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‘Make in India’ Software Defined Radio: ‘Mother’ of all solutions for tactical communications of armed forces

By Huma Siddiqui

New Delhi: Indian Navy’s Tactical Data Link will be the immediate beneficiary of this indigenous SDR Technology which is very critical as it will help for achieving better transfer rates for a large volume of Real Time data, with a reduced Network latency.

The Defence Acquisition Council’s (DAC) recent approval for the procurement of Software Defined Radio (SDR) technology is the ‘mother’ of all solutions for the desired Tactical Communication needs of the Armed Forces.

The indigenous SDR which needs to be groomed suitably to leverage its potential has been indigenously designed/developed through joint efforts of Weapons Electronics System Engineering Establishment (WESEE)/Defence Research and Development Organisation (DRDO) and BEL (Bengaluru). The BEL, in this case, is the manufacturing partner for DRDO.

Indian Navy’s Tactical Data Link will be the immediate beneficiary of this indigenous SDR Technology which is very critical as it will help for achieving better transfer rates for a large volume of Real Time data, with a reduced Network latency.

This indigenous technology will be readily implementable for the Indian Army and Indian Air Force (IAF) for improved transfer rates for data, voice and video information. This will enable troops on the ground carrying Handheld Man-portable SDR versions to achieve integration with higher echelons to accomplish true C4I capability. Also, with SDR technology, the possibility of swarms of Unmanned Aerial Vehicles (UAVs) operating in the battlefield looks encouraging.

With each warship as a Node generating humongous Real-Time data related to navigation, combat information etc., and the SDR solution was evolved by the Indian Navy through the efforts of it’s premium R&D organisation, WESEE.

What is Software Defined Radio (SDR)?

“Any radio system wirelessly transmits/receives signals in the radio frequency (RF) spectrum to facilitate the transfer of information. It is a very special kind of advance Radio system in which the physical layer functions are defined as software functionality i.e. a software code executes the role of a Circuit Board of the conventional radio and software-based filtering algorithms are used for frequency selection,” explains Milind Kulshreshtha, Artificial Intelligence and C4I expert.

According to Kulshreshtha, “The software generates the communication signal waveform which is equivalent to a modulated signal, making SDR capable of communicating over a large portion of the spectrum whilst supporting multiple protocols. These software algorithms are downloadable and adaptable over the life span of the hardware. The SDR is a multimode, multi-band and multi-functional Radio requiring only a software upgrade for improvements. Traditional hardware-based radio have cross-functionality limitations and can only be modified through physical changes.”

Defence Applications

The Defence Tactical communication operates at several different frequencies like HF, V/UHF etc. and each has its own unique type of protocol to meet the Battlefield demands. Each Unit/Node in a Tactical communication scheme forms a part of a secure interconnected Network for communicating with each other. SDR too operates in the same frequency spectrum ranges using multiple protocols.

Moreover, SDR is compatible with the legacy Military radio systems for feature enhancement, the AI & C4 expert.

Presently, SDR's communication waveform algorithms have been evolved by Indian Defence themselves and this makes the SDR system highly secure. Adding, SDR research shall be a continuous effort so as to keep the already deployed SDR resilient enough against jamming or hacking by an adversary with advanced technology.

<https://www.financialexpress.com/defence/make-in-india-software-defined-radio-mother-of-all-solutions-for-tactical-communications-of-armed-forces/1680536/>



Wed, 21 Aug 2019

DRDO hands over design of Mobile Metallic Ramp to Indian Army

Secretary Department of Defence R&D and Chairman DRDO, Dr G Satheesh Reddy, handed over the design of MMR to Vice Chief of Army Staff, Lt Gen Devraj Anbu

New Delhi: The Defence Research and Development Organisation (DRDO) handed over to the Army on Tuesday the design of Mobile Metallic Ramp (MMR) for strategic mobility of armoured and mechanised units as well as formations of the Army. Secretary Department of Defence R&D and Chairman DRDO, Dr G Satheesh Reddy, handed over the design of MMR to Vice Chief of Army Staff, Lt Gen Devraj Anbu.

With load bearing capacity of 70 metric ton (MT), the MMR has been designed and developed by DRDO's premier research laboratory, Centre for Fire, Explosive and Environment Safety (CFEES) on the requirements projected by Army for reducing the Strategic Mobility time of mobilising Armoured Fighting Vehicles.

The ramp will provide the strategic mobility for Armoured and Mechanised units and formations of the Army. It is portable, modular in design, which can be easily assembled or disassembled, an official statement said.

<https://economictimes.indiatimes.com/news/defence/drdo-hands-over-design-of-mobile-metallic-ramp-to-indian-army/articleshow/70760090.cms>



Wed, 21 Aug 2019

Army revamp orders issued

By Ajay Banerjee

New Delhi: The Ministry of Defence on Tuesday issued formal instructions on restructuring of the Indian Army headquarters that will result in reducing some 200 officers from Delhi besides creation of separate wings to deal with internal vigilance and human rights policies.

Called the Government Sanction Letter (GSL), the formal instructions were issued tonight, top sources in the Ministry of Defence confirmed to The Tribune.

The officers, who will be weaned off the headquarters, will be sent to formations. At present, there are an estimated 950 to 1,000 officers posted at the headquarters, located in Delhi.

This is the first major restructuring of the Army headquarters in the national capital. The decision is in line with the government's resolve to make the 1.3-million strong Army leaner and fit for a 21st century war.

The MoD has issued the first two parts of the GSL that will allow for moving 200 officers and creation of new wings that will deal with vigilance and also human rights policies.

The next part of the GSL that will issue instructions on merger of some directorates of the Army is expected after the one issued today. This includes merger two weapons and systems procurement agencies and created a new post of Deputy Chief who will coordinate with military intelligence, operations and logistics wings.

The next GSL is expected to create a new Deputy Chief to oversee strategy and operations, intelligence collation, conduct of operations and the movement of logistics. At present, the DG (Military Operations) and the DG (Military Intelligence) report to the Army Chief or Vice-Chief. Also, the restructuring will merge the Master General Ordnance (MGO), who is currently under the Vice-Chief, and the DG (Weapons and Equipment) under a single vertical with the Deputy Chief (Planning and Strategy), which will be renamed Capability Development.

Also expected is the creation of a consolidated information warfare wing that will subsume two existing wings under the DGMI and the DGMO. The DG (Military Training) will now be merged with the Shimla-based Army Training Command.

IAF chief compares Mig-21 with old car

- In what tells a picture of delay in procurement of fighter jets, Air Chief Marshal BS Dhanoa on Tuesday said: "We are still flying MiG-21 which is 44-year-old but nobody is driving cars of that vintage"
- Speaking at a seminar on modernisation of the IAF with Defence Minister Rajnath Singh by his side, he said the basic version of the Russian MiG-21 would be phased out this year. "Hopefully, I will fly the last sortie in September," he said

<https://m.tribuneindia.com/article/news-detail/820197/amp>

hindustantimes

Wed, 21 Aug 2019

IAF flying 44-yr-old MiG-21, says

Air Chief Marshal BS Dhanoa

The Russian-made MiG-21 joined the IAF in 1973-74

New Delhi: The Indian Air force (IAF) is still flying 44-year-old MiG-21 fighter jets when no one even drives cars that old, Air Chief Marshal BS Dhanoa said on Tuesday.

The Russian-made MiG-21 joined the IAF in 1973-74.

"We are still flying MiG-21 which is 44 years old but nobody driving cars of that vintage," Air Chief Dhanoa said at a seminar on "Modernisation and Indigenisation and plans of the Indian Air Force", in New Delhi.

Defence minister Rajnath Singh was also present. The Air Chief also said that MI-21M (type-96) would be phased out this year. "Hopefully, I will fly the last sortie in September, subject to visibility," he said.

Often dubbed “flying coffins”, at least 170 MiGs have been lost in accidents over the past decade.

In addition to the MiG-21M, another MiG-27 fighter squadron — each squadron comprises 16-18 fighters — will be phased out. With this, the IAF will be down to around 30 fighter squadrons.

Dwelling on the use indigenously-made products for the IAF, Air Chief Dhanoa said, “What ails our indigenous drive is the quality control in manufacturing, which has shown an improvement over the years but we have miles to go. As aircraft have a very low tolerance to failures, we often lose the platform if it seriously malfunctions in the air.”

He also mentioned in contrast, the indigenously made Light Combat Aircraft – Tejas — hasn’t seen a single crash. “It goes to the credit of ADA [Aeronautical Development Agency] and NFTC [National Flight Test Centre] that we have not lost a single LCA in flight testing since its maiden flight on 04 January 2001,” the Air Chief said.

Addressing the seminar, defence minister Rajnath Singh said, the IAF, besides the army and navy needed to keep pace with the “advancements in technology” to enhance operational capabilities. The government is making efforts to encourage the private sector in the defence sector.

The minister said that the private sector could now use government “test facilities”, for instance, airfields and firing ranges, to meet “quality standards”. He said the decision would facilitate the Indian private sector.

Singh also underlined that the government had tweaked the rules to facilitate more foreign direct investment in the defence manufacturing. The minister said that “up to 49%” of foreign investment in Indian defence manufacturing” is being allowed through the automatic route whereas “up to 100 per cent” investment was being allowed “on a case-to-case basis”. He urged foreign Original Equipment Manufacturers (OEMs) to establish manufacturing facilities in India.

<https://www.hindustantimes.com/india-news/iaf-flying-44-yr-old-mig-21-says-dhanoa/story-0ece2jUDc4hrTPaQroXfAK.html>



Wed, 21 Aug 2019

Govt. defence test facilities to be opened to private sector

A formal order that will remove the bottlenecks in the way of using the facilities by private entities will be issued, says Rajnath Singh

By Dinakar Peri

New Delhi: The Indian Air Force (IAF) is a technologically advanced and extremely potent force and the recent offensive strikes on terror outfits in the neighbourhood showed the reach and lethality of this formidable arm of the armed forces, Defence Minister Rajnath Singh said on Tuesday.

Addressing a long-pending demand of private industries to provide a level playing field in defence manufacturing, he announced that test facilities of the government and the Services would soon be opened for the sector.

“We have just approved a proposal to provide the test facilities of the government to the private sector after incorporating the comments of the stakeholders participating in indigenous manufacturing,” Mr. Singh said at a seminar on indigenisation and modernisation of the IAF, jointly organised by the Air Force and the Society of Indian Defence Manufacturers.

A formal order that would remove the bottlenecks in the way of using test facilities by private entities would be issued, he added

Of late, Indian industries had been manufacturing bigger military platforms but there were no test ranges to evaluate and improve the systems, forcing them to take the hardware abroad.

The defence products list had been revised for the purpose of issuing licences under the Industry Development and Regulation Act and most of the components, parts, sub-systems and testing and production equipment had been removed from it.

<https://www.thehindu.com/news/national/defence-ministry-to-open-govt-test-facilities-to-private-industry-rajnath-singh/article29174752.ece>

Newsweek

Wed, 21 Aug 2019

Russia and China say new U.S. missile test is just the kind of 'arms race' they're trying to avoid

The Russian-made MiG-21 joined the IAF in 1973-74

By Tom O'Connor

Russia and China have criticized the United States' testing of a missile banned for over three decades until the recent collapse of a Cold War-era treaty, with both countries calling it an attempt to draw them into an expensive and dangerous rush for new weapons.

Two weeks after leaving the 1987 Intermediate-range Nuclear Forces (INF) Treaty banning land-based weapons ranging from 310 to 3,420 miles, the Pentagon announced Monday it tested a cruise missile in California that would have been restricted under the agreement it has accused Russia of violating. In response, Kremlin spokesperson Dmitry Peskov cited President Vladimir Putin as saying Tuesday "such tests only proved that from the very start, the Americans were determined to derail the INF Treaty and were making preparations for it."



"We do not give into provocations. As Russian President [Vladimir Putin] said in France yesterday, we reiterate our commitment to a unilateral moratorium on deploying land-based intermediate-range systems until the U.S. deploys such systems in some part of the world," Peskov said, noting that "several weeks and even months are not enough to make preparations for such a test."

Quoting Russian Deputy Foreign Minister Sergei Ryabkov, Moscow's embassy in the United Kingdom tweeted: "Russia will not be pulled into [a] new arms race."

The U.S. has for years accused Russia of violating the INF through the development of the Novator 9M729 cruise missile, while Moscow has charged Washington with breaking the treaty by deploying defense systems that use platforms resembling Mark-41 Vertical Launch Systems (Mk-41 VLS) capable of firing offensive missiles like the Tomahawk Land Attack Missile. Though both sides have denied the claims against them, a Pentagon spokesperson confirmed to *Newsweek* on Monday that the weapon tested was indeed a Tomahawk variant fired out of an Mk-41 launcher.

"It is noteworthy that the test of an advanced Tomahawk-type missile was conducted just 16 days after the U.S. withdrew from INF, and the treaty was terminated," Ryabkov told the state-run Tass Russian News Agency. "Perhaps, there can be no clearer and more explicit confirmation of the fact

that the United States has been developing such systems for a long time, and preparations for quitting the agreement included, in particular, the relevant research and development."

He pointed out that "the missile had been fired using the Mk41 vertical launching system, noting "that's a universal launching system that is suitable for both firing SM-3 interceptor missiles and ground-to-ground and surface-to-surface cruise missiles." He added: "All that is regrettable. The United States has evidently set the course for fomenting military tensions."

Joining in Russia in condemning the test was China. Though not a party to the INF, Beijing has sided with Moscow in calling for talks to keep the arms control pact alive. Following reports of the new U.S. test, Chinese Foreign Ministry spokesperson Geng Shuang also noted that it occurred "less than three weeks after the U.S. announced its official withdrawal from the INF Treaty" and criticized the launch.

"This move by the U.S. will trigger a new round of an arms race, leading to an escalation of military confrontation and a serious negative impact on the international and regional security situation," he added. "We advise the U.S. to abandon its outdated Cold War mentality and zero-sum game concept, maintain restraint in the arms development, earnestly safeguard the existing arms control system and do more that is conducive to maintaining global strategic balance and stability and conducive to international and regional peace and tranquility."

Prior to the U.S.-imposed August 2 deadline for the INF's collapse, Beijing had rejected an offer from Washington to join a new, trilateral missile deal also including Moscow. China has argued that the U.S. and Russia have unique non-proliferation responsibilities as the top two nuclear powers.

China, with this same mindset, has also declined proposed three-way talks regarding the U.S. and Russia's New Strategic Arms Reduction Treaty (START). The deal, set to expire in 2021, limits Washington and Moscow's nuclear arsenals, which contain thousands of more weapons than that of Beijing.

As Russia faced sanctions over its alleged roles in the poisoning of an ex-double agent in the United Kingdom and the war in Ukraine and President Donald Trump and Chinese President Xi Jinping engaged in a costly trade war, the U.S.' top military rival and leading economic competitor have only expanded their relations. The two have taken joint stances against the U.S. on a number of geopolitical issues such as the war in Syria, the political crisis in Venezuela and in tensions with Iran, emphasizing the emergence of a more multipolar world.

<https://www.newsweek.com/russia-china-us-missile-arms-race-1455264>

hindustantimes

Wed, 21 Aug 2019

China uses battlefield robots, new tanks in drill on plateau, possibly near India

The military drill, which used live ammunition, the report said, could have been carried out on the Qinghai-Tibet plateau; India is west of the plateau

By Sutirtho Patranobis

Beijing: China has for the first time tested new weapons, including "battlefield robots" and frontline tanks on a "snow-covered plateau" to be battle-ready for plateau warfare to the west of the country, state media reports have said without identifying the area where the exercise was held.

The drills were conducted at altitudes of nearly 14000 feet and lasted several days.

It was two years ago in 2017 – between June and August - that India and China were locked in a 73-day military standoff near the Sikkim border in Doklam (Donglang in Chinese.)

“In preparation for potential plateau warfare, China recently used, for the first time, some of its most powerful weapons and equipment, including Type 99A main battle tanks and battlefield robots to a snow-covered plateau in combat exercises,” national broadcaster, China Central Television (CCTV) said in a report.

The military drill, which used live ammunition, the report said, could have been carried out on the Qinghai-Tibet plateau; India is west of the plateau.

The drills lasted for several days, the report said, adding that the troops practised several tactics through break through the enemy’s defence using tanks and robots.

“Taking part in the exercises at an elevation of 4,200 metres was a combined brigade under the 76th Group Army of the People’s Liberation Army (PLA), who conducted mock battles using live ammunition,” the report added.

“The report did not identify the area, but such terrain is usually found in western China. Weapons and equipment, including Type 99A tanks and battlefield robots used for minesweeping and reconnaissance were deployed for the first time in a plateau,” the report said.

The aim was to test the new weapons on a high-altitude plateau, and how they work in thinner air.

“Switching from the plains to a plateau, the tanks’ mobility and assault capabilities suffered, so we devised some tactics that best suit plateaus. Our goal is to maximise these new weapons’ combat readiness in a potential plateau warfare,” Fan Hailong, an officer with the 76th Group Army, told CCTV.

“The exercises allowed us to further test the combat capabilities and gathered data for all kinds of weapons in high elevation and cold weather,” said Zhao Xiang, another 76th Group Army officer.

The “...exercises lasted several days, during which time the troops discovered a dozen methods of breaking through enemy defenses, comprehensively expanding their combat capabilities under all kinds of terrain”.

China rarely makes information about military drills public but last year in June, the PLA had said it had carried out exercises in the Qinghai-Tibet plateau to check its capabilities in adverse climate and complex topography.

The PLA had held large-scale drills in the same region during the military standoff with the Indian armed forces in Doklam in 2017.

<https://www.hindustantimes.com/india-news/china-uses-battlefield-robots-new-tanks-in-drill-on-plateau-possibly-near-india/story-PXJ7sa9q6CiJEPRTqBo16K.html>

Chandrayaan-2 moves closer to the moon, wait begins for Sept 7 landing

Chandrayaan-2 successfully enters Moon's orbit: The spacecraft has been injected into an elliptical orbit that is 114 km away from the moon's surface at its nearest point and 18,072 km at its farthest. Sivan said this orbit would be changed through another series of manoeuvres, to let the spacecraft eventually attain a near-circular orbit of 100 km around the moon

By Amitabh Sinha

Pune: Almost 30 days after it was launched, the Chandrayaan-2 spacecraft moved into lunar orbit Tuesday, in preparation for a landing on September 7.

Chandrayaan-2, launched from the Satish Dhawan Space Centre in Sriharikota on July 22, is India's first lander mission to the moon.

"Today, the Chandrayaan-2 mission crossed a major milestone. The lunar orbit insertion manoeuvre carried out at about 9 am, for about 30 minutes, precisely injected Chandrayaan-2 in a pre-defined orbit (around the moon), in a perfect way... All the systems onboard are functioning normally. The spacecraft is in perfect health," Indian Space Research Organisation (ISRO) Chairman K Sivan told reporters in Bengaluru.

The spacecraft has been injected into an elliptical orbit that is 114 km away from the moon's surface at its nearest point and 18,072 km at its farthest. Sivan said this orbit would be changed through another series of manoeuvres, to let the spacecraft eventually attain a near-circular orbit of 100 km around the moon.

At this point, the Vikram lander, along with the small Pragyaan rover, is slated to separate from the main composite module and start its incremental descent towards the moon's surface. The separation is scheduled for September 4, following which the lander and rover would position themselves in a lower orbit, while the landing is planned to take place at 0140 hours IST on September 7. The main spacecraft module would continue to go around the moon in its orbit for at least one full year.

Sivan gave an account of the precision involved in inserting Chandrayaan-2 into the lunar orbit. He said because Vikram is meant to land in the region around the moon's South Pole, Chandrayaan-2 needed to attain an orbit that had an inclination of 90 degrees with respect to the lunar equator. In other words, the lunar orbit selected for Chandrayaan-2 had to pass directly over the polar regions.

"This is a unique requirement that only Chandrayaan-2 has... other countries that have landed (their spacecraft, all in the equatorial regions of the moon) did not have this constraint. With today's manoeuvre, Chandrayaan-2 is now going around the moon in an orbit of 114 km x 18,072 km with an inclination of 88 degrees. In due course, this orbit would be brought down to 100 km x 100 km, and further to 100 km x 30 km. At that time, the inclination of the orbit would also be 90 degrees," he said.

After its launch on July 22, the spacecraft had been put in an earth-bound orbit. It went around the earth till August 14, raising its orbit incrementally five times, before beginning its six-day journey towards the moon with higher energy. Sivan said when the spacecraft left its earth-bound orbit for the final time on August 14, it started with a velocity of 10.9 km per second (39,240 km per hour).

"To give you an idea of the precision required for today's manoeuvre, if the velocity of the spacecraft was different (from 10.9 km per second or 39,240 km per hour at the initial point) by even 10 cm/ sec (0.36 km per hour), the spacecraft would not have been able to attain the required inclination in lunar orbit. It would have been off by at least seven degrees," he said.

The ISRO chairman said Chandrayaan-2 had come under the influence of moon's gravity on Monday and had started gaining velocity, after having slowed down considerably, to well below 2 km per second (7,200 km per hour), during its journey. He said the spacecraft, at one point, had accelerated to 2.4 km per second (8,640 km per hour), which if left unchecked, would have made it fly past the moon. In order to keep it in the lunar orbit, it had to be slowed down to 2.1 km per second (7,560 km per hour), just like a moving vehicle needs to slow down while travelling from a straight road into a roundabout.

Over the next few days, Chandrayaan-2 will do a series of four 'burns' to slow down its speed further and get into a lower orbit, eventually reaching an orbit of 100 km x 100 km. The first of these manoeuvres is planned for Wednesday early afternoon. The other manoeuvres will take place on August 28, August 30 and September 1, Sivan said.

On September 3, before the planned separation, a three-second operation will be carried out to check the functioning of all onboard systems on the Vikram lander. The next day, the lander and the rover will separate from the main spacecraft through a manoeuvre that will last 6.5 seconds, Sivan said.

After separating, Vikram will not immediately land on the moon's surface. Instead, it will go around the moon for three days, during which all its parameters will be checked. Its powered descent will start in the early morning of September 7, around 1.40 am, and it is expected to land within 15 minutes, the ISRO chairman said.

<https://indianexpress.com/article/technology/science/isro-chandrayaan-2-successfully-enters-the-lunar-orbit-5919107/>

The Indian **EXPRESS**

Wed, 21 Aug 2019

Explained: Milestone for ISRO's Chandrayaan-2, Moon in sight

Chandrayaan-2 has just entered a lunar orbit. What makes it a milestone big enough for the ISRO head to announce it to the country? What are the next milestones coming up before the September 7 landing?

By Amitabh Sinha

Pune: On Tuesday, India's Chandrayaan-2 mission crossed a major milestone on its journey towards the Moon, having entered a lunar orbit, almost exactly 30 days after being launched on July 22. The mission has several more milestones to cross before the Lander and Rover components of the spacecraft, called Vikram and Pragyaan respectively, make a soft landing on the Moon's surface in the early hours of September 7. But Tuesday's milestone was big enough for India Space Research Organisation (ISRO) Chairman K Sivan to call a press conference and inform the nation about the event.

So, what exactly did Chandrayaan-2 achieve on Tuesday?

After being launched, Chandrayaan-2 had been put in an elliptical orbit around the Earth. Until August 14, it had been going around the Earth, incrementally raising its orbit by firing boosters on five occasions. Eventually, it reached an orbit that was 276 km from the Earth's surface at its closest and 142,975 km at the farthest. It spent nearly a week in that orbit, before firing a booster once again to break free from the Earth orbit and begin its journey towards the Moon. This transit from orbit to orbit

happened on August 14. After five days of this journey, Chandrayaan-2 came sufficiently close to the Moon to experience its gravity. And on Tuesday, it entered into an orbit around the Moon.

What exactly is meant by ‘insertion into lunar orbit’?

Just like it was going around the Earth at the start of its journey, Chandrayaan-2 is now orbiting the Moon. On Tuesday, it was placed into an elliptical orbit that was 114 km from the Moon’s surface at its nearest, and 18,072 km at the farthest.

The spacecraft will carry out a few more manoeuvres to eventually place itself in a circular orbit of 100 km × 100 km around the Moon (see illustration below). The Lander and Rover modules will detach themselves from here and descend into lower orbits before finally making a landing on September 7. The main spacecraft, however, will continue to orbit the Moon in the 100 km circular orbit for at least one year, making observations through the several instruments it has on board.

But why are these manoeuvres needed in the first place?

Indeed, it is possible to fly straight to the Moon, without getting into the Earth orbits. The lunar orbit, however, cannot be avoided. The spacecraft cannot land directly on the Moon.

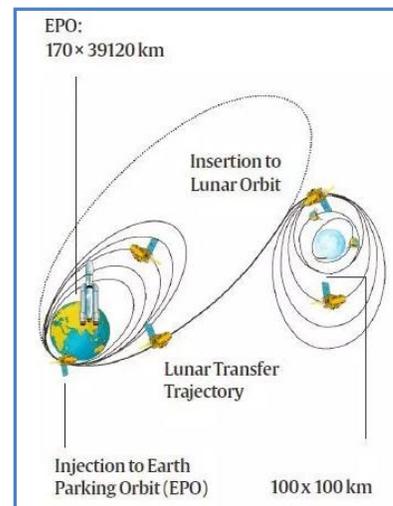
In fact, none of the Apollo missions that landed astronauts on the Moon took the route that Chandrayaan-2, or all other recent missions to Moon, have taken. The Apollo missions flew directly to the Moon. But this is not considered wise or economical.

That is because the rockets need to be extraordinarily powerful to carry the spacecraft all the way to Moon. An enormous amount of fuel too is required. Taking a longer route, however, makes it much easier for the spacecraft to travel. The rocket has to take the spacecraft only about 200 km from the Earth’s surface and deposit it in Low-Earth Orbit. Thereafter, the spacecraft moves around the Earth under the influence of gravity. This stable position is also a good time for ground controllers to check on the health of the equipment on board.

While circling the Earth, a substantially lower amount of energy is required to propel the spacecraft into higher orbits due to reduction in atmospheric drag. This is easily possible with a small amount of fuel onboard. With each higher orbit, however, the gain in energy is enormous, enabling the spacecraft to achieve great velocities, and the power to move much deeper into space.

To put things in perspective, the Apollo missions were carried on giant Saturn V rockets, which even today remain the most powerful rockets ever built. They were 111 metres tall, higher than a modern 30-storey building, and weighed 2,800 tonnes, a significant part being contributed by the fuel it carried. According to information on NASA website, the fuel it burnt to land astronauts on the Moon — several million litres of liquid oxygen and liquid hydrogen in different stages — could take a normal car 800 times around the Earth. It is said to have consumed 20 tonnes of fuel every second.

In comparison, ISRO’s GSLV Mk-III rocket used to launch Chandrayaan-2 is extremely modest. At 43.43 metres, it has less than half the height of Saturn V, and weighs 640 tonnes, less than one-fourth of Saturn V. It can carry less than 350 tonnes of fuel, roughly about one-fifth of what Saturn V needed for its Apollo missions.



COMING UP, STAGE BY STAGE

Date	Time	Orbit around Moon* (km)
August 20	8:30-9:30 am	118 × 18078
August 21	12:30 - 1:30 pm	121 × 4303
August 28	5:30 - 6:30 am	178 × 1411
August 30	6 - 7 pm	126 × 164
Sept 1	6 - 7 pm	114 × 128

* The two figures represent nearest and farthest distances from Moon

ISRO Chandrayaan-2: What next?

Chandrayaan-2 is said to have slowed down before entering lunar orbit. Why did it need to slow down?

ISRO Chairman Sivan said Chandrayaan-2, after coming under the influence of lunar gravity on Monday, had begun to accelerate. At one point, it had reached a velocity of 2.4 km per second (8,640 km per hour). This is just about equal to the escape velocity of the Moon. If Chandrayaan-2 had been allowed to speed up unrestrained, it would have escaped the Moon's gravity and moved away. To keep it in the lunar orbit, therefore, its velocity was brought down to 2.1 km per second (7,560 km per hour).

Spacecraft increase or decrease their velocities by firing on-board thrusters. To speed up, the thrusters are fired in a direction opposite to the motion of the spacecraft. It has an effect similar to the recoil that a gun experiences after firing. Velocity can be reduced if the thrusters are fired in the direction of motion.

<https://indianexpress.com/article/explained/isro-chandrayaan-2-enters-the-lunar-orbit-milestone-now-moon-in-sight-5921745/>



Wed, 21 Aug 2019

Space telescope offers rare glimpse of earth-sized rocky exoplanet

The planet lies about 48.6 light years from Earth

Direct observations from a NASA space telescope have for the first time revealed the atmospheric void of a rocky, Earth-sized world beyond our own solar system orbiting the most common type of star in the galaxy, according to a study released on Monday.

The research, published in the scientific journal Nature, also shows the distant planet's surface is likely to resemble the barren exterior of the Earth's moon or Mercury, possibly covered in dark volcanic rock.

The planet lies about 48.6 light years from Earth and is one of more than 4,000 so-called exoplanets identified over the past two decades circling distant stars in our home galaxy, the Milky Way.

Known to astronomers as LHS 3844b, this exoplanet about 1.3 times the size of Earth is locked in a tight orbit - one revolution every 11 hours - around a small, relatively cool star called a red dwarf, the most prevalent and long-lived type of star in the galaxy.

The planet's lack of atmosphere is probably due to intense radiation from its parent red dwarf, which, though dim by stellar standards, also emits high levels of ultraviolet light, the study says.

The study will likely add to a debate among astronomers about whether the search for life-sustaining conditions beyond our solar system should focus on exoplanets around red dwarfs - accounting for 75 percent of all stars in the Milky Way - or less common, larger, hotter stars more like our own sun.

The principal finding is that it probably possesses little if any atmosphere - a conclusion reached by measuring the temperature difference between the side of the planet perpetually facing its star, and the cooler, dark side facing away from it.

A negligible amount of heat carried between the two sides indicates a lack of winds that would otherwise be present to transfer warmth around the planet.

"The temperature contrast on this planet is about as big as it can possibly be," said researcher Laura Kreidberg of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. She is lead author of the study.

Similar analysis previously was used to determine that another exoplanet, 55 Cancri e, about twice as big as Earth and believed to be half-covered in molten lava, likely possesses an atmosphere thicker than Earth's. This exoplanet, unlike LHS 3844b, orbits a sun-like star.

The planet in the latest study was detected last year by NASA's newly launched Transiting Exoplanet Survey Satellite, an orbiting telescope that pinpoints distant worlds by spotting periodic, dips in the light observed from their parent stars when an object passes in front of them.

But it was follow-up observations from another orbiting instrument, the Spitzer Space Telescope, which can detect infrared light directly from an exoplanet, that provided new insights about its features.

<https://gadgets.ndtv.com/science/news/space-telescope-offers-rare-glimpse-of-earth-sized-rocky-exoplanet-2087600>