

**A Report on SERB/ANRF sponsored Two-Day online workshop
“Ionospheric Scintillations and its effects on Global Navigation Satellite
Systems” held at Koneru Lakshmaiah Education Foundation (KLEF),
Vaddeswaram on 27th and 28th Dec, 2024**



The **Science and Engineering Research Board (SERB)** aims to build up the best management systems that would match the best global practices in the area of promotion and funding of basic research. The **Anusandhan National Research Foundation (ANRF)** seeks to regulate all research and development in the fields of natural sciences establishments in India. It repeals the SERB Act, 2008 and dissolves the SERB. The workshop is organized by the sponsorship of SERB which aims to spread the benefits beyond the direct beneficiaries, especially to the less-endowed researchers. This approach is to integrate and align the social responsibility activities within the SERB Grantees' committed research activities.

This two-day workshop aims to provide researchers, faculty members, and Ph.D. scholars with a focused platform for in-depth exploration and discussion of the intricate relationship between Ionospheric Scintillations and GNSS technology. Around 60 Participants of various streams – Research scholars, faculties of ECE and Researchers from different institutes, colleges and universities across India and abroad have registered and participated in the workshop. The workshop has covered a variety of lectures on two days 27th and 28th December, 2024 by different national and international eminent researchers of Global Navigation Satellite Systems:

- Basic GNSS Principles and Augmentation systems
- Global/Regional Navigation Satellite Systems
- LEO satellites: Bridging the Gap in Future Navigation

- Mitigation of Ionospheric Scintillations
- Machine Learning for Forecasting of Ionospheric Scintillations
- GPS/GNSS Software Defined Receiver

Two Day workshop Schedule

Day/Session	Session 1 10.00 AM to 10.30 AM	Session 2 10.30 AM to 12.30 PM	Session 3 1.30 PM to 3.30 PM	Session 4 3.30 PM to 5.30 PM
Day 1 27.12.2024	Inauguration Ceremony	Topic: Basic GNSS Principles and Augmentation Systems Resource Person: Dr. P. Naveen Kumar	Topic: Mitigation of Ionospheric Scintillations Resource Person: Dr. P. B. Sreeharsha	Topic: Space Weather Effects on Low Latitudes Resource Person: Dr. Satya Srinivas Vemuri
Day/Session	Session 1 9.30 AM to 11.30 AM	Session 2 11.30 AM to 1.30 PM	Session 3 2.00 PM to 4.00 PM	
Day 2 28.12.2024	Topic: Ionospheric Forecasting models for Global Navigation Satellite System Users Resource Person: Dr. D. Venkata Ratnam	Topic: Global/Regional Navigation Satellite Systems Resource Person: Dr. A. Supraja Reddy	Topic: GPS/GNSS Software Defined Receiver Resource Person: Dr. Abhijit Dey	

The workshop started with welcome address of Prof. Dr. M.Suman, Vice-Principal & HOD, Dept. of ECE, KLEF, in the inaugural session. The workshop was conducted successfully by Convener, Dr.D.Venkata Ratnam, Professor & Head-Research, Dept. of ECE and Co-Convener Dr.M.Sridhar, Professor & Asst.Principal, Dept. of ECE with the support of management and in coordination with all the faculty members of ECE Department.

Dr M.Suman



Dr D.Venkata Ratnam Dr.M.Sridhar





**Dr.P.Naveen Kumar,
Director (Infrastructure)
& Professor, Department
of ECE, University
College of Engineering,
Osmania University,
Hyderabad**

In the second session of Day-1, Prof. Dr. P.Naveen Kumar, the chief guest, shared his insightful perspectives on the significance of understanding the ionospheric scintillations in the modeling of ionosphere to monitor and enhance the ease of use for GNSS researchers in the field of communications, which added immense value and deep

He has established in Osmania University, a State of the Art - an "Advanced GNSS Research Laboratory" in collaboration with ISRO, which was inaugurated by then Chairman ISRO – Shri. A.S.Kirankumar, during the centenary celebrations of Osmania University, in the year 2017.

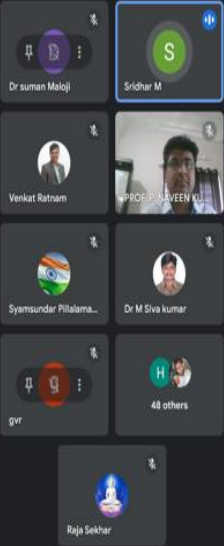
He is instrumental in establishing a New “Osmania TV”, which is the 1st university in the Country to have its own Satellite TV broadcasting Channel for transmitting its Educational content, in association with Dept. of ITE&C, Govt. of Telangana. He is the Nodal officer for several MoUs with Osmania University such as CMET (Govt. of India), OTH University Germany, SAC-ISRO, TSAT, Govt. of Telangana, etc.

Chief Guest and Key Note Speaker

Dr. P. Naveen Kumar

Director (Infrastructure) & Professor,
Department of Electronics & Communication
Engineering, University College of
Engineering, Osmania University, Hyderabad

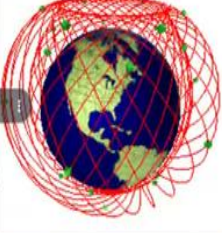




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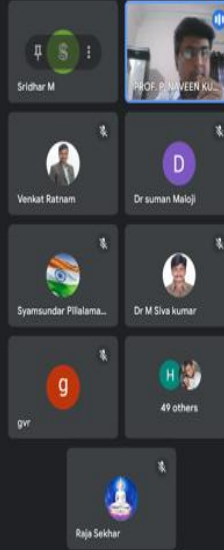
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Basic GNSS Principles and Augmentation Systems

Dr. Perumalla Naveen Kumar

Chairperson BoS(University), Professor and Nodal Officer (MoU (SRD-OU, CMET, OTH UNIV. GERMANY, TSAT))
Former Additional Controller of Exams, Former Director(CCC), Special Officer,
Department of Electronics and Communication Engineering,
University College of Engineering, Osmania University



10:19 AM | okw-pyrah-1bn

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PROF. P. NAVEEN KUMAR, OSMANIA UNIVERSITY (Presenting)

Errors on GPS Signal

① orbit error
② clock error
③ Ionospheric Delay
④ Ionospheric Scintillation
⑤ Multipath
⑥ Receiver Noise
⑦ Tropospheric Delay
⑧ Tropospheric Scintillation
⑨ Signal Masking
⑩ Jamming

<http://www.soi.wide.ad.jp/class/20050026/slides/01/61.html>

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PROF. P. NAVEEN KUMAR, OSMANIA UNIVERSITY (Presenting)

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PROF. P. NAVEEN KUMAR, OSMANIA UNIVERSITY (Presenting)

GPS Modernization

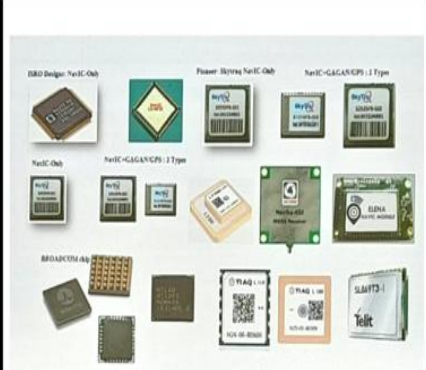
1st Generation	2nd Generation	3rd Generation
1978-2010	2005-2018	2013-2030
Block IIR	Block IIR-M, IIF	Block III
 • Adds L1C/A • First launch: Sep 1989 • 24 Satellites: 1995	 • Adds 2nd civil signal (L2C) • Adds new military code • First launch: Sep 2005 • 24 Satellites: 2012 • IIF: above capability plus • Adds 3rd civil signal (L5) • First launch: 2007 • 24 Satellites: 2015	 • Adds improved civil signal (L1C) • Increased accuracy (4.8 to 1.2m) • Evaluating integrity improvements • Navigation surety • Increased AJU power (+20 dB) • First launch: 2013 • 24 Satellites: 2021

10:58 AM | okw-pyah-ihn

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PROF. P. NAVEEN KUMAR, OSMANIA UNIVERSITY (Presenting)

GPS Modernization

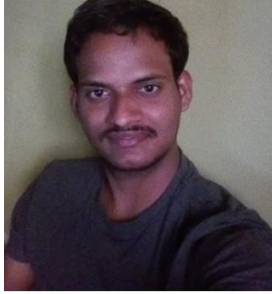


11:15 AM | okw-pyah-ihn

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People

- Lakshman Pappula
- M Lakshmana
- Maha Lakshmi T
- Mohammed Yousof
- Mutchakayala diva ganga...
- Nabanita Samanta
- You can't unmute someone else
- NAVEENKUMAR P
- parvathi p
- PELATI ALTHAF
- PROF. P. NAVEEN KUMAR...
- PROF. P. NAVEEN KUMAR... Presentation
- Rajasekhar Chukka



Dr. P. B. Sree Harsha,
Postdoctoral Researcher,
Department of Electrical and
Computer Engineering, College
of Design and Engineering,
National University of
Singapore, Singapore

In the session-3 of Day-1 Dr.P.B.Sree Harsha, currently a research fellow in MMIC Laboratory, National University of Singapore, delivered various research methods that are to be included for data assimilation methods. He also worked as a postdoctoral researcher in SONDRRA, CentraleSupélec, France. His research interests are in using data assimilation and predictive methods for radar and GNSS for space weather monitoring. Dr. Harsha demonstrated various mitigation techniques for ionospheric scintillations in detailed.

The impact of solar and geomagnetic indices on ionospheric parameters is explained in brief. Also, Kriging method is illustrated in brief to obtain semi-variograms and analyzed the TEC structural variations under Equatorial Ionization Anomaly (EIA) conditions for the severe storm St. Patrick's storm occurred during 15th- 20th March, 2015.

Ionosphere

"Ionosphere is a partially ionized, spherically stratified plasma with a wide spectrum of non-uniformly spaced irregularities, upon which is imposed a nonuniform magnetic field" (Hunsucker, 1991).

"Electrically charged (ionized) gas particles"

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Babu sree Harsha (Presenting)

Ionospheric scintillations: "Rapid fluctuation in the signal amplitude and phase"

Deep fading in the received signal strength and sudden phase jumps

Plasma instability mechanisms
Rayleigh-Taylor instability
(just after post-sunset hours)

Heavier fluid (plasma)
Lighter fluid

Equatorial Plasma Bubbles

Plane wave propagation in the ionosphere under scintillations

Ionospheric Scintillation: Solving Maxwell's equations for wave propagation under scattering regime

"Modeling ionospheric scintillations is necessary to withstand such effects on Satellite signals"

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Babu sree Harsha (Presenting)

GNSS: GPS+GLONASS+GALILEO+BEIDOU+QZSS+NAVIC

GNSS is Global Navigation Satellite Systems

- High sampling data from all the constellations
- 100+ satellite data can be recorded using GNSS receivers
- Ionospheric scintillation monitoring receivers are excellent instruments.

What it receives?

- 1) I & Q of GNSS signals
- 2) GNSS observables
- 3) Ionospheric scintillation indices

GNSS receiver and Antenna

Total Electron Content = $\int_0^h N_e ds$
Electron density: N_e

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Babu sree Harsha (Presenting)

Kriging Method:

Ionospheric ROTI and S4 maps using Kriging Method:

Model Specifications for ROTI and S4 maps:

Spatial Resolution (Geographic)	5° N - 2° N; 40° E - 65° E; 2° E; 100° E
Data	GAGAN (26 stations)
Temporal Resolution	5 minutes (ROTI) 5 minutes (S4)
Spatial Resolution	2 degrees
Semivariogram	Spherical
Condition	Geomagnetic storm condition 15 th March 2015 - 20 th March 2015

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graph TD
    GAGANData[GAGAN Data] --> ROTI[Rate of TEC]
    GAGANData --> S4[S4 values]
    ROTI --> ROTIIndex[Rate of TEC Index]
    ROTIIndex --> ROTIKriging[Applying Semivariogram Estimation And Kriging method]
    ROTIKriging --> ROTIMaps[ROTI Maps]
    S4 --> S4Kriging[Applying Semivariogram Estimation And Kriging method]
    S4Kriging --> S4Maps[S4 Maps]
  
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2:33 PM | okw-pyrah-ihn

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27-12-2024

People

- Raja Sekhar (You)
- Babu sree Harsha
- Babu sree Harsha (Presentation)
- BANDA SAI SANDEEP
- Bhavana D
- Bhuvnesh Bawar
- Devidas Kuna
- DIVYASREE UDDANDAPU
- Dr. Abhijit Dey
- Dr. Kumar Ni Ketavath



Dr. Satya Srinivas Vemuri,
Marie-Curie Postdoctoral
Researcher, Tampere
University, Finland.
, Hyderabad

The session-4 is lead by Dr.Satya Srinivas Vemuri, working as Marie Curie postdoctoral Research Fellow at Tampere University, Finland. He completed his Ph.D in Electronics and Communications Engineering with a thesis focus on GNSS signal time delay modeling from JNTU Hyderabad in 2014. This involves the use of mathematical models (Kriging, Spline, Planar fit, Modified Planar fit and anisotropic IDW) to predict and correct for the effects of the ionosphere on GPS and other satellite-based navigation signals.

With 8 years of experience in Global Navigation Satellite Systems (GNSS) technology, he is well-versed in assessing the performance of GNSS solutions. He developed techniques/strategies to mitigate the effects of various factors such as satellite geometry, atmospheric conditions, and receiver noise on the system performance.

Dr.Satya explained in detail about LEO PNT solutions to be proposed in future in ionospheric TEC modeling and various factors that affect the performance of Global Navigation Satellite System (GNSS).

The screenshot shows a Zoom meeting interface. The main window displays a presentation slide for Dr. Satya Srinivas Vemuri. The slide includes a portrait of Dr. Vemuri and text identifying him as a Marie-Curie Postdoctoral Researcher at Tampere University, Finland. To the right of the slide is a grid of participant avatars, including Dr. M.RAJANI DEVI, Sridhar M, Sampad Kumar P..., Dr. Satya Vemuri, venkataramana g..., veera kumar, syed shameem, 23 others, and Raja Sekhar. The bottom of the screen shows the Zoom toolbar with icons for mute, video, chat, and other functions. The system tray at the bottom indicates the time is 3:11 PM and the date is 27-12-2024.

The screenshot shows a Zoom meeting interface. The main window displays a presentation slide titled "SBAS concept" from Tampere University. The slide features a diagram of a satellite network and a world map showing the global coverage of SBAS systems. To the right of the slide is a grid of participant avatars, including Dr. Satya Vemuri, Sridhar M, venkataramana..., veera kumar, Sampad Kuma..., Suneetha E, 31 others, and Raja Sekhar. A "People" sidebar is open on the right, showing a list of participants and their status. The bottom of the screen shows the Zoom toolbar with icons for mute, video, chat, and other functions. The system tray at the bottom indicates the time is 3:26 PM and the date is 27-12-2024.

Dr. Satya Vemuri (Presenting)

Small Satellites Report small satellites 2023 State of the Art Small Spacecraft Technology Report - NASA

- Small satellites - less expensive, easy to launch
- SmallSats, are transforming in-space architectures in several innovative ways:
- Mass classification:

Mass Class Name	Kilograms (kg)
Femto	0.01 – 0.09
Pico	0.1 – 1
Nano	1.1 – 10
Micro	11 – 200
Mini	201 – 600
Small	601 – 1,200
Medium	1,201 – 2,500
Intermediate	2,501 – 4,200
Large	4,201 – 5,400
Heavy	5,401 – 7,000
Extra Heavy	> 7,001

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Dr. Satya Vemuri (Presenting)

Constellation Design

- Design depends primarily on mission objective.
- Constellation design follows specific pattern - Walker-Delta, heterogeneous, flower constellations
- Flower constellations: Satellites in a Flower constellation move in patterns that look like flower petals from above with repeating ground track. Not constrained to circular orbits - global, regional or spot areas services.
- Walker-Delta: Satellites are evenly distributed in multiple orbital planes, global coverage and is often used for navigation and communication satellites.
- Heterogeneous Constellation: simply means a group of satellites that are different from each other. These differences can be in their design, capabilities, or functions.

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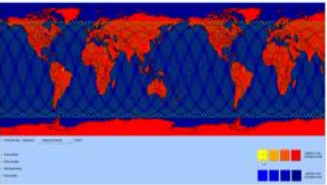
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Dr. Satya Vemuri (Presenting)

Framework LEO-navigation

Fig.2 depicts the visible satellite view, where it is evident that the marked red color on the entire map 3+ satellite visibility most of times.

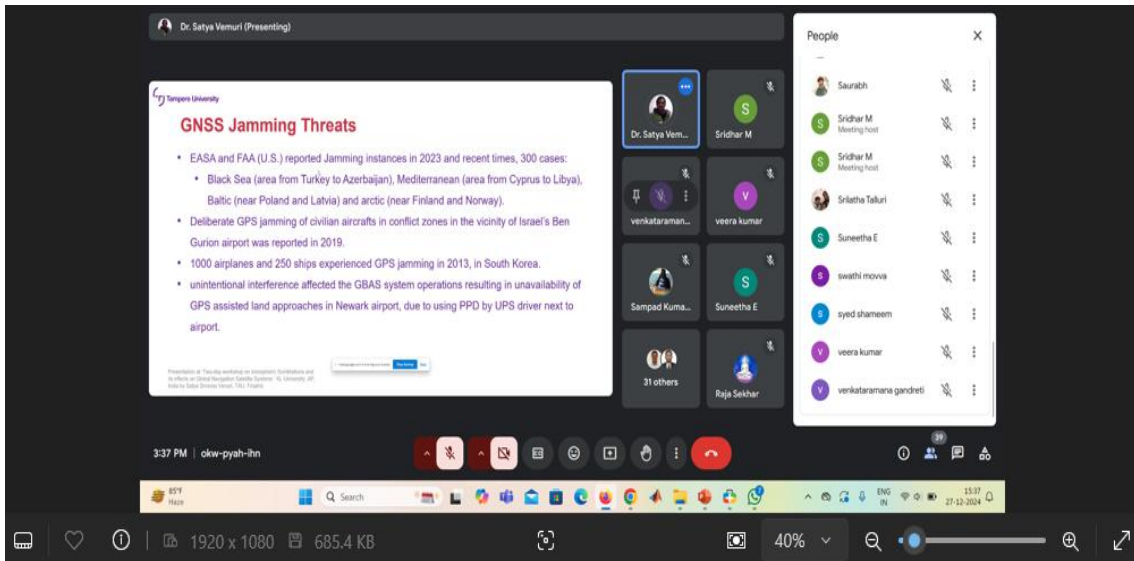
The ground trace is also depicted in green dots in the fig.



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**Dr. D. Venkata Ratnam,
Professor & Research Head,
Department of ECE, Koneru
Lakshmaiah Education
Foundation, Vaddeswaram,
Guntur**

On Day-2, the session-1 was covered with different ionospheric TEC forecasting models by an eminent researcher by Dr. D.Venkata Ratnam, Professor & Head- Research, Dept. of ECE, KLEF. Dr. Ratnam was the recipient of the Young Scientist Award (2012-2015) of the Department of Science and Technology (DST), India, and the Research Award (2015-2017) of the University Grants Commission (UGC), India and Early Career Research Award (2017-2020) from Science and Engineering Research Board (SERB), India. System.

In his research, ionospheric variability and models are investigated using ground-based Global Positioning Measurements. He has been executing four sponsored research projects related to Navigation systems from government agencies like DST, UGC, SERB, and ISRO with a research grant of more than 2 crores worth.

Dr. Ratnam established Space Technology and Atmospheric Science Laboratory at KL University and collaborated with the Asian Institute of Technology (AIT), Thailand, Nagoya University, and Space Application Centre (SAC) to carry out GNSS ionospheric Research. He is Convener of KL University student satellite project to launch

a satellite for a technology demonstration system for understanding space weather effects on communication and navigation links. He shared his vast knowledge on various machine learning (ML) models to perform TEC prediction and demonstrated extreme value analysis for estimating the likelihood of probability of occurrence of severe and rare events in near-future.

The screenshot shows a Zoom meeting in progress. The main window displays a presentation slide for Dr. D. Venkata Ratnam, who is identified as Professor & Research Head, Department of ECE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Quntur. The slide includes a portrait of Dr. Ratnam. To the right of the main window, there is a 'People' list showing participants: Sridhar M (Meeting host), Sridhar M (Presentation), Sridhar M (Meeting host), Suneetha E, Syamsunder Pillalamarri, syed inthiyaz, veera kumar, Venkat Ratnam, Venu gopala rao, and Vyoma Singh. Below the main window, the Zoom toolbar is visible, showing icons for chat, mute, video, and other controls. The system tray at the bottom shows the time as 10:06 AM and the date as 28-12-2024.

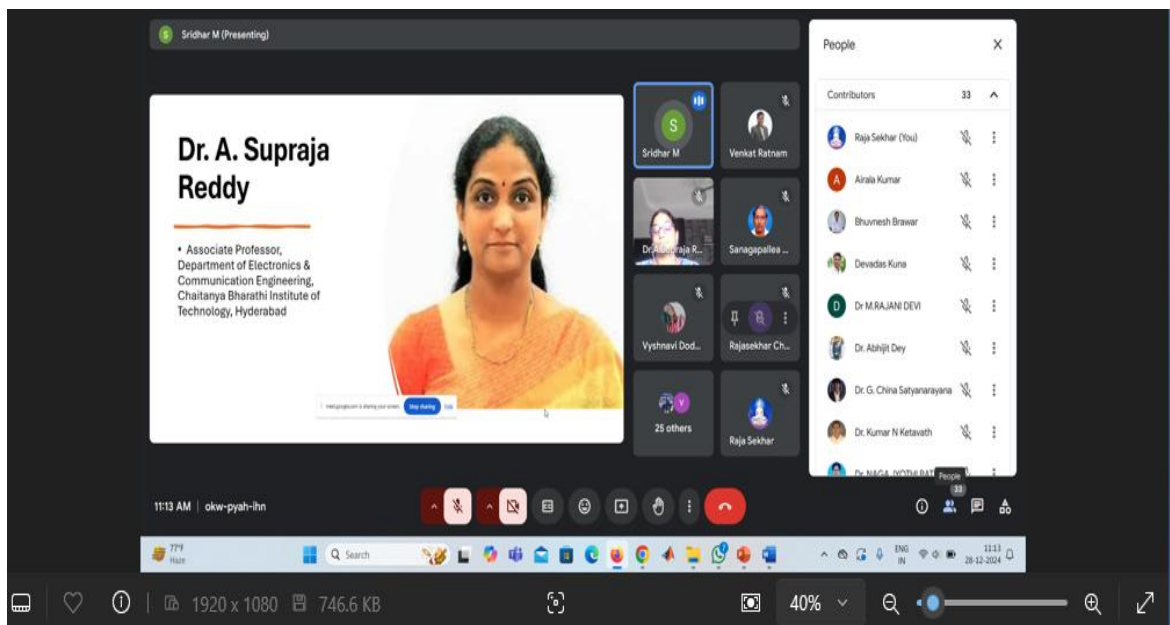
The screenshot shows a Zoom meeting in progress. The main window displays a presentation slide titled 'GAGAN and Iono Model Concept'. The slide features a diagram of the GAGAN system, which includes a satellite in orbit, ground stations, and a network of receivers. The diagram is labeled with 'GAGAN' and 'Iono Model Concept'. To the right of the main window, there is a 'People' list showing participants: Venkat Ratnam, Sridhar M, Rajasekhara Chukka, Syamsunder Pillalamarri, Sanagapalle Kot..., Vyshnavi Dadda, Dr. Kumar N Kota..., and Raja Sekhar. Below the main window, the Zoom toolbar is visible, showing icons for chat, mute, video, and other controls. The system tray at the bottom shows the time as 10:42 AM and the date as 28-12-2024.

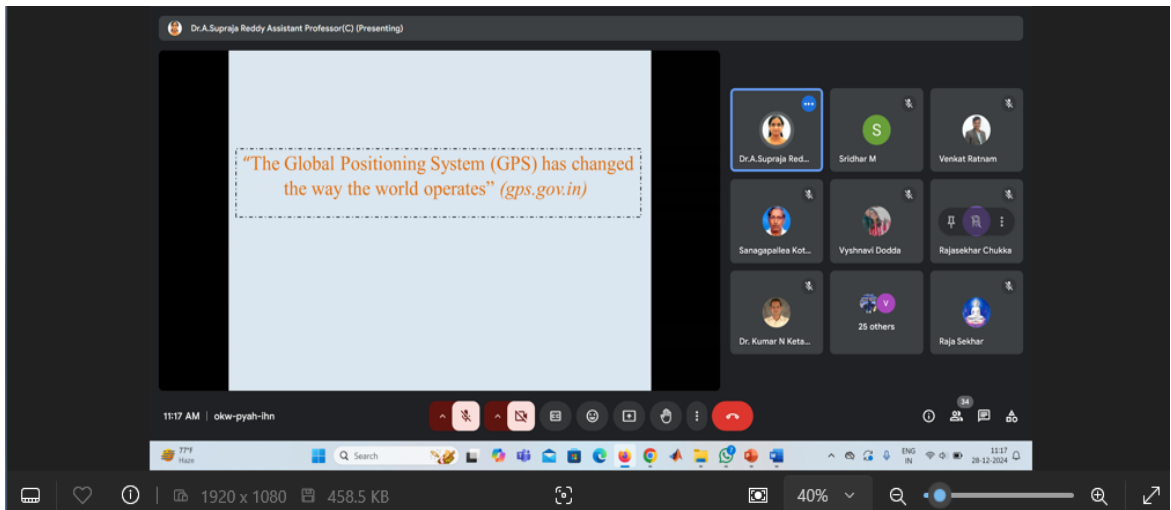


Dr. A. Supraja Reddy,
Associate Professor,
Department of Electronics &
Communication Engineering,
Chaitanya Bharathi Institute
of Technology, Hyderabad

The session-2 was continued with different Global and Regional Navigation Satellite Systems in detailed by Dr. A. Supraja Reddy, Associate Professor in the Department of Electronics and Communication Engineering, CBIT. She has published about 43 papers in reputed journals and international conferences. As the Principal Investigator of the research project sponsored by Space Applications Centre (SAC), ISRO, Ahmedabad, she has successfully completed the project with a funding is 19.34 Lacs. Currently she is the Co-Investigator of research project sponsored by SERB, DST under SURE Scheme.

She received “Best Paper” awards for her papers published in International conferences. She was invited by International Centre for Theoretical Physics (ICTP), Italy to attend a two-week workshop in April-May 2018. The trip was fully funded by ICTP. Dr. Supraja detailed about the importance of augmentation systems in Global navigation satellite systems and the affects that are to be reduced for improving the performance accuracy of satellite constellation systems in communication and navigation applications.

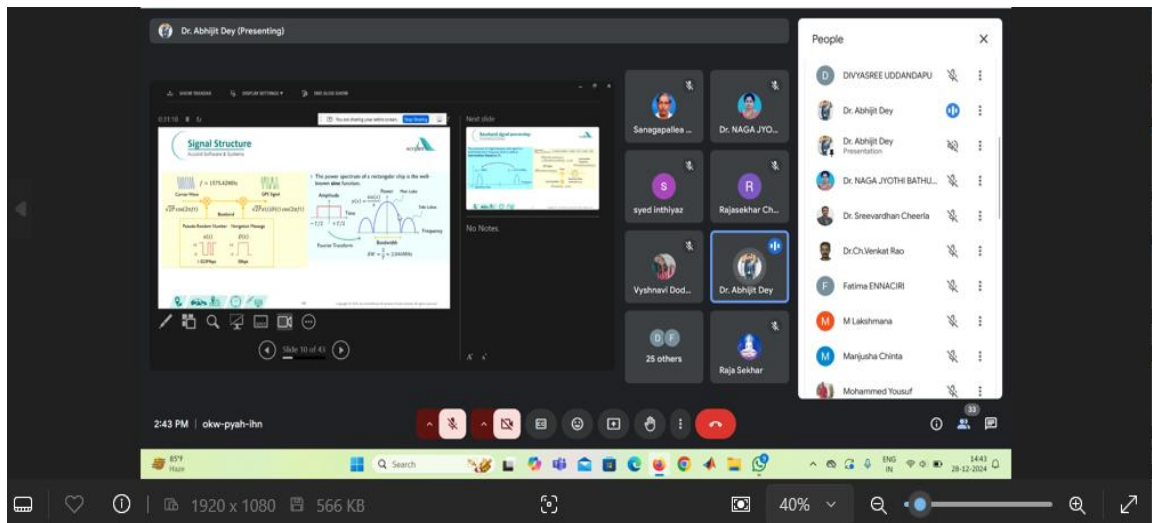
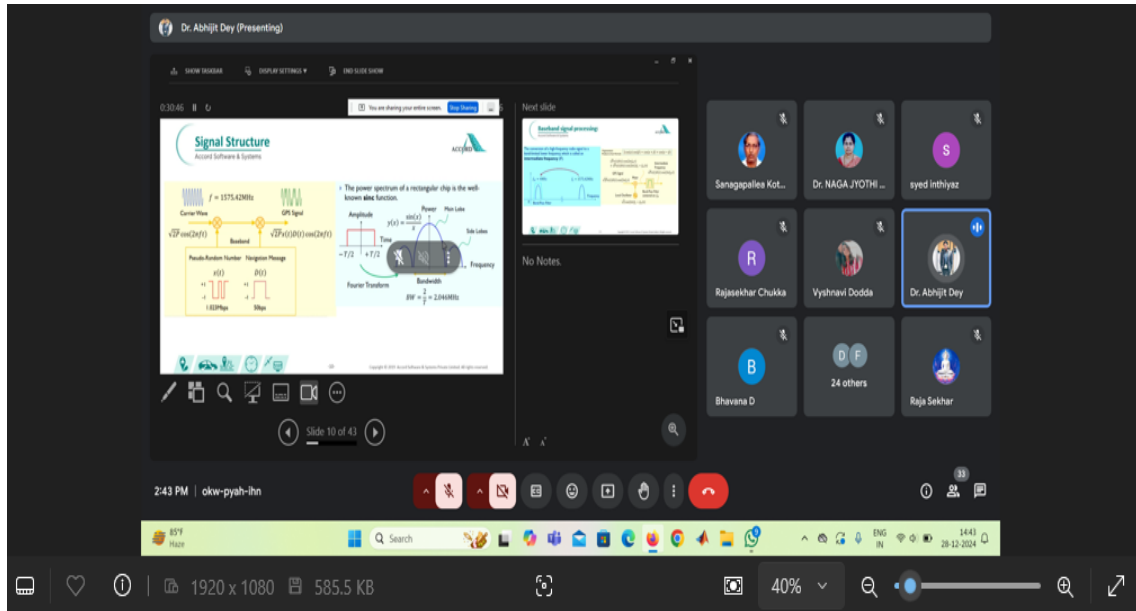




Dr. Abhijit Dey,
Senior System Engineer
(R&D), Accord Software &
Systems, Bangalore Urban,
Karnataka, India

The last session on Day-2 is handled by Dr. Abhijit Dey, Senior System Engineer with Accord Software and Systems Pvt. Ltd. He worked as a research student for one year with the National Atmospheric Research Laboratory (NARL), Department of Space, ISRO, in 2013-2014. From 2014 to 2017, he worked as an Assistant Professor at Guru Nanak University, Hyderabad. From 2017 to 2019, he worked as a Junior Research Fellow for an ISRO-funded project at BITS-Pilani.

In 2021, he was a Visiting Scholar with the Department of Aeronautical and Aviation Engineering, The Hong Kong Polytechnic University (PolyU), Hong Kong, SAR, China. Dr. Abhijit demonstrated the working and monitoring constraints for software-defined GNSS receivers in detail. He shared his knowledge on INS-GNSS integration and real-time kinematics in the navigational applications. Also, various detection methods and mitigation techniques for ionospheric scintillations in the ionospheric TEC modeling are briefly explained.



The screenshot displays a Zoom meeting in progress. The central area is occupied by a presentation slide titled "Open-Source GNSS Software Receivers" by Dr. Abhijit Dey. The slide lists several software receivers, including "Open-Source GNSS Software Receiver" and "Open-Source GNSS Software Receiver", along with their features and download links. The Zoom interface includes a top bar with the presenter's name, a right sidebar with a list of participants, and a bottom toolbar with various controls. The system tray at the bottom shows the time as 3:58 PM and the date as 28-12-2024.

