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Coordinates

Volume XVIII, Issue 3, March 2022

THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND

Aviation prepares to reorientate

Review of Continuously Operating Reference Stations activities in India

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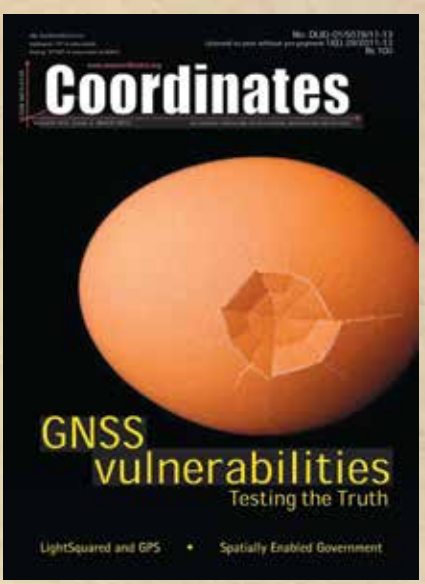


mycoordinates.org/vol-8-issue-3-March-2012

GNSS vulnerabilities: Testing the Truth

Dr C S Dixon
Business Development Manager, GNSS Research & Applications Centre of Excellence (GRACE), The University of Nottingham, UK

Dr C J Hill
Principal Research Officer, Nottingham Geospatial Institute, University of Nottingham, UK

Dr M Dumville
General Manager and a Director, Nottingham Scientific Limited, UK

Dr D Lowe
Principal Navigation Engineer, Nottingham Scientific Limited, UK

In our opinion users need to assess the vulnerabilities of their applications, and need to create procurement specications that specify actual operational needs, including robustness. End Users may need to engage specialist support to ensure that new equipment is not only cost-effective but operationally effective too! To support this, threat analyses, including characterisation of both unintentional and intentional threats needs to be published in order that they can be protected against.

Too Fast, Too Furious

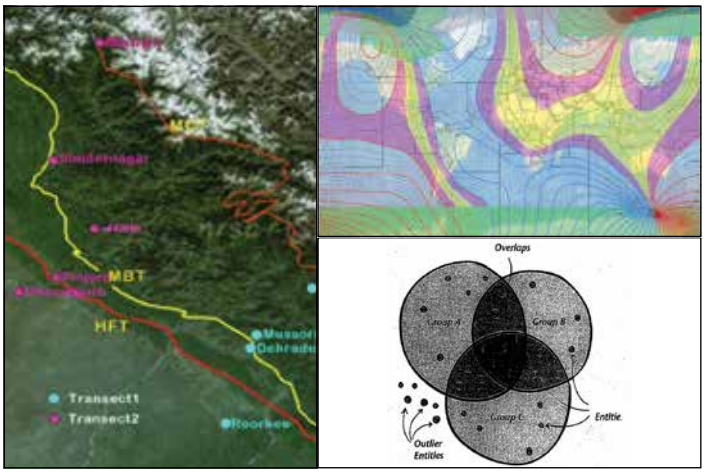
Gavin Schrock, PLS
Administrator, Washington State Reference Network Seattle Public Utilities, USA

It is almost tragic for both broadband and GPS that this episode came to this end. Whatever the outcome, or fate of LightSquared, the dialogue into solutions and alternatives should continue. But this must include all stakeholders. It was difcult to foster such conversations when there is a kind of spectral gun being held to the head of the end users. But despite this, a solution for the future, with enough time to implement is not out of the realm of possibility.

Cloud services are transforming the remote sensing industry

Brian Rohde
Senior Product Manager, DigitalGlobe

Just as the banking industry has leveraged technologies and practices to make online access secure, so, too have remote sensing providers. By implementing rigorous authentication and authorization procedures, and encrypting requests and responses, customers can be assured that their activities, information and imagery are secure. Cloud services are transforming the remote sensing industry as they continue to evolve together. While the Cloud will be a signicant part of this future, look for clear skies ahead.



In this issue

Coordinates Volume 18, Issue 3, March 2022

Articles

Aviation prepares to reorientate David Learmount 6 Package of approved revised ITU-R Recommendations on RNSS systems 10 Review of Continuously Operating Reference Stations activities in India Subhalakshmi Krishnamoorthy 11 Spatial analytics for a resilient and low carbon urban India A K Jain 17 Digital Twin: A Promising and futuristic integrated technology for digital transformation Komal S Pawar 30

Columns

Old Coordinates 3 My Coordinates Editorial 5 News GIS 31 GNSS 32 Imaging 33 LBS 34 LIDAR 35 UAV 36 Industry 37 Mark Your Calendar 38

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Editor Bal Krishna
Owner Coordinates Media Pvt Ltd (CMPL)

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V for values – will it stand victorious?

Raging pandemic inflicted enough wounds,

It is yet painful to see the lives of millions being razed.

The war, irrespective of being triggered by
human tendency to increase its expanse,

Or an urge to punish the fellow ones for non-compliance,

Or even on the pretext for protection from a plausible threat,

This leads to the trail of deaths and destruction.

When the humankind has been immensely benefitted

By the positive utilization of technology and that includes PNT,

The ongoing tragedy demonstrates

Its demonic sides too.

May better sense prevail!

Bal Krishna, Editor
bal@mycoordinates.org

Aviation prepares to reorientate

The debate about changing from Magnetic to True is no longer about whether to change, but how to manage the change, and when; March 2030 is the proposed date

David Learmount
Private pilot
Former pilot and Qualified Flying Instructor in the Royal Air Force
Independent aviation journalist, London, UK

Whilst professional mariners stopped using the earth's magnetic field as their primary directional reference some fifty years ago, civil aviation did not, because at that time accurate inertial navigation systems (INS) were too heavy and bulky for aircraft use.

Today, however, navigation by GNSS (global navigation satellite systems) - backed up by ring laser gyro-stabilized inertial navigation/attitude and heading reference systems (INS/AHRS), radio beacons and air traffic control surveillance using multiple technologies - enables aviation to navigate perfectly without any magnetic reference. The debate about changing from Magnetic to True is no longer about whether to change, but how to manage the change, and when; March 2030 is the proposed date.

Modern civil and military aircraft have the capability to fly to a True North reference at the push of a button: a flight management system (FMS) based on an inertial reference system (IRS) is designed to identify True North at startup, and when a magnetic reference is required, the FMS computes it from True by applying local magnetic variation from embedded look-up tables. Airways and approach procedures within the FMS, however, may use up to four different sources of magnetic variation (FMS, Procedure Design, Airport, or Station Declination) from either the FMS or an ARINC 424 navigation database, and errors occur when these do not match.

With the ubiquitous use of GNSS and the impressive capability of modern IRS, plus the steady decommissioning worldwide of surface-based radio navigation aids, the decision to rely on the constantly changing earth's magnetic field is increasingly hard to justify. The International Association of Institutes of Navigation (IAIN), which has meticulously studied all the issues, comments: "The biggest single problem in trying to implement this change worldwide would be inertia – the large number of countries involved and the difficulty of finding the will to all change at once."

To work out how best to overcome this inertia, the IAIN set up a specialist working group, the Aviation Heading Reference Transition Action Group (AHRTAG), which has been meeting monthly since early 2021. The AHRTAG is a Canadian-led multinational team of navigation and avionic experts from the USA, UK, France, the Netherlands, Japan and Australia, and is chaired by Nav Canada's Director of Operational Safety,

Anthony MacKay. The group includes representatives from several national aviation authorities (NAA), major aircraft manufacturers, pilot associations, and also the commercial air navigation charting and aviation information provider Jeppesen.

The migration of the geographic magnetic poles has accelerated in recent years, adding to the relentless task of updating systems and distributing the associated flight information. AHRTAG points out that updating aircraft magnetic variation look-up tables is a specialist and expensive maintenance activity that has no effect on the way the aircraft derives its directional information. It merely ensures the result is displayed as a magnetic value which will incorporate any uncorrected system errors and add them to the originally determined True heading. And if a future variation shift is sufficient to require correction to airport assets - like runway and taxiway signage and markings, plus instrument procedures, landing aids documentation, and FMS coding - at a major hub, the cost can top $20-30 million.

The one-off act of moving from Magnetic to True reference is no more challenging than, for example, the periodic task of re-orientating VOR and TACAN radio navigation beacons to take account of local magnetic variation changes. Across the industry, stakeholders have the necessary skills and knowledge to make the move.

Canada is now actively concentrating on implementing the change: it already references True North in nearly half its airspace because its far-northern territories contain the (slowly moving) surface location of the magnetic North Pole. Aviators in the northern Canadian airspace have employed tried and tested procedures for both traditional radio navigation beacons and all types of performance-based navigation (PBN) systems for decades. The country's air navigation service provider (ANSP) Nav Canada, working with the AHRTAG, has almost completed drawing up its concept of operations (CONOPS) for the switch to True within the whole of Canada's airspace.

With the ubiquitous use of GNSS and the impressive capability of modern IRS, plus the steady decommissioning worldwide of surface-based radio navigation aids, the decision to rely on the constantly changing earth's magnetic field is increasingly hard to justify.

The International Civil Aviation Organization (ICAO) has shown great interest in Nav Canada's "Mag2True" work, particularly since Canada presented a White Paper on the subject to ICAO's 13th Air Navigation Conference (2018), seeking agreement and proposing adoption by 2030. The conference agreed that further study of Mag2True cost/benefit should go ahead – which it has. The agency is hoping to be presented with "ready-made SARPS [standards & recommended practices] and implementation plans to move issues forward". Meanwhile, ICAO says, Canada presented a formal Mag2True information paper at the HLCC in October 2021, and a presentation by AHRTAG on True North was included in the agenda of ICAO's European PBN Task Force/ Navigation Steering Group meeting in early December. This month, a brief was given to the ICAO ANC Talk Series which generated significant interest.

Assisting ICAO to overcome global inertia might work like this: one state – Canada - unilaterally files a difference from international heading reference standards, successfully transitions to True North within its entire airspace, and demonstrates that the new system works.

The US Federal Aviation Administration is also warming to the idea. According to FAA sources, the agency's thinking is moving in much the same direction as Canada's, recognizing that pilots are accustomed to operating despite differences that come into play at a border. For example, most of the world measures flight altitude in feet, or thousands of feet, but in China, the Russian Federation and a few other states, altitudes below the transition level are in metres.

To sceptics reluctant to abandon any heading reference system – especially one as familiar as the magnetic compass - despite the existence of proven alternatives, AHRTAG member Dai Whittingham – also chief executive of the UK Flight Safety Committee – points out that modern aviation rulemaking is risk-based. Risk can never be reduced to zero, but the introduction of any new system must be proven to be extremely low-risk. Comparisons between the existing and proposed regimes are inevitable, but Whittingham believes it is wise – when playing "what if" games with the proposed system – to admit the existing one has many faults, and to enumerate those.

Meanwhile the AHRTAG, which continually seeks feedback from all parts of the industry, has been able to report that anticipated resistance to change in sectors like General Aviation (GA) is softening to the point of disappearance, especially as GA is a now big user of GNSS systems, whether employing installed avionics, hand-held GPS devices specified for aviation, or electronic flight bags (EFB tablet computers). Similarly, airline pilot associations and the airlines themselves, seem generally happy about the proposed changeover, for which the accepted shorthand has become Mag2True.

Canada's CONOPS

Canada's draft CONOPS offers a good indication of how the Mag2True

task might be rolled out. There are three aviation arenas affected: aircraft operations - which implies inclusion of the airlines and original equipment manufacturers (OEM); aerodromes; and, finally, ANSPs. Overseeing this will be the NAAs, with ICAO keeping an eye on standardization. Questions remain about timing. Should the switch to True be global and simultaneously on a single date, or managed regionally, or by hemisphere?

Canada's draft CONOPS offers a good indication of how the Mag2True task might be rolled out. There are three aviation arenas affected: aircraft operations - which implies inclusion of the airlines and original equipment manufacturers (OEM); aerodromes; and, finally, ANSPs. Overseeing this will be the NAAs, with ICAO keeping an eye on standardization.

Canada proposes 2030 as a target transition year, with NAAs, ANSPs and States triggering the change. If a target date can be agreed, it would be entered in ICAO's Aeronautical Information Regulation and Control (AIRAC) calendar in the normal way for promulgating changes.

Canada's draft CONOPS proposes that, in the six months ahead of Mag2True transition, a State would not action any changes to its aviation information publications (AIP), freezing all but emergency changes to procedures. The

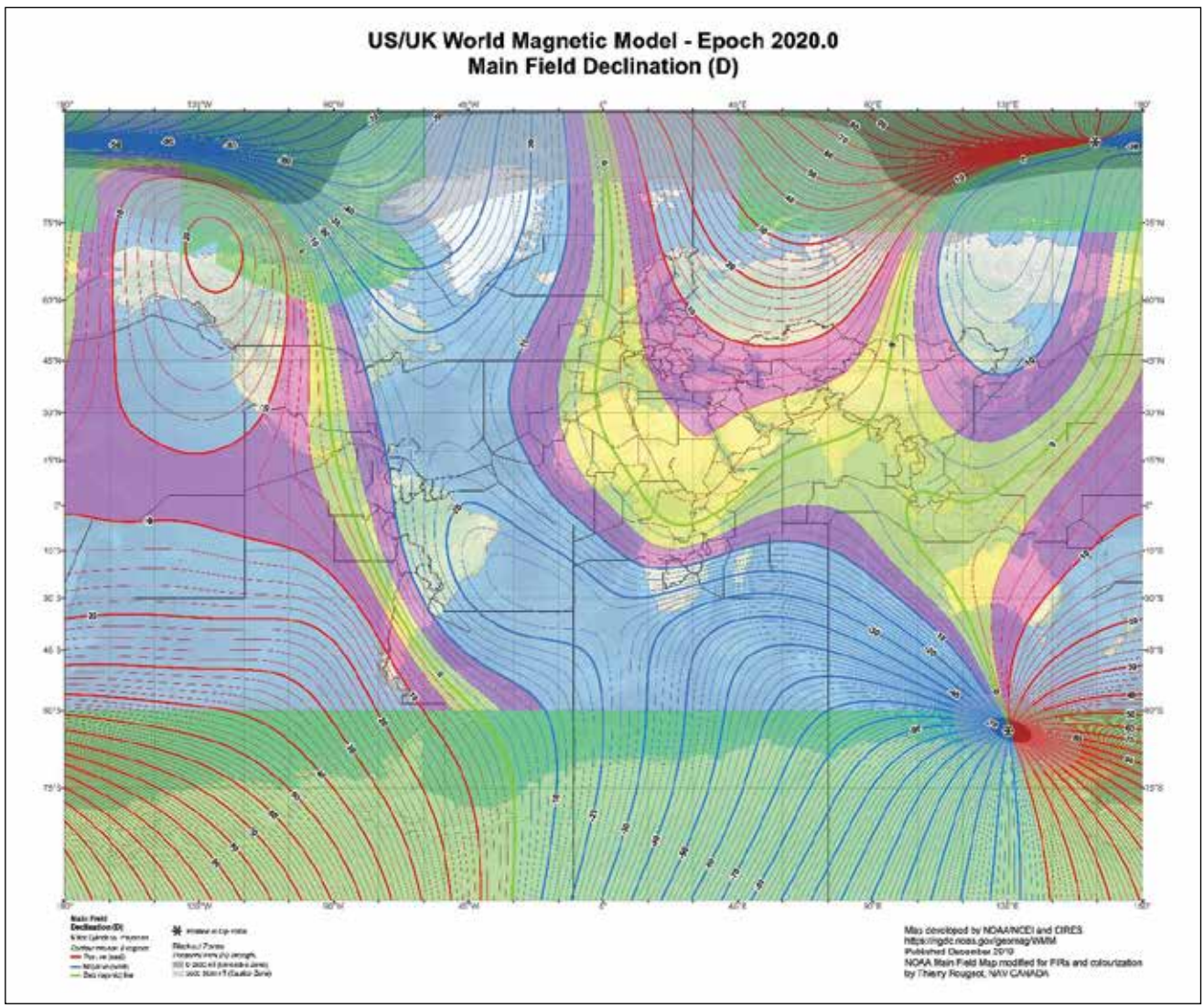


Figure 1

Assisting ICAO to overcome global inertia might work like this: one state – Canada - unilaterally files a difference from international heading reference standards, successfully transitions to True North within its entire airspace, and demonstrates that the new system works.

only changes promulgated would be changes to convert Mag to True.

During this time the State would also need to enact a plan to rotate its VORs and ensure surveillance systems and air traffic controllers were all ready for the change. All states have a procedure in place for crews to adjust VOR radials (+- bearing values) until publication of the corrected values once the VOR is rotated and calibrated. The Mag2True transition date would be the last rotation of VORs, because once set to "0" - or True - they would never need to be rotated again. The ARINC 424 Database that the State AIP feeds could be maintained with its current structure, with all magnetic variation values being set to "0". Jeppesen has successfully tested this conversion method, which was demonstrated via a CRJ 200 flight test with Nav Canada.

The draft CONOPS proposes a way of staging the changeover. The yellow areas of *Figure 1* designate the places where existing magnetic variation is small. VORs in those areas could safely be aligned today to within +- 4 degrees of True North and would still fall within the current tolerance of many states. Canada uses +- 2 degrees as a tolerance but given the amount of magnetic variation change from coast to coast, Canada would have to rotate its VORs anyway.

For many aerodromes in areas within the magenta and yellow zones – where the variation is less than plus or minus 10 degrees of True North - no immediate change to runway numbering, or to airports manuals, would be required. Indeed, the draft CONOPS notes, it could be argued that no change would ever be required. Areas shaded in green are the regions where True North is already in use today.

For the remaining areas, change would have to be more carefully managed. But these areas are predominantly either oceanic, or cover Canada, USA, Russia, and Brazil, the states most accustomed to having to implement updated variation values. Since many carriers already use True tracks during oceanic operations, there would be little or no change for the ANSPs managing oceanic areas, or for those bordering them.

Admittedly there would be other small but important details that would need attending to. For example, airport air traffic services would need to ensure adjusted vector headings for common procedures were included in any memory aids for controllers. But with the exception of NDB approaches and vector headings, most other conventional and PBN (performance-based navigation) procedures are now track-based anyway, allowing correct tracks over the ground to continue during the change period. However, the heading error would appear as apparent wind drift, and that could be misleading to aircrew.

Crew confusion could indeed arise from changes to routines, especially to oft-flown procedures. On the other hand, there is plenty of potential for confusion in a system that continues to use two heading references, especially where one is variable.

Here are just two examples of repeating heading reference problems that are endemic to the existing system:

A Boeing 757 was flying a CAT II approach to runway 29 at St John's, Newfoundland, Canada. When it intercepted the localizer, the aircraft rolled back and forth across the localizer trying to maintain the centreline. The cause was that the magnetic variation (mag var) of the published procedure differed from the out-of-date mag var tables in the aircraft's IRU (inertial reference unit).

At Calgary, Canada, a crew was testing the CAT III approach to the new runway 17L. The crew observed that the synthetic runway image in the head-up guidance system was misaligned by 7deg compared to the actual runway. The crew ran the same test again after the aircraft had been fitted with new IRUs for which the tables had been updated from 2010 to 2015, and suddenly the synthetic and actual world aligned perfectly.

In the months that followed, many crews conducting autolands on 17R at Calgary reported the aircraft moving off the centre-line when transitioning to autonomous flare mode. In all cases, those aircraft were found to have out-of-date mag var tables in their IRUs.

Canada's CONOPS offers a route to modernity and the avoidance of needless costs for the aviation industry. Moreover, the case for Mag2True will likely become unstoppable as the numbers of RPAS (remotely piloted air systems) and autonomous platforms increase – they already navigate in True. Why would aviation want to persist with two systems of reference, where True generates stability and Magnetic has constantly to be managed for error?

Useful links to Nav Canada CNS/ATM plans and action:

cns-operations-plan-may-2020en.pdf (navcanada.ca)

NAV CANADA Communication, Navigation and Surveillance

Package of approved revised ITU-R recommendations on RNSS systems

The ITU Membership considered and approved a package of three revised ITU-R Recommendations on radionavigation-satellite service (RNSS) systems as listed below.

Recommendation ITU-R M.1787-4 - Description of systems and networks in the radionavigation-satellite service (space-to-Earth and space-to-space) and technical characteristics of transmitting space stations operating in the bands 1 164-1 215 MHz, 1 215-1 300 MHz and 1 559-1 610 MHz

The information on orbital parameters, navigation signals and technical characteristics of systems and networks in the radionavigation-satellite service (RNSS) (space-to-Earth, space-to-space) operating in the bands 1 164-1 215 MHz, 1 215-1 300 MHz, and 1 559-1 610 MHz are presented in this Recommendation. This information is intended for use in the assessment of the interference impact between systems and networks in the RNSS and with other services and systems.

This Recommendation was revised mainly in its Annexes 2, 3, 7 and 11, in order to reflect updates in the characteristics, applications and signal structure of corresponding systems. Other editorial revisions and updates are made as well.

This Recommendation was revised in order to describe and to provide the technical characteristics and protection criteria of new types of receivers for certain RNSS systems.

Recommendation ITU-R M.1901-3 - Guidance on ITU-R Recommendations related to systems and networks in the radionavigation-satellite service operating in the frequency bands 1 164-1 215 MHz, 1 215-1 300 MHz, 1 559-1 610 MHz, 5 000-5 010 MHz and 5 010-5 030 MHz

This Recommendation is intended to provide guidance on other ITU-R Recommendations related to the technical characteristics and protection criteria of radionavigationsatellite service (RNSS) receiving earth stations and characteristics of RNSS transmitting space stations planned or operating in the frequency bands 1 164-1 215 MHz, 1 2151 300 MHz, 1 559-1 610 MHz, 5 000-5 010 MHz and 5 010-5 030 MHz. In addition, this Recommendation gives a brief overview of those Recommendations.

This Recommendation was revised to update references to ITU-R Recommendations and Reports related to the technical characteristics and protection criteria of radionavigation-satellite service (RNSS) receiving earth stations and characteristics of RNSS transmitting space stations planned or operating in the frequency bands 1 1641 215 MHz, 1 215-1 300 MHz, 1 559-1 610 MHz, 5 000-5 010 MHz and 5 010-5 030 MHz.

Recommendation ITU-R M.1902-2 - Characteristics and protection criteria for receiving earth stations in the radionavigation-satellite service (space-to-Earth) operating in the band 1 215-1 300 MHz

Characteristics and protection criteria for radionavigation-satellite service (RNSS) receiving earth stations operating in the band 1 215-1 300 MHz are presented in this Recommendation. This information is intended for performing analyses of radio-frequency interference impact on RNSS (space-to-Earth) receivers operating in the band 1 215-1 300 MHz from radio sources other than in the RNSS.

This Recommendation was revised in order to describe and to provide the technical characteristics and protection criteria of new types of receivers for certain RNSS systems.

All these ITU-R recommendations are freely accessible online at http://www.itu.int/rec/R-REC-M/en. The related studies are continuously evolving based on contributions to and participation at the meetings of ITU-R Working Party 4C, the responsible group within ITU-R Study Group 4, where all the related work is currently being conducted, so that those ITU-R recommendations can always reflect the most recent developments related to systems and networks in the RNSS.

– Nelson Malaguti
Counsellor, ITU-R Study Group 4 and CCV
Radiocommunication Bureau
International Telecommunication Union.

Review of Continuously Operating Reference Stations activities in India

This paper gives an overview of the activities related to CORS being carried out by various entities in India.

Subhalakshmi Krishnamoorthy
Deputy Director [Retd], ISRO Telemetry Tracking and Command Network, Indian Space Research Organisation, Bangalore

Abstract

Continuously Operating Reference Stations (CORS) is a network of stations that provide global navigation satellite system data consisting of carrier phase and code range measurements in support of three dimensional positioning, meteorology, space weather, and geophysical applications. The CORS network contains over 2000 stations, contributed by different organizations, and the network continues to expand. This paper gives an overview of the activities related to CORS being carried out by various entities in India.

Introduction

The CORS network is a multi-purpose cooperative endeavor involving government, academic, and private organizations. The sites are independently owned and operated. Each agency shares their data with NGS, and NGS in turn analyzes and distributes the data free of charge.

A CORS comprises of a GPS receiver and antenna set up in a stable manner at a safe location with a reliable power supply. The receiver operates continuously, logging raw data, perhaps also streaming (continuously outputting) raw data. The receiver is usually controlled by a computer that can be located remotely if necessary. The PC will usually download data files at regular intervals and pass them to an FTP server for access by the GPS user community. The first reference stations were setup along coastlines to transmit DGPS corrections to improve the accuracy of ship navigation. Today, reference stations are being established all over the world in ever increasing numbers to monitor the Earth's crust, to provide geodetic control, to support surveying, engineering, GIS data collection, machine control and precise positioning, as well as to monitor natural and man-made structures.

Applications of GNSS

With 506 IGS stations and 337 IGS multi-GNSS stations globally, interoperability and compatibility between the available constellations plays a vital role in achieving the best results to calculate the precise position for civil purpose.

Fig 1. Various Applications of GNSS

CORS System Details

Requirements of CORS Site

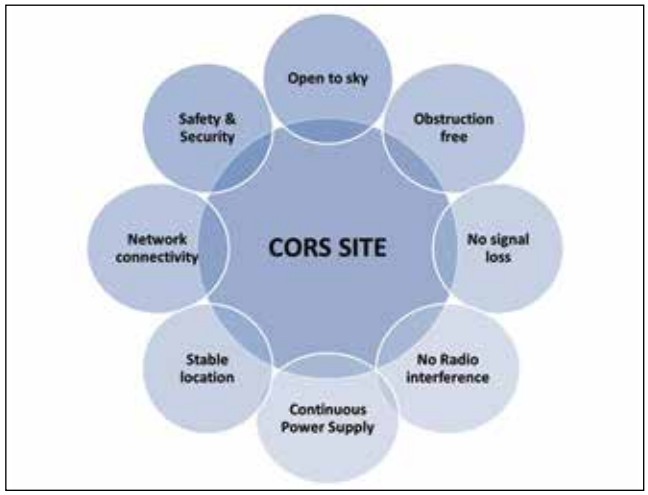


Fig.2. CORS Requirements representation

CORS Receiver Requirements:-

- Should receive from Satellite Constellations - GPS, GLONASS, Galileo, NavIC, Beidou, QZSS
- SBAS Capability -WAAS, EGNOS, GAGAN, MSAS
- Channels: 400+
- Multiple Data Logging Sessions
- Elevation Mask/Cut-off Angle – up to 10°
- Power: 4 W
- Operating Temperature: -40°C to 65°C

Other infrastructure required

- Choke Ring Antenna:- IGS calibrated Antenna with Ground Plane, Multipath Rejection, Quality Data and Radome to protect against adverse environments like wind, rain, snow and solar radiation)

Fig.3. Choke Ring Antenna

- Network Connectivity: LAN/GSM
- Data Storage Capacity:8 GB Internal, 32 GB USB/SD Card
- Uninterrupted Power, Internal Battery, Solar Panel, UPS Inverter with Battery Capacity 150 Ah
- Lightning Arrester

CORS Data Processing

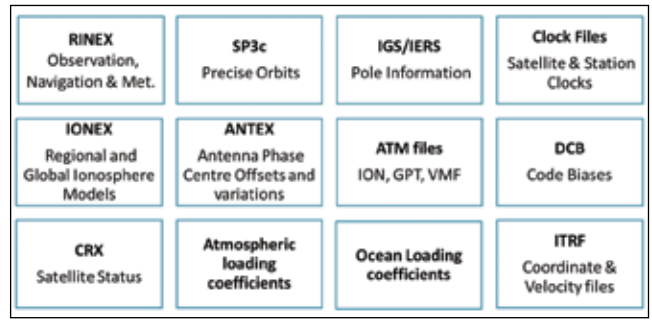


Fig.4. Data Processing blocks

CORS reference system

Coordinates of CORS is in ITRF08
IGS Reference Stations – ITRF08
Space geodesy techniques - GNSS, VLBI, SLR & DORIS

For CORS Data processing, many inputs such as RINEX, Clock files, etc required from International GNSS Service (IGS), IERS and Other Sources

Continuously Operating Reference Station (CORS) in India

In India**,** CORS will be used for high accuracy positioning, geodynamics, meteorology, space weather applications [similar to SOI CORS, NOAA CORS (US), SWEPOS (Sweden)]. CORS in India could consist of network of NavIC/GNSS receivers at pre-surveyed location and connected to master server for data processing. CORS can enable high precision positioning – RTK positioning, network RTK, PPP and related applications using NavIC.(Navigation with Indian Constellation)

CORS using NAVIC has many advantages.

- NavIC is dual band (L5+S) system (and tri-band after addition of L1)
- Lower Ionospheric Errors – Dual frequency/Grid based model
- Continuous coverage in Indian-sub continent
- Satellite always visible: lower probability of cycle slips
- High elevation satellites can augment other GNSS
- Accurate Code and Carrier Phase Measurements
- NavIC can provide precision positioning using RTK (PPP in near future)
- NavIC penetration is low; NavIC based RTK can be a candidate for Low cost RTK using mobile phones in Indian Region

S-band being a new band in GNSS services, there are antenna and baseband challenges, India might run a pilot project and demonstrate its usability in CORS/RTK

NavIC: Regional Navigation Satellite System of India

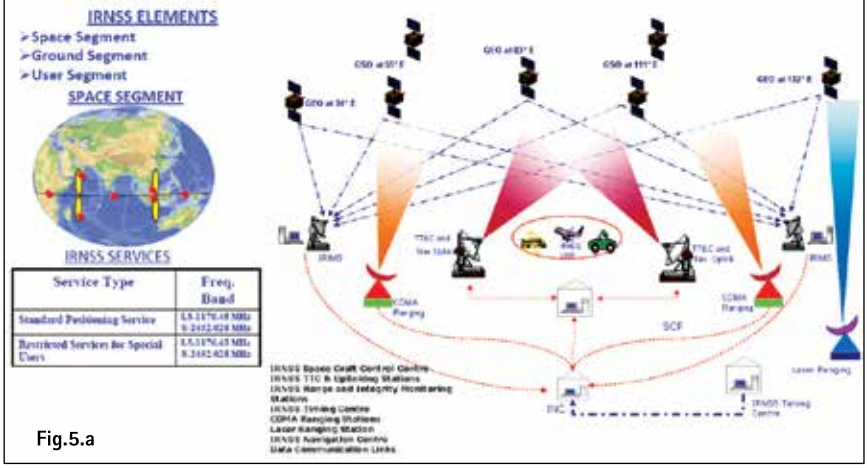
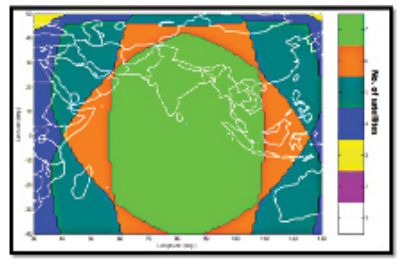


Fig.5.a

Service Area of NavIC Constellations



Spacecraft Visibility of NavIC Constellations

Frequency Band of NavIC and Received Power

Band of NavIC	Carrier Frequency	Bandwidth	Received Power (dBW)	
			Minimum	Maximum
SPS-L5	1176.45 MHz	24 MHz (1164.45 -1188.45)	-159	-154
SPS-S	2492.028 MHz	16.5MHz (2483.50 – 2500.00)	-162.3	-157.3

Fig.5.b

Fig.5.a & b. NavIC Architecture

Challenges:-

- In-house technology development to create IP for research and industry collaboration
- S-band – new band in GNSS services – antenna and baseband challenges – cost v/s benefits
- NavIC being regional system, industry participation to be evolved
- To run a pilot project and demonstrate its usability in CORS/RTK
- Transfer technology to industry for production and operationalization at later stage

Significance of a NavIC receiver in CORS

- Multi-GNSS support in L5/S/L1
- Provides precise code and carrier phase measurements to the network users
- Additional data – antenna phase centre, receiver phase delays, real-time location, Iono/Tropo parameters
- NavIC RTK Positioning using in-house developed NavIC Receivers

CORS activities by various entities in India

Survey of India

GNSS technology has transformed how surveying is done. However, its use in survey applications is limited because of inherent errors associated with the GPS signals. CORS is an infrastructure that can solve the problem of accuracy and real-time data acquisition. CORS is a geo-positioning infrastructure that provides seamless, consistent and uniform framework of the country. It offers highly accurate DGPS service that also improves the speed, efficiency, and simplicity of in-house data-acquisition process. In India, Survey of India plans to use the CORS in the construction of large infrastructure projects and in generation and up-dation of revenue maps, etc. The system will also augment with the NAVIC network along with other GNSS networks like GPS, Galileo and GLONASS. In future, with the NAVIC system, dependence on foreign satellite systems will be reduced, making India a self-reliant nation.

Council of Scientific and Industrial Research [CSIR]

CSIR Fourth Paradigm Institute [CSIR-4PI] is working on GNSS /NAVIC for CORS ----Application and Positioning

CSIR-National Geophysical Research Institute [NGRI], Hyderabad has undertaken the following activities- “Understanding geodynamics and earthquake processes through crustal deformation measurements using CORS GNSS”

GPS measurements were done in various parts of Himalayas. Crustal deformation and seismic hazard in the Indo-Burmese

Fig.6. NGRI CORS in Sites

Arc were studied. The other activities are Study of Co-seismic offsets, ionospheric disturbances and rupture modelling.

Academia

i. National Centre for Geodesy, Indian Institute of Technology Kanpur (estd. with support from DST, Govt. of India) has done Geodetic VLBI studies for Realization of ITRF and Estimation of Earth Orientation Parameters (EOPs)

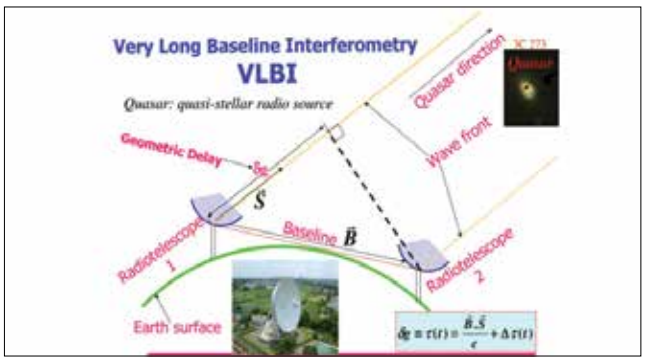


Fig.7.VLBI Concept

ii. Electronics Engineering Department, Sardar Vallabhbhai National Institute of Technology, Surat, India in collaboration with SAC, ISRO has done the following studies.

a. Intentional and Un-intentional Interference Effect on NavIC such as
   - Jamming Interference Study and observations
   - Wi-Fi Interference Study and observations
   - Ionospheric Error Study and observations

b. "SIRMI - Strengthening IRNSS receiver by Mitigation of Interference".

iii. GNSS Laboratory, University of Burdwan [GLB]

GLB has studied the experience of GNSS PPP using geodetic and low-cost, compact receivers. A CORS at GLB operating 24x7 used online PPP service (AUSPOS) to find out the precise antenna coordinate and is being used as the RTK BASE Station. Experiment was performed to find out best time to obtain precise NavIC based SPS from 2 places of West Bengal; Concurrent NavIC L5+S data were collected.

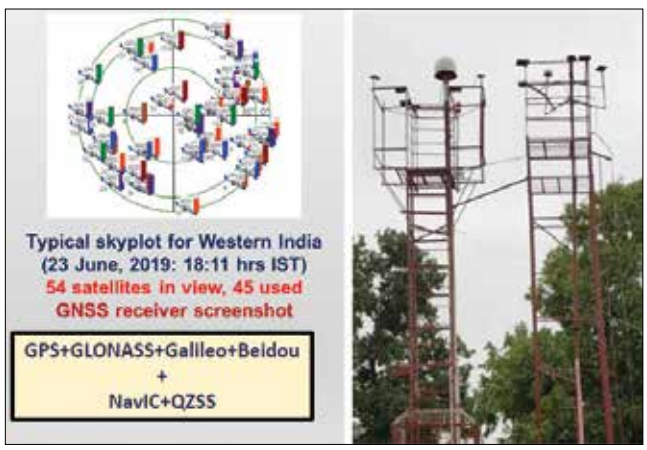


Fig.8. Multi GNSS Environment and CORS at GLB

CORS activities by ISRO

Coming to technology front, high precision geodetic grade NavIC/GNSS receiver is key component of CORS. Receiver antenna to be installed at pre-surveyed location to get full sky view, free of multipath and interference free environment

i. Space Applications Centre, ISRO has carried out work on code and carrier phase based precise positioning algorithms and software in differential mode using NavIC L5 signals, positioning software in real-time.

A prototype version of the NavIC based PPP engine is under development at SAC in collaboration with Academic Institution [Nirma University]

The challenges in receiver/algorithm development such as

- RTK using NavIC for short baseline to very long baseline
- RTK solution in multipath, canopy, semi-urban and urban
- Geodetic grade Tri band antenna
- Development of NavIC PPP receiver
- Development of RTK receiver capable of precise Positioning with advanced algorithms

are being addressed by SAC, ISRO.

ISRO has a Roadmap :-

- Proof-of-Concept NavIC CORS network for a limited geographical area
- Evolution of country-wide network of CORS in collaboration with all stakeholders
- Robust and reliable communication network
- NavIC RTK Positioning to be demonstrated using indigenous NavIC Receivers
- Develop techniques in NavIC receiver to overcome jamming, interference and spoofing

ii. National Remote Sensing Centre (NRSC), ISRO is doing research on GNSS application in geodynamics studies such

Fig.9. Study of Himalayan thrust systems using NRSC CORS

as crustal deformation monitoring, monitoring the Central Seismic Gap, generation of monthly dynamic hazard maps etc. NRSC has constructed 8 GNSS CORS Stations along major Himalayan thrusts belts within the central seismic gap. NRSC is also processing data from CORS data of GAGAN Indian Reference Stations [INRES]. Computation of velocity of Indian plate done from 10 Stations & 3 streams of GAGAN INRES data. As part of EOAM Project "GPS & GAGAN/IRNSS data analysis for Intra-Plate Geodynamic Profiling in Active Seismic Zones", Himalayan thrust systems were monitored

International GNSS Service (IGS)

International GNSS Service is a voluntary federation established in 1994 as a service of the International Association of Geodesy (IAG). It ensures open access (400+ worldwide stations) high quality GNSS data to scientific community and commercial applications. With a global network of more than 500 GNSS ground stations, IGS provides the highest-quality GNSS data, products and services. Currently IGS provides precise products for following constellations: GPS, Galileo, GLONASS, Beiduo, QZSS and SBAS

The following products are derived:

- Orbit
- Clock(Sat/Rx)
- Station Coordinates and velocities
- Tropo and Iono products
- Earth Rotation Parameters

IGS also provides CORS data. However, it has a global scope. The information on the individual stations can be accessed including the ITRF Cartesian coordinates and velocities for the IGS sites, but not all the sites are available from IGS servers.

The IGS products contain the following files:-

a. GNSS satellite ephemerides (.sp3 files)
b. Earth rotation parameters (.erp files)
c. Global tracking station coordinates and velocities (.snx files)
d. Satellite and tracking station clock information (.clk files)
e. Zenith tropospheric path delay estimates (.zpd files)
f. Global ionosphere maps (.ion files)

The following are the guidelines for IGS stations :-

The Station must be planned and installed for continuous and permanent operation. 5° is the elevation cut-off. GNSS receivers must be set to track as many satellites, healthy and unhealthy (all-in-view tracking), from as many constellations as possible (within receiver limitations), always including all GPS satellites as a minimum. The station's GNSS antenna absolute calibration must be available in igs14.atx. The Station's data handling and transmission to the relevant Data Center must occur reliably as scheduled. After a communication outage at the station, the data over the outage must be uploaded to the Data Center.

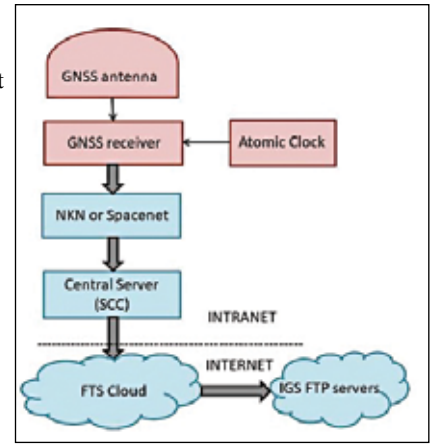


Fig.10. IGS Station architecture

IGS Activities by ISTRAC, ISRO

Sl. No.	Location	Owner agency	Signals tracked (as on 01/04/2021)	Commission Date
1	IISc Bangalore	JPL	GPS+GLO+GAL+ BDS+QZSS+ NavIC	1995
2	Hyderabad	NGRI	GPS, GLONASS	1995
3	Lucknow	ISTRAC/ISRO	GPS+GLO+GAL+ BDS+QZSS+ NavIC	2014
4	Lucknow	ISTRAC/ISRO	GPS+GLO+GAL+ BDS+QZSS+ NavIC	2014
5	Port Blair	ISTRAC/ISRO	GPS+GLO+GAL+ BDS+QZSS+ NavIC	2021
6	Jodhpur	ISTRAC/ISRO	GPS+GLO+GAL+ BDS+QZSS+ NavIC	2021
7	Shillong	ISTRAC/ISRO	GPS+GLO+GAL+ BDS+QZSS+ NavIC	2021
8	Dehradun	ISTRAC/ISRO	GPS+GLO+GAL+ BDS+QZSS+ NavIC	2021

Table.3. Accuracy level of IGS products

ISTRAC, ISRO has installed NavIC enabled IGS stations at Lucknow [2 stations], Port Blair, Jodhpur, Shillong and Dehradun. All these are operational and 4 of them are in APREF network [Asia Pacific Reference network] managed by GeoScience Australia.

With the inception of NavIC, NavIC based applications are proliferating rapidly in the civilian domain. NavIC messaging receivers are being provided to fishermen community via the state fisheries departments. Vehicle location tracking devices with NavIC capability are being mounted on public and commercial vehicles meeting the mandate set by the government. NavIC timing receivers are being employed for dissemination of time, including dissemination of the Indian standard time. Other applications like asset monitoring, industrial IoTs, scientific studies, etc. are also picking up rapidly.

The applications are constantly driving the need for better precision and higher accuracy from the NavIC receivers. These applications rely on technologies like differential NavIC, RTK and PPP for the requisite precision

and accuracy. To achieve this, we need to enable precise orbit determination capability for NavIC satellites through the vast network of IGS stations.

Applications of IGS Stations

1. Precise Coordinate estimation
2. Study of Crustal dynamics
3. Ionospheric irregularities measurement
4. Tropospheric modeling

IGS stations provide critical data for earth science, atmospheric science and navigation. The Indian-Eurasian-Australian Plates are moving at different relative velocities leading to compressional regimes at their margins leading to seismicity in these zones. Also, the coordinates of any geographical location experience a shift over the course of time due to tectonic plates movement and crustal dynamics.

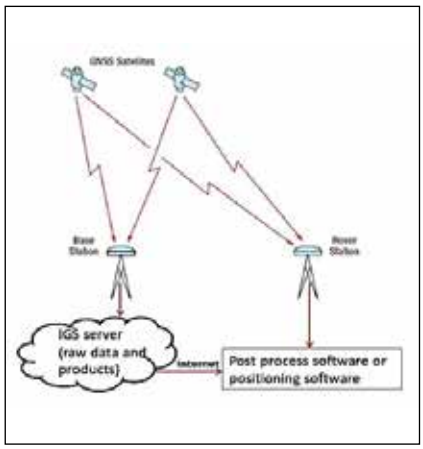


Fig.11. Coordinate estimation

Addition of IGS stations provide an advantage of fixing coordinates of all antennas, in the vicinity, within a level of 1cm accuracy besides providing data to international community for geodetic research and atmospheric study. As both Lucknow and Port Blair are in earthquake prone areas and are strategically located, they are not only critical elements for ISRO as well as for the Science community. The addition of NavIC L5 signal will help in calibration of the antennas' coordinates in the vicinity of the IGS station using NavIC data in addition to the other existing GNSS. Establishment of more NavIC enabled IGS stations

Table.2. IGS stations in India

S.no.	Type	Parameter	Accuracy	Latency
	GPS satellite orbits and clock products			
1	Broadcast	Orbits	~100cm	Real time
		Clocks	~5ns rms ~2.5ns SDev	
2	Rapid	Orbits	~2.5cm	17-41 hours
		Clocks	~75ps rms ~25ps SDev	
3	Final	Orbits	~2.5cm	12-18 days
		Clocks	~75ps rms ~20ps SDev	
	GLONASS satellite orbits and clock products			
4	Final	Orbits	~3cm	12-18 days
	Earth Rotation parameters Polar motion (PM), Polar motion rate (PMR), Length of day (LOD)			
5	Final	PM	~30µas	11-17 days
		PMR	~150 µas/day	
		LOD	~10µs	
	Note: 100µas = 3.1mm of equatorial rotation and 10µs = 4.6mm of equatorial rotation			
	Atmospheric parameters			
6	Final	Tropospheric zenith path delay with N, E gradients	4mm (ZPD)	<4 weeks
7	Final	Ionosphere TEC grid	2~8 TECU	~11days

The advantage will be NavIC primary navigation users (real time and offline) will be directly benefitted by this in addition to users through IGS

is being planned within and outside the country as suggested by CORS.

Need of NavIC enabled IGS :-

The widespread IGS network will provide appreciable improvement in measurement database for NavIC system. This measurement data available at NavIC Control Center can be used to generate high accuracy broadcast navigation parameters using NavIC POD software. The advantage will be that NavIC primary navigation users (real time and offline) will be directly benefitted by this in addition to users through IGS. Establishment of NavIC capable stations in IGS network will aid the IGS user community and IGS products can be generated through POD for end user applications by IGS team.

UR Rao Satellite Centre is working on Precise product generation for NavIC constellation using wide spread geodetic Rx

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11. Ghanshyam.J.Doshi, SAC-ISRO
12. Nishkam Jain, SAC-ISRO

Spatial analytics for a resilient and low carbon urban India

Optimum use of land and natural resources, lifestyle for environment and new partnerships are critical elements of a resilient, low carbon habitat

A K Jain
Worked as Commissioner (Planning), Delhi Development Authority and as a member of the Committee of the Ministry of Housing and Urban Affairs on the DDA (2015). He was a member of UN Habitat (2007-12). Author of several books, he is visiting faculty in planning and architecture. He was awarded 2nd Urban Professional Award 2014 at World Urban Forum in Medellin, Colombia and IBC Lifetime Achievement Award (2016).

Abstract

Urban India is passing through a rapid physical and socio-economic transformation leading to increasing carbon footprints, climate change and disasters. There are conflicts among spatial planning and sustainability due to chronic peripheralization, increasing pollution, transport, energy, land and water consumption. It needs relooking at the repertoire and processes of urban development which should shift from fossil fuel era to the circular concepts of urban planning, renewal, recycling and conservation of natural resources. Leapfrogging in the areas of fourth industrial revolution by using remote sensing and IT tools would help in making the cities resilient, pollution free and carbon negative.

Introduction

Climate change has become an imminent reality with a rise in global temperatures, changes in rainfall, floods, droughts, air pollution and water shortages. With increasing traffic, wastes and stubble incineration, fossil fuel usage, carbon footprints and growing air conditioning, adversely affecting population's health and productivity and decline in agriculture yield. This may cause an increase in incidences of droughts, floods, cyclones, earthquakes, pandemics, urban heat islands and changes in microclimate due to radiant energy in the earth's atmosphere. India continues to suffer from deadly air pollution in the North, while the South is inundated by catastrophic floods (November 2021). This calls for rethinking the paradigms of urban development and use of spatial analytics, remote sensing and IT tools to address the threats of climate change, pollution and disasters.

India's Perspective at the COP 26 (2021)

In 2015, the Sustainable Development Goals (SDGs) were adopted by the United Nations, which were signed by 193 countries, including India. The United Nations Conference of the Parties (COP 26) in Glasgow (November 2021) deliberated upon various measures to limit global warming to 1.5 degree Celsius by the year 2100. Indian delegation led by PM Narendra Modi put forward the need to scale up clean technologies and formation of the International Solar Alliance (ISA). Under this, One Sun-One World -One Grid envisions an interconnected trans-national solar energy grid. The COP 26 agreed to reduce the use of fossil fuels and coal by new sources, such as green hydrogen, green metals, carbon capture, solid state batteries, electric fuels, heat pumps, electric and hydrogen powered transport and next generation solar PV. PM Modi put forward his five-point agenda at the conference, and informed that India's non-fossil fuel energy will be raised from 160GW at present to 500 GW by 2030 and 50% of the power requirement will be met by renewable energy. The Union Budget (2022-23) has allocated Rs. 19,500 crores for solar modules under the products linked incentives (PLI) scheme. This will reduce the carbon intensity of the economy to less than 45%. India will achieve net zero emissions by 2070 by clean technologies, like electric transport, ethanol blending in gasoline, solar photovoltaic and batteries. These

technologies would play a critical role in India's decarbonisation. India has also led the formation of a global Coalition for Disaster Resilient Infrastructure (CDRI) and Clean Energy Ministerial Industrial Deep Decarbonisation Initiative (IDDI). PM Modi underlined at the COP 26 that there is a need for a mindful balance between development and environment.

Reimagining urban planning

Carbon footprint is the total set of greenhouse gas (GHG) emissions, mainly from energy, industries, transport , solid and liquid wastes, agriculture and forestry. Linked with it is the phenomenon of climate change and disasters, which impact health, infrastructure services, housing and livelihoods. These need to be resilient.

Resilience is defined as ***"****the ability of a city as a socio-ecological infrastructural system and its components to absorb and recover from shocks whilst retaining the essential functions and adjust to stresses to reorganise, develop, and transform in order to adapt to socio-economic and environmental changes, over temporal and spatial scales".*

This implies certain basic changes in the planning and urban processes, which are resilient and reduce the use of natural resources and energy. These should conform to net-zero energy and water standards, thrift consumption and doing more with less.

According to UNISDR, the Disaster Risk Reduction (DRR) related activities comprise planning regulations, plans and development activities; setting up institutional structures dedicated to DRR; constructing or enhancing hazard-mitigating infrastructures, along with education/awareness/training programmes.

Spatial analytics

Operationally useful and time bound information is the basis of the planning process. As such, it is important to identity appropriate indicators and their sources as integral elements of developing an interactive and flexible approach for information collection, rather than rigid statistical methods. This involves working out flexible check lists and semi-structured cross examination of various sources of information. The salient features of such an approach are as follows:

a. to collect digital information by new methods, such as Satellite Imagery, Drone Surveys, Total Station Surveys, UAVs, National Spatial Data Infrastructure (NSDI), National Resources Information System (NRIS), etc.
b. to relate information and inputs with reflective observation, conceptualization and experimentation.
c. to recognize the limitation of optimal ignorance and appropriate in precision.
d. adoption of triangulation process for a three-dimensional perception.
e. proxy indicators as an aid to information and perceptive understanding,
f. quality control vs quantitative/ statistical approach.
g. use of GIS and digital tools
h. recognizing the principle of "less is more" (time/information/resources).

As the basis of the planning, the following information is necessary:

i. Physical: such as land required, location, access, land ownership power and water, services, raw material, markets etc.
ii. Environmental factors: such as, pollution, EIA, carbon emissions and reduction, waste management, water recycling, energy efficiency etc.
iii. Organisation, Management and Legal issues, such as laws, rules, regulations, labour , organizations involved, contracting, completion, regulatory system, political support, timelines, etc.
iv. Technology: level, import potential, skills, safety retrofitting, repair, maintenance, impact, etc.
v. Finances and other resources, such as institutional finance, taxes, human resource, subsidies, cost benefit, market potential, pricing, etc.
vi. Service Delivery: consumers, society, local community, jobs, etc.

Once the spatial and attribute data are generated in GIS frame, their applications are many and varied. These include resource inventory and management, planning and monitoring, land records for taxation and ownership controls, facilities and services management, and environment impact assessment. GIS is being used for planning of various cities in India lately. Preparation of Digital Plan using RS & GIS can be undertaken in different layers for resource management and implementation. The cadastre map for planning is usually drawn on Survey of India sheets and the Satellite Imageries. Various information is superimposed on it from the cadastral maps, revenue records, plans and schemes of government agencies like service departments, Industrial Development Corporation, Public Works Department, Railways, National Highways Authority, etc.

The existing land use map incorporating the land use from the satellite interpretation and revenue records is taken for ground verification. The amount of ground verification varies from 15 to 50 percent. The Indian Space Research Organisation (ISRO) provides interpreted satellite imageries, thematic data and other services for urban and regional planning to the government agencies.

By utilising the Bhuvan portal the planners can create new data layers for the non-conforming land uses to assess the deviation between the previous approved Proposed Land use plan and the existing situation. Since the mapping has been done on GIS, temporal variations from the latest remote sensing imageries can also be superimposed. Such data can be uploaded on Bhuvan portal for public viewing. Both attribute data and pictorial data can be collected from the field through the app and uploaded on a centralized data base.

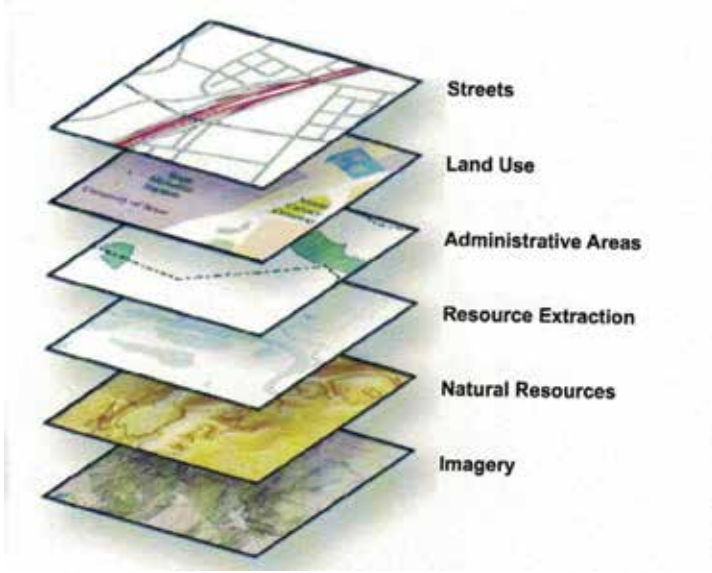

Fig. 1: GIS for Digital Planning and Resource Management

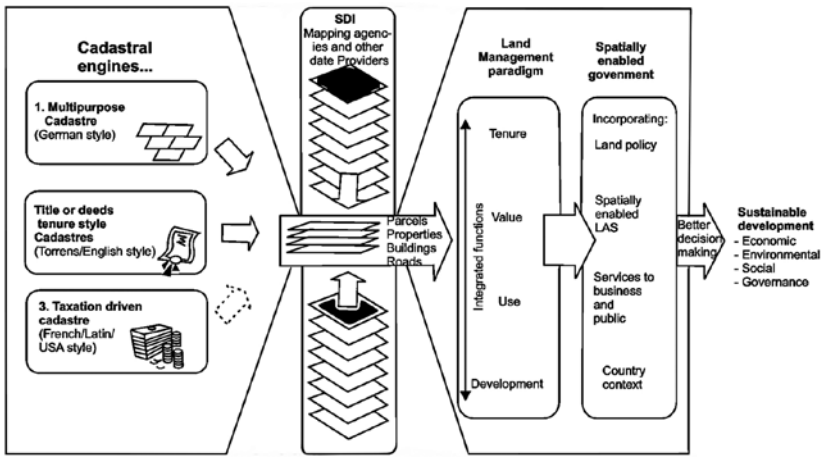

Fig. 2: Significance of the Cadastral (Williamson and Wallace, 2007)

Collecting the data

There are two kinds of data sources- primary and secondary. Primary data are first-hand information, gathered from original sources, for instance through interviews or going out and directly observing the phenomena that is being studied. Secondary data, such as collected by the Census of India provides such information.

Interviews

They can be face-to-face or by internet or telephone. Face-to-face interviews are more accurate, but any sort of interviewing is expensive. Interviewers must be trained and since one-shot surveys cannot hire full time interviewers, staffing a survey is difficult. In these circumstances, survey research centres, often affiliated with universities, are frequently used for survey and research.

Direct inspection

The direct inspection of conditions or activities is employed in making traffic counts, recreation area use surveys, housing quality studies, and many other kinds of surveys where human communication is not required to elicit the information directly. However, this is not always as easy as it sounds. A well-known direct technique is *participant-observation.* The techniques was developed by anthropologists in the study of community life. The surveyor becomes a resident of the community and lives among the people, learning their way of life by participating in it. It has been very effectively used by some social scientists to investigate the urban problems.

The choice of techniques rests primarily on two criteria-time and cost, both of which we always want to minimise but often reducing one results in increasing the other. This poses the need to strike a balance of the two. This means that each question should relate to its core purpose, such as the variations in the population being surveyed. This needs careful design and structuring the questions of a survey.

A sample, properly chosen of some fraction of the whole is usually adequate to estimate the information for the whole population. If the population to be surveyed is very large and the sampling proportion is small then a test run will allow the adjustments in sample size or number of questions. It also helps to spot the ambiguous questions, areas of misinterpretation and poor layout of the form. When surveys are conducted, some system of monitoring is advisable to discourage improper practices.

Multiple index surveys

To assess the particular aspect or condition, such as poverty, the multiple index system can be adopted by means of a sieve map (or quantitatively by calculating average multiple index). This may help to determine the areas having worst (shown by incidences of all the bad factors), moderate (few bad factors) or fair (no bad factors) conditions.

Average Multiple Index is calculated for different areas, which can be given different weight depending upon the gravity of a factor in contribution to condition of buildings, poverty or environment.

Transect

Transect as a schematic device can be extremely useful to obtain an overview of a particular area and its problems and issues. This is a diagrammatic illustration and record of major characteristics, events, profiles or issues. While conducting windscreen or triangulation reconnaissance, freehand transects can be prepared, which can supplement the records.

Proxy indicators

Proxy Indicators are short-cut to time consuming data collection and an alternative to unstructured observations. Information about these indicators may be readily available, which has to be applied on the basis of past experience, common sense and certain assumptions. For example, the growth in the number of banks in an area may indicate its economic base or a greater number of fast food restaurants may represent a youth dominated society or business.

Quality of information

Accuracy, timeliness, reliability and cost effectiveness are important qualities determining the usefulness of data for planning and formulation of policies. These factors should be kept in view while collecting the data. To collect quality information, the key informants should be selected carefully, so that those who are knowledgeable are approached. In addition to public agencies, other sources of information, viz. cooperatives, resident groups, women's organizations, traders associations etc. can also be useful to augment information obtained from primary and official sources. Secondary sources of data, such as reports and literature can also provide useful information. The information should be triangulated and integrated - synoptic/ sectoral data with local/ ground level studies and provider's perception with that of the consumers.

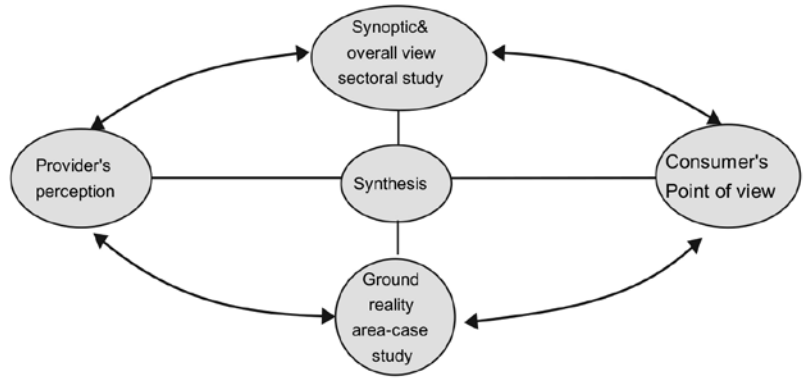

Fig. 3: Integration of Synoptic/Sectoral Study with Ground Reality/Area Studies; and Provider's Perception with Consumer's Perception

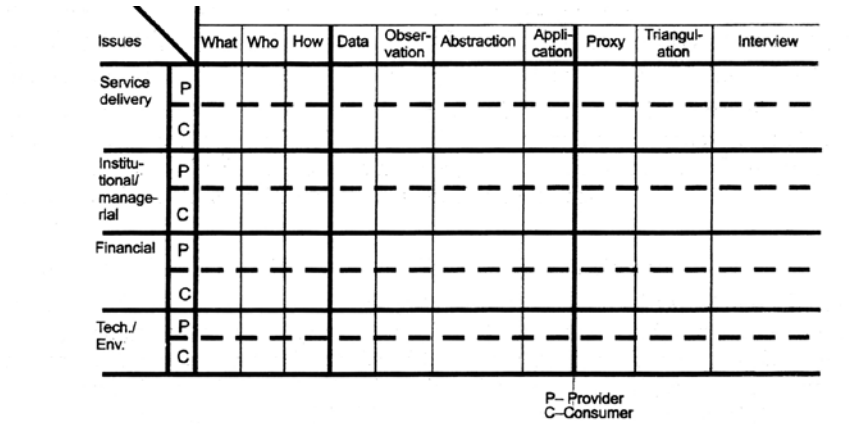

Fig. 4: Situation Analysis and Constraints

Triangulation

Triangulation is an important method to cross-check information obtained from different sources. Multi-disciplinary teams are useful in triangulation, so that the data and information can be cross-checked by observation, discussions and by inter-disciplinary perspectives. This way, the reliability of information obtained through rapid surveys/ appraisal can be enhanced.

Exploration

A preliminary visit can be very helpful to work out a handy semi-structured check list and a framework of indicators for actual survey. Simultaneously, a semi-structured questionnaire for interviews with people and organizations concerned can be prepared. The information thus obtained should be triangulated from time to time to make sense out of it. Information related with observations can be transformed into abstractions, which should be crisp and clear so that it can be digested, codified, analysed, and synthesized.

Triage

Triage is a useful method for assessing social, economic, institutional and technical performance of alternative options, systems or technology. It is particularly concerned with the technical aspects and design process and, therefore, is relevant for project planning and design. Under this method, various components of a system are given a score and a screening-criteria is evolved. For this, the results of the system and performance are reviewed and scored as low, medium or high, as case may be.

Force-Field analysis

Force-field Analysis is a well-established management tool. It allows the analysis of a problem, or an opportunity in a manner that helps to generate innovative but realistic actions. The actions generated may range from use of certain technology to manpower development and choice of partners in development. It has become an appropriate tool to develop innovative solutions to urban problems, such as better use of private sector participation to improve urban services.

Strategic issues identification

Many enterprises, whether infrastructure, industrial or business end up in failures. While the success stories become the talk of the town and the media, no one knows what happened to other 90% of failures. It is common to blame the political system, interference, corruption or red tape for the failures and troubles, while the planning and management pitfalls are underplayed. However, 'politics' in a democratic set up is part of the management and cannot be wished away. It works both ways-political alignment and interventions can speed up the project or kill it. The fact is that initiating a large infrastructure project involves a complex cohort of risks, clearances and interventions, such as obtaining licences, loans, land, labour, technology, public services (like power, water), environment impact assessment, etc.

Fig. 5: Force-Field Analysis

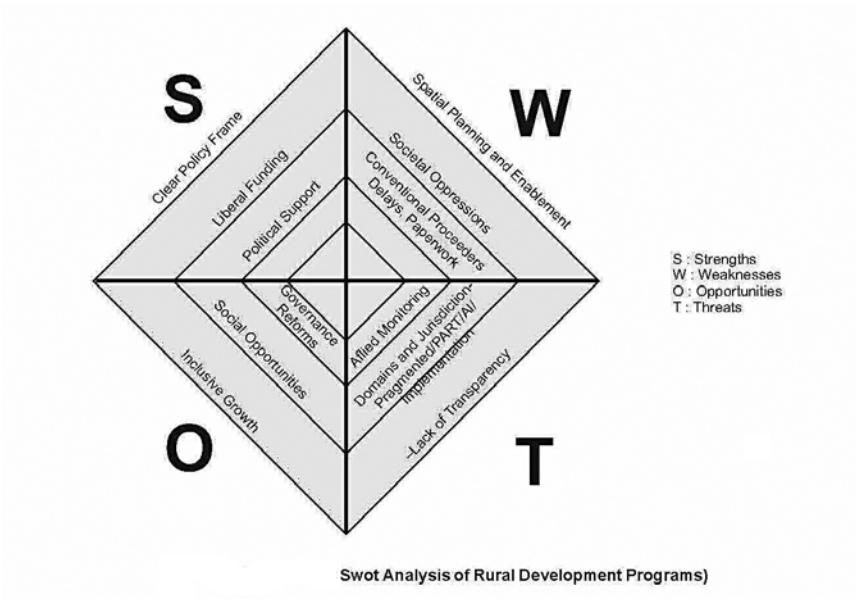

Fig. 6: SWOT Analysis

In order to obviate the unforeseen problems, which may adversely delay or stall the project, it is necessary to make a detailed study of the strategic issues which are critical for smooth operation of the project. This helps to troubleshoot the critical problems that could be anticipated. Some of these can be nipped in the bud through initial planning and legal framework, rules and regulations, agreements, etc.

Impact analysis

The purpose of impact analysis is to assess the impact of a particular service, project or facility. A preliminary impact analysis may be essential at the planning stage. For this, the intended or planned activity is placed at the centre and its direct and indirect, positive and negative results are listed in the boxes around the activity. The arrows linking various boxes indicate the linkages, directions and causes. The effects may be comprehensive, which can be categorized under physical, environmental, social, economic, political, institutional, legal and other impacts. For example, the impact of intended regularization of unauthorized colonies can be analysed by evolving a set of Impact Diagrams, such as given below:

Economic-how is the plan likely to impact economically. This includes its effects on employment and on business in the plan area and also at a broader level, e.g. the city or region.

- Social-what will be the impact on social organization?
- Political- Is the plan likely to have political repercussions?
- Environmental-what will be the environmental impact of the plans-both within the site and at a broader level?
- Cultural-Are the plans sensitive to existing culture? Are they likely to have an impact?

All these questions need to be answered both in terms of short term and long term impact.

Sustainability analysis

Sustainability is a key consideration in working out a policy and plans for urban development. For this at various stages, key areas involved in planning and implementation are listed, such as energy, water, building construction, waste management, greenery, noise, safety, etc. Against each, major issues are identified with their possible solutions. This allows assessing the proposal with the norms and exploration of possible options.

SWOT analysis

Evaluating strengths, weaknesses, opportunities and threats. Often, we realise that strategy falls short of the plans. This may be due to ad-hoc decisions, political, societal, or legal pressures or financial constraints. The SWOT analysis aims to visualise various weaknesses and threats, for which pre-planning may be necessary.

People, Objects, Environments, Messages and Services (POEMS)

The POEMS framework is an observational research framework to make sense of the five elements, i.e., people, objects, environments, messages and services. These help teams to think about context as systems of related elements by a note taking template to record and categorise the observations (notebooks, cameras, pens, recorders, etc.).

Tree/Semi-Lattice diagramming

The Tree and Semi-Lattice Diagrams are used to analyse the hierarchical nature and relationship among entities. In this dots or circles represent entities and lines show connections, hierarchy and understanding the differences for getting insight about the context.

Venn diagramming

Venn diagramming is an effective method

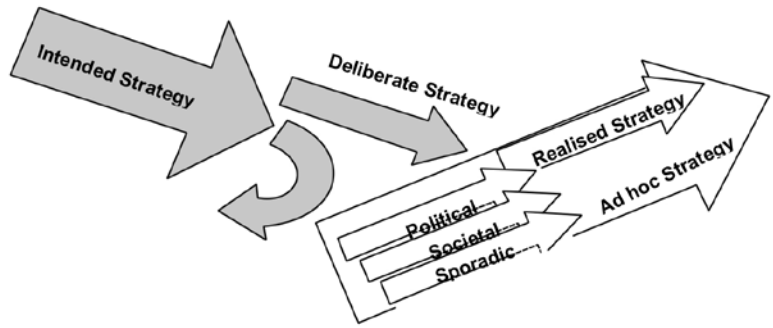

Fig. 7: Wide Gap between Intended and Realised Strategy

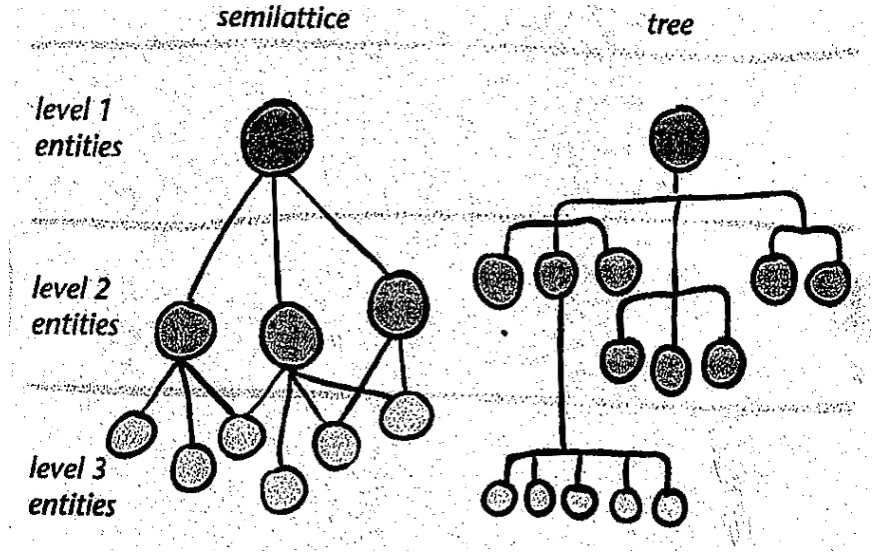

Fig. 8: Semi-Lattice and Tree Diagram
Source: Vijay Kumar (2012)

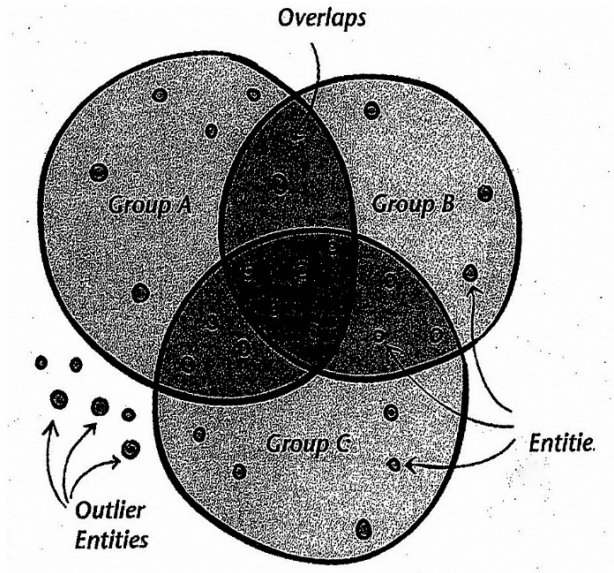

Fig. 9: Venn Diagram
Source: Vijay Kumar (2012)

to analyse the overlaps between two or more clusters of entities. Venn diagrams use visualisation with overlapping circles. The interior of the circle represents the entities in the cluster, while the exterior represents entities that are not members of the cluster.

Remote Research uses online research tools, such as given below:

- **Experience Simulation** engages peoples in simulated experiences to understand what matters to them.
- **Users Response Analyses** to understand patterns and drive insight
- **ERAF System Diagram to** analyse Entities, Relations, Attributes and Flows
- **Strategy Roadmap-** Planning solutions for short-term, mid-term and long-term, integrating information, processes and work flows
- **Trend Matrix** summarises changes that leads to future direction
- **Solution Database** involves organising the concepts and solutions in a searchable database
- **Five Human Factors** (physical, cognitive, cultural, social and emotional factors) are considered to synthesise the elements of remote research.
- **Behavioural Prototype** involves simulation to understand user behaviour
- **Insight Clustering Matrix** aims to understand the insights and showing their relations and hierarchies

Conceiving holistic solutions

Shifting from parts to whole, the objective is to look holistically at the individual concepts. Specialised teams talk through different possible configurations, concepts and evaluate which of these are optimal for a given context.

Concept generating matrix

It involves inter-relationship among various data, attributes and processes, and seeks to balance knowledge, abstraction, creative thinking/ideation and practice/ implementation. This may comprise the following tools

- Principles and Opportunities
- Mind Map
- Value Hypothesis and Ideation
- Concept Generating Mapping and Scenario
- Concept Metaphors and Analogies
- Concept Prototype, Sorting, Cataloguing and Matrix.

Morphological synthesis

The concepts lead to a systematic synthesis of plans and strategies by a series of steps, such as given below:

- Deep Learning and Artificial Intelligent Models
- Building Information Modelling (BIM)
- Concept-Linking Map
- Foresight Scenario
- Solution Diagramming, Prototypes and Evaluation
- Planning Roadmap
- Action Plan and Strategic Planning,
- Assessment and Monitoring of Techno-legal Constraints and Resources.

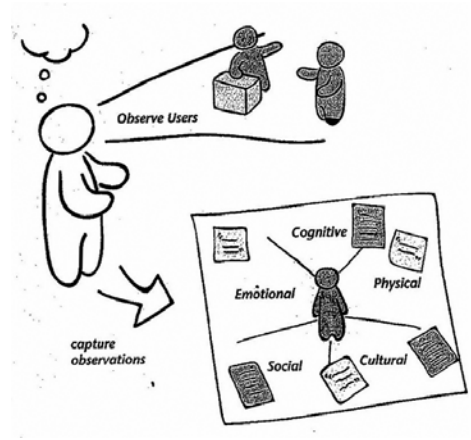

Fig. 10: Five Human Factors
Source: Vijay Kumar (2012)

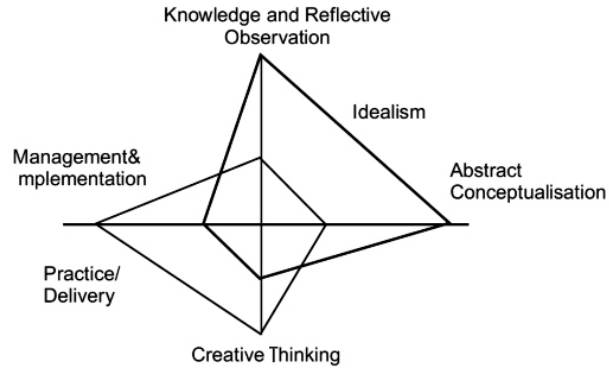

Fig. 11: Idealism and Practice Interface

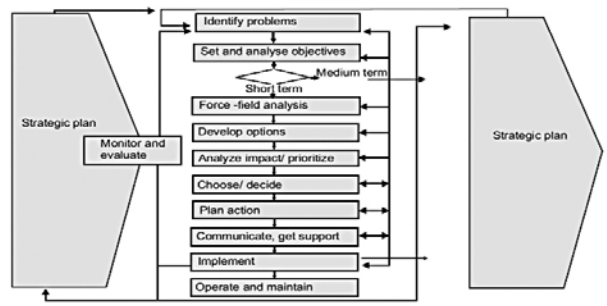

Fig. 12: Links to Strategic Planning
Source: Forbes Davidson (1994) Action Planning, IHS Rotterdam

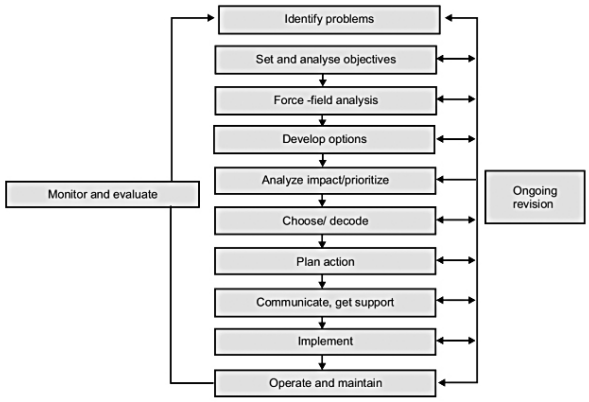

Fig. 13: Process of Action Planning

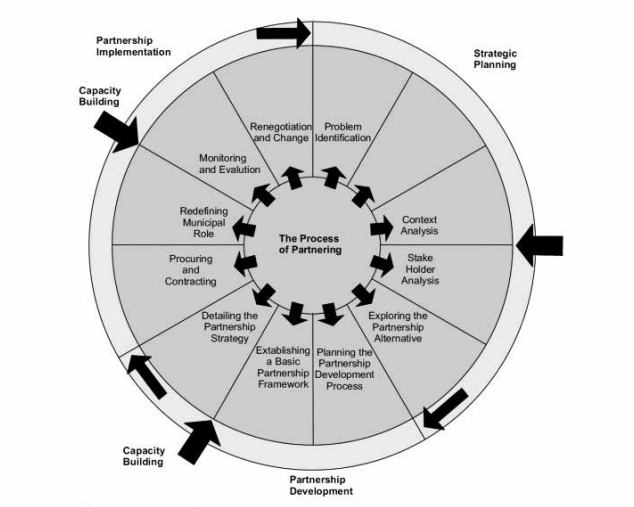

Fig. 14: Strategic Planning in the Development and Implementation of Partnerships
Source: Plummer, Janelle (2002) Focusing Partnerships to Municipal Capacity Building, Earthscan, UK

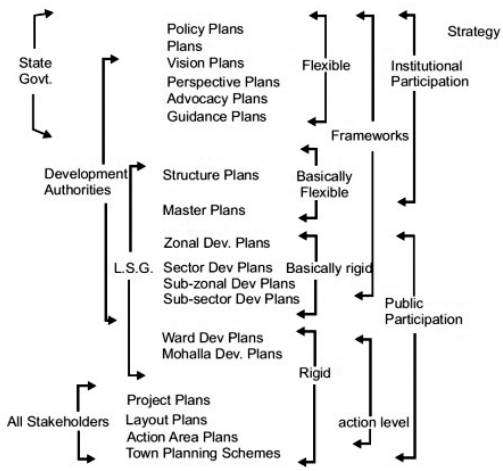

Fig. 15: Typologies of Plans for Integrated Development
Source: E.F.N. Ribeiro (2003) Metropolitan Vision in the Context of Rapid Urbanisation, Paper presented in AMDA Seminar, New Delhi

India's urban missions

Since 2014, the Government of India has launched several new urban missions, viz. Smart Cities Mission, Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Pradhan Mantri Awas Yojana, Historic City Development and Augmentation Yojana (HRIDAY) and Swachh Bharat Mission (SBM). The SBM 2.0 and AMRUT 2.0 continue to operate with effect from October 2021. The plans for these missions including 500 cities under AMRUT have adopted the technique of Geo-database Creation, GIS based Master Plan Formulation and Capacity Building. An MOU has been signed between National Remote Sensing Centre (NRSC), Department of Space and Ministry of Housing and Urban Affairs for Geo-database Creation.

These missions aim at low carbon urbanisation and the provision of core infrastructure services like water supply, sanitation and solid waste management, efficient urban transport, affordable housing for the poor, 24x7 power supply, IT connectivity and e-governance. These missions emphasize upon participatory planning and governance, livelihoods, connectivity and providing better education, healthcare, urban safety and smart services, which are intelligent, interconnected and instrumented.

Resilient and low carbon cities

The cornerstone of making a city resilient and low carbon is to adopt an integrated approach towards ecology, the conservation of the natural resources and sustainable urban development, including the services like drainage, water supply, air, sewerage, solid waste management, transportation and energy. The planning typology can be segregated as per the domain (Government, Development Authorities, Municipal Government, PPP, etc.), levels (Local, Zonal, Master Plan, Policy Plan/Regional Plan), time frame (short, medium and long term). At every stage public and institutional participation is necessary together with sustainable, resilient and low carbon development. This involves the following:

- Local Economic Promotion and Jobs
- Reducing urban footprint
- Biodiversity, Greenery and Amenity Spaces
- Urban Heat Mitigation
- Water Conservation and Management
- Decentralised and Intelligent Services
- Air Quality Management
- Clean Transport and Transit-Oriented Development
- Green Energy
- Green and Resilient Buildings
- LIFE- Lifestyle for the Environment

These targets involve setting up of SMART goals which are specific, measurable, attainable, realistic and time bound. The new paradigm also needs a basic change in the role of planners from a technical expert to facilitator, communicator, and a

catalyst of change. The thrust on strategies and action planning requires working out new mode of partnerships, financing and resource optimisation (including human resource and time).

In this digital age, all round disruptions are happening. In India the 20 year model of Master Planning was adopted during the 1950s which does not address the emerging problems of climate change, air and water pollution, public health, employment and disasters. It is also incongruent with the objectives of speed, scale and sustainability. It is necessary that urban and regional plans are prepared for a five year horizon, while their vision may extend to 20 years.

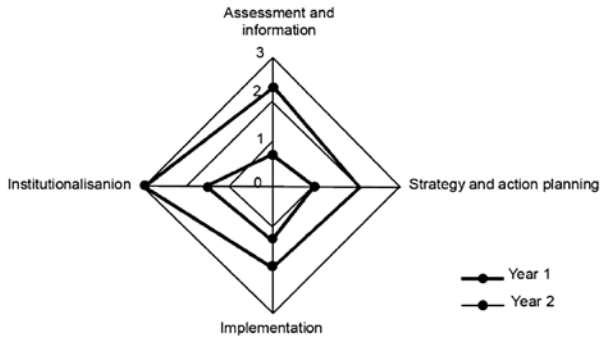

Fig. 16: Various Stages of Urban Policy Cycle

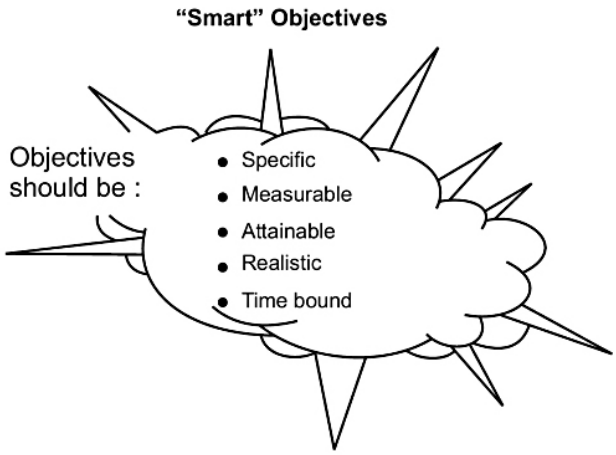

Fig. 17: Hyrum Smith's Concept of SMART Goals

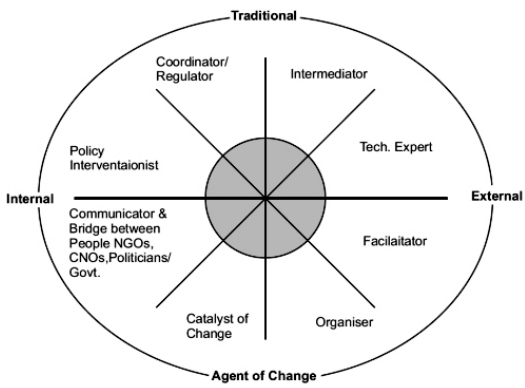

Fig. 18: Changing Role of Planning Professional

Local economic promotion and jobs

In India, the cities generate the country's 60% of GDP and 70% of the jobs. With Covid 19 pandemic, climate change and diminishing jobs, the factors of public health, creation of jobs, environmental sustainability and climate resilience have emerged as the key issues. A target of 10 million jobs in urban areas can be achieved in next five years by development of janta markets, workshops/ sheds, kiosks, shops, small offices, etc. At least 10 per cent area of shopping/commercial centres may be reserved for the informal sector (street vendors, kiosks, fruit and vegetable stalls, etc.). The residential areas also need a higher level of mixed use and the rationalisation of FAR/FSI, height and densities.

Reducing urban footprint

The urban footprint needs to be reduced so that it leads to travel reduction, economy of services and conservation of agricultural areas. The Indian cities have an overall density of 100 to 240 PPHa, which can be selectively doubled along public transit corridors, excluding the archaeological, heritage and conservation zones. The focus has to be on redevelopment of the brownfields, infrastructure services, transportation, public greens and facilities. The urban eco-system must be compact and dense. The urban planning, governance, businesses and industries have been transformed by fourth industrial revolution. The processes need to change which are compatible to circular economy by adoption of new technologies, such as digital blockchain, LADM framework, combinatorial and discrete optimisation, algorithms, complexity theory, artificial intelligence, big data, and the ubiquitous cloud.

A digital ledger is a geographically distributed database that is shared and synchronized across a network of the participants. It has a blockchain structure where the data is stored in blocks, linked and secured by cryptography for handling identities, contracts and assets. The blockchain is an electronic transactions system. It is based on a hash algorithm that converts data into a block. Digital Blockchain system for land management is indispensable for land pooling schemes in order to curb the frauds and power of attorney transactions, which are very common in urban and rural zones.

The Land Administration Domain Model (LADM) is an International Standard (IS) of the International Organisation for Standardization. It covers basic information related to components of land administration and includes agreements on administrative and spatial data, land rights and source documents (e.g. deeds or survey plans), and forms of tenures-customary tenure, government land, and privately held land.

The LADM, assigns the class and contains the Rights, Restrictions and Responsibilities., which are the basis of land adjustment and registration. Digital distributed ledger technology can simplify the complex and open to manipulation paperwork used for property records. As blockchain is immutable and not easily vulnerable to hacking, title records will become verifiable and simple in establish a clear chain of legal ownership.

Biodiversity, greenery and amenity spaces

A study of the present land use pattern in India indicates shortfall of land under forests and greens, while the lands under agricultural use are being increasingly converted for the highways, airports and settlements. It is estimated that an additional 2 to 3 million hectares would be required for human settlements during next 10 years. Sacrificing agricultural land for habitation implies reduction of land for producing food. The lands that sustain agriculture, biodiversity, surface water and groundwater, fragile and sensitive areas, coastal zones, etc. need protection and conservation.

In a city an overall area of 10 sq. m of greens per capita should be reserved for public greens at city, zonal and local levels. In built-up areas reservation of open space can be done by adopting appropriate regulations for redevelopment. The Government of Maharashtra has notified the regulations for Provision of Amenity Spaces and Open Recreational Spaces under Unified Development Control and Promotion Regulations (UDCPR 2020). These provisions oblige that a minimum 10% of space is reserved and provided in plots more than 4000 sqm against additional FSI or TDR for garden, playground, and/or for a municipal school, hospital, fire brigade and housing for affected people.

A system of landscaped linkages connecting various parts of the city, water bodies and monuments can provide a sense of oasis and shelter from oppressive climate. Peripheral green belts can act as wind breakers, filters of SPM and dust-storms. The green buffers with indigenous trees, land formations, mounds, embankments, etc. also provide effective barriers to transmission of noise.

The development of greenways can be integrated with the water bodies, drainage corridors and harvesting ponds, reservoirs and by sediment traps in the catchment zones. In water deficient, dry areas the landscape can be in form of Xeriscaping, which can reduce total water demand by as much as 50 to 90% by micro- just- in -time irrigation. Vertical gardens and urban farming can provide relief in the dense areas.

Urban heat mitigation

In a dense built up area air rises over the warmer city and settles down in the cooler environs. The hot air dome and its effect on microclimate may persist until wind or rain disperses it. Increased aerodynamics of built-up areas cause rapid deceleration of wind compared with open countryside. It has been calculated that wind velocity within a city is half of what it is over open land. At the town edge, it is reduced by a third. The mutations and reservation of greenery and open space in windward direction and cooler surface materials (roads, parking, buildings, roofs, etc.) help in mitigating the effects of urban heat island.

Water conservation and management

Water scarcity has become a persisting problem in Indian cities due to climate change, pollution of rivers, water bodies and massive construction. Several cities in India have become water stressed. Only 18% of the renewable water resource is being recycled, while 10% of the annual rainfall is being harvested in India. The issues of concern are increasing coliform levels and Bio-chemical Oxygen demand (BOD) in surface waters and increased concentration of nitrates in the groundwater. To overcome these problems, water sources need to be protected by sanitation/sewerage interception, and recycling and treatment of wastewater. Water resources can be augmented through recharging of groundwater and by rainwater harvesting (not only in building, but also on roads, parks and parking areas) along with conservation of rivers and water bodies, water efficient taps/fittings, dual plumbing, curbing Non-Revenue Water and recycling of wastewater. Blockchain and SCADA systems can help in 24x7 water supply of potable quality.

Decentralised and intelligent services

Surveys reveal that approximately 40% of urban population in India is not covered by sewerage, sanitation, drainage and solid waste disposal. Various alternative technologies, based on decentralized systems should be explored. The use of IT, simulation, blockchain and automation can make the services smart and intelligent. The common method of land filling for solid waste disposal is an environmental disaster. Instead, decentralized systems based on 5 R strategy of reduce, refuse, reuse, recover and recycling should be explored. Three bins provide separate bins for trash, recyclable and compost. Collection charges drop as trash drops. Biotechnology, enzyme based STP, bio-remedial treatment, vessel system, sludge gas/energy recovery, vermi-culture, fossilization and compositing options can be adopted for solid and liquid waste management. Underground pneumatic conveying systems can be adopted, which are more hygienic, economical and avoid movement of trucks for transportation of wastes.

Common utility ducts or tunnels carrying electricity, water, sewerage, wastes, cables and broadband internet minimize damage from traffic, road repairs, rains, etc. A series of low carbon zones across the city with co-located tri-generation energy systems (combining power, cooling and heating), and automated, segregated

Air quality data is significant to gaining a thorough understanding of local air pollution. Recent technological advancements have made it possible to gather data, with low-cost monitoring devices and advanced methods of collating and analysing it. This helps to gain an understanding of pollution levels, their causes and effect.

waste collection and recycling can lead to bundling 'green infrastructure' together.

Air quality management

Air quality in Indian cities is deteriorating due to indiscriminate use of fossil fuels and vehicular and industrial emissions. According to the surveys conducted by the CPCB ambient air quality in more than 20 Indian cities have reached a very critical situation. Relatively high levels of suspended particulate matter, dust, SPM, SO_2, NO_2, CO_2 and heavy metals, including lead content in the exhaust of automobiles and scooters, have been observed. The recent changes in the fuel like electric and hydrogen powered vehicles, adoption of clean technologies, new emission norms, development of shared taxis, NMTs and mass rapid transport system can reduce the pollution levels due to vehicular emissions. Airshed planning, continuous ventilation, use of cooler and light shaded surfaces/ materials and water spray are some other methods to reduce air pollution

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Now-a-days smart electricity poles with sensors are available to monitor pollution parameters along with light, CCTV, wi-fi, etc. The NDMC has been using them in New Delhi. Citywide air quality monitoring networks can provide the data of air quality.

The Google plans to map street by street air pollution that will be available to the common man. The active sensors will measure CO_2, CO, NO_x, NO_2, ozone and particulate matter. CEMS and Air quality Data can be used to identify major components, sources, quantification and projects. It can also help the government to apply monetary incentives and penalties for polluting companies. This can also be used to introduce a cap-and-trade system, instead of the existing 'command-and-control' regulations. The data can be used to analyse the issues, sources and project various options and actively schedule to assign the responsibilities, project management, including timelines and monitoring.

Clean transport and transit oriented development

Prime Minister Narendra Modi, while inaugurating the Global Mobility Summit in September 2018, encapsulated 7 Cs of mobility-common, connected, convenient, congestion free, charged, clean and cutting-edge. He underlined the need to use clean energy for transport as a powerful weapon against climate change, along with pollution-free clean drive. He championed the idea of clean kilometres which could be achieved through bio-fuels, electric charging and hybrid electric vehicles. The MOHUA has issued the Metro Rail Policy (2017) and Transit Oriented Development Policy (2017) which provide guidelines for promoting urban public transit with private sector participation.

As urban transport contributes nearly two-thirds of the total suspended particulate matter and 18 per cent of carbon emissions, it is time to think of sustainable modes of transit. It may be necessary to provide Integrated Transit Corridors (ITC) integrating BRT, Metro and trains together with pedestrian and cycle lanes. These can be flanked by public, semi-public, high-density developments. Metro, trains, sub-way and primary roads can run underground for easy bike and pedestrian traffic on the grade. Multi-modal integration, last mile connectivity and e-governance are the pillars of sustainable urban mobility. River/water transport and ropeways can be explored which are almost pollution free and cost-effective. Besides controlling growth of private vehicles, it is necessary to explore parking space in stilts, multi-level puzzle/ skeleton structures, on roofs and in underground spaces. Seamless multimodal public transport system comprising bus rapid transit and rail-based mass transport system would work better by adoption of single ticketing and restructuring of land uses by transit-oriented development. Subterranean garages near commuter destination reduce the need for ground parking. Digital parking meters tell mobile phone when a space opens up, reducing traffic caused by drivers trolling for space. The concept of walk to work should be the basis of urban structure and city size.

The concepts of cordon pricing, minimum occupancy vehicles, ceiling on new registration of private vehicles and establishment of a Unified Metropolitan Transport Authority can also contribute towards a sustainable and clean urban transport.

Green energy

Energy scenario in India is characterised by its increasing demand, which has been growing at the rate of about three

times the population growth rate in the last two decades. Low carbon energy can be derived from renewable sources, such as biofuels, wind, tidal and solar power. The concept of energy efficiency, renewable energy and Zero-fossil Energy Development (ZED) can reduce the energy demand and consequential pollution. The renewable energy not only helps in energy generation, but also in a pollution-free environment. Smart Micro-Grids, Distributed Energy Systems (DES), Micro-Districts and Anchor Microgrids should be linked with renewable energy network and energy efficiency.

The energy guzzling air-conditioning can be avoided by innovative methods like Net Zero Energy Design, variable refrigerant volume (VRV) system, earth air tunnel (EAT) and thermal storage. By HVAC and EAT systems inside temperature of a building can be maintained within 27 degree Celsius during summer and 19 to 24 degree Celsius during winter. Lower ambient lighting with bionic controls and integration of natural light with high performance glazing combined with light sensors can save energy use in a building. Optimum glazing design can also help to reduce glare. Synchronized lighting and bionic climate control systems can be designed to match building loads and schedules, which are segmented into multiple zones to allow intelligent controllability. Green roof, light coloured finishes and insulation can help to reduce energy demand.

Green and resilient buildings

A low carbon and green building aims to be sustainable, comfortable and net zero. The heating, lighting, cooling, ventilation, and powering of buildings are responsible for approximately 40% of the total energy use. As buildings are the largest energy users, incorporating energy storage into them will increase the resilience of the total energy distribution network and enable widespread use of renewable energy.

By passive design the building can be more climatically comfortable. It is necessary to specify building materials which are locally sourced and recycled from construction and demolition wastes, that have low embodied energy and require less energy for production and transportation to the site. Such materials include carbon-negative cements, low carbon steel, fibre The alternatives to steel reinforcement for bridges and buildings with low carbon emissions include basalt, fibre composite bars, bamboo, etc.

Building Information Models (BIM) can simulate the entire construction sequence beforehand addressing sustainability issues and reducing carbon emissions. Computer-Aided Manufacturing (CAM) and Computer Integrated Manufacturing (CIM) are useful in reducing emissions, dust and GH Gases. The simulation of construction process enables better control of time, machine, expenditure and the manpower, and could reduce carbon emissions, costs and time by half to one-third.

LIFE– lifestyle for the environment

Prime Minister Narendra Modi at COP 26 (Glasgow) has spoken of LIFE or Lifestyle for the Environment. The vision of sustainable production and consumption has to be based on mindful deliberation and utilisation, and not mindless and destructive consumption.

Low carbon lifestyle is a cluster of habits, embedded in a social context and enabled by efficient infrastructures that minimizes the use of natural resources and generation of emissions, wastes and pollution. Creating sustainable lifestyle requires a change in social norms and rethinking the ways of living based on the principles of organicity, non-accumulation (*aparigraha*), minimalism and slowing down. It is also about caring, sharing, recycling and living in balance with the natural environment. We in India have a reuse and repair culture, which needs to be promoted by provision of repair workshops in all the localities. Education, capacity building and participation of civil society are necessary to develop pragmatic and innovative practices of sustainable lifestyles.

Low carbon urban strategies can not work without involving the women, who comprise nearly half of the population and work everyday in home and on fields. However, they often face the 'gender service gap' in terms of access to energy, water, and toilets. A low carbon city has to be gender sensitive with adequate, safe and affordable spaces for living, working and vending by the women.

Conclusions

A resilient and low carbon city comprises smart and green transport, energy, water and buildings with net zero carbon emissions. It produces surplus energy from renewable sources that compensates for all carbon emissions associated with the transport, construction, industries and buildings. Net zero urban

Net zero urban development creates an environmental benefit by decarbonisation. Such a city promotes creation of jobs, urban variety, gender equity, digital planning and governance, adoption of micro-climatic design approach and intelligent services. Optimum use of land and natural resources, lifestyle for environment and new partnerships are critical elements of a resilient, low carbon habitat

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Digital twin: A promising and futuristic integrated technology for digital transformation

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With the recent evolution of Industry 4.0, Digital Twin technology has established itself as a key component of the digital transformation process. Grieves coined the term "digital twin" in 2002, primarily for its application in manufacturing industry. However, John Vickers of NASA was the first to adopt the digital twin concept for creating digital simulations of space capsules, and he presented it in 2010 roadmap report. Digital Twin is defined as a virtual representation of the physical asset, component, or piece of equipment with seamless integration of data between a physical and virtual system.

The Digital Twin (DT), in combination with enabling technologies is getting momentum in a wide range of industries. These enabling technologies are artificial intelligence (AI), the internet of things (IoT), augmented and virtual reality (AR/VR). The Digital Twin combined with IoT and data analytics is advantageous in performing predictive analysis. The application of DT can be found in healthcare, process industries, smart assets etc. Smart cities can benefit from Digital Twin technology in a variety of ways, including planning, utility distribution, and traffic control. Reformation has been noticed in construction industry too, where Digital Twin helps in property related data, operations, and maintenance information.

Oil & Gas industries are restructuring with the use of Digital Twin technology. In larger facilities or plants, the Digital Twin is an exact copy of the facility configuration. It consists of all the data and documents required to accurately describe the detailed configuration of a facility. It provides seamless integration with transactional data from computerized maintenance management system (CMMS), SAP ERP systems, real-time data from sensors, historians, and geographical location data. This integrated environment enables accurate analytics which is further used to make real-time decisions. This results in increased asset efficiency, improved business processes, increased productivity, reduced operational risk, and data-driven decision making.

To implement Digital Twin technology, industries can first learn about their current digital maturity stage through a digital maturity assessment. The digital maturity can be described in four stages across the asset lifecycle. The first stage of a Digital Twin is Project Twin, designed by engineering teams with a basic set of structured data and documents defining the facility configuration. For industries near the beginning of their digital transformation journey, this is an excellent start, empowering better decision making from more intelligent data and improving engineering-to-operations handover processes.

The second stage is connecting this intelligent data to 2D schematics, 3D models or laser scans that allows enhanced visualization and navigation. It begins to unlock the benefits of weaving engineering, operations, and maintenance information in an Operational Twin. The third stage is about interoperability. The Operational Twin's interoperability is improved in the third stage by exchanging data and giving connectivity to other information sources in the operations landscape, such as asset performance, data historian, maintenance management, and real-time data solutions.

Final and the fourth stage is where the major digital transformation business benefits will be realized, as the asset owners and operators can leverage a Digital Twin to manage value added work processes, such as human procedures, inspections, integrated safe systems of work and management of change. This ongoing stage of value addition can also include advanced analytics, artificial intelligence, machine learning and predictive and prescriptive analytics to reduce downtime.

This describes how a Digital Twin can assist a plant throughout its life cycle. Depending on digital maturity stage any industry can plan their digital journey towards using Digital Twin and can meet the data-centric way of working. To name a few, there are case studies on Digital Twin in the Power System, wind turbines, and energy modelling etc.

Numaligarh Refinery (NRL) is one of the first large-scale industry in India to adopt the Digital Twin technology, SDx from Hexagon in the year 2020, which is currently under implementation. With a project timeline of only 48 months, the Numaligarh Refinery Expansion Project (NREP) require intense collaboration among several stakeholders across multiple third-party organizations. It is a key project to support Government of India's Hydrocarbon Vision 2030 for the North-Eastern region. To accelerate this project, NRL decided to implement an Integrated Electronic Data & Document Management System (IEDDMS), a solution that would help save thousands of man hours by streamlining engineering review & approval workflows and manage its project and engineering workforce effectively during the entire project lifecycle. NRL chose Hexagon PPM's Digital Twin platform (SDx) to achieve their objective.

Rapid development of digital technologies and to survive in this digital era, companies need to transform their business architecture. We might witness more industries adopting Digital Twin in coming years.

Ordnance Survey finds its way with Altitude Angel

Altitude Angel has announced that Ordnance Survey are to incorporate its aeronautical data to its in-house survey planning platform.OS will be incorporating Altitude Angel's GuardianUTM Cloud platform into its in-house survey planning software which is used to determine whether it is suitable for their Unmanned Aerial System (UAS) team to carry out a survey using a UAS, or whether it is more appropriate for one of the OS's 230 surveyors to 'get their boots on the ground.' *www.altitudeangel.com*

World-first service letting farmers see through clouds

A world-first cloud-free imagery service that could revolutionise the way satellites are used in precision agriculture has been announced by UK technology companies Origin Digital and Aspia Space. The new 'ClearSky' service, launching imminently in the UK, feeds radar data into a deep neural network to derive the view of a field that a satellite would see if there were no clouds blocking its camera. Farmers using ClearSky are guaranteed to receive an image every 6 days showing them how their crop is developing, whatever the weather. This is in contrast to traditional, weather-dependent imagery, which can often have gaps of several weeks between cloud-free views. *https://digital.originenterprises.com*

UKHO supports maritime trade and economic growth in Belize

The UK Hydrographic Office (UKHO) has started surveying the seabed of the southern waters of Belize as part of the UK government's Commonwealth Marine Economies (CME) Programme. Following a stakeholder meeting with the Belize Port Authority and wider Belizean government in late 2019 it was agreed that the country's southern waters would be surveyed using Satellite Derived Bathymetry (SDB). SDB uses satellites to capture high resolution imagery which can then be processed to calculate seabed depths down to 40 metres, depending on the clarity of the water. This method captures large areas quickly and has no negative impact on ecosystems and marine life. Data collection and processing is expected to take several weeks and will focus on areas south of Belize City. *https://www.gov.uk*

India to have two National Centres of Excellence in Carbon Capture & Utilization

Two National Centres of Excellence in Carbon Capture and Utilization are being established in India.

The two Centres, namely the National Centre of Excellence in Carbon Capture and Utilization (NCoE-CCU) at Indian Institute of Technology (IIT) Bombay, Mumbai and the National Centre in Carbon Capture and Utilization (NCCCU) at Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru are being set up with support from the Department of Science & Technology, Govt. of India.

These CoEs will facilitate capturing & mapping of current R&D and innovation activities in the domain and also develop networks of researchers, industries and stakeholders with coordination and synergy between partnering groups and organizations. The Centres will act as multi-disciplinary, long-term research, design development, collaborative and capacity-building hubs for state-of-the-art research and application-oriented initiatives in the field of CCU. *https://dst.gov.in*

Bluesky Adds Scottish Cities to MetroVista 3D City Line-up

Bluesky International has added Edinburgh and Glasgow to its growing coverage of MetroVista 3D city models. Acquired using a state-of-the-art aerial sensor that simultaneously captures vertical and oblique imagery together with high point density LiDAR, MetroVista data is becoming increasingly popular for smart city applications. Providing a geographically accurate and detailed 3D representation of the urban environment, MetroVista data has already provided insight for a range of applications including urban design, defence and security modelling, insurance assessments and utility and telecom planning. *www.bluesky-world.com*

XMAP Cloud GIS brings government flexible working closer to home

XMAP, the local government GIS, has been developed to underpin the UK government's latest proposals for flexible working. If adopted, the initiative will give millions of workers the right to request flexible working, including remote working, from the moment they start a new position.

XMAP, a service by Geoxphere, is a native cloud-based web application that can be accessed from any, web-enabled device, without plug-ins, bolt-ons or additional installations. This ensures users working remotely on laptops or in the field using tablets or mobile phones can access the geospatial data they need when they need it. *https://xmap.geoxphere.com*

FORM IV

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I, Sanjay Malaviya, hereby declare that the particulars given above are true to the best of my knowledge and belief.

March 1, 2022 Signature of publisher

U.S. Air Force procures Orolia's CRPA testing solution

Orolia Defense & Security has been selected by the U.S. Air Force Guided Weapons Evaluation Facility to deliver a BroadSim Wavefront. BroadSim Wavefront is a pillar of innovation among Orolia's Skydel-powered advanced GNSS simulators. The GWEF provides laboratory testing and simulation tools for developing precision-guided weapon technology, including a comprehensive scope of GPS/INS systems and integrated components like sensors, signals of opportunity and Controlled Reception Pattern Antennas.

New Vega 34™ Heading and Positioning OEM Board by Hemisphere GNSS

Hemisphere GNSS (Hemisphere) has announced the fourth of the Vega™ series heading and positioning OEM board using the Lyra II™ and Aquila™ chipset technology. Integrators who use predecessor Hemisphere 34-pin products like Crescent Vector H220 and Phantom 34 OEM boards enjoy a quick and easy transition to the improved positioning performance and the superior satellite tracking abilities of the Vega series. The Vega 34 board connectors have no circuitry changes and are identical for all Vector users who can now add Atlas H10 and H30 PPP in their solutions. *www.hgnss.com*

UNSW Sydney buys nanosatellite bus

The University of New South Wales (UNSW) in Sydney, Australia, has contracted mission integrator NanoAvionics to build a nanosatellite bus for UNSW's satellite innovation laboratory. It will deliver a 6U nanosatellite bus fully assembled and tested on a functional level, ready for its research and educational purposes. Payload integration for laboratory testing, modifications, and mission operations validation will be carried out by UNSW Sydney.

The intended GNSS (global navigational satellite systems) payload named "Harry v2" will consist of two "KEA" GPS receivers, developed by the Australian Centre for Space Engineering Research at UNSW, to perform remote Earth sensing operations using GPS reflectometry. Able to host multiple experiments, it will take measurements from reflections coming from the Earth while using navigation signals from other GPS satellites. The receivers, designed for both aircraft and CubeSat operations, are capable of recording intermediate frequency (IF) data and delay Doppler maps (DDM) with its associated metadata. The experiment data can be used to infer sea-state, wind speed, water-land boundaries and many other unexplored applications. *www.nanoavionics.com*

Smartphones sold in EU now required to leverage Galileo signals

As of 17 March 2022, all smartphones placed in the European single market should be leveraging Galileo signals, in addition to other Global Navigation Satellite Systems. The addition of the EU positioning system to enhance the 112-calls location will result in faster response times and consequently, more lives saved.

The European 112-emergency number is operational in nearly all EU Member States, as well as other countries. People in danger can call it 24/7 to reach the fire brigade, medical assistance and the police.

The majority of phone calls to the 112-emergency number are placed from mobile phones. These calls already support the sending of location information to emergency services. However, this information was not based on GNSS capabilities until recently.

Three years ago, the Commission Delegated Regulation anticipated measures to get advantage of GNSS and WiFi location capabilities in smartphones placed on the European Union market from 17 March 2022 onward. This will enable smartphones to transfer caller location information from GNSS (at least Galileo) to the appropriate emergency service. *www.euspa.europa.eu*

France enlists Synchrocube's solutions when GNSS navigation signals are unusable

Syrlinks is at the initiative of this innovative offer and will provide both the payload and the ground receiver necessary to provide this service. Synchrocube brings together several innovative technologies within a single 6U nanosatellite platform. U-Space, ANYWAVES, COMAT and Syrlinks, 4 French companies specializing in NewSpace are joining forces to promote their respective skills around this project.

Synchrocube relies on a consortium of French space industry players. U-Space, as supplier of the nanosatellite platform, has a key role in this in-orbit demonstration project. ANYWAVES and COMAT are also partners in the project, each contributing their own innovative technologies. By pooling their technologies, the companies in this consortium demonstrate their ability to provide effective and competitive solutions to respond to ambitious space programs.

Today, the digital economy requires increasingly complex systems with more and more data exchanges. Synchrocube is part of this evolution by meeting the synchronization needs of telecommunication networks, energy, intelligent transport and finance by providing a precise and secure time reference.

NextNav showcases APNT backup

NextNav has recently participated in the European Commission's Joint Research Centre (JRC) alternative positioning, navigation, and timing (APNT) evaluation in Ispra, Italy. According to the JRC, the trial is analyzing the technologies "which could deliver positioning, and/or timing information, independently from GNSS, to be effective backup in the event of GNSS disruption, and if possible to be able to provide PNT in

the environments where GNSS cannot be delivered." The test furthers the European Union's creation of a backup to the GNSS, such as Galileo or GPS, and is intended to assess which technologies could strengthen and expand the European PNT capacity. *https://nextnav.com*

Exploring GNSS alternatives for weapon systems

The United Kingdom's Defence and Security Accelerator (DASA) has launched a new Market Exploration called Alternative Navigation for Weapon Systems, which aims to explore alternatives to GNSS for military navigation.

The Market Exploration is being run on behalf of Defence Equipment and Support (DE&S) and seeks to understand the range of technologies used for commercial positioning and navigation systems.

GNSS such as GPS and Galileo are widely used for commercial and military positioning and navigation, but these systems are vulnerable to jamming and spoofing. DASA wants to explore alternative navigation technologies that could be developed and trialed within the next three years.

The potential system should:

- be developed to an operational level in either a civilian or on military application
- currently be at a Technology Readiness Level of 4 or above.
- not be solely reliant on GNSS.
- have the potential to be further developed to meet military specifications.
- have sufficient accuracy to monitor position during deployment to within 5 meters.

The agency is particularly interested in innovations from non-traditional defence suppliers and has a dedicated team of DASA Innovation Partners who can discuss proposals with submitters. The deadline to submit proposals is April 7. *www.gov.uk*

Brazilian Space Agency and AWS sign statement of strategic intent

The Brazilian Space Agency and Amazon Web Services (AWS) signed a Statement of Strategic Intent and Cooperation. The initiative, on which the Brazilian Embassy in Washington also collaborated, is the first of its kind for AWS in Latin America, and will support innovation and the continued growth of the country's space industry. The Brazilian Space Agency (known as the AEB, for the Agência Espacial Brasileira in Portuguese) plays an important role in the Latin American context, as it is responsible for a wide variety of space activities related to space transport, satellites, research, and applications.

The cooperation between the AEB and AWS outlines three specific areas of collaboration designed to support the AEB's goals for long-term economic and technological development. These educational, economic, and political initiatives will benefit the Brazilian government, Brazilian commercial space organizations, and space-focused startups. *https://aws.amazon.com*

UP42 partnership with Near Space Labs

The UP42 geospatial developer platform is now offering very high-resolution, high-frequency imagery captured by balloons flying in the Earth's stratosphere. The zero-emission "Swifty" balloon fleet is operated by Near Space Labs, based in New York and Barcelona, to acquire detailed imagery that is more environmentally friendly and more affordable than traditional aircraft and satellite data. In commercial operations to date, Near Space Labs' imagery has been used to inform decision making by governments, energy utilities, insurance agencies, and conservation organizations. *https://up42.com*

Open Cosmos to launch Alisio-1 satellite for the Canary Islands

Space company Open Cosmos has been selected to design, manufacture and commission the Alisio-1 satellite.

The ALISIO-1 project (Advanced Land-Imaging Satellite for Infrared Observations), financed with funds from the recovery and resilience mechanism of the European Union – NextGenerationEU, will be executed in 13 months, and includes the design, manufacture, testing and integration of a 6U+ satellite with S-band communications and laser.

The main payload, called DRAGO-2, has been fully developed by IACTEC-Espacio, and operates in the SWIR (Short Wave InfraRed) range between 1.0 and 1.7 µm. It is an improved version of its predecessor, DRAGO-1. Its data will allow measurements to be made in the short wave range both in the Canary Islands and in other parts of the world and will allow IACTEC-Espacio to deepen its research on the different applications of this sensor. *www.open-cosmos.com*

COSMO-SkyMed Second Generation FM2 mission

Falcon 9 launched the COSMO-SkyMed Second Generation FM2 mission to low Earth orbit from Space Launch Complex 40 (SLC-40) at Cape Canaveral Space Force Station in Florida. This was the third launch and landing of this booster, which previously supported the launch of Arabsat-6A and STP-2. The Cosmo-SkyMed Second Generation program is funded by the Italian Space Agency, the Italian Ministry of Defense and the Italian Ministry of Education, Universities and Scientific Research. The system consists of two satellites, which are designed to observe Earth using synthetic aperture radar (SAR). *https://earth.esa.int*

Planet is now a Carbon neutral company

Planet Labs PBC, a leading provider of daily data and insights about Earth, announced that as of December 2021, it is officially a carbon neutral company as part of its commitment to sustainability. Planet worked with SCS Global Services (SCS to certify its operations as carbon neutral in accordance with the internationally recognized PAS

2060: 2014 Carbon Neutrality Standard. This certification covers the entire supply chain – from manufacturing and launching their satellites to all aspects of its corporate operations – for the 2020 calendar year. *www.planet.com*

10-meter resolution forest monitoring platform by TerraPulse

TerraPulse, Inc., the green technology startup that introduced the world's first high-resolution satellite map of global tree canopy cover in 2013, recently announced the company's terraView land-monitoring platform. It will now host tree canopy, deforestation, and other forest-monitoring indices at 10-meter spatial resolution from 2017 to present, allowing detection and monitoring of forest change globally at the highest spatial and temporal resolution possible to date.

Applying terraPulse's artificial intelligence (AI) to the European Space Agency's publicly available global archive of satellite images, the technology allows measurement and monitoring of natural assets from the entire globe down to individual forest stands. *https://terraplus.ca*

RIEGL'S RIPROCESS 1.9 with RIUNITE

RIEGL's project-oriented software for managing and processing RIEGLairborne, mobile and UAV-based data now makes use of the NEW RiUNITE software module. Based on a 64-bit architecture, large quantities of data can now be handled conveniently. Data processing is accelerated immensely by an improved file structure and reduced data handover. The results are given in less and smaller files.

1 hour of continuous scan data acquisition can now be processed within 1.5 hours on a state-of-the-art PC. The size of data for storage is reduced by 50-75%. Scan data adjustment can be done 3 times faster, colorization of georeferenced point clouds needs just 25% of the time that was needed before. The speed of exporting data is set to a new standard: The colorized point clouds can be exported as LAS 1.2 and 1.4 files 6x – 10x faster! *www.riegl.com*

JLR Announces Partnership With NVIDIA

Jaguar Land Rover has formed a multi-year strategic partnership with NVIDIA, the leader in artificial intelligence (AI) and computing, to jointly develop and deliver next-generation automated driving systems plus AI-enabled services and experiences for its customers.

Starting in 2025, all new Jaguar and Land Rover vehicles will be built on the NVIDIA DRIVE™ software-defined platform — delivering a wide spectrum of active safety, automated driving and parking systems as well as driver assistance systems. Inside the vehicle, the system will deliver AI features, including driver and occupant monitoring, as well as advanced visualisation of the vehicle's environment. *https://nvidianews.nvidia.com*

Baidu brings Apollo Go Robotaxi Service to Downtown Shenzhen

Baidu Apollo's ride-hailing service platform Apollo Go has launched trial operation in Shenzhen's Nanshan District, providing autonomous robotaxi services to Shenzhen commuters. Shenzhenis the seventh city where Baidu has introduced its robotaxi ride services in China.

The launch of Baidu's robotaxi services is set to drive further developments in autonomous driving in Shenzhen and accelerate the development of local intelligent connected vehicles, underscoring Baidu's continuous efforts and ambition to lead the transformation of intelligent transportation in China. *baidu.com*

Fullu integrated SoC solution for direct-to-satellite IoT connectivity

Orca Systems announced its first wireless system-on-chip (SoC) solution for the satellite Internet of Things (IoT), the ORC3990. The company, which focuses on cost-effective, low-power wireless solutions for IoT applications, designed and developed the fully integrated ORC3990 SoC to meet the demands of satellite IoT connectivity. The new SoC solution provides enabling RF technology for Totum, an innovator in IoT connectivity, enabling direct-to-satellite, indoor operation over Totum's Low Earth Orbit (LEO) network. *www.orcasystems.com*

Autoliv to collaborate with Polestar

Autoliv, Inc. has announced its intent to collaborate with Polestar in its industry-leading initiative Polestar 0. The goal is to develop a truly climate-neutral car by 2030.

The "Polestar 0" project unites companies across the automotive supply chain to leverage innovation and collaboration to address the climate crisis and change the view of how to manufacture cars in a sustainable way. The collaboration is in line with Autoliv's commitment to be the first automotive safety supplier to become carbon neutral in its own operations by 2030 and aim for net-zero emissions across its supply chain by 2040. *www.autoliv.com*

Lumen to modernize and transform USDA's IT services across

The U.S. Department of Agriculture (USDA) recently awarded Lumen Technologies a task order worth more than $1.2 billion to deliver a fully integrated wide area data transport service with secure remote access, contact center and cloud connectivity solutions to more than 9,500 USDA locations across the country and abroad.

These solutions will enable nearly 100,000 USDA employees to effectively manage vital farming, food and nutrition, forestry and rural economic development services upon which America relies.

The Lumen platform's edge computing architecture and vast fiber connectivity will help the USDA securely acquire,

analyze and act on data closer to where it is collected at the edge of the network, which reduces latency and saves bandwidth. *https://news.lumen.com*

Baraja and Tier IV collaboration

Baraja and Tier IV have announced a new collaboration to research and develop a new software-defined sensor suite combining best-in-class LiDAR and HDR cameras to enable the future of autonomous vehicles.

Joining forces in the development of this new system for the first time, the suite will bring together Baraja's leading Spectrum-Scan™ LiDAR technology with Tier IV's sensor fusion software and HDR cameras, creating a perception solution designed to provide optimal performance in the widest possible range of situations and environments for autonomous vehicles. The two companies will collaborate on building a reference unit that will form the basis of future commercial product opportunities with automotive OEMs. *https://tier4.jp/en*

NextNav partnership with CRG

NextNav has partnered with Critical Response Group (CRG). By leveraging NextNav Pinnacle, CRG will strengthen its mapping capabilities, which are relied upon by thousands of building owners and public safety agencies across the country.

CRG's mapping data combines a gridded overlay, high resolution imagery, and floor plans together into one map to provide customers and public agencies with the situational awareness needed to improve emergency response coordination and ultimately help first responders get to people in need more quickly.

The integration of the NextNav Pinnacle will strengthen existing and new building surveys with critical vertical location data, and help ensure that each building has the proper preparations and protocols in place to aid emergency response. *https://nextnav.com*

Fugro achieves Carbon Trust's highest rating

Fugro's SEAWATCH® Wind Lidar Buoy has achieved the highest commercial maturity rating, Stage 3, in accordance with the Carbon Trust Roadmap for the Commercial Acceptance of floating LiDAR technology. Fugro's floating LiDAR system is the first in the world to gain this Stage 3 rating, which certifies the SEAWATCH Wind Lidar Buoy as a primary source of wind resource data to support financial investment decisions for offshore wind farms. *www.fugro.com*

Aeva Aeries II is the world's first 4D LiDAR

Aeva has unveiled Aeries™ II, a 4D LiDAR™ sensor built with automotive grade reliability to enable the next wave of autonomy across applications in automotive, industrial and beyond. Leveraging Aeva's unique Frequency Modulated Continuous Wave (FMCW) technology and the world's first LiDAR-on-chip module design, the sensor uniquely detects the fourth dimension of instantaneous velocity for each point in addition to 3D position. Advanced 4D Perception™ software powers groundbreaking new features like 4D Localization™ and Ultra Resolution™, a camera-level image with up to 20 times the resolution of legacy LiDAR sensors. *www.aeva.ai*

Space technology in the monitoring of pigmented skin lesions

GMV and the Biomedical Research Foundation of Madrid's Hospital Universitario La Paz (FIBHULP) have launched the DALEM project, collaborating in the development and application of the transfer of space technology for the monitoring of pigmented skin lesions.

Opening up new markets for space technologies and increasing the return on investment in them is one of the objectives of the European Space Agency (ESA). To this end, it has recently opened new calls for proposals aimed at transferring space technologies to other sectors. One of these has taken the form of the DALEM project, in which the technology multinational GMV is collaborating with FIBHULP to improve early diagnosis of skin cancer.

Numerous studies show that the best way to facilitate early diagnosis of melanoma and reduce related morbidity and mortality is self-examination. Although specialists prescribe periodic check-ups and recommend self-examination, carrying out self-examination becomes more complicated if the number of lesions increases. In addition, patients' rate of use of self-examination would increase if they could use an accessible device such as a cell phone.

Nowadays, cell phone cameras have sufficient resolution and quality to record an image-based skin map in which pigmented lesions can be identified and traced. Tracking a mole using a cell phone allows a person with no clinical knowledge or special devices to locate and record the evolution of each mole on his or her body over time based on a history of images that the specialist can review at the time of a medical checkup. Thus, adequate screening as a preventive measure in people especially susceptible to developing melanoma would help early diagnosis and reduce morbidity and mortality.

The spatial navigation algorithms developed by GMV, which are based on the vision-based algorithms for the precise descent and landing of space rovers, will be applied to the cell phone-based monitoring of pigmented skin lesions. In the spatial context, so-called navigation strategies are able to match points of interest such as craters or other orographic features from a previously acquired image. This allows location tracking and determination of speed and alignment parameters with the desired landing point. *www.gmv.com*

Daily drone-based parcel delivery service in the Middle East

UVL Robotics has launched the first in the Middle East service of day-to-day parcels delivery based on drones. The payload of flying couriers is 6.6 pounds. Delivery drones are able to cover a distance of more than 25 miles. Previously, the UVL Robotics team obtained all official permits from the Civil Aviation Authority for BVLOS in the Sultanate of Oman. More than 100 air routes of delivery drones were agreed with the local clients. The project will include different modifications of the drone's landing system: ground landing, on the smart parcel locker or with a rope dropping system. It includes delivery of parcels and e-commerce packages as well as medicine for remote areas. It's already in high demand among users. *www.uvl.io*

Brazil introduces agricultural drones from XAG

A forest restoration project using XAG Agricultural Drones has been initiated in Brazil. The trial will help demonstrate the effectiveness of drone to boost forest growth, paving the way for the autonomous technology to be used in large-scale planting of Brazilian forests.

This drone seeding application is part of the Arboreto Project, carried out by the Federal University of Paraná (UFPR), Brazil's oldest university, in collaboration with Timber, XAG's local partner and a supplier of autonomous agricultural machinery. It aims to help speed up the process of forest restoration through planting tree species with commercial interest and environmental adaptation.

During the field experiment, different amounts of seeds were weighed and sorted into the smart container onboard the drone. After the pilot entered all the operation parameters into the mobile APP, such as waypoints, flight speed, and spray volume, the XAG Agricultural Drone with a spreading attachment was planned to run along target lines, evenly distributing seeds from different forest species native to the region. *www.xa.com/en*

ESA Navigation Lab showcases multi-receiver UAV

The Navigation Laboratory of the European Space Agency (ESA) has acquired an unmanned aerial vehicle (UAV) that can carry different types of satellite navigation receivers to collect data for follow-on analysis.

The NavLab, based at ESA's ESTEC technical centre in Noordwijk, the Netherlands, is focused on the testing, analysis and characterization of navigation systems for both ESA and external customers.

With UAVs representing a rapidly expanding user base, the new UAV is a timely addition to the NavLab's suite of platforms for testing GNSS technologies and techniques, ESA said. Other tools include static, mobile and pedestrian platforms and a pair of test vans. *https://technology.esa.int*

Sagetech Avionics to test detect and avoid technology with NUAIR

Sagetech Avionics Inc. and NUAIR(Northeast UAS Airspace Integration Research Alliance, Inc.) a New York based nonprofit have partnered to test Detect and Avoid (DAA) solutions and Automatic Dependent Surveillance–Broadcast (ADS-B) transponders, both developed by Sagetech. The testing to occur will be for various concepts of operations including package delivery, lateral infrastructure inspection, and other advanced operations where crewed and uncrewed aviation must safely share the same airspace. *https://nuair.org*

Import of Drones in India prohibited with exceptions

The Directorate General of Foreign Trade (DGFT) under the Ministry of Commerce and Industry, Government of India issued an order on February 9 2022, prohibiting with immediate effect the import of drones in Completely-Built-Up (CBU), Semi-knocked-down (SKD) or Completely-Knocked-down (CKD) forms. In Chapter-88 of Schedule-I (Import Policy) of ITC (HS), 2022, the Policy Condition No. 03 is revised as follows: -

Existing Policy condition No. 03	Revised Policy Condition No. 03
Import of Unmanned Aircraft System (UAS)/Unmanned Aerial Vehicle (UAVs)/ Remotely Piloted Aircraft (RPAs)/ drones is "Restricted" requiring prior clearance of the Directorate General of Civil Aviation (DGCA) and import license from DGFT. Further, import of Civil Remotely Piloted Aircraft (RPA) is governed as per the Guidelines issued by the Directorate General of Civil Aviation vide F.No.05-13/2014-AED Vol. IV dated 27th August, 2018. However, Nano category (less than or equal to 250 grams) and operating below 50ft/ 15 meters above ground level requires Equipment Type Approval (ETA) from WPC Wing, Department of Telecommunications for operating in de-licensed frequency band(s) and does not require import clearance of the Directorate General of Civil Aviation (DGCA) or import license from DGFT.	1. Import of drones in Completely-Built-Up (CBU), Semi-knocked-down (SKD) or Completely-Knocked-down (CKD) form is Prohibited, with following exceptions: - i. Import of drones by Government entities, educational institutions recognized by central or state government, government recognized R&D entities and drone manufacturers for R&D purpose shall be allowed in CBU, SKD or CKD form subject to import authorisation issued by DGFT in consultation with concerned line ministries. ii. Import of drones for defence & security purposes shall be allowed in CBU, SKD or CKD form subject to import authorisation issued by DGFT in consultation with concerned line ministries. 2. Import of drone components shall be 'Free'.

Pulse-40: First tactical grade IMU by SBG Systems

Pulse-40 Inertial Measurement Unit by SBG Systems is a tactical-grade IMU that offers unmatched performance in harsh conditions in a miniaturized size for applications where precision and robustness matter in all conditions.

The Pulse-40 is a 6 degrees of Freedom, tactical grade IMU. It integrates cutting edge MEMS three axes accelerometers and gyroscopes in a unique redundant design that allows to shrink the system size while pushing performance level to its maximum. Among the performance specifications, it features excellent gyro and accelerometer bias instability of 0.8°/h and 6µg respectively, enabling long dead reckoning and maintaining excellent heading performance.

The Pulse-40 has been designed from the ground up with reliability in mind. Thanks to a drastic selection of sensors featuring extremely low Vibration Rectification Error (VRE), the Pulse-40 is able to sustain high vibration environments, up to 10g RMS.

John Fischer receives ION's 2022 distinguished PTTI service award

The Institute of Navigation (ION) presented John Fischer, Vice President of Advanced Research and Development for Orolia, with the prestigious Distinguished PTTI Service Award during the ION ITM/PTTI 2022 Meeting on January 27 in Long Beach, Calif. The international organization recognized Fischer's pioneering research, patents, and leadership that pushed the boundaries of improving time and frequency solutions and his prominent role in increasing global awareness of positioning, navigation and timing (PNT) technology.

New Trimble Catalyst GNSS handheld accessory

The new Trimble Catalyst GNSS system handle accessory puts the power of Catalyst precision directly into a user's hand. The lightweight, ergonomic solution provides a convenient handheld way to carry out mapping and field data collection workflows. The magnetic mount can be attached to the back of a phone or tablet, snaped onto the handle after which it starts receiving accurate positions on the device in one's hand. *www.trimble.com*

Space Codesign Systems obtains ESA/NAVISP funding for spaceborne GNSS receiver

Space Codesign Systems has received funding from the European Space Agency (ESA) Navigation Innovation and Support Programme (NAVISP) Element 2, made possible thanks to the Canadian Space Agency's participation in the NAVISP. The company will use this funding to support the design of a spaceborne GNSS receiver based on mixed criticalities partitioning and targeting System-on-Chip (SoC) field programmable gate arrays (FPGA). *www.spacecodesign.com*

Applanix introduces next-generation OEM solution

Applanix has announced the Trimble® AP+ Land GNSS-inertial OEM solution for accurate and robust position and orientation for georeferencing sensors and positioning vehicles in land mobile mapping applications. It is a comprehensive solution for land vehicle applications that are small enough to easily integrate into the most compact mobile mapping systems. It is also compatible with virtually any type of mapping sensor, including single or multi-LiDAR systems, video cameras, photogrammetric and panoramic cameras and other similar sensors. *mobilemapping.applanix.com*

ViaLite adds resilience to critical GPS timing services

Timing-critical infrastructures in areas such as defense and cyber security can now be protected from this kind of attack by installing one of ViaLite's new GPS Protection Packages. The packages integrate either the GPS Resilient Kit or OtoSphereTM Protection Module products from Focus Telecom for jamming protection.

The GPS Resilient Kit has two GPS antennas, which enables the direction of the attack to be pinpointed. At its heart is the small OtoSphere Protection Module, which has a unique interference filtering algorithm that combines the patterns from the two omnidirectional antennas. *www.vialite.com*

The Inertial Labs GPS-aided Inertial Navigation System

Inertial Labs has launched a new GNSS-aided inertial navigation system. INS-DM is an IP68-rated version of the company's new generation of super ruggedized units, shielded from electromagnetic interference. The fully integrated device combines the inertial navigation system (INS) with an attitude and heading reference system (AHRS) and air data computer (ADC).

The high-performance strapdown system determines position, velocity and absolute orientation (heading, pitch and roll) for any device on which it is mounted. Horizontal and vertical position, velocity and orientation are determined with high accuracy for both motionless and dynamic applications. *http://inertiallabs.com*

Thales Alenia Space paves the way to the future satellite navigation systems

Thales Alenia Space, joint venture between Thales (67 %) and Leonardo (33 %), has announced that it has been awarded a contract by the French Space Agency CNES to develop a DFMC (Dual Frequency Multi Constellations) SBAS prototype in the frame of the next generation of SBAS, like EGNOS, the European navigation satellite system.

This prototype will complement both GPS and Galileo systems taking benefit of signals transmitted in multiple frequencies for better performances in particular dedicated to aviation navigation and landing, but also to any applications

demanding a highly reliable and a highly accurate positioning information.

When developed, this prototype will be deployed and tested in an operational mode in real condition using a geostationary satellite. The performances will be analyzed in details according to international standard criteria as accuracy, availability, continuity and service integrity. *www.thalesgroup.com*

Orbital Insight to develop technology to identify intentional GNSS disruptions

Orbital Insight, has been awarded a contract from the U.S. Department of Defense (DoD) to deliver a new technology platform for identifying intentional GNSS interference and manipulation operations across the world. The platform will leverage commercially available data to detect GNSS spoofing, where falsified or manipulated GNSS signals are used to confuse adversaries or obscure illicit activities, presenting risk to both government and commercial operations. Orbital Insight was selected through DoD's Defense Innovation Unit (DIU) solicitation process seeking commercial solutions to counter the growing threat of GNSS disruptions to national security. *www.orbitalinsight.com*

oneNav delivers pureL5TM RTL

oneNav has announced the commercial availability of its pureL5TM GNSS digital IP core. Its architecture enables it to directly acquire and track L5 signals from GPS, Galileo, BeiDou, QZSS and GLONASS without any L1 aiding. This eliminates the entire L1 RF chain, saves PCB area and simplifies the RF front end and antenna subsystem in smartphones, wearables and trackers. *www.onenav.ai*

Synzen antennas and Next Big Thing join on IoT GNSS platform

Synzen Precision Technology has teamed up with venture studio Next Big Thing AG (NBT) to produce the sensor-based LTE-M/NB-IoT development platform Prometheus which promises fast cellular IoT prototyping.

The new Prometheus platform showcases Synzen's leading expertise in LTE 4G and GNSS antenna solutions when combined with the latest Nordic nRF9160 module to provide unrivalled 4G connectivity combined with high performance and industry best GNSS positioning solutions. *www.synzen.com.tw*

CATARC Ltd selects Rohde & Schwarz's C-V2X RF automated test system

The GB/T "Technical Requirements for Vehicle Information Interaction System Based on LTE-V2X Direct Communication" is the cornerstone of the Internet of Vehicles standard system, which is being formulated by the Auto Standards Committee. The content includes the RF performance requirements and test methods of Internet of Vehicles products.

To conduct its On-Board Unit (OBU)/Road Side Unit (RSU) RF performance testing, China Automotive Technology and Research Center Co. Ltd (CATARC) has chosen Rohde & Schwarz's RF C-V2X automated test system. The system was selected because of its comprehensive coverage of Internet of Vehicles C-V2X RF test cases and overall system standard assessment capability. *rohde-schwarz.com*

MARK YOUR CALENDAR

July 2022

IGARSS 2022 (hybrid form)
17-22 July 2022
Kuala Lumpur, Malaysia
https://igarss2022.org

September 2022

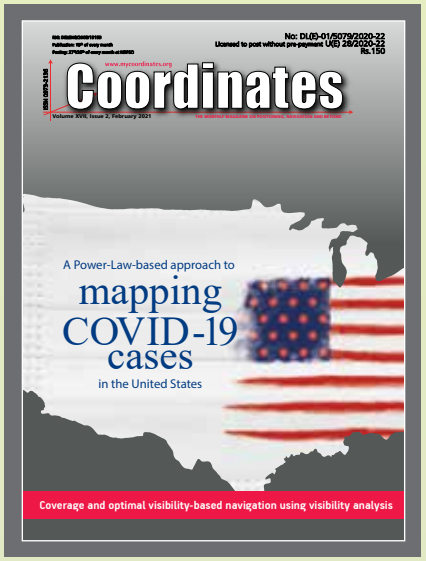
Commercial UAV Expo Americas
6-8 September 2022
Las Vegas, USA
www.expouav.com

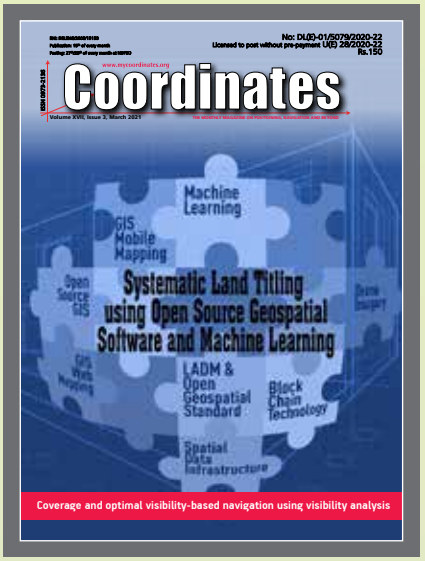
October 2022

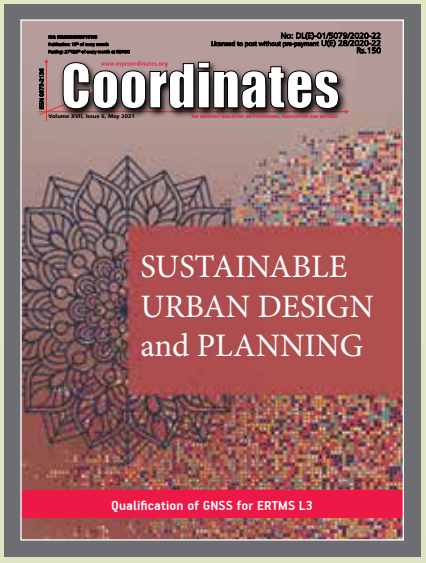
Intergeo Hybrid
18-20 October 2022
Essen, Germany
www.intergeo.de

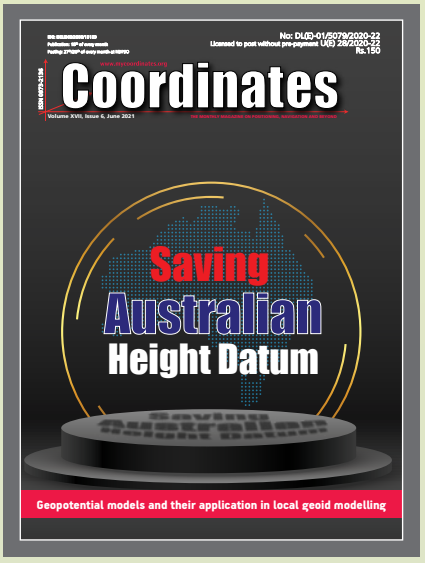
November 2022

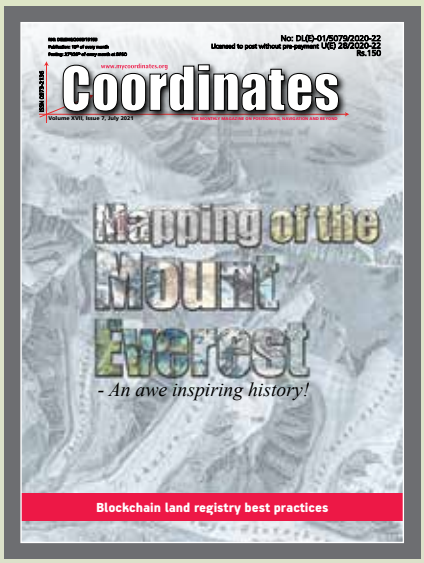
Trimble Dimensions+
7-9 November 2022
Las Vegas, USA
https://dimensions.trimble.com

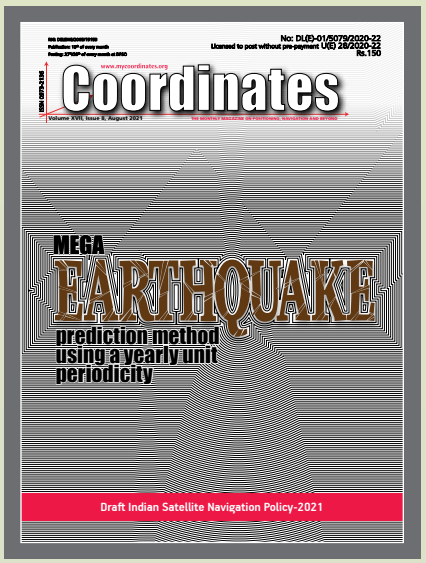


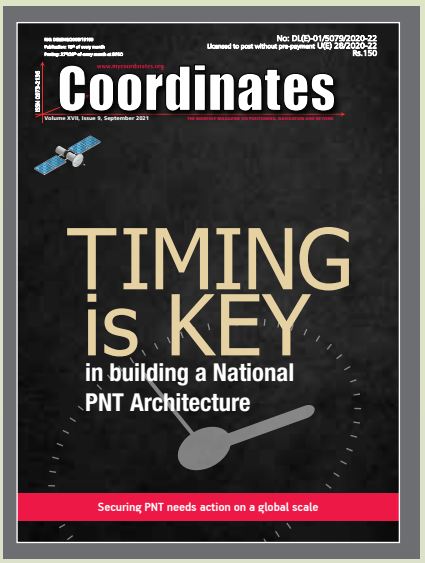












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