DOI: 10.5281/zenodo.15552947
Link: https://zenodo.org/records/15552947

CUBESATS AND THEIR ROLE IN UZBEKISTAN’S COMMUNICATION SECTOR

Abdualimov F.G.
intern teacher of department of “Mobile communication technologies”,
Tashkent university of information technologies named after Muhkamad al-Khwarizmi,
abdualimovferuz1833@gmail.com

Siddikov Bobirbek Norpo‘lat ugli
Bachelor Student of Tashkent university of information technologies named after Muhkamad al-Khwarizmi

Abstract. *This article explores the significance of CubeSats in transforming Uzbekistan’s communication sector. CubeSats, as cost-effective and compact nanosatellites, offer valuable solutions for enhancing connectivity, especially in remote and underserved areas. The paper discusses the technical characteristics of CubeSats, including their modular design, communication capabilities, and application in Internet of Things (IoT) integration. Uzbekistan’s current initiatives in educational programs and international collaborations are highlighted, demonstrating the country’s growing interest in satellite technology. Furthermore, the strategic importance of CubeSats for national security, economic development, and scientific research is analyzed. Tables and diagrams support the analytical overview, emphasizing the potential of CubeSats to contribute significantly to Uzbekistan's digital infrastructure.*

Keywords. *CubeSat, nanosatellite, Uzbekistan, satellite communication, IoT, remote connectivity, LEO satellites, space technology, national infrastructure, digital transformation*

Introduction

Small satellites, or CubeSats, are envisioned as a promising solution for future satellite communication networks because of their low costs and short deployment cycle. Currently, CubeSats communicate at conventionally allocated satellite communication frequencies. However, with the increase in the number of CubeSats, CubeSat-enabled communication systems, and many new use cases, new spectrum bands and a more efficient spectrum usage are needed. In this paper, a novel CubeSat design with reconfigurable multi-band radios for communication in dynamic frequencies is proposed.The multi-band radio design is realized by two complelectronics-based and a photonics-based approach[1]. The multi-band communicatementary approaches, namely, an ion covers a wide range from radio frequencies (2–30 GHz), millimeter wave (30 - 300 GHz), Terahertz band (up to 10 THz), and optical frequencies (with typical bands of 850 nm/350 THz, 1300 nm/230 THz, and 1550 nm/193 THz). A thorough link budget analysis is conducted to demonstrate the potential of the proposed multi-band architecture for space information networks. Key parameters in the satellite constellation design are investigated to explore the feasibility of deployment at different altitudes in the exosphere orbit (500 km and above). A continuous global coverage is demonstrated to serve the *Internet of Space Things*, a new paradigm for next generation satellite communication networks[2].

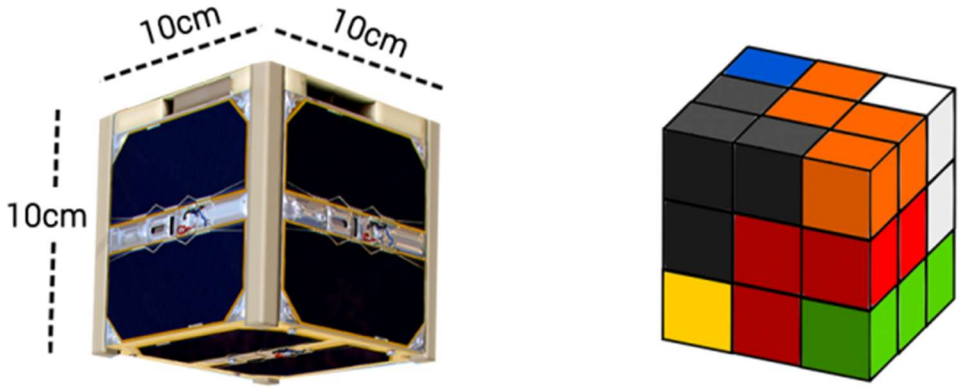

Figure 1. Appearance of three dimensional CubeSat (10x10x10) cm

CubeSats, or cube satellites, are a class of nanosatellites that have revolutionized space technology due to their compact size, cost-effectiveness, and versatility. Typically measuring 10x10x10 cm per unit (1U), these satellites can be combined to form larger configurations (e.g., 2U, 3U). Originally developed for educational purposes, CubeSats have found applications in various sectors, including communication, Earth observation, and scientific research[3].

In Uzbekistan, the integration of CubeSat technology into the communication sector presents opportunities to enhance connectivity, especially in remote areas, and to foster technological advancement.

2. Technical overview of CubeSats

2.1. Structural design

CubeSats are standardized in units (U), with each unit being a 10 cm cube. They are constructed using commercial off-the-shelf components, which significantly reduces development costs. The modular design allows for scalability and customization based on mission requirements[4].

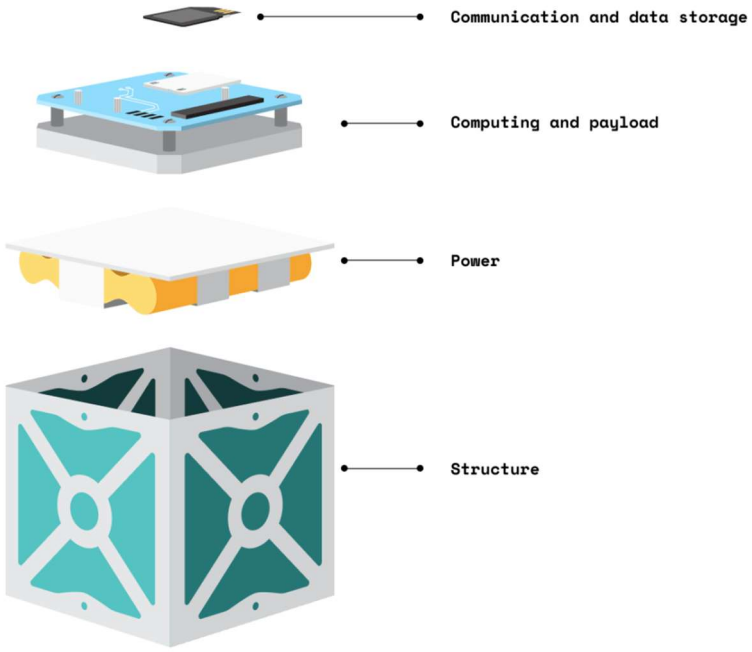

Figure 2. Structural Design of CubeSat

2.2. Communication capabilities

Equipped with various communication modules, CubeSats can operate in different frequency bands (e.g., UHF, VHF, S-band, X-band) to transmit data to ground stations. Advancements in technology have enabled high-speed data transmission, making CubeSats viable for communication purposes[5].

3. Applications of CubeSats in communication

3.1. Enhancing connectivity in remote areas

CubeSats can provide communication services to regions lacking terrestrial infrastructure. By forming constellations, they offer continuous coverage, facilitating internet access and communication in underserved areas[6].

Table 1.

Standard CubeSat sizes and characteristics

CubeSat Size	Dimensions (mm)	Typical Mass (kg)	Common Applications
1U	100 × 100 × 113.5	~1.33	Educational missions, technology demonstrations
1.5U	100 × 100 × 170.2	~2.00	Enhanced payload capacity, extended missions
2U	100 × 100 × 227	~2.66	Earth observation, scientific experiments
3U	100 × 100 × 340.5	~4.00	Communication systems, advanced research
6U	100 × 226.3 × 366	~8.00	High-resolution imaging, complex payloads
12U	226.3 × 226.3 × 366	~16.00	Advanced scientific missions, deep space exploration

3.2. Disaster management and emergency communication

In the event of natural disasters, CubeSats can establish emergency communication links when ground-based networks are compromised. Their rapid deployment and flexibility make them suitable for disaster response scenarios[7].

3.3. Internet of Things (IoT) integration

CubeSats can support IoT applications by providing connectivity for sensors and devices in remote locations. This integration aids in data collection for agriculture, environmental monitoring, and infrastructure management.

4. Uzbekistan’s initiatives in CubeSat development

4.1. Educational programs and capacity building

Uzbekistan has launched educational initiatives to promote CubeSat development, aiming to build local expertise in satellite technology. These programs involve hands-on training in satellite design, assembly, and operation, fostering a skilled workforce in the space sector[8].

4.2. International collaborations

The country has engaged in partnerships with international space agencies and organizations to facilitate knowledge exchange and technical assistance in CubeSat

projects. Such collaborations enhance Uzbekistan's capabilities in satellite technology and open avenues for joint missions[9].

5. Strategic importance of CubeSats for Uzbekistan

5.1. Economic development

Investing in CubeSat technology can stimulate economic growth by creating new industries, generating employment, and attracting foreign investment in the aerospace sector[10].

Table 2.

Additional CubeSat specifications

Feature	Description
Structure Material	Typically aluminum alloys (e.g., 6061 or 7075) for lightweight and strength
Power System	Solar panels with rechargeable batteries (e.g., Li-ion)
Communication Bands	UHF, VHF, S-band, X-band depending on mission needs
Onboard Computer (OBC)	Low-power processors (e.g., ARM Cortex series) with real-time operating systems
Attitude Control	Systems may include magnetorquers, reaction wheels, sun sensors, and gyroscopes
Deployment Mechanism	Compatible with standard deployers like P-POD or NanoRacks

5.2. National security and surveillance

CubeSats can be utilized for border surveillance, monitoring of critical infrastructure, and ensuring national security through real-time data acquisition.

5.3. Scientific research and innovation

The deployment of CubeSats enables scientific experiments in space, contributing to research in atmospheric studies, space weather, and other scientific fields[11].

6. Visual aids

6.1. CubeSat communication architecture

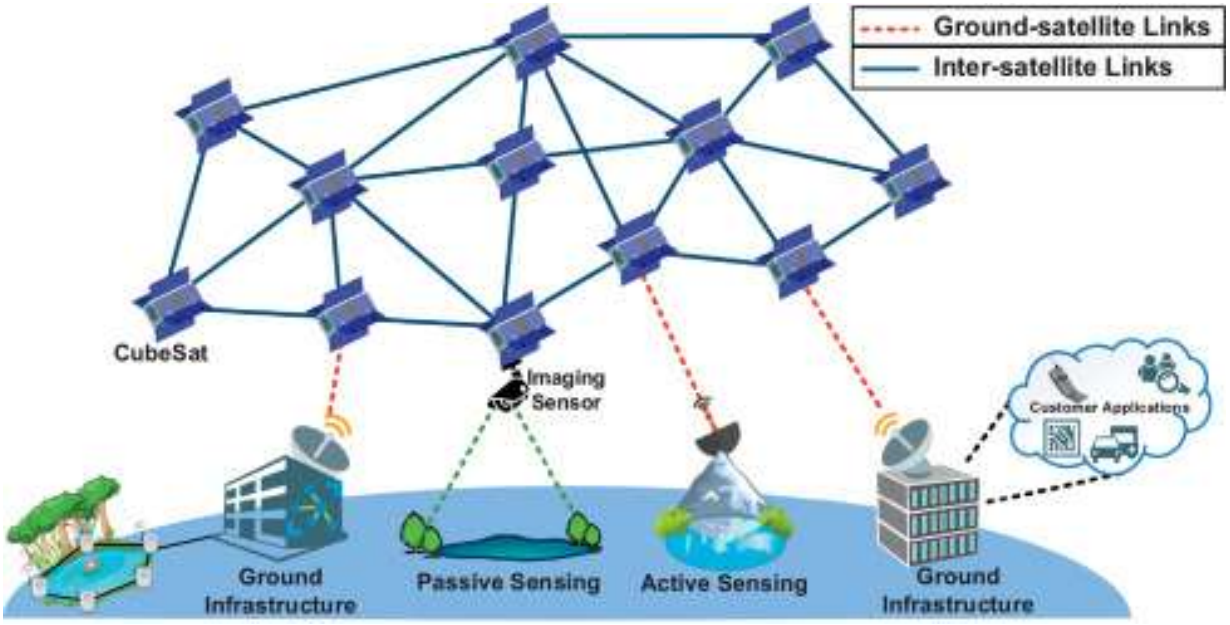

Figure3. CubeSat network communication architecture[12]

6.2. CubeSat deployment mechanism

Key components of CubeSat deployment mechanism

1. Deployment Container
- Usually a standardized canister like P-POD (Poly-Picosatellite Orbital Deployer) or NANOSATC-D.
- Protects CubeSats during launch and positions them for ejection.
2. Spring-Loaded Ejection System
- Uses compressed springs or pistons to eject CubeSats after reaching orbit.
- Ensures controlled velocity to avoid collisions[13].
3. Door or Lid Mechanism
- A hatch that opens in space (often triggered by a burn wire or motor).
- Keeps CubeSats secure during launch and opens at the right time.
4. Release Trigger System
- An electronic command from the main spacecraft triggers the deployment.
- Often includes burn wires, actuators, or pyrotechnic devices.
5. Telemetry and Monitoring
- Sensors verify deployment.
- Sends confirmation back to mission control[14].

7. Conclusion

The integration of CubeSat technology into Uzbekistan's communication sector holds significant promise for enhancing connectivity, fostering economic development, and advancing scientific research. By addressing technical and regulatory challenges through strategic planning and international cooperation, Uzbekistan can leverage CubeSats to achieve its communication and technological objectives.

References

1. Saeed, N., Elzanaty, A., Almorad, H., Dahrouj, H., Al-Naffouri, T. Y., & Alouini, M.-S. (2019). CubeSat Communications: Recent Advances and Future Challenges. *arXiv preprint arXiv:1908.09501*.

2. Bulanov, A. (Year). Inter-Satellite Communication for LEO CubeSat Network: QoS Parameters and Feasibility of Massive MIMO. *Journal of Communications Technology and Electronics*.

3. KUPSAT. (n.d.). Applications and Accessibility of Cube Satellites. Retrieved from https://kupsat.com/applications-and-accessibility-of-cube-satellites/

4. UniSat Uzbekistan. (n.d.). Retrieved from UniSat Uzbekistan

5. Almalki, F. A., Mutawi, A. M., Turkistani, I. A., & Almubayed, Y. M. (2022). Developing CubeSat and AI Framework for Crowd Management Case of Short-Term Large-Scale Events. *ResearchGate*.ResearchGate

6. Bhagavathula, K. B., & Gupta, Y. (2015). Design, analysis and testing of Antenna Deployment mechanism for CubeSat Applications. *ResearchGate*.ResearchGate

7. Roknabadi, M. H. A., Khatir, P. A., Barkhordari, M., & Aval, R. E. (2022). Design of Earth Observation Cubesat based on a systems engineering approach. *ResearchGate*.ResearchGate

8. Liubimov, O., Turkin, I., Pavlikov, V., & Volobuyeva, L. (2023). Agile Software Development Lifecycle and Containerization Technology for CubeSat Command and Data Handling Module Implementation. *ResearchGate*.ResearchGate

9. Wikipedia contributors. (2025). CubeSat Space Protocol. *Wikipedia*. Retrieved from https://en.wikipedia.org/wiki/Cubesat_Space_Protocolen.wikipedia.org

10. Wikipedia contributors. (2025). Phi-Sat-2. *Wikipedia*. Retrieved from https://en.wikipedia.org/wiki/Phi-Sat-2en.wikipedia.org

11. Toorian, A., Blundell, M., & Puig-Suari, J. (2008). CubeSats as responsive satellites. *AIAA 3rd Responsive Space Conference*, Los Angeles, CA.

12. Swartwout, M. (2016). The first one hundred CubeSats: A statistical look. *Journal of Small Satellites*, 2(2), 213–233.

13. Poghosyan, A., & Golkar, A. (2017). CubeSat evolution: Analyzing CubeSat capabilities for conducting science missions. *Progress in Aerospace Sciences*, 88, 59–83. https://doi.org/10.1016/j.paerosci.2016.11.002

14. Langer, M., & Bouwmeester, J. (2016). Reliability of CubeSats–Statistical Data, Developers' Beliefs and the Way Forward. *CEAS Space Journal*, 8(1), 67–76.