

# WARNING!

**Superficial sociological interpretation  
followed by simplistic computer simulation**



- *Some say that....*
- *Increasingly, in post-industrial societies,*
- *old social identities are breaking down*
- *People structure interaction around superficial and ephemeral symbols and “brands”*
- *Postmodern culture is seen as broken into transitory and superficial groups – neo-tribes*
- *Corporations use “tribal marketing” to create them*
- *“Without the rigidity of the forms of organization with which we are familiar, it refers to a certain ambience, a state of mind, and is preferably to be expressed through lifestyles that favour appearance and form.” (Maffesoli 1996:98)*



- Interestingly, there is a rise of a certain kind of technology
- Computers on the internet form ephemeral teams to service user needs
- P2P systems like kazaa, bittorrent, skype
- We find that simple rules of superficial attachment based on “tags” can support high levels of cooperation and trust
- But our early models produced highly disconnected “tribes”
- We introduce a simple enhancement that gives small-world fully connected “tribes”
- Our aim is to actually create functional P2P systems over the internet rather than understand human systems
- Since P2P are a new kind of social system, by creating them we change social realities rather than trying to reflect them.

# DELIS

Dynamically Evolving, Large-scale Information Systems



## SLAC and SLACER:

# Socially inspired copy & rewire algorithms for trust and cooperation in P2P

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Information Society  
Technologies

## Self-Organising Cooperation in Peer-to-Peer Systems

- Algorithm based on social simulation models of “tags”
  - Introduced by Holland early 1990’s
  - Developed recently by Riolo; Hales; Edmonds.
- Tags are observable “markings”, labels or social cues, attached to agents (e.g. hairstyle, dress, accent)
- In an evolutionary algorithm tags evolved just like any other artificial gene in the “genotype”
- They are displayed directly in the “phenotype”
- When agents bias interactions towards those with similar tags, even selfish evolution selects for cooperative and altruistic behaviour

## Self-Organising Cooperation in Peer-to-Peer Systems

*We translated the tag algorithm into a network*

- nodes move to find “better” neighbors
- producing a kind of evolution in the network
- “bad guys” become isolated

*Results in a “duplicate and re-wire” rule*

- Producing a kind of “group selection” between clusters
- a functional reason for temporal structures found in the “natural” networks?

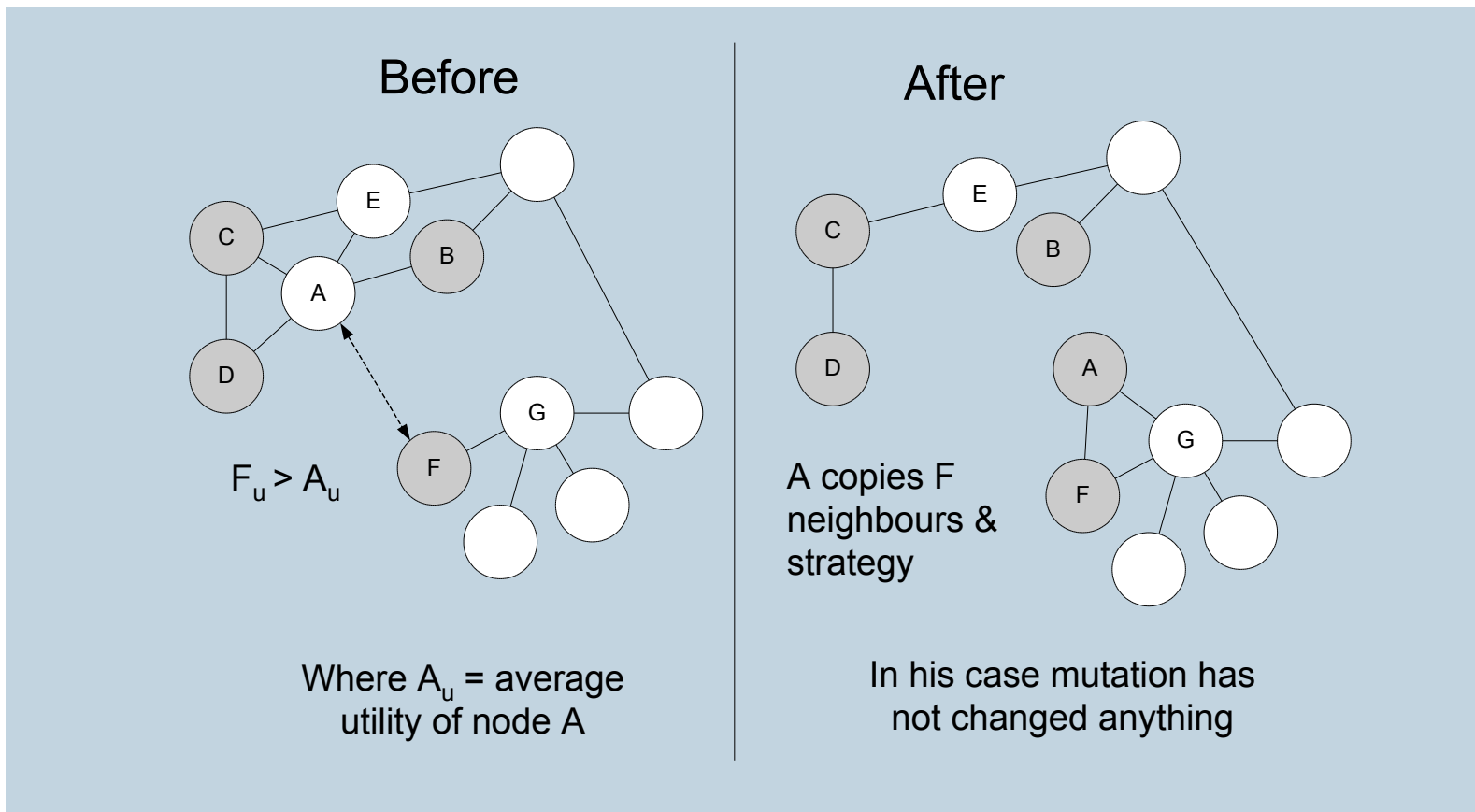
## Self-Organising Cooperation in Peer-to-Peer Systems

### *Basic Algorithm*

- Periodically **do**
  - Each node compare “utility” with a random node
  - **if** the other node has higher utility
    - copy that node’s strategy and links (reproduction)
    - mutate (with a small probability):
      - change strategy (behavior)
      - change neighborhood (links)
  - **fi**
- **od**

### Self-Organising Cooperation in Peer-to-Peer Systems

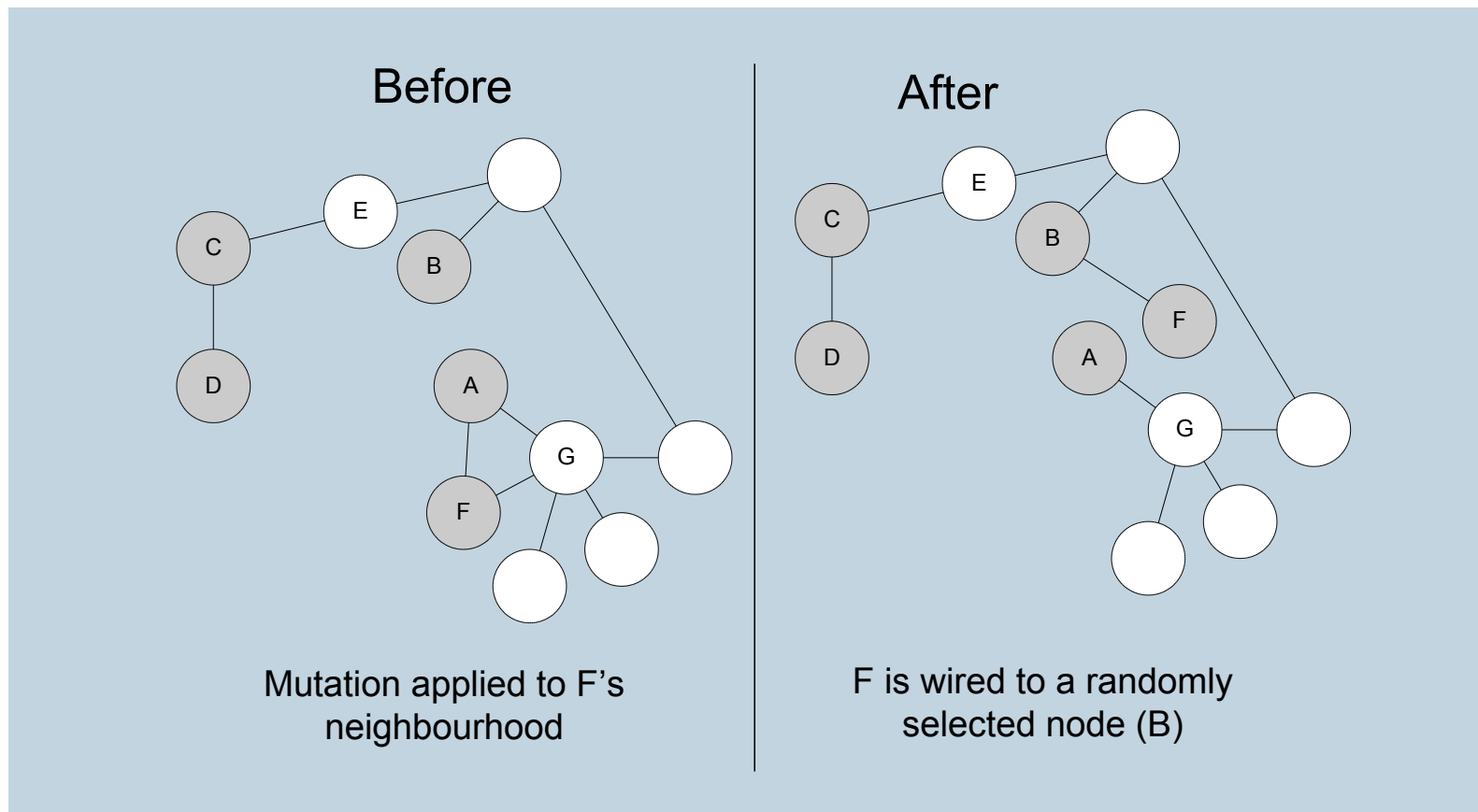
*“Reproduction” = copying a more successful node*





### Self-Organising Cooperation in Peer-to-Peer Systems

*“Mutation of the neighbourhood” = random movement in the net*

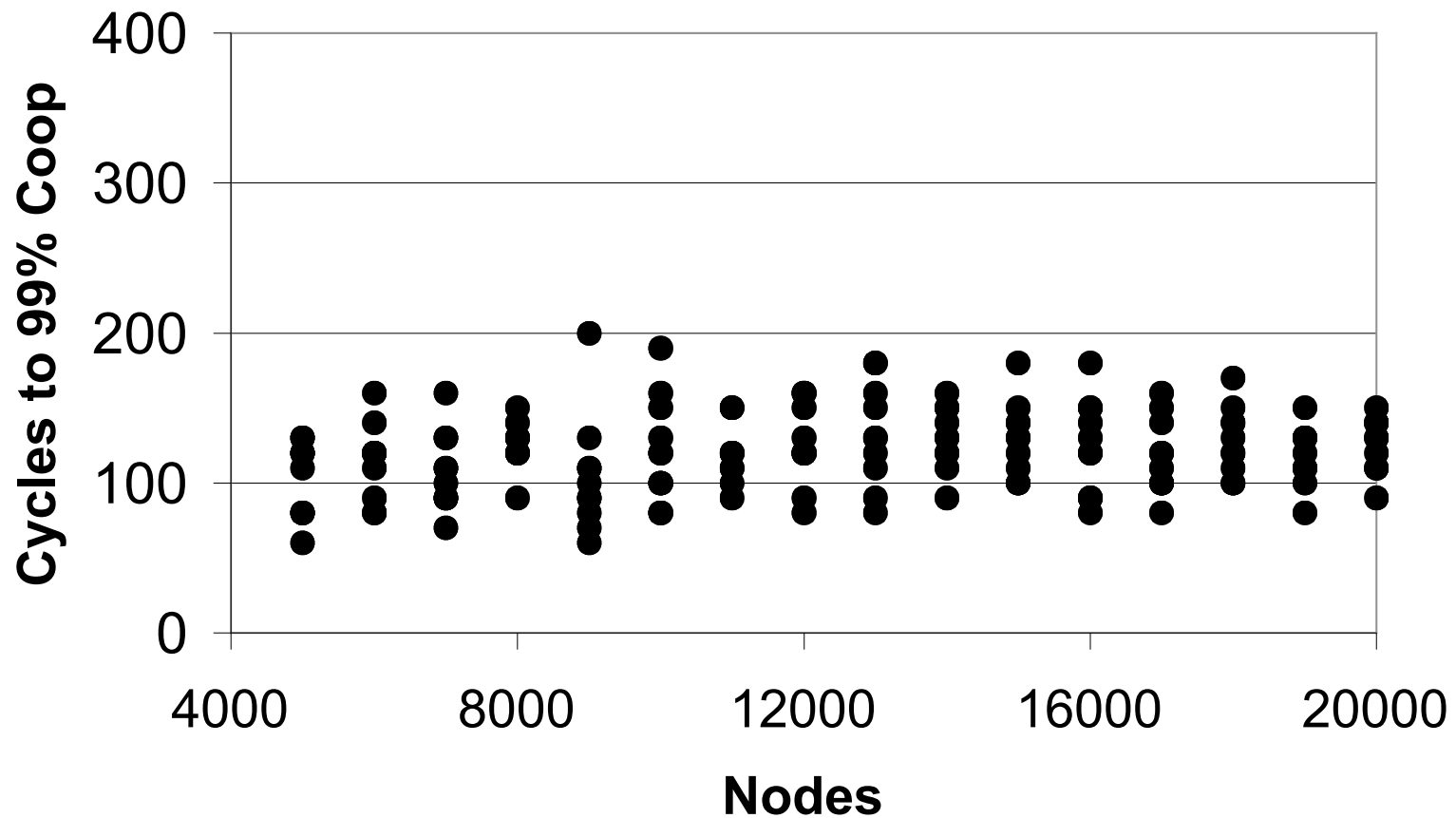


## Self-Organising Cooperation in Peer-to-Peer Systems

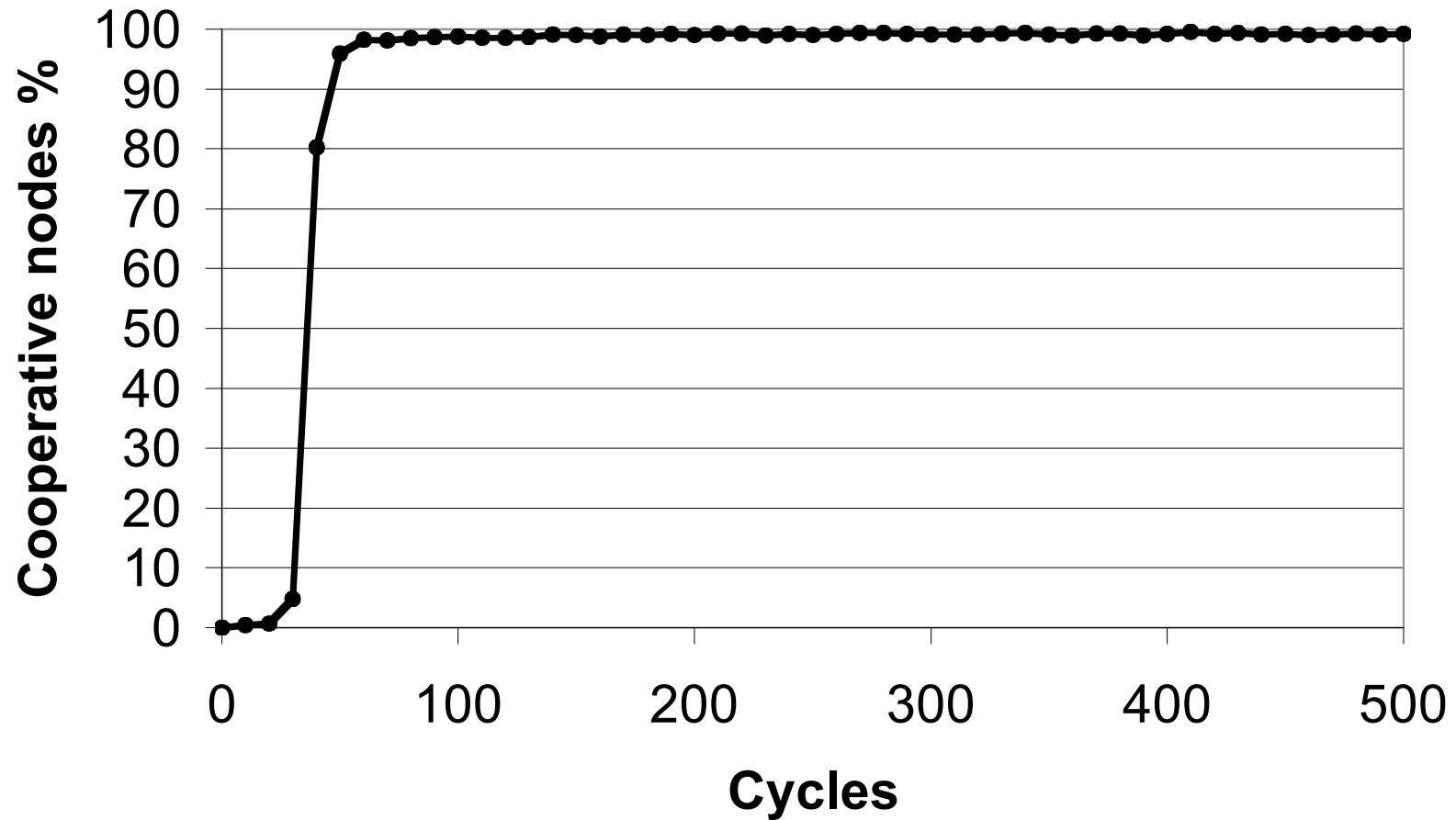
### *Applied to a simulated Prisoner's Dilemma Scenario:*

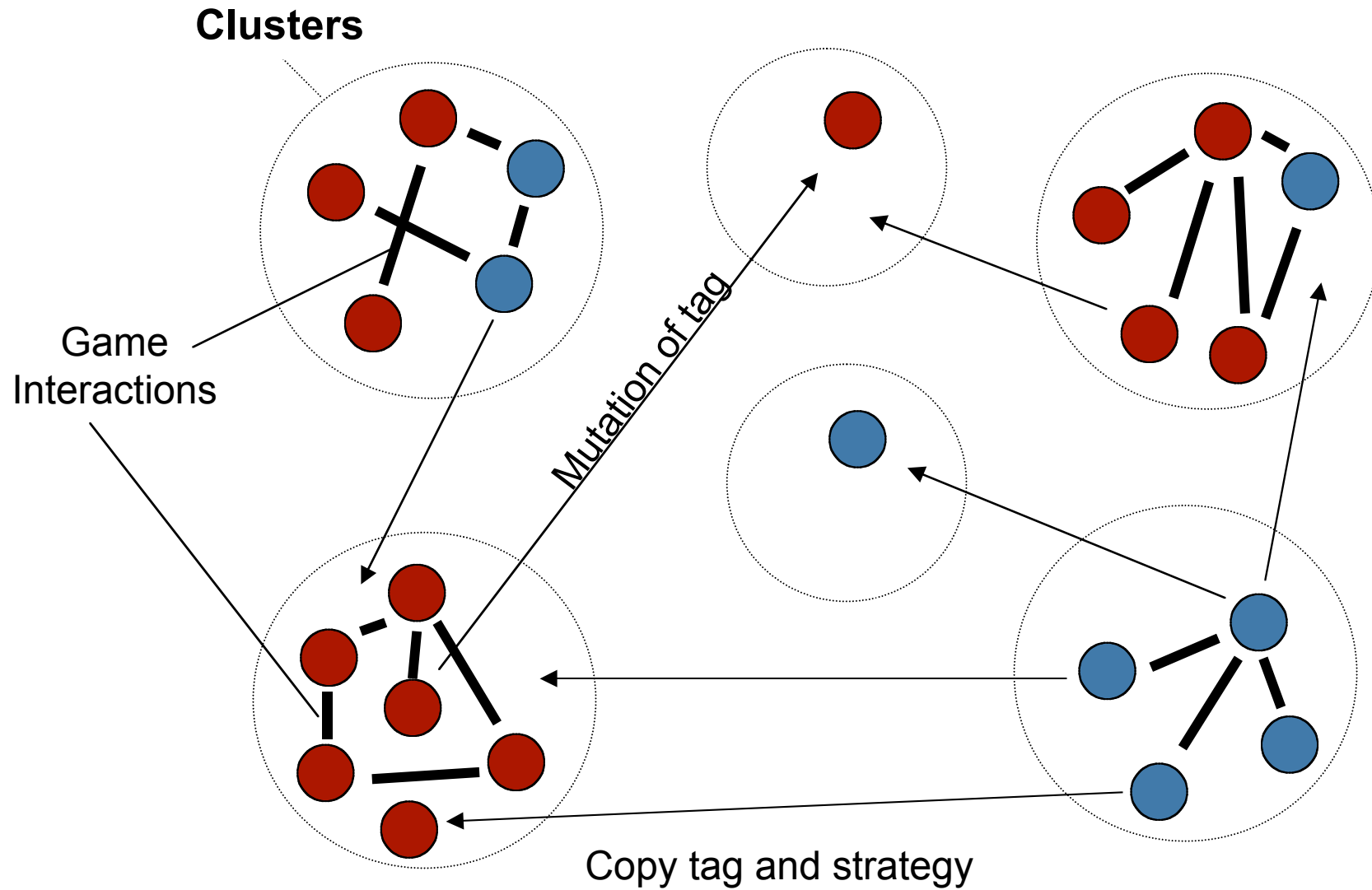
- Where selfish behavior produces poor performance – Nash Eq.
- Nodes store a pure strategy, either cooperate or defect
  - *Play the single round PD with randomly selected neighbours*
  - *Using their strategy*
- We take average payoff as the node utility
- Mutation of strategy: flip strategy
- Nodes randomly selected to play a random neighbours some number of times each period

## Cycles to High Cooperation



### Typical Individual Run





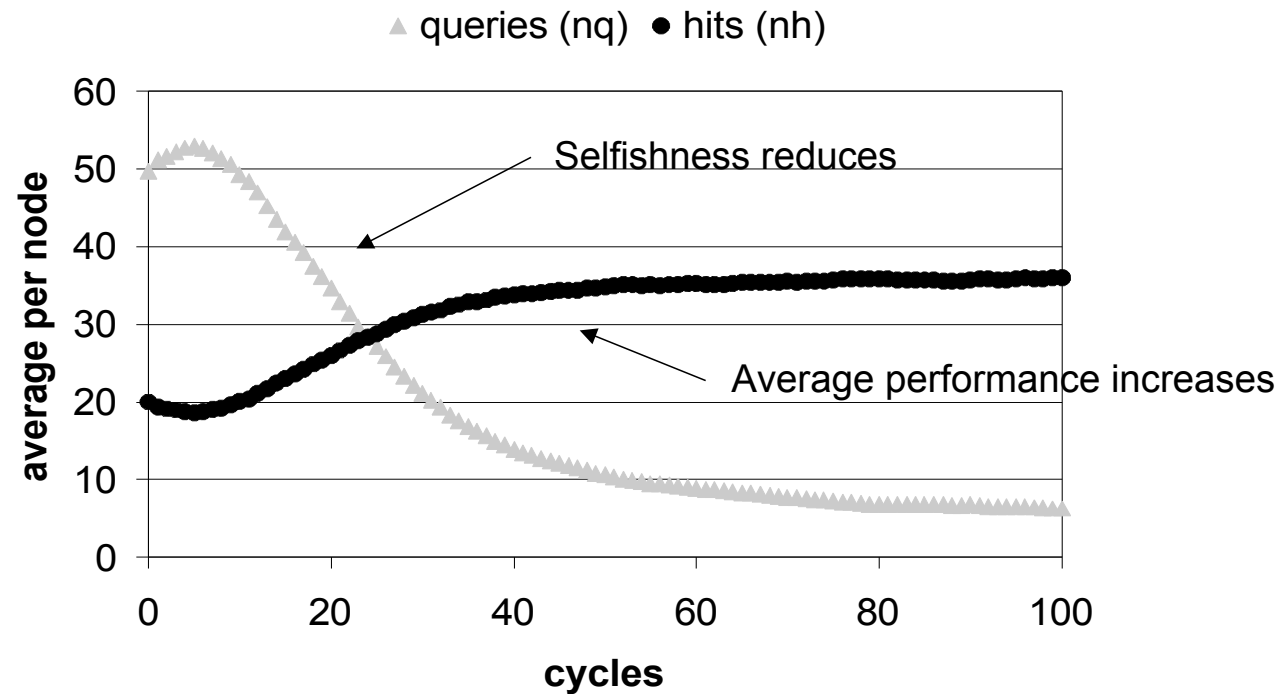
## Self-Organising Cooperation in Peer-to-Peer Systems

### *Applied to a simulated P2P File Sharing Scenario:*

- Simplified form of that given by Q. Sun & H. Garcia-Molina 2004
- Nodes control how much capacity devoted to generating or answering queries based on  $P = [0..1]$ 
  - $P = 1.0$  *selfish* (only generates queries)
  - $P = 0.0$  *altruist* (only answers queries)
- We take as node utility the number of *hits*
- Mutation of strategy: change  $P$  randomly
- Flood fill query method, TTL's etc

### Self-Organising Cooperation in Peer-to-Peer Systems

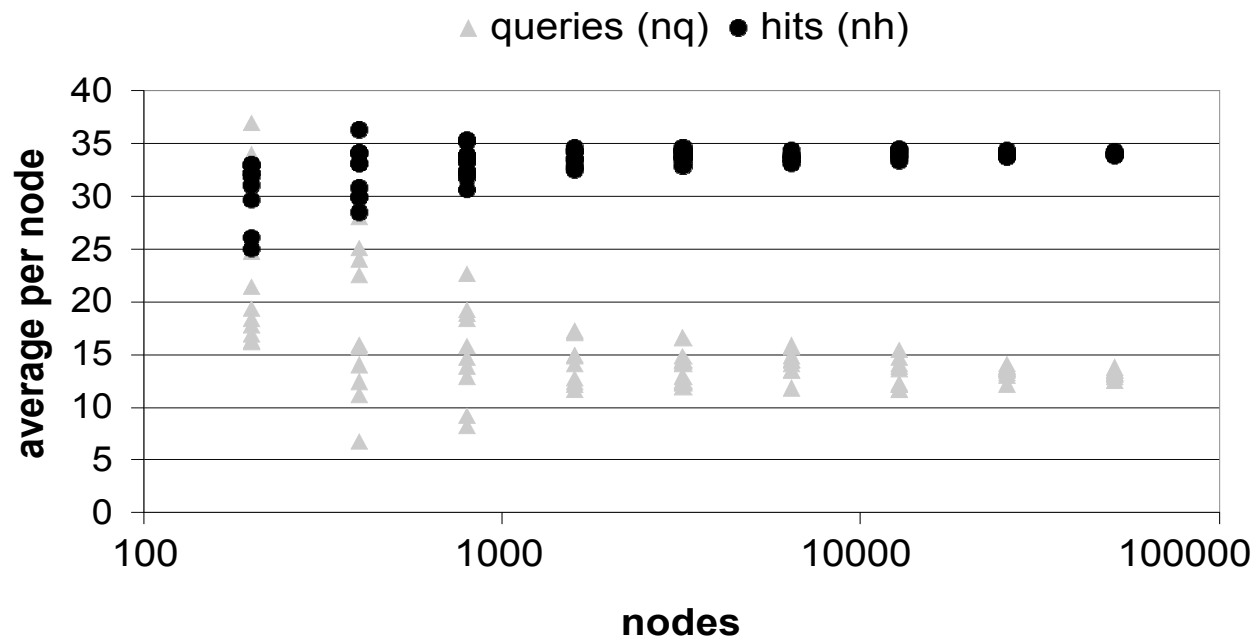
#### *Some simulation results*



A typical run for a  $10^4$  node network

### Self-Organising Cooperation in Peer-to-Peer Systems

#### *Some simulation results*



Results showing number of queries (nq) and number of hits (nh) (averaged over cycle 40..50) for different network sizes with 10 individual runs for each network size

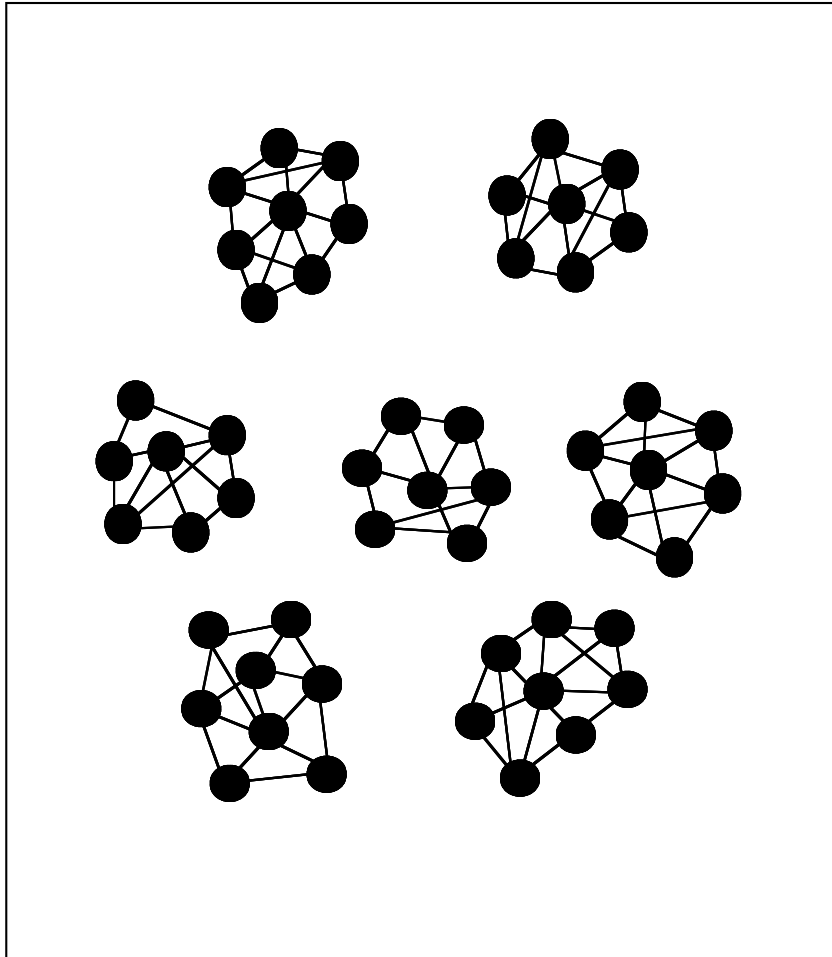




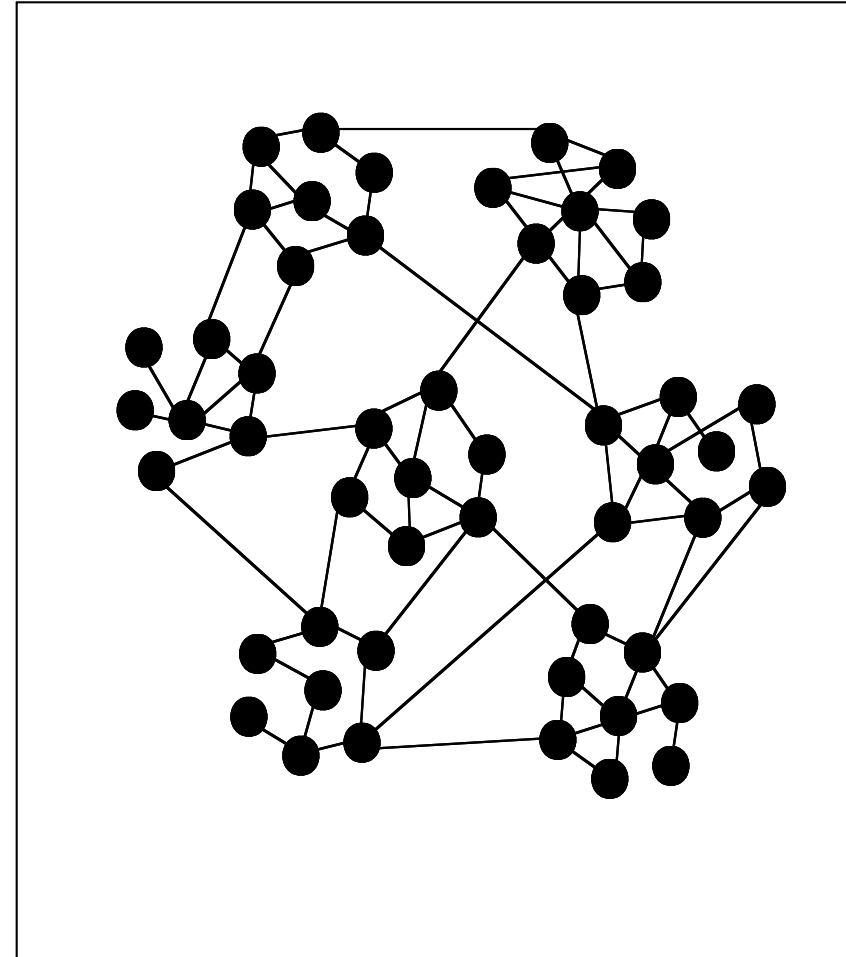
- SLAC is OK for some tasks – as we have seen
- But produces disconnected components
- This is no good when we want
- An “Artificial Friendship Network” to span the network
- Connected – such that all nodes are linked with short path
- Chains of trust between all nodes – preferably short also
- To achieve this we modify SLAC and introduce SLACER

### *Basic Algorithm*

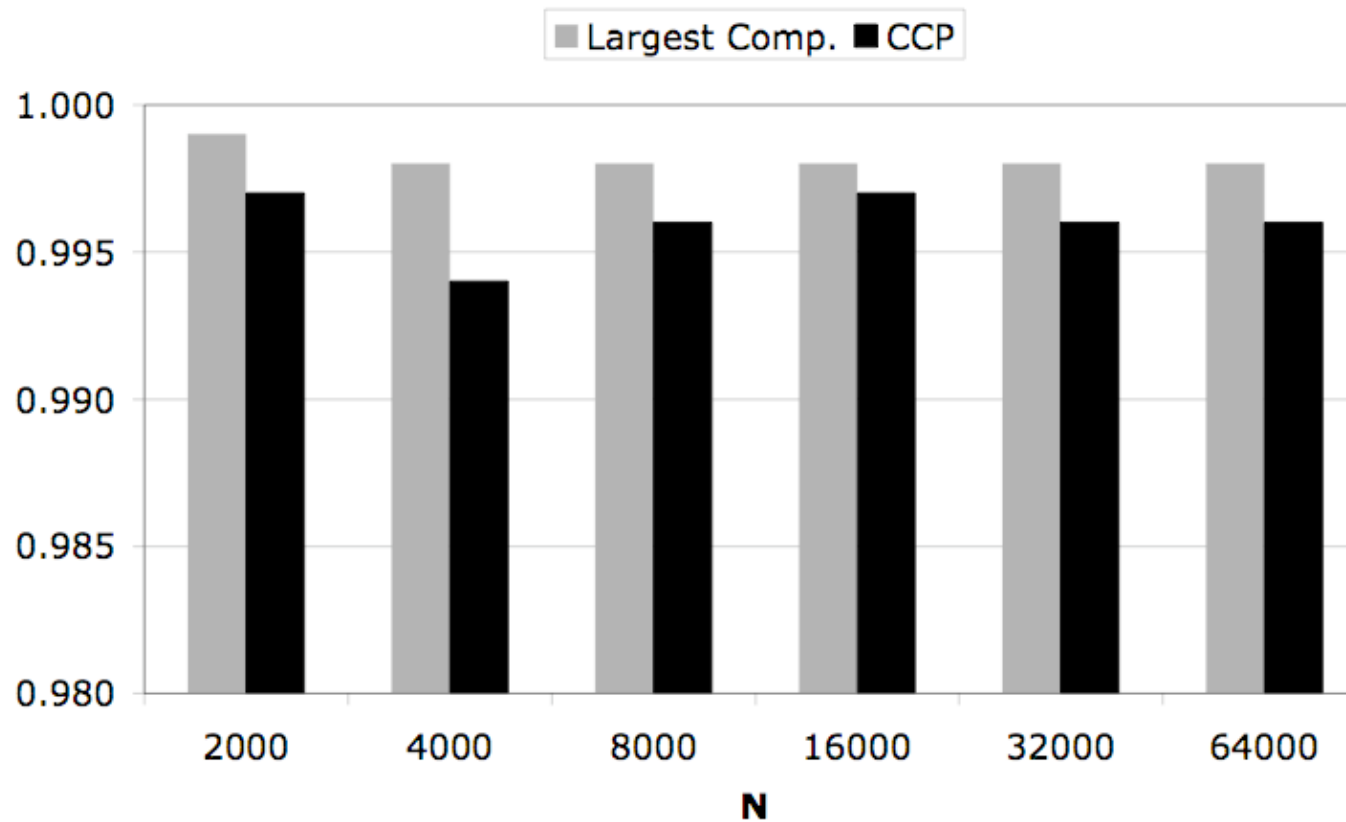
- Periodically **do**
  - Each node compare “utility” with a random node
  - **if** the other node has higher utility
    - copy that node’s strategy and links, probabilistically retaining some existing links
    - mutate (with a small probability):  
change strategy (behavior)  
change neighborhood (links), probabilistically retaining some existing links
  - **fi**
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SLAC

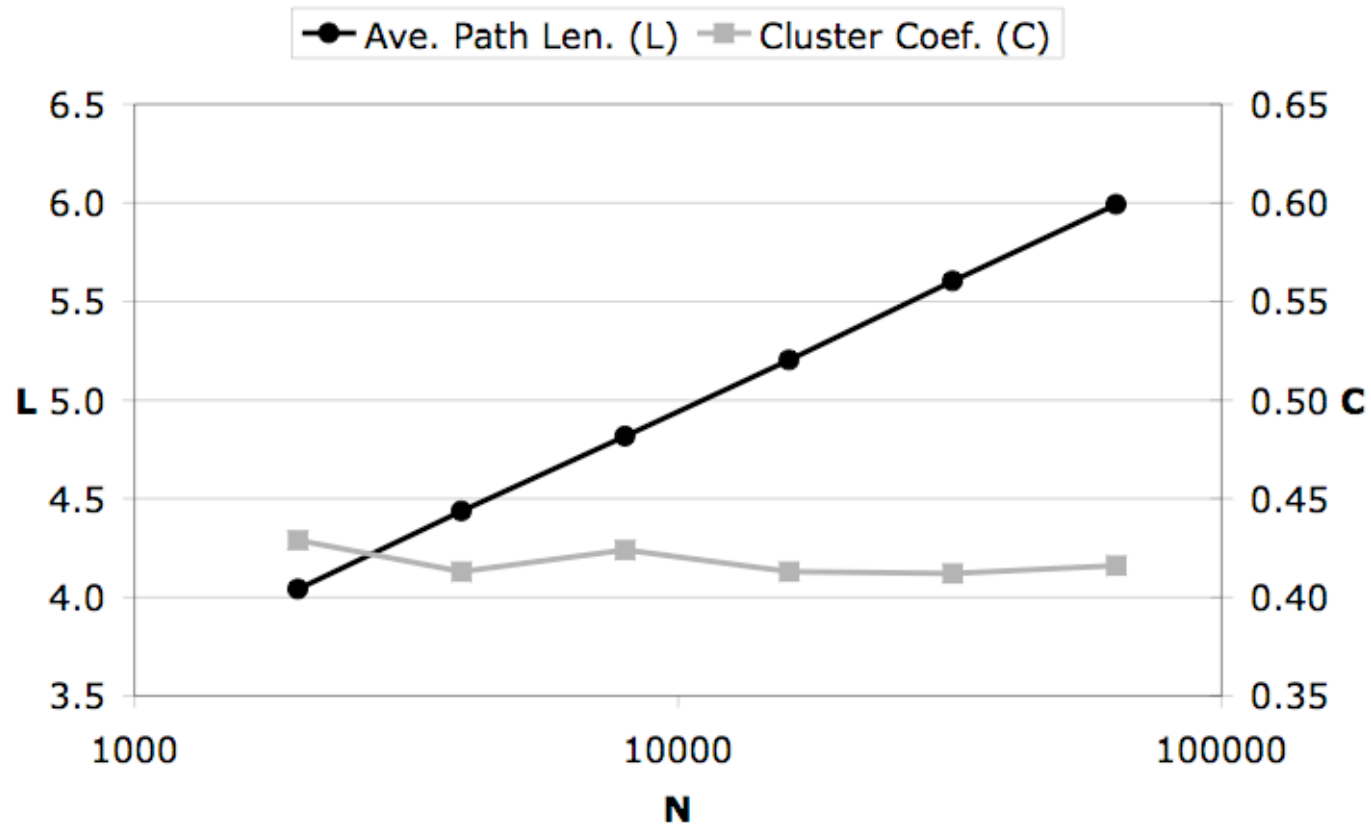


SLACER





- By establishing a fully connected “Artificial Social Network” (ASN)
- This can be used as input to existing P2P applications
- Specifically those that assume or require trusted social networks as input
- Currently harvested from e-mail contacts or “buddy lists” in chat applications
- Example: Collective spam filtering:
- *J. S. Kong, P. O. Boykin, B. Rezei, N. Sarshar, and V. Roychowdhury, “Let you cyberalter ego share information and manage spam,” 2005. Available as pre-print: <http://xxx.lanl.gov/abs/physics/0504026>.*





- Simple copy and rewire algorithm
- No need for centralized trust or enforcement mechanism
- No need for knowledge of past interactions
- Process cooperative behavior even when nodes behave in an egotistical way, locally and greedy optimizing
- Works through a kind of “group selection” – “tribal selection”
- Can produce trusted and cooperative Artificial Social Networks
- Could be applied to existing protocols with minor modification
- Available on open source P2P simulation platform Peersim.

# Self-Organising Cooperation in Peer-to-Peer Systems

## References

- *Hales (2004) "From Selfish Nodes to Cooperative Networks", Fourth IEEE International Conference on Peer-to-Peer Computing (p2p2004), IEEE Press*
- *Hales & Edmonds (2005) "Applying a socially-inspired technique (tags) to improve cooperation in P2P Networks", IEEE Transactions on Systems, Man, and Cybernetics, Part A*
- *Hales & Arteconi (submitted) Artificial Friends: Self-Organizing Artificial Social Networks for Trust and Cooperation – IEEE Int. Systems.*

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# SLAC and SLACER

 Dynamically Evolving, Large-scale Information Systems

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- Fini