Design of Pricing Algorithm for Efficient Resource Management in Integrated Terrestrial and Non-Terrestrial Network

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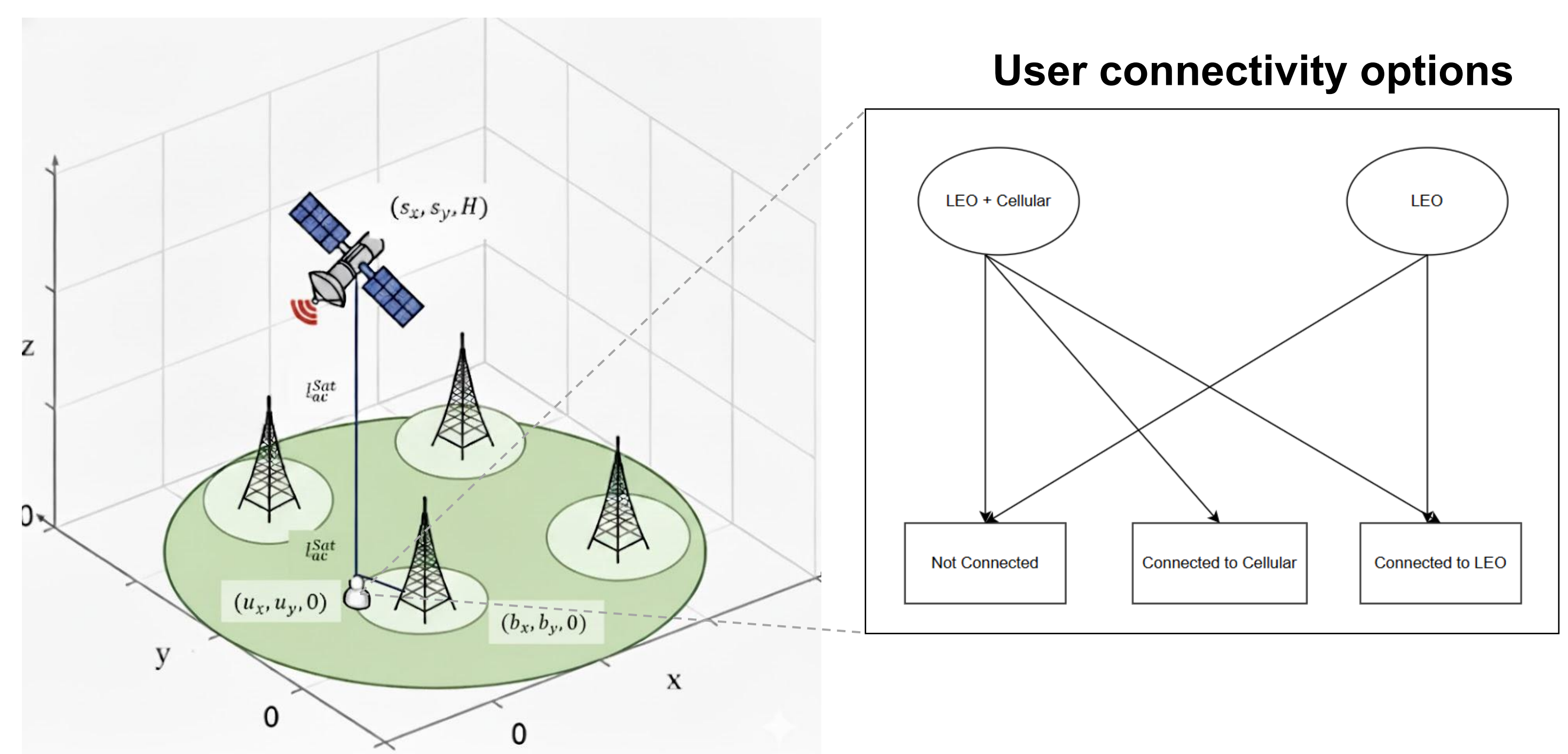University of Cape Town

1. Background

- The 6G vision: The integration of Terrestrial and Non-Terrestrial Networks (TNs & NTNs).
- TNs: Provide high-capacity, low-latency coverage in densely populated urban and suburban areas, but have limited coverage in remote or low-density areas due to infrastructure availability and high deployment costs
- NTNs (satellites, aerial platforms): Extend coverage to underserved or unserved areas, complementing TNs.
- Problem: TNs and NTNs use independent pricing schemes, leading to inefficiencies:
    - For users: Multiple subscriptions leading to a suboptimal user experience
    - For operators: Inefficient resource management in integrated networks

2. Objective

- Design and implement a unified pricing algorithm to enable seamless, single subscription experience and efficient resource management in integrated networks
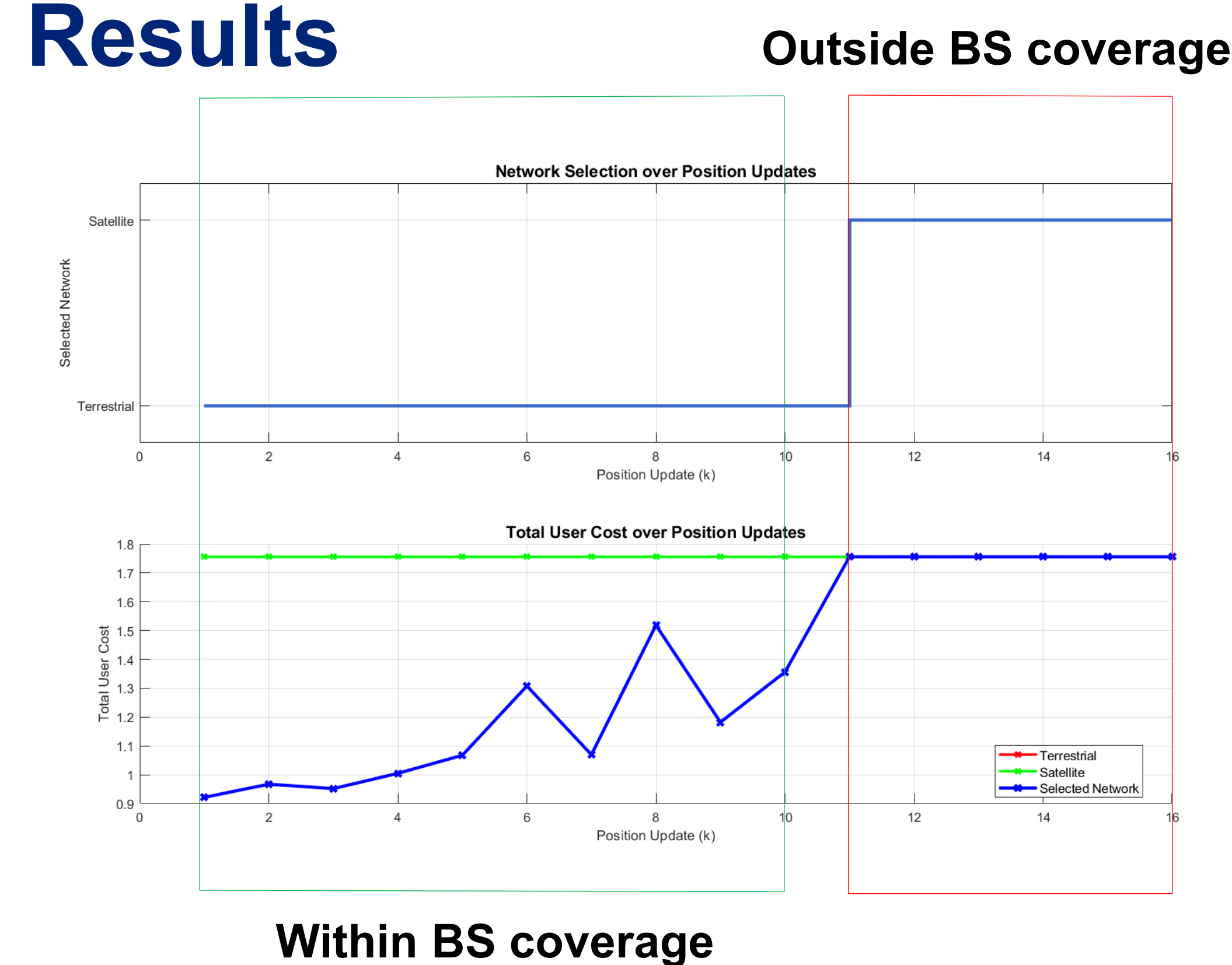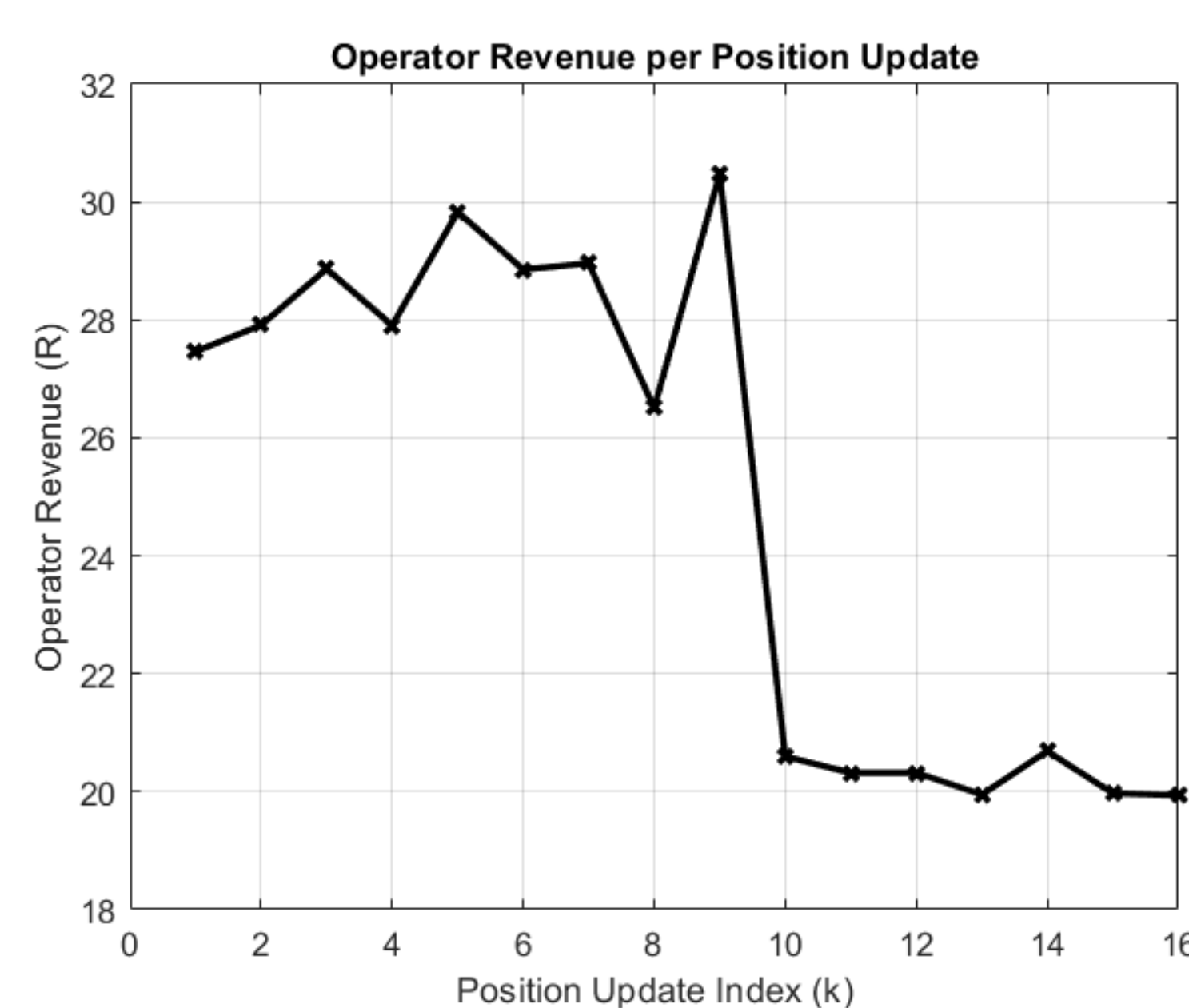
3. Approach

- **Network Model**

User connectivity options

- **Dynamic Pricing Mechanism:**
  Adjusts the network access cost based on current network load and available capacity.
- **Unified Cost Optimisation:**
  The algorithm selects the network (Terrestrial or Satellite) that minimises the Total User Cost, a weighted sum of Network Access Cost and Energy Consumption Cost.
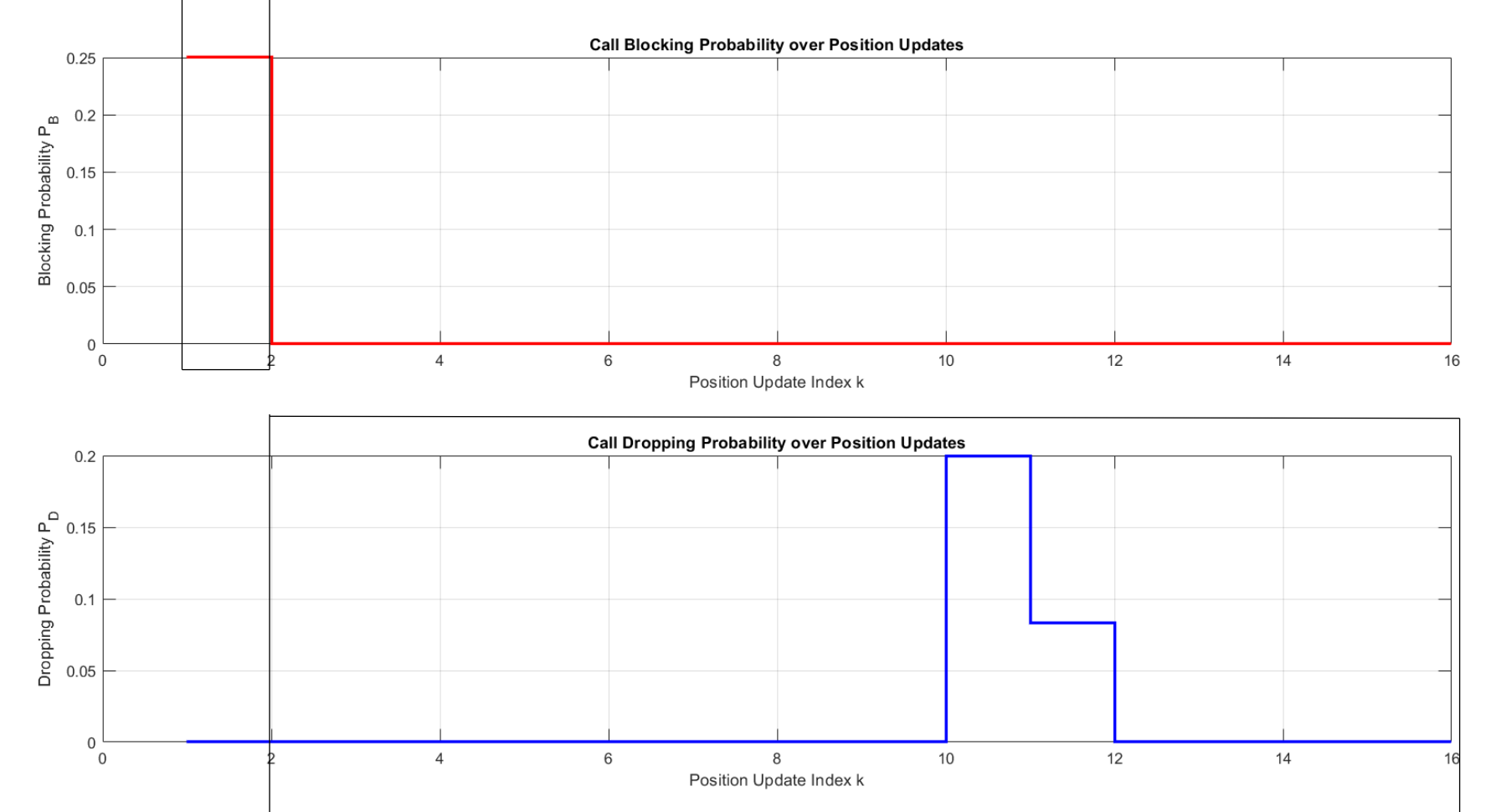
4. Results

Outside BS coverage

Within BS coverage

Network Selection and Total User Cost for User-i where $i = 1, 2, \ldots, N$

Network Operator Revenue

New calls admitted @ $k = 1$ — A new call is admitted if and only if $L_{proj,n}$ does not exceed $t_{m,n}$

Handoff calls admitted @ $k = 2, \ldots, K$

A handoff call is admitted if and only if $L_{proj,n}$ does not exceed C_n

Call Blocking and Call Dropping Probability

5. Conclusions

- The proposed unified pricing algorithm enables dynamic and seamless network selection to minimise user costs
- It improves Quality of Service (QoS) by prioritising handoff calls

6. Future Work

- Extend the network model from a single BS and LEO satellite to multiple BSs and LEO satellites.
- Integrate AI/ML techniques to develop a more adaptive and predictive pricing algorithm

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