Title	リンク淘汰とショートカット付加による自己組織的なネットワーク
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Citation	
Issue Date	2011-03
Type	Thesis or Dissertation
Text version	author
URL	http://hdl.handle.net/10119/9669
Rights	
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Self-organization network by link survival and shortcut addition

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March 2011

Keywords: self-organization, population density, packet routing, network robustness

In case of constructing a communication network on geographic, following properties should be considered. 1. Low cost to establish and use, 2. Rapid transportation between nodes 3. Robustness network in failure or attack. Also, it is important to be able to establish the network autonomous and distributing for calamity and mobile communication. In this thesis, we proposes a model of structural transition network by link survival and path reinforcement from initial planar graph with random position nodes.The proposed network model generated by following step.

1) **Configuration**
   To set planar graph with random position nodes on population mesh.
2) **Packet generating and routing**
   Packet generate from sources and destination node, which selected by corresponding probability population of node. Then packet is forwarded by Greedy routing + Self-avoiding or Compass routing + Self-avoiding. In that case, link weight w_e increase by unity of the used for packet forwarding.
3) **Link survival**
   If weight of link $w_e = 0$ then this link has been reduced. In the order case w_e decrease by probability p_d.
4) **Repeating**
   Repeating Step 2 to 3 for 10000 times.

5) **Shortcut addition**

Adding shortcut on link survival network (LS) by path reinforcement (PR) or random shortcut (RS).

From the propose network model we get following results mainly.

i) Topological properties

From the feedback of visible network, we known that links in the high population density area are survived. But links in the low population density area have been removed. The distribution of survival link length exponential decay following Waxman rule. And in case of LS and RNG of network without the shortcut, total link length is abele to estimate $\sqrt{N_t}$ (N_t is number of survival nodes).

ii) Communication efficiency

Average minimum hops $\langle L_{ij} \rangle$ between any two nodes in network, as LS and RNG of the network without the shortcut, value of $\langle L_{ij} \rangle$ following $\langle L_{ij} \rangle \approx \sqrt{N_t}$ (N_t is number of survival nodes). On the other hand, the network with adding shortcuts PR and RS become smaller than LS and RNG, $\langle L_{ij} \rangle \approx \log N_t$ without giant hub.

iii) Network robustness

We found the improvement of robustness by adding shortcut for the network. The value of average size of isolated clusters $\langle s \rangle$ except for the giant component. At the peak, the giant component breaks off and divided into small clusters. f_c mean the value of critical fraction. In the case of random failures, as LS and RNG of the network without the shortcut, the value of f_c is small with about 0.4 and 0.2. But f_c on the network with adding shortcuts is stronger than no shortcut network which $f_c \approx 0.7$. On the other hand, against attacks on hubs selected in decreasing order degree, as LS and RNG of the network without shortcut, the value of f_c is only showing with 0.2 and 0.1. But f_c on the network with adding shortcuts is stronger than no shortcut network which $f_c \approx 0.5$.

According to i, we found the propose network can be establishing and using by low cost. And as a result of ii, we knew that propose network has good communication efficiency. According to iii, we knew the propose network can become stronger for random failures and hub attacks by adding shortcut.