Self transforming to power law topology for overlay networks.

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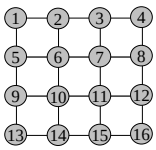
Presentation Outline

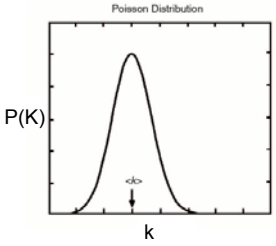
- Background.
  - Power law topology.
  - Self organization system.
- Proposed method.
- Simulation results.
- Conclusions.

Background – Degree distribution?

- The spread of node degrees over a network is characterized by a distribution function *P(k)*, which is the probability that a randomly selected node has exactly *k* edges.

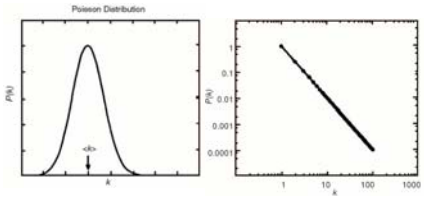


- P(2) = 4 / 16
- P(3) = 8 / 16
- P(4) = 4 / 16



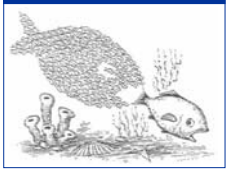
Background – Power law topology

- Preferential attachment. (BA model)
  - A.-L. Barabási and R. Albert, Science **286**, 509 (1999).
  - Continuously grow by the addition of new nodes, and new nodes are preferentially attached to existing nodes with large numbers of connections. (“rich get richer”).



Background - Self organizing system

Self organizing systems



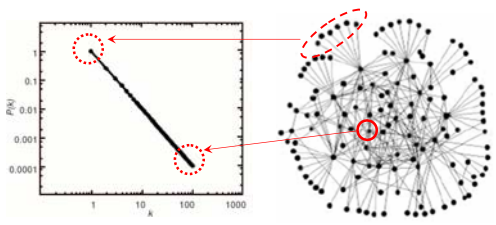
- No central control.
- Emerging structures.
- No single failure.
- High Scalability.
- High Security

- There is NO leader.
- Somehow, they build a certain structure…. Shape of a big fish
- Although one or two disappear, the whole system does not experience any failure.
- Individuals only need to keep distance with their neighbors – Scalability.
- Individuals do not need to know anything except who are its neighbors - Security.

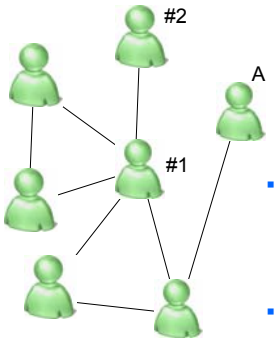
Background - Why Power law topology?

- Robust against random failure.
- Small diameter topology.

  (e.g. d≈ln(lnN) – logarithm diameter).



Background - Why Self organization?



Who is important ?

# 1	prob1
# 2	prob2

- Any problem for this method to build a power law topology?
  - Scalability
  - Security
- How to solve the problems ?

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Background – Needs of overlay networks

Power law topology	Low diameter, Robustness
Self organizing Mechanism	Scalability, Security
Self organizing Power law topology	Low diameter, Robustness, Scalability, Security

Needs of overlay networks

- Low diameter
  - Good search efficiency.
- Robustness
  - Maintain global connectivity from random node failures.
- Scalability
  - A large network can be constructed as simple as a small network is done.
- Security
  - Hiding global properties of whole system from attackers.

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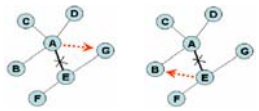
Proposed method.

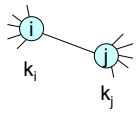
Step (1)



(A) (B)

$$g(t+1) = \beta g(t)_A - (1-\beta) g(t)_B$$

Step (2)



$$H(g(t)) = \sum_{i,j \in N} -c_{ij}\left(1 - \frac{\min\{k_i, k_j\}}{\max\{k_i, k_j\}}\right)$$

$$p = \min\{1, e^{-[H(g(t+1)) - H(g(t))]}\}$$

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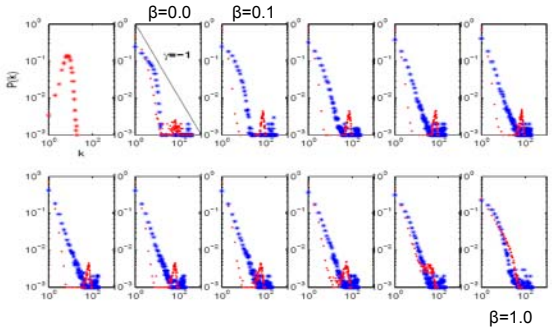
Simulation results - (1).



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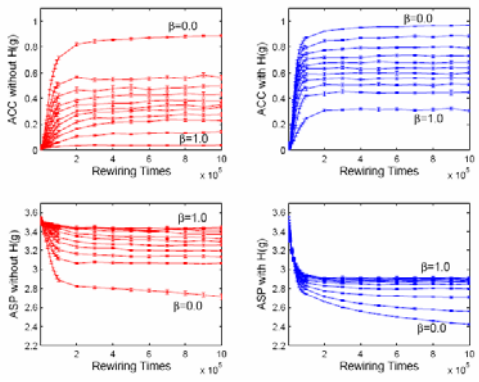
Simulation results - (2).



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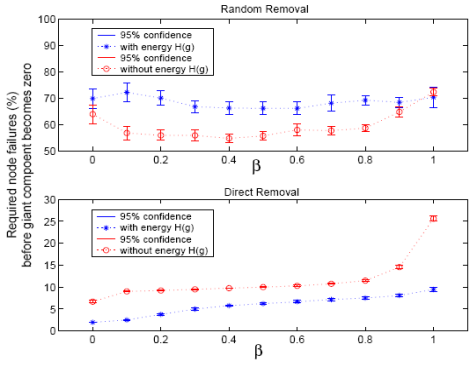
Simulation results - (3).



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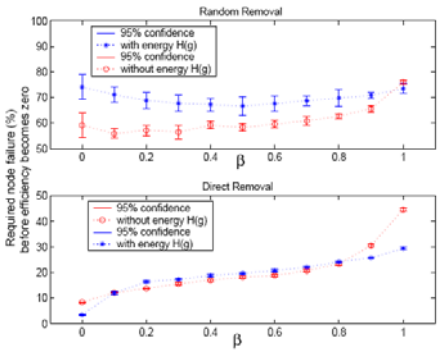
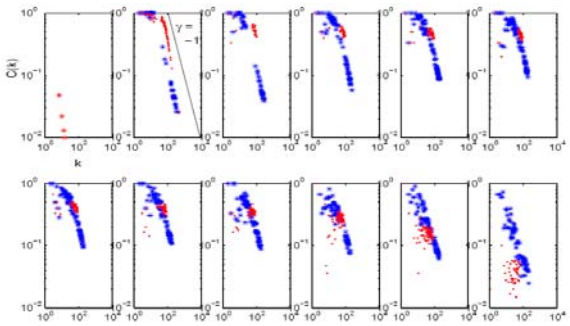
Simulation results - (4).



Simulation results - (5).



Conclusions

- A power law topology emerges through the proposed rewiring scheme with the energy function.
- The proposed evolution model runs in a self-organizing manner, which provides scalability and security for the system.
- The performances of evolved topologies were evaluated in terms of robustness and efficiency.
- We observed a power law distribution in its degrees and the clustering coefficients of nodes.
- The former and the latter enhance robustness and efficiency of evolved topologies.