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K.S.R. COLLEGE OF ENGINEERING

ELECTRONICS AND COMMUNICATION ENGINEERING

MAGAZINE

TRONIX

K.S.R. COLLEGE OF ENGINEERING

An Autonomous Institution

(Approved by AICTE, Affiliated to Anna University, Accredited by NAAC (A+))

K.S.R. Kalvi Nagar, Tiruchengode – 637 215, Namakkal District, Tamil Nadu

DEPARTMENT OF ELETRONICS AND COMMUNICATION ENGINEERING

TRONIX

TECHNICAL MAGAZINE

ACADEMIC YEAR 2025-2026

Vision and Mission of Institution

Vision

To become a globally renowned institution in Engineering and Management, committed to providing holistic education that fosters research, innovation and sustainable development.

Mission

IM1 Deliver value-based quality education through modern pedagogy and experiential learning.

IM2 Enrich Engineering and Managerial Skills through cutting-edge laboratories to meet evolving global demands.

IM3 Empower research and innovation by integrating collaboration, social responsibility, and commitment to sustainable development.

Vision and Mission of Department

Vision

We envision as a center of excellence in the field of Electronics and Communication Engineering to produce technically competent graduates with diverse teaching and research environments.

Mission

DM1 To educate the students with the state of art technologies to meet the growing challenges of the industries.

DM2 To develop an innovate, competent and ethical Electronics and Communication Engineer with strong foundations to enable them for continuing education.

DM3 Nurture Innovation and Research towards sustainable solutions and societal well-being.

PEOs and PSOs

Program Educational Objectives (PEOs)

PEO1 -	**Employability and Higher Education**	Excel in Professional career and higher education by acquiring knowledge in mathematical, social, scientific & engineering principles.
PEO2 -	**Core Competence**	Analyze, design and develop/implement core engineering problems in communication systems that are technically sound, economically feasible and socially acceptable.
PEO3 -	**Interpersonal Skills and Team Work**	Graduates will explore competency in the higher education and research and to become the State-of-the-art technocrat.

Program Specific Outcomes (PSOs)

PSO1 -	**Professional Skill**	Specify design and test modern electronic systems that perform analog and digital processing functions.
PSO2 -	**Problem – Solving Skills:**	Design essential elements (circuits and antennas) of modern RF/Wireless communication systems.

K.S.R. COLLEGE OF ENGINEERING

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Chairman Message

Shri. R. Srinivasan, BBM., MISTE.,
Chairman, KSR Educational Institutions

"Education is the foundation of a brighter tomorrow, and this magazine reflects the vibrant spirit of our learners."

It brings me immense joy to witness the publication of this edition of the **Electronics and Communication Engineering Department Technical Magazine – TRONIX**. As we stand at the forefront of rapid technological advancement, it is essential that our students are not only informed but inspired to think critically, innovate responsibly, and act ethically.

At **KSR College of Engineering**, we have always emphasized the **importance of holistic learning**—where academic excellence is complemented by research, practical experience, and ethical grounding. This magazine is a testament to that vision. It represents the convergence of classroom knowledge and **real-world application**, aligning perfectly with our mission to create globally competitive and socially responsible engineers.

I extend my heartfelt congratulations to the editorial board, contributors, and faculty coordinators for their efforts in bringing this edition to life. I am confident that **TRONIX** will inspire many young minds and serve as a milestone in our journey towards academic and professional excellence.

With best wishes,
Shri. R. Srinivasan
Chairman, KSR Educational Institutions

K.S.R. COLLEGE OF ENGINEERING

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Dean Message

Dr. M. Venkatesan, M.E., Ph.D.,
Dean, KSRCE

"Knowledge shared is knowledge multiplied."

I am delighted to extend my warm wishes to the Department of Electronics and Communication Engineering for the successful launch of the **TRONIX** magazine. This remarkable initiative stands as a reflection of the department's unwavering commitment to fostering knowledge sharing, innovation, and awareness in the dynamic and ever-evolving field of electronics and communication.

The insightful contributions from both students and faculty members, as showcased in this magazine, are a true testament to their dedication, creativity, and technical excellence. It is encouraging to see such a platform being established to spotlight emerging technologies, thought-provoking perspectives, and real-world applications in the ECE domain.

I whole heartedly encourage everyone to actively engage with **TRONIX**, leveraging it as a valuable medium to share insights, explore new ideas, and collaboratively strengthen the electronics and communication engineering ecosystem.

My heartfelt congratulations to the entire team behind **TRONIX** for their exceptional efforts and vision.

With best wishes,
Dr. M. Venkatesan
Dean, KSR College of Engineering

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Principal Message

Dr. P. Meenakshi Devi, M.E., Ph.D.,
Principal, KSRCE

"It is with immense pride that I present the Electronics and Communication Engineering Department magazine."

This edition of **TRONIX** is not just a compilation of technical articles—it is a mirror reflecting the intellectual energy, dedication, and innovation of our students and faculty. In an era where technology is rapidly transforming every aspect of our lives, it is crucial that educational institutions take the lead in nurturing professionals who can think critically, innovate effectively, and uphold ethical standards in the face of evolving engineering challenges.

At **KSR College of Engineering**, we take immense pride in offering an environment that fosters innovation, interdisciplinary collaboration, and hands-on experience. Our state-of-the-art laboratories, industry-relevant curriculum, and dedicated faculty ensure that students are not only **job-ready but also future-ready**. This magazine is living proof of that vision—where students are encouraged to question, explore, and solve real-world problems through the lens of electronics and communication engineering.

I offer my heartfelt congratulations to the editorial team, student authors, and department staff who have contributed to the successful release of this magazine. Your efforts have created a platform for **thought leadership, creativity, and technical** insight.

Let this magazine serve as a source of **motivation, knowledge, and academic excellence**, and may it inspire all readers to contribute meaningfully to the ever - evolving world of electronics and communication.

With best wishes,
Dr. P. Meenakshi Devi
Principal, KSR College of Engineering

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HoD Message

Dr. C. Gowri Shankar, M.E., Ph.D.,
Professor & Head, KSRCE

"It is with great pleasure that I present the Electronics and Communication Engineering Department magazine."

This edition of ***TRONIX*** goes beyond a simple collection of articles—it embodies the **enthusiasm, creativity, and hard work** of our students and faculty. In today's fast-paced technological world, it is vital for academic institutions to cultivate individuals who are not only technically sound but also ethically grounded and forward-thinking.

At **KSR College of Engineering**, we remain committed to providing a learning environment that **champions innovation, practical exposure, and interdisciplinary growth**. With cutting-edge labs, an industry-aligned curriculum, and passionate educators, we ensure that our students are equipped to face the future with confidence. ***TRONIX*** stands as a testimony to that mission—encouraging students to imagine, innovate, and implement.

I extend my warmest congratulations to the editorial board, contributing writers, and faculty coordinators who have worked diligently to bring this edition to life. Your dedication has given rise to a platform that **inspires knowledge-sharing, originality, and technical excellence.**

With best wishes,
Dr. C . Gowri Shankar
HoD, KSR College of Engineering

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TRONIX

ECE IN HEALTHCARE: FROM PACEMAKERS TO TELEMEDICINE

Introduction

Electronics and Communication Engineering (ECE) has emerged as a transformative force in the healthcare sector, bridging the gap between medicine and technology. From lifesaving implants like pacemakers to global telemedicine platforms, ECE is redefining how medical services are delivered, monitored, and enhanced.

Pacemakers – The Foundation of Bioelectronics

The pacemaker stands as one of the earliest and most impactful contributions of electronics to medicine. By delivering controlled electrical impulses to the heart, it prevents irregular rhythms and ensures patient survival.

- Miniaturized sensors track cardiac activity
- Low-power microcontrollers extend battery life.
- Wireless telemetry enables remote monitoring by physicians. This pioneering innovation laid the foundation for bio electronic medical devices.

Medical Imaging and Signal Processing

Medical imaging technologies like MRI, CT, ultrasound, and PET scans are powered by electronic circuits and communication systems.

- High-frequency transducers convert signals in ultrasound.
- Digital Signal Processors (DSPs) enhance image clarity and reduce noise.

Wearable Devices and IoT in Healthcare

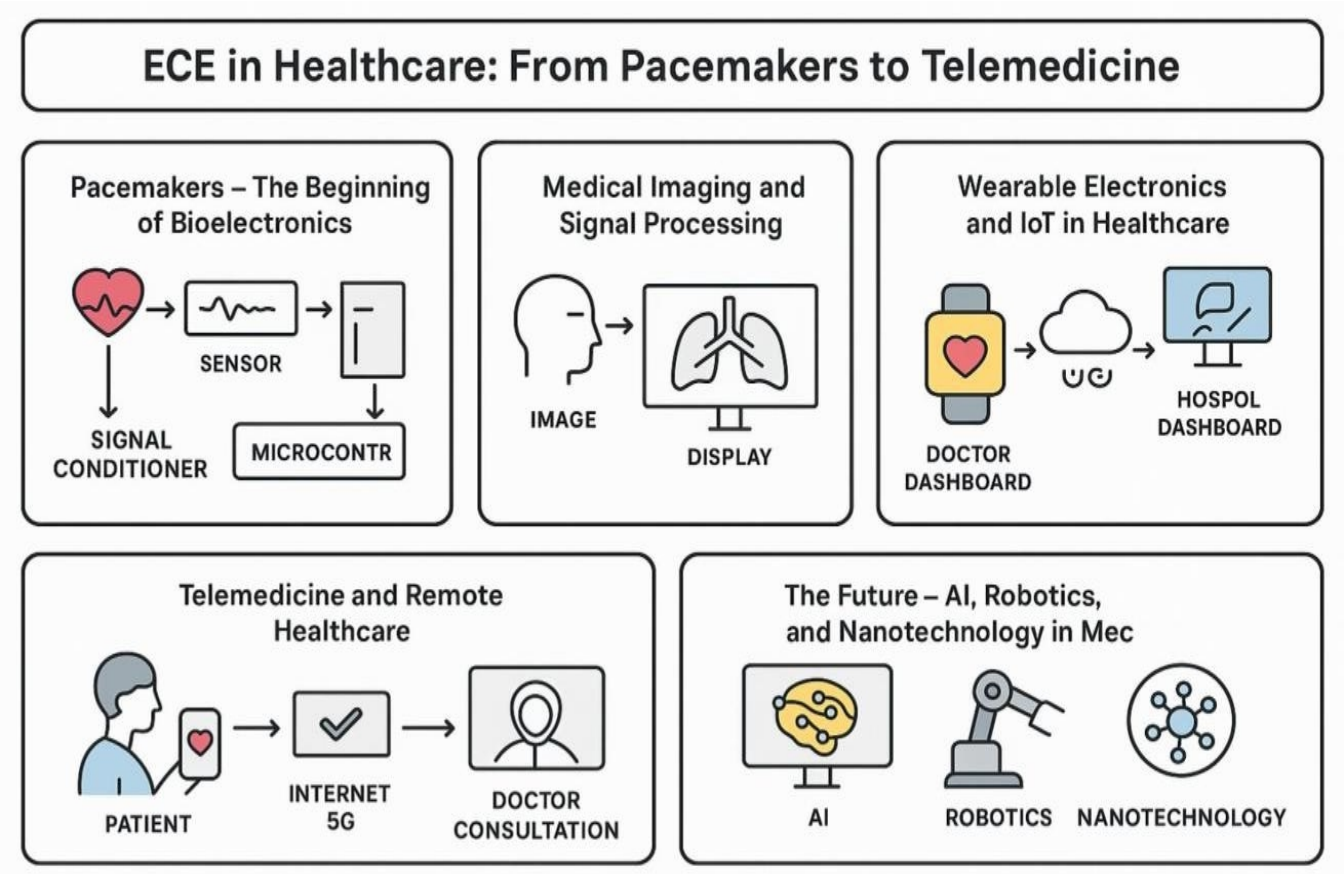
The rise of Internet of Things (IoT) has enabled smart, wearable healthcare devices:

- Smart watches that measure ECG, oxygen saturation, and sleep cycles.
- Continuous glucose monitors for crucial for accurate treatment.
- Diabetic patients.
- Implantable biosensors for round-the-clock health monitoring. These systems rely on embedded electronics, wireless communication (Wi-Fi/5G), and cloud computing, ensuring real-time data availability for doctors and patients.

Telemedicine – Healthcare at Your Fingertips

Telemedicine has become indispensable, especially during the COVID-19 pandemic.

- 5G technology enables real-time, low-latency video consultations.
- Secure communication networks ensure patient privacy. Through ECE innovations, medical care has expanded beyond hospital walls into patients' homes.



Conclusion

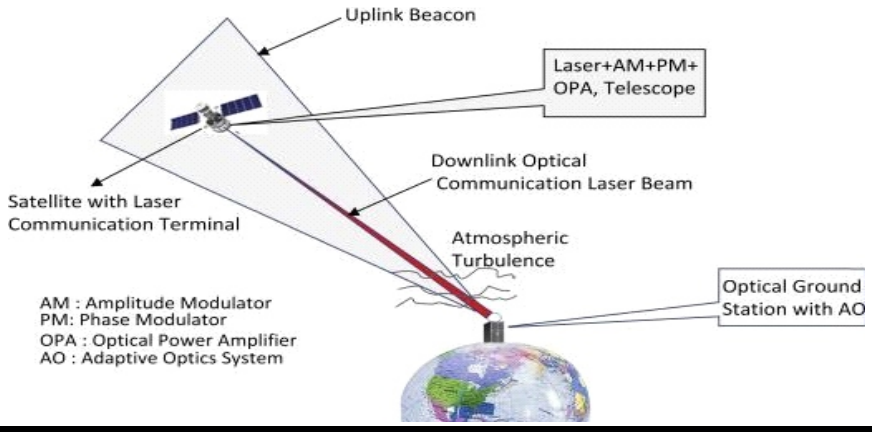
From the invention of pacemakers to the evolution of telemedicine, ECE has been a game changer in healthcare. By merging electronics, signal processing, and communication systems, it has enabled better diagnosis, improved treatment, and global access to medical services.

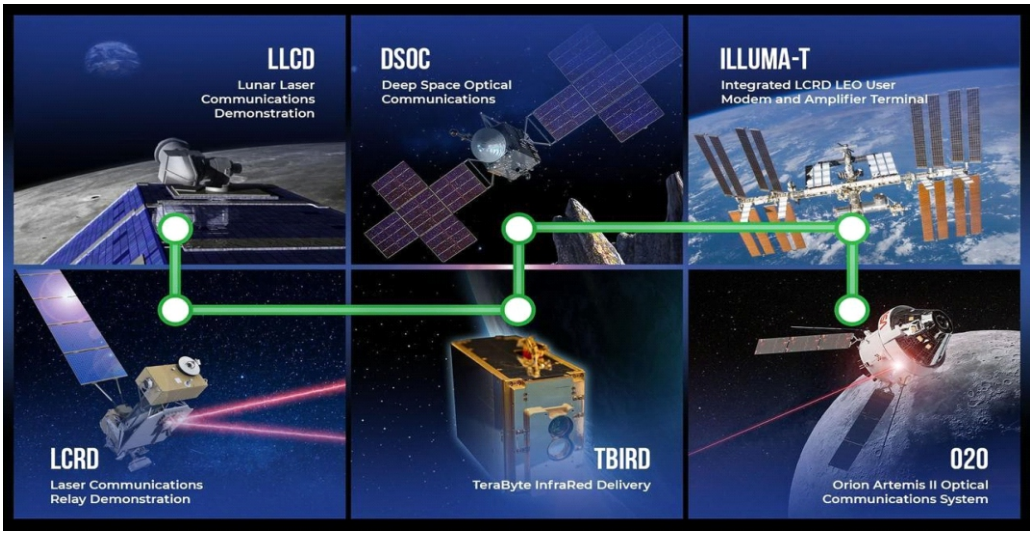
BOOPATHI RAJA R
I-ECE

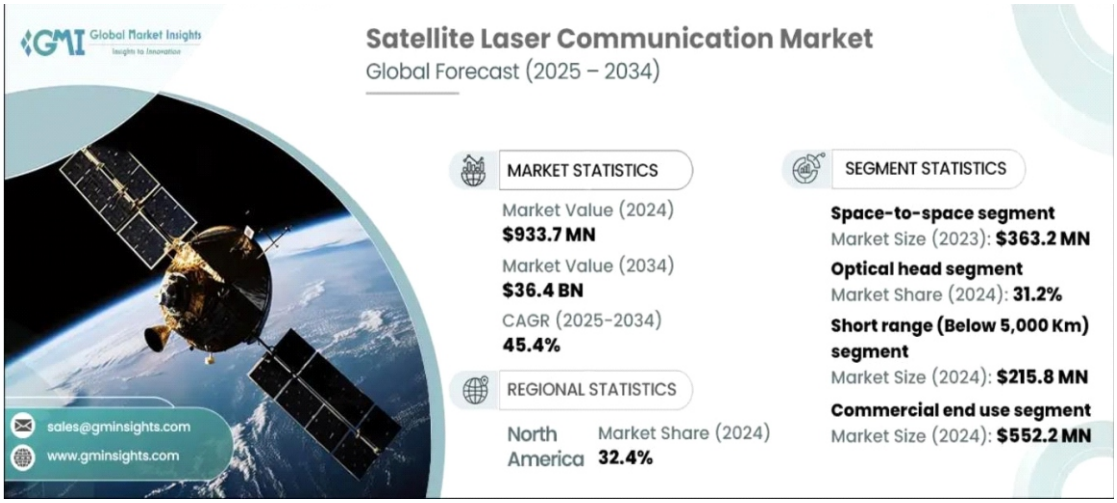
LIGHT-SPEED LINKS: THE RISE OF LASER COMMUNICATION

Introduction

Laser communication (also called optical or free-space optical FSO communication) uses lasers to send information through the atmosphere or vacuum instead of radio waves. Because light has vastly more bandwidth than radio, optical links can carry orders-of-magnitude more data per second for a given transmitter. The trade-offs are that laser links require fine pointing, and atmospheric effects (clouds, turbulence) can interrupt ground-to-space links - so engineers combine smart ground networks, adaptive optics, and hybrid RF/optical architectures.







Three big forces are converging to make laser com essential: (1) explosive data from Earth-observation and video satellites, (2) the growth of large LEO constellations that need high-speed inter-satellite backbone links, and (3) deep-space missions that want to return far more science data without massive RF antenna systems. Laser com solves the bandwidth bottleneck while offering narrower beams that are harder to intercept — a security plus for military and commercial users.

ESA&NASA Earth– space optical campaigns

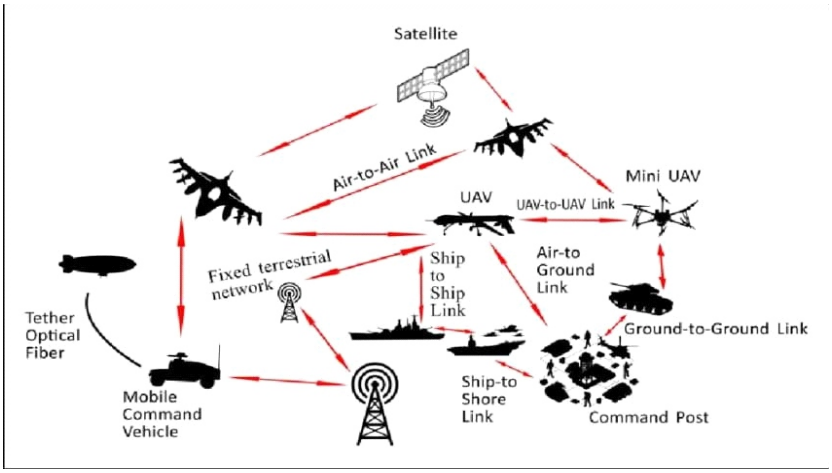
Demonstrations in 2025 pushed optical links over long distances (including experiments with the Psyche mission), showing photon-efficient receivers and advanced ground lasers can track low-horizon spacecraft. These tests helped validate ground transmitters and single-photon detection techniques.

European Space Agency

Commercial inter-satellite terminals surfacing Several vendors now sell small, two-way laser terminals (e.g., Laser Cube and similar LCTs) geared to small satellites, enabling LEO constellations to build high-capacity optical backbones.

Military and national demos

Projects funded by defense customers and agencies (e.g., Black Sky / U.S.
Navy phases, and demonstration board experimental vehicles) advanced optical inter- satellite links for tactical ISR and resilient communications.



Ongoing NASA Demonstrations (LCRD, DSOC, ILLUMA-T)

NASA continued to mature relay and deep-space optical systems, demonstrating reliable downlinks from the ISS and experimental deep-space transceivers. These flight demons trations validate the protocols, modems, and ground networks needed for operational laser com.

Applications and Impact

- Space science & exploration: Deep-space optical links (e.g., NASA's DSOC experiments) promise to return dramatically more data from probes without huge RF dishes.
- Commercial broadband: Laser backbones between satellites make it possible to route traffic in space at fiber-like speeds, reducing latency and increasing throughput for global Internet services.

PRAVEEN P
I-ECE

5G VS 6G COMMUNICATION TECHONOLOGY

Introduction

5G is a widely deployed mobile technology offering high speeds, low latency, and massive device connectivity for current applications like IoT and advanced video streaming. In contrast, 6G is the next evolutionary generation, promising orders of magnitude higher speeds (up to 1 terabit/s), near-instantaneous (<1 ms) latency, and the integration of technologies like terahertz (THz) spectrum and artificial intelligence to enable future innovations such as holographic communication and truly autonomous systems, though commercial deployment is not expected until around 2030.

What is 6G?

6G is the anticipated sixth generation of wireless technology, a significant upgrade from 5G that aims to enable hyper-connected, integrated digital and physical worlds through vastly faster speeds (up to 1 TB), near-zero latency, and the use of new frequencies like Terahertz (THz). It will leverage technologies like Artificial Intelligence (AI) and intelligent surfaces to deliver immersive experiences such as holographic communication, support widespread Internet of Things (IoT), and revolutionize industries like healthcare and manufacturing. Commercial deployment is projected around 2030.

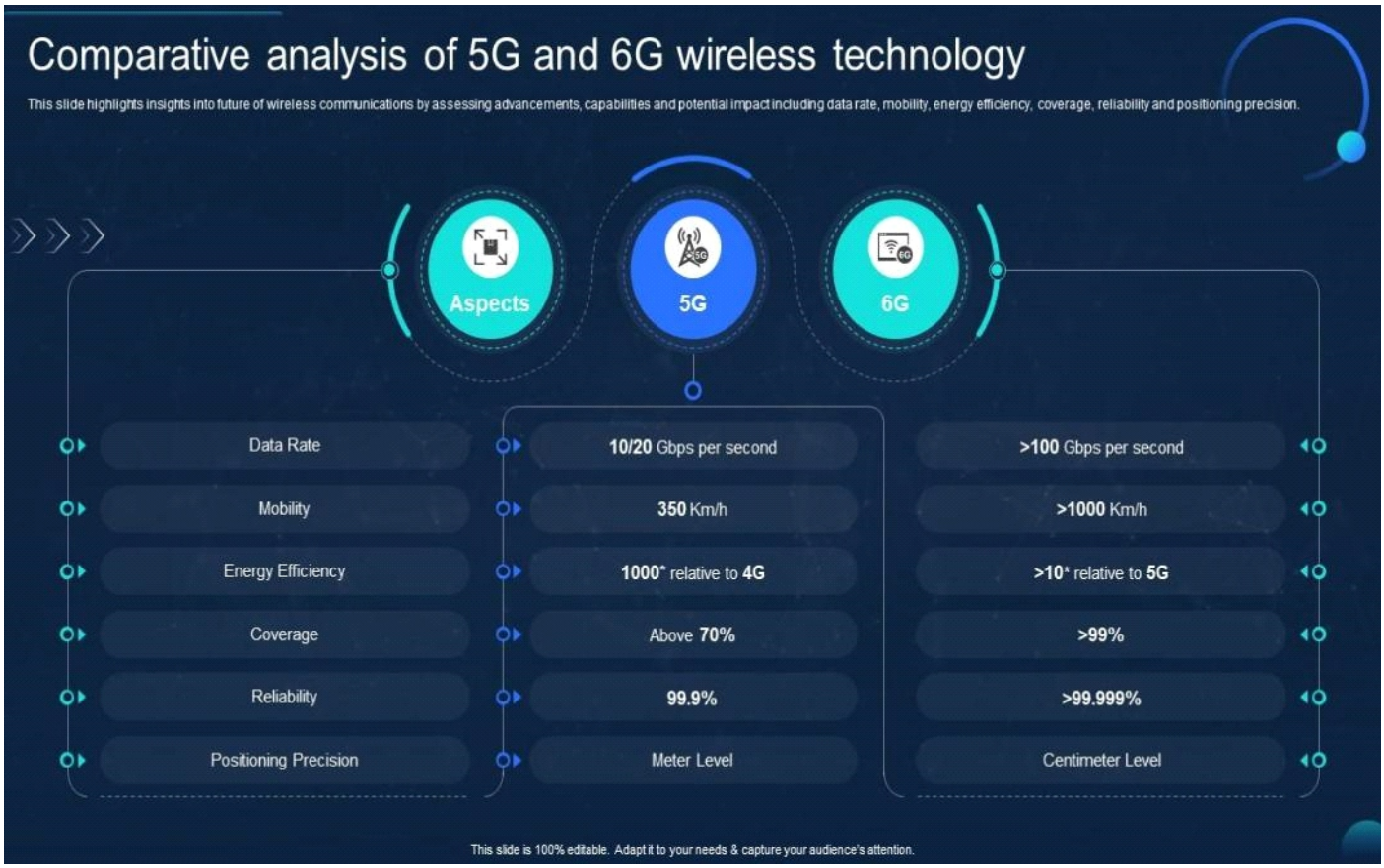
Key Features and Goals:

- Extreme Speed: 6G is expected to provide data speeds up to 1 terabit per second (TB), which is significantly faster than 5G.
- Ultra-Low Latency: It will feature extremely low latency, enabling near instantaneous.
- Immersive Experiences: 6G will unlock advanced holographic
- communication, real-time augmented reality (AR), and virtual
- reality (VR) applications.
- Massive IoT Support: Its high capacity will support massive

  deployments of Internet of Things devices and machine-to-machine communication.

Applications

- Healthcare: Real-time remote surgery and advanced robotic control.
- Manufacturing: Smart factories, advanced automation, and robotics for Industry 4.0.
- Transportation: Highly reliable and low-latency communication for autonomous vehicles.
- Smart Cities: Enhanced smart city applications and intelligent.



DHARANITHARAN P
ECE

TERAHERTZ COMMUNICATION: THE FUTURE BEYOND 5G

Introduction

The world is rapidly moving from 5G towards 6G communication technologies, and one of the most promising candidates to power this revolution is Terahertz (THz) communication. Terahertz waves occupy the frequency range between 0.1 THz to 10 THz, sitting between the microwave and infrared regions of the electromagnetic spectrum. This 'THz gap' has long been underexplored, but with recent advances in semiconductor devices and photonics, it is now emerging as a key enabler for ultra-fast, ultra-reliable communication systems.

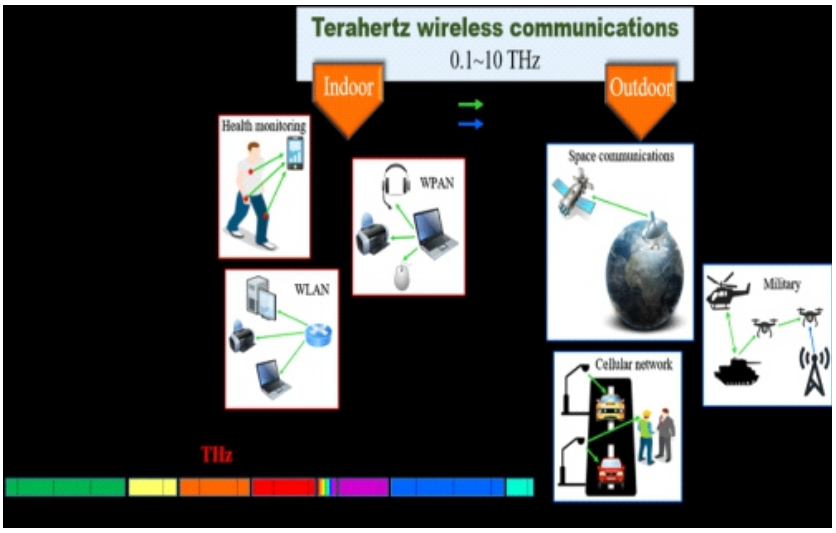
Applications

- 6G Wireless Networks – Supporting ultra-high data rates of up to 1 Tbsp. for future connectivity.
- Security Scanners – Terahertz waves penetrate clothing and packaging without harmful radiation, useful for airport security.
- Medical Imaging – Non-invasive imaging for cancer detection, dental scans, and tissue diagnostics.
- Space Communication – High-bandwidth satellite links for deep space missions.
- Non-Destructive Testing – Inspecting aircraft materials, semiconductor chips, and artworks without damage

History & Evolution

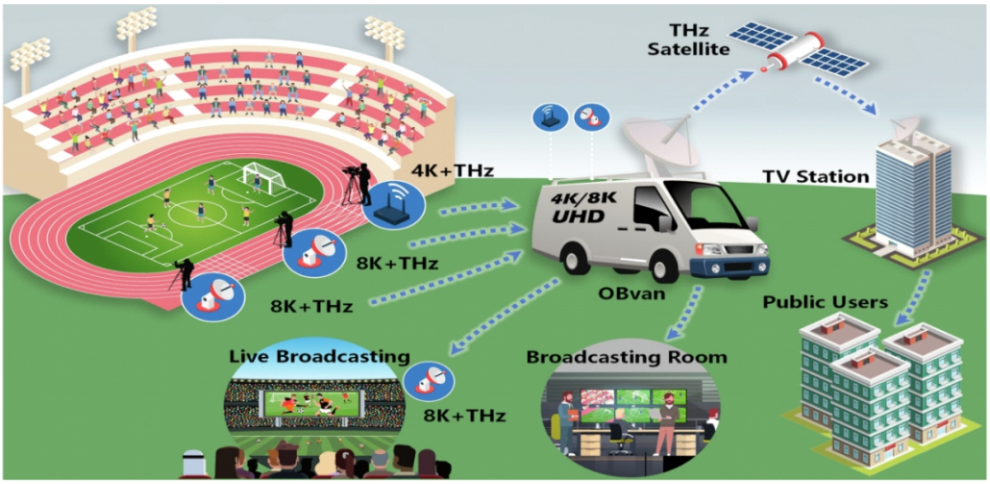
For decades, terahertz frequencies were known as the 'THz gap' because generating and detecting them efficiently was extremely difficult. Early experiments in the 1960s used bulky vacuum tubes and lasers, but the technology was impractical. The turning point came in the 2000s with advances in semiconductor terahertz sources, quantum cascade lasers, and

photo mixers. Today, miniaturized THz systems are paving the way for real-world applications.



Working Principles

- Terahertz Generation – Achieved using photonic methods (lasers, nonlinear crystals) or electronic methods (oscillators, multipliers).
- Propagation – THz waves are highly directional but easily absorbed by water vapor, requiring advanced antenna designs.
- Detection – Specialized detectors such as bolo meters and Scotty diode receivers capture THz signals.



Challenges

- High Propagation Loss – THz waves are easily absorbed by the atmosphere.
- Short Range – Requires many base stations for effective coverage.
- Expensive Components – THz devices are still costly to manufacture.
- Heat Management – High-frequency devices generate significant heat.

Recent Innovations

- Grapheme-based Terahertz Transceivers – Low-cost, high-speed THz components.
- AI-Powered Beam forming – To overcome propagation losses in 6G systems.
- Terahertz Wireless Backhaul – Supporting 6G network infrastructure.
- Portable THz Scanners – For medical and security applications.

Future Outlook

Terahertz communication will be a cornerstone of 6G and beyond. It promises holographic calls, immersive AR/VR, space internet, and real-time

AI applications. As material science and nanotechnology reduce costs, THz devices will become as common as today's Wi-Fi routers, enabling an unimaginably fast and connected future.

Future Insight: Terahertz will power 6G networks enabling holographic calls and immersive VR.

Conclusion

Terahertz communication represents the next leap in wireless technology. With its ability to deliver unprecedented data rates and power futuristic applications in healthcare, security, and space, it holds the key to a truly interconnected digital world. Despite challenges, ongoing research ensures that the 'THz gap' will soon be filled, making it one of the most exciting frontiers in Electronics and Communication Engineering.

CHRISWIN J
III ECE

ADVANCED IC PACKAGING AND MINIATURIZATION

Introduction

Modern electronics are shrinking in size while growing in power. From smartphones to data centers, the demand for faster, smaller, and more energy-efficient devices has fueled innovations in Advanced IC (Integrated Circuit) Packaging and Miniaturization. These technologies are no longer just engineering feats-they are the hidden force behind the gadgets we use every day, making them smarter, lighter, and more reliable.

What is advanced IC Packaging and Miniaturization?

Traditional chip design was about making circuits smaller, but today it's about how these circuits are packaged, stacked, and connected to maximize performance.

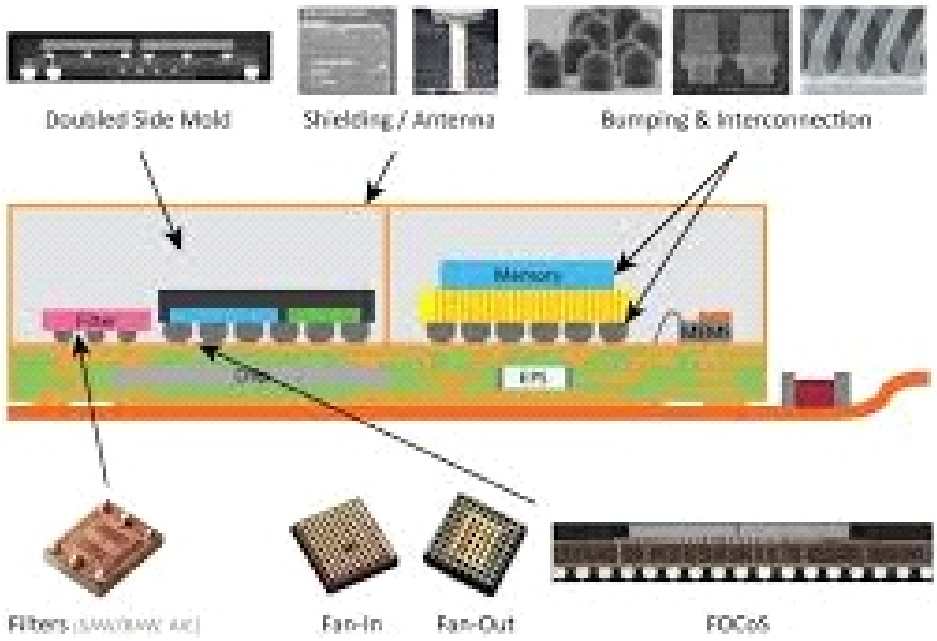
- **IC Packaging:** The process of enclosing semiconductor chips to protect them and enable connectivity. Modern packaging goes beyond protection—it optimizes heat dissipation, speed, and reliability.
- **Miniaturization: T**he art of making devices smaller without compromising power. It involves nanometer-scale transistor design, 3D stacking, and innovative cooling methods.

Key Innovations and Applications

- **3D IC and System-in-Package (SIP):** Instead of placing chips side by side, engineers now **stack them vertically** like skyscrapers. This reduces space, improves performance, and lowers power consumption. Smartphones and AI processors rely heavily on this innovation.
- **Fan-Out Wafer-Level Packaging (FOWLP):** This packaging method eliminates bulky interconnects, making devices thinner and faster. It's
- widely used in high-end mobile processors and wearable devices.
- **Heterogeneous Integration:** Different types of chips (logic, memory, sensors) are integrated into a single package. This allows for powerful yet compact devices, such as AR/VR headsets, medical implants, and IoT sensors.

Advantages of Flexible and Wearable Technology

- **Compact Size:** More performance in smaller devices.
- **Power Efficiency:** Reduced energy consumption for sustainable electronics.
- **Higher Performance:** Faster data transfer and computation.
- **Reliability:** Better heat management and durability.



Future scope for Electronics and Communication Engineers

Advanced IC packaging and miniaturization offer careers in semiconductor design, 3D IC development, biomedical devices, and AI hardware. Engineers skilled in this field will drive the next generation of compact, high-performance electronics.

PRABHU M
III-ECE

BIOMEDICAL ELECTRONIC SAND WEARABLE SENSORS

Introduction

Healthcare is no longer limited to hospitals and clinics—it is becoming personal, portable, and preventive. Biomedical electronics and wearable sensors are at the heart of this revolution. These technologies make it possible to monitor health anytime, anywhere, giving people control over their well-being and helping doctors provide smarter, data-driven care.

What are Biomedical Electronics and Wearable Sensors?

Biomedical electronics are devices and systems that use electronics to support medical diagnosis, treatment, and patient monitoring. Wearable sensors are small, lightweight devices designed to continuously track body signals. Together, they allow real-time health monitoring and early detection of potential health problems. Examples include:

- **Smart watches** that measure heart rate and blood oxygen.
- **Wearable ECG monitors** that track heart activity continuously.
- **Glucose sensors** that help manage diabetes without frequent finger pricks.
- **Smart patches** that monitor hydration, temperature, and muscle activity.
-

Key Areas and Innovations in Nano Electronics

1. Remote Patient Monitoring

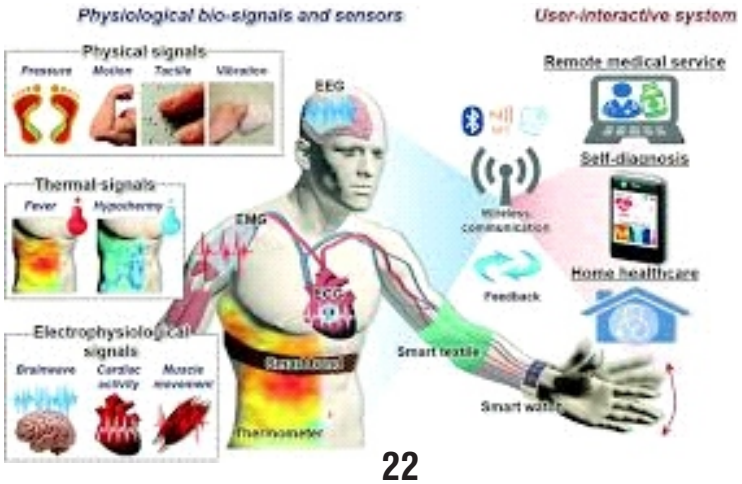
Patients with chronic conditions can be monitored from home, reducing hospital visits and improving comfort.

2. Sports and Fitness

Athletes use wearable trackers to optimize performance and prevent injuries through continuous feedback.

3. Early Disease Detection

Sensors detect irregularities such as abnormal heart rhythms, allowing preventive action before emergencies occur.



Advantages of Biomedical Electronics and Wearable Sensors

- **Accessibility:** Makes healthcare available outside hospitals.
- **Preventive Care:** Detects problems early, reducing medical emergencies.
- **Cost-Effective:** Reduces hospitalization and treatment expenses.
- **Data-Driven:** Provides continuous health records for accurate diagnosis.

Conclusion

Biomedical electronics and wearable sensors are transforming healthcare into something more personal, predictive, and empowering. They make health monitoring seamless and accessible, while also opening exciting career opportunities for engineers to innovate in life-saving technologies.

THEJASHREE M
III-ECE