VIT®
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

School of Electronics Engineering
Innovate | Collaborate | Create Impact

SENSETRONICS

THE ECE MAGAZINE

NOV 2026

Connecting Ideas to Innovations



DEAN'S MESSAGE
Pioneering Innovation for a Smarter Tomorrow

RECOGNITIONS
Accolades that Inspire

AWARDS & ACHIEVEMENTS
Celebrating Excellence

HACKATHONS & STARTUPS
From Ideas to Impact

CREATIVE CORNER
A Space for Creativity and Expression

ELECTRONICS | COMMUNICATIONS | PHOTONICS | SIGNAL PROCESSING | EMERGING TECHNOLOGIES

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VISION

- Transforming life through excellence in education and research.



MISSION

- **World class Education:** Excellence in education, grounded in ethics and critical thinking, for improvement of life.
- **Cutting edge Research:** An innovation ecosystem to extend knowledge and solve critical problems.
- **Impactful People:** Happy, accountable, caring and effective workforce and students.
- **Rewarding Co-creations:** Active collaboration with national & international industries & universities for productivity and economic development.
- **Service to Society:** Service to the region and world through knowledge and compassion.

DEAN'S MESSAGE

Dear VITians,

Warm greetings to each member of our vibrant VIT community!
It gives me immense pleasure to share some noteworthy updates and developments from the School of Electronics Engineering (SENSE) as we continue our journey of academic excellence and innovation.
In keeping with our commitment to providing a dynamic and industry-relevant education, we have recently undertaken a comprehensive review of our academic programs. The revised curriculum aims to integrate the latest trends in electronics and communication technologies, ensuring that our students stay well ahead in the rapidly changing engineering landscape. Enhanced laboratory infrastructure, advanced electives, and experiential learning modules are being introduced to strengthen both conceptual understanding and practical expertise.
At SENSE, research and innovation remain at the core of our mission. We are proud to announce new research initiatives supported by national and international funding agencies, along with collaborative projects involving industry leaders. These endeavors will empower our faculty and students to engage in impactful research addressing real-world technological challenges.
Furthermore, to strengthen the academia–industry interface, we are expanding partnerships with prominent organizations across the globe. Through internships, industrial visits, expert talks, and collaborative projects, our students are gaining invaluable exposure to contemporary practices and emerging technologies in the professional sphere.
It is with great enthusiasm that I present our Magazine, "SENSETRONICS," for the year 2026.
This edition celebrates the remarkable achievements, milestones and contributions of our talented faculty and students, highlighting their dedication, creativity, and excellence.
I extend heartfelt appreciation to every member of the SENSE fraternity for their continuous support and contributions that make these accomplishments possible. Together, we move forward with renewed energy toward realizing the vision and mission of our institution.
Thank you, and let us continue to innovate, inspire, and impact the world through technology.

With best wishes,



Dr Jasmin Pemeena Priyadarsini M
Dean
School of Electronics Engineering (SENSE)
Vellore Institute of Technology, Vellore.

ECE ANTHEM

We are the sparks, we are the light,
Engineering dreams, reaching new heights.
Circuits and signals, shaping tomorrow,
Turning challenges into possibilities we follow.

From silicon chips to satellites above,
ECE is our passion, ECE is our love!

We are E-C-E!
The power of technology!
Connecting hearts, connecting minds,
Building a future that truly shines!

We are E-C-E!
Innovation is our identity!
Together we dream, together we rise,
ECE forever, reaching the skies

Through waves and networks, signals flow,
With AI and VLSI, new frontiers we show.
Optical fibres carry light so bright,
Wireless wonders connect day and night.

From research labs to innovations new,
We make the impossible come true!

ECE! ECE! Let the world hear our name!
Knowledge and innovation, our driving flame!
With courage, creativity and unity,
We lead the world through technology!

ECE – Connecting the World, Creating the Future!

COLLABORATIONS & OUTREACH

- INDUSTRY–ACADEMIA CONCLAVE

VIT VELLORE · SCHOOL OF ELECTRONICS ENGINEERING

Industry Academia *Conclave 2026*

Two days, sixteen events, one campus: workshops, tech talks and a hackathon that put industry practice in front of students and scholars.

16
EVENTS

3
DEPARTMENTS

822+
REPORTED PARTICIPANTS

7–8 Sep
2026 · PRE-TALK 3 SEP

Hosted by the Departments of Communication Engineering, Micro & Nanoelectronics and Sensors & Biomedical Technology. Participant counts appear only where the source reports gave them.

Communication Engineering

Radar Signal Processing with MATLAB

7 Sep · TT232 · 33 participants

Dr. Rohit Kumar (Ducom Aerospace) led a hands-on run through the full radar chain, from waveform generation to target detection: matched filtering, pulse compression and range–Doppler processing.



EVENT 1 · Radar Signal Processing with MATLAB

Modelling Advanced Photonic Devices

7 Sep · TT144 · 62 participants · hybrid

Dr. Monu Nath Baitha and Dr. Yadvendra Singh taught the Transfer Matrix Method and Fiber Bragg Grating sensor simulations. Attendees came from across India, including a BEL professional.



EVENT 2 · Modelling Advanced Photonic Devices

Secure IoT Communication with Raspberry Pi

7 Sep · PRP108 · 40 participants

Dr. Ganesh Prabhu S (Ciyes Systems) covered IP tunnelling and configuring an MQTT broker for node-to-node data exchange.

6G Innovation through EDA and System-Level Design

8 Sep · TT145 · 41 participants

Mr. Shubham Kumar Tiwary (Infinipoint) discussed 6G engineering challenges, the move from system concept to hardware, and Keysight solutions.

Integrating Fiber Broadband and 5G

8 Sep · TT144 · 61 participants

EA Facilities Pvt Ltd explained GPON/FTTH architectures, structured cabling, switching and SD-WAN, and the scalability, security and cost challenges of deployment.

Industry–Institute Faculty Interaction

8 Sep · TT144 · 9 participants

Faculty and EA Facilities explored ten collaboration areas: expert talks, internships, sponsored projects, joint R&D, curriculum input and a Centre of Excellence.

Micro & Nanoelectronics

From Silicon to Skill: VLSI and Semiconductor Design

7 Sep · TT Gallery 2 · 180 participants

Dr. Krishna Kanth Avalur (MOSart Labs) outlined emerging semiconductor trends and the skills industry expects from graduates.



EVENT 7 · From Silicon to Skill: VLSI and Semiconductor Design

From Layout Automation to Layout Intelligence

7 Sep · 200 participants

Ms. Sudarvizhi P (Qualcomm India) showed how automation and AI are reshaping IP layout development and productivity.

Sensors & Biomedical Technology

Pre-talk: Explore on Agentic Frameworks

3 Sep · MS Teams · 95 participants

Mr. Jai Ganesh Suresh (VALEO) introduced AI agents that plan, use tools and act on goals, with healthcare examples under human oversight.

Global Regulatory Strategy for Medical Device Startups

7 Sep · Ambedkar Auditorium

Er. Boopathi Sakthivel of Prasham Medical Technologies delivered the industry talk.

Electronics to Robotics

7 Sep · PRP 406

Engineers from Medtronic and Siemens Healthcare covered testing, quality assurance and the role of electronics, sensors and robotics in healthcare.

Industry Hackathon: Neural Current

7–8 Sep · PRP 405

Judged by Prasham Medical Technologies and TMI Systems, with cash awards sponsored by Ant Solutions and Food Printer Pvt Ltd.

Cybersecurity and Ethical Hacking

7–8 Sep · TT Gallery 1 · 58 participants

Mr. Ajinkya L (Ditto Security) ran a two-day lab, from footprinting to system hacking, web and wireless attacks, and DoS defence.



EVENT 13 · Cybersecurity and Ethical Hacking

AI in Healthcare

8 Sep · Ambedkar Auditorium

Mr. S. Kumar (TMI Systems) spoke on transforming medicine with AI.

AI and IoT-based Biomedical Equipment

8 Sep · Ambedkar Auditorium

Mr. Paresh Modh (Pamtronics Healthcare Devices) covered connected medical devices.

Long-Range Communication with LoRa and ESP32

8 Sep · PRP 406 · 43 participants

Mr. Saisharan Murali (Greenwave TechLabs) guided hands-on LoRa/ESP32 links for IoT, agriculture and smart-city uses.

HACKATHON AWARD

SANDISK CEREBRUM

STUDENT ACHIEVEMENTS · VLSI DESIGN

BAND4BAND • Second Place

SanDisk Cerebrum Hackathon

Team **BAND4BAND** from VLSI Design, B.Tech. ECE, VIT Vellore, secured **second place** at the SanDisk Cerebrum Hackathon. From around 1,200 teams across India, 13 teams were invited to present in Bengaluru, and BAND4BAND advanced to the final presentation.

The team comprises **Anusha Ghose** (24BEC0649), **Barath Srinivasan** (24BEC0207), **Mithilesh Makarand Angal** (24BEC0767) and **Sanika Prasad Jamkhedkar** (24BEC0657).



HACKATHON

SAEINDIA SDV 2026

SECURE CONNECTED VEHICLES · 9 OCTOBER 2026 · BANGALORE

VIT Teams Secure Top Positions at SAEINDIA Software Defined Vehicles SDV 2026 Hackathon

VIT teams secured top positions in the **SAEINDIA Software Defined Vehicles SDV 2026 Hackathon** on Secure Connected Vehicle Communication using Post Quantum Cryptography, held on 9 October 2026 in Bangalore.

Congratulations to team **VIT ASCON**, which secured **AIR Second**. The team members are **Ramya G** (25MEA0019), **Patil Rutwik Bhushan** (26MEA0013) and **Athulkrishna S** (26MES0020).

Congratulations also to team **VIT Qshield**, which secured **AIR Fourth**. The team members are **Ujwal Kumar N L** (25MES0005), **Kiran S** (26MES0005) and **Vamsi Krishna D** (26MES0049).



SPORTS ACHIEVEMENTS

2025–26 · Inter-Collegiate Honours

January–February 2026

SENSE students won medals and titles at inter-collegiate tournaments including VIBRANCE 2026 (VIT Chennai), Riviera 2026, the REVELS Cup 2026 (MIT Manipal) and the 12th LICET Tournament (Loyola–ICAM).

Student	Reg. No.	Sport	Result
Yashita Shrivastava	24BEC0194	Basketball (Women)	VIBRANCE 2026, 11–12 Feb: Bronze Riviera 2026: Winners
Thaadshayini T	25BML0057	Football (Women)	REVELS Cup 2026, 21–26 Feb: Silver Medal
Najla Zahir Hussain	25BEC0437	Volleyball (Women)	12th LICET Tournament, 8 Jan: Bronze Medal
Mekha K M	23BVD0035	Volleyball (Women)	LICET, 8 Jan: Bronze · VIBRANCE 2026: Bronze Riviera 2026: Runners-Up
Diyaa T	25BVD0138	Volleyball (Women)	LICET, 8 Jan: Bronze · VIBRANCE 2026: Bronze Riviera 2026: Runners-Up
Pranav Rajesh	24BVD0102	Cricket (Men)	Riviera 2026: Runners-Up
Soumil Patel	23BEC0189	Football (Men)	Riviera 2026: Winners
Neville Philips Jommy	22BEC0944	Football (Men)	Riviera 2026: Winners



The men's football team, Riviera 2026 winners

2026–27 · FIDE-Rated Chess Tournament

Forking Knights Academy, Jawaharlal Nehru Stadium, Chennai · 21–23 August 2026

Student	Reg. No.	Sport	Result
Lakshmanan R	23BEC0493	Chess (Men)	22nd position · cash prize ₹4,000

SPORTS ACHIEVEMENTS

SDAT Tamil Nadu Chief Minister's Trophy · District Inter-Collegiate 2026

12–17 September 2026

Student	Reg. No.	Sport	Result
Praket Rai Saxena	24BEC0690	Table Tennis, Men's Doubles	15 Sep: Gold Medal
Lakshmanan R	23BEC0493	Volleyball (Men)	15 Sep: Winners
Noel Thomas Jommy	23BEC0464	Football (Men)	15 Sep: Winners
Thaadshayini T	25BML0057	Football (Women)	17 Sep: Winner
Snehan Dutta	24BEC0626	Football (Men)	15 Sep: Runners-Up
Uttiyo Majumder	24BEC0070	Football (Men)	15 Sep: Runners-Up
Sarin V R	24BEC0460	Football (Men)	15 Sep: Runners-Up
Vansh Tyagi	23BEC0080	Football (Men)	15 Sep: Runners-Up
Ronit Aswani	25BEC0373	Basketball (Men)	15 Sep: Runners-Up
Agastya Singh	26BVD0150	Basketball (Men)	15 Sep: Runners-Up
Rahul Kumawat	25BEC0239	Cricket (Men)	15 Sep: Runners-Up
Rithaniya C	23BEC0408	Cricket (Women)	17 Sep: Runners-Up
Palak Kumawat	24BEC0686	Volleyball (Women)	17 Sep: Runners-Up
Palak Bisht	26BEC0700	Volleyball (Women)	17 Sep: Runners-Up
Mekha K M	23BVD0035	Volleyball (Women)	17 Sep: Runners-Up
Vritti Jasmin Patel	24BML0108	Swimming, 100 m Backstroke (Women)	12 Sep: Silver Medal
Parveshh Prabhu	24BEC0084	Yoga (Men)	15 Sep: Silver Medal
Praveenkumar S	23BEC0443	Kabaddi (Men)	15 Sep: Bronze Medal
Hariharan A S	24BEC0713	Yoga (Men)	15 Sep: Bronze Medal
Vismaya Kumaraswamy	26BEC0282	Badminton, Women's Doubles	17 Sep: Bronze Medal



Women's volleyball team with coaches and faculty



SENSE students at the CM Trophy 2026

SPORTS ACHIEVEMENTS

SDAT Tamil Nadu Chief Minister's Trophy · Regional Level 2026

Squash · 25 September 2026

Two SENSE squash players advanced to the regional round and returned with gold and silver medals.

Student	Reg. No.	Sport	Result
Krish Puri	24BML0045	Squash, Men's Doubles	25 Sep: Gold Medal
Krish Puri	24BML0045	Squash, Men's Singles	25 Sep: Gold Medal
Nishkarsh Kumar	26BEC0559	Squash, Men's Doubles	25 Sep: Silver Medal
Nishkarsh Kumar	26BEC0559	Squash, Men's Singles	25 Sep: Fourth Place



Squash players at the regional round

ELECTRO-SOLVE

Restoring Sustainability Through Electronics Engineering

School of Electronics Engineering (SENSE), VIT · 29 October 2026

About the event

Electro-Solve 2026 is the signature technical showcase of the School of Electronics Engineering (SENSE) at VIT. It brought together undergraduate students from all schools, along with faculty, for a full day of innovation and technical excellence on 29 October 2026. Its central theme was restoring sustainability through electronics engineering.

Project Expo and Poster Presentation

At the centre of the event was a Project Expo and Poster Presentation. Participating teams presented working models, prototypes and research across both hardware and software domains.

Date	29 October 2026
Theme	Restoring sustainability through electronics engineering
Participation	About 70 teams, comprising roughly 300 students
Shortlisted	Nearly 30 teams, for the next round (tentatively December 2026)

Why it matters

Electro-Solve gives students an interactive platform for interdisciplinary engagement, peer learning and real-world problem-solving, turning student ideas into impactful technical solutions.

Organising team

Dr. Dhanbal R, Dr. Naveen Kumar Vaegae, Dr. Naushad Manzoor Laskar, Dr. Debashish Dash, Dr. Hemant Kumar Sahu and Dr. Prabin Jose.



Participants and faculty during the Electro-Solve 2026 project expo.

STARTUPS

- VALSI ASSISTED MOBILITY

STARTUP-VALSI ASSISTED MOBILITY

VALSI Assisted Mobility

An affordable, modular, sensor-enabled paediatric walker for Indian children

VALSI Assisted Mobility is a healthcare technology startup project that is developing a low-cost, modular walker for Indian children with mobility challenges, particularly children with cerebral palsy. It brings selected features of advanced rehabilitation systems into a practical design suited to Indian families and rehabilitation centres. The planned features include height and width that adjust as the child grows, motorised mobility assistance, sensor-based movement and tilt monitoring, and rehabilitation session tracking. Because the walker is adjusted rather than replaced as the child grows, its useful life is extended.

How it began

VALSI grew out of a paediatric mobility problem statement posed by Dr. Andrea Duncan of the University of Toronto in February 2026, which highlighted the need for accessible mobility solutions for children, especially in India. Conventional walkers offer little support, while advanced robotic rehabilitation systems are expensive. The team set out to bridge that gap by combining adjustability, motor assistance and sensor-based monitoring in one practical design. With faculty guidance and support from the University of Toronto India Foundation (UTIF) and the VIT Technology Business Incubator (VIT-TBI), the project has progressed to prototype development.

Innovation and differentiation

- **Designed for Indian children:** addresses the mobility needs and everyday usage conditions of Indian children and families.
- **Growth-adjustable design:** adjustable height and width accommodate changes in a child's body over time.
- **Smart mobility assistance:** brings motor assistance and sensor-based monitoring, normally found in advanced systems, into a more accessible design.
- **Sensor-based monitoring:** uses an ESP32 and an MPU6050 IMU, with wheel encoders being integrated or evaluated for movement monitoring.
- **Safety-oriented design:** a stability-focused frame, with tilt-based safety responses being implemented and validated.
- **Rehabilitation session tracking:** plans to record session information and show progress on a monitoring dashboard.

Contribution to society

- Aims to make adaptive mobility support more accessible to Indian children with cerebral palsy and other mobility challenges.
- Adjustable dimensions can extend the useful life of the walker as a child grows.
- Provides a platform for exploring movement monitoring and rehabilitation progress tracking.
- Seeks to improve access to assistive mobility technology for families and rehabilitation settings.
- Supports inclusive mobility, independence and participation in everyday activities.

Milestones

- Project initiated in response to the University of Toronto's paediatric mobility problem statement.
- Received ₹75,000 in project funding support.
- Completed the VALSI WalkAssist V1 paediatric walker prototype.
- Obtained ethical clearance for the planned evaluation and field-trial activities.
- Preparing for field trials at Amar Seva Sangam (ASSA) and Anbu Illam, subject to the necessary permissions and arrangements.

The team

B.Tech students of Electronics and Communication Engineering (Biomedical) and Mechanical Engineering, guided by **Dr. Sharmila N**, Department of Sensor and Biomedical Technology, School of Electronics Engineering (SENSE), VIT Vellore.

Team member	Reg. No.
Iraiyanbu M	23BML0013
Shenbaga Swedha P	23BML0018
Mupli Rajesh J	23BME0051



The VALSI team with the WalkAssist V1 prototype

EMERGENT TRENDS & TECHNOLOGY

UPCOMING TECHNOLOGIES

UPCOMING TECHNOLOGIES

Intelligent Reflecting Surface-Assisted Free-Space Optical Communication: An Emerging Technology for 6G Networks

Dr. G. Aarthi
Associate Professor, Department of Communication Engineering
School of Electronics Engineering, VIT Vellore

Introduction

Free-space optical (FSO) communication sends information through the air as modulated beams of light. It offers high data rates, a large unlicensed bandwidth, low electromagnetic interference and very narrow beams. These qualities make it attractive for 6G networks, smart cities, satellite links and high-capacity wireless backhaul [1], [2].

Its main weakness is the need for a clear line-of-sight (LoS) path between transmitter and receiver. Buildings, atmospheric turbulence, fog and beam misalignment can all degrade the link.

Intelligent Reflecting Surface (IRS)-assisted FSO addresses this problem. An optical IRS is an array of engineered reflective elements that redirects an incoming beam toward the intended receiver. By controlling how the elements reflect light, the system can create an alternative optical path when the direct one is blocked, which may improve connectivity in complex urban environments [3], [4].

Working Principle

An IRS-assisted FSO system has four main parts:

- **Optical transmitter:** converts information into an optical signal and aims the beam at the surface.
- **Optical IRS:** redirects the incident light by controlling the optical response of its elements.
- **Controller:** configures the surface for the required reflection direction.
- **Optical receiver:** collects the redirected beam.

When a building blocks the direct path, the IRS can provide an alternative route, provided that suitable transmitter-to-IRS and IRS-to-receiver paths exist. Unlike a conventional active relay, a passive reflecting surface redirects the beam without full optical-to-electrical-to-optical signal regeneration.

Fig. 1 shows the working principle of an optical IRS. Fig. 2 shows a deployment in which a building obstructs the direct path while the IRS creates a reflected path between transmitter and receiver.

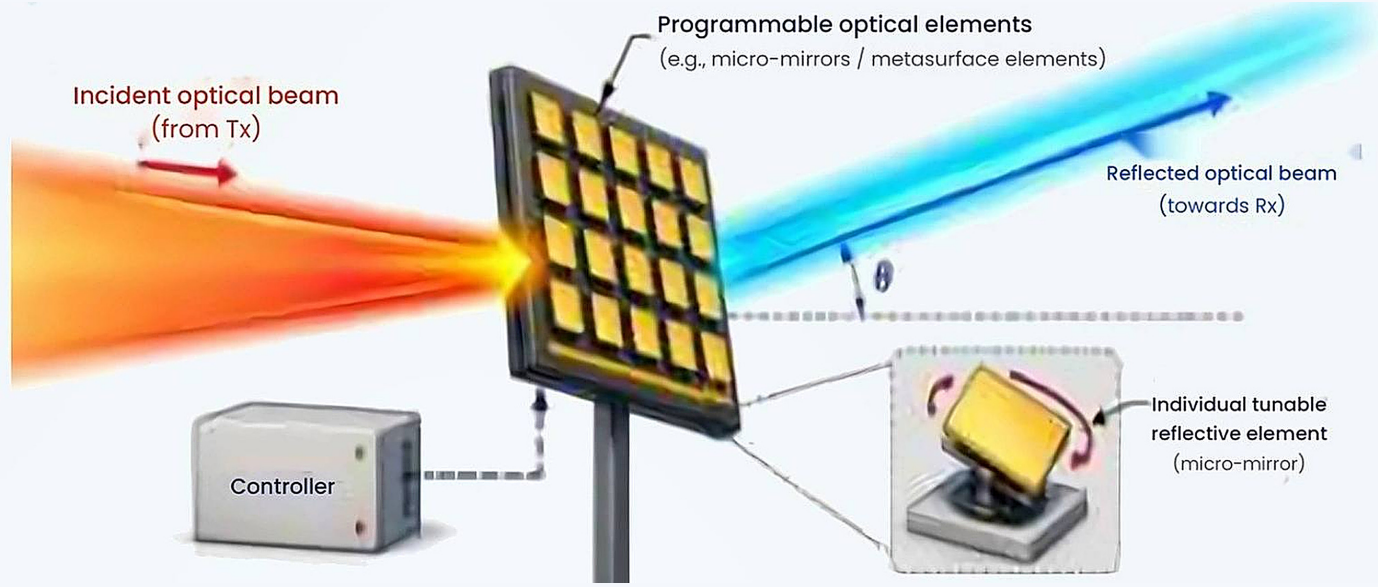

Figure 1. Working principle of an optical IRS.

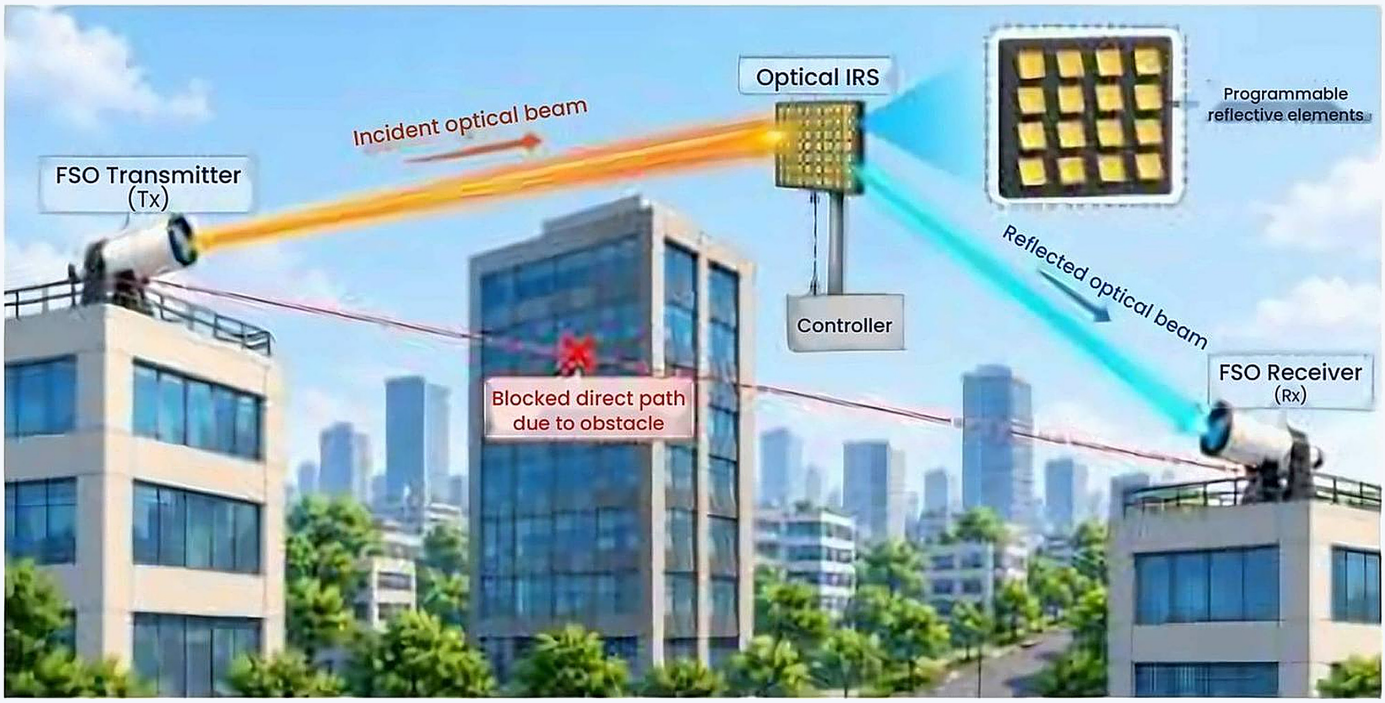

Figure 2. Conceptual illustration of an IRS-assisted FSO communication system that establishes reliable optical connectivity in obstructed environments.

Advantages

- **Improved connectivity:** creates alternative optical paths around obstacles in dense urban environments.
- **Flexible beam redirection:** the reflection characteristics can be adjusted for different receiver locations and changing network requirements.
- **Potentially lower power consumption:** passive surfaces avoid the power needs of active signal-regeneration equipment, although control electronics and optical losses must still be considered.
- **Deployment flexibility:** IRS panels can be installed on building facades, rooftops or other suitable structures.
- **Support for 6G:** IRS-assisted optical links could provide high-capacity backhaul and access connections for connected buildings, smart infrastructure and aerial platforms.

Applications

Potential applications include smart-city networks, inter-building communication, disaster-recovery networks and UAV-assisted FSO systems. For example, a UAV carrying an optical transmitter could reach a ground receiver through a suitably positioned optical IRS when no direct link is available. Fig. 3 illustrates some of these use cases.



Figure 3. IRS-assisted FSO communication for reliable optical connectivity in urban environments with obstructed line-of-sight paths.

Challenges and Future Directions

Optical beams are highly directional, so even a small alignment error can stop the reflected beam from reaching the receiver. Atmospheric turbulence, scattering and absorption affect both propagation segments. Optical IRS design must also account for reflection efficiency, element size,

phase or directional control, and the practical limits of fabricating and controlling large arrays.

Future research should focus on:

- efficient optical beam steering;
- accurate pointing, acquisition and tracking (PAT) mechanisms;
- adaptive IRS configuration;
- robust channel modelling under atmospheric turbulence and pointing errors;
- artificial intelligence and machine learning to optimise surface configurations in dynamic environments;
- combining optical IRS with UAV-based FSO systems to provide flexible and resilient links in smart cities.

Conclusion

IRS-assisted FSO communication is a promising way to extend optical wireless networks beyond conventional fixed LoS links. By intelligently redirecting optical beams, it may improve connectivity in obstructed environments and reduce dependence on active relaying infrastructure. Practical deployment still requires solutions to alignment, atmospheric propagation and reflection-efficiency challenges, but continued advances in optical surfaces and beam-control techniques could make it an important component of future 6G communication systems.

References

[1] A. Jahid, M. H. Alsharif and T. J. Hall, "A contemporary survey on free space optical communication: Potentials, technical challenges, recent advances and research direction," *Journal of Network and Computer Applications*, vol. 200, Art. no. 103311, 2022, doi: 10.1016/j.jnca.2021.103311.

[2] C.-W. Chow, "Recent advances and future perspectives in optical wireless communication, free space optical communication and sensing for 6G," *Journal of Lightwave Technology*, vol. 42, no. 11, pp. 3972–3980, 2024.

[3] V. Jamali, H. Ajam, M. Najafi, B. Schmauß, R. Schober and H. V. Poor, "Intelligent reflecting surface assisted free-space optical communications," *IEEE Communications Magazine*, vol. 59, no. 10, pp. 57–63, 2021, doi: 10.1109/MCOM.001.2100406.

[4] "Intelligent Reflecting Surfaces for Free Space Optical Communication Systems," *IEEE Transactions on Communications*, 2021, doi: 10.1109/TCOMM.2021.3084637.

UPCOMING TECHNOLOGIES

Robotic Nervous System: Toward a Body-Wide Sensory Computing Architecture

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Registration no.: 25BEC0149
Programme: Electronics and Communication Engineering
Institution: Vellore Institute of Technology, Vellore

A robot can carry thousands of sensors across its body. The real question is not only what they can measure, but where that information should be understood, and what should happen when there is no time to ask the main controller.

Picture a robot hand closing around a bottle. Sensors across the fingers and palm register pressure, shear, vibration and temperature. Cover an entire body in skin like this and the data stream becomes too much for a single processor to read properly. The problem has changed: it used to be getting a signal at all, and now it is deciding where that signal should be understood.

Sensors that think and stay quiet

The first shift was to stop treating sensors as passive endpoints. HEX-O-SKIN, developed by Philipp Mittendorfer and Gordon Cheng in 2011, used small hexagonal modules across robot surfaces. Each module combined several kinds of sensing with a local controller that could preprocess readings, route data through neighbouring modules and work around broken connections. It was not only skin; it was already a small network (Mittendorfer & Cheng, 2011).



Figure 1. A humanoid robot covered with modular tactile-sensing units. Image source: New Atlas (Quick, 2019). Photo: Astrid Eckert / Technical University of Munich (TUM).

But a smart sensor that reports everything all the time only moves the problem. Thousands of modules talking at once can still fill the wiring and overload the processor. ACES, introduced in 2019, took a different direction: it sends asynchronous pulse events on a shared conductor, so information is sent when something happens rather than on a fixed schedule. The demonstrated system had up to 240 artificial mechanoreceptors. Support for more than 10,000 sensors was an architectural claim, not a demonstrated array (Lee et al., 2019).

Event-based optical skins show the same idea in another form. One recent system watches changes inside a soft optical waveguide with an event camera. When the event stream was reduced to one out of 1,024 events, it could still localise touches, although the error grew. The lesson is not only about electronics: sometimes the useful information is much smaller than the raw sensor stream (Koolani et al., 2026).

Some things cannot wait

Think of a robot pressing its hand against something with too much force. If the sensor sends this information to the central processor, waits for it to be understood, and then waits for a command to come back, the response may arrive too late.

NRE-skin, published by Gao and colleagues in PNAS in 2025, uses a threshold the authors call pain. When the threshold is crossed, a local reflex can trigger a protective motor response without waiting for a central processor. Pain here is an engineering comparison; it does not mean the robot feels pain (Gao et al., 2025).

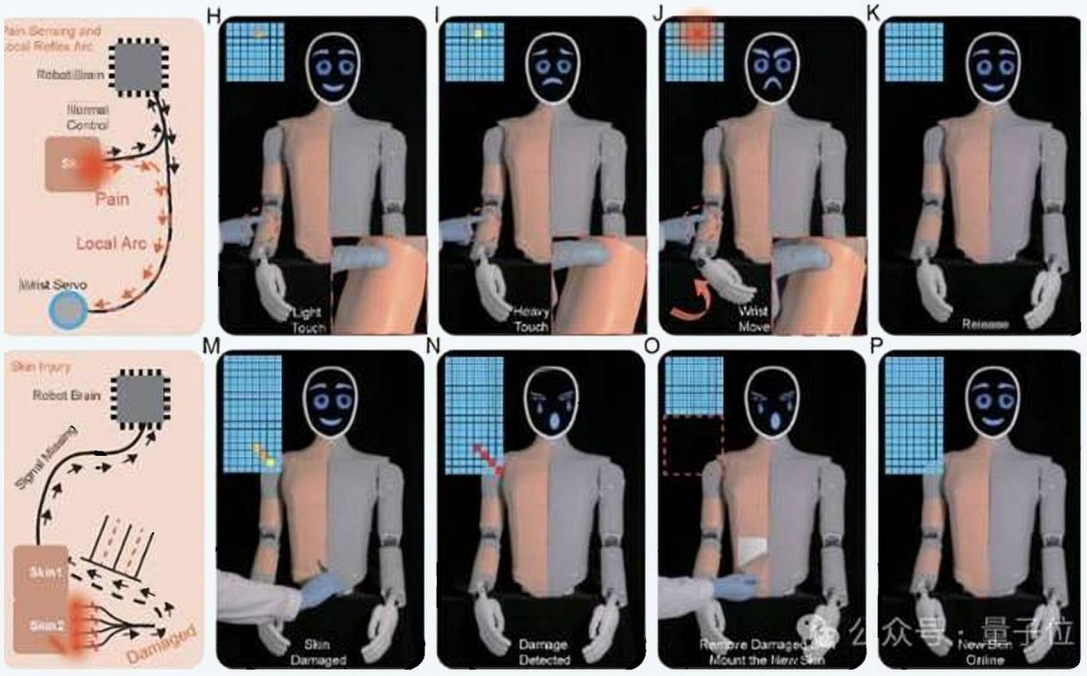

Figure 2. Neuromorphic robotic skin demonstrating protective responses and injury detection. Source: Gao et al. (2025). Image source: The Paper (QbitAI), reporting on Gao et al. (2025).

A body that knows itself

So far this is about sensing what is around the robot. A robot also needs to understand its own body: where its arm is, how it is moving, and sometimes whether a part of it has stopped working. In humans, proprioception helps us understand body position and movement, while interoception concerns internal condition. Robotics is starting to bring these ideas together.

EmArm, published in *Nature Sensors* in 2026, combines large-area tactile skin with proprioceptive sensing and a closed-loop perception-action system on a robotic arm. It is still an arm-level system, not a complete body-wide solution, but it shows why touch alone may not be enough (Tang et al., 2026).

Damage is another problem. If sensors are spread across a body, some of them will eventually fail or lose their connections. Ozaki and colleagues showed a self-rerouting sensor network for electronic skin in *Nature Communications* in 2025. After damage is detected, the network can rebuild a readout path through the remaining connections. It reroutes communication; it does not pretend that a lost sensor is still giving a reading (Ozaki et al., 2025).

How RoboCells would work

The proposed architecture has four levels, plus a separate reflex path (Figure 3).

- **RoboCell.** A small hardware and firmware node that senses, checks its own readings, makes simple features and events, reports useful changes, and can relay traffic from nearby cells. A cell could sense touch, posture or internal condition; these are roles it can have, not completely separate kinds of cell.
- **Regional processor.** One for a hand, foot or other body region. Instead of asking every sensor in a hand what it is measuring, it combines their reports and works out what is happening in that region, for example whether an object is slipping from the hand.
- **Body Sensory Interface.** Gives the central controller a common way to ask for information, receive alerts and subscribe to changes. It is kept thin on purpose and should not become another brain that understands the whole body.
- **Central controller.** Still does the planning, learning, decisions and overall control.
- **Reflex path.** A separate route that can bypass the hierarchy when a predefined protective response is needed.

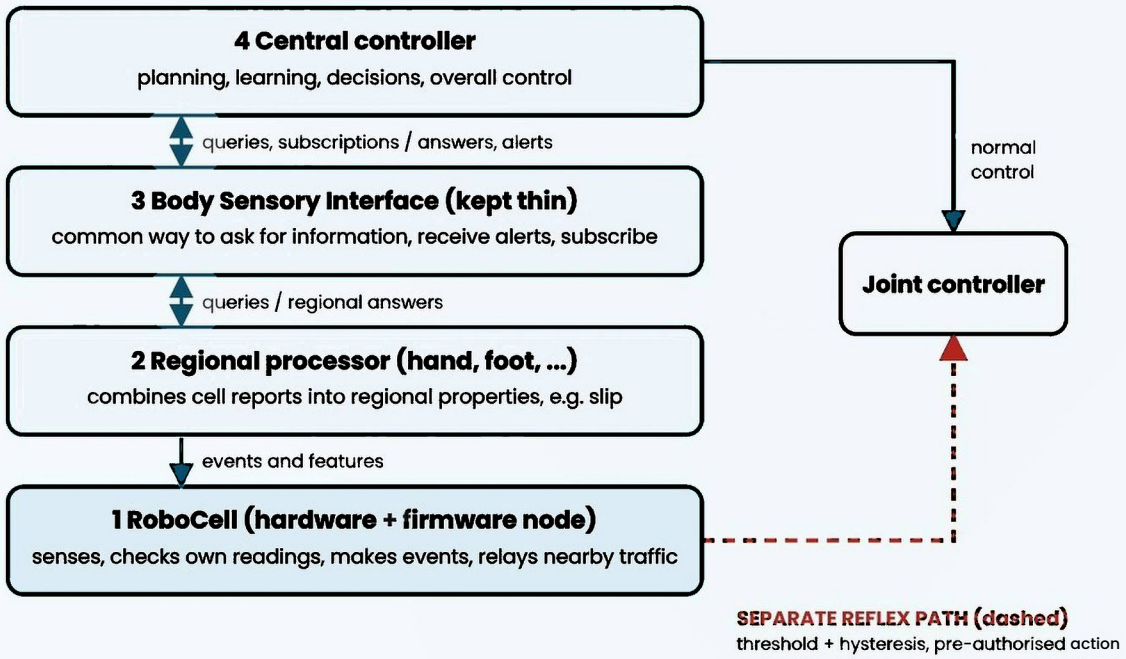

Figure 3. Proposed RoboCells architecture. This is a design proposal, not an implemented or tested system.

Back to the bottle

As the fingers close around the bottle, the RoboCells measure pressure, shear and vibration. They send changes to the regional processor in the hand, which combines the information and estimates a property called **slip**.

The central controller does not need every raw reading from every cell. It can ask whether the bottle is slipping, or subscribe to slip updates. An answer could look like this: slip is estimated at 0.72, confidence is 0.91, eight out of eight cells contributed, and the information is twelve milliseconds old. The system also keeps a record of which cells and method were used. These numbers only illustrate how the proposed interface could work; they are not results from an actual RoboCells implementation.

Now suppose one of the eight cells stops working. The system should report that only seven of eight cells contributed, and confidence may go down. If the remaining information is not enough for a useful estimate, it should say so instead of filling the gap with a made-up value. Here, confidence means the quality of the available evidence; it does not automatically mean a 91 percent chance that the estimate is correct.

What if the robot presses the bottle too hard? This is where the reflex path helps. A predefined threshold, with hysteresis so the response does not keep switching on and off, could trigger a pre-authorised action through the joint controller: stop, hold, limit torque or move back slightly. The central controller receives the alert afterwards and decides what comes next. This is a proposed form of bounded protection, not a claim that the system would be certified as safe.

More than adding sensors

Several ideas hold this architecture together:

- The controller gets useful answers instead of being flooded with raw readings.
- Each answer carries information about where it came from and how complete the evidence is.
- Different levels process information at different depths, not because any level should have more authority over the robot.
- Normal messages, urgent alerts and reflex events still have to work in the same overall system.
- When something fails, the failure itself becomes information the controller can use.

Takeaway. The next step in robotics is not simply adding more sensors to a robot body. More sensors can give more information, but that does not automatically make a robot better at understanding what is happening. What matters is how that information is processed, how quickly the robot can respond, and whether it knows when its own information is incomplete.

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UPCOMING TECHNOLOGIES

Native 6G Networks: From Intelligent Resource Allocation to Autonomous Communication

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Introduction

Wireless communication has changed how people interact, work and access information. Every generation, from voice calls in 1G to high-speed mobile broadband in 5G, has introduced new capabilities. As connected devices, intelligent applications and data-intensive services keep growing, researchers are exploring the next generation: 6G, also known as IMT-2030.

Conventional systems focus mainly on transmitting data. Future 6G networks are envisioned to integrate communication, computing, sensing and artificial intelligence (AI). One promising direction is the **AI-native network**, in which AI is built into network design and operation rather than used only as an extra optimisation tool.

The need is real. Networks are becoming far more complex, with billions of connected devices, many frequency bands, satellites and drones, and services that each demand different speeds and levels of reliability. Managing all of this with hand-written rules is becoming impractical, so researchers and industry are turning to networks that can learn and adapt by themselves.

From AI-Assisted to AI-Native Networks

AI-native 6G networks are designed to use AI and machine learning (ML) throughout network operation. These technologies can help a network learn from changing conditions, predict future demand, make decisions and adapt its behaviour.

In conventional networks, many operations rely on predefined rules and fixed configurations. These approaches work well in many situations, but rapidly changing traffic, mobility, interference and device requirements make network management increasingly complex. AI-native networks aim to address this by learning from network data and adapting to changing environments.

AI-native communication does not mean using only chatbots or large language models. It also includes machine learning, deep learning, reinforcement learning and other AI techniques that support network control, prediction and optimisation, as shown in Fig. 1.

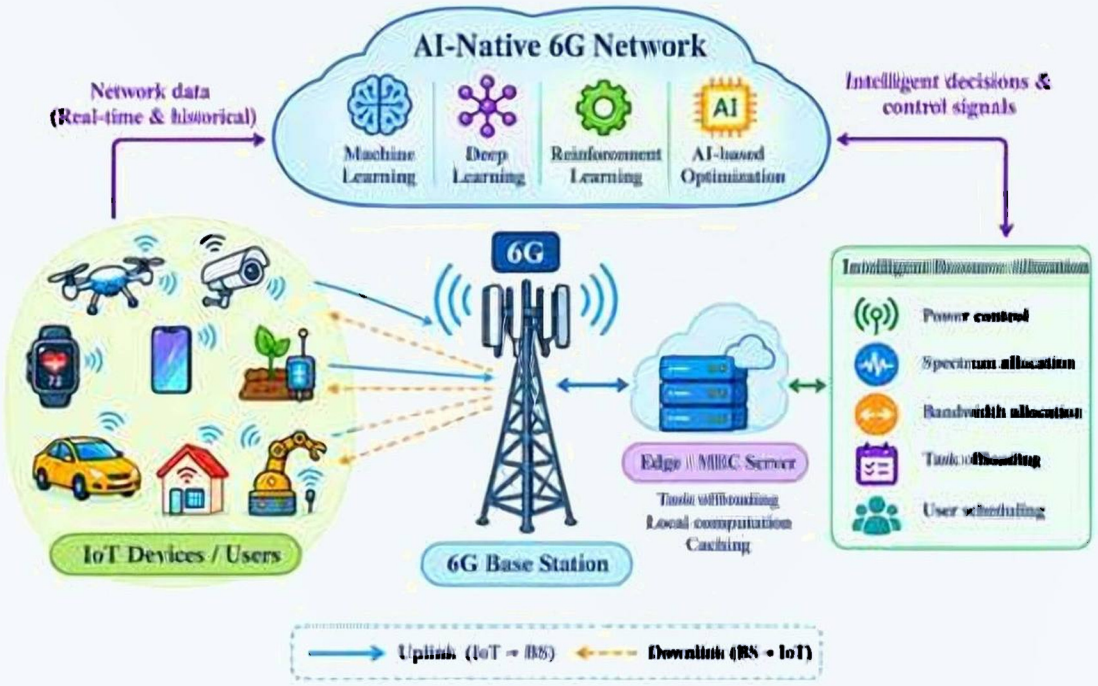

Figure 1. AI-native 6G network architecture.

Intelligent Resource Allocation: Making Every Resource Count

Distributing wireless resources efficiently among users and devices is essential for reliable, energy-efficient communication. AI algorithms can analyse channel quality, user mobility, traffic demand and energy availability to allocate resources dynamically. Once trained, such models can make allocation decisions far faster than traditional optimisation methods.

For example, in a network with many Internet of Things (IoT) devices, an AI-based controller could give more resources to devices that need urgent data transmission, while reducing unnecessary energy use for less demanding devices. Reinforcement learning can also help a network learn good allocation decisions through feedback and reward signals.

AI-assisted resource allocation has the potential to:

- improve spectrum utilisation;
- reduce interference;
- balance network traffic;
- support low-latency services.

The actual benefits, however, depend on the network environment, algorithm design, available data and implementation constraints.

Toward Autonomous Communication

The next step is to move beyond individual intelligent decisions toward autonomous communication networks. Such networks aim to monitor their environment, identify problems,

select appropriate actions and keep improving their performance with minimal human intervention. The process can be understood as four stages:

1. **Sense:** collect information about channel conditions, network traffic, device mobility and energy consumption.
2. **Analyse:** use AI models to identify patterns, predict demand and detect possible network problems.
3. **Decide:** select actions such as adjusting transmission power, allocating bandwidth, changing computing resources or rerouting traffic.
4. **Act and learn:** apply the chosen actions, evaluate the results and update future decisions.

Industry roadmaps and research surveys describe AI/ML-supported network functions that could enable self-monitoring, self-organisation, self-optimisation and self-healing to some extent. Fully autonomous operation, however, remains a development goal rather than a universal capability of today's networks.

Conclusion and Future Scope

Despite its promise, AI-native 6G faces important challenges. AI models consume computing power and energy that must be weighed against the sustainability goals of 6G. Network data raises privacy and security risks. Automated decisions must also be trustworthy, explainable and reliable under unfamiliar conditions.

For researchers, this opens several promising directions:

- learning models that generalise to new environments with little retraining;
- explainable AI with provable performance guarantees;
- lightweight, energy-aware learning algorithms;
- semantic and task-oriented communication theory;
- joint sensing and communication design;
- open datasets for reproducible evaluation.

> **Looking ahead.** If these challenges are addressed, integrating AI into network design, resource management and operational control could make future networks more adaptive and efficient, supporting smarter cities, connected industries, advanced healthcare and large-scale IoT applications.

UPCOMING TECHNOLOGIES

Non-Terrestrial Networks and LEO Satellites: An Integrated Architecture for Future 5G-Advanced and 6G Wireless Communication

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Introduction and Network Architecture

Non-Terrestrial Networks (NTNs) extend wireless access beyond conventional ground-based cellular infrastructure by integrating satellites, high-altitude platform stations (HAPS) and terrestrial 5G/6G networks.

Low-Earth-orbit (LEO) satellites, typically at roughly 300–1,500 km altitude, are especially attractive. Their shorter propagation distance compared with geostationary satellites can reduce latency, and large constellations provide broad, resilient coverage. NTN is not meant to replace terrestrial networks. It complements them by providing service continuity in rural and remote areas, at sea, during disasters, and for moving users such as aircraft and vehicles [1–3].

The reference architecture combines three segments:

- **Space segment:** a LEO constellation and inter-satellite links (ISLs), with either transparent payloads that relay radio signals or regenerative payloads that perform some baseband processing and routing onboard.
- **Air segment:** may include HAPS to bridge coverage gaps or provide temporary capacity.
- **Ground segment:** satellite gateways, 5G/6G radio access networks (RANs), core-network functions, cloud/edge platforms and user equipment (UE) such as smartphones, IoT sensors, ships and aircraft.

A **service link** connects the UE to a satellite; a **feeder link** connects the satellite to a gateway. Optical ISLs can move traffic between satellites without routing every packet through a ground station, which can improve path diversity and reduce dependence on gateway visibility [1], [2].

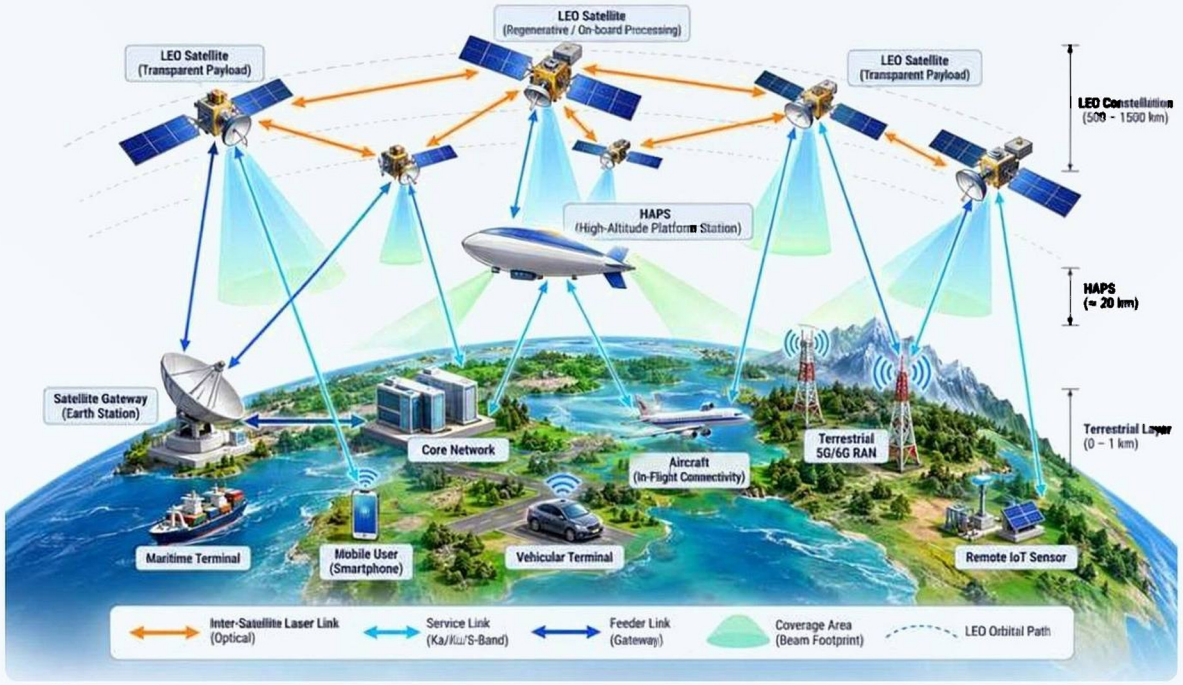

Figure 1. Reference NTN–LEO architecture showing the space, aerial, gateway and core-network segments.

Figure 1 shows the system architecture. It should be understood as a multi-layer network (Figure 2): control and user-plane functions may remain on the ground or be distributed toward satellites, depending on payload capability, latency targets and operational constraints. Interoperability with terrestrial 5G/6G core functions enables mobility management, authentication, policy control and service continuity across terrestrial and non-terrestrial access.

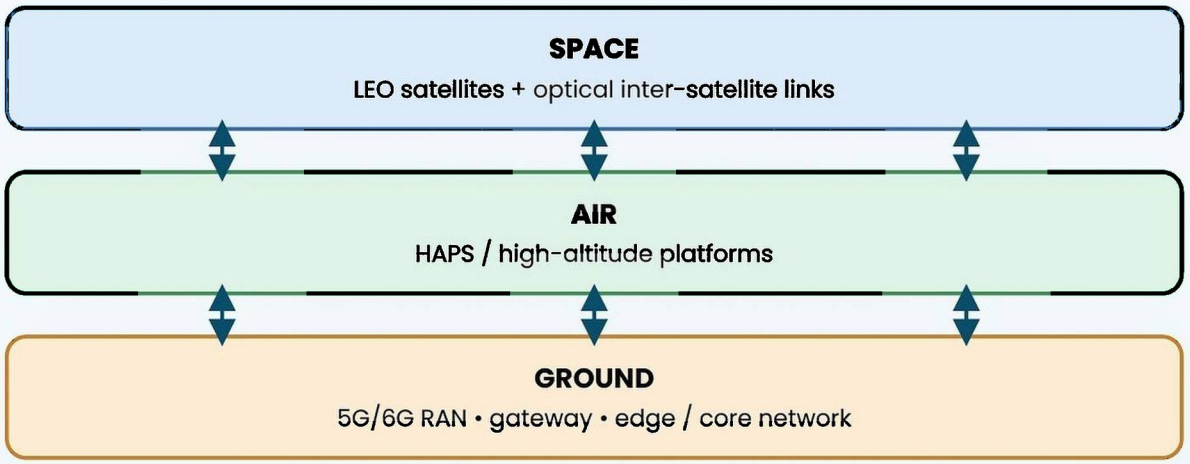

Figure 2. Multi-layer NTN access for resilient 6G services.

Enabling Technologies and Future Applications

Several technologies are central to practical NTN deployment:

- **Phased-array antennas and multi-beam beamforming** improve link budgets and spatial reuse.
- **Adaptive coding and modulation** respond to changing link quality.
- **Doppler pre-compensation and timing-advance procedures** handle satellite motion and long propagation paths.
- **Optical ISLs** support inter-satellite routing.
- **Software-defined networking, network slicing, edge computing and AI-assisted orchestration** allocate resources according to traffic demand and link availability.

Integrated sensing and communication, direct-to-device satellite connectivity and satellite support for massive IoT are promising directions for future systems [2–5].

Key Design Challenges

- large, time-varying Doppler shifts;
- handovers between fast-moving satellites;
- intermittent gateway visibility;
- weather and atmospheric attenuation at high frequencies;
- limited onboard power;
- spectrum sharing;
- cybersecurity;
- the cost of user terminals.

Future networks will need predictive handover based on satellite ephemeris (Figure 3), resilient routing, multi-connectivity across terrestrial and satellite links, and energy-aware scheduling. For time-critical applications, edge processing and regenerative payloads can reduce dependence on distant ground infrastructure, although onboard processing increases satellite complexity and power consumption.

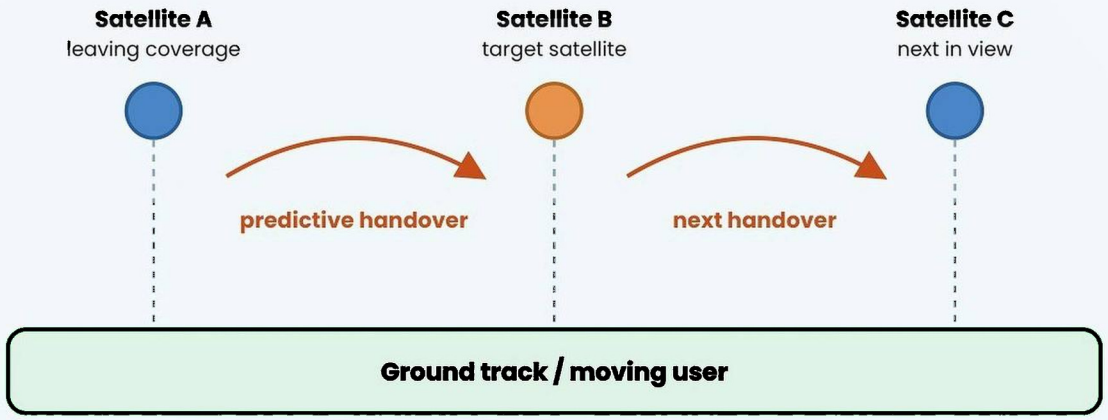

Figure 3. LEO mobility: coverage changes as satellites move rapidly across the sky, so handover must be predicted in advance.

Fundamental Link and Performance Relations

The link performance of an NTN can be described with a few **fundamental relations.**

Free-space path loss, where f_{GHz} is the carrier frequency in gigahertz and d_{km} is the link distance in kilometres:

$$L_{FS}\,(\text{dB}) = 92.45 + 20\log_{10}(f_{GHz}) + 20\log_{10}(d_{km})$$

One-way propagation delay, where d is the propagation distance and c is the speed of light:

$$\tau = d / c$$

Doppler shift caused by radial relative motion, where v_r is the radial relative velocity and f_c is the carrier frequency:

$$f_D = (v_r / c)\, f_c$$

Received signal-to-noise ratio and the ideal **Shannon channel-capacity bound**, where P_r is received power, N_0 is noise power spectral density and B is bandwidth:

$$SNR = P_r / (N_0 B) \qquad C = B\log_2(1 + SNR)$$

Together, these relations explain how distance and frequency affect link loss, the propagation delay of satellite links, the need for Doppler compensation, and the theoretical upper bound on data rate. The Shannon expression is an ideal limit, not a guaranteed user rate.

NTN Applications and 5G·6G Integration

NTNs extend coverage where terrestrial infrastructure is limited or temporarily disrupted.
They complement terrestrial 5G to support reliable service across diverse environments.

Emerging Applications

- **Remote connectivity**
  Broadband for rural, island and mountain areas.
- **Mobility**
  Coverage for aircraft, ships and connected vehicles.
- **Resilience**
  Emergency links when terrestrial networks fail.
- **Massive IoT**
  Support for agriculture and environmental monitoring.

5G-Advanced and 6G

- **Multi-connectivity**
  Combine terrestrial and satellite links for continuity.
- **Intelligent handover**
  Predict handovers from satellite position and link quality.
- **Edge computing**
  Process delay-sensitive data near users and devices.
- **AI orchestration**
  Adapt routing and resources to traffic and link status.

Design takeaway

Seamless NTN performance depends on coordinated mobility, reliable links, spectrum sharing and secure integration with terrestrial network control and core functions.

Conclusion

NTNs integrated with LEO satellite constellations offer a practical way to extend 5G-Advanced and future 6G connectivity beyond the reach of terrestrial networks. By combining satellite service links, feeder links, inter-satellite links, HAPS, terrestrial RANs and core or edge infrastructure, the architecture can support remote communities, maritime and aeronautical users, mobile platforms and large-scale IoT deployments.

Realising these benefits requires careful management of Doppler shift, propagation delay, satellite handover, gateway visibility, spectrum coexistence, onboard energy and network security. Beamforming, adaptive transmission, predictive mobility management, optical inter-satellite links, regenerative payloads and AI-assisted orchestration can help. Ultimately, close integration between non-terrestrial and terrestrial network functions will be essential for delivering reliable, resilient and more ubiquitous wireless services in the 5G-Advanced-to-6G evolution.

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CREATIVE CORNER

- POEMS
- MINI MYSTERIES

POEMS

Signals I Should Have Detected



I learned to read waveforms,
To trace each signal to its source,
To filter noise and find the truth,
To understand a circuit's course.

Yet when you said, "I'm fine,"
I missed the noise beneath the line.
Your signals flickered, clear as day,
But I was busy looking away.

Some signals need no oscilloscope,
Just less resistance, more hope.
For some things lost won't reappear,
No reset switch can bring them near.

When the Earth Breathes



The morning sun spills gold on green,
And paints the world in shades unseen.
The flowers wake, the rivers gleam,
The world unfolds a waking dream.

The trees stand tall, the birds take flight,
The oceans shimmer in the light.
The mountains touch the skies above,
And every breeze speaks words of love.

Yet we rush past this world so grand,
Too busy building, brick by hand.
Let us protect what keeps us whole,
For nature is the Earth's very soul.

1 LIFE IN BINARY 0



The world would be so simple then,
A yes or no, a one or zero,
No second thoughts, no might-have-beens,
No fear of being someone's hero.

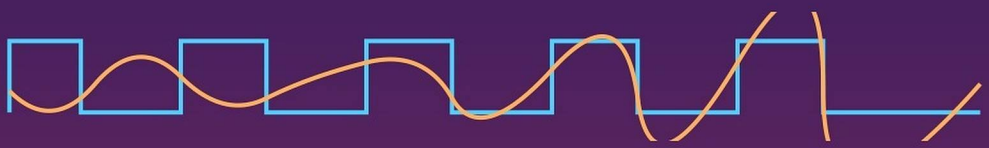
A zero for the days we lost,
A one for every dream pursued,
No shades of grey, no lines crossed,
No complicated gratitude.

But where would all our doubts belong?
The almost-right, the nearly-true?
The times we knew we'd done things wrong,
Yet found a better way to do?

For love isn't a bit that's set,
And grief can't fit in memory.
The things we wish we could forget
Still shape the ones we're meant to be.

So let the world run on its code,
Let logic rule the digital sea.
I'll take the messy, winding road,
For life is more than 0 and 1.

It's everything between the two,
The things no code can quite define,
And all the ways we make them true.



MINI-MYSTERIES

Case 01: The lab that lied

At 7:00 PM, a prototype circuit was working perfectly. By 8:00 PM, it had stopped functioning, and a confidential design file had disappeared from the lab computer.

Only three students had access to the lab.



Aarav *"I left at 7:15 PM. The circuit was working when I left."*

Diya *"I arrived at 7:30 PM. The circuit was already dead, so I never touched it."*

Kabir *"I was there from 7:45 PM to 8:00 PM, but I only used the computer."*

The lab's digital log revealed three facts:

1. The circuit's power supply was switched off at 7:40 PM.
2. The design file was copied to a USB drive at 7:50 PM.
3. The computer recorded a login at 7:50 PM using Diya's account.

Diya insists she never logged in that evening. Kabir claims he never touched a USB drive.

The question:

Who is the most suspicious, and what can you actually conclude from the evidence?

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