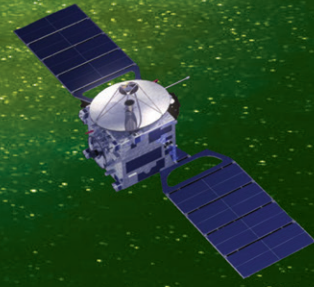




SPACE

SCIENCE. TECHNOLOGY. APPLICATION.



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SPACE newsletter wishes all its readers a bright and brilliant New Year

INDIA NEEDS TO NURTURE EXPERTISE TO ANALYSE SPACE DATA!

With each passing day, Space Data is phenomenally increasing leaps and bounds. The reasons are obvious. Today the satellite services are ever expanding without stop. Satellites are getting sophisticated with volley of sensors, cameras, scanners etc providing new data. With more nations deploying satellites, the satellite services are becoming affordable for many nations. Science and engineering focussed Space exploration, journey to Mars and beyond have their own implications in adding more to the space data. "Big Data analytics via satellite will generate close to \$17.7 billion in cumulative revenues by 2028, owing to increasing demand from end users in the Transportation, Government & Military, Energy and Enterprise sectors." (Ref: NSR's Big Data Analytics via Satellite, 3rd Edition (BDvS3) report, June 2019). According to this report, space imagery data is predicted to grow at an impressive 23.5 percent Compound Annual Growth Rate (CAGR) through to 2027. What a great opportunity today to our scientists, engineers, entrepreneurs! Sametime, we do not know how many people fully understand the large scale use and implications of this big data. Recent advances in robotics, ML, and Artificial Intelligence (AI) are readily available today to unravel the hidden secrets of volumes of the petabytes of space data and to provide value added big space data capabilities bringing out altogether new perspectives. Satellite Operations are being revolutionised using ML applicable to any orbit (GEO, MEO and LEO). Today we have space application related computational processors, and dedicated AI chips. Through machine learning embedded flight software, we can objectively automate satellite

operations enhancing current capability at reduced operational costs. Space scientists can in turn use this data to revise their ideas to help space based tools make faster and better decisions, increase reliability, better optimization and in turn opens up new data resources in an endless cycle of space exploration. This data is available in public domain or at cost from agencies like ISRO, NASA, JAXA, ESA etc., Just think of one sector agriculture – the benefits are enormous. Scientists can use image data to better understand what factors influence the growth of crops, how weather pattern affects, how exposure to sunlight, moisture, humidity make a difference or how pest activity can be monitored, to realise optimal conditions for better productivity. How good we are at using this space data decides whether satellite technology is a just a financial investment or it is investment for human wellbeing while protecting fragile natural resources on earth.

India through its large pool of academic institutions excelling in big data analytics should endeavour to take a share of projected big data based revenue of \$3.1 billion by 2028.

TREATMENT FOR VENOUS THROMBOSIS DURING SPACEFLIGHT

A curious case of an obstructive jugular – vein thrombosis was noticed in the neck region without any serious symptoms when one of the astronauts was carrying out routine ultrasound scan on himself. He just completed two months in the space station and he has 4 more months to go. Guided by a team of radiologists on earth in real time, it is established that venous thrombosis exists with sub-acute



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characteristics. Luckily there was sufficient quantity of enoxaparin, a well known drug formulation for this medical problem in the space station medical chest to begin the treatment. Additional supplies of the medicine were made available to the space station with continued ultrasound monitoring and dose adjustments. Ultrasound examination after landing revealed spontaneous flow in the supine position with residual thrombus flattened to the vessel walls. This case of venous thromboembolism in spaceflight throws up several unique challenges like clinical decision making without much evidence, remotely guided telemedicine ultrasonography, limited stock of medicines, limited medical equipment. For more details (Ref: J Serena M. Auñón-Chancellor, M.D., M.P.H. et al, The New England Journal of Medicine, January 2, 2020, 382:89-90, DOI: 10.1056/NEJMc1905875)

METAL 3D PRINTING FOR HIGH PERFORMANCE MINIATURIZED SATELLITE ANTENNAS

14.0 is fast entering in space component manufacture domain through disruptive technology like 3-D printing. One critical example applicable to any satellite is minimizing the size and mass of high performance metal waveguide antennas. Engineers prefer metal waveguide RF antennas as ideal because they have the lowest transmission loss. We all know the convenience with Metal 3D printing which allows easy customization of highly complex parts to be made in a single component in required size and weight at lowest cost meeting available satellite space while giving necessary advantage to compete in the market.

THE WORLD'S LARGEST RADIO TELESCOPE WITH ONE MILLION ANTENNAS IN A SQUARE KILOMETRE ARRAY (SKA) TO MONITOR THE WHOLE SKY

Popularly known as SKA project received positive design reviews when reviewed by the eminent experts in December 19 invited from ESO, NRAO, LSST, Gemini, NSF, Berkeley & Caltech universities who are associated with some of the biggest astronomical facilities in the world signalling further action over the progress made in the last 7 yrs.

The Square Kilometre Array (SKA) design and construction is a mammoth international project with many of the world's finest scientists, engineers

and policy makers engaged from around 100 organizations 300 research centres in 10 countries and India is proud to be one of them. National Centre for Radio Astrophysics (NCRA), Pune is the proud Indian agency involved in this international programme.

To survey the whole sky as fast as possible and as in greater detail as possible than any system that exists today it is estimated that this radio telescope needs thousands of dishes and an extent of one million antennas.

The system configuration comprises of SKA-low using 130,000 dipole antennas operating at low frequencies and SKA-mid having 200 parabolic dish antennas working at high frequencies, each located in different places namely western Australia and South Africa respectively.

The radio telescope will produce some 160 terabytes of raw data per second throwing a huge challenge to today's data scientists. Luckily we have companies like IBM, Intel, Nvidia, Cisco, Amazon etc to take on this challenge. Engaged in concerted efforts to set up this world class engineering marvel, it is expected that this facility will be ready for scientific observations earliest by 2027. Countries taking part in this monumental endeavour are Canada, China, India, Italy, South Africa, Spain, Sweden, The Netherlands, United Kingdom. Source: Website of SKA Global Headquarters dated 19 December 2019

ACCURATE SPACE BORNE US MISSILE WARNING SYSTEMS

In the military conflict that ensued between Iran and USA post US drone strike that killed a top ranking Iranian General, Iran has fired in retaliation its sophisticated missiles on US base in Iraq. USA was so confident that these missiles will not cause any significant damage to US systems nor can take away any human lives. Iran has developed missiles which are accurate enough to cause severe damage within a few tens of metres. Then, how is it possible for US personnel to escape unhurt? It clearly shows the US knew in advance the launch and the flight path of Iranian Missiles that hit the US base. Yes, US has an early warning constellation system that works very well. Now, US has four missile tracking infra-red satellites SBIRS GEO Flights-1, 2, 3 and 4 equipped with powerful scanning and staring infrared

surveillance sensors, dedicated to tracking missile launches around the globe. Two more infrared missile detection systems -5 and -6 are likely to be hosted on classified National Reconnaissance Office satellites during next couple of years as complimentary to the existing, to bolster situational awareness on the battlefield. In the subject case of the Iranian missile attack, these satellites have given at least 2-3 hrs advance communication and signal intelligence information to the US military that missiles are likely to be launched by tracking the launch preparation. When launched, US could easily compute flight path trajectory and pin point the vulnerable area of strike with in few minutes of launch enough period to escape from the area of hit. Even interception is possible. But, there are advanced missiles which can change their trajectories mid-flight, then it will become a challenge to exactly predict the strike point. This reminds us of the importance of a robust missile early warning system.

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"I don't think the human race will survive the next thousand years, unless we spread into space. There are too many accidents that can befall life on a single planet. But I'm an optimist. We will reach out to the stars."

STEPHEN HAWKING,
The Daily Telegraph, October 16, 2001

HOW TO REDUCE SPACE TRAVEL FROM EARTH TO MARS TO 39 DAYS?

The demand to reach Mars, the fourth planet from the Sun is increasing among scientists. Many space organisations like ISRO,NASA,ESA etc have space crafts orbiting Mars. NASA currently have one rover/ one lander on the surface. Despite knowing Mars' surface cannot support life, countries are launching missions to determine whether there was life in the past or there is future potential for life on Mars. Todate, with best of our chemical fuel rockets one can reach Mars in 6 months. The journey will be gruelling, harsh and most difficult. How to cross the technology barriers to reduce this time of travel is a great challenge.

Ad Astra Rocket Company at Texas founded in 2005 by Plasma physicist from MIT and former space shuttle astronaut Franklin Chang-Diaz came up with an ion propulsion based new engine design called "Variable Specific Impulse Magneto plasma Rocket (VASIMR)". We all know that plasma is a superheated

ionized gas and by using electric fields,one can push these ions out of the engine's nozzle at high speed to create thrust. Of course, we already use plasma-powered engines on many modern satellites today. But VASIMR is different and powerful enough ion propulsion engine that promises to shorten the journey to just 39 days. VASIMR uses a radio frequency generator to create most powerful super conducting plasma at 1 million degrees C in the presence of a strong magnetic field to create a resonance effect with ion spin frequency, resulting in thrust of several orders as proved during a recent trial. This gives a hope to humans that reaching Mars is doable in the near future. (ref:<https://www.newscientist.com/article/dn17476-ion-engine-could-one-day-power-39-day-trips-to-mars>)

SPACE FORCE

The Trump administration created a new military department, known as the US Space Force, carved out of US Air Force Space Command with congressional authorization in Dec2019. Space Force is one of the eight U.S. uniformed services and forms sixth branch of the U.S. military with nearly \$ 13 billion budget and manpower 13000. With changing technologies, the future wars are predicted to be fought in both underwater and space. The concept of Space Force is however not new since such dispensation exists in both Russia and China as a single chain of command. US feel that it is time to create such unit to counter growing threat to US space systems leading to national security concerns. The main reasons seem to be the following:

- i) Present dispensation which looks after space security concerns is highly fragmented. It appears there is no single individual or entity in place which can demonstrate centralized leadership in decision making, accountability, cohesive planning which are needed to provide a valuable direction to combatant commanders.
- ii) There is no dedicated work force in the form of a stable service cadre who can be entrusted with full responsibility to nurture specialised knowledge on space centric security doctrinal issues.
- iii) Present system of several agencies dealing with space centric strategy has inherent conflicts of interest because this is not their primary domain. In fact, it is found that there is no single military service which consistently advocates for space

**EDITORS PICK OF SPACE ARTICLE :
CHINA AND INDIA LEAD IN GREENING OF THE
WORLD THROUGH LAND-USE MANAGEMENT**

Source: Nature Sustainability volume 2, pages122–129(2019)

Authors: Chi Chen, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K. Chaturvedi, Richard Fuchs, Victor Brovkin, Philippe Ciais, Rasmus Fensholt, Hans Tømmervik, Govindasamy Bala, Zaichun Zhu, Ramakrishna R. Nemani & Ranga B. Myneni

Abstract:

Satellite data (2000-17) show increasing leaf area of vegetation due to direct factors (human land-use management) and indirect factors (such as climate change, CO₂ fertilization, nitrogen deposition and recovery from natural disturbances). Among these, climate change and CO₂ fertilization effects seem to be the dominant drivers. However, recent satellite data (2000–2017) reveal a greening pattern that is strikingly prominent in China and India and overlaps with croplands world-wide. China alone accounts for 25% of the global net increase in leaf area with only 6.6% of global vegetated area. The greening in China is from forests (42%) and croplands (32%), but in India is mostly from croplands (82%) with minor contribution from forests (4.4%). China is engineering ambitious programmes to conserve and expand forests with the goal of mitigating land degradation, air pollution and climate change. Food production in China and India has increased by over 35% since 2000 mostly owing to an increase in harvested area through multiple cropping facilitated by fertilizer

use and surface- and/or groundwater irrigation. Our results indicate that the direct factor is a key driver of the 'Greening Earth', accounting for over a third, and probably more, of the observed net increase in green leaf area. They highlight the need for a realistic representation of human land-use practices in Earth system models.

ABOUT THIS NEWSLETTER

This quarterly News Letter from NIAS, IISc Campus is to bring out various latest and important S&T developments likely to find place in future space programs. The future programs include Man in space, Exploitation of extra-terrestrial resources, space based services, space exploration, science of microgravity, space for national security etc.,. The intention is to provide brief information to researchers, academicians, R&D personnel, space industry to generate S&T leads in the minds of people. It is our endeavour to keep this newsletter fresh and engaging with well researched content. Interested persons can contribute by way of small articles. Any suggestion(s) for improvement of this newsletter shall be highly appreciated. - Editor

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