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Optimizing Network Performance using Weighted Multipath Routing

Junjie Zhang, Kang Xi, H. Jonathan Chao

Polytechnic Institute of New York University

NEW YORK UNIVERSITY

Agenda

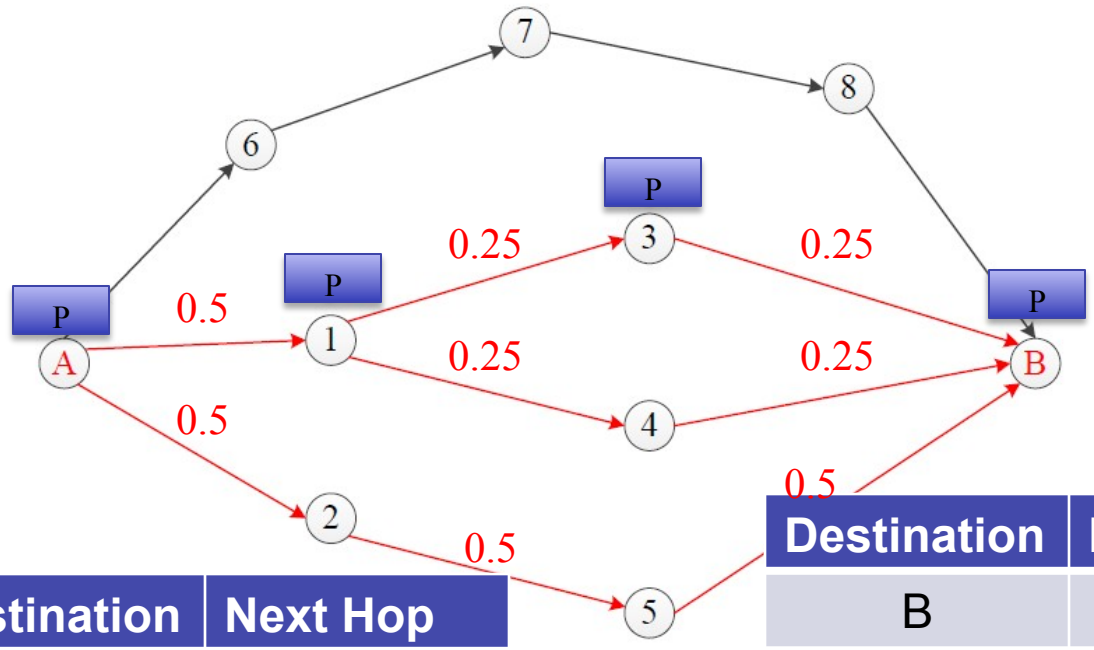
- Background
  - Multipath routing
  - ECMP: equal-cost multipath
  - The problems
- Our approach
  - Source routing model
  - Conversion from source routing to IP routing
  - Performance Evaluation

Multipath Routing & ECMP

- Multipath routing
  - Deliver traffic through multiple paths
  - Load balancing, congestion avoidance
  - Used in practice
- Problem description
  - Given a network with traffic demand matrix, what is the best multipath routing to minimize the max link utilization?
    - How to choose multiple paths
    - How to distribute traffic among these paths.
- ECMP: equal-cost multipath routing
  - In one router, if there are multiple available next hops for one destination, traffic headed to that destination would be evenly distributed among those next hops.

Example of ECMP

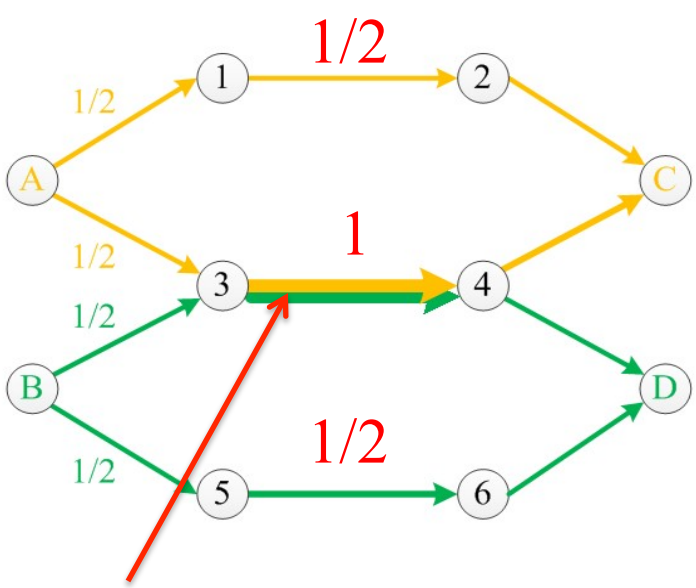
- Assume each link cost = 1, each link capacity = 1.



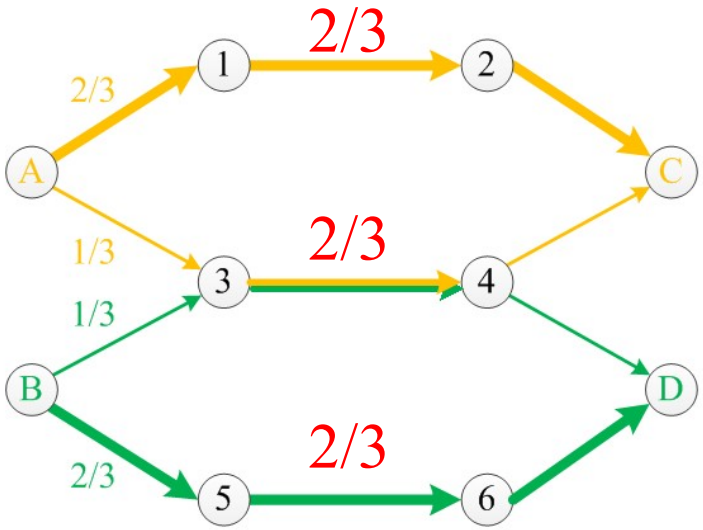
Dest	Destination	Next Hop
	B	3, 4

Destination	Next Hop
B	B

Problem of ECMP and Intuition



Bottleneck link



Better traffic allocation

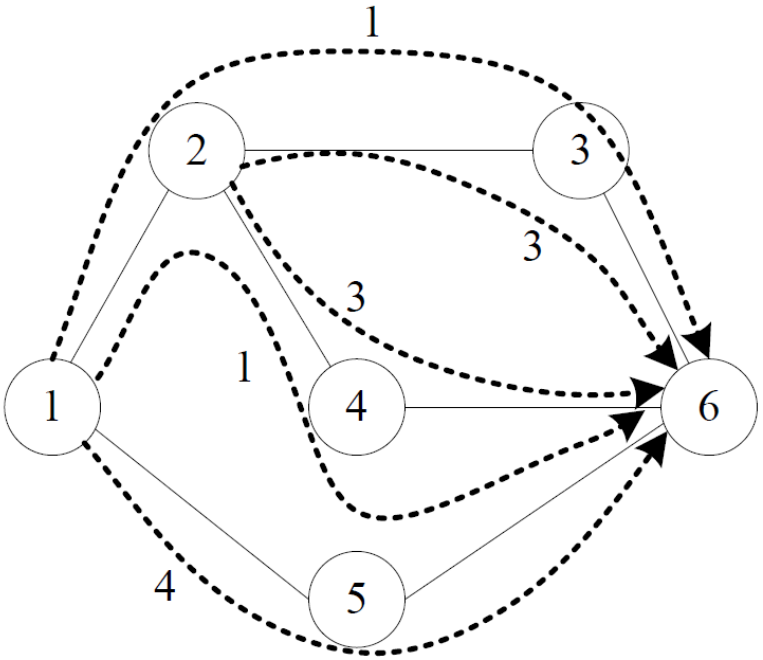
The challenge is how to distribute traffic efficiently, so that network performance is optimized !

How to Design a Weighted ECMP?

- Mathematical formulation and optimal solution
  - High complexity
- Heuristics
  - How to develop a low-complexity algorithm?

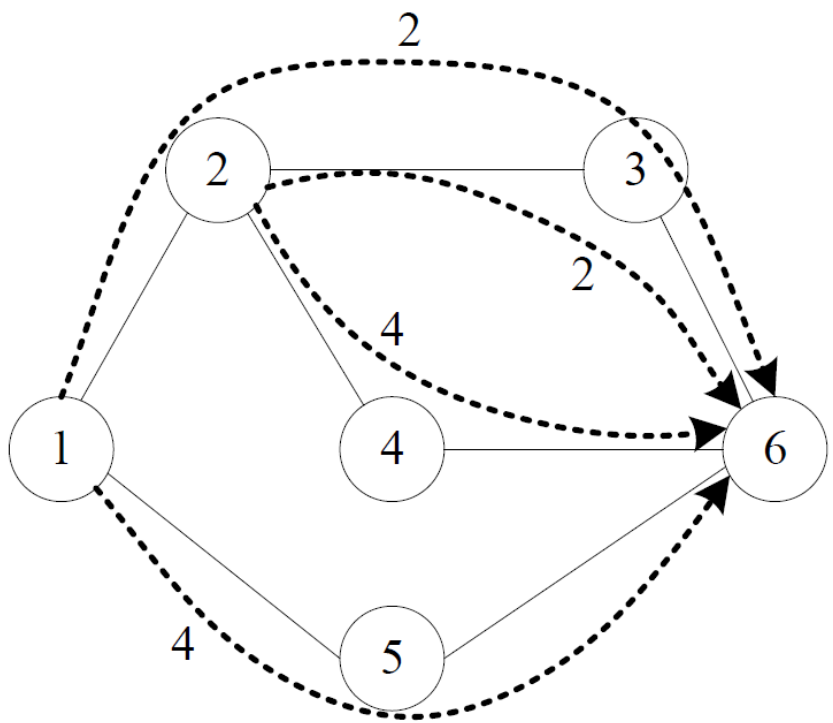
Heuristic Algorithm in IP Routing

- IP routing is destination-based
- Each router performs ECMP traffic splitting and affects the downstream traffic distribution on many branches.

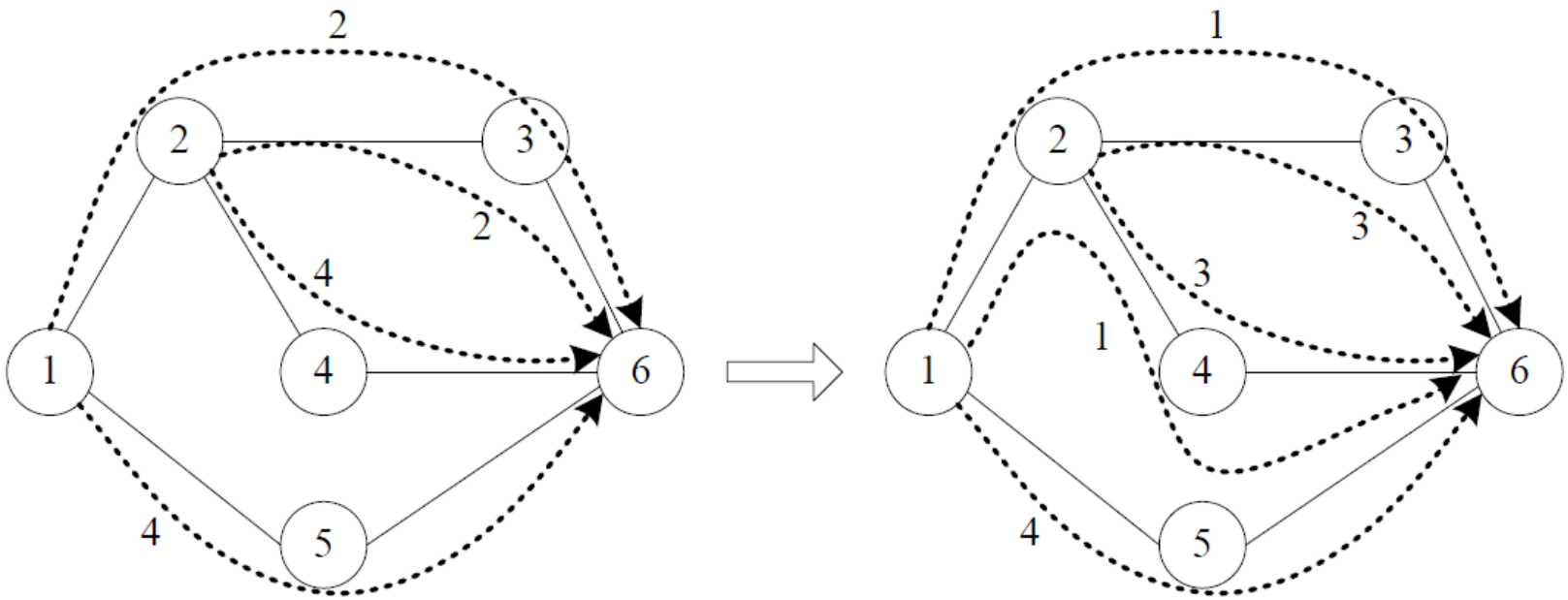


Heuristic in Source Routing

- Source node splits traffic and decides routing



Possible to Convert Source Routing to IP Routing?

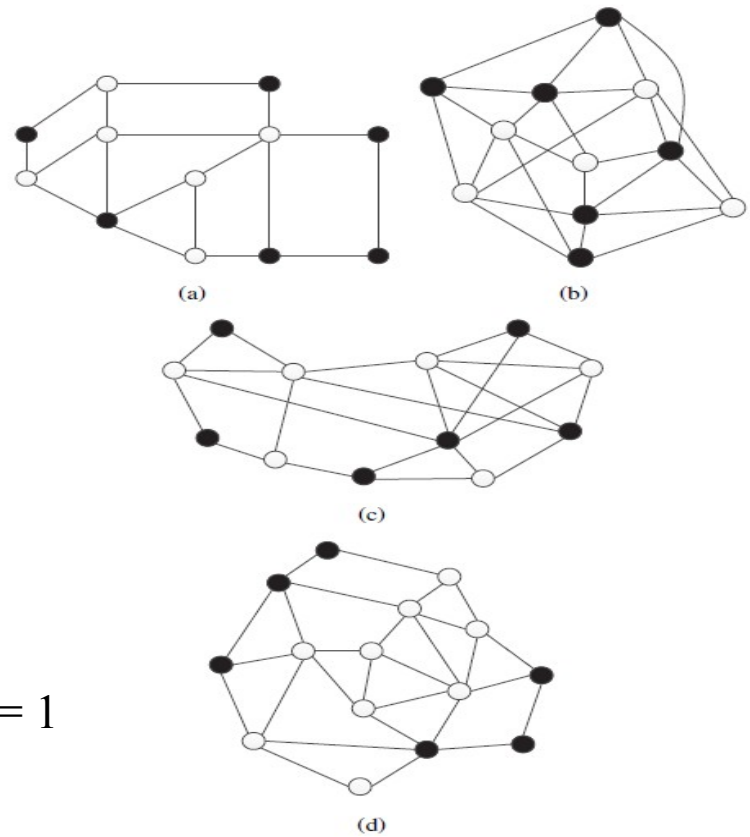


Yes, proved!

Solution to Weighted ECMP

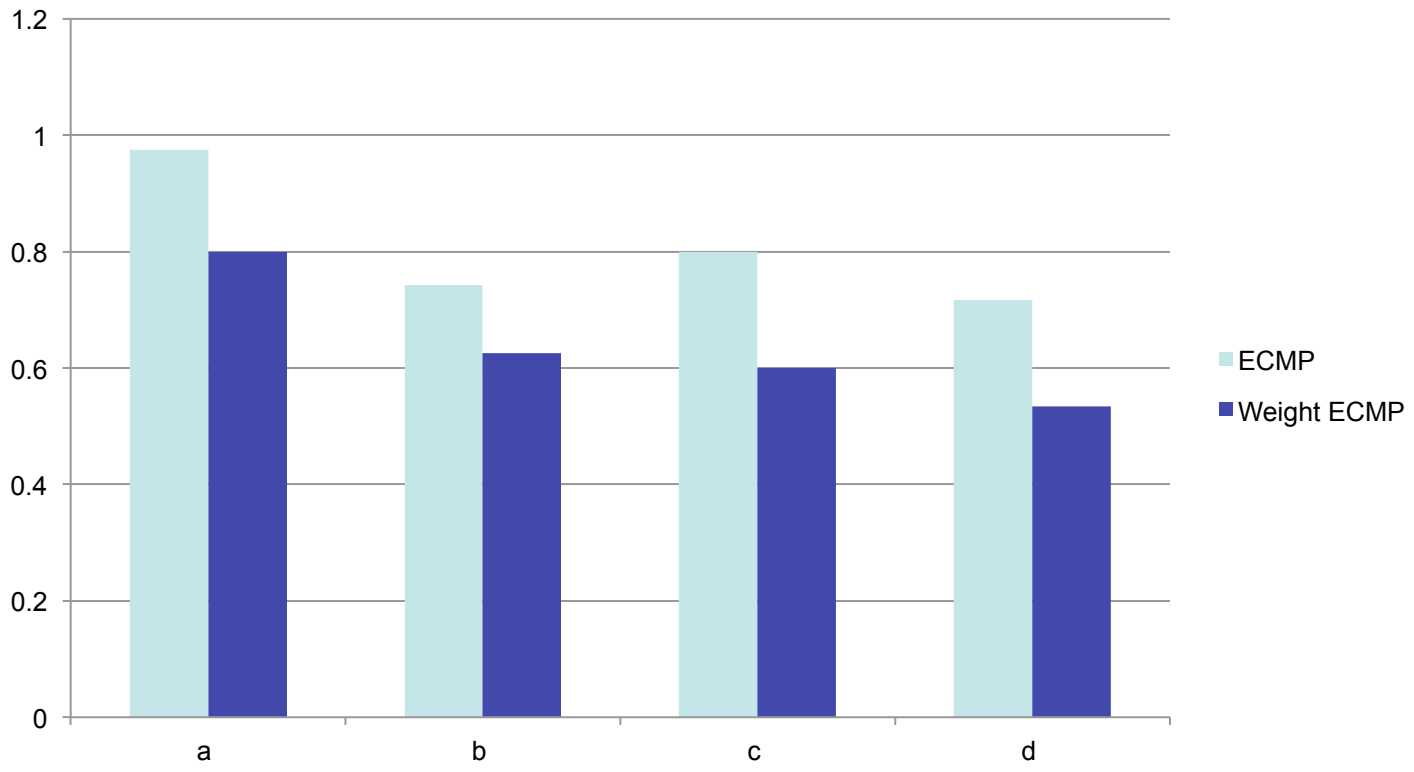
- Use a heuristic algorithm to find optimal traffic distribution based on source routing (done using simulated annealing)
- Convert the source routing solution to IP routing ECMP split ratios
- Configure the routing tables

Topologies



Link capacity = 25
Demand = 5
Initial link weight = 1

Maximum Link Utilization



Conclusion

- Given a network with traffic matrix, weighted ECMP is able to significantly improve load balancing compared to ECMP.
- Low-complexity heuristic algorithms can be developed based on source routing. After that, the results can be converted to IP routing.

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Thank you !