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Department of Electronics & Communication Engineering

Emerging Innovators: Bhumi Chouhan (EC 4th Year)

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Vision of the Institute

To be a nationally recognized institution of excellence in technical education and produce competent professionals capable of making a valuable contribution to society.

Mission of the Institute

- To promote academic growth by offering state-of-the-art undergraduate and postgraduate programs.
- To undertake collaborative projects which offer opportunities for interaction with academia and industry.
- To develop intellectually capable human potential who are creative, ethical and gifted leaders.

Vision of the Department

To produce globally competent electronics & communication engineering students with knowledge of core as well as inter-discipline domains.

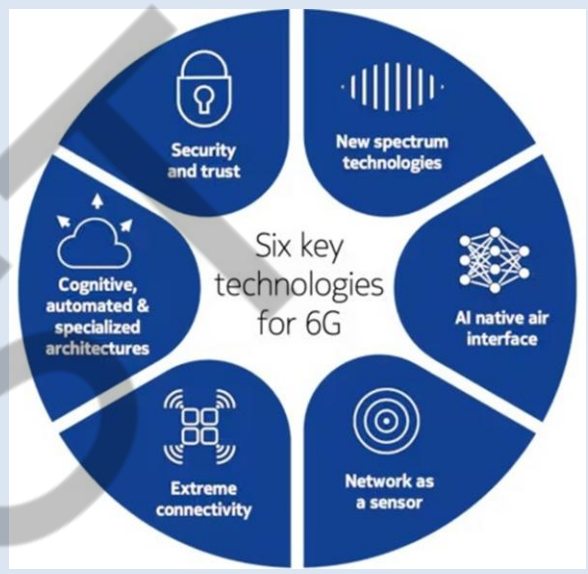
Mission of the Department

- Educating the students in field of electronics and communication engineering to create competent professionals with moral values, social ethics and pursuing higher education.
- Inculcating the understanding technical competence in the fields of electronics and communication engineering and implementation of theoretical concepts in practical multidiscipline scenarios.

Message from the Head of Department

We stand on the brink of a new connectivity era with 6G technology. This issue explores its prospects for creating ubiquitous intelligence, navigates the significant hurdles and horizons of its development, and highlights the next-generation innovations destined to redefine global communication and electronics.

6G News Highlights



- The 3GPP began its official standardization efforts, a major step towards defining the new network.
- Global collaboration is strengthening, with new MoUs and partnerships between alliances in India, Europe, and other regions.
- The industry is placing a strong emphasis on AI-native networks and advanced hardware, including the development of new air interfaces.
- Research is focused on enabling technologies like terahertz (THz) communication and reconfigurable intelligent surfaces (RIS).
- Several countries, including India, are launching new research initiatives and testbeds, with significant funding committed to accelerating 6G development.
- The integration of communication with sensing is emerging, allowing the network to function as a large-scale sensor.

Beyond 5G (6G Technology): Ushering in the Era of Ubiquitous Intelligence

6G technology represents the next major leap in wireless communication, moving far beyond the capabilities of 5G to create a truly interconnected and intelligent world. While 5G focused on enhanced mobile broadband and massive machine-type communication, 6G is envisioned as a network of networks, seamlessly integrating ground, air, and space-based systems. It promises peak data rates of up to 1 Tbps (terabits per second) and sub-millisecond latency, enabling applications that are currently in the realm of science fiction. The core of 6G will be a shift from mere connectivity to omnipresent intelligence, where devices not only communicate but also sense, reason, and act in real-time. This will empower a new generation of applications such as holographic communication, hyper-realistic extended reality (XR), and truly autonomous systems..

Prospects for Electronics and Applied Fields

The advent of 6G will fundamentally reshape electronics and applied fields, creating new markets and technical challenges. From an electronics perspective, 6G requires a complete overhaul of hardware. Operating at terahertz (THz) frequencies demands new RF front-end modules, antennas, and transceivers that are power-efficient and high-performance. Semiconductor materials like Gallium Nitride (GaN) and Silicon-Germanium (SiGe) will play a key role due to their suitability for ultra-high-frequency operation. Massive edge data processing will drive energy-efficient, AI-enabled chips, with edge computing and federated learning minimizing latency and ensuring privacy.

In applied fields, 6G's impact will be transformative. Automotive applications will rely on real-time V2X communication for fully autonomous driving, enabling instant data sharing between vehicles, infrastructure, and pedestrians. Healthcare will benefit from remote surgery and telemedicine with haptic feedback, allowing complex procedures at a distance. The IoT will evolve into the Internet of Everything (IoE), connecting billions of devices, from smart fabrics to industrial robots, seamlessly and intelligently. Extended Reality (XR) will support immersive, high-resolution holographic displays and virtual worlds without bulky headsets or cables. These innovations will drive the development of new sensors, processors, and protocols, ushering in a new wave of electronics and communication technologies.

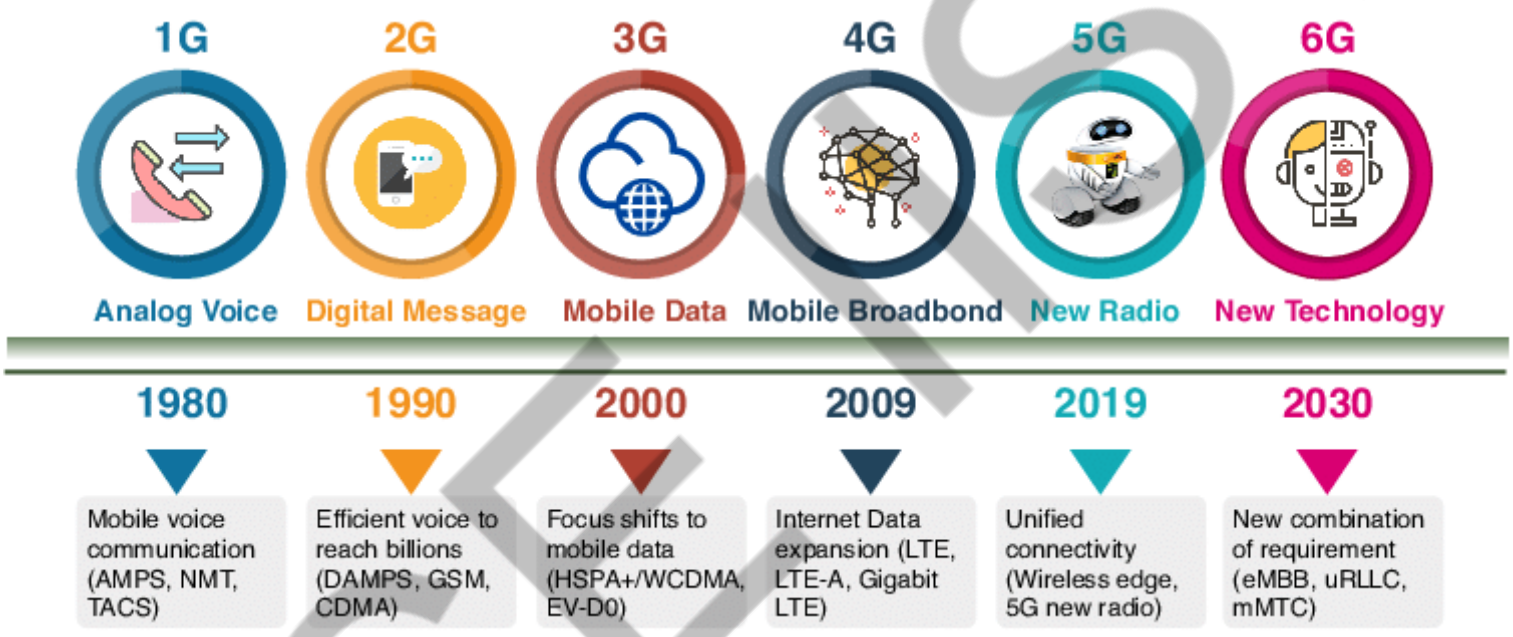
Navigating 6G: Hurdles and Horizons

The development of 6G technology presents significant opportunities to revolutionize communication, but it is not without major challenges. On the opportunity side, 6G's promised speeds and ultra-low latency will unlock a host of new applications, from fully autonomous vehicles and smart cities to real-time holographic communication and remote medical procedures. It has the potential to bridge the digital divide by providing ubiquitous, high-speed connectivity. Furthermore, the integration of AI with the network itself will make 6G smarter and more efficient, capable of optimizing performance and predicting network needs. This creates immense opportunities for innovation in both hardware and software.

Despite these prospects, several technical hurdles must be cleared. Operating in the terahertz spectrum poses a significant challenge, as these signals have a shorter range and are highly susceptible to atmospheric attenuation (e.g., rain and moisture). This will require a massive densification of network infrastructure, with a need for a much larger number of small cell base stations. Additionally, developing cost-effective and energy-efficient THz antennas and transceivers is a major engineering challenge. Another hurdle is security and privacy. With a hyper-connected world and a vast amount of data being collected by 6G-enabled devices, ensuring robust and unhackable security will be paramount. The complexity of a multi-layered network also makes it more vulnerable to cyber attacks.

From an economic and infrastructural standpoint, the cost of deploying a 6G network will be immense, requiring significant investment from both governments and private companies. Standardization is also a key challenge, as various global bodies must agree on a unified set of protocols to ensure interoperability and avoid a fragmented ecosystem.

Nevertheless, the long-term benefits of 6G are expected to outweigh these challenges. With concerted research and development efforts, international collaboration on standards, and strategic investments in infrastructure, 6G could usher in a new era of innovation, leading to a more connected, intelligent, and sustainable world.



Next-Generation 6G Innovations

6G technology, expected around 2030, will extend communication far beyond 5G by emphasizing ubiquitous connectivity, intelligence, and sustainability. While 5G focuses on speed and reliability, 6G will serve as the foundation for future electronics and applied fields. A key trend is the use of terahertz (THz) frequencies between 100 GHz and 1 THz, promising up to 1 Tbps data rates for holographic communication, ultra-immersive extended reality (XR), and high-definition streaming. This shift will rely on advanced semiconductor materials like GaN, SiGe, and 2D materials to enable efficient, high-frequency devices. The integration of artificial intelligence will make 6G networks adaptive and intelligent. AI-driven optimization, predictive analytics, and resource management will reduce latency, cut energy consumption, and ensure seamless connectivity for billions of devices.

Another defining feature is the Internet of Everything (IoE), extending connectivity from devices to people, processes, and intelligent systems. This will transform industries by enabling remote surgery with real-time haptics, fully autonomous transport through real-time V2X communication, and smart cities with energy-efficient infrastructure and grids. 6G will also incorporate quantum communication technologies, such as quantum key distribution (QKD), to create unbreakable security for defense, finance, and critical networks. Sustainability is central to 6G's vision. Ultra-low power operation, energy harvesting, eco-friendly hardware, and edge computing will help achieve greener communication while reducing carbon footprints. Federated learning will allow localized data processing, ensuring both efficiency and privacy.

> ***"6G will turn connectivity into intelligence."***
>
> ***~ Dr. Mischa Dohler***

In essence, , 6G will not just be a communication technology but a foundation for future societies, enabling applications across electronics, healthcare, industry, and defense. With its convergence of THz communication, AI, IoE, quantum security, and sustainability, 6G is set to transform the way humans and machines interact in the digital era.