LOI (entering lunar orbit), performing one of the trickiest maneuvers in its historic mission to the moon. 27) - After four weeks in space, the spacecraft completed its LOI as planned,ISRO (Indian Organization for Space Exploration) said in a statement that entry was successfully completed today at 09:02 IST (03:32 GMT) as scheduled, using the onboard propulsion system. The manoeuvre lasted 1738 seconds. India is seeking to become the fourth nation after Russia, the United States and China to land a spacecraft on the moon. If the rest of the mission is planned, the Indian probe will land on the Lunar South Pole on September 7th. To enter final orbit over the moon's poles, Chandrian-2 will undergo four more similar maneuvers, with the next scheduled for August 21. - ISRO Commander K. Sivan said the maneuver was a key milestone for the mission, adding he hoped for a perfect landing next month. • August 14, 2019: The final orbital elevation maneuver of the Chandrayaan-2 spacecraft was successful today (August 14, 2019) at 02:21 AM IST (Indian Standard Time). During this maneuver, the spacecraft's liquid engine was fired for about 1203 seconds (20 minutes). With that, Chandrian-2 enters lunar transfer orbit. Earlier, the spacecraft's orbit gradually increased fivefold in the period July 23 to August 6, 2019. 28) - The spacecraft's health is continuously monitored from MOX (Mission Operations) antennas at ISRO Telemetry, Surveillance and Network Command (ISTRAC) in Bangalore with support for IDSN (Indian Deep Space Network) in Byalalu, near Bangalore. Since its launch on July 22, 2019 by the GSLV MkIII-M1 vehicle, all systems aboard the Chandrian-2 spacecraft have been performing nominally. - Chandrayaan-2 will approach the moon on August 20, 2019 and the spacecraft's liquid engine will be fired again to put the spacecraft into lunar orbit. As a result, there will be four more maneuvers in orbit to cause the spacecraft to enter its final orbit passing over the moon. About 100 km from the moon's surface. Maneuver Date Time (IST) Orbit around the Moon (KM) LOI/LBN #1 August 20, 2019 8:30-9:30 118 x 18,078 LBN#2 (Phase Bound Moons #2) August 21, 2019 12:30 PM – 13:30 121 x 4,303 LBN#3 August 28, 2019 05:30 – 06:30 178 x 1,411 LBN#4 August 30, 2019 18:00 – 19:00 126 x 164 LBN #5 September 01, 2019 18:00 - 19:00 114 x 128 Table 1: Final Plan for Future Action After Trans Moon Injection - After that, the Vikram Lynx lying will separate from orbit on September 02, 2019. Two maneuvers in orbit will be performed on the lying before the start of the landing triggered to make a soft landing on the lunar surface on September 07, 2019. • August 8, 2019: The Indian Space Agency on Tuesday (August 5) successfully raised Chandrian-2's orbit for the fifth time at 3:04 p.m. According to ISRO, Chandrayaan-2's orbit was elevated to a orbit of 276 x 142,975 km by firing the engines aboard the spacecraft for 1,041 seconds.29) - all parameters of the spacecraft were normal. The next maneuver is TLI (Trans Moon Income), which is scheduled for August 14, 2019, between 3-4 a.m. The Chandrayaan-2 is then scheduled to reach the moon by August 20, and the Vikram thy moon will land on Earth's only satellite on September 7. Figure 22: An illustration of the Chandrayaan-2 orbital sequence to travel from Earth's orbit to lunar orbit (Image credit: ISRO) • August 5, 2019: The fourth orbit raising activity for India's Chandrayaan-2 lunar spacecraft was successfully executed at 3:27 p.m. on August 2, according to ISRO. ISRO said chandrayaan-2's trajectory was raised to 277 x 89,472 km by firing the engines on board for 646 seconds. All parameters of the spacecraft are normal, he said. The fifth runway elevation maneuver is scheduled between 2:30 p.m. and 3:30 p.m. on August 6. The third runway elevation activity was completed on July 29. 30) - ISRO said the trans-lunar entrance of Chandrayaan-2, which will send it to the moon, is scheduled for 14 August. - After that, Chandrayaan-2 is scheduled to reach the moon by August 20 and the Vikram thym thrust will land on Earth's only satellite on 7 September. • July 26, 2019: India's second Moon Chandrayaan-2 spacecraft put into Earth orbit on 22 July, scheduled to reach the moon by 30 August, the Indian Space Agency said on 25 July 2019. ISRO said that the first Earth orbiter raising maneuver for Chandrayaan-2 was successfully executed in the afternoon on 25 July by firing the engines on board for 57 seconds. 31) - The new route is 230 x 45,163 km. The second runway-raising maneuver is scheduled for July 26 at 1:09 a.m. .m,' she added. - On July 22, the Chandrayaan-2 was thrown into an elliptical orbit of 170 x 45,475 km by India's heavy lifting missile, the Geosynchronous Satellite Launch Vehicle-Mark III (GSLV Mk III) in by-the-book style. - ISRO said major activities include Earth-related maneuvers, inserting through the moon, moon-related maneuvers, separating the lyst from its Chandrayaan-2 At the south pole of the moon. - Furthermore, ISRO has stated that the trans-lunar entrance of Chandrayaan-2 is scheduled for August 14, which will send the spacecraft to the moon, which it will reach by August 20. The Vikram lying will land on the moon on September 7. • July 22, 2019: Approximately 16 minutes and 14 seconds after liftoff, the vehicle injected the Chandrian-2 spacecraft into an elliptical EPO (Earth parking orbit). Immediately after separating the spacecraft from the vehicle, the spacecraft's solar array was automatically deployed and ISRO Telemetry, Surveillance and Network Command (ISTRAC), Bengaluru successfully took control of the spacecraft (Ref. 6). Dr. Kaye Sivan greeted the launch vehicle and satellite crews involved in this challenging mission. Today is a historic day for space science and technology in India. I am very pleased to announce that GSLV MkIII-M1 has successfully injected Chandrayaan-2 into a orbit of 6000 km longer than the intended route and is better. The complementary Orbiter sensor (CLASS, XSM, IIRS, SAR, CHACE-2, TCM-2) spacecraft Chandrayaan-2 will orbit the moon at an altitude of 100 km. The mission will carry five instruments on the spacecraft. Three of them are new, while two others are improved versions of those flown on Chandrayaan-1. 32) Class (Chandrayaan-2 Large Area Soft X-ray Spectrometer) Grade is provided by ISAC (ISRO Satellite Center), Bengaluru. The purpose of CLASS is to map the abundance of the main rock and creates elements on the lunar surface using the technique of X-ray fluoresc during solar flare events. CLASS is a continuation of the CIXS XTRometer (Chandrayaan-1 Imaging X-ray) experiment on Chandrayaan-1 (of RAL, United Kingdom). CLASS is designed to provide lunar mapping of elementary abundance with a nominal spatial resolution of 25 km (FWHM) from a circular orbit of 100 km of Chandrian-2. Class's scientific goals are to conduct global studies on the diversity and distribution of moon lithology, quantitative evaluation of Mg abundance, essential for determining the distribution of Mg suite rocks, bulk composition of the crust, abundance patterns in the major crusted provinces and basalt sosa variety. CLASS is expected to provide global maps of major mena-to-mouth elements in decisions of several dozen miles. Along with this mineralogical data will provide a comprehensive picture of the chemistry on the lunar surface. 33) Figure 23: A class tool showing the four boroughs with four SCDs (swept charging devices) each. The electronics are in the box behind the detector units. An aluminum door protects the detectors from radiation damage on the way to the moon. Passive radiators attached to heat pipes provide the required low temperature environment for the detectors (image credit: ISRO) XSM (solar X-ray monitor) XSM provided by Ahmedabad's PRL (Physical Research Laboratory) for mapping the current major elements on the lunar surface. XSM device will Any two packages, the XSM sensor package and the XSM electronics package. XSM will accurately measure a spectrum of solar X-rays in the energy range of 1-15 keV with energy resolution ~ 200 eV @ 5.9 keV. This will be achieved by using a state-of-the-art silicon drift detector (SDD), which has the unique ability of maintaining high energy resolution at a very high event count rate expected in solar X-rays. The XSM aboard chandrayaan-2 will be the first experiment to use such a detector for solar X-ray monitoring. 34) IIRS (Imaging IR Spectrometer) IIRS device is provided by Ahmedabad's SAC. The goal is to map the lunar surface across a wide wavelength range for current mineral, water and hydrofaxyl exploration. Spectral range coverage 0.8-5 µm for lunar mineralology and due to signatures of hydroxyl (OH) and water (H2O) molecules in the polar regions. A study of mare volcanism, basaltic compositional variations, heterogeneous pelvic clot and local scale. SAR (from you synthetic aperture in L- and S-band) SAR was developed at the SAC (Space Application Center), Ahmedabad for experience in the first tens of meters of the lunar surface for the presence of various components, including water ice. SAR is expected to provide further evidence confirming the presence of water ice beneath the shady areas of the moon. The S-band SAR will provide continuity to the Chandrayaan-1MiniSAR data, while the L-band is expected to provide deeper lunar regulatory penetration. The system will have selectable slope resolution from 2m to 75m, along with independent imaging modes (L- or S) and S-band at the same time. Various features of the device like hybrid and full polar, wide range of imaging prevalence angles (~10º to ~35º) and high spatial resolution will greatly improve our understanding of surface features especially in the polar regions of the moon. The system will also help resolve some of the ambiguity in interpreting high circular polarization ratio (resuscitation) observed in MiniSAR data. The additional information from full polarimetric data will enable greater confidence in the results derived specifically in identifying the presence (and estimate) of ice water in the polar craters. 35) Being a Planetary Mission, L&A S-band SAR for Chandrayaan-2 faced strict limits on mass, strength and data rate (15 kg, 100 W and 160 Mbit/s, respectively), regardless of any of the planned operating modes. This requires large-scale miniaturization, extensive use of onboard processing, power-saving devices and techniques. This paper discusses the scientific objectives that drive the demand of the SAR lunar mission and presents the configuration of the instrument, along with a description of several features of the system, designed to meet the scientific goals with optimal resources. CHACE-2 (Chandra-2 Atmospheric Vehicle Explorer, Neutral Mass Spectrometer) Developed in SPL (Space Physics Laboratory), Thiruvananthapuram perform detailed research of the lunar exosphere. The CHACE-2 mass spectrometer aboard the Chandrayaan-2 spacecraft will explore the lunar exosphere from a 100 km polar orbit in the range of 1 to 300 amu with 1 amu mass resolution. CHACE-2 will cover the moon's polar regions including the permanently clear areas (PSR), which are believed to be pure enough to maintain the history of the inner solar system. Taking advantage of the moon's axis rotation and Chandrian-2's polar orbit, chace-2 will be useful for studying the global distribution of the lunar exosphere. It will also explore the day-night variation of the lunar neutral exosphere, as well as the variation during the transition through the geomagnetic tail. 36) TMC-2 (Space Mapping Camera-2) TCM-2 is provided by SAC (Space Application Center), Ahmedabad. The goal is to make a three-dimensional map essential for the study of the moon's minerology and geology. Vikram lander complementary sensor (RAMJBHA, ChaSTE, ILSA, LRA) Chandrayaan-2 and Vikram Lander will detach from the spacecraft and go down to a moon orbit of 30 km x 100 km using its 800 N liquid primary engines. It will then conduct a comprehensive inspection of all systems on board before attempting to land on the lunar surface. RAMBHA (Radio Anatomy of the Moon is linked to an oversensitive ionosphere and atmosphere) rambha instrument supplied by SPL (Space Physics Laboratory), Thiruvananthapuram. RAMBHA is a unique payload package that will provide a comprehensive exploration of the lunar plasma environment. RAMBHA consists of a suite of three experiments, an LP (Langmyor probe) and will experiment with DFRS (dual frequency radio science) to measure the density of the moon's plasma near the surface and how it changes over time. DFRS will measure the total electron content of the lunar ionosphere. 37) ChaSTE (a thermo-surface physical experiment of Chandra) ChaSTE is provided by PRL (Physical Research Laboratory), Amehdabad. ChaSTE's goal is to measure the color transition of the vertical temperature and thermal conductivity within the top 10 cm of regolith. The experiment contains a thermal probe which will deploy up to ~10 cm into the lunar regolith at the landing site. Harness, running from the test, will connect the probe to the electronics located inside the lyst. An important aspect of the charger is the design of precision and wide temperature measurement (FE) and the selection of custom developed platinum RTD, PT1000 as a sensory element. 38) ILSA (Lunar Seismic Activity Instrument) ILSA device supplied by ISRO. The goal is to measure seismicity around the landing site. The LRA (Laser Reflector Array) LRA device is provided by Nasa/GSFC for precise measurements of Earth-moon distance. Complementary Sensor Rover (APXS, LIBS) APXS (Alpha Particle X-ray Spectroscope) APXS Supplied by PRL (Physical Research Laboratory) Ahmedabad. The goal is to study the elementary composition of moon rock and soil aboard the Chandrayaan-2 rover by projecting the lunar surface with alpha and X-ray particles using an active radio alpha source. APXS' working principle involves measuring the intensity of characteristic X-rays emitted by the sample due to alpha-induced X-ray emissions (PIXE) and X-ray florence processes (XRF) using an Alpha 241Am source that allows the project to determine components from Na to Br, spanning the energy range of 0.9 to 16 cubes. The electronics design of the APXS experiment was complete and showed that the developed system provides an energy resolution of ~150 eV @ 5.9 keV which resembles an off-the-shelf SDD (silicon erosion detector) based on X-ray spectrometers. 39) The APXS device consists of two packages each named APXS Sensor Head and APXS Rear End Electronics. The head of the APXS sensor will be mounted on a robotic arm. In command, the robotic arm brings the sensor's head closer to the surface of the moon (without touching it) and after measurement, the sensor head is taken back to the parking position. The APXS sensor head assembly contains SDD, six alpha sources and front electronic circuits such as a charge sensitive mapper (CSPA), designer circuits, and a filter associated with the detector. The sensor head contains a round disk containing 6 alpha sources symmetrically around the disk and the detector in the center. LIBS (Laser Induced Breakdown Spectroscope) LIBS was developed at LEOS (Laboratory for Electro-Optical Systems), Bengaluru. The goal is to simultaneously perform a multi-element determination of matter in each of its varied forms, earthy, solid, liquid or gas using the intense nanosecond pulse duration of the lunar regolith laser beam from an in-situ distance of 200 mm from the surface. The plasma emissions generated from the target's surface are collected by a revised chromatic grating COU (optics-unit collection) and spectra are acquired through a revised aberration in the holographic clenn and linear-CCD-based spectrograph. The spectrograph supports variable time delay in the range of 1µs to 5 µs and integration time of 8 µs to 1ms. LIBS device materializes with a mass of 1.2 kg, power consumption of <5 W and footprint of 180 mm x 150 mm x 80 mm. 40) Figure 24: Chandrayaan-2 Rover operational configuration (Image credit: ISRO) Mission Land Segment Chandrayaan-2 will utilize the ISRO land segment consisting of the following four main entities: 41) • ISRO MOX (Mission Operations Complex) located on ISTRAC's Peenya Campus (ISRO Telemetry, Surveillance and Network Command) near Bangalore in Karnataka State. MOX has facilities such as the main control room, mission analysis room, mission planning and flight dynamics, mission scheduling facility and cargo timing. Mission and spacecraft experts along with ISTRAC's operations team perform operations from the MOX. • IDSN Deep space network) consisting of 11m, 18m and a 32m antenna were set up on the IDSN campus in Bialo near Bangalore as part of the ground part of the Chandrian-1 mission. The IDSN station will receive the health data of the Chandrayaan-2 spacecraft, as well as the cargo data. For the route elevation phase, TTC functions will be performed by ISTRAC network ground stations (Bangalore, Mauritius, Port Blair, Brunei, Biak, Trivandrum). Nasa/JPL DSN (Deep Space Network of Goldstone, Canberra, and Madrid) will provide deep space communications with the Chandrayaan-2 spacecraft as secreted. • The ISSDC is a new facility established by ISRO for chandrian-1 deep space missions and the future, as the main data center of the Cargo Data Archives of Indian Space Science Missions. Located on the IDSN (Indian Deep Space Network) campus in Bangalore, this data center is responsible for ingesting, archiving and distributing cargo data and related data related to space science missions. ISSDC interfaces with Complex Operations Task (MOX) through dedicated communication links, data absorption centers, cargo designers, cargo operations centers, lead researchers, mission software developers, and scientific data users. • POCs (cargo operation centers) focus on higher levels of scientific data processing, cargo operations planning, performance assessment of cargo calibration and cargo. These centers are located in a partner location with the institutions/laboratories of device designers, the lead researchers, and will process and analyzing data from a specific cargo. POCs will draw relevant pay packet content (level 0 and level 1) and secondary data futures from an ISSDC distribution server and process the data to create higher-level products. These products will be archived in the ISSDC after certification. 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