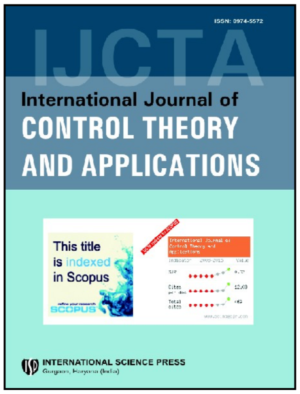

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Capacity Improvement for Integrated Add-on Femtocell Architecture in Wireless Mesh Networks

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Abstract: Wireless Mesh Network (WMN) is a special type of Wireless ad-hoc network. WMN has planned configuration with cost effective connectivity in a specific area. It offers connectivity to the nodes through the gateways. Femtocell (FC) is a small base station and it gives the connectivity to the nodes within a small area like small industries, shopping malls and apartments. The Femtocell avoids network traffic caused in the macrocell. Add on Femtocell with Wireless Mesh Network (AFCWMN) is an integrated architecture to supports the data transmission both indoor and outdoor nodes. Enhanced Selective Packet Discarding (ESPD) method is proposed to increase the capacity of the nodes based on some criteria. From this criterion, the capacity of the nodes will be improved by discarding the unwanted packets. Thus the primary users can support more secondary users. Simulation results are taken using Network simulator. Results are shown and discussed about the improvement of some of the Quality of Service parameter for AFCWMN architecture.

Keywords: Femtocell, Enhanced selective packet discarding, congestion, Integrated architecture, primary user, secondary user.

1. INTRODUCTION

Wireless mesh network is self configured and self healing network. All nodes are connected with each other which allow communicating with the other nodes without any routing technique. WMN consists of Mesh Router (MR), Mesh Clients (MC) and Internet Gateways (IGW). It forms any one of the types of architecture such as Infrastructure wireless mesh network, Client wireless mesh network or Hybrid wireless mesh network. Mesh router forms an infrastructure for mesh clients is called Infrastructure WMN. Group of MCs alone form the client WMN. MCs accessing the network performance and it performs with other MC is called Hybrid WMN. Deploying a WMN is not too difficult, because all the required components are already available in the form of ad hoc network routing protocols, MAC protocol, WEP security, etc. [1].

Femtocells are small, inexpensive and low power base stations that are generally consumer deployed and connected to their own wired backhaul connection [2]. One of the most interesting trends to emerge from this cellular evolution are Femtocells [3], [4]. There are three access strategy of FC [5]

i) Open access – the users have no restrictions in accessing Femtocells

ii) Closed access – only small group of users can be connected to the FCs and

iii) Hybrid access - a combination of both strategies. Closed access FCs could also be used by service level agreement between users. [6],[7], especially open access FCs and hybrid access FCs.

Add on Femtocell is a switching model where the additional Femtocell connectivity provides the secondary user node [8]. The additional Femtocell connectivity gives solution to avoid overhead and delay in pre emptive and non pre emptive switching models [9]. Since the cost, traffic, congestion and number of hops between the nodes and gateways create more problems in WMN. To eliminate such problems by integrating Add on femtocells with wireless mesh networks. Congestion can be avoided by the integration of Femtocell architecture with WMN. To avoid the traffic in mobile nodes multigateways are used. Nodes are used IGW as multigateway when it is connected with macrocell where as FC as a multigateway when nodes are connected with indoor coverage area.

Resource sharing is improved by avoiding congestion and collision in a network. Unwanted data traffic can be mitigated by utilizing the channel in an efficient manner. Packet dropping is a solution to avoid such congestion. But it should not affect the importance and performance of the data transmission. There are many solutions are existing to drop the unwanted data packets in various kinds of wireless networks like ad hoc network, sensor network etc. [10, 12]. Corrupted and error packets are not worthy for transmitting also it causes the transmission delay [13, 20]. Fig. 1 illustrates the integrated architecture of Add on Femtocell with Wireless mesh network.

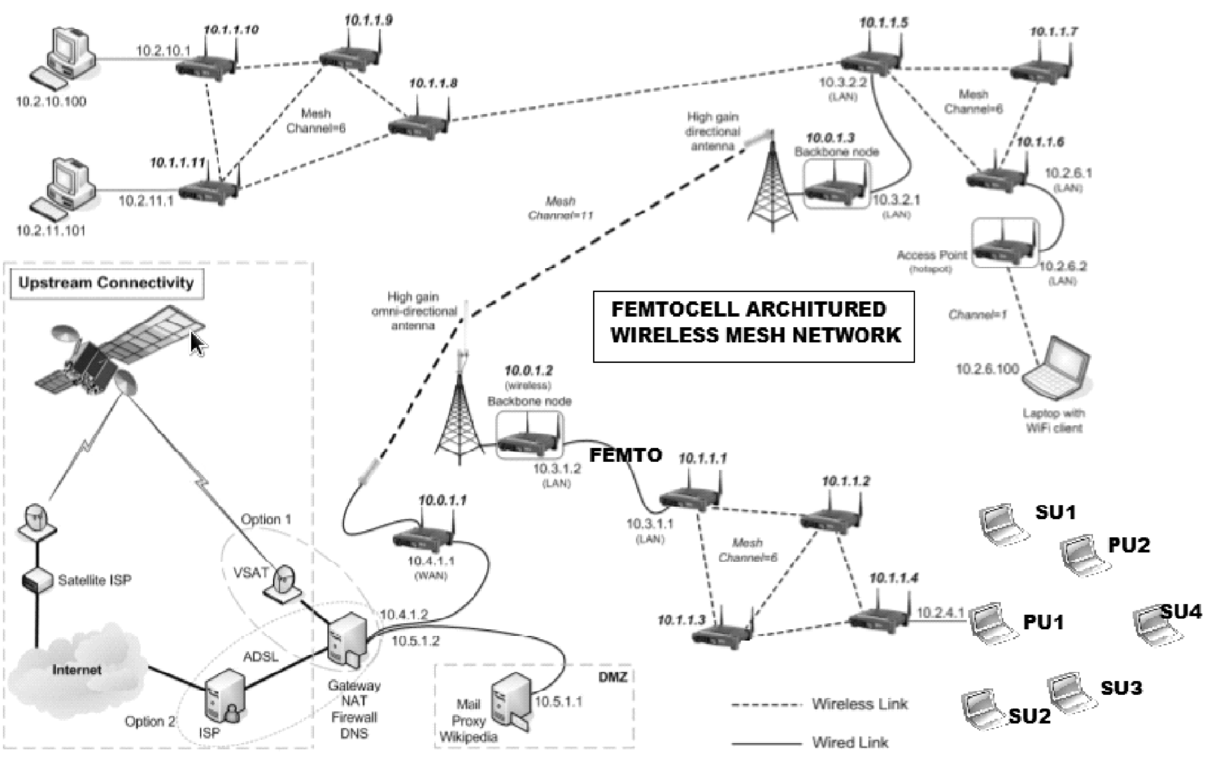

Figure 1: Add on Femtocell architecture in WMN

2. RELATED WORK

A Femtocell connects with a node is said to be primary user. The primary user which provides the connectivity to the other nodes is called secondary user. The secondary user gets the priority list z of primary user (Femtocells) around the nodes. It periodically updates ON/OFF behaviour of the Femtocells.

Mesh router (secondary user) always switches to the highest priority Femtocell when it is available. Even though the highest priority FC is ON but the bandwidth is insufficient to support the secondary user, mesh router cannot get the connectivity with the highest priority femtocell. In such case the next priority Femtocell gives the connectivity to the secondary user. FC should be attempted to improve throughput and delay for reconnection in case of current FC becomes unavailable.

In AFCWMN architecture number of primary nodes is placed with a specific interval. Two Femtocells support the connectivity for a secondary user which provides uninterruptable data transmission which does not affect the running task.

The network needs solution to improve the number of secondary users to get connected with the primary user. By dropping the unwanted data packets the data transmission will be more effective.

2.1. Integration of AFC with WMN

To improve the speed and reduce the traffic of the network the indoor and the outdoor network can be combined as a single network. Mesh router can utilize both the networks based on the location of the node or user. Femtocell is a small base station which is used as indoor network gateway and it provides the connectivity to the indoor nodes. Mesh Router is a Gateway for the nodes beyond the FC coverage area.

2.2. Add on Femtocell

Primary user in AFCWMN network can support more secondary users based on its bandwidth availability. Secondary users get the priority list of the primary user (FC). The highest priority FC is called the Most Preferred FC (MSF) and the next priority FC is called the More Preferred FC (MRF). Mesh router always connects with the most preferred FC. Two FCs namely MSF and MRF support one secondary user. If any disconnection occurs with MSF then the secondary user automatically connected with MRF without any interruption of the current task. If the data transmission is efficiently done then more secondary users can share the primary user.

2.2. Network Congestion

The traffic of the entire network is due to queue in each node. This queue of each node makes the congestion of the network. Poor channel quality and high error rate will lead to the congestion. Duplicate packets create buffer overhead and network traffic. Less time to live packets produce high error rates. These error rates do not help the effective data transmission. To avoid such congestion Packet discarding is a common solution for the wireless networks. Drop Tail (DT) is a technique which drops all the packets that arrive upon a full buffer [14].

2.3. Existing Packet discarding techniques

The earlier and simplest method for collision avoidance using discarding technique is Drop Tail of the packets those who enter after the buffer is full [15]. This method has low throughput. Partial Packet Dropping (PPD) [16] achieved better throughput but poor fairness. The Earlier PD (EPD) [11, 17] solves problem in PPD. Selective packet discarding (SPD) method improves the performance degradation [10, 14] but no solution for effective data transmission yet for wireless mesh network scenario.

3. PROPOSED TECHNIQUE

There are some performance degradations like low throughput, high energy consumption, high cost, more end to end delay etc in the existing discarding methods. In selective packet discarding method (SPD), all small size of the packets is dropped. If there is important information may contain such small packets then it affects the efficiency of the data transmission. For example in the medical field, it affects the diagnostic of disease. The effective way of congestion avoidance is proposed in this paper to solve the above limitations. So the Enhanced Selective Packet Discarding is the optimal solution to meet the network performance parameter.

If the traffic generated in the WMN can reach the internet through multiple FCs and vice versa, it reduces the average MR-IGW hop distance which would help us increase the capacity.

3.1. Enhanced Selective Packet Discarding (ESPD)

If the data packets are efficiently handled in the secondary user then primary user further can support more secondary users. One of the effective way of handling the data packets is Enhanced Selective packet discarding. ESPD keeps all the data packets are in uniform size. So the small packets discard will be avoided. Less hop data packets are back up in a specific node called back up node. Even though the less hop data packets are discarded ESPD can retrieve the packets where it is needed.

There are some pre defined criteria in ESPD to improve the performance of the integrated Add on femtocell with Wireless mesh network (AFCWMN) architecture.

3.1.1. Pre defined Criteria for ESPD

All the data packets in AFCWMN are uniform size. Small data packets are discard in SPD which leads many issues will be overcome in ESPD. Some important data may contain in smaller packets. So there are no discarding criteria based on packet size.

The unimportant packets are discarding if it satisfies the following criteria:

- If the packets are duplicate
- If the packets are less Time To Live (TTL)
- High Bit Error Rate (BER)
- Corrupted packets
- Data packet with less hop count is discarded and the message will be back up in a backup node which is already fixed.

4. ALGORITHMS FOR ESPD

Three algorithms are followed to meet the criterion for the proposed method.

4.1. RREQ Packet for Each Node

If packet has been received then

Initialize the route request

Else

If hop_count <= Threshold of arrival rate

then **ACCEPT** the packet

broadcast the route request.

Else
# Wait for TTL time Period
# Rebroadcast the route request
End if
If (Packets == fixed size) ***then***
ACCEPT the packet for Route Discovery.
Else
If packets!= Duplicate Packet ***then***
ACCEPT the packet for Route Discovery
If (Packets == obsolete|| Packets == Error || Packets ==big) then
DISCARD the packet for Route Discovery.
End if
End if
End if

4.2. Rrep Packet for Each Node

If current node is the sender ***then***
# Create a fixed size packet and Check the arrival rate
# Broadcast the RREQ packet
transmitting the data with error free
Else
# Route the route reply message to the sender before traverse.
End if

4.3. Packet Processing in Each Node

If the REEQ packet is a duplicate ***then***
DISCARD
Else If
# the route request has been received ***then***
If the route request has been broadcasted ***then***
# Broadcast the RREQ packet based on packet lifetime.
Else
DISCARD the route request and packet information.
End if
Else
DISCARD the RREQ packet.
End if
End if

4.4. Packet Discaring at Each Node

# For each node determine the fixed packet size (512 bytes)
If Arrival rate of Packet > threshold ***then***
add the nodes into packet drop node list
if (each node is error free)
{
node X checks ACK and sort them for packet acceptance // X is the error free listed node
if (any DuplicatedPacket is from neighbor nodes)
{
check the Packet ACK from destination to neighbour node
comp (PacketACKneighbor, PacketACKdestination)
{
If ((neighbor –PacketACKdestination)>=Threshold)
Add node into Packet drop node list
Else
Add node into Packet acceptance node list
break;
}
}
}

5. SIMULATION RESULTS AND DISCUSSION

To simulate the proposed Packet discarding the network simulator 2 (ns2) is used. 100 nodes are taken in 1400 X 1200 m area. Packet size is taken as 512 bytes. 10 nodes are considered as Femtocells and 10 nodes considered as Gateways which supports other 80 nodes to perform the data transmission. Simulation results are observed with various number of nodes.

(A) Comparison of Packet Delivery Ratio

Packet delivery ratio of AFCWMN with ESPD is compared with existing Selective packet discarding method. From the Fig.2, 14.2% of the packet delivery ratio is improved in the proposed Enhanced packet discarding technique.

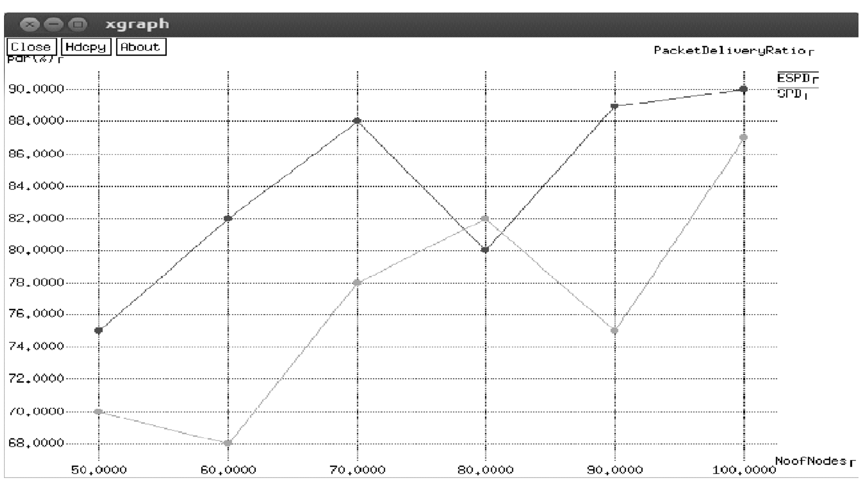

Figure 2: Packet Delivery Ratio

(B) Comparison of End to end delay

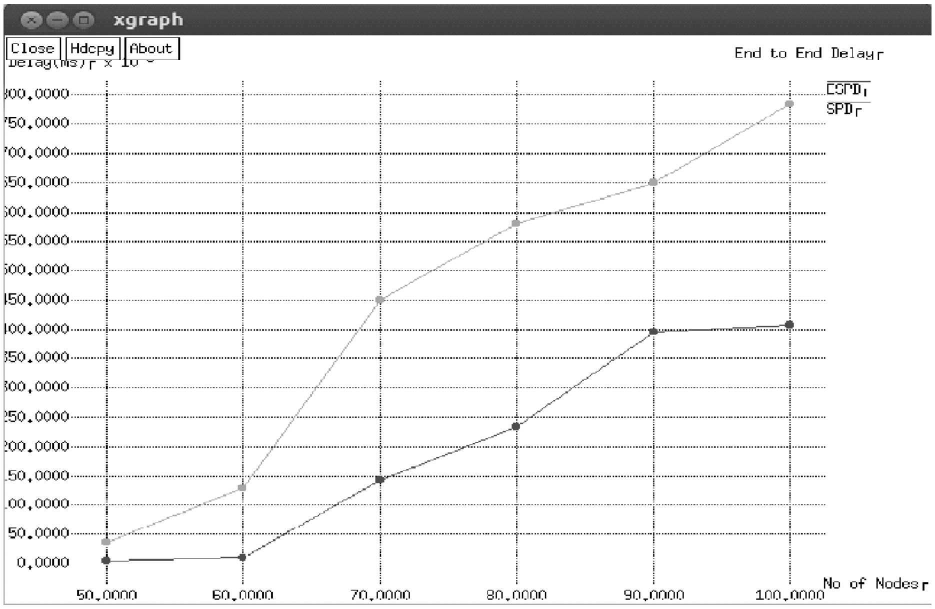

Figure 3: End to end delay

Since unwanted packets are discarded and avoid the congestion the end to end delay of the proposed technique is minimized. Fig.3 shows the comparison of end to end delay. From the observed simulation result there is 23.4% of performance improvement than the existing system.

(C) Comparison of Average energy

Enhanced Selective packet discarding scheme considerably reduce the energy consumption of each node. The simulation results are shown in Fig. 4. It also improves the longevity of the entire network as it saves the energy for longer period of the network existence.

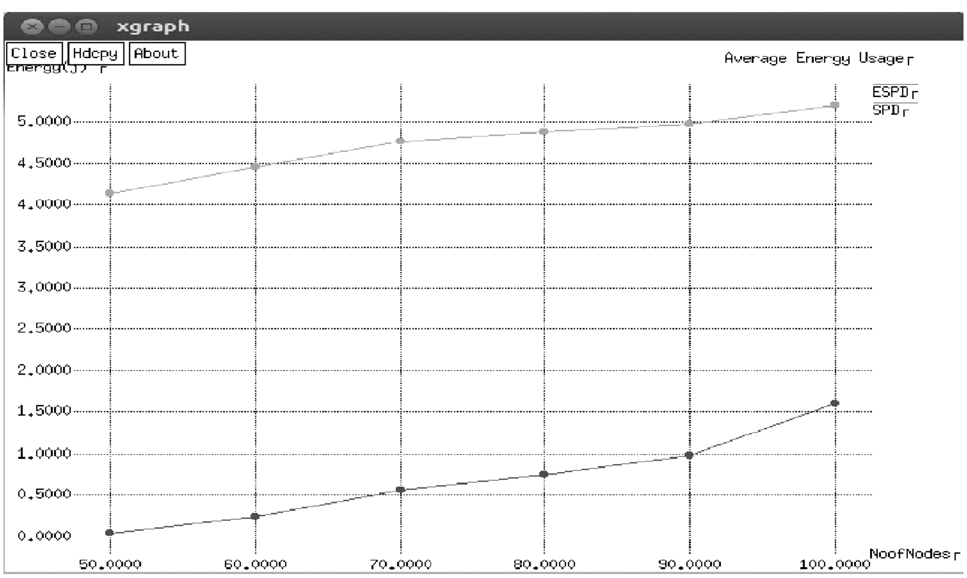

Figure 4: Average Energy

(D) Comparison of Throughput

Throughput is an important parameter to improve the quality of service for any wireless network. Fig. 5 shows the comparison of the proposed scheme with existing scheme. Observed that throughput of the proposed scheme gives the better performance than the existing discarding method.

6. CONCLUSIONS AND FUTURE WORK

The proposed Enhanced Selective packet discarding improves the Packet delivery ratio, End to end delay, Average energy and throughput of the integrated Add on femtocell with wireless mesh network. Through this enhanced approach it avoids the unnecessary discarding of packets. So the criterion of ESPD is the optimal solution for the packet discarding in wireless networks. Thus the capacity of the nodes were improved which leads to more secondary user can share the primary user in an efficient way. Since the proposed method is intelligently discarding the unwanted packets and also back up the less hop data, assures the prevention of the important data. ESPD helps the medical diagnostic system, defense department and banking system.

Future work may be implemented with the other quality of service parameter like jitter, bandwidth utilization, latency, etc. network track the users and dynamically adapt the network topology to seamlessly support both their intragroup and intergroup communications from source to destination. The use of multiple FC association can be provide significant capacity benefits. Network capacity can increase linearly with the number of FCs only with proper load balancing and resource provisioning.

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