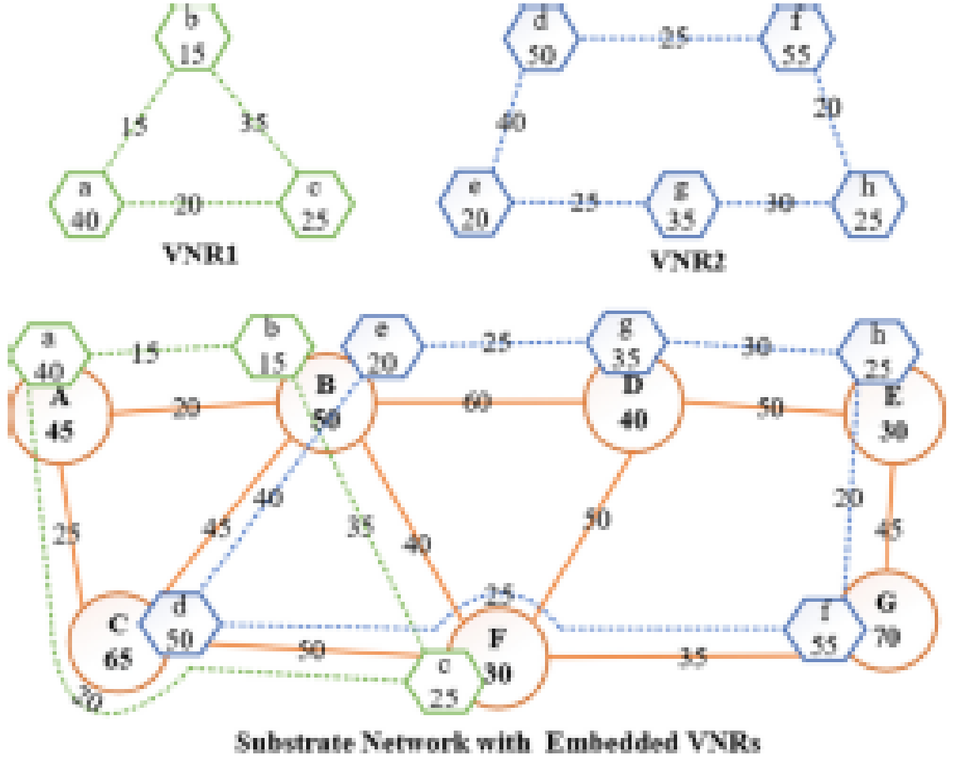
Energy efficient VNE

Background of the Study

- **Network Virtualization:** Enables multiple virtual networks to coexist on a shared physical network, increasing resource utilization.
- **VNE Problem**: Involves mapping virtual nodes and links onto physical nodes and links, while respecting resource constraints.



Substrate Network with Embedded VNRs

Introduction

- **Overview:** Virtual Network Embedding (VNE) allows resource sharing in data centers by embedding virtual networks on a shared physical network.

Challenges: VNE is NP-hard; existing solutions lack adaptability for dynamic conditions.

Objective

Introduce PPO-VNE, a deep reinforcement learning (DRL)-based approach for efficient, coordinated VNE..

Proposed Methodology

PPO-VNE Approach:

- **Algorithm:** Proximal Policy Optimization (PPO) to coordinate node and link mapping adaptively.
- **Feature Extraction:** Combines handcrafted and Graph Convolutional Network (GCN) features.
- **Reward Function:** Multi-objective, balancing revenue and energy consumption.

System Model

- **Substrate Network:** Physical infrastructure with nodes and links, each with resource attributes like CPU and bandwidth.
- **Virtual Network Requests:** Includes arrival and end times, resource demands for each virtual node and link.

Problem Formulation

- **Goal:** Map virtual network onto substrate network efficiently.
- **Objective:** Maximize overall revenue while minimizing energy consumption.

Framework

RL Modeling:

- **State:** Represents real-time network status.
- **Action:** Selection of substrate node for each virtual node.
- **Reward:** Guides towards maximizing revenue-energy efficiency.

Algorithm Design:

Hybrid feature extraction with GCN, training with PPO for policy optimization.

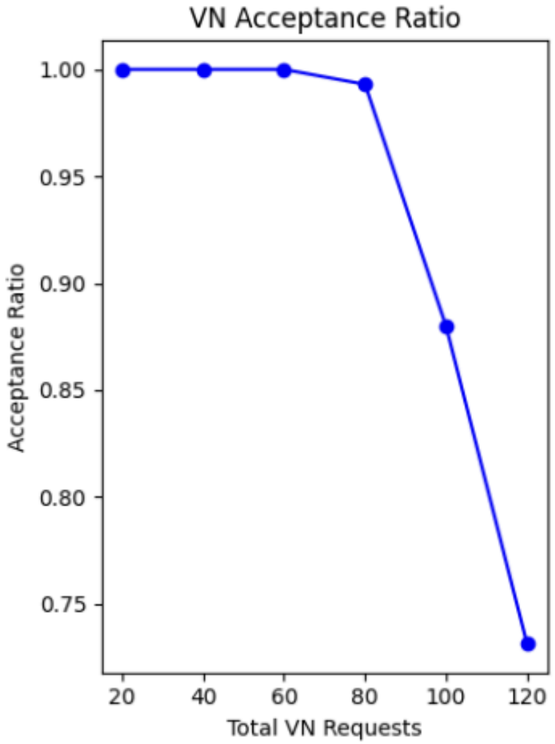
Implementation Details

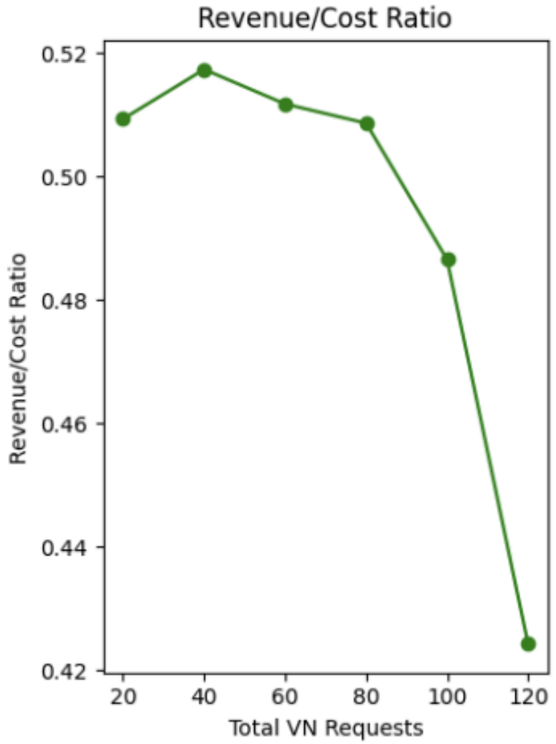
- **Mapping Process:** Virtual nodes mapped to physical nodes based on available resources.
- **Reward Mechanism:** Rewards for successful mappings, penalties for exceeding resource limits or unsuccessful mappings.

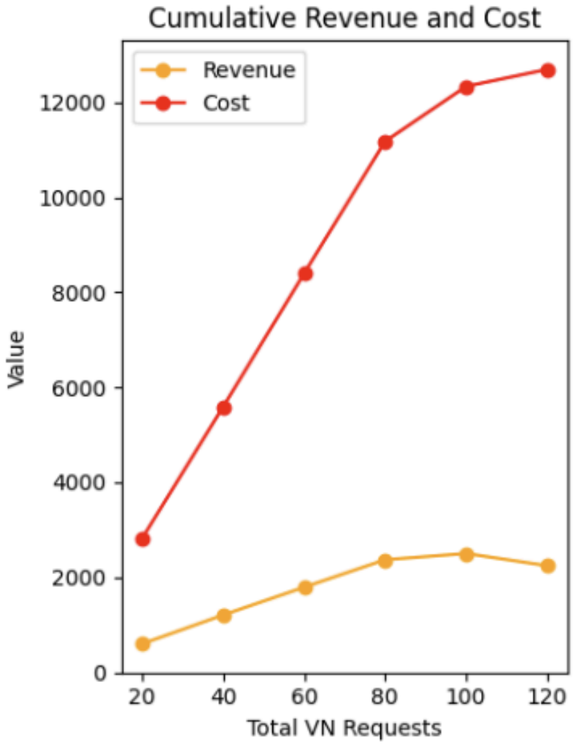
Performance Metrics

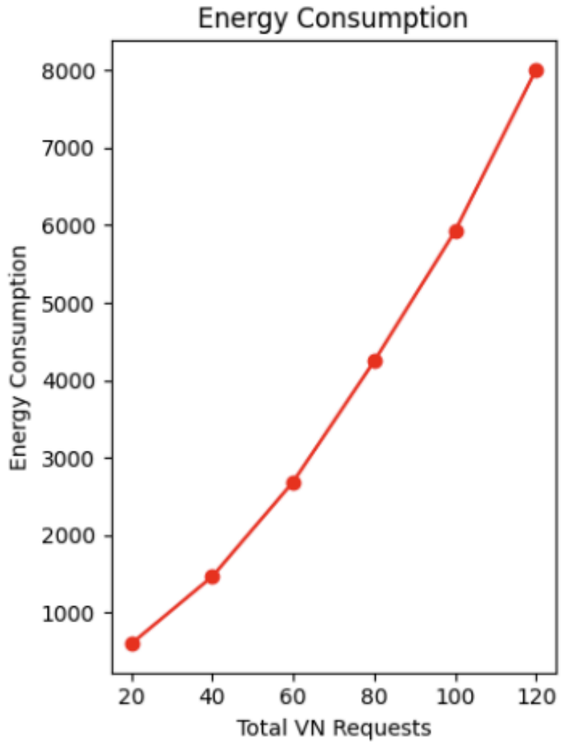
- **Final Cost**
- **Final Revenue**
- **Revenue/Cost Ratio**
- **Acceptance Ratio**
- **Energy Consumption**

Results


VN Acceptance Ratio
Acceptance Ratio
1.00
0.95
0.90
0.85
0.80
0.75
20
40
60
80
100
120
Total VN Requests


Revenue/Cost Ratio
Revenue/Cost Ratio
0.52
0.50
0.48
0.46
0.44
0.42
20
40
60
80
100
120
Total VN Requests


Cumulative Revenue and Cost
Revenue
Cost
Value
12000
10000
8000
6000
4000
2000
0
20
40
60
80
100
120
Total VN Requests


Energy Consumption
Energy Consumption
8000
7000
6000
5000
4000
3000
2000
1000
20
40
60
80
100
120
Total VN Requests

Results

- **Acceptance Rate:** PPO-VNE shows a higher acceptance rate than other algorithms.
- **Revenue and Cost Efficiency:** Superior revenue generation and lower energy cost.
- **Energy Consumption:** Optimized energy use, especially in resource-scarce conditions.

Thank You