Agenda

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- Technology Evolution of Satellite IoT
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- Key Challenges of Satellite IoT
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Satellite Internet of Things Ecosystem

AS PER EU SPACE ACT,

- Quote“ The Twenty First Century will be the century of space and century of new frontiers”
- Unquote EU SPACE and Defence commissioner

- SatIoT steps in as the enabler of “connectivity without borders.” It is the connective tissue that extends IoT services to every corner of Earth, regardless of geography or infrastructure

Satellite Internet of Things Ecosystem

- The Satellite Internet of Things ecosystem is emerging as key enabler of global connectivity and real time, decision making, specially in the regions beyond the reach of terrestrial networks. By leveraging satellite links to connect billions of low power sensors and devices.
- SATIOT extends digital infrastructure to oceans, mountains, forests, desserts and unconnected geographies.
- For a country like India with over 65 percent rural population and vast and varied geography SATIOT offers both social economic and strategic advantages.

Satellite Internet of Things Ecosystem

Satellite IoT (SatIoT) refers to the integration of Internet of Things (IoT) systems with satellite communication technologies. This hybrid architecture enables devices located in remote or underserved areas to connect and exchange data where traditional cellular networks are unavailable or unreliable.

- **Definition:** Satellite IoT involves connecting IoT-enabled devices to satellite networks for data transmission.
- **Why it Matters:** Crucial for ensuring connectivity in remote, rural, oceanic, and disaster-hit areas where terrestrial infrastructure is lacking.
- **Applications:** Agriculture (crop monitoring), logistics (fleet tracking), maritime operations, energy infrastructure monitoring, defense, and emergency services.
- **Connectivity Modes:** Utilizes Low Earth Orbit (LEO), Medium Earth Orbit (MEO), and Geostationary Orbit (GEO) satellites, depending on use case needs (coverage, latency, bandwidth).

Technology Evolution of Satellite IoT

The technological progression of Satellite IoT can be viewed in phases:

- **Phase 1: Legacy Satellite M2M Systems** Early SatIoT systems supported basic Machine-to-Machine (M2M) communication, primarily for high-value, static assets. These systems were characterized by bulky equipment, high latency, and expensive services, making them inaccessible for large-scale IoT deployment.
- **Phase 2: Emergence of LEO Constellations** With companies like OneWeb, Iridium, and SpaceX (Starlink) launching cost-effective LEO satellite constellations, SatIoT has evolved to offer faster, affordable, and near-global connectivity. These smaller satellites are easier to deploy and maintain, providing greater flexibility.
- **Phase 3: Integration with 5G Non-Terrestrial Networks (NTN)** The 3GPP Release 17 introduced Non-Terrestrial Networks (NTN), allowing seamless integration between terrestrial and satellite IoT systems within 5G architecture. This marked a shift toward unified communications.
- **Current Developments** Modern trends include satellite miniaturization (e.g., CubeSats), the integration of edge AI to reduce uplink data, and the development of ultra-low-power terminals that allow long-term operation in remote fields.

Use Cases of Satellite IoT

Satellite IoT brings transformative use cases across various sectors:

- **Agriculture** Farmers in remote regions benefit from IoT-connected sensors that measure soil moisture, monitor livestock, and track crop health. This leads to improved yield predictions and efficient resource utilization.
- **Logistics and Asset Tracking** Global supply chains rely on SatIoT for tracking cargo in transit, especially over seas and across remote areas where cellular connectivity is absent. Real-time updates enhance operational efficiency and reduce losses.
- **Disaster Management** In natural disasters where ground networks fail, SatIoT provides uninterrupted communication for rescue operations and crisis coordination. Devices can relay vital environmental data to response teams.
- **Defense and Border Security** Military and border forces utilize SatIoT to monitor equipment, track movements, and control unmanned systems in distant or hostile terrains.
- **Utilities and Infrastructure Monitoring** Pipeline integrity, offshore energy platforms, and remote substations are continuously monitored using SatIoT. This reduces inspection costs and improves fault detection and maintenance scheduling.

Policy Landscape & Regulation (India Focus)

India is shaping a proactive policy framework to support SatIoT expansion:

- **GMPCS (Global Mobile Personal Communications by Satellite)** This licensing framework regulates the provision of mobile communication services via satellite in India. It is overseen by the Department of Telecommunications (DoT) and governs access, licensing, and operational compliance.
- **INSPEES (Indian Satellite-based Provision of Earth Station Equipment Scheme)** INSPEES sets technical and safety standards for earth station equipment connected to satellite networks. It ensures equipment meets national compliance requirements and supports interoperability.
- **SECAS (Simplified Earth Station Class Licensing Scheme)** SECAS reduces procedural hurdles for deploying satellite earth stations. It simplifies the licensing process for commercial and public use, particularly benefiting enterprises setting up ground infrastructure for SatIoT.
- **New Space Policy 2023** This policy fosters private sector participation and innovation in satellite communications, allowing easier market entry for startups and international collaborations in SatIoT applications.
- • **ISRO's IN-SPACe** and private space players like Pixxel, Dhruva, and GalaxEye are building capacity for high-resolution sensing and LEO platform hosting.

Global Trends - ESG and SDG Alignment

SatIoT is gaining momentum globally, aligning closely with sustainability and governance goals:

- **Environmental, Social, and Governance (ESG)**
- **Environmental:** SatIoT systems monitor environmental parameters such as air quality, deforestation, and ocean pollution.
- **Social:** They enable telemedicine, distance learning, and disaster preparedness in underserved communities.
- **Governance:** Governments use SatIoT for smart city planning, resource transparency, and infrastructure compliance.
- **Sustainable Development Goals (SDGs)**
- **SDG 9:** Enhancing resilient infrastructure and promoting innovation.
- **SDG 11:** Making cities inclusive, safe, and sustainable through smart technologies.
- **SDG 13:** Addressing climate change with accurate environmental monitoring.
- **Global Investment Landscape** Public and private sectors globally are investing in SatIoT through space-tech startups, joint ventures, and governmental programs. Partnerships are being formed to support climate monitoring, biodiversity, and defense through space-based IoT.

Key Challenges of Satellite IoT

Despite rapid development, SatIoT still faces barriers:

- **Spectrum Management** There is growing demand for harmonized spectrum sharing between satellite and terrestrial networks, particularly in the 5G era. International coordination is essential to avoid signal interference.
- **Cost Constraints** The high initial investment for satellite terminals and ongoing subscription costs can hinder adoption, especially for MSMEs and public organizations with limited budgets.
- **Latency and Bandwidth Limitations** While LEO networks reduce latency, they still face challenges in supporting delay-sensitive applications like autonomous vehicles or precision robotics.
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- **Cybersecurity and Data Privacy** Data transmitted over satellite channels is susceptible to interception. Strong encryption, secure communication protocols, and regulatory oversight are needed.
- **System Integration** Integrating satellite networks with terrestrial IoT systems presents interoperability issues due to differing protocols and network architectures.
- **Awareness and Skill Gaps** Many potential users, especially in agriculture and small industry, are unaware of SatIoT capabilities. Technical education and awareness campaigns are necessary.

Thought Leadership Insight

- "**Satellite IoT** is not just about connectivity — it's about visibility, predictability, and sustainability. It's a nervous system for the planet."
- SatIoT supports interoperability, sustainability, and resilience across industries and ecosystems.

- **Closing Vision: Satellite IoT and Humanity's Future**
- "In the 20th century, we connected cities. In the 21st, we connected people. In the next decade, we will connect everything — and space will be the fabric."

Space sector as a resource for the progress of common man

- Hon'ble Prime Minister of India Shri Narendra Modi's Vision –
"India is introducing pioneering space reforms which will provide an opportunity for both industry and academia. Time has come for private and public sector to emerge and fly. India in its 75th year of independence has opened the private sector as a gift to India. In this sector, after many reforms suggested, this initiative has been launched. In a short time, ISPA has been conceived and launched. All stakeholders are attending this today. This will make a difference to the poorest person in the country. The enthusiasm toward this initiative is remarkable, and I am looking forward."

Conclusion

- Satellite IoT is revolutionizing how we connect and manage systems across inaccessible regions. By combining IoT intelligence with satellite reach, SatIoT addresses critical gaps in global connectivity.
- India's enabling regulatory environment, through schemes like GMPCS, INSPEES, and SECAS, positions it as a key player in the global SatIoT landscape. Technological innovations such as LEO constellations and 5G NTN are making SatIoT more efficient and cost-effective.
- Globally, the role of SatIoT in achieving ESG objectives and Sustainable Development Goals is being increasingly recognized. However, challenges related to cost, security, and integration must be systematically addressed.
- With collaborative policy, investment, and innovation, Satellite IoT is set to drive inclusive growth, environmental stewardship, and technological resilience for decades to come

Thank you for your attention

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