Traffic properties affected by population on geographic networks

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In case of constructing a communication network on geographic plane, following properties should be considered. ①Low cost to establish and use, ②Rapid transportation between nodes and ③Network robustness. Also, it is natural to set many nodes on population density spot because people are sending and receiving more packets than other spots. Then, a geographic network model taking account of these things has been proposed recently.

The proposed network model is generated by next four steps. 1) To set an initial triangle (or square) on population mesh. 2) Selecting one triangle (square) by probability proportional to inner population of target one. 3) Splitting selected triangle (square) to new four triangles (squares). 4) Repeat 2) and 3) until total nodes size reach N. Here, population mesh is statistics data indicating how much population exists on each point.

We confirmed geographic network generated by above four steps on different four area's population mesh satisfying ① and ② by 100 times simulation result that link length distribution, average link length and Stretch Factor of generated network. Stretch Factor is the numeral value that shortest path length on network divided by direct distance of two nodes. Also, important nodes and links that packets pass frequently may exist in triangle (square) split network when considering traffic flow although each node degree (links of node) in such network is nearly same. Therefore we investigated important nodes and links by simulation experiment selecting source and terminal randomly or by probability corresponding to population of node and sending packet in condition of not interfering each other. Population of node means amount of population in each node's territory.

We get next ⅰ, ⅱ, ⅲ results mainly.

ⅰ. Many link's length are short compared with length of initial triangle's (square's) link and average link length is also short. More concrete, a value of link's length is **0.1** under in many case and a value of average link length is under **0.1** on different four area if we set length of initial triangle's (square's) link **1**. This result corresponds to ① in the point of there are few long link taking much cost.

ⅱ. An average value of Stretch Factor is **1.1~1.2**. Because triangle (square) split network satisfies t-spanner property known in Computer Science and Computer Geometry, a value of Stretch Factor is bounded **2**. This result corresponds to ② in the point that packet not have to move long distance compared with direct distance of two nodes.

ⅲ. We found important nodes and links whose load is higher than others. Positions of those node and link change depending packet routing algorithm. If packets move shortest path based on distance, loads of nodes and link existing on the line between population density spot become high. On the other hand, if packets move shortest path based on hop, loads of nodes and links existing near the initial triangle's (squares') edge become high. Therefore, we should distinguish position of important nodes and links that should be defended prior to other nodes and links depending on packet routing protocol.

According to ⅰ and ⅱ, this proposed geographic network has good distance property such as average short link's length and small value of Stretch Factor. We shall next consider hop property and concrete load value of nodes (called betweenness) and links on triangle (square) split network compared with other geographical networks for practical construction and use.