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Efficacy Analysis for On-Selection Candidate Nodes in Correlation Aware Opportunistic Routing

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Abstract - Opportunistic network is a type of challenged network where the nodes come across erratic contacts and whose performance is highly variable. In opportunistic network source and destination are in different range and one hop communication is carried out, when two nodes comes into the same range. Challenging factor in opportunistic network is tracing and routing. When routing protocol like epidemic, direct delivery, etc are used more number of packets gets dropped due to flooding. This problem can be solved when opportunistic routing protocol is used. Recent studies shown that wireless links are not independent, they are correlated. Instead of preselecting a particular node to forward the packets, a set of candidate nodes are chosen to forward the packets. Since links are correlated all nodes receives the packet send by the sender and these nodes forwards the packets to the destination. So duplication of packets occur in the destination node. This duplication of packets gets avoided by assigning priority to nodes. And here OAPF (Opportunistic Any-Path Forwarding) routing protocol is proposed to improve the performance of design when more number of candidate nodes are chosen to forward the packets. It is shown that when OAPF routing protocol is used, the delivery probability of packets is higher than other routing protocols by using ONE simulator.

Key words - Wireless networks, link correlation, Opportunistic Any-Path Forwarding routing protocol.

INTRODUCTION

Opportunistic network is a subclass of Delay-Tolerant Network where communication opportunities are intermittent. In opportunistic network end-to-end path never exist. Link performance in an opportunistic network is highly variable. TCP/IP protocol will break in this kind of environment because end-to-end path between the source and the destination exist for a short and random period of time. Opportunistic network is a combination of user willingness and powerful devices. Opportunistic networks are highly dynamic composed of mobile and static nodes and take advantages of opportunistic time-changing contacts among users transport them to exchange information. Opportunistic network is a challenged network. In opportunistic network there does not exist a complete path from source to destination. The path can be highly unstable and may change or break quickly.

In opportunistic network, a network is separated into several network partitions called regions. Classical applications are not suitable for this kind of surrounding because they normally assume that the end-to-end connection must survive from the source to the destination. The opportunistic network enables the devices in different regions to connect by operating message in a store-carry-forward method. The intermediate nodes execute the store-carry-forward message switching mechanism by superimposing a new protocol layer called bundle layer. Bundle layer act as a host, a router or gateway. The bundle layer can store, carry and forward the entire bundles between the nodes in the same region. Bundle layer of gateway is used to transfer messages across different regions. Gateway can forward bundles between two (or) more regions and may optionally be a host. So it must have constant storage and support custody transfers.

Recent studies shown that wireless links are not independent. Packet receptions on nearby links are correlated. Previously sender estimate whether the transmission is successful based on the acknowledgement from the receiver. Instead of

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preselecting a particular node to forward the packet, a set of candidate nodes are selected to forward the packets. Duplication of packets occur in the destination node because the links are correlated. If more number of candidate nodes are selected, the performance of the design will get reduced.

In this chapter explained about opportunistic network. An opportunistic network node consist of a device with short-range wireless communication capabilities. In correlation aware routing wireless links are not independent, so that packet receptions on wireless links are correlated. If more number of candidate nodes are selected to forward the packets, the performance of the design gets reduced. So to improve the design performance opportunistic routing protocol is used.

RELATED WORK

A Simple Opportunistic Adaptive Routing protocol (SOAR) to explicitly support multiple simultaneous flows in wireless mesh networks. SOAR incorporates the following major components to achieve high throughput and fairness: adaptive forwarding path selection to leverage path diversity while minimizing duplicate transmissions, priority timer-based forwarding to let only the best forwarding node forward the packet, local loss recovery to efficiently detect and retransmit lost packets, and adaptive rate control to determine an appropriate sending rate according to the current network conditions [13].

The Least-Cost Any Path Routing (LCAR) problem: how to assign a set of candidate relays at each node for a given destination such that the expected cost of forwarding a packet to the destination is minimized. The key is the following trade-off: increasing the number of candidate relays decreases the forwarding cost, but on the other, it increases the likelihood of "veering" away from the shortest-path route. apply LCAR to low-power, low-rate wireless communication and introduce a new wireless link-layer technique to decrease energy transmission costs in conjunction with any path routing. Simulations show significant reductions in transmission cost to opportunistic routing using single-path metrics [4]. Increase the number of candidate relays decrease the forwarding cost. Link layer protocol randomly selects which receiving node will forward a packet. In wireless networks it is less costly to transmit a packet to any node in a set of neighbours than to one specific neighbour. Increase the candidate decrease the forwarding cost but increase the overhead.

Flooding delivers a message from one node to all the other nodes inside the network. Direct acknowledgement per receiver leads to high collision [20]. To address the issues utilize link correlation. Collective Flooding (CF), which utilize the link correlation to achieve flooding reliability using the concept of collective ACKs. CF requires only 1-hop information at each node, making the design highly distributed and scalable with low complexity. The mechanism of collective ACKs allows the sender to infer the success of a transmission to a receiver based on the ACKs from other neighbouring receivers by utilizing the link correlation among them.

The localized opportunistic routing (LOR) protocol, which utilizes the distributed minimum transmission selection (MTS-B) algorithm to partition the topology into several nested close-node-sets (CNSs) using local information. LOR can locally realize the optimal opportunistic routing for a large-scale wireless network with low control overhead cost. Since it does not use global topology information, LOR highlights an interesting trade-off between the global optimality of the used forwarder lists and scalability inferred from the incurred overhead [8].

Efficient QoS-aware GOR (EQGOR) protocol for QoS provisioning in WSNs. EQGOR selects and prioritizes the forwarding candidate set in an efficient manner, which is suitable for WSNs in respect of energy efficiency, latency and time complexity. Evaluate EQGOR by comparing it with the multipath routing approach and other baseline protocols through ns-2 simulation and evaluate its time complexity through measurement on the MicaZ node [3]. Evaluation results demonstrate the effectiveness of the GOR approach for QoS provisioning in WSNs. EQGOR significantly improves both the end-to-end energy efficiency.

Multi-hop communication between two end nodes is carried out through a number of intermediate nodes whose function is to relay information from one point to another. Instead of pre-selecting a node to be next-hop forwarder, a candidate forwarders are selected to deliver packets [15]. If neighbour nodes are close enough to each other forwarder packets would be heared and duplicates are avoided. Nodes are to be prioritized, so that nodes with highest priority forwards the packet to the destination. So that the nodes with low priority will not send the packets. So that duplication of the packets of the packets in the receiver are avoided.

On minimizing energy consumption and maximizing network lifetime for data relay in one-dimensional (1-D) queue network. Following the principle of opportunistic routing theory, multihop relay decision to optimize the network energy efficiency is made based on the differences among sensor nodes, in terms of both their distance to sink and the residual energy of each other. Specifically, an Energy Saving via Opportunistic Routing (ENS_OR) algorithm is designed to ensure minimum power cost during data relay and protect the nodes with relatively low residual energy [10].

To overcome the traditional routing limitations, and to increase the capacity of current dynamic heterogeneous wireless networks, the opportunistic routing paradigm has been proposed and developed in recent research works. Motivated by the great interest that has been attributed to this new paradigm within the last decade, a comprehensive survey of the existing literature related to opportunistic routing [2]. A taxonomy for opportunistic routing proposals, based on their routing objectives as well as the optimization tools and approaches used in the routing design. Hence, five opportunistic routing classes are defined an, namely geographic opportunistic routing, link-state-aware opportunistic routing, probabilistic opportunistic routing, optimization-based opportunistic routing, and cross-layer opportunistic routing.

Priority-Energy Based Data Forwarding Algorithm(PEDF) which empowers the node to choose the most suitable packet forwarding path, based on the priority of the packet and the current energy status of the forwarding node. The algorithm hence dynamically adapts to the prevailing energy-scenario of the network and takes routing decisions accordingly, based on packet priority [16]. Minimizing delay, minimizing energy utilization, maximizing throughput and maximizing network lifetime. The advantage is that duplication of packets gets avoided. The disadvantage are if power level gets decreased then workload also decreased automatically.

In this chapter explained about the literature survey. Source node forwards the packet to the intermediate nodes and the intermediate nodes forwards the packet to the destination node. Since the links are correlated all the intermediate nodes receives the packet and send to the destination node. So duplication of packets occur in the destination node. To avoid duplication of packets, the node has to be prioritized. So that node which is having the highest priority forwards the packet. If more number of candidate nodes are selected, the performance of the design gets reduced. To improve the performance of the design opportunistic routing protocol is used.

PROPOSED WORK

Wireless links are not independent so that they are correlated. Instead of pre-selecting a particular node to forward the packet, a set of candidate nodes are chosen to forward the packets. So that the transmission time to forward the packets gets reduced. Since the links are correlated all the nodes in the group of candidate nodes will forward the packet to the destination. So that duplication of

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packets will occur in the destination. So that this duplication of packets gets avoided by prioritizing the nodes in the group of candidate nodes [15]. So that, the node with highest priority forwards the packet to the destination. Since the links are correlated all the nodes in the group will hear upon the transmission of the packets to the destination by higher priority nodes in the group. Upon hearing this transmission nodes with lowest priority will drops the packets. So that duplication gets avoided.

If one path gets failure then the packet which was send by the sender will not reach the destination, when links are positively correlated. When links are negatively correlated, even-though path gets failed the packet will reach the destination by another path. So when links are negatively correlated, the packets will not get dropped. The values of link correlations are -1, 0 and 1. Negatively correlated link is -1, positively correlated link is 1 and uncorrelated link is 0 [15].

A. CANDIDATE FORWARDER SELECTION

Instead of pre-selecting a particular node to forward the packet, a set of candidate nodes are chosen to forward the packet. So that the transmission time for sending the packets gets reduced [15]. A source node forwards the packet to the set of candidate nodes which are close to the destination. And all the nodes in the group will receive the packet which was send by the sender because the links are correlated. They send acknowledgement to the source node after receiving the packets. All the nodes will send the received packets to the destination. So that duplication of packets occur in the destination [1][5][10][11]. To avoid the duplication of packets, nodes in the group are prioritized. So that node with highest priority forward the packet to the destination. And the destination node send the acknowledgement to the source node after receiving the packets which was send by the source node[9].

Table 1 : Multipath Candidate Selection

```
Algorithm multipath_candidate_selection ( )
// Input : nodes with max EAX values  Output : Selection of candidate key
// EAX : Expected Any-path transmission
F ← Candidate set
F ← max ( EAX )
DAG ← E( s , d ) // DAG : Directed Acyclic Graph
if min ( EAX ( s , d ) ) then
      eliminate E ( s , d )
  else
      include E ( s , d )
E ( s , F , d ) = α + β
// α captures the expected number of transmissions for successfully transmitting a packet from s to atleast one of the candidates and getting one acknowledgement
// β captures the expected number of transmissions for delivering the packets from candidate to the destination
loop ( F ← max ( EAX ) )
```

In multipath candidate selection algorithm the input is packet with minimum Expected Any-path transmission and the output is selection of candidate key. F is the candidate set. The node which is having the maximum Expected Any-path transmission count (EAX) is added to the candidate set. A Directed Acyclic Graph (DAG) from source s to destination d is created. Eliminate candidates which is having the minimum EAX values. $E(s, F, d) = \alpha + \beta$ where α captures the expected number of transmissions for successfully transmitting a packet from s to atleast one of the candidates and getting one acknowledgement. β captures the expected number of transmissions for delivering the packets from candidate to the destination. Proceed the loop until enough candidates are selected for predesigned set size.

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B. PRIORITY BASED PACKET FORWARDING

Source node forwards the packet to the destination node with the help of intermediate nodes. Instead of preselecting a particular node to forward the packets, a set of candidate nodes are selected to forward the packets. Since the links are correlated all the nodes in the candidate set will receive the packets. So all the nodes in the candidate set forwards the packet to the destination nodes. So that duplication of nodes occur in the destination. And they send the acknowledgement to the source node after receiving the packets[16]. To avoid the duplication of nodes in the destination priority is used for nodes. So node with highest priority forwards the packet to the destination. Since links are correlated all the nodes in the candidate set hear the transmission of the packets[13][19]. Upon hearing the transmission of the packets all the nodes with lowest priority drops the packets. So that duplication of packets gets avoided in the destination node. And the destination node send the acknowledgement to the source node after receiving the packet which was send by the source node[3][4][7][9].

In priority based packet forwarding the input is assign priority to nodes and the output is highest priority forwards packet. Here u is assigned as urgent packet, h as highly important packet, m as moderately important packet and l as less important packet. If node n is urgent packet then forward the packet else forward the packet which is highly important packet else forward the packet which is moderately important else forward the packet which is less important packet. Otherwise drop the packets.

Table 2 : Priority Based Packet Forwarding

```
Algorithm priority_based_packet_forwarding ( )
// input : assign priority to nodes  // output : highest priority forwards packet
// u : urgent packet
// h : highly important packet
// m : moderately important packet
// l : less important packet
n ← node
if n ← u then
    forward u
  else if n ← h then
      forward h
else if n ← m then
        forward m
      else if n ← l then
          forward l
else
    drop packet
end if
```

In priority based packet forwarding the input is assign priority to nodes and the output is highest priority forwards packet. Here u is assigned as urgent packet, h as highly important packet, m as moderately important packet and l as less important packet. If node n is urgent packet then forward the packet else forward the packet which is highly important packet else forward the packet which is moderately important else forward the packet which is less important packet. Otherwise drop the packets.

C. OPPORTUNISTIC ROUTING PROTOCOL

The source node forwards the data packets. Upon the reception of this packets, one relay node is chosen among the candidate relays. The selected relay carries on the packet transmission by opportunistically selecting the next relay and so on. This process goes on until the packet reaches the destination[2]. The next hop relay is chosen after it has actually received the packet, thereby reducing the number of packet retransmission. Wireless nodes do not have to worry about path or link breakages, since only the candidate relays that successfully received the packet participate in the forwarding process. Packet sent from the same source to the same destination may always take different paths depending on the opportunistic reception of the packets. If more number of candidate forwarders nodes are selected for forwarding the packets means, the performance of the design will gets reduced. To

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improve the performance of the design opportunistic routing is used[6][12][18][19].

In this chapter explained that a set of candidate nodes are selected to forward the packets to the destination node which was send by the source node. Duplication of packets occur in the destination node, since all the candidate nodes forwards the packet to the destination node. So, nodes have to be prioritized. Node which is having the higher priority forwards the packet. To improve the performance of the design opportunistic routing protocol is used.

EXPERIMENTAL SETUP

In ONE simulator, the network environmental set up is created for 82 nodes and these nodes are grouped into 3 groups and 2 interfaces are created and the time limit is also given. When the time limit is reached the simulation gets completed. If more number of candidate nodes are selected, the performance of the design gets reduced.

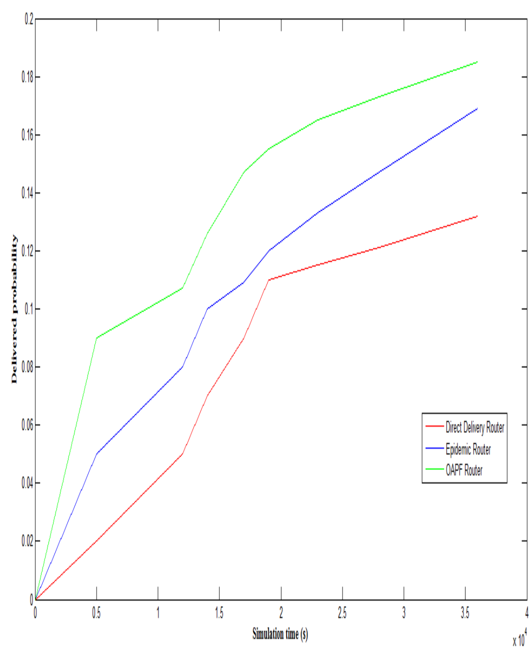

Fig 1 : Performance Analysis

To improve the performance of the design Opportunistic Any-Path Forwarding (OAPF) routing protocol is used. This routing protocol is compared with epidemic and direct delivery routing protocol. In Fig 1, it is shown that the delivery probability for direct delivery router is 0.1322, delivery probability for epidemic router is 0.1691 and the delivery probability for OAPF routing protocol is 0.1856. It is proved that Opportunistic Any-Path Forwarding (OAPF) routing protocol has the maximum delivery probability when compared to other routing protocols.

CONCLUSION

Wireless links are independent so that links are correlated. Instead of pre-selecting a particular node to forward the packet, a set of candidate nodes are chosen to forward the packets. All the nodes in the group of candidate nodes receive the packets which was send by the sender because the links are correlated. So that all the nodes in the group forwards the packet to the destination. So that duplication of packets occur in the destination. It is proposed that candidate nodes are chosen efficiently to forward the packets and also duplication of packets gets avoided by assigning priority to nodes. The performance of the design gets improved when opportunistic routing protocol is used.

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