Routing Protocol Analysis of Ad Hoc Network Based on Location Information

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ABSTRACT

Routing has been a key technology of Ad Hoc Network. The sort of routing protocol was discussed. The fundamental of routing protocol based on location information was researched. As an emphasis, some typical routing protocols based on location information were analyzed. The transmitting policy of packet was researched.

Keywords: Ad Hoc network; routing protocol

FOREWORD

Ad Hoc network is a self-organizing wireless LAN. In the process of transmission, it does not depend on basic establishment. It spontaneously correspond the transmission of information flow between each nodes. The position of each mobile node is unfixed. Its topology structure is dynamic changed.

When Ad Hoc network is transmitting data, routing protocol realizes packet transmitting. Routing protocol can detect the dynamic changing of network topology[1]. It can realize real-time routing path finding, transmitting and maintenance. It can also ensure the connectivity of network. So, routing technology is the chief problem to research Ad Hoc network. It is primary hotspot and difficulty to research.

INTRODUCTION

Sort of Routing Protocol

According to the different structure of network, almost all the routing protocol of wireless sensor network can be divided into three kinds: (1) plane routing protocol (focus on data) (2) layered routing protocol (3) routing protocol based on location information. According to different routing method that source node search for destination node, routing protocol can be divided into voluntary mode, passive mode and mixed mode.

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Fundamental of Routing Protocol Based on Location Information

In Ad Hoc network, many applications need location information. Along with the development of orientation technology such as GPS, sensor nodes can expediently get location information of self, neighbor node and destination node[2]. Routing protocol based on location information is to choose routing according to location information. And it transmits packet data to destination node according to definite strategy.

In routing protocol based on location information, node gets its location through some methods such as GPS. It gets the location of destination node through “location service”. According to the number which nodes participate in location service, location service can be divided into “part nodes” participant location service and “all nodes” participant location service.

While knowing the location of self and other nodes, the next work is to transmit packets. The strategy of transmitting packet includes three kinds: (1) greedy packet transmitting: Packet is transmitted to a one-hop node which is near to destination directional node. The choosing of neighbor node is depended on optimize guide line of arithmetic. (2) restricted directed-flood: Packet is transmitted to multi-one-hop nodes which is near to destination directional node. (3) hierarchical packet transmitting: Packet transmitting is organized according to its level, so it can suit to the network extension.

ANALYSIS OF SEVERAL TYPICAL PROTOCOLS

GPSR Protocol

GPSR(Greedy Perimeter Stateless Routing) protocol is a typical routing protocol based on location information[3]. When transmitting packet data, it only uses location information of neighbor node. It is a greedy stateless routing protocol.

![Figure 1. Greedy transmitting strategy.](image-url)
Supposing S is source node, D is destination node and the radio bound is R which is shown in Figure 1. Greedy packet transmitting strategy includes the following:

1. MTR (most forward within R) transmitting towards destination node direction
   The farthest neighbor node towards destination node direction is selected as next hop. Under MTR strategy, C node is transmitting node.

2. NFP (nearest with forward progress) transmitting towards destination node direction
   The nearest neighbor node towards destination node direction is selected as next hop. Under MTR strategy, A node is transmitting node.

3. CSL (closest to the straight line) transmitting
   The node closest to the straight line between source node and destination node is selected as next hop. Under CSL strategy, B node is transmitting node.

The maximal advantage of GPSR is node only depend on location information of neighbor node and destination node to transmitting packet [4]. It does not depend on other nodes in networks. It can only use one next-hop node. So using greedy transmitting strategy can efficiently reduce packet loss rate in networks.

But the before-mentioned transmitting strategy has problem which is shown in Figure 2. In the radio bound of S node, S node is the nearest node to D node. According to the before-mentioned routing strategy, M node is the next hop node of S node. S node is also the next hop node of M node. This is called routing loop and S node can not transmit packet data to D node.

![Figure 2. Problem of greedy transmitting strategy.](image)

In order to solve this problem, someone bring forwards perimeter transmitting strategy. Under this mode, GPSR routing protocol can use right-hand rule or left-hand rule to make sure neighbor node as the next hop node. So it selects E node as the next hop node. Finally F node transmits packet data to destination node D.
DREAM Protocol

InDREAM (Distance Routing Effect Algorithm for Mobility) protocol, each node in network knows the location information of other nodes. When needing to transmit packet data, source node computes the destination node direction. Then source node transmits packet data to one-hop neighbor node. All nodes keep on use the same fashion to transmit packet until the packet is transmitted to the destination node.

![Figure 3. Computing of flood direction in DREAM.](image)

Source node and middle node separately compute the direction from oneself to destination node during the transmitting. Considering the motion of destination node, an angle range is computed which is shown in Figure 3. C is called desired area.

Source node S computes the desired area C according to the location information and motion speed of destination node D. Then two tangents is drawn from source node S to this desired area. Supposing that \( t_1 \) is current time and \( t_0 \) is the time that S node gets D node’s location information. \( v_{max} \) is the maximal motion speed of node D. Then the radius \( r \) of desired area C will be computed as formula (1).

\[
r = (t_1 - t_0) \times v_{max}
\]

Due to the uncertainty of destination node motion speed, it can not ensure that destination node D is in desired area C. Though a path from source node to destination node can be found, it can also not ensure packet data can be transmitted to destination node D. Though DREAM protocol restricts the flood bound to destination node, it can ensure there is no routing loop. So it has better robustness.
LAR Protocol

LAR uses location information to enhance the routing discovery process of on-demand routing protocol. Similar to DREAM protocol, it uses location information of destination node to restrict the packet flood bound during the process of routing discovery.

When node S wants to establish a routing path to destination node D, node S computes a motion area of D which is called “Desired area of D”. And it also defines a request area which is a set of nodes that according rules to transmit packets. Commonly “Request area” contains “Desired area of D”. So, only nodes in request area can transmit packets. If location information of D is unknown, it can also use simple flood.

LAR protocol requires nodes to judge whether in “Request area” of a routing path. So that it decides whether to transmit packets. LAR protocol gives two methods to carry out above-mentioned decision.

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(1) plan 1: “Request area” is a rectangle which is shown in Figure 4.

相似于DREAM protocol，源节点S根据目的节点D(x,d, y,d)计算“目的地范围D层”。它定义一个矩形“请求区域”该矩形包含“目的地范围D层”。它把“请求区域”和目的节点D(x,d, y,d)的位置信息放入请求包中。然后开始路由发现过程。

① 中间节点B根据包中的位置信息判断自己是否在“请求区域”内。如果在该区域范围内则广播包否则丢弃包。

② 当请求包到达目的节点后，它会发送一个包含目的节点如当前位置、时间及平均速度等信息的路由响应包。
(2) plan 2: Each node computes the distance from oneself to destination node and compares with the distance from above hop node to destination node (included in packet) Thus it can decide whether to transmit packet.

① Source node S computes the distance d₁ to destination node. It puts (x_d, y_d) and d₁ in request packet. Then it initiates routing discovery.

② Node B received request packet computes the distance d₂ from oneself to destination node. When d₂ \(\leq d₁\), it uses d₂ to replace d₁ in packet. Then it transmits packet else discards packet.

Hierarchical Routing Transmitting Protocol

Terminodes Routing protocol is a typical hierarchical routing transmitting protocol. It bases on two-layer routing protocol. It uses routing algorithm based on location information on one layer [5]. On another layer, it uses routing algorithm not based on location information. So it is suitable for large scale network.

Terminodes Routing protocol is made up of TLR (Terminode Local Routing) and TRR (Terminode Remote Routing) routing algorithms. The algorithms will be determined by the communication distance. When node packet arrived is very near to destination node, it uses TLR algorithms to transmit packet. When node packet arrived is very far to destination node, it uses TRR algorithms to transmit packet.

SUMMARY

By analyzing several path-finding mechanism of location information routing, they are all by using some kind of rule to narrow the range of nodes involved in path-finding. The purpose of reducing network overhead is realized. Then the routing process is realized by selecting the best path within the path-finding node range.

REFERENCES