Characterizing Selfishly Constructed Overlay Routing Networks

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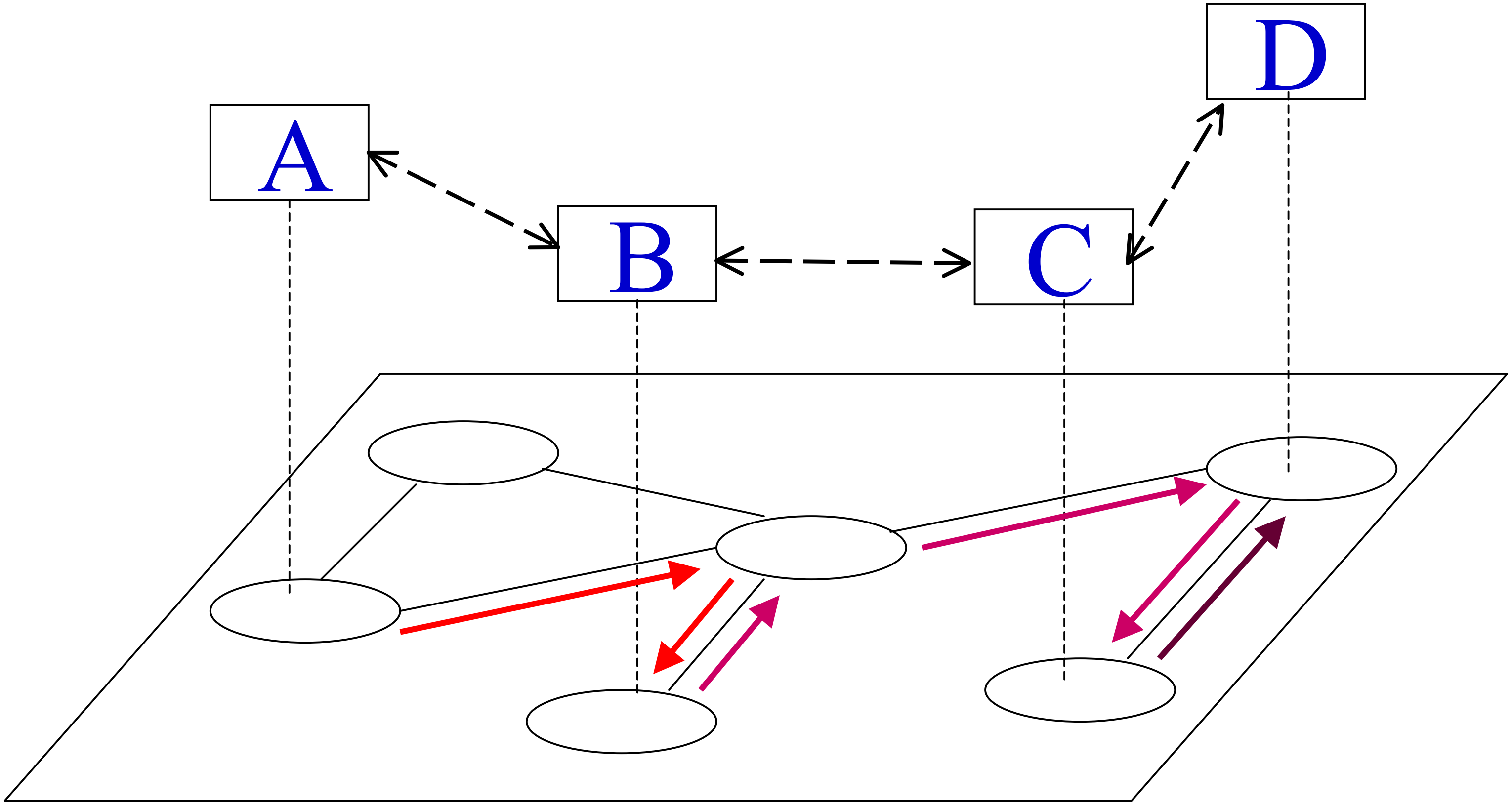
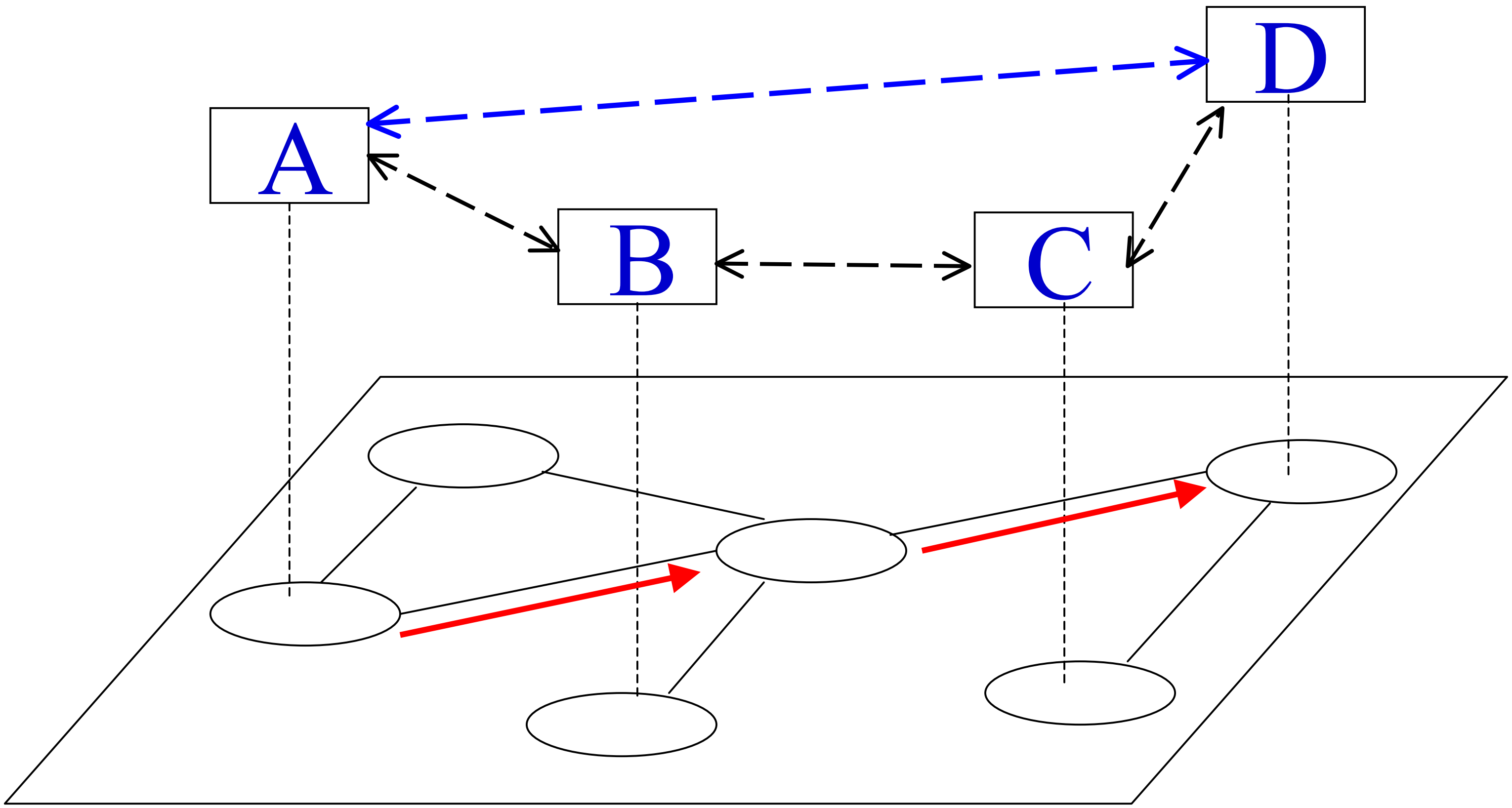
Motivation



Motivation



Network Creation Model

- Extension of the model of Fabrikant et al.
- Non-cooperative game of n overlay nodes
  - Each node choose neighbors to set up links to minimize its cost

$$C_i(s) = \alpha \boxed{\sum_{j \in B(i)} t_j} + \boxed{\sum_{j=0}^{n-1} d_{G[s]}(i,j)}$$

  - Each node reaches the stable state where no node can benefit by changing its links, while the other nodes keep their links unchanged.

Case Study (Simple)

- Physical topology: fully-connected topology with unit distance between nodes
- $d_G(i,j)$: number of hops
-

Cost Model	Linking Cost (t_j)
Unit	1
Exponential	c_j ($E(c_j)=1$)
Node-degree	degree(j)

[Fabrikant et al. 03]

- 20 overlay nodes
- Exhaustive search

Case Study (Realistic)

- Physical topology: transit-stub topology
- $d_G(i,j)$: latency from physical topology
- Linking cost (t_j) : Unit with the degree bound (MaxDegree)
- 100 overlay nodes
- Randomized local search: similar to Narada ([Chu et al. 03])

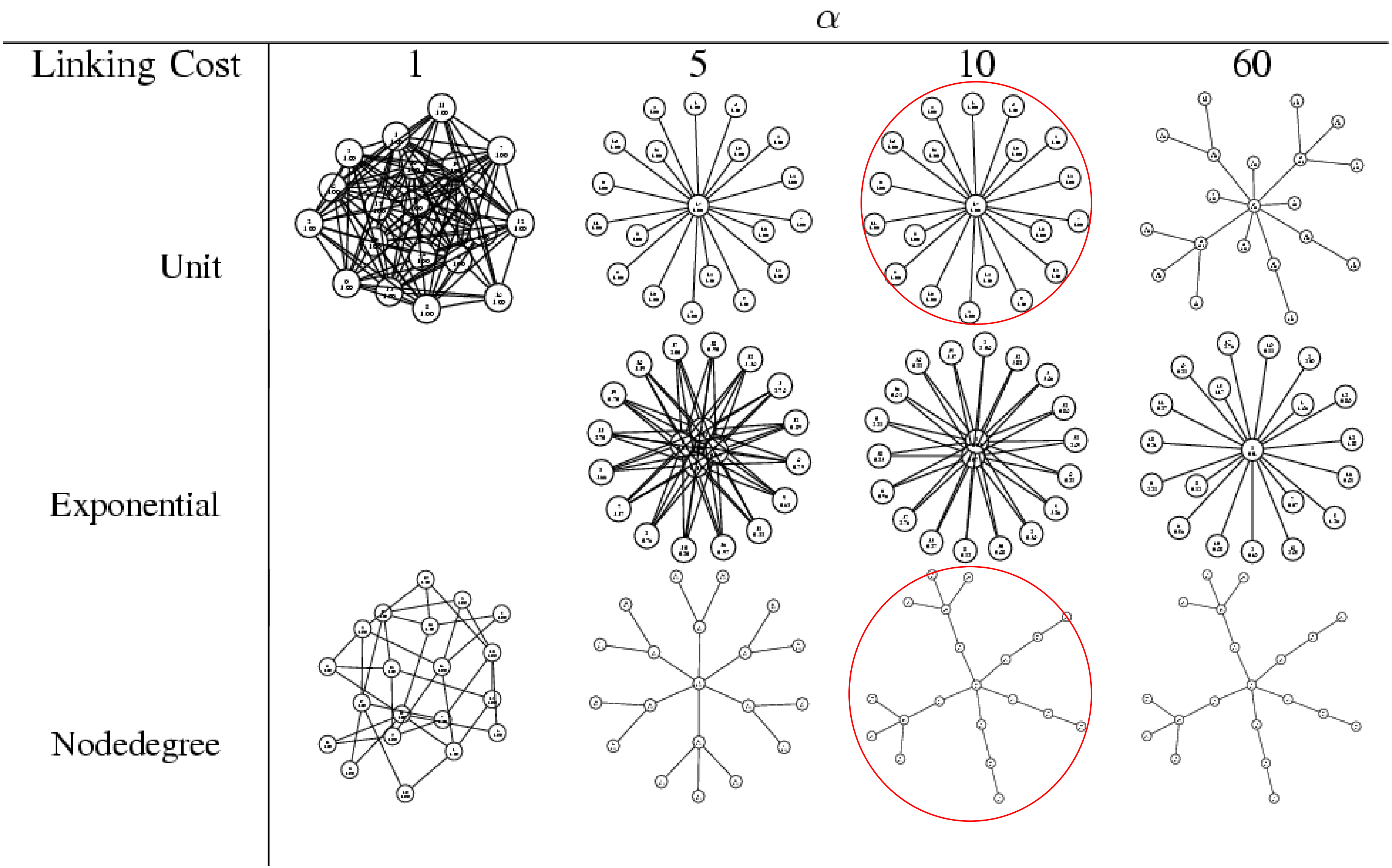
Case Study (Realistic)

- Each node runs link addition and dropping.
- Link addition
  - Randomly select a node not in the neighbor set, compute latency, and get the linking cost
  - If its cost decreases with the selected node, add the link
- Link Dropping
  - For each node in the neighbor set, compute the cost without the node.
  - Pick up the node whose removal gives minimum cost.
  - If its cost decreases by dropping the neighbor, drop the link.

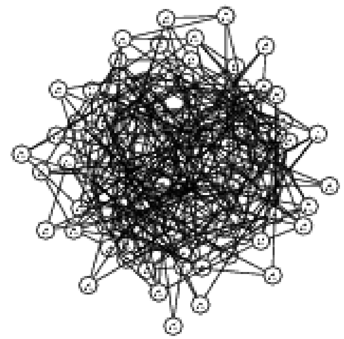
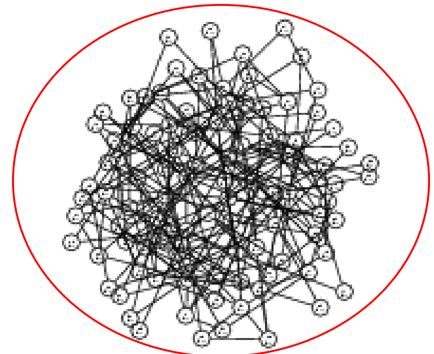
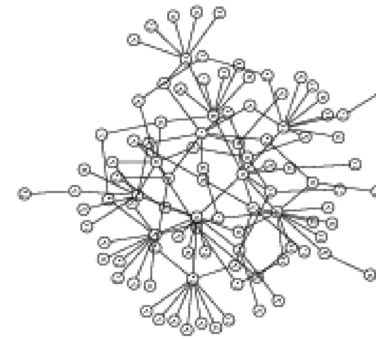
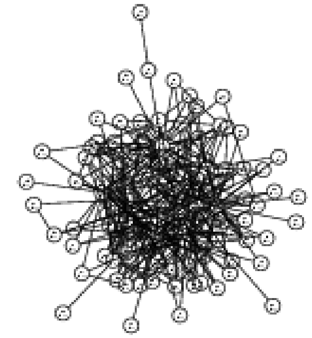
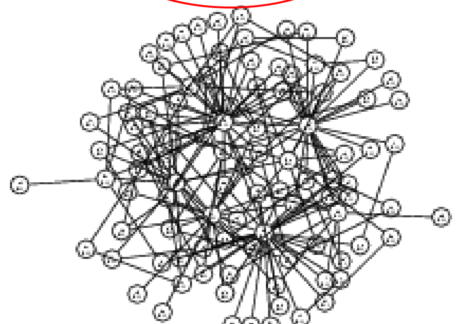
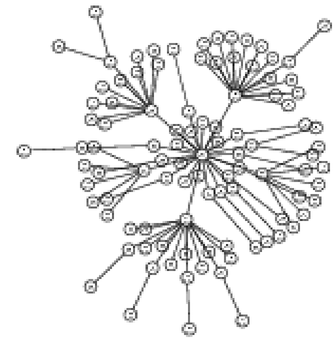
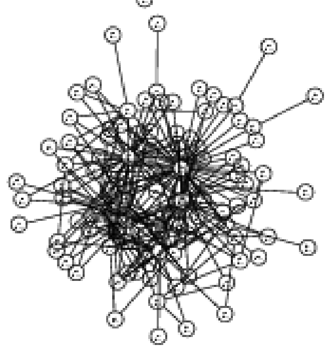
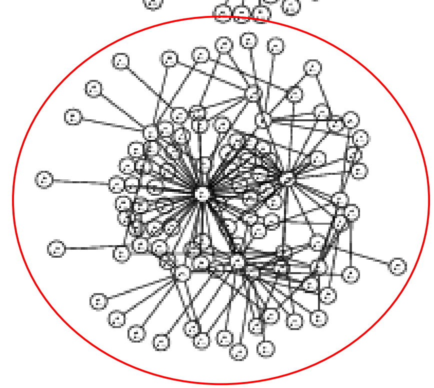
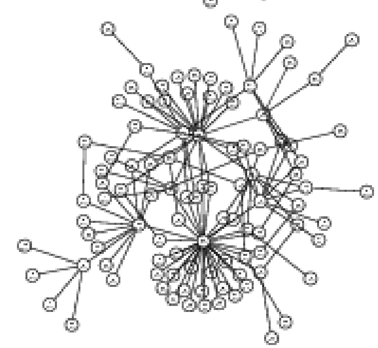
Simulation Results

- Widely different networks produced by selfish nodes
  - Simple scenario: complete graphs, k-regular graphs, k-core stars, trees
  - Realistic scenario: networks with exponential degree distribution or Pareto degree distribution
- Tradeoff between performance and resilience in the selfishly constructed networks

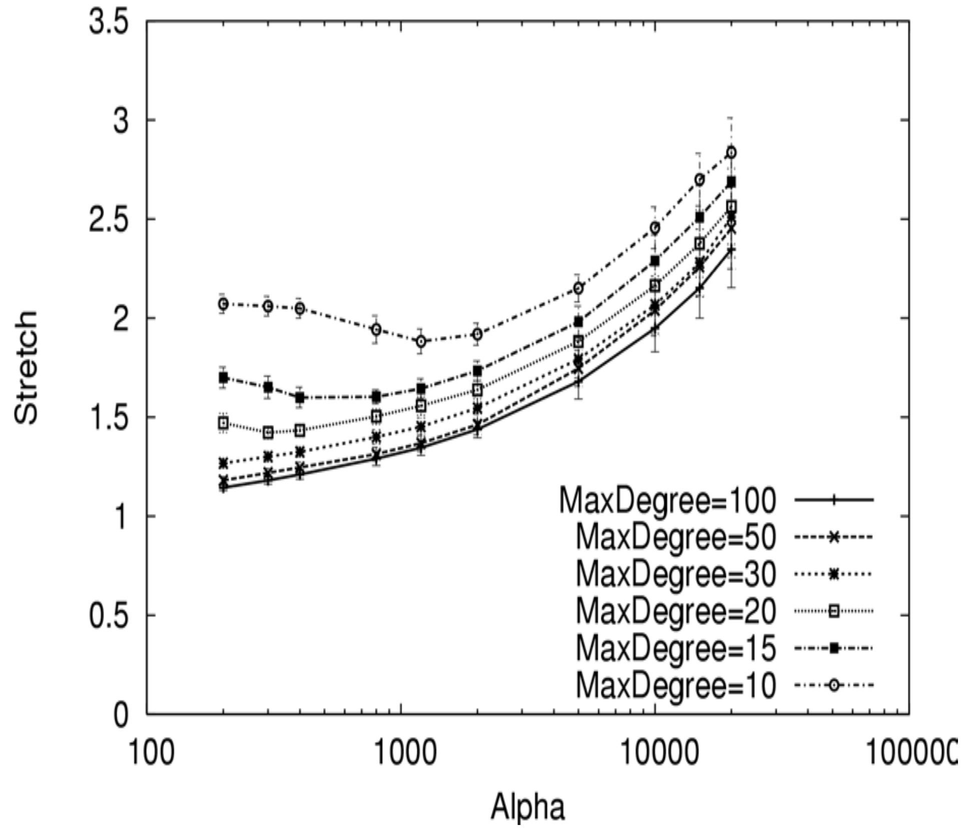
Topology (Simple)



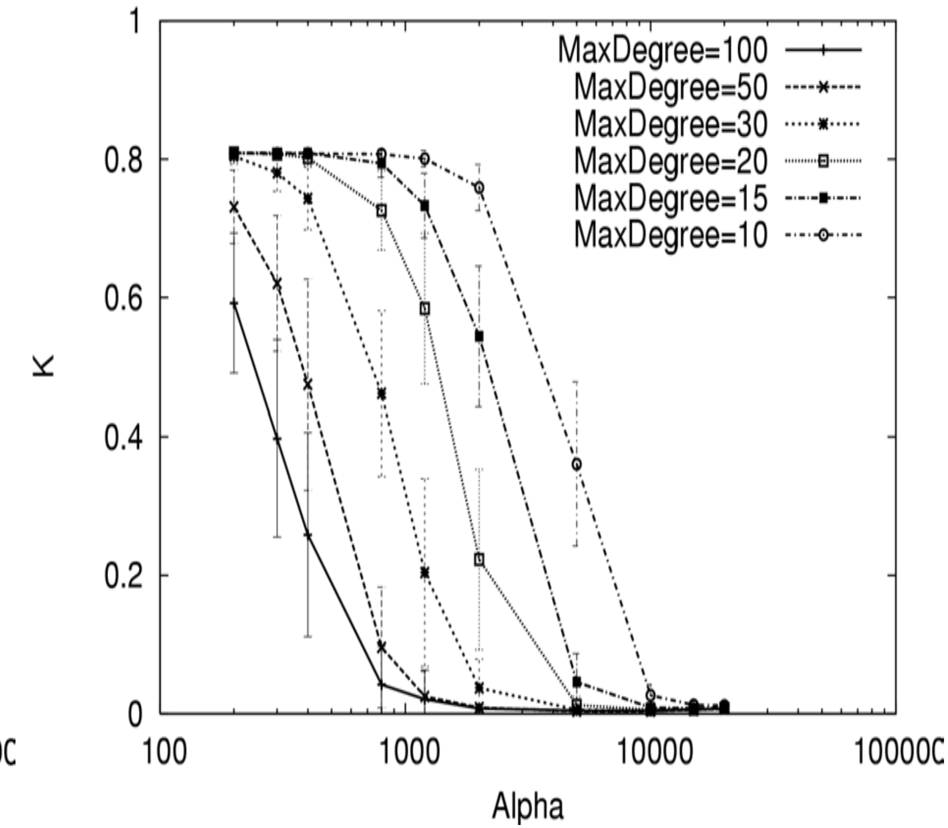
Topology (Realistic)

	α		
Max Degree	800	2000	10000
10			
30			
100			

Performance / Resilience (Realistic)

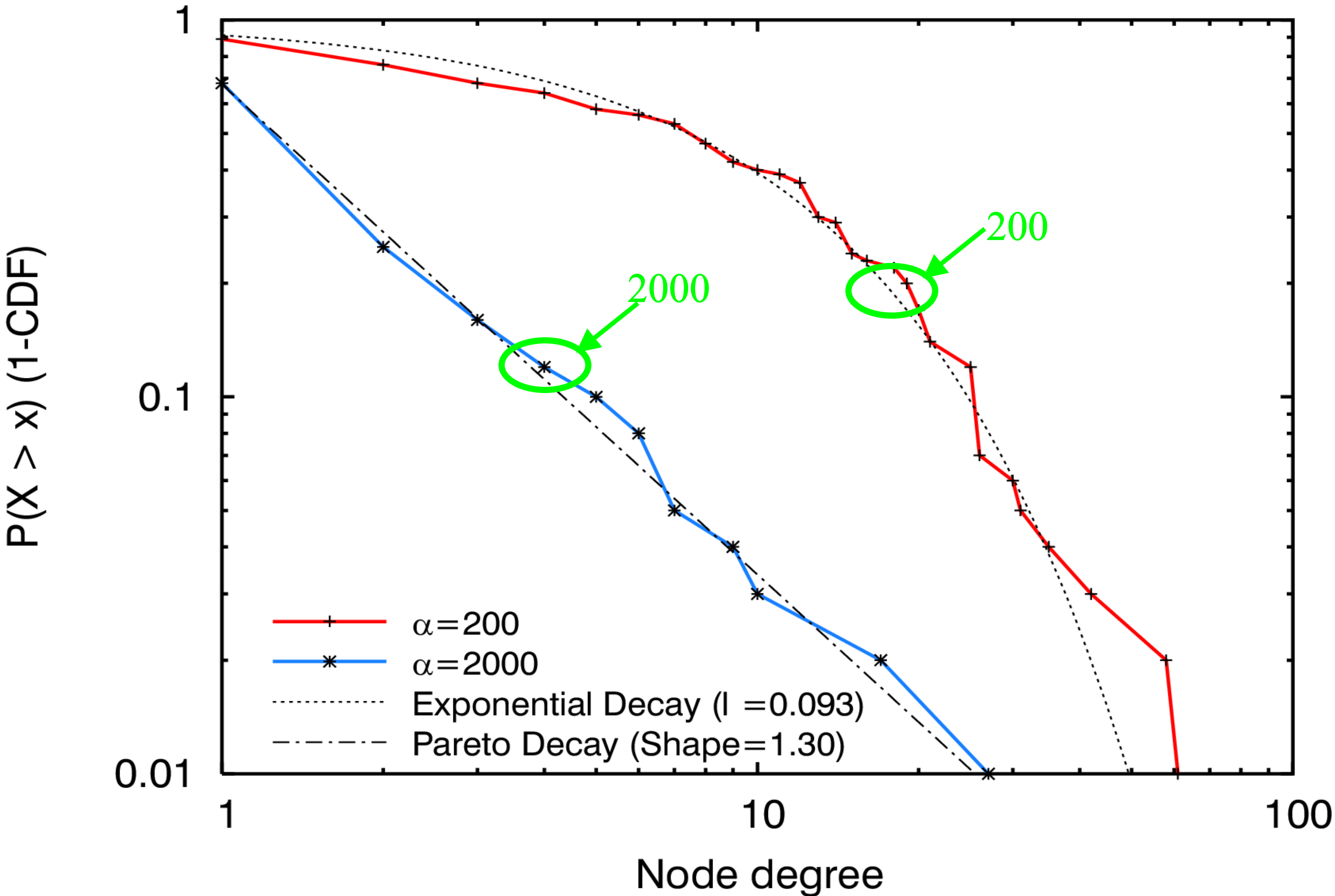


(a) Stretch



(b) Attack tolerance (10% subject to attacks)

Degree Distribution (Realistic)



Conclusion

- Examine networks created by selfish nodes using a non-cooperative game model
- Show diverse networks produced by games when we vary α, linking cost functions, and underlying physical topology.
  - Complete graphs to trees with different properties
  - Networks with node degree distribution whose tails vary from exponential to pareto.
- Show the tradeoff between performance and resilience when we vary parameters.

Future Work

- Variations of linking cost functions
- Relationship between the underlying topology and the produced overlay topologies
- Dynamic network
- Traffic into consideration
- Different cost metrics
- Algorithmic mechanism design

Questions?