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High-efficiency and Low-overhead Selfish Node Detection Algorithm in Opportunistic Networks

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Abstract

To address the problems of large overhead and inaccurate judgment for selfish node of the existing selfish node detecting algorithm in opportunistic networks, a high-efficiency and low-overhead algorithm to detect the selfish node HLSND algorithm is proposed. The algorithm combines the SV list interactive information and attributes of the message forwarded by encounter node to judge its selfishness. According to the message attributes forwarded by the node, it can be judged whether it has the selfish behavior of forged the message in SV list. The RSSI technique is used to measure the distance of the nodes to improve the judgment accuracy of self - interest behavior. At the same time, information of selfish node is carried when forward other message to reduce the system overhead. The simulation results show that the HLSND detection algorithm can effectively improve the throughput and message delivery rate in the network and reduce the energy consumption and time delay of the system.

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1 INTRODUCTION

The opportunistic network is a mobile ad hoc network in which there is no complete transmission path between the source node and the destination node, and the opportunity of the node mobility is used to realize the communication between the source node and the destination node (Xiong Yongping, 2009). Probabilistic routing (Lindgren A, 2004) is a routing algorithm in which a message in a chance network is only transmitted in a direction with a higher probability of encountering the destination address. Due to the limitations of the resources (energy, cache capacity, etc.) of the nodes in the opportunistic network, the nodes will exhibit selfish behaviors that refuse to provide message forwarding services to other nodes, resulting in performance degradation or even failure of the entire network. Therefore, how to design an efficient detection mechanism to facilitate the smooth transmission of messages between non-selfish nodes is an important issue in the opportunity network. At present, there are many detection methods for selfish nodes. The Watchdog (Marti S, August2000.2000:255-265) algorithm uses the behavior of the next hop node to listen, and judges the selfish node according to the monitoring result, but the next hop node may be out of the listening range or the link is unstable. The current node's judgment on the next hop node is incorrect. The 2-ACK-based selfish node detection algorithm (Tang Tang, 2012 (Z2): 30-221)uses the previous hop node to receive ACK information to determine its own next hop node (ie, the current node). Aiming at the above-mentioned problems, this paper proposes an efficient and low-cost opportunity network probabilistic routing self-empty node detection algorithm (HLSND (High-efficiency and Low-overhead Selfish Node Detection), which can effectively improve node selfish judgment. Accuracy and reduce system overhead. Whether it is selfish, but introduces too many ACK messages, which increases system overhead. Another RSND detection algorithm (Ren Zhi, 2016, 37(3):1-6) uses the mechanism of error frame analysis to judge the selfishness of the encountering nodes, but it is difficult to determine the misjudgment caused by the qualitative probability of the type. At the same time, in the probabilistic routing, the node forwards the message. Related to the probability of encountering the destination node, a node with a low probability of encountering the destination node may be misjudged as a selfish node because it is not forwarded. In order to solve the above problems, this paper proposes an efficient and low-cost chance network probabilistic routing self-node detection algorithm.

2 hypothesis and problem description

2.1 Assumptions

Hypothesis 1: The nodes in the network are divided into self-private nodes and non-self-private nodes. Non-self-private nodes actively participate in the forwarding of messages in the network. The self-private nodes only send messages generated by the node and receive messages from the node as the destination node.

Hypothesis 2: The nodes in the network are configured the same, that is, each node has the same data processing capability, transmission and reception power, communication range, and the like.

Hypothesis 3: The nodes in the network adopt the forwarding method of probabilistic routing, that is, the message will be forwarded only when the probability of encounter between the current node and the destination node is higher.

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2.2 Description of the problem

Problem 1: Because the nodes in the opportunistic network are mobile, during the listening process, the communication range may be moved from each other and the monitoring fails, which makes it impossible to determine the selfishness of the node.

Problem 2: The self-determination process after the data forwarding is finished, when it is determined that the encountering node is a self-private node, the previously performed data interaction process still consumes its own energy, so the interaction process of the node can be fully utilized to perform the self-determination of the node.

Problem 3: It is impossible to give a positive judgment to the nodes that may have selfish behaviors. Using probabilistic qualitative judgment to determine that such nodes still have the problem of inaccurate judgment.

Problem 4: When the current node detects that other nodes are selfish nodes, when the self-node information is disseminated, separate control information or the length of the message is required, resulting in an increase in system overhead.

3 HLSND Algorithm

Whether it is selfish; if there is a message in the SV message list of the other party that the source address is not the other node, it indicates that the other party is forwarding the message for other nodes, according to which it can be judged that the other node is a non-selfish node; if the source of the message in the SV list of the other node is The addresses are all opposite nodes, and they are judged to be selfish (Viani F, 2008 ,44(10):653-654). If it is the first time and the SV message list contains only the message whose source address is its own, it is classified as a node of difficult type, and avoids the misjudgment that the other node may just enter the network.

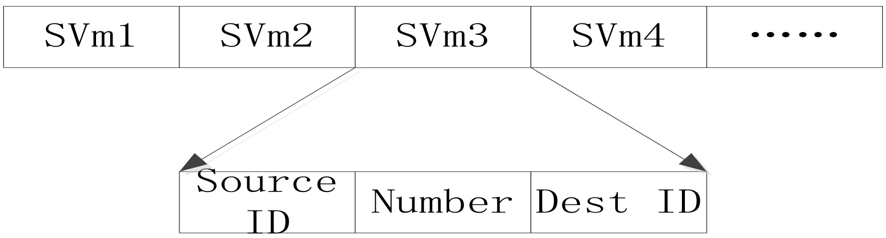

Figure 1 Schematic diagram of the SV message list

3.1 Interaction Model

The specific communication process of the opportunity network encounter node is shown in Figure 1. After receiving the periodic HELLO packet of the Node B, the node C exchanges the SV (Summary Vector) list and the DP (Delivery Predictability) list with the Node B, and the SV list stores each .The summary information of the messages carried by the nodes. The DP list records the probability of encountering the node with other nodes. After comparing the SV list and the DP list, the nodes B and C request the other party's message and send the other party. Message.

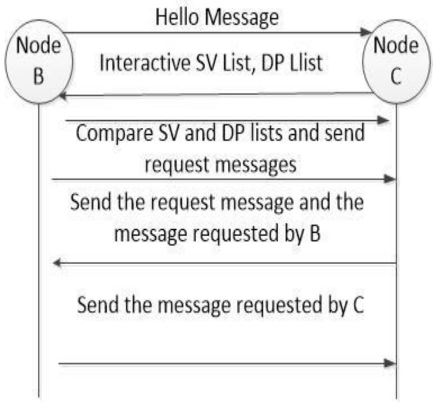

Figure 2 Inter-node interaction model

3.1.1 Distance prediction

After the nodes in the network meet, the RSSI technology is used to measure the distance between each other in the process of mutual information interaction. When the current node receives the HELLO message of the other node, it records the current time and the distance between each other. In the SV interaction process, the time and the distance between the two are recorded, and the relative time and interval of the two records are calculated. Speed, when self-interesting behavior is monitored for the encountering nodes, it can be estimated whether the communication range is out of range by the relative speed and distance.

3.1.2 Meeting judgment

After receiving the HELLO message of the other node, the current node determines whether it first meets. If not, after receiving the SV list of the other party, the current node uses the message in the SV list of the other party to determine whether the other party is Data transmission, extracting the header information of the monitored data packet, recording the ID of the node C and comparing the header information with the message header stored by itself and transmitted to the other node, and if it is the same, determining that it is a non-self-private node. If the node A meets the node C, if there is no message in the SV of the node C that the node A forwarded to the node B is not the other party B and the C and the destination node have a higher probability of forwarding than the node B, then it can be determined. Node B is a selfish node.

3.1.3 Interactive judgment

After the encountering node interacts with the SV and DP lists, if the self-privateers of the other node is still not determined, the other party requests a message that the user does not have a higher probability of encountering the target node than the other node, and sends the message requested by the other party to the other party. This process has the following decisions:

1. The source address of the message requested by the current node is all the other node. Since the source address of the requested message is the other node, the received message cannot be used to determine the other node, and the type of the other node is classified as It is difficult to determine the type.

2 .The source address of the message requested by the current node is not the other party node. If all the requested messages are received, it is determined to be a non-self-private node; if only the source address is the message of the other node, the other node is returned. In order to determine the type, if it is out of communication range and it is monitored that the

other node is within the communication range and a data message is sent to another node, it can be determined that the other node is a selfish node and it provides a fake SV list .

3. The node SV includes a message that the destination node is not in the other party node SV and the destination node is not the other party node, and the probability that the partner node and the destination node meet a higher probability. However, the other party node does not request such a message, and can determine that it is a self-private node.

3.1.4 Monitoring judgment

After the two-node information is exchanged, if the self-privateness of the other party is still not accurately determined, the RSSI information is used to determine the distance between each other. After the current node A transmits the message of the destination address other than the node B to the node B, it listens to the forwarding process; if it listens to the node B and the node C,

3.1.5 Self-contained information carrying transmission and indirect qualitative

The current node determines that the other node is a self-serving node and carries the immune information carrying transmission, that is, the probability value of the self-node in the DP list is set to -1, and the current node exchanges the probability list with other nodes, if there is a certain probability list in the other party's probability list The probability of encountering a node is -1, indicating that the corresponding node is a selfish node. Similarly, the other node can learn the selfish node by querying the probability list of the current node.
For the problem that the selfish type of some nodes is difficult to determine out of communication range, it is determined by indirect qualitative. That is, when exchanging the probability list with other nodes, if the probability value of the other node to the difficult-to-determine node is -1, it indicates that the node is selfish, and the probability value to the node is set to -1.

3.2 Algorithm operation

The specific steps of the HLSND algorithm are as follows:

Step1: After receiving the HELLO packet broadcast by the Node B, the node C changes the encounter probability to the node if it is not the first time to meet and judges that the other party is a non-self-private node according to the DP list; if the first encounter, the DP list is added and the initial value is added, and then The own summary vector SVC and the probability list DPC are transmitted to the Node B.

Step 2: After receiving the SV and DP messages of the node C, the B performs an encounter determination operation. If it is determined that the other node is a non-self-private node, it sends its own SVB and DP information to the node C, and compares both SV and DP lists and sends them to the node C. Request message.

Step 3: After receiving the SVB and DP information and the request message of the Node B, the C performs an interaction judgment operation according to the SVB and the DP information and the request message, and if it determines that the other node is a non-self-private node, sends its own SVB and DP information to the node C, At the same time, the SV and DP lists are compared, the request message is sent to the Node B, and the data packet requested by the Node B is sent.

Step 4: After receiving the Node C request message, the Node B determines the self-privatizes of the node C according to the C request message and the data packet received by the Node B.

If it is determined that the other party is not a selfish node, then the requested message is sent to the node C.

Step 5: Node C determines B's selfishness again according to the data packet in the received message, and assists B to forward the message if it determines that the other party is a non-selfish node.

Step 6: When it is still difficult to determine after the information is exchanged, it is judged whether it is out of the communication range by the monitoring judgment and the RSSI information.

Step 7: For the problem that the node is difficult to determine, when communicating with other nodes, if the probability of encountering the corresponding node in the DP list of other nodes is -1, the corresponding node is determined to be a self-private node. If it is judged that the other party is a selfish node in each judgment, the communication with it is stopped and the probability of encountering the node is set to -1.

4 simulation verification

In this paper, the performance of HLSND algorithm is verified by OPNET14.5 simulation software, and the simulation results are compared with the simulation results based on 2-ACK algorithm and RSND detection algorithm.

4.1 Simulation parameters and statistics

In this simulation, 50 mobile nodes are randomly arranged in a virtual scene of 1 500 m × 300 m. The specific parameters of the simulation are shown in Table 4.1.

Table 4. 1 Simulation parameter settings

parameter	**Value**
Simulation time / s	3600
Simulation area size	1500 m×300 m
Number of nodes	50
Node moving rate / $(m \cdot s^{-1})$	1~3
Proportion of selfish nodes /%	{0~80}
Node communication radius / m	10
Random seed value	{64,128,256,512,1024}

Whether the point is a selfish node can correctly process messages generated by selfish nodes and non-selfish nodes, reducing the punishment strategy adopted for non-selfish node judgment errors, so that more messages can be delivered to the destination node, thus throughput The amount has been improved.

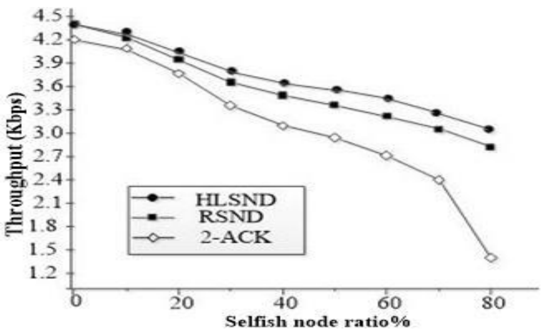

Figure 3 Network throughput as a function of selfishness

4.2.2 Message arrival rate

As shown in Figure 4, the message arrival rate of the HLSND detection algorithm is also improved compared to the 2-ACK and RSND detection algorithms. The reason is that in the RSND algorithm, when the selfishness of the encountering nodes cannot be determined, the proportion of selfishness nodes in the network is used to determine the probability of the encountering nodes. When the proportion of selfishness nodes in the network increases, the judgment of non-selfishness nodes is wrong The probability is getting higher and higher, causing more messages to fail to be transmitted. The detection algorithm of the HLSND algorithm is more accurate in judging the selfish behavior of nodes and is not affected by the proportion of selfish nodes, so the message arrival rate is improved.

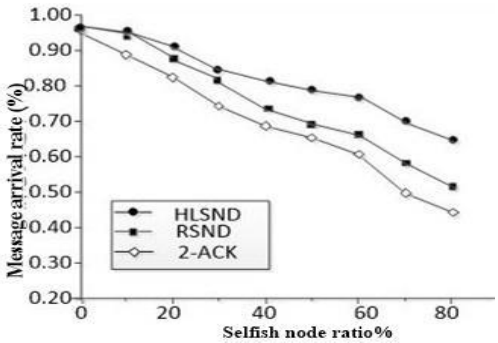

Figure 4 Message arrival rate changes with selfish proportion

4.2 Simulation results and analysis

4.2.1 Throughput

It can be seen from the simulation results shown in FIG. 3 that the throughput of the HLSND detection algorithm is significantly higher than that of the 2-ACK detection algorithm and the RSND detection algorithm. The main reason is that HLSND can more accurately judge the selfish nodes of the encountering node and the detection is more accurate, avoiding the delay caused by the non-selfish nodes' incorrect forwarding of the messages, which enables messages to be sent to non-selfish nodes more quickly. Transfer.

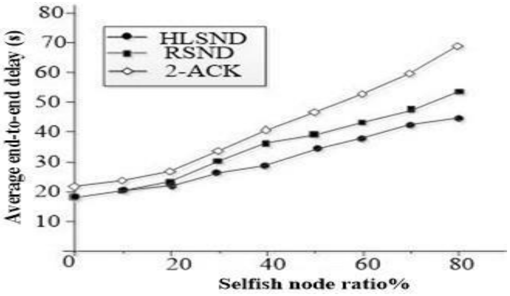

Figure 5 Average delay varies with selfishness

4.2.4 Total system energy consumption

As can be seen from Figure 6, the total energy consumption of the HLSND algorithm is less than the 2-ACK and RSND algorithms. The reason is that as the proportion of selfish nodes increases, more and more nodes do not participate in message forwarding in the network, so the energy consumption of the system will decrease. Since the selfishness determination of the HLSND algorithm is more accurate, the selfish nodes can be accurately determined in a timely manner, which reduces the energy consumption of data forwarding caused by the inaccurate determination of the selfish nodes in the network. At the same time, the current node in the HLSND algorithm detects selfishness After the nodes, the transport method is adopted to avoid the extra overhead caused by the selfish information transmission in other algorithms, so the energy consumption of the HLSND algorithm is the lowest.

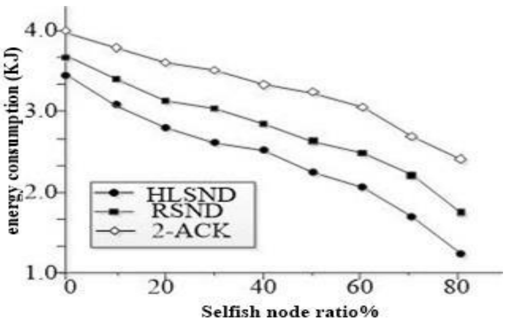

Figure 6 Total system energy consumption varies with selfish proportion

4.2.3 Average delay

It can be seen from Figure 5 that the average delay of the HLSND algorithm is less than the 2-ACK detection algorithm and the RSND detection algorithm. The reason is that the HLSND detection algorithm uses the RSS-based distance judgment and the SV-based distance judgment for the selfish opportunity network probabilistic routing selfish node detection algorithm. Compared with the existing detection algorithms, this algorithm can effectively improve the accuracy of the selfishness judgment of the nodes in the network and reduce the system overhead.

5 Conclusion

Aiming at the problem of inaccurate node judgment of existing selfish behaviors, this paper proposes an efficient and low-cost theoretical study of the Internet of Things and MAC protocols.

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