A Novel Multi Copy Routing Scheme for Delay Tolerant Networks

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ABSTRACT: *A delay tolerant network (DTN) is a network designed to operate effectively over extreme distances such as those encountered in space communications or on an interplanetary scale. In such an environment, long latency -- sometimes measured in minutes, hours or days -- is inevitable. However, similar problems can also occur over more modest distances when interference is extreme or the network resources are severely overburdened. DTNs involves some of the same technologies as are used in a disruption-tolerant network b ut there are important distinctions. A DTN requires hardware that can store large amounts of data. Such media must be able to survive extended system restarts and power loss. This paper presents a multi- copy routing method for DTNs. For this we introduce a novel DTN routing protocol, called Self Adaptive Utility-based Routing Protocol (SAURP) that aims to overcome the shortcomings of the previously reported multi-copy schemes. Our main goal is to achieve a superb applicability to the DTN scenario with densely distributed hand-held devices. The main feature of SAURP method is the strong capability in adaptation to the fluctuation of network status, traffic patterns/characteristics, user encounter behaviors, and user resource availability, so as to improve network performance in terms of message delivery delay, message delivery ratio, and number of transmissions.*
Keywords: *Delay tolerant network, Multi copy, SAURP, Routing.*

I. INTRODUCTION

The widespread adaptation and employment of the wireless technologies means that a wide range of devices can be interconnected over vast distances through wireless links. As successful as these networks have been, they nonetheless cannot reach everywhere, and for some applications, the high cost of the associated scenarios is mainly prohibitive. One of the most serious challenges arises in cases in which the network connectivity cannot be guaranteed. For such challenged networking environments, the current networking technology relies on the set of fundamental assumptions that are not true in all practical environments. The first and most of the important fundamental assumption is the existence of a direct end-to-end path from a source to a destination. This assumption can easily be violated due to power-saving policies, nodal mobility, or unreliable packet delivery strategies. As a result, the mechanism of the TCP/IP-based network model that provides end-to-end communication is not valid, so any synchronous communication paradigm is likely perform very poorly. For these challenged networking environments, such as those found in mobile in motion networks and the dynamic wireless networks, network connectivity is rather opportunistic.

Techniques for producing applications that can tolerate high delays and disruptions in network connectivity are essential for these opportunistic networks. Networks that include such applications are often collectively called as Intermittently Connected Mobile Networks (ICMNs) or Delay Tolerant Networks (DTNs) [1]. Many real ICMNs fall into this category, such as Military Networks [2], Inter-Planetary Networks (IPN)[3], Pocket Switched Networks (PSN)[4], wildlife tracking and habitat-monitoring sensor networks [5], and networks that provide low-cost Internet service to remote communities [6]. These networks belong to the general category of delay networks, in which delays incurred are unpredictable and can be very long. This situation arises because of the sparse network topologies, node heterogeneity, and volatile link conditions that are possibly due to wireless propagation phenomena and node mobility. As a result, network links may be mostly disconnected or highly susceptible to a variety of disruptions that cause them to perform a set of disconnected clusters of the nodes. To achieve eventual delivery, some nodes must store the messages and wait for the opportunity to forward the interrupted messages.

Routing is one of the most fundamental problems in dealing with the intermittently connected networking. In contrast to the routing schemes in Mobile Ad-hoc Networks (MANETs) such as Dynamic Source Routing (DSR), Optimized Link State Routing Protocol (OLSR), Ad hoc On-demand Distance Vector (AODV)[7], a DTN may lack an end-to-end path for a given node pair for most of the time. Protocols developed for adhoc networks are therefore unable to address the intrinsic characteristics of a DTN. This paper presents a multi- copy routing method for DTNs.

II. RELATED WORK

Intermittently connected wireless systems represent a challenging environment for networking research, due to the problems of ensuring the messages delivery in spite of frequent disconnections and random meeting patterns. Due to the mobility of the nodes, protocols such as Adhoc On-demand Distance Vector routing (AODV), Optimized Link State Routing (OLSR), Dynamic Source Routing (DSR), continuously update routes when users require them (AODV and DSR) or in a proactive way (OLSR). These routes commonly time out after a few number of seconds. When a path between two nodes does not exist through the network, then no route can be created. Needless to say that these protocols can hardly run over Delay Tolerant Networks (DTNs) and will fail to deliver the data most of the time, because the assumption on the existence at a given time of a complete path between a source and a destination is simply not met. Many solutions have been proposed for use in such tolerant environments over the last few years. In [8], the authors proposed a new family of routing protocols. This family, called as Spray routing, can be viewed as a tradeoff between single and multiple copies techniques. Spray routing consists of two steps: the first is called spray, and the second is either wait (spray-and-wait protocol) or focus (spray-and-focus protocol). In the spray step, a carefully chosen number of copies of the message are generated and disseminated in the network to the same number of relay nodes. In the wait step, relays simply wait to meet the destination in order to deliver the message. In the focus step, each copy of the message is routed according to a utility-based single copy routing algorithm. The authors showed that, if carefully designed, spray routing incurs significantly fewer transmissions per message than epidemic routing, and achieves a trade-off between efficient message delivery and low overhead.

Another related work with a routing scheme called as Binary Spray and Wait routing algorithm [9] works as, the source of a message initially starts with L copies; any node A that has n>1 message copies, encounters another node called B with no copies, hands over to B, n/2 and keeps n/2 for itself; when it is left with only one copy, it switches to direct transmission. This algorithm performs well in both the message delivery and transmissions rate. The next scheme is similar to the single copy routing scheme, which scheme uses only one copy per the message. In [10], the authors used Seek and Focus (hybrid) routing algorithm. In this method each node maintains a timer for every other node. Nodes emit beacon signal, which then advertise their presence. Other nodes which sense this beacon signal and establish the relationship by exchange id, called encounter. A node holding the single message- copy, will handover to another node it encounters. The above algorithm has bad transmission rate when a single copy get lost.

III. PROPOSED WORK

The main feature of self adaptive utility based routing protocol (SAURP) is its ability in adaptation to the fluctuation of network status, traffic patterns/characteristics, and user behaviors, so as to reduce the number of transmissions, message delivery time, and increase delivery ratio. This is achieved by jointly considering the node mobility statistics, congestion, and buffer occupancy, which are subsequently fused in a novel quality-metric function. In specific, the link availability and the buffer occupancy statistics are obtained by sampling the channels and buffer space during each contact with another node. We use time-window based update strategy because it is simple in implementation and rather robust against the parameter fluctuation. Note that the network conditions could change very fast and make a completely event-driven model that is unstable. The developed quality-metric function targets to facilitating the decision making for each active data message, resulting in optimized network performance. Figure 1 illustrates the functional modules of the SAURP architecture along with their relations.

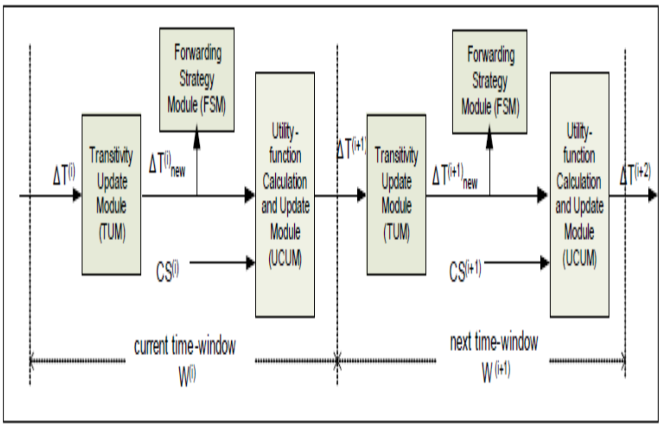

Figure 1: The SAURP Architecture

A. Contact Statistics

To compromise between the network state adaptability and the computation complexity, each node continuously updates the network status over a fixed time window. The maintained network states are called as Contact Statistics (CS), which include nodal contact durations, channel conditions, and buffer occupancy state, and are fed into UCUM at the end of each time window. The statistics collection process is described as follows. Let two nodes A and B be in the transmission range of each other, and each node broadcasts a pilot signal per k time units in order to look for its neighbors within its transmission range. Let T(A,B), Tfree, and Tbusy represent the total contact time, the amount of time the channel is free and the buffer is not full, and the amount of time that the channel is busy or the buffer is full, respectively, at node A or B during time window W(i). Thus, the total duration of the time in which node A and B can exchange information is calculated as:

Tfree = T(A,B) – Tbusy

B. Utility-function Calculation and Update Module (UCUM)

This module is applied at the end of each time window and is used to calculate the currently observed utility that will be further used in the next time window. The two inputs to this module in time window $W^{(i)}$ are:

1. The predicted inter-contact time $\Delta T^{(i)}$, which is calculated according to the previous time window utility and
2. The observed interencounter time obtained from the current $CS^{(i)}$ (denoted as $\Delta T_{CS}^{(i)}$).

An eligible contact of the two nodes occurs if the duration of the contact can support a complete transfer of at least a single message between the two nodes. Thus, in the event that node A encounters node B for a total time duration Tfree during time window $W^{(i)}$, the number of eligible contacts in the time window is determined by:

$$n_c^{(i)} = \left\lfloor \frac{T_{free}}{T_p} \right\rfloor$$

where Tp is the least time duration required to transmit a single message. Let $\Delta T_{CS(A,B)}^{(i)}$ denotes the average inter-encounter time duration of node A and B in time $W^{(i)}$ and is given by:

$$\Delta T_{cs(A,B)}^{(i)} = \frac{W^{(i)}}{n_c^{(i)}}$$

C. The Transitivity Update Module (TUM)

When the two nodes are within transmission range of each other, they exchange utility vectors with respect to the message destination, based on which the custodian node decides whether or not each message should be forwarded to the encountered node. With a newly received utility vector, the transitivity update is initiated and we propose a novel adaptive transitivity update rule as follows. The transitivity property is based on the observation that if the node A frequently encounters node B and B frequently encounters node D, then node A has a good chance to forward messages to D through B. Such a relation is implemented in the proposed work using the following update strategy:

$$\Delta T_{(A,D)new}^{(i)} = \alpha \Delta T_{(A,D)}^{(i)} + (1-\alpha)(\Delta T_{(A,B)}^{(i)} + \Delta T_{(B,D)}^{(i)})$$

where α is a weighting factor that must be less than 1.

D. The Forwarding Strategy Module (FSM)

The decision of message forwarding in proposed work is mainly based on the utility function value of the encountered node regarding the destination, and the number of message copy tokens. If more than one message copy is currently carried, the weighted copy rule is applied; otherwise the forwarding rule is applied. The forwarding rule is as follows: If the destination node is one hop away from the encountered node, the custodian node hands over the message to the encountered node and completes the message delivery. If the inter-encounter time value of the encountered node relative to that of the destination node is less than that value of the custodian node by a threshold value, a custodian node hands over the message to the encountered node. The complete mechanism of the forwarding strategy in SAURP protocol is summarized in the following algorithm.

Algorithm:
Step 1: On contact between node A and B, exchange summary vectors
Step 2: for every message M at buffer of custodian node A do
Step 3: if destination node D in transmission range of B
Step 4: then A forwards message copy to B
Step 5: end if
Step 6: else if $\Delta T_{(A,D)}^{(i)} > \Delta T_{(B,D)}^{(i)}$ do
Step 7: if message tokens >1 then
Step 8: apply weighted copy rule
Step 9: end if
Step 10: else if $\Delta T_{(A,D)}^{(i)} > \Delta T_{(B,D)}^{(i)} + \Delta$ Tth then
Step 11: A forwards message to B
Step 12: end else if
Step 13: end else if
Step 14: end for

IV. CONCLUSION

The objective of this work is to achieve end-to-end data delivery over intermittently connected mobile networks. Regular adhoc network protocols fail to provide successful communications due to user's frequent disconnections and long disconnection periods. This research work has presented our studies and has provided a suit of solutions to problems of routing in DTNs. Based on this proposed work, the research has been expanded to cover the routing problem for highly congested DTNs. In this paper, self adaptive utility-based routing Protocol (SAURP) is proposed. SAURP is characterized by the ability of identifying potential opportunities for forwarding the messages to their destinations via a novel utility function based mechanism, in which a suite of environment parameters, such as the wireless channel condition, nodal buffer occupancy, and encounter statistics, are jointly considered. Thus, SAURP can reroute the messages around nodes experiencing high buffer occupancy, wireless interference, and/or congestion, while taking a considerably small number of transmissions.

REFERENCES

[1] Delay Tolerant Networking. http://www.dtnrg.org.

[2] Disruption tolerant networking. http://www.darpa.mil/ato/solicit/DTN/.

[3] S. Burleigh, A. Hooke, L. Torgerson, K. Fall, V. Cerf, B. Durst, and K.Scott. Delay-tolerant networking: an approach to interplanetary Internet. IEEE Communications Magazine, 2003

[4] A. Chaintreau, P. Hui, J. Crowcroft, C. Diot, R. Gass, and J. Scott. Pocket switchednetworks: Real-world mobility and its consequences for opportunistic forwarding. Technical Report UCAM-CL-TR-617, University of Cambridge, 2005

[5] P. Juang, H. Oki, Y. Wang, M. Martonosi, L. S. Peh, and D. Rubenstein. Energy- efficient computing for wildlife tracking: design trade of early experiences with zebranet. In Proceedings of ASPLOS, 2002.

[6] A. Seth, D. Kroeker, M. Zaharia, S. Guo, and S. Keshav. Low-cost communication for rural internet kiosks using mechanical backhaul. In Proceedings MobiCom, 2006

[7] J. Broch, D. A. Maltz, D. B. Johnson, Y.-C. Hu, and J. Jetcheva. A performance comparison of multi-hop wireless ad hoc network routing protocols. In Mobile Computing and Networking, pages 85_97, 1998.

[8] Autonomic Information Diffusion in Intermittently Connected Networks ,Sara Alouf, Iacopo Carreras, Álvaro Fialho, Daniele Miorandi and Giovanni Neglia 2010.

[9] T. Spyropoulos, K. Psounis, and C. S. Raghavendra, “Spray and wait: Efficient routing in intermittently connected mobile networks,” in Proc. ACM SIGCOMM Workshop on Delay Tolerant Networking (WDTN), 2005.

[10] T. Spyropoulos, K. Psounis, and C. S. Raghavendra, “Efficient routing in intermittently connected mobile networks: The Single copy case,” IEEE Trans. Networking, vol. 16, no. 1, Feb. 2008.