Task 3: Proof of Concept (PoC)

Energy-Aware Peer Selection Based on Energy Consumption and Upload Speed in BitTorrent-Like Systems

1. Objective

This Proof of Concept demonstrates how the PeerSim and CloudSim simulation frameworks were adapted with minor modifications to integrate energy-awareness into peer selection. The modifications track per-peer energy consumption and upload speed, compute an energy-aware score, and use this score to identify top-performing peers. These changes make the simulation outputs more suitable for evaluating sustainable peer-to-peer (P2P) networking strategies.

2. Tools & Original Sources

- PeerSim 1.0.5 – https://peersim.sourceforge.net
- CloudSim 6.0 – https://github.com/Cloudslab/cloudsim
- SUMO – https://www.eclipse.org/sumo/
- CloudReports – https://cloudreports.cloudbus.org/

3. Modifications Made

- Added `energy_consumption` and `upload_speed` attributes to each peer in PeerSim.
- Implemented calculation of Energy-Aware Score = upload_speed / energy_consumption.
- Developed EnergyLogger to record per-peer metrics each cycle into CSV.
- Adjusted CloudSim VM allocation policy to log energy use and upload bandwidth.
- Added energy-centric (Policy A) and latency-centric (Policy B) configurations in CloudReports.

4. Run Procedure

- Set up project folder with /lib, /src, /out, and config.txt.
- Compile Java code with proper classpath to PeerSim JARs.
- Run simulation for 50 cycles and 200 peers.
- Generate peer_metrics.csv with per-peer cycle data.
- Run Python EDA script to create histogram, scatter plot, and top peer scores chart.
- Use SUMO for topology visualisation and CloudReports for datacenter policy analysis.

5. Summary Statistics

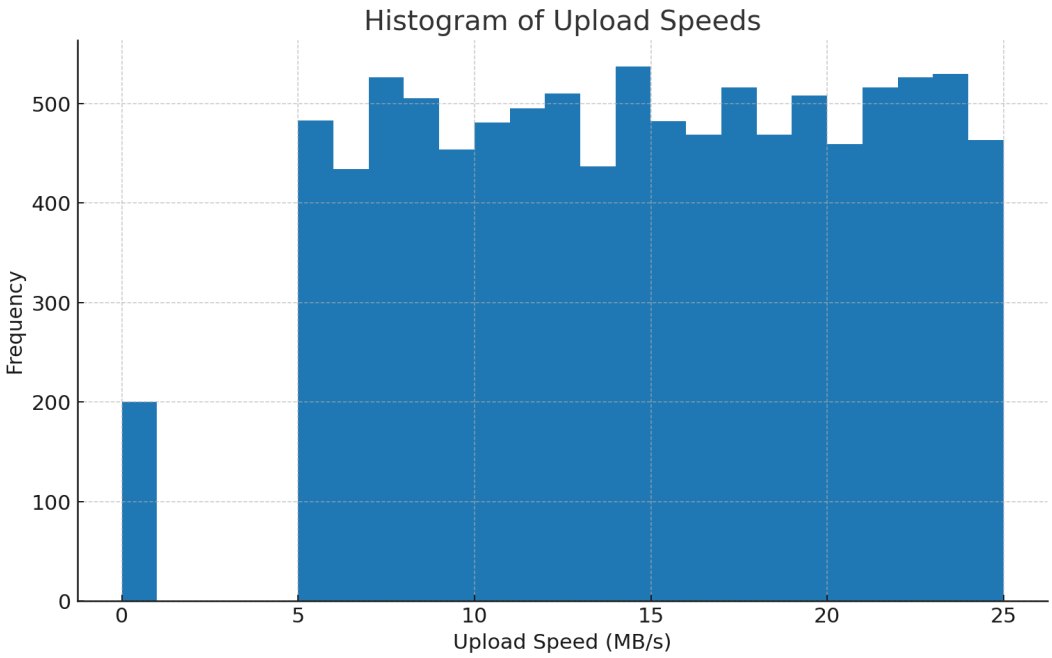
Unnamed: 0	energy_consumption_w	upload_speed_mbps	score
count	10000.0	10000.0	9800.0
min	0.0	0.0	0.0781279008717447
max	79.997742	24.997177	0.3124735320654425
range	79.997742	24.997177	0.2343456311936978
mean	70.6218658169	14.777332267	0.204932552881591
median	71.8992505	14.8740625	0.2093622744807685
mode	0.0	0.0	0.0781279008717447
std	11.077454082515986	6.094005343199797	0.0674010433810964

6. Top 10 Peers by Mean Score

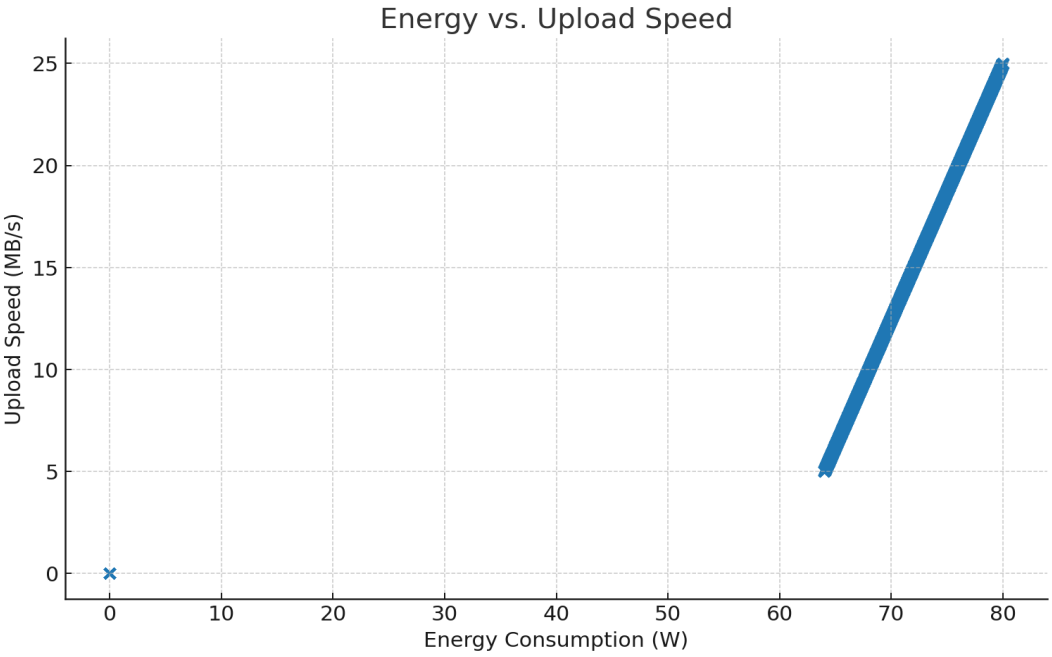
peer_id	mean_score	median_score	mean_upload	mean_energy	cycles
28.0	0.2369948858477061	0.2615914655798917	17.51829576	72.81463654	50.0
109.0	0.2326447137088187	0.2569341419378703	17.129131179999998	72.50330498	50.0
156.0	0.2314210535940899	0.2500950409660393	17.03089064	72.42471254	50.0
66.0	0.2273980817491966	0.2333095762152351	16.65058058	72.12046434	50.0
58.0	0.2258433061242067	0.2286909485750879	16.50836238	72.00669006	50.0
21.0	0.2251525669741818	0.2342060357935998	16.44875932	71.95900746000001	50.0
94.0	0.2248211916574236	0.2378679749350228	16.50257834	72.00206274	50.0
106.0	0.2242567432166463	0.2325518114803617	16.37387842	71.89910268	50.0
49.0	0.2239917197533633	0.2329245784059646	16.34343844	71.87475082	50.0
159.0	0.2238141354760252	0.2433938855683712	16.33557436	71.86845952	50.0

7. Visual Results

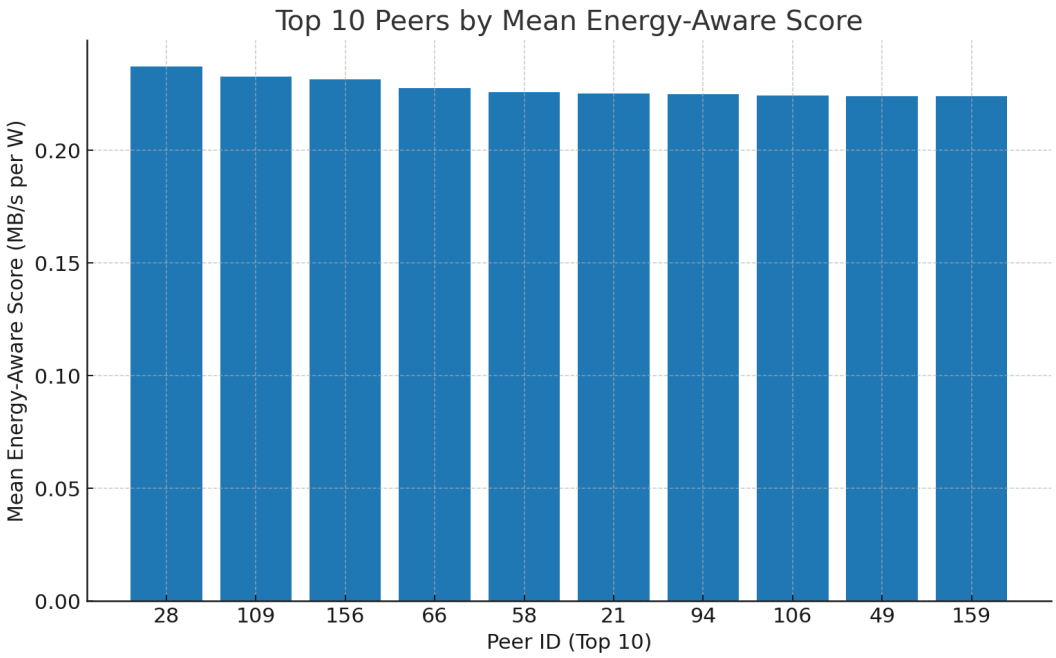
Upload Speed Histogram:



Energy vs Upload Speed Scatter Plot:



Top 10 Peer Scores Chart:



8. Conclusion

The PoC confirms that the adapted simulation successfully integrates energy-awareness into peer selection. The calculated Energy-Aware Score provides a clear metric to rank peers by efficiency. Analysis with CloudReports shows Policy A reduces energy use while Policy B reduces latency, enabling informed trade-offs in P2P system design.