Journal of Theoretical and Applied Information Technology
15th December 2012. Vol. 46 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

A REAL-TIME INFORMATION ORIENTED SERVICE-AWARE ROUTING ALGORITHM

[1] HUA LIANG, [2] AN YING, [3]HAOWANG

[1] department of information science and engineering, Hunan International Economics University,

Changsha 410205, Hunan, China

[2] department of Information Science and Engineering, Central South University,
Changsha 410083, Hunan, China

Hunan International Economics University, Library

Changsha 410205, Hunan, China

ABSTRACT

The mobile nodes perceive the real-time routing information of different sections, and analyze the reliability of the movement direction of nodes, data exchange, and transmission delay and path failure. By combining movement direction, speed and locations, the routing path is adaptively updated according to the network states of the sections so as to achieve effective message delivery. In this paper, a real-time information oriented service-aware routing algorithm (RTIA) is proposed. The transmission mode of the RTIA is no copy, real-time information oriented, and service aware, which can effectively improve the message delivery rate and reduce delay. The simulation results prove the superiority of the RTIA algorithm. the merchant can trace the traitors from a pirated copy by means of the embedded unique fingerprint, while the customer is immune of being framed due to the asymmetric property. First, multicast that is an efficient transport technology for one-to-many communication is exploited, which can reduce the bandwidth usage significantly. Second, symmetric encryption instead of public-key encryption is performed on the multimedia content, which can reduce the complexity and communication cost.

Keywords: *Delay Tolerant Network, Data Delivery Rate, Data Delay*

1. INTRODUCTION

Delay tolerant network (DTN) is network architecture under the special environment, such as satellites and interplanetary communication networks, sparse mobile ad hoc networks. Compared with the traditional network, the DTN has some features, such as node fast moving, long delay, intermittent connectivity, limited storage and energy, and unstructured topology. The most of the existing Internet network architectures and protocols only support end-to-end link communication but cannot guarantee the connectivity of the network. Thus in the DTN scene, the traditional "store-forward" routing mechanism has to be converted to store-carry and forward routing mode. Under this kind of mode, nodes carry data while moving and forward data when they contact with suitable nodes.

At present, Sushant Jain, Kevin Fall and et. al [1] proposed the DTN network architecture, which realized asynchronous message transmission mechanism using unicast routing strategy. It is mainly used to provide the message forwarding for the constrained networks. In the DTN, two nodes can only communicate in their wireless communication range. But it is difficult to accurately predict the next encounter time and the duration of transmission of the node because of the randomness of node movement. In the DTN, there are two kinds of routing strategy: passive and active routing strategies.

1) In the passive routing strategy, the message delivery is mainly accomplished by the inherent mobility of the node or equipment in the network. The total number of message copies is significantly reduced and the network overhead is improved. However, the passiveness of message transmission inevitably decreases the communication opportunities and increases the transmission delay, which finally leads to a reduction of message delivery rate.

2) In the active network routing strategy, some of the nodes in a network are called message ferries [2] or data mules [3], which actively or consciously draw near to the destination node between the

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

partitioned nodes or regions, and then complete message transmission. This mechanism transfers messages in the same way as flooding, thus both the total transmission delay and queuing time are short. But it may suffer a massive resource consumption which easily leads to network congestion. According to this strategy, the nodes in the network are divided into two categories: the common nodes and the ferry nodes. The common nodes have the same communication range and stay static or move randomly in a given area. The ferry nodes, characterized by high moving speed, large storage space, adequate energy and so on, are special nodes which search and transmit information in the network.

A kind of real-time information oriented service-aware routing mechanism based on the effective data transmission of the ferry nodes is proposed, which discusses the data exchange between nodes, node movement direction, node delay and path failure. The store-carry and forward paradigm is used in this protocol. The experimental results show that this algorithm has the advantages of real time and high efficiency in the minimum consumption bandwidth and the storage capacity.

2. RELATED WORKS

An important application field of DTN is that Ferry node is used to query the real time information when it is without Internet. For example, [4] proposed to use the fixed node assisted routing protocol SADV to query the service area, gas station and other information out of several kilometers. In the typical vehicular active safety (VAS) application, each mobile node periodically broadcasts its movement direction, GPS position, speed, acceleration and braking state, so that the vehicle safety driving and traffic information can be collected. Banerjee and et. al. [5] deployed the static Throwboxes node in the concentrated region of the mobile DTN. It realizes the remote neighbor access through a double decked data transmission, which reduces the network latency and provides more data forwarding opportunities.

Due to the intermittent connectivity of DTN, the active adjustment of the moving route has significant impact on the network performance. Wen Rui Zhao and et al. [4] proposed four kinds of routing scheme, which mainly discussed the ferry route strategy of the multiple ferry nodes. In the single routing algorithm SIRA, all ferry nodes access all common nodes along a single path and the information is transformed with little hops, which results in insufficient bandwidth; in the multipath routing algorithm MURA, different ferry nodes access according to different moving paths. This algorithm allocates the ferry node for different types of services and determines the corresponding ferry route, which reduces the number of hops in the message transmission. In the nodes relay algorithm NRA, the fixed base point is set to store ferry node data in the moving route region. The other nodes or ferry nodes forward data for the node, the synchronization between the nodes is not required, which thereby improves the capacity of information transmission. In the ferry relay algorithm FRA, the ferry nodes can exchange information with other ferry nodes, which reduces the waiting time during the transmission, but also introduces some problems such as data synchronization and routing loops. But in practice, it is difficult to change the direction of movement of a mobile vehicle for the transmission of data.

3. REAL TIME INFORMATION ORIENTED SERVICE-AWARE ROUTING MECHANISM (RTIS)

In the existing routing protocols, buffer and the network bandwidth are limited, which affects the performance of each protocol. Data replication, the flooding of the copies and long delay will cause real-time of data be invalid. Therefore, in DTNs, the single copy data transmission scheme is used to limit resources consumption. Services are distinguished based on the urgency of the data, so the fundamental problem is the routing of the urgent data. This section the scenarios are set as the traffic accident on the motorway, from the angle of actual network communication based on real-time service aware routing mechanism, we discuss how to provide real-time urgent information to mobile vehicles through the vehicle network so as to inform the drivers nearby away from the accident. Each vehicle query traffic information to the command center in real time manner and then reasonably avoid the congestion.

3.1 Assumption

Suppose that the whole city highway is abstracted as a directed graph, each intersection is the node, each road is the edge. In this paper, L_i denotes the crossing, R_{ij} denotes the directed section from L_i to L_j. Each vehicle is loaded GPS service, then the location and the direction can be determined, each vehicle goes based on GPS electronic street map, which also determines the path of data transmission. Vehicles communicate

Journal of Theoretical and Applied Information Technology
15th December 2012. Vol. 46 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

using short broadcast radio channel (100m~200m), and obtain the information table of the automobile adjacent to the band through the beacon broadcast message as follows:

Table 1 Neighbors Car Information Sheet

Vehicle id	Vehicle location	Vehicle speed	Direction	Previous vehicle
A	108.911 952 234° 45.234 534 650°	5m/s~40m/s	north	D
B	120.232.345 233° 35.134 464 563°	5m/s~40m/s	south	C

3.2 Scene

In the intermittent connective network, the data carried time is shortened, the data transfer rate is improved, data transmission through the wireless communication mode between the vehicles is strengthened, and the transfer delay is reduced. In the real-time road conditions of Figure 1, according to the road condition at that time, vehicle A inquiries the best path to the destination, and then send a message to the traffic command center T. Suppose that the position of the traffic command center T is accessed by GPS service, the path 1 or 2 can be selected from Figure 1 to complete the message relay. When selecting the path, on the one hand, the channel coverage should be considered: for example, the coverage is larger if the wireless channel of the vehicle is about 200M, the hop count of message forwarding through the wireless communication between the vehicles is less, so the transfer delay is small; if the range of the channel is about 100M, the coverage is small, with more hop counts of message forwarding, and the time delay is big. On the other hand, the density of vehicles should be considered: In Literature [5], it is pointed that the sections with the large vehicle density and the short data transfer delay should be selected as the routing path when the vehicle forwards messages. But in the section with large vehicle density, the unexpected events, especially the traffic jam are prone to occur, which will increase the probability of message forwarding delay and resending, the reasonable delay mechanism will be helpful for message forwarding. Therefore, how to apperceive service-aware routing path to timely adjust forwarding mechanism based on the real-time situation of the routing link is important for the routing of vehicular ad hoc networks.

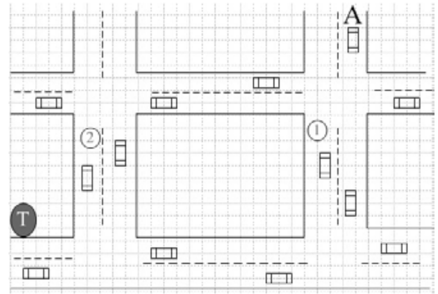

Figure 1: Paths Of Traffic Guidance Center

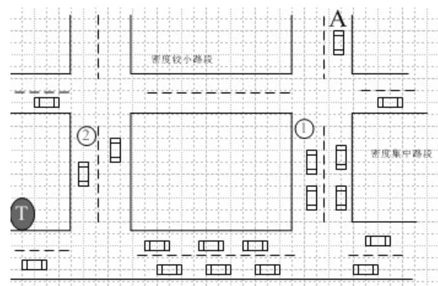

Figure 2: Effect Of Vehicle Density

4. RTIA

In RTIA algorithm, the path with the shortest data transfer delay is computed in the electronic map based on Dijkstra algorithm, the network delay of each section is estimated, the vehicle transfers data using the carry and forward mode, and no copy is produced. The data transfer path is generated by the automobile producing data; the desired path is stored in the head of the data packet. According to the real-time motion direction, the speed and the location of the vehicle, the routing path is dynamically computed to update the routing information. In RTIA algorithm, a directed link is determined by entering the intersection, researches are separately implemented from the straight section mode, the intersection mode and the crossing route recovery strategy.

4.1 The Straight Section Mode

In the straight sections with small vehicle density, the delay of the vehicle carrying a message packet is longer. So, when A sends data to T, it will choose the path 1 with the greater density to forward data, but during the running process, it is necessary to preferentially forward data packets to the vehicle running in the same direction, it also needs to consider the vehicle in the reverse direction. When the running direction of a vehicle is the same to the range direction, the vehicle will forwards data to the vehicle in front and that in the reverse direction, then at this time two situations

Journal of Theoretical and Applied Information Technology
15th December 2012. Vol. 46 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

will occur: in one case, the vehicle in front will favorably forward the data packet to the destination, the rear vehicle will be away from the destination, which must cause the situation of the packet occupying buffers, so it will be in favor of the data cache problem that the useless packets are discarded according to the set limitation of the data packet; in another case, the data packet is selected to forwarded to the vehicle in front, at that time the vehicle meets with that in the reverse direction, it is possible that the vehicle in the reverse direction is more close to the destination. When the running direction of a vehicle is opposite to the range direction, the vehicle can forward the data packet to the rear vehicle, also can forward to the vehicle in the range direction, which will cause the routing loop problem of the rear vehicle and the vehicle in the range direction, therefore the packet must be identified using the information of the previous vehicle. This will prevent that the vehicle in the range direction and the rear vehicle rout the same packet.

The delay from the straight sections is the time of carrying data from entering the crossing i to leaving the crossing j, the network delay of the section r_{ij} is recorded as:

$$d_{ij} = F(R) \times T_r + (1 - F(R) \times \frac{L_{ij}}{V_{ij}}) \quad (1)$$

Where, $F(R) \times T_r$ denotes the data forwarding delay among multiple vehicles, $(1 - F(R)) \times \frac{L_{ij}}{V_{ij}}$ means the running delay, L_{ij} is the distance of the section r_{ij}, V_{ij} is the average speed of each vehicle in the section r_{ij}. Suppose that during the vehicle running process, no record is left in one section r_{ij}, the real-time data transfer cannot be maintained by the section, and then each vehicle will record this information to choose the best path to forward data. The vehicle use the spacer mechanism to broadcast a stored new record of the running section in the interval□t, each vehicle will compare and analysis the routing path record based on the time stamp to select the best route to update the forwarding data.

4.2 The Intersection Mode

In the intersection mode, the vehicle A located in the intersection needs to forward a data packet to the direction C. Suppose that there is no vehicle in the current C direction, but the vehicle B is running in the south direction. If the vehicle A does not forward data, waiting will cause delay. Therefore, the route selection of the vehicle at the intersection can be adjusted based on the direction of the vehicle at that time; the routing is dynamically selected to forward the data packet to the vehicle B because the vehicle is more close to the vehicle running to the north. During the dynamically routing, the delay from the intersection I_a to the destination needs to be estimated:

$$D_{ij} = W_{ij} + d_{ij} \quad (2)$$

W_{ij} is the average time of the vehicle waiting from the intersection I_a to the intersection I_b, d_{ij} is the estimated delay between each intersection. According to the above information, the travel time is estimated, which is the summary of the travel time of each section, the travel time at the intersection and the delay at the intersection.

$$T^i = T_1^i + T_2^i + D_{ij} \quad (3)$$

$$T_1^i = \frac{L_i}{V_i}, \quad T_2^i = \frac{L_i}{V_i} \quad (4)$$

Where, T is the travel time of the i^{th} section; T_2^i is the travel time at the i^{th} intersection; D_{ij} is the delay time at the i^{th} intersection; L_i is the distance of the i^{th} intersection, V_i is the speed of this section. When the data enters into the section in the range direction, it is transferred in accordance with that in the straight section mode.

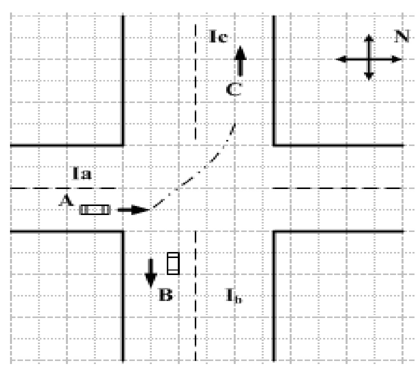

Figure 3: The Vehicle A Reaches The Intersection And Transfers The Data Packet.

4.3 The Crossing Route Recovery Strategy

It is easy to cause the routing error under intersection multi-choice characteristics, the data packet may not be transferred in the range direction. Route recovery strategy is used in the intersection: (1) When the data packet is away from

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

the desired path and enters into the opposing sections, the vehicle obtains the vehicle information in the desired direction, transfers the data to the nearby vehicle, and forwards the data packet to the desired routing path according to the beacon broadcast message; (2) According to the timeout mechanism, after the vehicle moves into the next crossing, the data packet cannot be transferred to the nearby vehicle in the opposite sections within the prescribed time delay, the current position is set as a starting point based on the previously mentioned straight section method, the optimal path to the destination is recomputed, the vehicle transfers the data along the new path and empties time delay. When the data arrives, the target point feedbacks information to the previous source point according to the historical records, thereby to protect the contact between the original vehicle A and target point.

5. 5 PERFORMANCE EVALUATION

5.1 Experimental Setup

The agent-based discrete event simulator ONE (opportunity networking environment) developed in network experiment of Helsinki University of Science and Technology is used to simulate the road scene of Hexi Lugu high-tech zone, Changsha. In the scene, the movement path of the vehicle is limited by the road, and the vehicle density distribution is not uniform.

In the simulation scene, the simulation area is 4000M × 3200M, the velocity range of each node is 5m/s~40m/s. The communication radius of the sports node is 10m. RTIS broadcast time interval t is 10s, the time interval of beacon message is 1s. 10 nodes are randomly selected from the 600 moving nodes to transfer the CBR packet to the traffic guidance center, sending 1~10 packets by each 10s, the size of each data is from 0.5KB to 5KB, the cache size is 50 to 600 packets, the simulation time is 4h.

5.2 Simulation Results and Performance Analysis

In this section, we use the following two metrics to evaluate the performance:

1) Delivery ratio, which is defined as the total number of successful messages received over the total number of messages transmitted. Analysis and comparison of the data delivery rate and delay of different algorithms, and most likely transferring information in this scene, namely the data successful delivery rate, are also the paramount consideration. In addition, although the delivery delays in DTN network can be tolerated, but it is also one aspect of evaluating the merits of the routing method. RTIA data delivery rate has obvious advantages, it is usual that during the rush hour, the vehicle density is high, and data delivery rate is gradually increased. When the density is high, the costs of the algorithms also increase gradually, the RTIA algorithm uses no copy transfer mode to maximal reduce the storage and network overhead. As shown in Fig. 4, the delivery ratio increases as the buffer size of node increasing. The delivery ratio of Epidemic is the lowest because of the excessive resource consumption. Both the RTIA and the DRIP adopt the single-copy forwarding paradigm to transfer messages, thus the network overhead are much lower than that of Epidemic. When the buffer size is 200, the delivery ratio of DRIP is 76% while RTIA achieves 85%. When the buffer size is large enough (more than 400), the delivery ratios of all three algorithms are approaching 100%. Fig. 5 illustrates the delivery ratio with varying moving speed of nodes. It can be seen that, RTIA predicts the best next-hop node according to the moving direction and speed of nodes, so it achieves the highest delivery ratio.

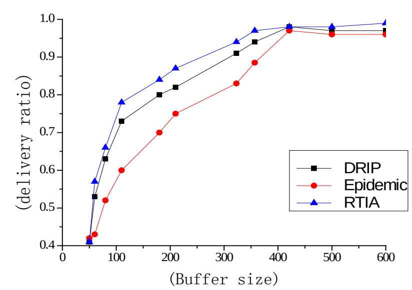

Figure 4: Message Delivery Ratio With Different Buffer Size

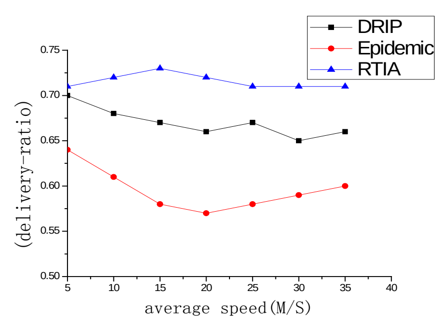

Figure 5: Message Delivery Ratio With Different Moving Speed

2）Delay, which is defined as the average time elapsed when the message is generated by the source and when it is successfully received by the destination. For the data delivery delay showing in Fig. 6, at the initial stage, the number of the node is less, in RTIA algorithm data is transferred by "carry and forward" mode, with a high delay. With the number of nodes increasing, meeting becomes more frequent. The advantages in message transfer rate of RTIA reduce the transfer delay. In Epidemic algorithm, the increase of message transfer opportunities triggers the increase of the message copy number, after the queue is full, the ingoing nodes generate messages, which occupies a large proportion, the total transfer delay increase, so the node density increases is prior to message passing, and is closer to the direct transfer strategy. The experimental results show that, in the RTIA algorithm the energy of each node receiving the broadcast message is from the vehicle itself, so it can better balance the network overhead and message delivery successful rate with a less delay and a longer life of network. As can be shown in Fig. 7, in the condition of the same moving speed and the same number of node, the delay of RTIA is remarkably shorter than those of the other two algorithms.

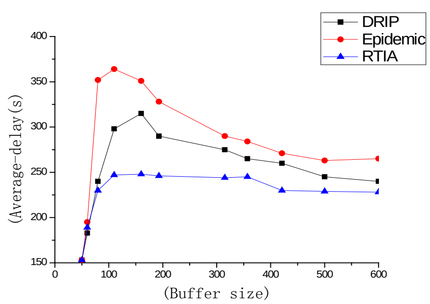

Figure 6: Average Delay With Different Buffer Size

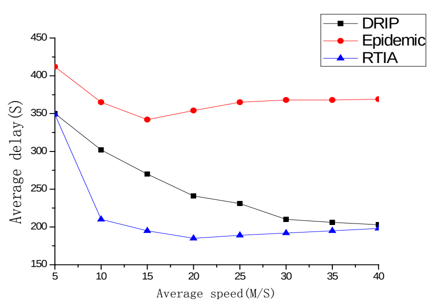

Figure 7: Average Delay With Different Moving Speed

6. CONCLUSIONS

The vehicular ad-hoc network which is applied in the framework of DTN not only provides users with an important transportation and information query but also can meet the requirements of the network communication in the whole city. For the intermittent connectivity of the network, a RTIS mechanism is proposed for the vehicle to obtain the real-time information, apperceive service and update the routing path in the network. The RTIA algorithm is studied from straight section mode, intersection mode, and crossing route recovery strategy. The storage and network overhead is minimized. Finally, the performance of the algorithm is improved greatly.

ACKNOWLEDGEMENTS

This work was supported by the scientific research fund of Hunan provincial education department No.11C0789.

REFERENCES:

[1] K. Fall, "A Delay-Tolerant Network Architecture for Challenged Internets", *Computer Communication Review*, Vol.33 No.4, 2003, pp.27-34.

[2] Zhao W, Ammar M H, "Message ferrying: proactive routing in highly-partitioned wireless Ad hoc networks", *Proceedings of the Ninth IEEE International Workshop on Future Trends of Distributed Computing Systems*, May 28-30,2003, pp.308-314.

[3] Zhao W, Ammar M H, Zegura E, "Controlling the mobility of multiple data transport ferries in a delay-tolerant network", *Proceedings of the 24th Annual Joint Conference of the IEEE computer and Communications Societies*, March 13-17, 2005, pp. 1407-1418.

[4] Zhao J,Cao G, "VADD: Vehicle-Assisted data delivery in vehicular ad hoc networks", *Proceedings of the 25th IEEE International Conference on computer communications*, April 23-29,2006,PP.1-12.

[5] Spyropoulos T, Psounis K, Raghavendra, C S, "Single-copy routing in interimittently connected mobile networks", *Proceedings of First Annual IEEE Conference on Communications Society*, Oct 4-7, pp.235-244.

[6] Wang Y, Wu H Y, Dang H, Lin F, "Analytic, simulation, and empirical evaluation of delay fault-tolerant mobile sensor networks", *IEEE Transactions on Wireless Communications*, Vol .6, No.9, 2007, pp.3287-3296.

[7] Song C, Liu M, Gong HG, Chen GH, Wang XM, "Distribute real-time information based routing protocol in vehicular ad-hoc networks", *Journal of Software*, Vol.22 , No.3, 2011, pp.466-480.

[8] K. Harras and K. Almeroth, "Transport Layer Issues in Delay Tolerant Mobile Networks",

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Proceedings of the 5th international IFIP-TC6 Conference on Networking Technologies, May 15-19, 2006, pp. 463-475.

[9] Nathanael Thompson, et al., Retiring Replicate: Congestion Control for Intermittently-Connected Networks, *Proceedings of the INFOCOM 2010*, March 14-19, 2010, pp. 1-9.

[10] Giorgos Papastergiou, Christos V. Samaras and Vassilis Tsaoussidis, "Where Does Transport Layer Fit into Space DTN Architecture", *Proceedings of Advanced satellite multimedia systems conference (asma) and the 11th signal processing for space communications workshop (spsc)*, Sept 13-15, 2010, PP. 81-88.

[11] A. Lindgren, A. Doria, and O. Schelen, "Probabilistic routing in intermittently connected networks", *Proceedings of the Service Assurance with Partial and Intermittent Resources*, Aug 1-6, 2003, pp. 19-20.

[12] R. Ramanathan, et al., "Prioritized epidemic routing for opportunistic networks", Proceedings of the First International MobiSys Workshop on Mobile Opportunistic Networking, June 11, 2007, pp. 62–66.