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Energy-Efficient UAV-Supported Satellite IoT Communications

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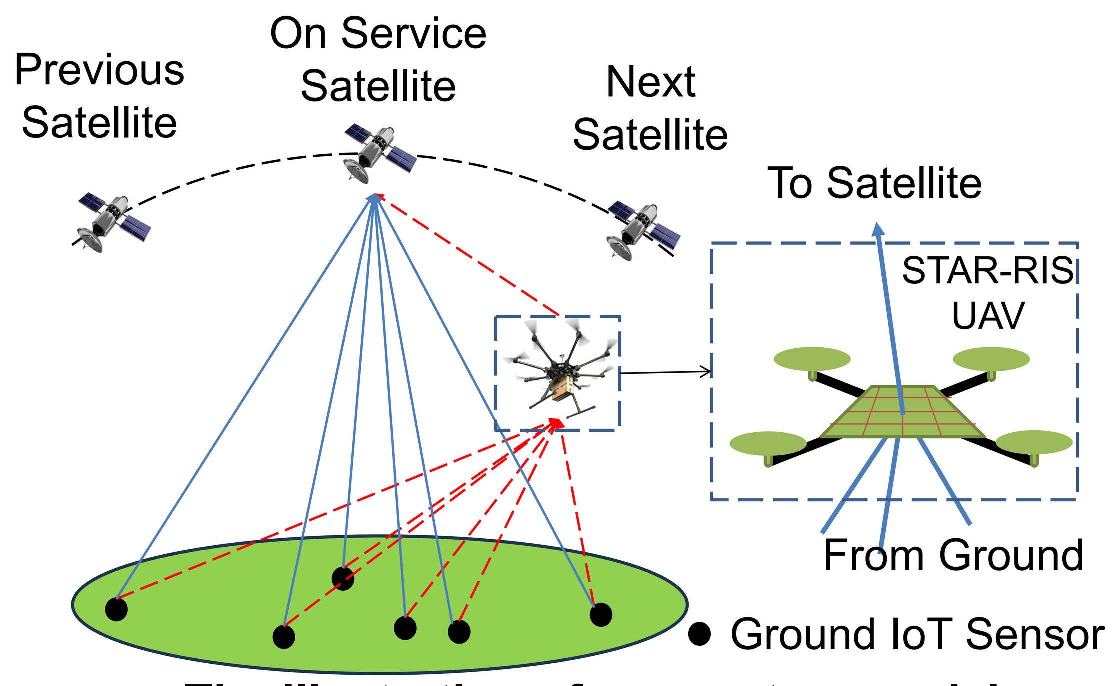
Introduction

In this study, we design a UAV-based relay support system to enhance ground-to-satellite IoT network, **aiming to enhance the throughput and reliability in the communication links**. To support the network, we consider the cutting-edge **STAR-RIS technology**, integrating it onto the UAV platform. **Our primary objective in this work is to achieve maximum energy-efficiency for the STAR-RIS-assisted UAV-based relaying system.**



The illustration of our system model

STAR-RIS: *Simultaneously Transmitting and Reflecting Reconfigurable Intelligent Surface*

Our system model consists of multiple ground IoT devices, a single UAV, and LEO constellations.

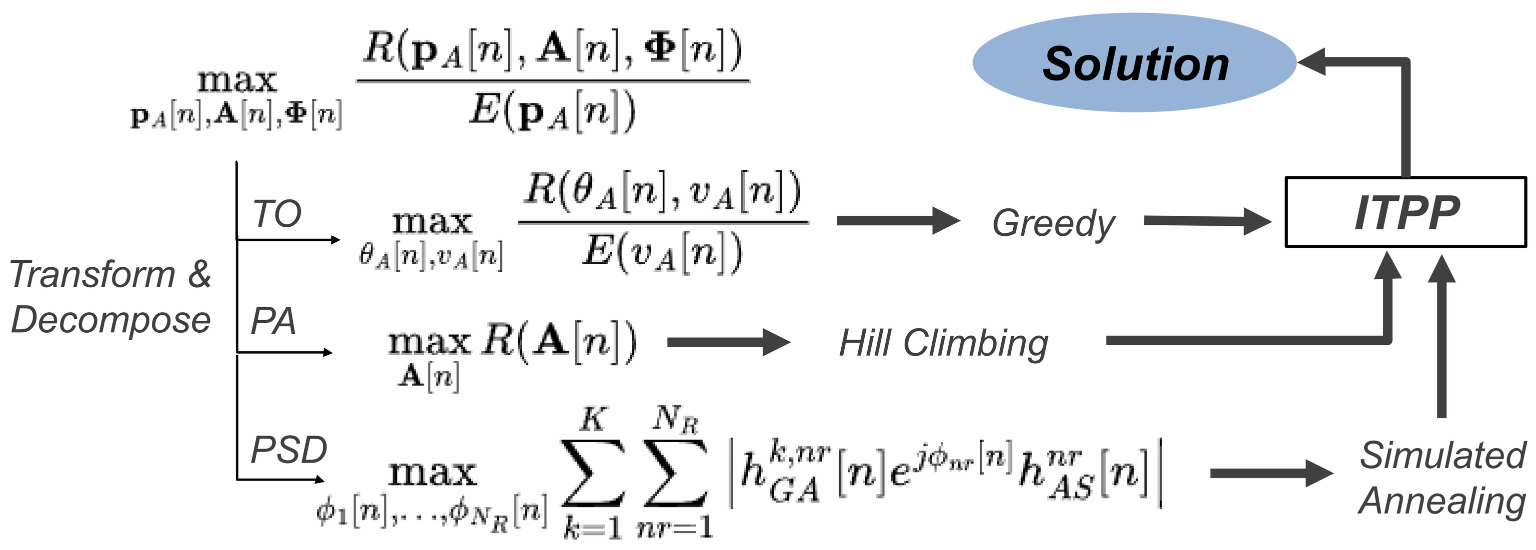
Practical Challenges

To optimize the communication framework, we design an **energy-efficient trajectory** for the UAV, the STAR-RIS' **optimum phase-shift configuration** to increase the transmission capacity, and a power allocation scheme to **maintain the throughput fairness** over all users.

However, the complex nature of the problem renders analytical solutions impractical, thus driving the necessity to craft a heuristic optimization framework.

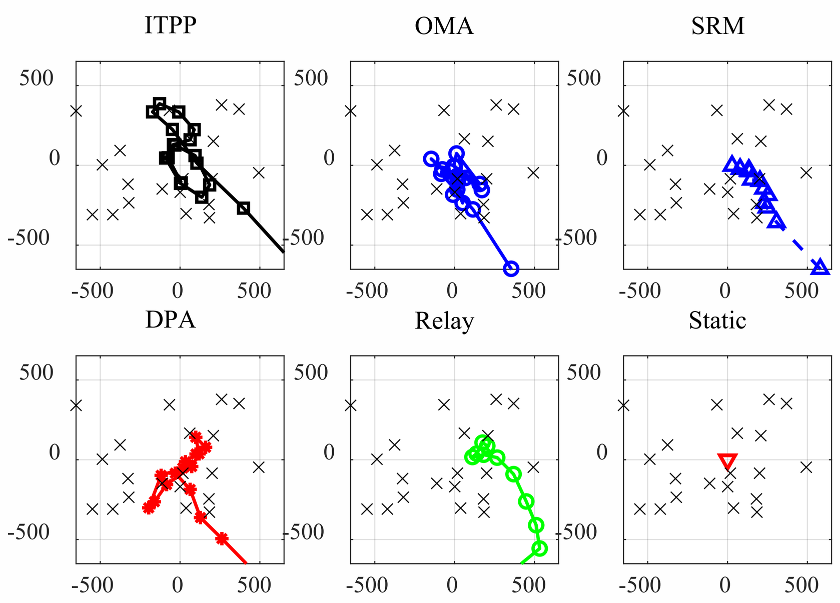
Methods

We refer our proposed method as Integrated Trajectory, Power Allocation, and Phase-Shift (ITPP), which operates on an alternating optimization procedure, sequentially optimizing trajectory, power allocation, and phase-shift design optimization. Within ITPP, we employ a combination of the Greedy approach, Hill-Climbing procedure, and Simulated Annealing to tackle these optimization tasks, each in turn.

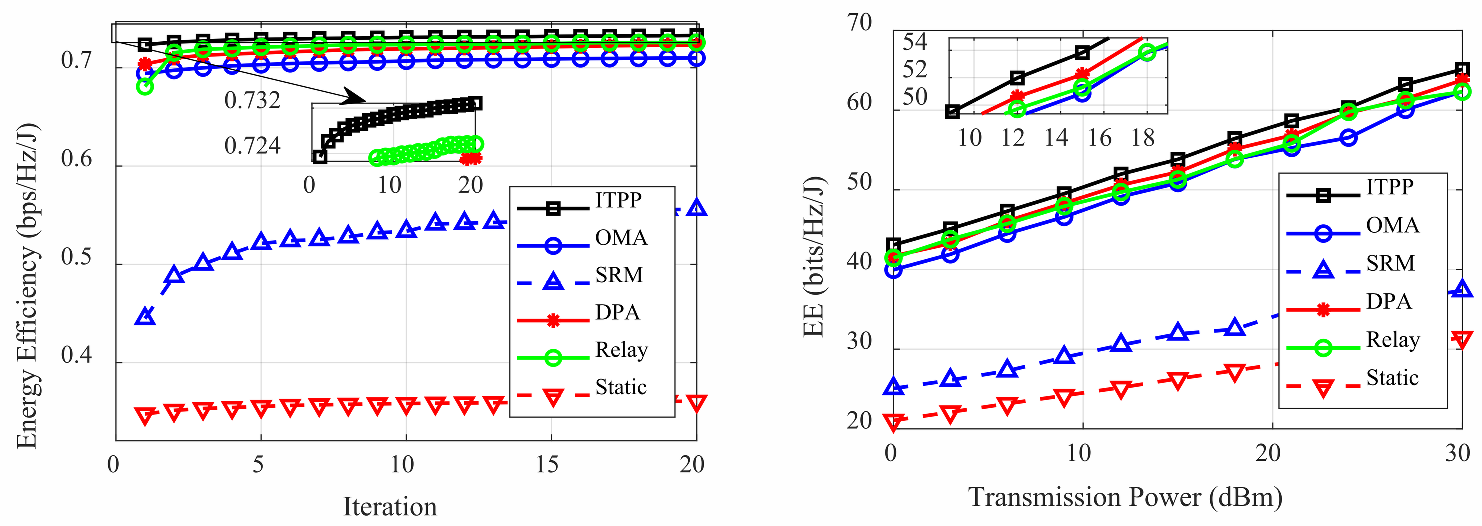


Results

To prove the superiority of our proposed ITPP, we run a series of simulations and compare with other baselines. The results are given below.

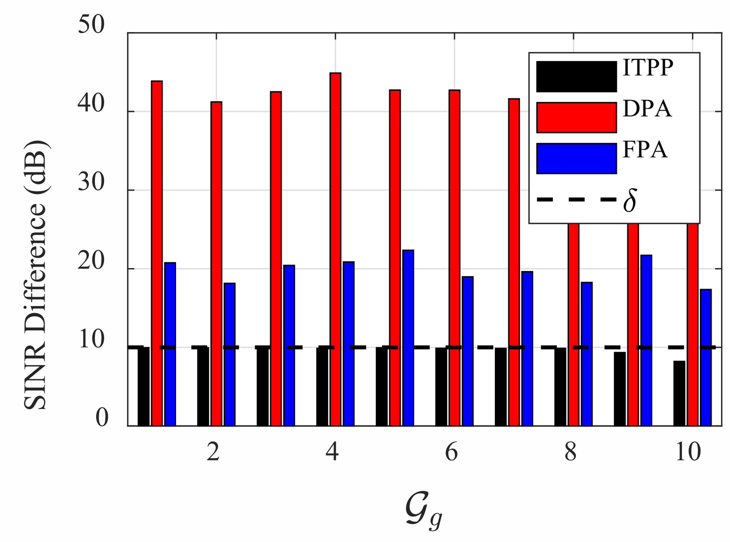


Our optimized trajectory exhibits a notably smooth profile without any sudden or excessively slow movements. This smooth trajectory contributes to enhanced energy efficiency in our system.



Our proposed optimization scheme demonstrates rapid convergence, surpassing the other baseline methods from the initial iteration onwards. Our results remain consistent across various transmission power levels.

Our proposed method also prioritizes SINR fairness within a resource block, ensuring that the difference remains below the predefined threshold.



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